FRANKLIN COUNTY
EMERGENCY MANAGEMENT
& HOMELAND SECURITY

**Franklin County
Emergency Management &
Homeland Security**

2018
NATURAL HAZARD MITIGATION PLAN



EXECUTIVE SUMMARY

This plan serves as the official Franklin County Natural Hazard Mitigation Plan for Franklin County and all included jurisdictions. Mitigation planning efforts for Franklin County began in 2005 with the creation of the first Federal Emergency Management Agency approved plan for Franklin County. That plan was formally adopted in 2007. The 2012 version was the first official update to that plan. The 2018 plan represents the most recent version of the mitigation plan for Franklin County.

Franklin County is at risk of damage due to flooding, heavy snow or ice, tornadoes, extreme heat, and other natural hazards. This plan provides a long-term approach to reducing the likelihood that a natural hazard will result in severe damage.

The Risk Assessment for Franklin County, which was first created in 2010 and updated in 2016, was updated again in 2018 during the mitigation plan update process (see **Appendix A. Risk Assessment for Franklin County 2018)**. This Mitigation Plan represents the work of residents, business leaders, as well as elected and appointed government officials to develop a blueprint for protecting community assets, preserving the economic viability of the community, and saving lives. Endorsed by FEMA as being in compliance with regulations based on the Disaster Mitigation Act of 2000, the plan will help the County to implement mitigation projects so natural hazards do not result in a natural disasters.

The hazard mitigation planning process consisted of gathering and analyzing data available from various sources including the Risk Assessment for Franklin County. The data show that the hazards most likely to result in costly damages are flooding, tornadoes and high winds, and heavy snow and ice.

The plan recommends a number of public education efforts, continued support for flood mitigation buy-outs, and the examination and the potential modification of planning guidance and other development regulations to ensure the risk of damage to new structures is minimized. Many of these recommendations are highlighted in the Mitigation Action section of the plan.

By adopting this plan, Franklin County government, as well as the cities, villages and townships within commit to working with citizens and business owners to make Franklin County safer.

This project was made possible through a Federal Emergency Management Agency grant provided by DHS: FEMA.

The 2018 NHMP includes the following key updates:

- Historical hazards: Each natural hazard section within this plan documents NCDC-reported hazards.
- County profile: Demographics, social, and economic data, as well as existing and future land use descriptions, are updated to reflect the current status of the county and its jurisdictions.
- Planning description: The new planning team and updated planning process are described and documented.
- Risk assessment: The Risk Assessment for Franklin County, which was first created in 2010 and updated in 2016, was updated again in 2018 during the mitigation plan update process. Karst/Sinkholes, extreme heat, and dam/levee failure were added during the 2018 update process.
- Mitigation: The mitigation section addresses the status of the previous plan's strategies in addition to new mitigation actions.

TABLE OF CONTENTS

List of Tables

List of Figures

INTRODUCTION

The Franklin County Natural Hazard Mitigation Plan (NHMP or Plan) was first developed and adopted for implementation by Franklin County, Ohio in 2007. The plan was updated in 2012. This plan must be updated and adopted by all participating jurisdictions every 5 years. The 2018 version represents the most up-to-date version of this plan.

Historical information shows that Franklin County is at risk of damage from a variety of natural hazards: flooding, dam/levee failure, severe winter weather, tornadoes, severe summer storms, extreme heat, earthquake, drought, karst/sinkhole, and invasive species. This plan explains a rigorous analysis of the potential effects of these natural hazards on the structures and infrastructure within Franklin County and proposes measures to reduce the risk of a natural hazard leading to a disaster including property loss, business disruption, or even loss of life.

Most recently, Franklin County has experienced severe winter storms and severe summer storms, but history demonstrates that Franklin County is also susceptible to flooding and damage resulting from high winds or tornadoes. Documented Presidential Disaster Declarations for Franklin County confirm the County's susceptibility to multiple types of natural hazards as seen in Table 1 below. Although it is impossible to predict when these disasters may occur, planning and community cooperation make it possible to minimize the effects of natural disasters.

TABLE 1: PAST PRESIDENTIAL DECLARATIONS OF MAJOR DISASTER IN FRANKLIN COUNTY

Date	Hazard
March 1964	Heavy Rains and Flooding
June 1968	Heavy Rains and Flooding
April 1974	Tornadoes and High Winds
January 1978	Severe Blizzard
June 1989	Severe Storms and Flooding
June 1990	Severe Storms, Tornadoes, and Flooding
August 1992	Severe Storms, Tornadoes, and Flooding
June 1998	Flash Flooding, Flooding, High Winds, and Tornadoes
November 2002	Severe Storms and Tornadoes
March 2003	Ice/Snow Storm
August 2003	Severe Storms, Tornadoes, and Flooding
January 2004	Severe Storms and Landslides
January 2005	Snow Removal and Response
February 2005	Severe Winter Storms, Ice and Mudslides
September 2008	Wind
August 2012	Severe Storms and Straight-line Winds

This plan utilizes a number of different references to provide a thorough analysis of natural hazards in Franklin County. Real estate parcels located in floodplains and floodways were identified by the Franklin County Auditor, repetitive flood loss data in Franklin County was obtained from the Federal Emergency Management Agency (FEMA), and maps were created using the Franklin County Emergency Management & Homeland Security (FCEM&HS) Geographic Information System (GIS). Several regional development plans served as resources, as well as local jurisdiction floodplain management and zoning standard guidelines. Finally, historical information provided by the National Weather Service, Franklin County publications and local library research were included in the final document.

The Risk Assessment for Franklin County serves as the foundation for the hazard and risk data found in this plan (see **Appendix A. Risk Assessment for Franklin County 2018)**. This document details the risks faced by Franklin County including detailed histories and impacts.

Purpose of the Plan

As the cost of natural disasters continues to rise, FEMA has implemented programs to identify effective ways to reduce vulnerability from disasters. With FEMA grant assistance, Franklin County has been able to coordinate the creation of natural hazards mitigation plan to assist communities to reduce their risk from natural hazard events. This natural hazards mitigation plan is used to develop strategies for risk reduction and to serve as a guide for all mitigation activities throughout the County.

This plan includes a list of action items developed by the Local Mitigation Core Group to reduce risks from natural hazards through public education and outreach, new and enhanced partnerships and implementation of preventative activities.

Franklin County is a highly urbanized county with a population that exceeds one million people and consists of 15 cities, 9 villages and 17 townships. All Franklin County jurisdictions participated in the development of this plan and are considered throughout.

Although the plan does not establish development requirements, the background information and resources provided in the plan are useful in determining land use strategies in un-developed areas of incorporated and unincorporated parts of Franklin County. All mitigation efforts are local, and the primary responsibility for development and land use policies occurs at the local level.

Adoption of this plan ensures Franklin County and participating jurisdictions continue to remain eligible to apply for and receive Federal mitigation grant funds administered by the State of Ohio on behalf the Federal Emergency Management Agency (FEMA). This plan complies with the requirements set forth in the Disaster Mitigation Act of 2000 and its implementing regulations published in Title 44 of the Code of Federal Regulations (CFR) Section 201.6.

Organization of the Plan

Action Plan Strategies

The initial development of the Franklin County Natural Hazards Mitigation Action Plan was in response to the passage of the Disaster Mitigation Act of 2000 (DMA2K). DMA2K is a federal effort to stem the losses from disasters, reduce future public and private expenditures, and to speed up response and recovery from disasters. The act establishes a requirement for local governments to prepare a Natural Hazards Mitigation Plan in order to be eligible for mitigation related funding from FEMA.

The Franklin County Natural Hazard Mitigation Plan was developed to serve as a blueprint for coordinating a countywide planning process that promotes participation from a wide variety of organizations, disciplines and representatives of the community, while complying with the DMA2K. The plan identifies the hazards that can occur in the county and our vulnerability to these events.

The plan includes countywide mitigation goals and strategies as well as local jurisdiction based projects. The next phase of mitigation planning will be to continue working with individual local jurisdictions on developing local mitigation strategies and activities, using the ODNR Structure Inventory to continually update the local risk assessments, and coordinate local mitigation strategies with the Franklin County Natural Hazard Mitigation Plan.

Original Plan Development

This plan was originally completed and adopted in 2007 using a countywide approach. Franklin County has 41 separate jurisdictions, made up of cities, villages, and townships and County government. In 1988 all jurisdictions in Franklin County entered into an agreement establishing a countywide emergency management agency as provided for in the Ohio Revised Code Section 5502.26. This agreement states: "…the Franklin County Emergency Management Agency, being hereby established, shall perform the service of coordinating the emergency management activities of Franklin County and the political subdivisions which enter into this agreement…" and …"the (individual jurisdiction name) desires to enter into this agreement with the Franklin County Board of Commissioners and the Chief Executives of the other political subdivisions within Franklin County.

All jurisdictions were invited to participate in plan development and the creation of the mitigation strategy. The original plan included all Franklin County jurisdictions with the exception of the City of Westerville, which was at the time a Project Impact Community. All participating jurisdictions were asked to adopt the plan and all did- including each township that participated. The Franklin County Natural Hazard Mitigation Plan is the result of a collaborative effort between Franklin County citizens, public agencies, the private sector and regional planning representatives.

Update Development

The first update of the Plan began in 2011. Franklin County applied for and received Hazard Mitigation Grant Funding (FY2010) to prepare the FEMA required update of the Franklin County Natural Hazard Mitigation Plan. Work began on this plan update in March of 2011 with the first Core Group Meeting. During the March 2011 Core Group meeting it was decided that a new format would be utilized for greater clarity and organization of the overall Franklin County Natural Hazard Mitigation Plan. The FEMA Mitigation Crosswalk was utilized throughout this planning process to ensure that all of the requirements were met. The plan is formatted in such a way that it follows the Crosswalk to make the State and Federal review process easier.

The City of Westerville had a standalone mitigation plan created in 2007, but was included as part of the Franklin County Natural Hazard Mitigation Plan. Westerville adopted the 2012 plan and is considered part of the Franklin County Natural Hazard Mitigation Plan.

The 2018 Franklin County Natural Hazard Mitigation Plan constitutes the second update. While the format remains mostly consistent with the 2012 plan, the 2018 stand-alone risk assessment for Franklin County was updated to serve not only as the risk assessment for the Franklin County Natural Hazard Mitigation Plan, but all other plans and programs, as well. Emphasis was placed on reducing and eliminating any redundancies between the various documents (see **Appendix A. Risk Assessment for Franklin County 2018)**.

Implementation, Monitoring and Evaluation

The Plan Maintenance Section of this document details the process to keep the Franklin County Natural Hazard Mitigation Plan an active document. Plan revision will occur every five years and changes will be made as necessary. Franklin County Emergency Management & Homeland Security (FCEM&HS) will be tasked with overall plan maintenance, and will work with local government and regional planning agencies to incorporate mitigation strategies into future development plans, capital improvement budgets, and building code standards.

Plan Adoption

This Plan represents a comprehensive description of Franklin County's commitment to significantly reduce or eliminate the potential impacts of disasters through planning and mitigation. Adoption by the local governing bodies within the County legitimizes the Plan and authorizes responsible agencies to implement mitigation responsibilities and activities. To be eligible for federal mitigation funding, each participating jurisdiction must adopt the plan. After thorough review, the Franklin County Board of Commissioners adopted the plan on <date adopted>. Additional adoptions are included in **Appendix H. Participating Jurisdiction Plan Adoption.**

Following Federal review and approval, the participating jurisdictions in this plan intend to formally adopt the plan by Resolution or Ordinance.

Economic Analysis of Mitigation Projects

The Federal Emergency Management Agency’s approach to natural hazard mitigation strategies typically involves a benefit/cost analysis. Conducting benefit/cost analysis for a mitigation activity can assist communities to determine whether a project is worth undertaking now to avoid disaster related costs later. Determining the economic feasibility of mitigation projects provides decision-makers with a basis upon which to compare alternative projects.

Public Involvement

FCEM&HS will be responsible for plan maintenance, distribution and public comments. FCEM&HS will continue to include public comments and suggestions into reviews and/or updates of the Natural Hazards Mitigation Plan. This plan will be housed on the FCEM&HS website for download by the public at any time.

Evaluation of the Plan

Plan Outline

To make the plan easier to follow and to have a more comprehensive analysis of each hazard, this updated plan references the **Risk Assessment for Franklin County 2018** that was created by Franklin County Emergency Management and Homeland Security. This document is **Appendix A** to this plan. The

Risk Assessment provides a detailed analysis of each hazard facing Franklin County including history and impacts. It also includes a methodology for prioritizing the risks faced by each hazard.

The sections of this plan are:

- **Introduction:** Identifies the purposes of this plan and the jurisdictions that have participated in plan development.
- **Planning Process:** Summarizes the original planning process as well as the process used to update this plan.
- **Community Profile:** Discusses existing conditions, including development trends and current local government capabilities.
- **Hazard Identification:** Identifies the natural hazards that may affect Franklin County.
- **Summary of Risk Assessment Findings:** Highlights the conclusions of the previous Risk Assessment Sections.
- **Mitigation Goals:** Presents planning principles, mitigation goals, and objectives.
- **Alternative Mitigation Actions:** Explains the status of actions proposed in the previous plan, presents a comprehensive array of possible actions, and explains how actions were evaluated.
- **Proposed Mitigation Actions:** Explains how actions address existing and future development and continued compliance with the National Flood Insurance Program (NFIP), how actions will be incorporated into other plans, and how actions will be implemented.
- **Plan Maintenance:** Explains how mitigation actions will be monitored and how the plan will be evaluated and updated.
- **Sources of Information and Acronyms:** Lists websites, publications, and acronyms used to develop this plan.
- **Appendices:** Include sample plan adoption resolutions, public notices about the planning process, and the survey instruments used by participating jurisdictions.

Jurisdictions Represented in the Plan

This is a multi-jurisdictional hazard mitigation plan. The jurisdictions that participated in the development of this plan are the same jurisdictions that participated in the development of the 2012 version of the plan and adopted it. The 15 cities, 9 villages and 17 townships of Franklin County are represented in this plan. No additional jurisdictions have participated in the development of this plan.

Along with the County government, the following municipalities in Franklin County participated in the mitigation planning process and will adopt this plan and authorize municipal government staff to carry out proposed actions:

Cities:

- Bexley
- Canal Winchester
- Columbus
- Dublin
- Gahanna
- Grandview Heights
- Grove City
- Groveport
- Hilliard
- New Albany
- Reynoldsburg
- Upper Arlington
- Westerville
- Whitehall
- Worthington

Villages:

- Brice
- Harrisburg
- Lockbourne
- Marble Cliff
- Minerva Park
- Obetz
- Riverlea
- Urbancrest
- Valleyview

Townships:

- Blendon
- Brown
- Clinton
- Franklin
- Jackson
- Jefferson
- Hamilton
- Madison
- Mifflin
- Norwich
- Perry
- Plain
- Pleasant
- Prairie
- Sharon
- Truro
- Washington

Adoption Resolutions

Appendix G. Sample Resolution provides a sample adoption resolution that participating jurisdictions can use to adopt the mitigation plan after FEMA Region V determines that this plan is approved pending adoption. An approvable plan meets planning requirements specified in 44 CFR Section 201.6. A plan is fully approved after it is adopted; signed adoption resolutions will be included in **Appendix H. Participating Jurisdiction Plan Adoption**.

Project Funding

This project was made possible through grant funding provided through the DHS: FEMA and time commitments from members of the Natural Hazards Mitigation Plan Core Group and the staff of Franklin County Emergency Management & Homeland Security.

PLANNING PROCESS

Planning Process Update

This 2018 plan is an update of the Franklin County Natural Hazard Mitigation Plan that was updated and adopted for implementation by Franklin County, Ohio and participating jurisdictions within the County in 2013.

This updated Franklin County Natural Hazard Mitigation Plan represent the work of citizens, elected and appointed government officials, business leaders, and volunteers of non-profit organizations in developing a blueprint for protecting community assets, preserving the economic viability of the community, and saving lives.

Planning Process

Hazards

As in the previous version, the Core Group utilized the **Risk Assessment for Franklin County 2018** to help prioritize the hazards addressed in this plan.

During the planning process, Franklin County and community representatives considered all natural hazards for inclusion in the plan. Per FEMA's mandate to address all natural hazards, the following natural hazards were not included because these hazards do not directly impact the County or have not created problems in the past. They are:

- Hurricanes
- Landslides
- Sea Level Rise
- Space Weather
- Storm Surge
- Tsunami
- Wildfire

The final list of hazards identified and assessed for this Plan are as follows (in alphabetical order):

TABLE 2: HAZARDS

Dam/Levee Failure
Drought
Earthquake
Extreme Heat
Flooding

Invasive Species
Severe Summer Weather
Severe Winter Weather
Sinkhole/Karst
Tornado

Review of Existing Plans

Franklin County completed its initial Plan in 2007 and updated it in 2013. Integrated Solutions Consulting and the planning team reviewed the 2013 plan prior to beginning this five-year update process for 2018. Additionally, the county and local communities utilize land use plans, emergency response plans, municipal ordinances, and building codes to direct community development. The **Community Profile: Planning Capabilities** describes the jurisdiction-specific plans that were reviewed.

Since a Hazard Mitigation Plan is only a part of the emergency planning, mitigation, preparedness, response and recovery process, a second objective of the planning process was to coordinate Plan preparation with existing Franklin County emergency plans, programs, procedures and organizations. For the purposes of this Plan, existing hazard mitigation goals and objectives within Franklin County were reviewed. It should be noted that this Plan does not replace any existing plans or programs, but is intended to provide a reference on hazard mitigation to be used in planning and program development.

Review of Technical Resources

The planning team identified representatives and/or resources from key agencies to assist in the planning process and to identify relevant technical data, reports, and studies. The organizations and associated contributions are listed in the table below.

TABLE 3: TECHNICAL RESOURCES

Agency	Resource
Franklin County Geographic Information System	GIS data
Ohio Department of Natural Resource (ODNR)	GeoFacts
United States Army Corps of Engineers	National Inventory of Dams
United States Army Corps of Engineers	National Levee Database
NOAA	Historical Natural Hazard Data
City of Columbus	Climate Change in Columbus Ohio

Core Group Participation

During the 2018 update, the update of the plan was again led by a Core Group. Each organization from the original Core Group as well as other community leaders were invited in October 2017 by FCEM&HS to actively participate in updating the plan; those who accepted the invitation comprise the current Core Group members, listed further in this section. Meeting minutes, sign-in sheets, and invitations for Core Group meetings and all other meetings are located in **Appendix B. Meeting and Workshop Documentation**.

The Core Group was headed by FCEM&HS. Other members of the committee included representatives from various county departments, cities and villages, and other key emergency management partners. All members of the Core Group were actively involved in attending the NHMP core group meetings, provided historical hazard information, reviewing and providing comments on the draft plans, coordinating and participating in the public input process, and coordinating the county's formal adoption of the plan.

Core Group members for updating the plan in 2018 were:

TABLE 4: CORE GROUP MEMBERS

Franklin County	Franklin County Emergency Management & Homeland Security	Jeff Young, Director
		Darrel Koerber, Deputy Director
		Andrew Jarvi, Emergency Management Planner
	Franklin County Economic Development and Planning Department	Matt Brown, Planning Administrator/Floodplain Administrator
	Franklin County Engineer	Ken Cooper, Safety & Security
		Melissa Tuttle, Office Assistant
	Franklin County Soil and Water Conservation District	Dave Reutter, Urban Conservation Specialist
City of Columbus	Department of Public Services	Tomeka Hopson, Deputy Director
City of Dublin	Police Department	Tom Hirschy, Law Enforcement Planner/Emergency Management Coordinator
City of Gahanna	Gahanna Police Department/Emergency Management	Pat Millenbaugh, Sgt
	Mayor's Office	Dottie Franey, City Administrator
Mid-Ohio Regional Planning Commission		Nathaniel Vogt, TIP & Funding Manager
City of Whitehall	Economic Development & Public Service	Zach Woodruff, Director of Economic Development & Public Service
Ohio State University	Division of Emergency Management & Fire Prevention	Robert Armstrong, Director
City of Westerville	Westerville Division of Fire	Brian Miller, Fire Chief
Private Sector	Continuity Professionals of Ohio	Alice Kaltenmark, MBCP, MBCI, President

To aid in the development of the plan, the County contracted the services of Integrated Solutions Consulting, a consulting firm with expertise in hazard mitigation planning.

2018 Local Jurisdictional Participation

Each of the 41 participating jurisdictions identified representatives to serve on the Local Planning Teams. The Local Planning Teams were instrumental in identifying community-specific risks/hazards, and identifying and prioritizing mitigation actions that would reduce the costs of disaster response and recovery, protect people and infrastructure, and minimize overall disruption to their respective communities in the event of a disaster.

TABLE 5: PARTICIPATION DOCUMENTATION

Jurisdiction	Core Group Representation	Community Mitigation Survey Participation (includes participation from general public)	Participation via Phone	Participation via E-mail Correspondence	Represented at a Webinar	Represented at a Workshop/Meeting(s)	Submitted at least one (1) New Mitigation Project	Reviewed/Updated Past Mitigation Project(s), as applicable	Accessed Online Planning System
Franklin County	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bexley City		✓ (13)	✓	✓			-	✓	
Canal Winchester City		✓ (23)	✓	✓		✓	✓	✓	✓
Columbus City	✓	✓ (609)	✓	✓	✓	✓	✓	✓	✓
Dublin City	✓	✓ (208)	✓	✓	✓	✓	✓	✓	✓
Gahanna City	✓	✓ (50)	✓	✓	✓	✓	-	✓	✓
Grandview Heights City		✓ (11)	✓	✓			-	✓	
Grove City		✓ (97)	✓	✓			-	✓	
Groveport City		✓ (14)	✓	✓		✓	✓	✓	✓
Hilliard City		✓ (125)	✓	✓			-	✓	
New Albany City		✓ (26)	✓	✓		✓		✓	✓
Reynoldsburg City		✓ (34)	✓	✓		✓		✓	✓
Upper Arlington City		✓ (64)	✓	✓		✓		✓	
Westerville City	✓	✓ (99)	✓	✓		✓	✓	✓	✓
Whitehall City	✓	✓ (7)	✓	✓			-	✓	
Worthington City		✓ (36)	✓	✓		✓	✓	✓	✓
Brice Village		✓ (2)	✓	✓			-	✓	
Harrisburg Village		✓ (1)	✓	✓			-	✓	
Lockbourne Village		✓ (3)	✓	✓			✓	✓	
Marble Cliff Village		✓ (3)	✓	✓			-	✓	
Minerva Park Village		✓ (2)	✓	✓			-	✓	
Obetz Village		✓ (2)	✓	✓			-	✓	

Riverlea Village		✓ (2)	✓	✓			✓	✓	
Urbancrest Village			✓	✓			-	✓	
Valleyview Village		✓ (1)	✓	✓			-	✓	
Blendon Twp		✓ (16)	✓	✓			-	✓	
Brown Twp		✓ (4)	✓	✓			-	✓	
Clinton Twp		✓ (26)	✓	✓			-	✓	
Franklin Twp		✓ (29)	✓	✓		✓		✓	
Hamilton Twp		✓ (12)	✓	✓			-	✓	
Jackson Twp		✓ (5)	✓	✓	✓	✓		✓	✓
Jefferson Twp		✓ (38)	✓	✓		✓	✓	✓	✓
Madison Twp		✓ (42)	✓	✓			-	✓	✓
Mifflin Twp		✓ (2)	✓	✓			-	✓	
Norwich Twp		✓ (9)	✓	✓		✓	✓	✓	
Perry Twp		✓ (17)	✓	✓		✓	✓	✓	✓
Plain Twp		✓ (5)	✓	✓		✓	✓	✓	✓
Pleasant Twp		✓ (8)	✓	✓			✓	✓	
Prairie Twp		✓ (56)	✓	✓			-	✓	
Sharon Twp		✓ (10)	✓	✓			-	✓	✓
Truro Twp		✓ (4)	✓	✓		✓	✓	✓	
Washington Twp		✓ (2)	✓	✓		✓	✓	✓	✓

TABLE 6: LOCAL PLANNING TEAM REPRESENTATIVES

Jurisdiction	Name	Title	Department/Agency
Franklin County	Jeff Young	Director	Franklin County Emergency Management & Homeland Security
	Darrel Koerber	Deputy Director	Franklin County Emergency Management & Homeland Security
	Andrew Jarvi	Planning Manager	Franklin County Emergency Management & Homeland Security
	Donald Murphy	Drainage Tech	Franklin County Drainage Engineer
	Matt Brown	Planning Administrator/Floodplain Administrator	Franklin County Economic Development and Planning Department
	Ken Cooper	Safety & Security	Franklin County Engineer
	Melissa Tuttle	Assistant	Franklin County Engineer
	Dave Reutter	Urban Conservation Specialist	Franklin County Soil and Water Conservation District
	Sean Farrell	Intern	Franklin County Emergency Management & Homeland Security
Bexley City	Ben Kessler	Mayor	Bexley City
Canal Winchester City	Michael	Mayor	Canal Winchester City

	Ebert		
	Matthew Peoples	Director of Public Service	Public Service
Columbus City	Andrew Ginther	Mayor	City of Columbus
	Tomeka Hopson	Deputy Director	City of Columbus, Department of Public Services
	Leslie diDonato	Director, Office of Emergency Preparedness	Columbus Public Health
	Cathy Collins	Assistant Director	City of Columbus, Public Safety
	Pete Kowal	Program Manager	Columbus Public Health
	Ann Aubry	Deputy Director	Public Utilities
	Tony Celebrezze	Assistant Director	Building and Zoning
	Christopher Lohr	Planning Manager	Development-Planning
Dublin City	Greg Peterson	Mayor	City of Dublin
	Tom Hirschy	Law Enforcement Planner/Emergency Management Coordinator	Police Department
	J.M. Rayburn	Planner I	Department of Development: Planning Division
	Mike Bliss	Fleet Tech	Dublin Fleet Management
	Rob Wagner	Crew Supervisor	Parks Operation
	Chris Nichol	Operations Administrator	Parks Operations
	Kyle Kridler	Economic Development Administrator	Economic Development Division
	Kyle McKee	Project Manager	Planning/Community Development/GIS
	Ron Whittington	Risk Manager	City of Dublin
	Kelly Rigano	Operations Supervisor	City of Dublin, Recreation Services
	Brandon Brown	Data/GIS Manager	City of Dublin
	Tim Elmer	Operations Administrator	Facilities Management
	Nick Plouck	Management Assistant	City of Dublin

	Trish Lackey	Event Administrator	City of Dublin/Parks & Recreation/Events Administration
	Tim Stitt	Senior Building Inspector	City of Dublin Building Standards
Gahanna City	Thomas Kneeland	Mayor	City of Gahanna
	Pat Millenbaugh	Police Sergeant	Gahanna Police Department
	Dottie Franey	City Administrator	City of Gahanna
Grandview Heights City	Ray DeGraw	Mayor	Grandview Heights City
Grove City	Richard Stage	Mayor	Grove City
	William Vedra	Administrator	Grove City
Groveport City	Lance Westcamp	Mayor	Groveport City
	Marsha Hall	City Administrator	Groveport City
Hilliard City	Donald Shonhardt	Mayor	Hilliard City
New Albany City	Sloan Spalding	Mayor	City of New Albany
	Scott McAfee	Chief Communications and Marketing Officer	New Albany, Ohio
Reynoldsburg City	Brad McCloud	Mayor	City of Reynoldsburg
	James Mosic	Director of Public Safety	Public Safety
Upper Arlington City	Theodore Staton	City Manager	City of Upper Arlington
	Chad Gibson	Senior Planning Officer	City of Upper Arlington
	Thomas Nutini	Public Service Manager	City of Upper Arlington, Public Service
Westerville City	Craig Treneff	Mayor	City of Westerville
	Richard Lorenz	Water Utility Manager	Water Division
	Brian Miller	Fire Chief	Westerville Division of Fire
Whitehall City	Kim Maggard	Mayor	City of Whitehall
	Zach Woodruff	Director of Economic Development & Public Service	Economic Development & Public Service
	Preston Moore	Fire Chief	Fire Department

Worthington City	Scott Holmes	Mayor	City of Worthington
	Jerry Strait	Chief of Police	Worthington Division of Police
	John Bailot	Fire Chief	City of Worthington
Brice Village	Cathy Compton	Mayor	Brice Village
Harrisburg Village	Michael Lytle	Mayor	Harrison Village
Lockbourne Village	Christie Ward	Mayor	Lockbourne Village
Marble Cliff Village	Kent Studebaker	Mayor	Marble Cliff Village
Minerva Park Village	Lynn Eisentrout	Mayor	Minerva Park Village
	Kim Neusse	Police Chief	Police Department
Obetz Village	Greg Scott	Mayor	Obetz Village
	Rod Davisson	Administrator	Obetz Village
Riverlea Village	Eric MacGilvray	Mayor	Riverlea Village
Urbancrest Village	Joseph Barnes	Mayor	Urbancrest Village
Valleyview Village	Marzia Helton	Mayor	Valleyview Village
Blendon Twp	Bryan Rhoads	Administrator	Blendon Township
Brown Twp	Greg Ruwe	Fiscal Officer	Brown Township
Clinton Twp	Deborah Steele	Fiscal Officer	Clinton Township
	Brian Fraley	Fire Chief	Fire Department
Franklin Twp	Lisa Morris	Fiscal Officer	Franklin Township
	Jessica Rice	Administrative Coordinator	Franklin Township
Hamilton Twp	Lisa E. Shirkey	Fiscal Officer	Hamilton Township
	Howard Hahn	Trustee	Hamilton Township
Jackson Twp	Lynn Bruno	Administrator	Jackson Township
	Rex Blair	Facilities Manager	Jackson Township - Franklin County
Jefferson Twp	Ken Jones	Fiscal Officer	Jefferson Township
	Joe Gerhart	Service Superintendent	Service Department
	Mike Anderson	Development Director	Jefferson Township
Madison Twp	Susan Brobst	Administrator	Madison Township
Mifflin Twp	Nancy White	Fiscal Officer	Mifflin Township
Norwich Twp	Jamie Fisher	Township Administrator	Norwich Township
Perry Twp	Michele M.	Fiscal Officer	Perry Township

	Elliott		
	John Petrozzi	Chief of Police	Perry Township Police Department
	Ian Warren	Road Superintendent	Perry Township
Plain Twp	Ben Collins	Township Administrator	Plain Township
Pleasant Twp	Paula Wilkins	Fiscal Officer	Pleasant Township
	Nancy Hunter	Trustee	Pleasant Township
Prairie Twp	Tracie Hatmaker	Administrator	Prairie Township
Sharon Twp	John S. O'Keeffe	Fiscal Officer	Sharon Township
Truro Twp	Jason Nicodemus	Township Administrator	Truro Township
Washington Twp	Eric Richter	Township Administrator	Washington Township

During the process of updating the plan, each meeting of the Core Group was open to representatives of participating jurisdictions. Representatives were invited to attend the meetings in person or to send a liaison to address any comments or concerns they may have.

Mitigation Orientation Webinars

A series of webinars to introduce the mitigation planning process to local officials was conducted. In total, nine (9) webinars were conducted over a two-week period, including morning, afternoon, evening and weekend webinars.

Mitigation Workshops

Four (4) workshops were held to identify hazards and update and consider new mitigation strategies. In addition, an individual workshop meeting was held with the City of Columbus.

See Figures below.

FIGURE 1: WORKSHOP REGISTRATION SITE

Franklin County Emergency Management and Homeland Security

2018 FRANKLIN COUNTY NATURAL HAZARD MITIGATION PLAN: LOCAL JURISDICTIONAL WORKSHOPS

REGISTRATION SITE

Please register below.

What: Register today and bring your local planning team to one of our mitigation workshops. These in-person workshops will give your local planning team an opportunity to work with Franklin County Emergency Management and Homeland Security staff to identify local hazards and areas of concern, review previously identified mitigation actions, develop future mitigation projects, prioritize mitigation projects moving forward and update your jurisdiction's section of the 2018 Franklin County Natural Hazard Mitigation Plan.

Why: Participating in updates to the mitigation plan is a FEMA Requirement to be eligible for federal disaster funding before and after disasters. By bringing your local planning team to one of these workshops, you will be meeting that requirement.

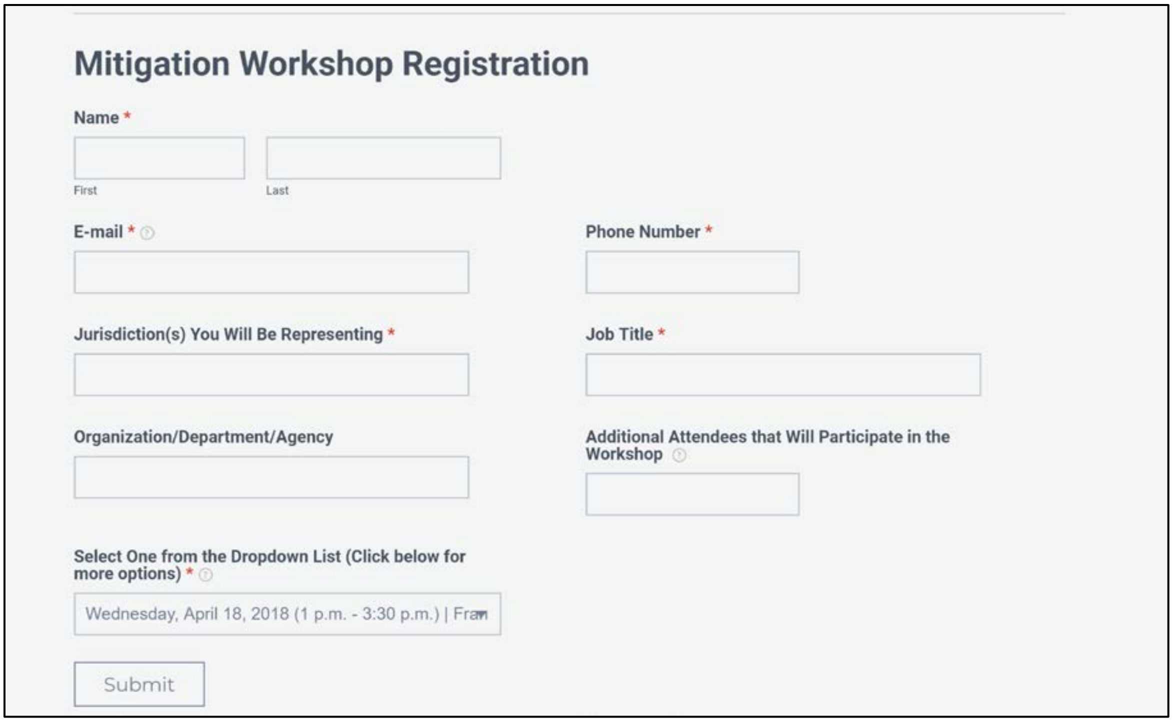
Who Should Attend: These workshops should be attended by **EVERY** jurisdiction within Franklin County. Recommended attendees include:

Building Code Enforcement | City/Township/Village Administration/Management | Elected Officials | Fire & Law Enforcement | Floodplain Administrator | Legal | Parks & Recreation | Planning/Community Development/GIS | Public Works/Transportation (Roads & Bridges) | Sanitation/Storm Water Management/Utility Districts | School Districts & Universities | Treasurer/Tax Assessor

WHEN & WHERE THE WORKSHOPS WILL TAKE PLACE:

- Wednesday, April 18, 2018 (1 p.m. - 3:30 p.m.) | Franklin County Emergency Management and Homeland Security
  5300 Strawberry Farms Blvd., Columbus, Ohio 43230
- Wednesday, April 18, 2018 (6 p.m. - 8:30 p.m.) | Franklin County Emergency Management and Homeland Security
  5300 Strawberry Farms Blvd., Columbus, Ohio 43230 (Note: This meeting is for individuals who have commitments during the workday.)
- Thursday, April 26, 2018 (9 a.m. - 11:30 a.m.) | Franklin County Emergency Management and Homeland Security
  5300 Strawberry Farms Blvd., Columbus, Ohio 43230
- Thursday, April 26, 2018 (1 p.m. - 3:30 p.m.) | Franklin County Emergency Management and Homeland Security
  5300 Strawberry Farms Blvd., Columbus, Ohio 43230

For registration assistance please contact Andrew Jarvi at aljarvi@franklincountyohio.gov or (614)724-0805



Mitigation Workshop Registration

Name *

First

Last

E-mail *

Phone Number *

Jurisdiction(s) You Will Be Representing *

Job Title *

Organization/Department/Agency

Additional Attendees that Will Participate in the Workshop

Select One from the Dropdown List (Click below for more options) *

Wednesday, April 18, 2018 (1 p.m. - 3:30 p.m.) | Fran

Submit

Online Planning System

Local Planning Team members were invited to participate via the online planning system (https://oh-franklin-emhs.isc-cemp.com), known as the Franklin County Knowledge Management System (KMS).

One of the key features of the Online Planning System was the ability to provide real-time access to the Plan and to allow stakeholders to comment on key sections. Core Group members and Local Planning Team members were given access to the system. The comments tool was used to encourage collaboration. The comments tool allowed the user to make comments on any page within the manual and mark the comment as an observation or feedback. Comments for pages were visible to all administrators and users who had editing privileges for the specific page.

To make a comment, users were instructed to click on the Comment link on the bottom of the content page and a pop-up box would appear. The person used the drop-down box to designate whether the comment was a Feedback or an Observation. After entering the comment, they clicked the Send Comments button to submit.

The comment would appear after the page refreshes (if user is allowed to view comments). An email notification was sent to users who were designated to receive comment notification.

All jurisdictions participated in the planning process even though the some were not present at the workshop meetings. Some jurisdictions participated by phone or email. One jurisdiction was removed from the 2013 plan, the Village of New Rome, which was dissolved since the creation of the plan.

Stakeholders & Subject Matter Experts

Stakeholder Outreach Activity	Date	Location	Details of Activity
County Engineers Meeting and Dinner Event	March 2018		Discussed the purpose of the Hazard Mitigation Plan and invited jurisdictions to participate in the Plan. This event included many key municipal leaders and stakeholders.

Neighboring Communities

Officials of Delaware, Licking, Fairfield, Pickaway, Madison, and Union counties were notified and invited to participate in the planning process. Franklin County has existing mutual aid agreements with each of these adjacent counties and works with representatives regularly. An email was also sent to these counties to notify them of the planning effort and invite participation and comment. The letter can be found in **Appendix C. Public Participation Documentation & Feedback**.

TABLE 7: NEIGHBORING COMMUNITIES

Neighboring Jurisdiction	Organization	Participation Description
Delaware	Emergency Management	Reviewed the plan
Licking	Emergency Management	Reviewed the plan
Fairfield	Emergency Management	Reviewed the plan
Pickaway	Emergency Management	Reviewed the plan
Madison	Emergency Management	Reviewed the plan
Union	Emergency Management	Reviewed the plan

2018 Public Involvement

The general public must be given an opportunity to be involved in the planning process. As such, a number of public outreach activities were organized to ensure public participation and input was obtained. This section describes those efforts.

A notice about updating the Franklin County Natural Hazard Mitigation Plan was posted on FCEM&HS's website throughout the planning process which is included in **Appendix C. Public Participation Documentation & Feedback**. Residents of Franklin County, volunteer watershed groups, and neighboring communities with an interest in the process were invited to contact the Franklin County Mitigation Planner and were invited to participate in the process through plan comment or attendance at meetings.

Franklin County Community Preparedness and Mitigation Survey

Surveys were distributed through a variety of methods beginning on October 2017 including email blasts and the Nextdoor app. Community organizations were critical in connecting county and city residents with the survey, and the Franklin County EM&HSA utilized their broad-based distribution lists of community stakeholders and partners to disseminate the survey to residents.

Online survey results were compiled together upon the close of the survey February 2018. In total, 2,098 respondents participated in the survey. To ensure all data could be accurately correlated, only the 1,593 completed surveys were used in the final analysis. Approximately, 505 respondents submitted incomplete surveys.

The survey instrument utilized a combination of descriptive and exploratory questions to gain an understanding of general preparedness intentions and behavior, as well as personal and demographic factors influencing decision making (e.g., information sources, risk perception, age, and socioeconomic status).

The survey was a combination of multiple choice, Likert-scale rating (degree of agreement/disagreement style questions), and open-ended questions. It totaled 31 questions, and respondents took an average of 13 minutes to complete the questionnaire (both online and hardcopy).

The survey instrument contained questions that fall into a number of broad categories: general preparedness; emergency information sources; hazard risk perception; hazard mitigation priorities; disaster experience; evacuation; functional and access needs; and demographics.

- **Survey Questions:** See Appendix D – Community Preparedness & Mitigation Survey
- **Final Report:** See Appendix E – Community Preparedness & Mitigation Final Report

FIGURE 2: SOCIAL MEDIA OUTREACH EFFORTS

Public Forums & Outreach

The public was invited to attend multiple meetings to review the risk assessment results and discuss mitigation strategies. The public meeting was advertised locally prior to the meetings. Advertisement space was purchased in the Columbus Dispatch and local weekly newspapers throughout the County.

- **Public Forum Sign-in Sheets:** See **Appendix C. Public Participation Documentation & Feedback**

FIGURE 3: PUBLIC MEETING INVITE

Public Plan Review and Feedback

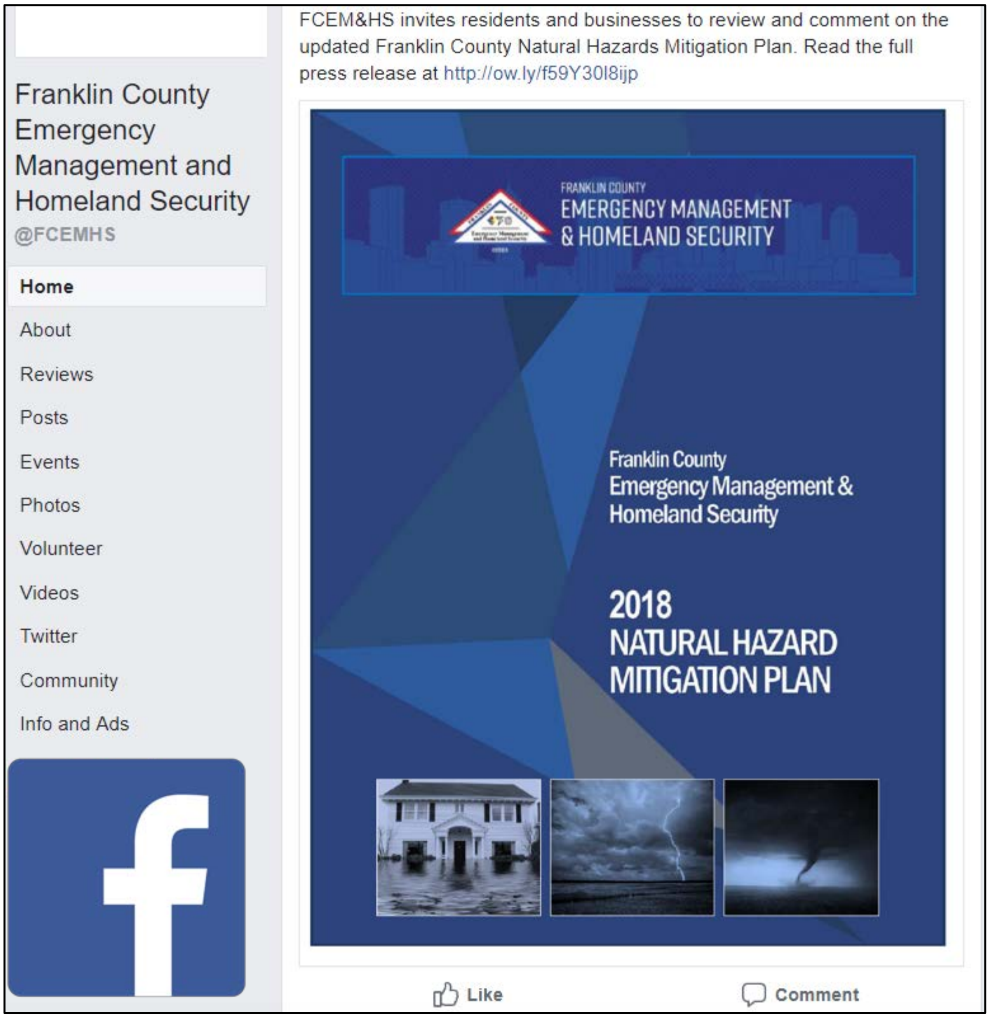
An invitation to the public to review and comment on the draft plan was posted on the home page of Franklin County Emergency Management and Homeland Security's Website on July 16th and remained online throughout the entire review process. A screen shot of the Web page is displayed in **Appendix C. Public Participation Documentation & Feedback**.

FCEM&HS also issued a press release inviting review and comment on the plan (see **Appendix C. Public Participation Documentation & Feedback)**. The press release was sent to all media outlets and all local jurisdictions.

After receiving and addressing public and workgroup comments, the draft of the updated plan was re-posted on the FCEM&HS website for final public comment. Once approved, the plan will be made available to the public in its final form.

FIGURE 4: WEB SITE FOR PUBLIC REVIEW AND COMMENT

Figure 5: Social Media Post for Public Review and Comment



Other Planning Mechanisms

During the process of updating the plan, the consultant coordinated with the Franklin County Economic Development and Planning Department and the Core Group by reviewing the existing planning mechanisms to ascertain community capabilities and identify opportunities for implementing mitigation actions. Documents consulted included existing municipal and county zoning and subdivision regulations and flood damage prevention ordinances; the existing comprehensive plans; county building code; and Flood Insurance Rate Maps, which were revised starting in 2008 during FEMA's Map Modernization Program.

Gathering New Data

Gathering and analyzing new data about natural hazards and the community was critical to the process of updating the plan. New data used for the plan are identified throughout the plan, and specifically in **Appendix A. Risk Assessment for Franklin County 2018**.

COMMUNITY PROFILE

See **Appendix A. Risk Assessment for Franklin County 2018** (Section 2: Franklin County Profile) for more information about the County and municipalities.

Planning for Natural Hazards in Franklin County

Natural hazards impact citizens, property, the environment and the economy of Franklin County. Franklin County is susceptible to flooding, high winds, tornadoes, severe winter storms, droughts, periods of intense heat, and earthquakes. Franklin County residents and businesses have been exposed to the economic, as well as the health and emotional costs, associated with natural disasters.

Franklin County continues to experience growth in development, housing and population. The population of Franklin County currently exceeds 1 million people. The inevitability of natural hazards, and the growing population and activity within the county create an urgent need to develop strategies, coordinate resources and increase public awareness to reduce risk and prevent loss from future natural hazard events. Developing strategies to reduce the impact of a hazard event can assist in protecting life and property of citizens and businesses.

The National Flood Insurance Program's (NFIP) Community Rating System (CRS) was implemented in 1990 as a program for recognizing and encouraging community floodplain management activities that exceed the minimum NFIP standards. Under the CRS, flood insurance premium rates are adjusted to reflect the reduced flood risk resulting from community activities that meet the three goals of the CRS: (1) reduce flood losses; (2) facilitate accurate insurance rating; and (3) promote the awareness of flood insurance. Discounts on premiums may range from 5% to 45% based on the actions taken in each community. CRS provides credit for adopting, implementing, evaluating and updating a comprehensive floodplain management plan. Currently, only the Village of Obetz in Franklin County is identified as a CRS participating community.

Historical Hazard Events

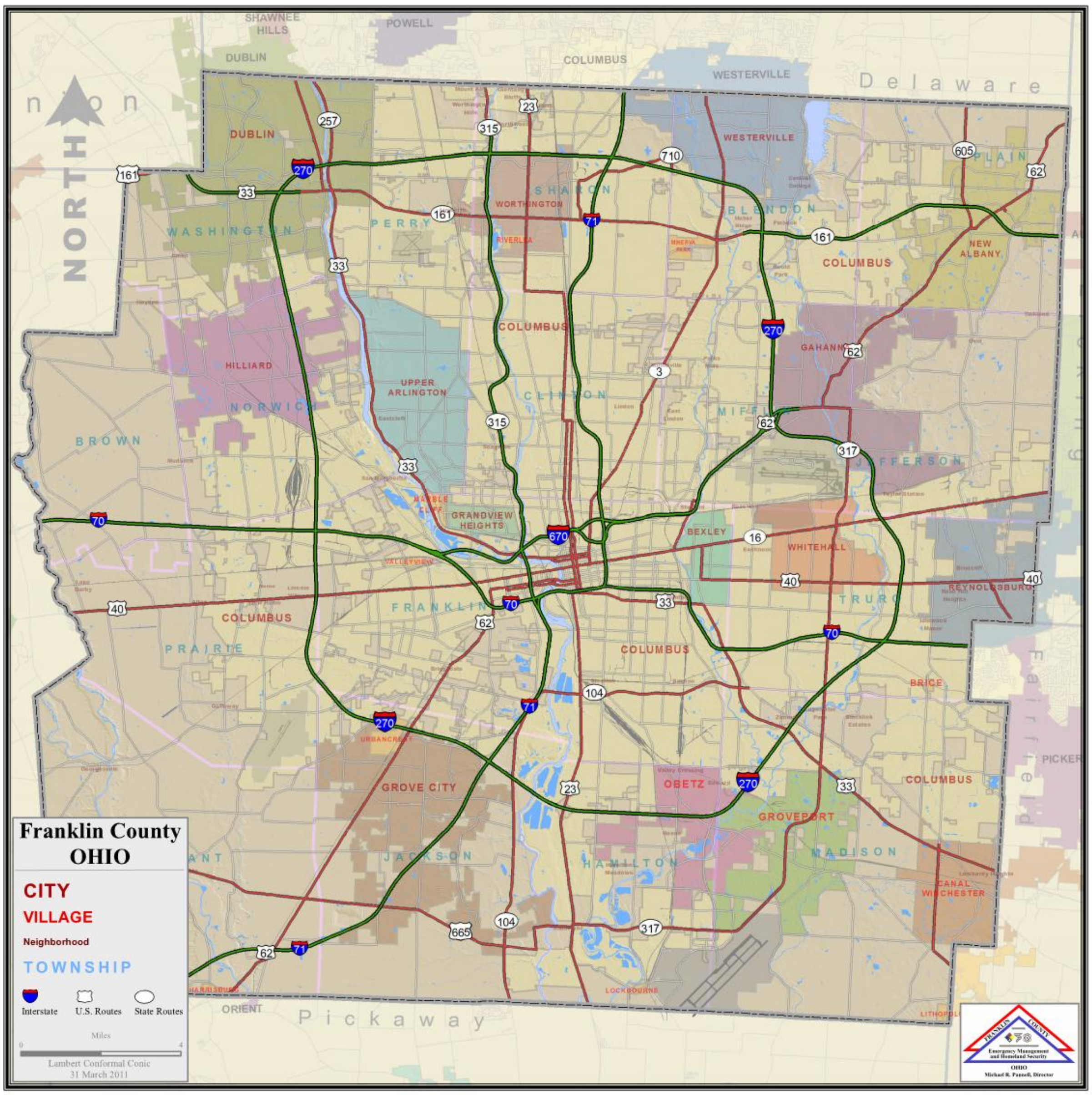
Franklin County is susceptible to a variety of natural hazards. The worst flood in Franklin County history occurred in March 1913. A levee break flooded the near west side (Franklinton area) resulting in the flooding of more than 4,000 homes and 95 people lost their lives. In January 1959, high water from heavy rains on frozen ground caused another levee break and flooding on the west and east side of Columbus. Between 1964 and 2011, nine presidential disaster declarations have been declared in Ohio for flooding, high wind damage, tornadoes and severe winter weather.

The late spring and early summer is when Franklin County traditionally experiences high wind and tornado activity. Two deaths have been recorded from tornadoes in Franklin County since 1916. Since 1950, more accurate information regarding injuries to citizens and damage to property has been recorded. Seven injuries were reported from a tornado in Franklin County on February 22, 1971, and nine injuries reported from tornadoes occurring in May 1973.

In January 1978, Franklin County experienced record cold and snowfall totaling more than 34 inches. The blizzard of 1978 began as rain and changed over to snow, resulting in more than 10 inches of snow. Wind gusts up to 69 MPH contributed to significant blowing and drifting of snow across much of the county. January 1978 holds the monthly snowfall record in Franklin County at 34.4 inches. The coldest winter season (December through February) occurred in 1976/1977, with an average temperature of 20.9 degrees. Prior to 1978, Franklin County had not experienced this level of snowfall since 1910.

Franklin County is predominantly urban, encompasses 543 square miles and consists of 41 jurisdictions. A map of the Franklin County shows the cities, villages and townships in Figure 6. Delaware, Licking, Fairfield, Pickaway, Madison and Union Counties form the border of Franklin County.

FIGURE 6: FRANKLIN COUNTY MAP



Demographics and Population

Franklin County is a predominantly urban area, consisting of 15 cities, 9 villages and 17 townships. Central Ohio continues to experience steady development, as well as shifts in the distribution of population and jobs in the region. Historically, most growth in central Ohio has occurred in a radial pattern, with population moving outward from the central city, to the inner suburbs and then to outer suburban areas. The Columbus area of Delaware County, which has grown over 60 percent since 2010, is just north of Franklin County.

Based on U.S. Census figures, Franklin County has experienced steady population growth and can expect continued development and population growth. After the 1990 and 2000 U.S. Census, Franklin County's population totaled 961,437 and 1,068,978, respectively. Based on 2010 U.S. Census figures, the county's population surpassed 1,163,414, an 8.1 percent increase. This growth rate is comparable to the 10 percent growth between 1990 and 2000. Other notable information related to population in Franklin County is the fact that the age group from 20-24 years is the largest. The large number of residents in this category can most likely be attributed to the presence of The Ohio State University. The county also continues to experience an increase in the number of residents aged 62 or older. In terms of race and culture, Franklin County is experiencing steady increases in population from all minority groups, most notably the Hispanic and Somalian communities.

Populations listed below are based on 1990, 2000, and 2010 U.S. Census figures and are broken down into cities, villages and townships located in Franklin County. Unofficially, 2017 census estimates indicate that Franklin County has an estimated population of 1,291,981.

TABLE 8: CITIES

CITY	1990 POPULATION	2000 POPULATION	2010 POPULATION	% CHANGE 2000-2010
Bexley	13,088	13,203	13,057	-1.1%
Canal Winchester	2,617	4,478	7,101	58.6%
Columbus	632,270	711,470	787,033	10.6%
Dublin	16,366	31,392	41,751	33.0%
Gahanna	27,791	32,636	33,248	1.9%
Grandview Hts.	7,010	6,695	6,536	-2.4%
Grove City	19,661	27,075	35,575	31.4%
Groveport	2,948	3,865	5,348	38.37%
Hilliard	11,796	24,230	28,435	17.4%

CITY	1990 POPULATION	2000 POPULATION	2010 POPULATION	% CHANGE 2000-2010
New Albany	1,621	3,711	7,724	108.1%
Reynoldsburg	25,748	32,069	35,893	11.9%
Upper Arlington	34,128	33,686	33,771	0.3%
Westerville	29,092	35,318	36,120	2.3%
Whitehall	20,572	19,201	18,062	-5.9%
Worthington	14,869	14,125	13,575	-3.9%

More than 90% of the population of Franklin County lives in an incorporated area, leaving the other 10% of the population in unincorporated areas. Population in incorporated areas is occurring at a much greater rate than in unincorporated areas. Densely populated housing developments created on land that was previously used for agricultural purposes have appeared in most areas of Franklin County. Many of these developments are located in flat, low-lying areas.

Table 9: Villages

VILLAGE	1990 POPULATION	2000 POPULATION	2010 POPULATION	% CHANGE 2000-2010
Brice	109	70	114	62.9%
Harrisburg	340	332	320	-3.6%
Lockbourne	173	280	237	-15.3%
Marble Cliff	633	646	573	-11.3%
Minerva Park	1,463	1,288	1,272	-1.1%
New Rome	111	60	Dissolved	
Obetz	3,167	3,977	4,532	14.1%
Riverlea	503	499	483	-3.21%
Urbancrest	862	868	960	10.6%
Valleyview	604	601	620	3.2%

TABLE 10: TOWNSHIPS

TOWNSHIP	1990 POPULATION	2000 POPULATION	2010 POPULATION	% CHANGE 2000-2010
Blendon	11,194	9,193	9,069	-11.3%
Brown	1,825	2,031	2,293	12.9%
Clinton	4,579	4,294	4,109	-4.5%
Franklin	14,757	11,798	10,271	-12.9%
Jackson	25,265	32,625	40,608	24.5%
Jefferson	3,983	5,322	10,972	106.2%
Hamilton	9,746	7,950	8,260	3.9%
Madison	18,749	21,243	23,509	10.7%
Mifflin	28,449	35,787	35,710	-0.2%
Norwich	15,960	27,488	31,807	15.7%
Perry	5,933	4,087	3,637	-11.0%
Plain	4,366	5,926	9,829	65.9%
Pleasant	6,678	7,030	6,671	-5.1%
Prairie	16,945	17,118	16,498	-3.6%
Sharon	17,493	16,455	15,969	-3.0%
Truro	26,265	27,151	26,837	-11.2%
Washington	13,090	1,412	1,549	9.7%

The Township population figures above may not reflect the population living only within the unincorporated areas of the township.

TABLE 11: POPULATION PROJECTIONS

	2010 Census	2015 Projection	2020 Projection	2025 Projection	2030 Projection	2035 Projection	2040 Projection
Franklin County	1,163,414	1,227,560	1,291,320	1,348,980	1,394,980	1,439,060	1,483,160

Source: Ohio Development Services Agency

Land Use and Development Trends

The purpose of including an analysis of land use and development trends in this mitigation plan is to identify the potential for future structures to be at risk of damage due to natural hazards.

Land and Development

Incorporated areas of Franklin County are subject to planning and zoning requirements set forth in local ordinance and are enforced at the local level. Unincorporated areas are subject to zoning regulations adopted by the Franklin County Board of Commissioners or local townships, and are enforced by the Franklin County Economic Development and Planning Department or township zoning officials.

Most of the new development in central Ohio is occurring near or outside of the I-270 outer-belt. Despite significant development in the downtown area, rapid suburban development has reduced the central city's "market share" of regional population and jobs. In addition, the "inner ring" suburbs (Upper Arlington, Bexley, Whitehall and Grandview Heights) are losing their market share of non-residential tax base to new development in the newer city and suburban county. An analysis of the population statistics in Table 8 reflects an enormous amount of growth during the last 10 years in younger municipalities in Franklin County, most notably the Cities of New Albany, Dublin and Grove City. With the exception of the City of Columbus, most of the older, land-locked municipalities have experienced little to no growth.

This trend is also reflected in the population of unincorporated township areas of Franklin County in Table 10. Although significant growth has occurred in many of the unincorporated townships, the decrease of population in these areas results from annexation of the unincorporated areas to a municipality. An example of this is reflected in the 89% decrease in population of Washington Township between 1990 and 2000. Large portions of Washington Township were annexed to the City of Dublin during this 10 year period. Significant housing development and construction in the City of Dublin during this period contributed to a 40% increase in its population. More information on annexation can be found in the next section.

TABLE 12: RESIDENTIAL CONSTRUCTION

Residential Construction	2013	2014	2015	2016	2017
Total units	6,087	5,058	5,373	5,770	5,854
Total valuation (000)	$623,810	$811,638	$843,224	$917,019	$1,054,351
Total single-unit bldgs	1,497	1,672	1,508	1,604	1,719
Average cost per unit	$232,514	$282,719	$291,183	$289,590	$288,579
Total multi-unit bldg units	4,590	3,386	3,865	4,166	4,135
Average cost per unit	$60,073	$100,098	$104,559	$108,621	$135,014

Source: Ohio Development Services Agency

Community Development & Annexation

The stable, yet diverse economy of Franklin County has contributed to the strong business and residential growth it has experienced over the past decade. As home to Ohio's Capital, government employment accounts for approximately 16% of the workforce in Franklin County. The stability of the local economy combined with low interest rates has contributed to a strong real estate market.

The median sales price of a single-family home in Franklin County during 2016 was $166,669. This figure has increased over the past five years. There are currently more than 428,311 real estate parcels in Franklin County and more than 4,500 manufactured homes. In Tax Year 2016, the total value of property in Franklin County reached a record high of $102.3 billion. The previous high came in 2015 at $100.8 billion. The county's total property value has increased more than six percent since values dipped to $95.6 billion following the 2011 Reappraisal.

The Franklin County Economic Development and Planning Department serves as a representative of the Board of Commissioners on community and economic development issues. This office coordinates Housing and Urban Development (HUD) and Community Development Block Grants (CDBG) for the county to assist with home buyer counseling and down payment assistance. The office also focuses on strengthening business/industry growth in Franklin County by establishing community reinvestment areas and the use of incentives such as tax abatements for expanding businesses. Nearly every municipality located in Franklin County employs a community and economic development official, dedicated to focusing on the growth of their community. Ohio's home-rule statute has contributed to many municipalities' ability to plan and prepare for growth in their community.

Annexation has had a significant impact on development in Franklin County. The City of Columbus has expanded into developing areas that are more typically in suburban areas. In 1950, Columbus covered 39.9 square miles. By 2007, the city exceeds 213 square miles. During the period covering 1992-98, the City of Columbus acquired 48% of the 22,103 acres annexed in Franklin County. The Village of New Albany annexed 20%; Grove City annexed 10%; and Hilliard annexed 5% of all land annexed in the county during this period.

The City of Columbus also has a very strong historic preservation community. There are currently 19 historic districts, and 34 individual properties listed on the Columbus Register of Historic Places which are overseen by the Historic Resources Commission. The four primary historic districts formally recognized by City Council include the Brewery District, German Village, Italian Village and Victorian Village.

New Development

Active development has occurred in newer areas of the City of Columbus. During the period of 1993 to 1998, more than half of all new single-family housing units in Franklin County were located within the newer city. Comparatively, only 4% were for homes located in the older city of Columbus. Multi-family housing development continues to be concentrated in the newer city. Much of this development has been located near other newer city development, including Tuttle Mall, Mill Run and Easton.

Mid-Ohio Regional Planning Commission (MORPC) has prepared development forecasts for the Columbus urbanized area. MORPC projects the majority of growth in retail and office development will occur in the northern tier of the region, while new industrial warehouse and distribution centers will be located in the southern half of the county.

The Hollywood Casino completed 5 years ago on the west side of the County was expected to encourage further development in that area. Since Hollywood Casino opened in October 2012, 41 small and large businesses have either opened or expanded in the nearby area.

Insight2050

Insight2050 is an effort to prepare Central Ohio for future growth. With the region slated to grow by more than 1 million people and an additional 300,000 jobs by 2050, insight2050 is designed to provide local and regional policy makers, business leaders, developers, and public stakeholders with a clear and objective understanding of the impacts of varying growth and public investment decisions.

This initiative strives to arm decision makers and stakeholders with solid and defensible information about the fiscal, mobility, environmental, and public health impacts of development and investment choices.

Like other metropolitan regions across the US, Central Ohio is looking towards a future population that is significantly different than the population that drove its growth over the past decades. As a nation and a region, there is an increasing proportion of aging baby boomers and young adults. Indeed, these age cohorts are slated to represent nearly 80% of the growth in Central Ohio over the next two to three decades. This changing population is expressing a demand for a broader range of housing types – more small-lot single family homes, more townhomes, and more multifamily apartments and condos – in more complete, walkable communities.

FIGURE 7: PROJECTED HOUSEHOLD GROWTH

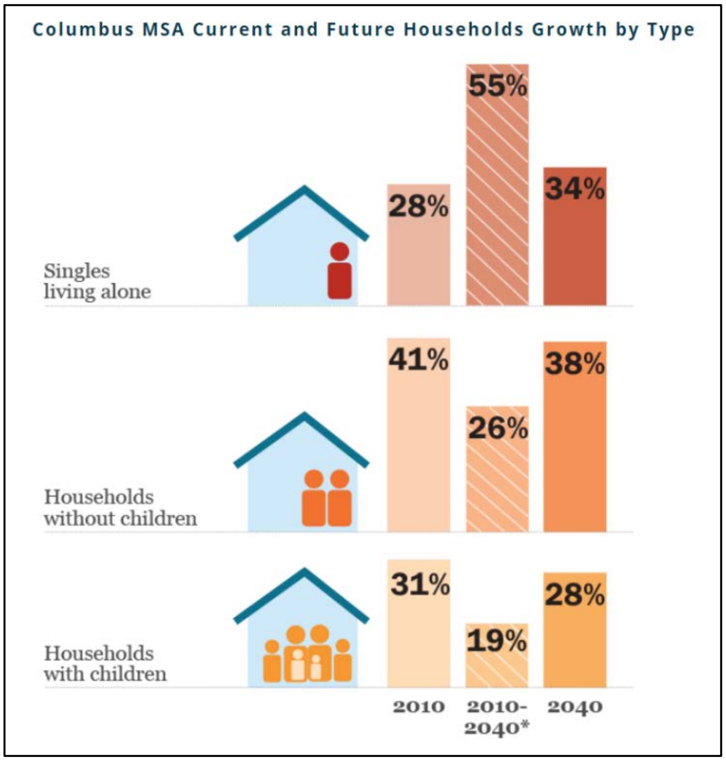
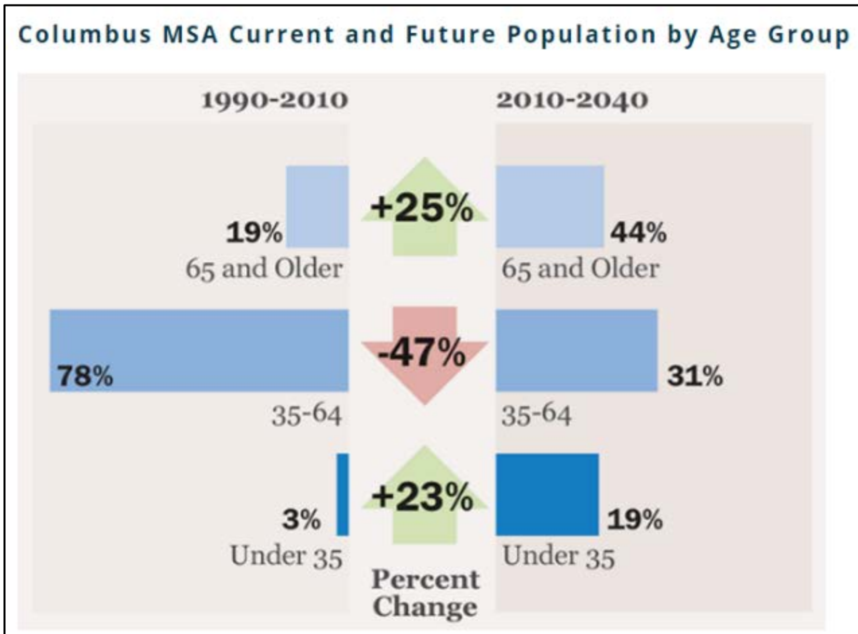


FIGURE 8: PROJECTED DEMOGRAPHIC CHANGES



Source: Arthur C. Nelson, COLUMBUS< OHIO Metropolitan Area trends, Preferences and opportunities: 2010 to 2030 and to 2040 (NRDC)

Franklin County Greenways Plan

The Franklin County Greenways Plan provides a comprehensive view of river and stream management, focusing on ecological, environmental and conservation interests. However, several recommendations made in the Greenways Plan are consistent with the goals and objectives established in the Franklin County Natural Hazard Mitigation Plan.

Recommendations from the Franklin County Greenways Plan that are consistent with the objectives of this plan include:

- A more consistent, regional approach to river related development including subdivision, stormwater management, erosion, and sediment control regulations.
- Encourage countywide participation in the Community Rating System (CRS) of the National Flood Insurance Program (NFIP). Currently, only the Village of Obetz participates in the Community Rating System.
- Implementation of a regulatory floodplain for Franklin County.

Lower tax rates for floodplain properties to encourage owners to leave the floodplain in a natural state.

Capability Assessment

The purpose of the Capability Assessment is to identify strengths and weaknesses that will affect the ability of the County and participating jurisdictions to implement mitigation actions. Capabilities include a variety of regulations, existing planning mechanisms, and administrative capabilities provided through established agencies or authorities.

Regulatory Capabilities

A **zoning ordinance** specifies the types of development that can occur in particular locations. The Franklin County Zoning Resolution applies to unincorporated land in Blendon, Brown, Clinton, Franklin, Hamilton, Madison, Mifflin, Norwich, Pleasant, Sharon and Truro Townships. The remaining 6 townships all have adopted township zoning: Jackson, Jefferson, Perry, Plain, Prairie and Washington Townships. Subdivision regulations further specify how land can be divided. Franklin County and all 15 cities have adopted Subdivision Regulations. The Franklin County Subdivision Regulations apply to unincorporated land in all townships.

Stormwater management regulations provide for the conveyance of stormwater to decrease flooding. Stormwater Management requirements are covered in the Franklin County Subdivision Regulations, Franklin County Zoning Resolution, the township zoning resolutions, and the Franklin County Stormwater Drainage Manual. Stormwater regulations can vary from jurisdiction to jurisdiction, however most have adopted some form of stormwater regulation.

Adoption and enforcement of **building codes** ensure that both residential and commercial structures are safe. Every municipality in Franklin County has adopted the 2009 International Code Council (ICC) Family of Model Codes including the 2009 International Residential Code (IRC).

A local **historic district ordinance** enables a community to regulate development in a specific, designated area of historic significance.

Table 14 identifies Planning mechanisms for Franklin County and summarizes the regulatory tools used in Franklin County and participating jurisdictions. These regulations support the goals of this hazards mitigation plan and provide opportunities for further mitigating the potentially negative effects of natural hazards through regulation.

NFIP

The Franklin County Special Resolution NFIP Regulation applies to unincorporated land in all townships. **All jurisdictions participate in the National Flood Insurance Program with the exception of the Villages of Brice, Harrisburg and Urbancrest**. All jurisdictions have adopted **floodplain management ordinances** to regulate development in the floodplain.

TABLE 13: NFIP PARTICIPATION (POLICIES IN-FORCE)

Jurisdiction	Policies In-Force	Insurance In-Force Whole $	Written Premium In-Force	Total Losses	Total Payments $
FRANKLIN COUNTY	706	$96,558,400	865,973	220	1,048,384.96
BEXLEY, CITY OF	35	$9,988,900	18,042	23	48,583.61
GAHANNA, CITY OF	76	$23,100,200	160,719	26	90,787.49
GRANDVIEW HEIGHTS, CITY OF	45	$8,327,100	51,856	3	29,877.05
GROVE CITY, CITY OF	51	$10,468,700	49,811	44	129,492.48
GROVEPORT, CITY OF	12	$3,071,900	14,787	9	99,738.56
HILLIARD, CITY OF	18	$6,047,500	16,815	4	2,387.83
LOCKBOURNE, VILLAGE OF	4	$292,000	5,785	1	9,250.18
MARBLE CLIFF, VILLAGE OF	1	$350,000	411		
MINERVA PARK, VILLAGE OF	1	$210,000	351	3	6,322.85
OBETZ, VILLAGE OF	4	$1,240,000	1,832		
RIVERLEA, VILLAGE OF	1	$350,000	415		
UPPER ARLINGTON, CITY OF	46	$13,412,800	47,965	42	157,699.55
VALLEYVIEW, VILLAGE OF	5	$828,100	11,803	8	69,937.88
WHITEHALL, CITY OF	88	$10,521,200	94,041	45	82,472.46
WORTHINGTON, CITY OF	37	$10,109,500	30,234	52	220,505.90

The National Flood Insurance Program's (NFIP) Community Rating System (CRS) was implemented in 1990 as a program for recognizing and encouraging community floodplain management activities that exceed the minimum NFIP standards. Under the CRS, flood insurance premium rates are adjusted to reflect the reduced flood risk resulting from community activities that meet the three goals of the CRS: (1) reduce flood losses; (2) facilitate accurate insurance rating; and (3) promote the awareness of flood insurance. Discounts on premiums may range from 5% to 45% based on the actions taken in each community. CRS provides credit for adopting, implementing, evaluating and updating a comprehensive floodplain management plan. Currently, only the Village of Obetz in Franklin County is identified as a CRS participating community.

TABLE 14: REGULATORY CAPABILITIES

Jurisdiction	Zoning Ordinances	Subdivision Regulations	Floodplain Management Regulations	Stormwater Management Regulations	Building Codes	Historic Preservation Ordinance
Bexley City	✓	✓	✓	✓	✓	✓
Canal Winchester City	✓	✓	✓		✓	
Columbus City	✓	✓	✓	✓	✓	✓
Dublin City	✓	✓	✓	✓	✓	✓
Gahanna City	✓	✓	✓	✓	✓	
Grandview Heights City	✓	✓	✓	✓	✓	✓
Grove City	✓	✓	✓	✓	✓	
Groveport City	✓	✓	✓	✓	✓	
Hilliard City	✓	✓	✓	✓	✓	
New Albany City	✓	✓	✓	✓	✓	✓
Reynoldsburg City	✓	✓	✓	✓	✓	✓
Upper Arlington City	✓	✓	✓	✓	✓	✓
Westerville City	✓	✓	✓	✓	✓	✓
Whitehall City	✓	✓	✓	✓	✓	✓
Worthington City	✓	✓	✓	✓	✓	✓
Brice Village			✓		✓	
Harrisburg Village			✓		✓	✓
Lockbourne Village			✓		✓	
Marble Cliff Village			✓		✓	
Minerva Park Village			✓		✓	
Obetz Village			✓		✓	
Riverlea Village			✓	✓	✓	✓
Urbancrest Village			✓	✓	✓	✓
Valleyview Village			✓	✓	✓	✓
Blendon Twp	✓	✓	✓	✓	✓	
Brown Twp	✓	✓	✓	✓	✓	
Clinton Twp	✓	✓	✓	✓	✓	
Franklin Twp	✓	✓	✓	✓	✓	
Hamilton Twp	✓	✓	✓	✓	✓	
Jackson Twp	✓	✓	✓	✓	✓	

Jurisdiction	Zoning Ordinances	Subdivision Regulations	Floodplain Management Regulations	Stormwater Management Regulations	Building Codes	Historic Preservation Ordinance
Jefferson Twp	✓	✓	✓	✓	✓	
Madison Twp	✓	✓	✓	✓	✓	
Mifflin Twp	✓	✓	✓	✓	✓	
Norwich Twp	✓	✓	✓	✓	✓	
Perry Twp	✓	✓	✓	✓	✓	
Plain Twp	✓	✓	✓	✓	✓	
Pleasant Twp	✓	✓	✓	✓	✓	
Prairie Twp	✓	✓	✓	✓	✓	
Sharon Twp	✓	✓	✓	✓	✓	
Truro Twp	✓	✓	✓	✓	✓	
Washington Twp	✓	✓	✓	✓	✓	

= No

Critical, Facilities & Infrastructure

Critical Facilities are defined as locations necessary to coordinate response activities. These include emergency operations centers, 911 communication centers, police and fire stations, public works facilities, sewer and water plants, and hospitals. These are facilities that, if damaged, could cause serious secondary impacts.

Infrastructure generally refers to services necessary to respond to and recover from the hazard such as power lines, gas lines, bridges, highways, roads, railroads and airports.

There are currently 16 hospitals within Franklin County. It is important to note that Mt. Carmel West was originally located in the 100-year floodplain. However, with the completion of the Franklinton Floodwall, the hospital is no longer located in the floodplain.

TABLE 15: INFRASTRUCTURE AND ASSETS

Critical Facilities, Infrastructure and Assets	Number/Description
Communications	
Television Stations	7
Radio Stations	32
Weekly Newspapers	19
Daily Newspapers	1

Education	
Public School Buildings	387
Non-public Schools	80
4-year public university	1
Private Universities	4
Healthcare	
Physicians	5,191
Hospitals	16
Hospital Beds	6,056
Nursing Homes	60
Transportation	
Interstate Miles	118.63
US Highway Miles	117.76
State Highway Miles	122.54
County, Municipal Road Miles	4,299.74
Commercial Airports	6

Planning Capabilities

A variety of planning mechanisms are used in Franklin County and participating jurisdictions. Other plans can support the goals of this hazards mitigation plan and provide opportunities for integrating actions that will mitigate the potentially negative effects of natural hazards with actions designed to achieve other goals. The Mitigation Core Group, which has many representatives involved in the planning mechanisms denoted in this plan, suggested a process for incorporating mitigation alternatives and strategies into other existing planning efforts. The process includes coordination between the agencies involved in the developing the planning mechanisms for Franklin County and the participating jurisdictions. As part of their continued commitment to be on the Mitigation Core Group, each member will evaluate the mitigation alternatives, short and long term and the jurisdictional alternatives to potentially add to their existing plans. Many of the plans already denote the Franklin County Mitigation Plan as reference for the County and jurisdictions. As part of the Mitigation Plan monitoring and evaluation efforts the Mitigation Core Group will then validate the incorporation of key mitigation alternatives into the planning mechanisms during the Mitigation Plan updating process.

The **Columbus Comprehensive Plan** was completed and adopted in 1993. A comprehensive plan is a policy document identifying community goals and objectives for future growth and development. The Plan is intended to serve as a guide with which to protect and enhance the quality of life in Columbus. It accomplishes this by fostering orderly, manageable, and cost-effective growth and establishing a framework for future land use decisions.

FCEM&HS was established according to Ohio Revised Code (ORC) Section 5502.26 governing countywide emergency management. The countywide agreement between all 41 jurisdictions in Franklin County establishing FCEM&HS as the emergency management agency for the entire county was signed in 1988 and is on file at the offices of FCEM&HS. This **Franklin County Emergency Operations Plan (EOP)** serves as the legally required all hazards emergency operations plan for all 41 jurisdictions within Franklin County and is produced by FCEM&HS. The Franklin County EOP addresses Franklin County's planned response to extraordinary emergency situations associated with all hazards such as natural disasters, technological emergencies and acts of civil hostility. When confronted with a minor emergency, local agencies routinely carry out their responsibilities independent of other agencies or with pre-existing mutual aid agreements. However, large-scale emergencies and disasters often create situations requiring planned, coordinated responses by multiple agencies and jurisdictions. Such disasters and emergencies pose major threats to life and property and have long-term economic, political, and/or environmental implications.

Emergency Action Plans have been prepared according to state law for high hazard dams located in Franklin County as well as those for which the inundation area includes parts of Franklin County. Each Emergency Action Plan addresses ways to safeguard lives and reduce property damage within the inundation area; procedures for effective dam surveillance; procedures for prompt notification of emergency management officials; warning and evacuation procedures; and emergency response actions that will be taken in the event of potential or imminent failure of the dam. Plans have been prepared, reviewed by Franklin County officials, and are on file at the FCEM&HS Office for the following dams:

- Hoover Dam- operated by the City of Columbus
- O'Shaughnessy Dam- operated by the City of Columbus
- Griggs Dam- operated by the City of Columbus
- Delaware Dam- operated by the Army Corps of Engineers
- Alum Creek Dam- operated by the Army Corps of Engineers

Franklin County and the City of Columbus address regional planning concerns by participating in planning activities with the Mid-Ohio Regional Planning Commission (MORPC). The City of Columbus has over 50 comprehensive area plans addressing land use issues within the City. Many other Franklin County jurisdictions have similar plans in place, which are discussed in the table below.

TABLE 16: PLANS

Community	Type of Community	Type of Plan	Plan
Bexley	City	Area Plan	Southwest Bexley Master Plan
Bexley	City	Land Use Plan	Bexley Land Use Strategy
Bexley	City	Site Plan	Jeffrey Park Master Plan
Bexley	City	Area Plan	Southwest Bexley Master Plan
Blendon Township (Franklin County)	Township	Comprehensive Plan	Blendon Community Plan
Blendon Township (Franklin County)	township	Area Plan	Westerville Road Area Plan
Brown Township (Franklin County)	Township	Comprehensive Plan	Brown Township Comprehensive Plan
Canal Winchester	Village	Area Plan	Canal Winchester and Violet Township CEDA Plan
Canal Winchester	Village	Area Plan	Violet Pointe: CEDA Area Land Use Plan & Development Standards. Canal Winchester/Violet Township "Moving Forward Together" 2002
Canal Winchester	City	Area Plan	Canal Winchester Old Town Plan
Clinton Township (Franklin County)	Township	Land Use Plan	Clinton-Mifflin Land Use Plan
Clinton Township (Franklin County)	Township	Area Plan	Cleveland Avenue Streetscape 2020
Columbus	City	Area Plan	315 Research & Technology Corridor: Business Plan
Columbus	City	Area Plan	315 Research & Technology Corridor: Master Plan
Columbus	City	Area Plan	Big Darby Accord
Columbus	City	Area Plan	Greater Parson's Avenue Area Vision Plan
Columbus	City	Area Plan	Hamilton Road Corridor / Eastland Area Revitalization Plan
Columbus	City	Area Plan	Harrison West Plan
Columbus	City	Area Plan	Milo-Grogan Neighborhood Plan
Columbus	City	Area Plan	Northeast Area Plan
Columbus	City	Area Plan	Riverfront Vision Plan
Columbus	City	Area Plan	North Discovery District
Columbus	City	Area Plan	Tri-South Neighborhood Plan
Columbus	City	Area Plan	South Alum Creek Neighborhood Plan
Columbus	City	Area Plan	North Linden Neighborhood Plan Amendment
Columbus	City	Area Plan	Southeast Area Plan
Columbus	City	Area Plan	Holtzman-Main Neighborhood Plan

Columbus	City	Area Plan	McKinley Avenue Corridor Plan
Columbus	City	Comprehensive Plan	Columbus Comprehensive Plan
Columbus	City	Area Plan	South Central Accord
Columbus	City	Area Plan	Westland Plan
Columbus	City	Area Plan	Italian Village East Redevelopment Plan
Columbus	City	Area Plan	Near East Area Plan
Columbus	City	Area Plan	South Linden Neighborhood Plan
Columbus	City	Area Plan	North Market Plan Update 1993
Columbus	City	Area Plan	North Central Plan
Columbus	City	Area Plan	South Side Plan
Columbus	City	Area Plan	Southeast Area Plan - Bixby Road Economic Development Amendment
Columbus	City	Land Use Plan	Southwest Area Plan
Columbus	City	Area Plan	Fifth by Northwest Neighborhood Plan
Columbus	City	Area Plan	Clintonville Neighborhood Plan
Columbus		Area Plan	Livingston East Area Plan
Columbus	City	Area Plan	Scioto Southland Area Plan
Columbus	City	Area Plan	Greater Hilltop Plan Amendment (2010)
Columbus	City	Area Plan	King-Lincoln District Plan
Columbus	City	Area Plan	Broad-Blacklick Area Plan
Columbus	City	Area Plan	East Columbus Neighborhood Plan
Columbus	City	Area Plan	Near Southside Area Plan
Columbus	City	Area Plan	Interim Hayden Run Corridor Plan
Columbus	City	Area Plan	East Franklinton Creative Community District Plan
Columbus		Area Plan	Columbus Near East Side Blueprint for Community Investment
Columbus		Area Plan	Olentangy West Area Plan
Columbus		Area Plan	Northland I Area Plan
Columbus	City	Area Plan	Trabue/Roberts Area Plan
Columbus	City	Area Plan	West Franklinton Plan
Columbus	City	Area Plan	Northwest Plan
Columbus	City	Area Plan	Brice Tussing Market Study
Columbus	City	Area Plan	Eastmoor: Main and Broad Street Corridor Revitalization Plan
Columbus	City	Area Plan	Greater Hilltop Plan (2001)
Columbus	City	Area Plan	Northland Plan - Volume II
Columbus	City	Area Plan	Warehouse District Plan
Columbus	City	Area Plan	University District Plan
Columbus	City	Area Plan	South Central Accord Amendment

			(2000)
Columbus	City	Area Plan	South Central Accord Amendment (2004)
Columbus State		Area Plan	Columbus State Community College Master Plan: A Flexible Framework
Dublin	City	Comprehensive Plan	City of Dublin 2007 Community Plan
Dublin	City	Area Plan	Bridge Street Corridor Study: Planning Foundations
Dublin	City	Area Plan	Bridge Street Corridor Study Vision Report
Dublin	City	Comprehensive Plan	Community Plan
Dublin	City	Area Plan	Crossroads Area Plan
Dublin	City	Area Plan	Bridge Street District Area Plan
Franklin County	County	Area Plan	Southwest Area Plan
Franklin County	County	Land Use Plan	Clinton-Mifflin Land Use Plan
Franklin County	County	Area Plan	Scioto-Franklin Neighborhood Plan
Franklin County		Area Plan	Big Darby Town Center Master Plan
Franklin County	County	Area Plan	Big Darby Accord
Franklin County		Area Plan	Clinton West Neighborhood Plan
Franklin Township (Franklin County)	Township	Land Use Plan	Southwest Area Plan
Franklin Township (Franklin County)	Township	Area Plan	Westland Area Interim Development Framework
Gahanna	City	Area Plan	The West Gahanna Development Study
Gahanna	City	Area Plan	Heartland Concept Plan
Gahanna	City	Area Plan	Olde Gahanna and Creekside Traffic Study
Gahanna	City	Area Plan	Olde Gahanna Beautification Plan
Gahanna	City	Area Plan	Olde Gahanna Vision Plan
Gahanna	City	Comprehensive Plan	Land Use Plan Update
Gahanna	City	Corridor Plan	Hamilton Road Corridor Plan
Grandview Heights	City	Area Plan	Grandview Avenue District Plan
Grandview Heights	City	Area Plan	Southeast Area Residential Neighborhood Plan
Grove City	City	Land Use Plan	Grove City Land Use Analysis
Grove City	City	Area Plan	Grove City Town Center Plan
Groveport	City	Comprehensive Plan	Groveport Ohio Comprehensive Plan
Hamilton	Township	Comprehensive Plan	Obetz & Hamilton Township Community Plan
Hilliard	City	Comprehensive Plan	Hilliard Comprehensive Plan
Jackson Township	township	Comprehensive Plan	Jackson Township Comprehensive Plan

Jackson Township (Franklin County)	Township	Land Use Plan	Southwest Area Plan
Jefferson Township (Franklin County)	Township	Comprehensive Plan	Jefferson Township Comprehensive Land Use Plan
Madison Township (Franklin County)	Township	Comprehensive Plan	Madison Township Comprehensive Plan
Mifflin Township (Franklin County)	Township	Land Use Plan	Clinton-Mifflin Land Use Plan
New Albany	City	Area Plan	Village Center Plan
New Albany	City	Area Plan	Research & Information District
New Albany	City	Comprehensive Plan	Village Center Strategy
New Albany	City	Comprehensive Plan	New Albany Strategic Plan
New Albany	City	Area Plan	Triangle Area Plan
Norwich Township (Franklin County)	Township	Comprehensive Plan	Norwich Township Land Use Plan
Obetz	Village	Area Plan	The Obetz Triangle
Obetz	Village	Comprehensive Plan	Obetz & Hamilton Township Community Plan
Ohio State University	University	Area Plan	The Ohio State University Framework Plan
Ohio State University		Area Plan	15+High Project
Plain Township	Township	Comprehensive Plan	Land Use Plan 2012 Update
Pleasant Township (Franklin County)	Township	Comprehensive Plan	Pleasant Township Comprehensive Plan
Prairie Township (Franklin County)	township	Comprehensive Plan	Prairie Township Comprehensive Plan Update
Reynoldsburg	City	Area Plan	Olde Reynoldsburg Strategic Plan
Reynoldsburg	City	Area Plan	Brice and Livingston Strategic Area Plan
Upper Arlington	City	Comprehensive Plan	City of Upper Arlington Master Plan
Upper Arlington	City	Comprehensive Plan	2013 Master Plan
Washington Township (Franklin County)	Township	Comprehensive Plan	Washington Township Comprehensive Plan
Washington Township (Franklin County)	Township	Area Plan	Big Darby Accord
Westerville	City	Area Plan	Central College Area Plan
Westerville	City	Area Plan	Otterbein Master Plan
Westerville	City	Area Plan	North Westerville Plan
Westerville	City	Comprehensive Plan	Imagine Westerville Community Plan
Westerville	City	Area Plan	South State Street Study and Guidelines
Westerville	City	Area Plan	Westerville Road Area Plan
Worthington	City	Comprehensive Plan	Comprehensive Plan Update & Strategic Plan for Worthington
Worthington		Area Plan	Wilson Bridge Road Corridor Study

The Franklin County Natural Hazard Mitigation Plan identifies the potential impacts of natural hazards in Franklin County and makes recommendations that can be included in existing and future programs. Upon adoption of the Mitigation Plan, FCEM&HS will continue to work with local municipalities to incorporate natural hazard mitigation goals and actions into their local planning objectives.

FCEM&HS Mission and Vision

Mission- Franklin County Emergency Management & Homeland Security coordinates and prepares for county-wide all-hazards disaster planning, community education, warning, training, grant funding, response, and recovery efforts in order to prepare and protect the citizens of Franklin County before, during, and after natural and man-made disasters.

Vision- To establish Franklin County Emergency Management & Homeland Security as the center of excellence and influence for Emergency Management and Homeland Security programs and requirements within Franklin County.

Emergency Response Functions

FCEM&HS serves as the emergency management agency for all 41 jurisdictions in Franklin County and focuses on the following core competencies: warning systems, emergency operations center, resources, recovery, planning, training, exercises, citizen preparedness, and grants.

Weather Forecasting

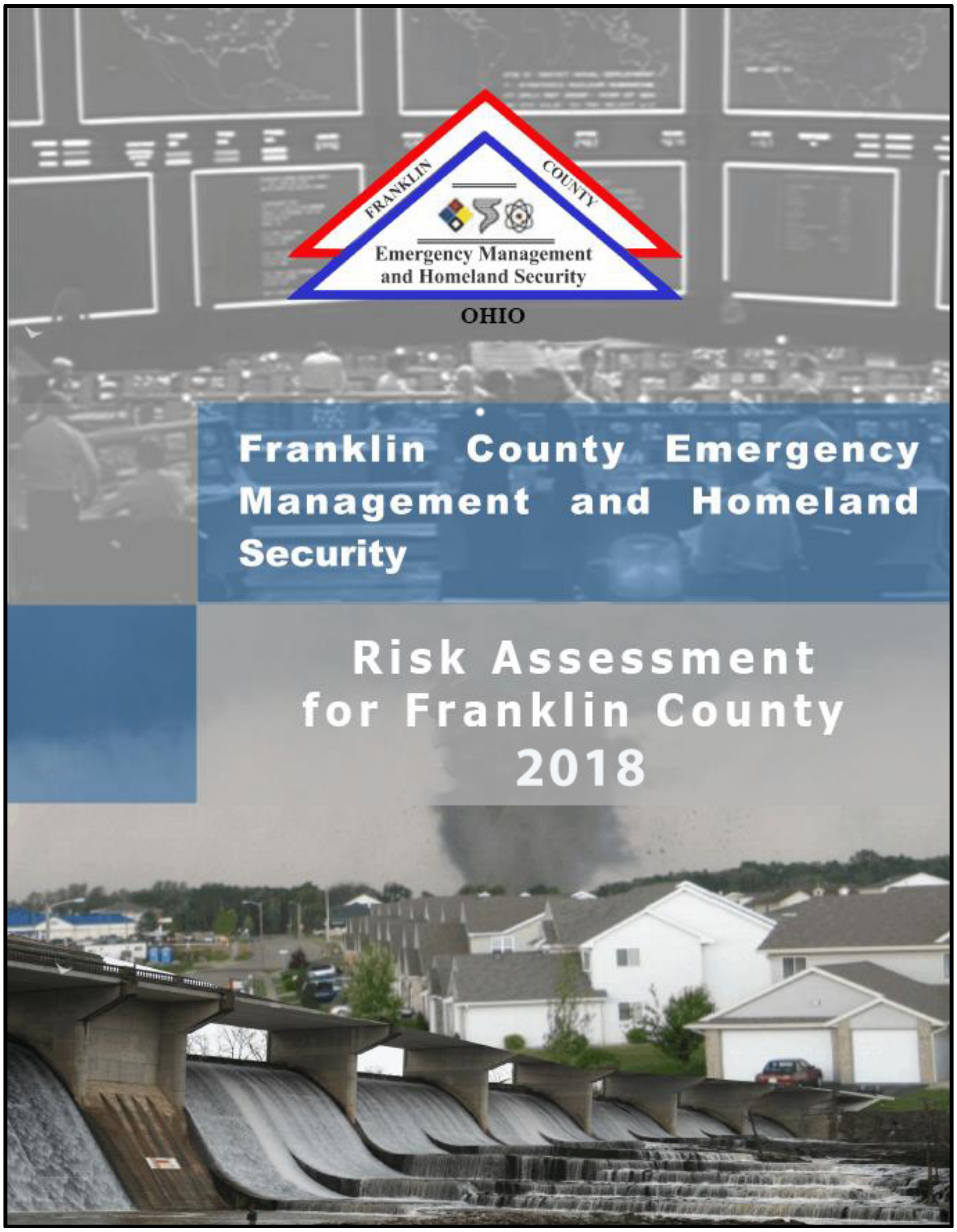
The Wilmington, Ohio office of the National Weather Service provides weather watches and warnings for Franklin County in conjunction with the Storm Prediction Center in Norman, Oklahoma. When considering severe summer storms, the most common advisories relate to severe thunderstorm watches and warnings, and high wind warnings and advisories. Tornado and flood related advisories are also common. When the National Weather Service issues a tornado warning the Franklin County outdoor warning sirens are immediately sounded countywide. Others means of notification of severe weather within Franklin County include broadcast radio, local television stations, and NOAA weather radios. The National Weather Service defines a WARNING as an event that alone poses a significant threat to public safety and/or property, probability of occurrence and location is high, and the onset time is relatively short. A WATCH meets the classification of a warning, but either the onset time, probability of occurrence, or location is uncertain.

NOTE: Additional Franklin County and jurisdictional information can be found in **Appendix A. Risk Assessment for Franklin County 2018** (Section 2: Franklin County Profile).

HAZARD IDENTIFICATION

See **Appendix A. Risk Assessment for Franklin County 2018** to access the full risk assessment document. This section only provides a summary of the hazards included in this plan, and the overall findings as it pertains to the **Natural Hazards** that may potentially impact the county.

FIGURE 9: RISK ASSESSMENT FOR FRANKLIN COUNTY 2018



Hazard Identification Update

Only natural hazards are identified and examined in this plan update as required by the Disaster Mitigation Act of 2000. See **Appendix A. Risk Assessment for Franklin County 2018** for all of the hazard-specific information and history of each hazard within the county.

The table below compares the hazards identified for the initial plan, seven natural hazards identified and analyzed in the 2012 update, and 10 natural hazards identified and analyzed for the 2018 update.

TABLE 17: IDENTIFIED HAZARDS

Hazards Identified for 2007 Plan	Hazards Identified for the 2012 Plan	Hazards Identified for the 2018 Plan
Flooding	Flooding	Flooding
Winter Storms	Severe Winter Weather	Severe Winter Weather
Tornadoes	Tornadoes	Tornadoes
Thunderstorms	Severe Summer Weather	Severe Summer Weather
Drought	Drought	Drought
----	Invasive Species	Invasive Species
Earthquake	Earthquake	Earthquake
		Extreme Heat
		Dam/Levee Failure
		Karst/Sinkhole

During the planning process, Franklin County and community representatives considered all natural hazards for inclusion in the plan. Per FEMA's mandate to address all natural hazards, the following natural hazards were not included because these hazards do not directly impact the County or have not created problems in the past. They are:

- Hurricanes
- Landslides
- Sea Level Rise
- Space Weather
- Storm Surge
- Tsunami
- Wildfire

***Note**: Although Space Weather is addressed in the **2018 Risk Assessment for Franklin County**, the Core Group determined that Space Weather would not be included in the 2018 Natural Hazard Mitigation Plan because it is not a typical hazard that offers many realistic and fundable mitigation opportunities for the participating jurisdictions. Wildfire was also not included because fire departments have determined the risk of wildfire is low enough that many departments are no longer maintaining brush fire trucks.*

Identifying Hazards

To reduce the potential for damage due to hazards, it is necessary to identify hazards that may affect the County. This process was completed during the update of the **2018 Risk Assessment for Franklin County**. The methodology used to identify and rank the hazards faced in Franklin County can be found in **Appendix A. Risk Assessment for Franklin County 2018**. Hazard identification investigates, identifies and documents potential hazards, and examines their causes and impact chains, which can vary in length. The severity of impact is further influenced by vulnerability factors (water catchment areas, steep slopes) and whether there are elements present which are vulnerable to the hazard, e.g., structures in low lying areas.

Knowledge of the types of hazards that may impact an area is essential for analyzing and assessing risks. Hazards require different levels of risk assessment depending on the extent of the impact they can have on the community. A hazard that is unlikely to happen (and if it does, causes very little damage) will not require the same level of assessment as one that happens frequently and causes severe damage.

Steps in Hazard Identification

1. Identification and classification of hazards.
2. Determination of appropriate risk analysis level, based on potential impact and data available.
3. Identification and characterization of hazard-prone locations.
4. Estimation of the probability of occurrence.
5. Estimation of possible magnitude.

Hazard identification describes and assesses the frequency of occurrence, at a specific place, at a specific time, and with a specific intensity and duration, for a vulnerable population, property, economy and environment.

Countywide hazards, which include Severe Winter Weather, Tornadoes, Severe Summer Weather, Drought, Invasive Species, Earthquakes, and Extreme Heat affect **<u>all</u>** participating jurisdictions of this plan. The following is a brief description of each of the natural hazards impacting the County.

Dam Failure/Levee Failure

Dam/ Levee Failure is defined as an uncontrolled release of impounded water. A dam is defined as an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material, for the purpose of storage or control of water. The causes of dam failures include overtopping caused by floods that exceed the capacity of the dam, deliberate acts of sabotage, structural failure of materials used in dam construction, movement and/or failure of the foundation supporting the dam, settlement and cracking of concrete or embankment dams, piping and internal erosion of soil in embankment dams, and inadequate maintenance and upkeep. Despite efforts to provide sufficient structural integrity and to perform inspection and maintenance, problems can develop that can lead to failure. While most dams have storage volumes small enough that failures would have little or no consequences, dams with large storage amounts could cause significant flooding downstream. The O'Shaughnessy Dam and the Hoover Dam are the two dams impacting Franklin County that are found on the Ohio EMA's list of the ten most potentially hazardous dams in the state, based on the possible catastrophic consequences should they fail.

A levee is any artificial barrier together with appurtenant works that will divert or restrain the flow of a stream or other body of water for the purpose of protecting an area from inundation by flood waters. Generally, a levee is subjected to water loading during a few days or weeks in a given year; unlike a dam that is retaining water most days in the same year. A levee breach results when a portion of the levee breaks away, providing an opening for water to flood the landward side of the structure. Such breaches can be caused by surface erosion due to water velocities, or they can be the result of subsurface actions. Levee overtopping is similar to dam overtopping in that the flood waters simply exceed the design capacity of the structure, thus flowing over the lowest crest of the system. Such overtopping can lead to erosion on the landward side which, subsequently, can lead to breaching. The National Levee Database lists the West Columbus Local Protection Project (LPP), Agg Rok Reach Levee, and King Ave Levee as the three levees in Franklin County.

Drought

Drought is defined as a prolonged period of abnormally dry weather, where the lack of sufficient precipitation causes a serious hydrologic imbalance with economic and/or social consequences. Franklin County is primarily impacted by drought relating to shortages in the water supply as well as a decrease in overall water quality. Drought also greatly impacts land throughout the county that is utilized as cropland or pasture.

Earthquakes

Earthquakes are caused by the movement of the earth’s crustal plates along faults. Franklin County is not located on a fault line, nor have any epicenters been located in Franklin County. Earthquakes occurring in other areas have been felt in Franklin County; however, no damage has been reported.

Extreme Heat

Extreme Heat events, or heat waves, are prolonged periods of excessively hot weather, which may be accompanied by high humidity. In 2012, three people died as a result of extreme heat in Ohio. From 2004-2013, the average number of heat related deaths per year exceeded all other weather related fatalities.

Flooding

Flooding occurs in many forms, from naturally occurring to human-induced. Common to all flooding is the accumulation of too much water in too little time in too small a place. From 1950 to December 2017, 116 flood and flash flood events were reported in Franklin County according to the NOAA National Climactic Data Center Storm Events Database. From 1999 to 2017 Franklin County was subject to many different types of flooding and received as many as 10 flood warnings in a single year. Flash flooding is the deadliest form of flooding in the United States.

Invasive Species

Invasive Species are defined as any species that is not native to an ecosystem and whose introduction causes or is likely to cause harm to the economy, environment, or human health. An increasing threat of exotic diseases, such as the dangerous West Nile virus, exists because of increased transportation and encroachment of humans into previously remote ecosystems. Two events that have caused substantial economic and environmental damage in Ohio are the introduction of zebra mussels into waterways and the infestation of the emerald ash borer, responsible for killing ash trees.

Karst/Sinkholes

Karst refers to a landform that develops on or in limestone, dolomite, or gypsum by dissolution and that is characterized by the presence of characteristic features such as sinkholes, underground (or internal) drainage through solution-enlarged fractures (joints), and caves. Sudden collapse of an underground cavern or opening of a sinkhole can cause surface subsidence that can severely damage or destroy any overlying structure such as a building, bridge, or highway. A sinkhole is a hole that forms in the Earth's surface as a result of the chemical weathering of carbonate rocks like limestone, as well as salt beds or rocks that can be severely weathered as water runs through them and erosion.

Severe Summer Weather

Severe Summer Weather is classified as thunderstorms, hail, lightning, and damaging wind. Each of these hazards has its own severity measure and often all four occur in one storm system, causing much more damage than each would have alone. According to the NOAA National Climactic Data Center's Storm Events Database, there were 436 strong/high/thunderstorm wind, and lightning events, as well as 212 hail events, for Franklin County from January 1950 to December 2017.

Severe Winter Weather

Severe Winter Weather is classified as snow, ice and extremely cold conditions. Winter storms are events in which the dominant forms of precipitation occur only at cold temperatures. According to the NOAA National Climactic Data Center's Storm Events Database, there were reports of 94 winter weather events for Franklin County from January 1996 to December 2017.

Tornadoes

Tornadoes are nature's most violent windstorms – even weak ones can cause significant damage and fatalities. A tornado is defined as a rotating column of air, in contact with the surface, pendant from a cumuliform cloud, and often visible as a funnel cloud and/or circulating debris/dust at the ground. According to the National Climactic Data Center, 32 tornadic events were reported in Franklin County from January 1950 through December 2017, all of which were rated F3 (or EF3) and under.

SUMMARY OF RISK ASSESSMENT FINDINGS

The purpose of completing a rigorous assessment of risk is to inform decision-making about the mitigation actions that are most appropriate to implement in relation to the hazards affecting Franklin County.

The conclusion of the risk assessment findings is that the greatest damage attributable to a single hazard occurring in Franklin County is tornado and flooding (see **Appendix A. Risk Assessment for Franklin County 2018)**. This is not to suggest that other hazards do not pose a threat. However, based on historical incidents and their impacts and the likelihood of future occurrences, tornado and flooding offer many opportunities to mitigate.

Risk Methodology and Scoring

Risk Factors

For each hazard, each risk factor was scored on a scale of 0 – 5. Benchmark descriptions for each rating's numerical value were described in the methodology section of **Appendix A. Risk Assessment for Franklin County 2018**. The ratings were based largely on historical data in regards to natural disasters. The objective of scoring the threats and hazards was to obtain ordinal data so the threats and hazards can be compared to one another. The following represent the key risk factors:

- **Likelihood Factor**: For natural hazards the historical incidence, when readily available, was used to estimate the likelihood of an event occurring in Franklin County. When data was not readily available, the Workgroup's collective opinion was used to estimate the likelihood of the threat or hazard occurring.
- **Special Circumstance Factor**: For non-terrorist hazards, events or conditions that may increase the historical occurrence of natural disasters (e.g. climate change) or technological failures (aging infrastructure) are also important risk modifying factors.
- **Loss of Life Factor**: An estimation of the number of lives lost, based on the severity of the event, historical data, and the maximum amount of workers, visitors, and general public that are expected to be at the location of an event at the time of its proposed occurrence.
- **Injury Factor**: An estimation of the total number of individuals (workers, visitors, and general public) that are likely to require hospitalization and/or outpatient care until full recovery.
- **Property Damage Factor**: An estimation in dollars of the total cost for the restoration of damaged property, including replacement of physical structures, demolition and waste removal, and any restoration activities following any event.
- **Economic Impact Factor**: An estimation of the impact, expressed in terms of dollars, on the local economy is based on a loss of business revenue, worker wages and local tax revenues or on the impact on the local gross domestic product (GDP).

- **Relocation Factor**: An estimation of the total number of households (not individuals) requiring relocation for more than a week from their primary residence. Households falling within this category will likely experience psychological stress attributable to the event. Additionally, the number of household requiring relocation provides an indirect indication of the extent of property damage.
- **Speed of Onset**: An estimation of the duration in time from when those impacted by the event are first warned of the event and the time for when the associated negative consequences cannot be avoided. It is presumed that the greater the speed of onset, the more severe the likely negative consequences.

Weighted Factors

Each of the risk factors were then weighted according to their perceived importance by the FCEM&HS Risk Assessment Workgroup, which was charged with conducting the risk evaluations. The weighed value represents how significant the specific risk factor is relative to the overall risk rating. The total weighted score was used for ranking purposes. The weighted risk values for each risk factor are as follows:

TABLE 18: RISK FACTORS

Risk Factor	Weighted Factor
Likelihood of Occurrence	15
Special Circumstance	10
Loss of Life	30
Injuries	25
Property Damage	15
Economic Impact	15
Relocation	10
Speed of Onset	10

Risk Formula

The overall relative risk score for a particular threat or hazard scenario is then determined by multiplying the 0 to 5 scaled risk factor value (RF) by the appropriate weighted value (W) and then summing the resulting product across all eight risk factors, as follows:

Relative Risk Score = $RF_1 \times W_1 + RF_2 \times W_2 + \ldots + RF_8 \times W_8$

For example, the following scenario received a relative risk score (425) as calculated in the following table:

TABLE 19: RISK SCORING PROCESS

Risk Factor	Risk Factor Score (RF)	Weighted Value (W)	RF x W
Likelihood of Occurrence	1	15	15
Special Circumstances	2	10	20
Loss of Life	3	30	90
Injuries	4	25	100
Property Damage	4	15	60
Economic Impact	4	15	60
Relocation	3	10	30
Speed of Onset	5	10	50
Relative Risk Score			425

Franklin County Natural Hazards Risk Scores

Franklin County Emergency Management & Homeland Security led an effort to assess and score the risks facing Franklin County utilizing a scientific methodology coupled with subject matter expertise. While utilizing a defensible scientific methodology is crucial to the risk management process, subject matter expertise and discretion also played a critical role.

The following represent the risk scores for Natural Hazards per **Appendix A. Risk Assessment for Franklin County 2018.**

TABLE 20: NATURAL HAZARD RISK SCORES

	Methodology Derived Scores	Raw Score
1	Tornadoes	379.17
2	Flooding	355.83
3	Dam/Levee Failure	338.82
4	Severe Winter Weather	281.76
5	Severe Summer Weather	260.59
6	Extreme Heat	204.12
7	Earthquakes	182.94
8	Invasive Species	168.24
9	Karst/ Sinkhole	140.00
10	Drought	135.59

MITIGATION GOALS

The Franklin County Natural Hazard Mitigation Plan Core Group developed problem statements, goals and objectives in an incremental, step-by-step process. This section summarizes the process used to develop the Action Plan for the natural hazards identified in the mitigation plan.

The mission of the Franklin County Natural Hazard Mitigation Plan is to provide a comprehensive view of natural hazards in Franklin County and make recommendations designed to protect citizens, essential facilities, infrastructure and private property from natural hazards. This can be achieved by incorporating these ideas into existing and future land use planning documents, identifying at-risk infrastructure and increasing public education about natural hazards.

The Core Group examined existing and repetitive problems occurring in Franklin County and the mitigation plan goals were identified based on their findings. The goals focus on a specific area serving as an umbrella over several problem statements related to that goal.

The plan goals determined by the Core Group provide the foundation for the Action Item recommendations. From each mitigation goal, ideas for implementation have been included to reduce or prevent losses from natural hazards in Franklin County, they are as follows:

1. **Manage Development:** Integrate goals and action items from the Franklin County Natural Hazard Mitigation Plan into existing and future land-use planning documents, and existing regulatory programs.
2. **Maintain Public & Private Infrastructure:** Develop inventories of at-risk infrastructure and prioritize preventative measures in areas vulnerable to natural hazards.
3. **Manage Debris Along Streams & Waterways:** Involve watershed and natural resource management, and all other interested parties, in natural hazards mitigation planning to rehabilitate and maintain streams and waterways.
4. **Minimize Damage to Public & Private Property:** Strengthen partnerships between government agencies and private sector businesses to develop public awareness of and involvement in natural hazards mitigation strategies.
5. **Minimize Loss of Life from Severe Weather Hazards:** Develop and implement public education programs to increase public awareness and understanding of the risks associated with natural hazards.
6. **Reduce the Number of Repetitively Damaged Existing Structures:** Protect buildings in repetitive loss areas through acquisition, elevation or other mitigating activity.

Mitigation Strategies & Additional Ideas for Implementation

There are a number of ways to mitigate the effects of future disasters on communities. This section focuses on the types of actions communities have specifically identified to mitigate risks and potential losses.

The following mitigation actions are discussed in four primary areas: preventative measures, property protection, resource protection and structural projects.

Preventative Measures

Preventative measures are those measures put in place to protect new and future development from potential hazards. Building codes, standards for manufactured homes, planning, zoning, subdivision regulations, green space preservation and stormwater management are examples of preventative measures.

Building Codes

Building Codes are a useful tool in addressing most of the hazards a community may face, including earthquakes, tornadoes, high winds and snow storms. Provisions can include anything from retrofitting roofs to accommodate heavy snows, to requiring new buildings to have tornado "safe rooms".

Manufactured Home Standards

Aside from location, manufactured or "mobile" homes are generally not regulated at the local level. They must meet construction standards set by the US Department of Housing and Urban Development (HUD). All mobile homes constructed after June 15, 1976 must comply with HUD's National Manufactured Home Construction and Safety Standards.

Mitigating activities to protect mobile homes from wind damage includes anchoring the mobile home to a permanent foundation.

Planning and Zoning

The intent of planning activities is to direct development away from areas considered to be high hazard. Various local planning documents are referenced in the flooding chapter of this plan.

Zoning ordinances or resolutions provided criteria for how land should be used within a zoning district.

Property Protection

Property protection measures are used to modify buildings or property subject to damage to lessen its impact. Flood proofing a structure is a form of property protection. A flood proofed structure is designed to allow the structure to flood with minimal damage, so the structure is usable relatively quick after the event.

Physical Barriers

A number of alternatives exist to protect property from the effects of flooding. Barriers can be created to keep a flood hazard away. The Franklinton Floodwall is an example of a flood barrier. Completed in 2004, this structure is designed to re-direct the flow of water away from improved properties in low-lying areas. Relocation, building elevation and demolition are other alternatives available to removing at-risk structures from hazard areas.

Retrofitting

Retrofitting involves modifying a property or site to minimize or prevent damage. Flood retrofitting measures can include both dry and wet flood proofing. In dry flood proofing, walls are coated with waterproofing compounds and any openings are closed. Wet flood proofing operates under the assumption that flooding will occur and everything that could be damaged by a flood is removed or elevated above the flood level. Structural components below the flood level are replaced with materials that are not subject to water damage.

Resource Protection

Resource protection involves preserving natural areas such as fields, floodplains and wetlands in a natural state. This chapter covers the resource protection programs and standards that can help mitigate the impact of natural hazards, while improving the overall environment. Many of these issues have been touched upon in the hazard specific chapters.

Wetland Protection

Wetlands are generally found in floodplains and depression areas of a watershed. Wetlands serve as a depository for floodwaters, which reduces the flow of water downstream. They also serve as a natural filter, which helps to improve water quality, and provide habitat for fish, wildlife and plants.

Wetlands that are determined to be part of the waters of the United States are regulated by the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency under Section 404 of the Clean Water Act. Before a "404" permit is issued, the plans are reviewed by several agencies, including the Corps and the U.S. Fish and Wildlife Service. Each of these agencies must sign off on individual permits.

There are also nationwide permits that allow small projects that meet certain criteria to proceed without individual permits. Wetlands not included in the Corps' jurisdiction or that are addressed by a nationwide permit may be regulated by local authorities.

If a permit is issued by the Corps or the county, the impact of the development is typically required to be mitigated. Wetland mitigation can include creation, restoration, enhancement or preservation of wetlands elsewhere. Wetland mitigation is often accomplished within the development site; however, mitigation is allowed off-site and sometimes in another watershed. When a wetland is mitigated at another site there are drawbacks to consider. First, it takes many years for a new wetland to approach the same quality as an established one. Second, a new wetland in a different location will not necessarily have the same flood damage reduction benefits as the original one did.

Erosion and Sedimentation Control

Farmlands and construction sites typically contain large areas of exposed soil. Surface water runoff can erode soil from these sites, sending sediment into downstream waterways. Erosion also occurs along stream banks and shorelines as the volume and velocity of flow destabilize and wash away the soil.

Sediment suspended in the water tends to settle out where flowing water slows down. It can clog storm sewers, drain tiles, culverts and ditches and reduce the water transport and storage capacity of river and stream channels, lakes and wetlands. When channels are constricted and flooding cannot deposit sediment in the bottomlands, even more is left in the channels. The result is either clogged streams or increased dredging costs.

There are two principal strategies to address these problems: minimize erosion and control sedimentation. Techniques to minimize erosion include phased construction, minimal land clearing, and stabilizing bare ground as soon as possible with vegetation and other soil stabilizing practices.

If erosion occurs, other measures are used to capture sediment before it leaves the site. Silt fences, sediment traps and vegetated filter strips are commonly used to control sediment transport. Runoff from the site can be slowed down by terraces, contour strip farming, no-till farm practices, hay or straw bales, constructed wetlands, and sediment basins. Slowing surface water runoff on the way to a drainage channel increases infiltration into the soil and reduces the volume of topsoil eroded from the site.

River Restoration

The objective of river restoration is to return streams, stream banks and adjacent land to a more natural condition. A key component of these efforts is to use appropriate native plantings along the banks that resist erosion. This may involve retrofitting the shoreline with willow cuttings, wetland plants and rolls of landscape material covered with a natural fabric that decomposes after the banks are stabilized with plant roots.

Restoring the right vegetation to a stream helps reduce the amount of sediment entering the water, can reduce flood damage by slowing the velocity of water and can reduce long term maintenance costs.

Structural Projects

Structural projects are usually funded by public agencies and constructed to protect people and infrastructure from damage due to natural hazards. Floodwater management is the primary focus of structural projects. A good example of this is either a floodwall or levee.

Drainage and Storm Sewer Improvements

Man-made ditches and storm sewers help drain areas where the surface drainage system is inadequate, or where underground drainage ways may be safer or more practical. Storm sewer improvements include installing new sewers, enlarging small pipes and preventing back flows. Drainage and storm sewer improvements usually are designed to carry the runoff from smaller, more frequent storms. Because drainage ditches and storm sewers convey water faster to other locations, improvements are only recommended for small local problems where the receiving stream or river has sufficient capacity to handle the additional volume and flow of water. To reduce the cumulative downstream flood impacts of numerous small drainage projects, additional detention or run-off reduction practices should be provided in conjunction with the drainage system improvements.

A combination of restored wetland detention, vegetation and infiltration trenches that reduce runoff can be implemented in conjunction with stormwater system improvements.

Drainage System Maintenance

Detention ponds, stream channels, swales, ditches and culverts all serve as drainage systems. Drainage system maintenance is an ongoing program to clean out blockages caused by an accumulation of sediment or overgrowth of weedy, non-native vegetation or debris, and remediation of stream bank erosion sites.

“Debris” refers to a wide range of blockage materials that may include tree limbs and branches that accumulate naturally, or large items of trash or lawn waste accidentally or intentionally dumped into channels, drainage swales or detention basins. Maintenance activities do not alter the shape of the channel or pond, but they do affect how well the drainage system can do its job. Sometimes there is a fine line that separates debris that should be removed from natural materials that helps form habitat. Therefore, written procedures that are consistent with state laws and environmental concerns are usually needed.

MITIGATION STRATEGIES AND ACTIONS

The heart of the mitigation plan is the mitigation strategy, which serves as the long-term blueprint for reducing the potential losses identified in the risk assessment. The mitigation strategy describes how the community will accomplish the overall purpose, or mission, of the planning process. In this section, mitigation goals and objectives were reevaluated and updated; and mitigation actions/projects were updated/amended, identified, evaluated, and prioritized.

Plan participants assessed over 240 hazard mitigation strategies/actions, including strategies from FEMA documents, strategies from the 2012 Franklin County Natural Hazard Mitigation Plan and suggestions from participating communities and their respective stakeholders during a series of workshops that took place throughout the County in the Spring of 2018. These mitigation strategies/projects were further evaluated by the Core Group during the final meeting held in July 2018, resulting in a prioritized list of 28 new strategies/actions, in addition to 153 ongoing/updated mitigation strategies/actions from the previous Plan, and 35 completed strategies/actions. Two strategies/actions were removed or considered not relevant.

The mitigation strategies and actions from the County and participating jurisdictions will be updated and maintained annually on the online planning system. Each of the participating jurisdictions have been granted access to the system, and will have the ability to update their respective section of the plan.

This section includes the following:

- **Franklin County Mitigation Strategies/Actions:** County Mitigation Actions (County Departments and Mitigation Actions that Apply to the County and **All** Participating Jurisdictions)
- **Jurisdiction Mitigation Strategies/Actions** (Cities, Townships, and Villages)

Each entities' Mitigation Strategies & Actions are organized as follows:

- **New Mitigation Actions** - New actions identified during this 2018 update process
- **Ongoing Mitigation Actions** - These ongoing actions were included in the previous update and have yet to be completed. Some of these actions have no definitive end. During the 2018 update, these "ongoing" mitigation strategies/actions were modified and/or amended, as needed, to better define the strategy/action.
- **Completed Mitigation Actions** - Completed actions since 2012. Completed actions also included a brief description of the "Resulting Reduction or Limitation of Hazard Impact(s) Achieved" in order to show the resulting benefits of implementing the mitigation initiative.

Mitigation Action Items Update

Each of the participating communities, including Franklin County, were invited to participate in a series of workshops in which goals, objectives, and strategies were discussed, identified, updated and prioritized. Each participant in this session was provided with a number of resources to help them identify relevant mitigation strategies. These include the following documents:

- FEMA Mitigation Ideas Handout (see **Appendix B. – Meeting & Workshop Documentation**)
- Franklin County Mitigation Examples Handout (see **Appendix B. – Meeting & Workshop Documentation**)

All potential strategies that arose through this process are included in this Plan. A final draft of the Plan was presented to all stakeholders to allow them to provide final edits and approval of the strategies and their priority.

At the mitigation workshops, participating jurisdictions reviewed mitigation objectives. Some objectives were identified as having been achieved in Franklin County since the initial version of this plan was prepared. Completed objectives for the County remain and are briefly described in discussions below to show mitigation accomplishments since the initial plan was developed.

County-Level Mitigation Action Items & Prioritization Process

Action Items

This plan was designed to serve as a county-wide strategic plan which jurisdictions can use to guide local mitigation efforts. Included in this plan are short-term action items, long-term action items and jurisdiction based action items.

The core group worked to define and update the short-term and long-term action items. The short-term action items were considered the higher priority items in that they addressed a specific problem, they could be completed in less than five years and funding could be reasonably expected. The long-term action items are those items considered to be continuous or take more than five years. Funding requirements range from very little (planning issues) to very expensive (replacing aging infrastructure).

It should be noted that these actions apply to the County, including county-level departments and organizations, and all participating jurisdictions unless noted otherwise.

Natural Hazards Mitigation Plan Action Items

This mitigation plan identifies short and long-term action items developed through core group activities, research and data collection. These activities may require federal and state grant funding, or be implemented at the local level through partnerships and cooperation. Each Action Item is separated into four components that include the following:

- **Ideas for Implementation:** Actions that can be taken to meet the goals of the action item
- **Coordinating Organization:** Organizations willing to organize resources, identify funding sources (if necessary) and monitor activity implementation

- **Timeline:** An estimate of the amount of time needed to implement the action
- **Plan Goals Addressed:** This identifies the specific goal the action item addresses
- **Benefit Cost Review:** Provides a comprehensive review of monetary and non-monetary costs and benefits associated with each action. A Benefit Cost Review for all the short-term and long-term action items was conducted.

In addition to the action items developed by the core group, local jurisdictions were asked to update and create action items related specifically to their jurisdictions (see **Jurisdictional Mitigation Actions)**. They were given copies of the goals and action items developed by the core group in order to guide their efforts, in addition to other resources to assist them in identifying mitigation projects.

Prioritization Methodology

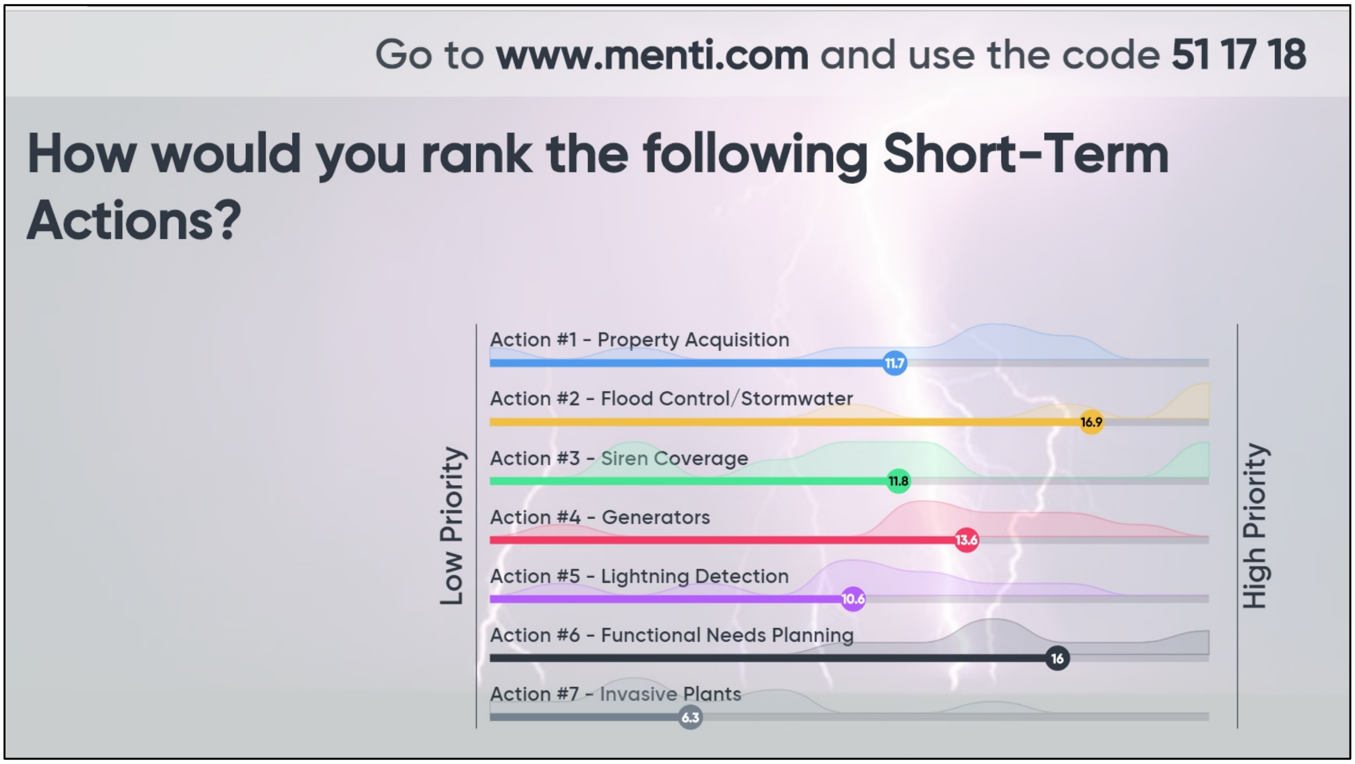
The mitigation strategy/action must be prioritized according to a benefit/cost analysis of the proposed projects and their associated costs (44 CFR, Section 201.6(c)(3)(iii)). The benefits of proposed actions were weighed against multiple factors as part of the project prioritization process. The benefit/cost analysis was not of the detailed variety required by FEMA for project grant eligibility under the Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation (PDM) grant program. A less formal approach was used because some actions/strategies may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time. The mitigation strategies/actions were prioritized and evaluated based on updated information and the Core Group had an opportunity to evaluate and discuss the priority and importance of both the short-term and long-term actions.

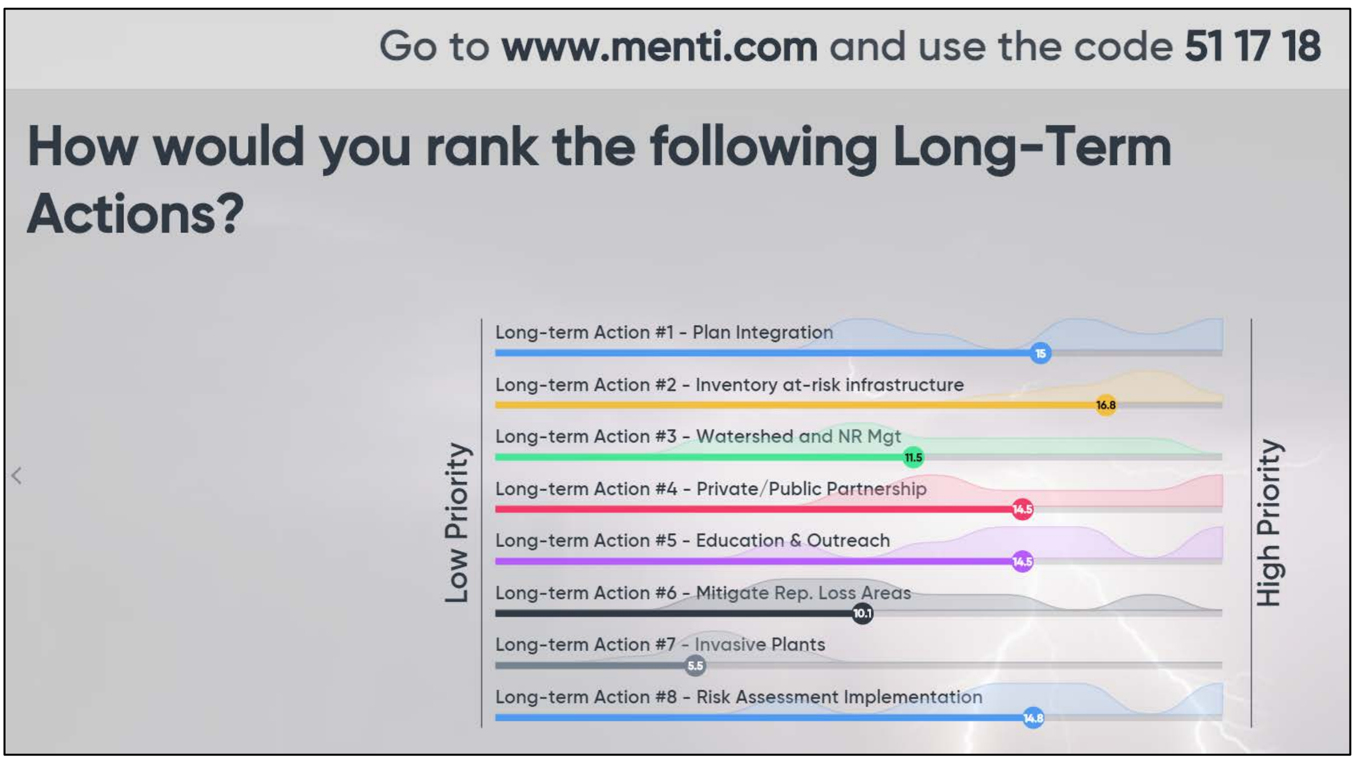
For “New Actions” proposed for the County, the following form “New Mitigation Action Projects Form” and the online equivalent (https://integratedsolutions.wufoo.com/forms/m1s10l811j70594/) were created to facilitate the **baseline prioritization process**. The hard copy form was distributed and completed during the workshops. The online form was made available to plan participants via the online planning system.

However, in order to prioritize **all** proposed strategies (new and ongoing), the Core Group met on July 19, 2018 to discuss and prioritize the short-term and long-term actions. A real-time survey assessment tool was used as a planning activity to gauge priority, which then allowed the Core Group to further discuss the merits of the results. County-level actions (Short-Term and Long-Term) were then reprioritized based on this cumulative process.

The following figure shows the results of the real-time survey assessment and planning activity.

FIGURE 10: COUNTY-LEVEL PRIORITIZATION RESULTS





Short-Term Action Items

The short-term action items were considered the higher priority items in that they addressed a specific problem, they could be completed in less than five years and funding could be reasonably expected.

Based on the prioritization process, the Short-Term Actions were renumbered in ordered of priority.

SHORT-TERM ACTION ITEM #1

PROBLEM:

There are increased impervious surfaces in multiple watersheds around the County. Siltation from bank erosion is a major cause of impairment in streams near new development. The source of the increased volume of stormwater is an increase in development and impervious surfaces. There have been extensive changes in the landscape from agricultural to residential areas and businesses throughout Franklin County. Stormwater retention ponds from housing developments were not designed to reduce volume, and there is a lack of floodplain to dissipate the energy of the flow. Most subdivisions do not have stormwater infrastructure to address volume or water quality.

ACTION ITEMS:

- Create wetlands and rain gardens where the stormwater retention ponds are not designed to reduce volume. Implement land management practices to reduce the volume of stormwater runoff from developed communities.
- Reconnect 150 linear feet of Dysart Run to the floodplain and stabilize 3 sections of bank with severe erosion to reduce erosion and siltation
- Increase stormwater retention/detention features along waterways like, Holcomb Ditch, to reduce and/or slow the flow of stormwater.

IDEAS FOR IMPLEMENTATION:

- Stabilize sections of bank with severe erosion to reduce erosion and siltation.
- Form a group of stakeholders to determine the extent and cause of repeat flooding problems.
- Evaluate potential solutions for technical feasibility, costs/benefit and environmental impact.
- Research and secure funding for potential solutions.

STATUS:

- Ongoing

COORDINATING ORGANIZATION(S):

- Franklin County Emergency Management & Homeland Security (FCEM&HS)
- Franklin County Engineer’s Office
- City of Hilliard
- Norwich Township
- Ohio Department of Natural Resources (ODNR)

TIMELINE: Ongoing. February 2007- February 2023.

PLAN GOALS ADDRESSED:

- Manage Debris Along Streams and Waterways
- Minimize Damage to Public and Private Property

BENEFIT COST REVIEW

Vulnerability	Before the Action Item is Implemented	After the Action Item is Implemented	Difference
Increased urban flooding due to rapid urbanization of once rural areas	Numerous	Reduced urban flooding	Less Impact
Number of people affected by hazard	Numerous	Reduced probability of significant impact on the population	Less Impact
Area affected	Franklin County	Reduced number of affected areas, some still at risk	Less Impact
Number of parcels	Numerous	Reduced number of parcels impacted	Less Impact
Loss of Life	NA	NA	NA
Injury	NA	NA	NA
Benefits			
Reduced urban flooding			
Reduced amount of damage to business and residential structures			
Less maintenance on systems that are taxed by stormwater and localized flooding.			
Costs			
Time to implement to change regulations			
Coordination between municipalities			

SHORT-TERM ACTION ITEM #2

PROBLEM:

Franklin County has a significant population of citizens with functional needs. These needs range from being reliant on life sustaining equipment to speaking a foreign language to not having access to a vehicle.

ACTION ITEM:

Development of a plan and strategy to ensure residents with functional needs are properly cared for in an emergency.

IDEAS FOR IMPLEMENTATION:

- Develop a registry to identify residents who may need additional assistance in an emergency.
- Develop further relationships with direct care providers throughout the county.

STATUS:

- Ongoing. Functional Needs Sheltering Plan in Draft form as of the writing of this plan. 75% Complete. Still ongoing and needs to be completed

COORDINATING ORGANIZATION(S):

- Franklin County Emergency Management & Homeland Security (FCEM&HS)
- Franklin County social service agencies

TIMELINE: February 2007- February 2020.

PLAN GOALS ADDRESSED:

- Minimize loss of life from severe weather hazards

BENEFIT COST REVIEW

Vulnerability	Before the Action Item is Implemented	After the Action Item is Implemented	Difference
Functional Needs Populations	Throughout the county- some are mapped through GIS	Improved information for planning, response and recovery in protecting the population with functional needs	Less Impact
Number of people affected by hazard	Thousands	Reduced probability of significant impact on the functional needs population	Less Impact
Area affected	Populations live throughout the county	Functional needs communities less at risk	Less Impact

Number of parcels	Numerous	Reduced number of parcels impacted	Less Impact
Loss of Life	Various	Reduced probability for loss of life in the functional needs population	Less Impact
Benefits			
Increased planning and awareness to protect the population with functional needs			
Costs			
Time consuming effort to identify these populations			
Time commitments of personnel to coordinate these efforts is extensive			

SHORT-TERM ACTION ITEM #3

PROBLEM:

Back-up generators are essential during power outages to maintain critical public functions. These functions include emergency communications, traffic signals, pump and water booster stations.

ACTION ITEM:

Seek funding for back-up generators for critical public buildings and infrastructure.

IDEAS FOR IMPLEMENTATION:

- Each community should prioritize critical public functions and back-up generator needs.
- Communities with generators may need to increase capacity as demands for electricity and the need to power additional capabilities is becoming more important.
- Funding sources should be researched and secured.

STATUS:

- Ongoing. Individual jurisdictions have prioritized their critical facilities and added back-up generators as they are able and budgets allow.

COORDINATING ORGANIZATION(S):

- Franklin County Emergency Management & Homeland Security
- All 41 jurisdictions

TIMELINE:

- February 2007- February 2023.

PLAN GOALS ADDRESSED:

- Minimize Loss of Life from Severe Weather Hazards

BENEFIT COST REVIEW

Vulnerability	Before the Action Item is Implemented	After the Action Item is Implemented	Difference
Critical infrastructure impacted by power outages	Several areas within Franklin County have the continued need for back-up generators	Reduced amount of critical infrastructure impacted by power outages	Less Impact
Number of people affected by hazard	Thousands	Less than 100	Less Impact
Area affected	Some of Franklin County and listed municipalities	More resilient critical infrastructure	Less Impact
Number of parcels	Numerous	Significantly less	Less Impact

Loss of Life	NA	NA	Less potential loss of life
Benefits			
Less critical facilities without power during needed times for operation			
Critical Facilities able to respond to needs of community			
Costs			
Not a fundable FEMA project as a standalone project			
Funding is a concern, must consider alternate sources of funding			
Difficult expense due to limited use			

SHORT-TERM ACTION ITEM #4

PROBLEM:

Development has occurred at a rapid pace in Franklin County and lands that had previously been used for agricultural purposes are quickly being developed as housing developments. This intense development has increased the population of Franklin County and left gaps in the coverage area of the outdoor warning siren system. FCEM&HS sees a need for fully covering the county with outdoor warning sirens.

ACTION ITEM:

Develop comprehensive strategies to increase siren coverage for outdoor warning as well as promote weather radios as a reliable means of indoor warning.

IDEAS FOR IMPLEMENTATION:

- Prioritize areas of the county in need of sirens based on current and expected population growth and the costs/benefits.
- Work with local jurisdictions to identify gaps and secure funding to remedy them.
- Seek out public funding to expand the outdoor siren warning system to areas of the county with inadequate coverage.
- Encourage or require developers to install outdoor sirens in new housing developments. Create public/private partnerships with developers.
- Research and secure funding for potential solutions.
- Seek out private or public funding to purchase NOAA weather radios for use in public and private schools, trailer courts, churches, nursing homes, etc.

STATUS:

- Ongoing. 50% complete. 20 Sirens purchases (2013-2015) throughout the county during prior planning cycle.

COORDINATING ORGANIZATION:

- Franklin County Emergency Management & Homeland Security (FCEM&HS)
- All 41 local jurisdictions

TIMELINE:

- This project will be in effect for the life of this plan. February 2007- February 2023.

PLAN GOALS ADDRESSED:

- Minimize Loss of Life from Severe Weather Hazards

BENEFIT COST REVIEW

Vulnerability	Before the Action Item is Implemented	After the Action Item is Implemented	Difference
Increased need for siren coverage	Need additional sirens to cover the gaps in Franklin County	Full coverage of Franklin County	Less Impact
Number of people affected by hazard	In the thousands	Less than 100	Less Impact
Area affected	Individual pockets of Franklin County	Significantly less of Franklin County	Less Impact
Number of parcels	Numerous	Zero	Less Impact
Loss of Life	NA	NA	Less potential loss of life
Benefits			
More residents are aware of the hazard of tornados			
Potentially less injuries and deaths due to sirens warning residents			
Costs			
Securing funding			
Long-term maintenance costs			
Municipality buy-in to process			

SHORT-TERM ACTION ITEM #5

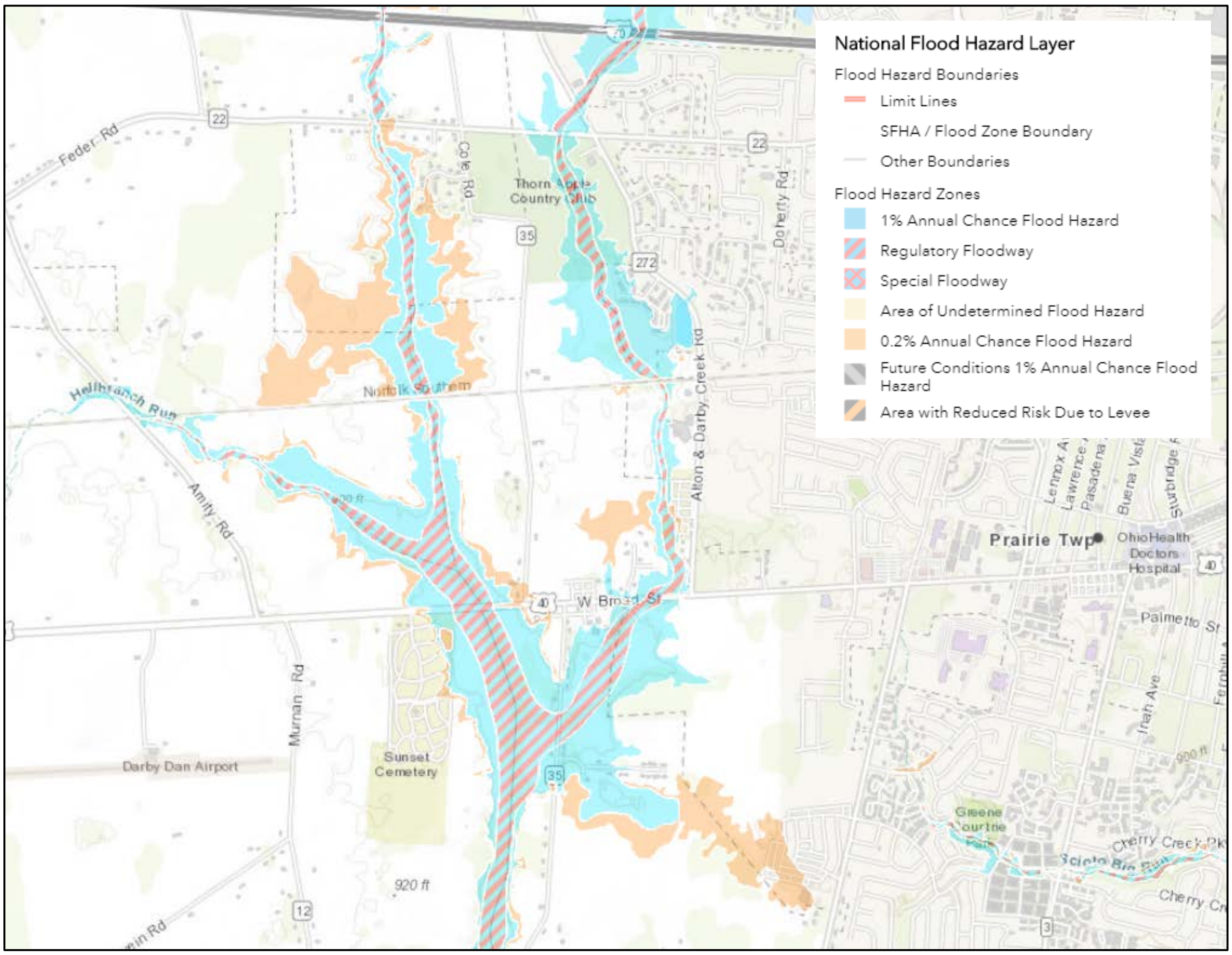
PROBLEM:

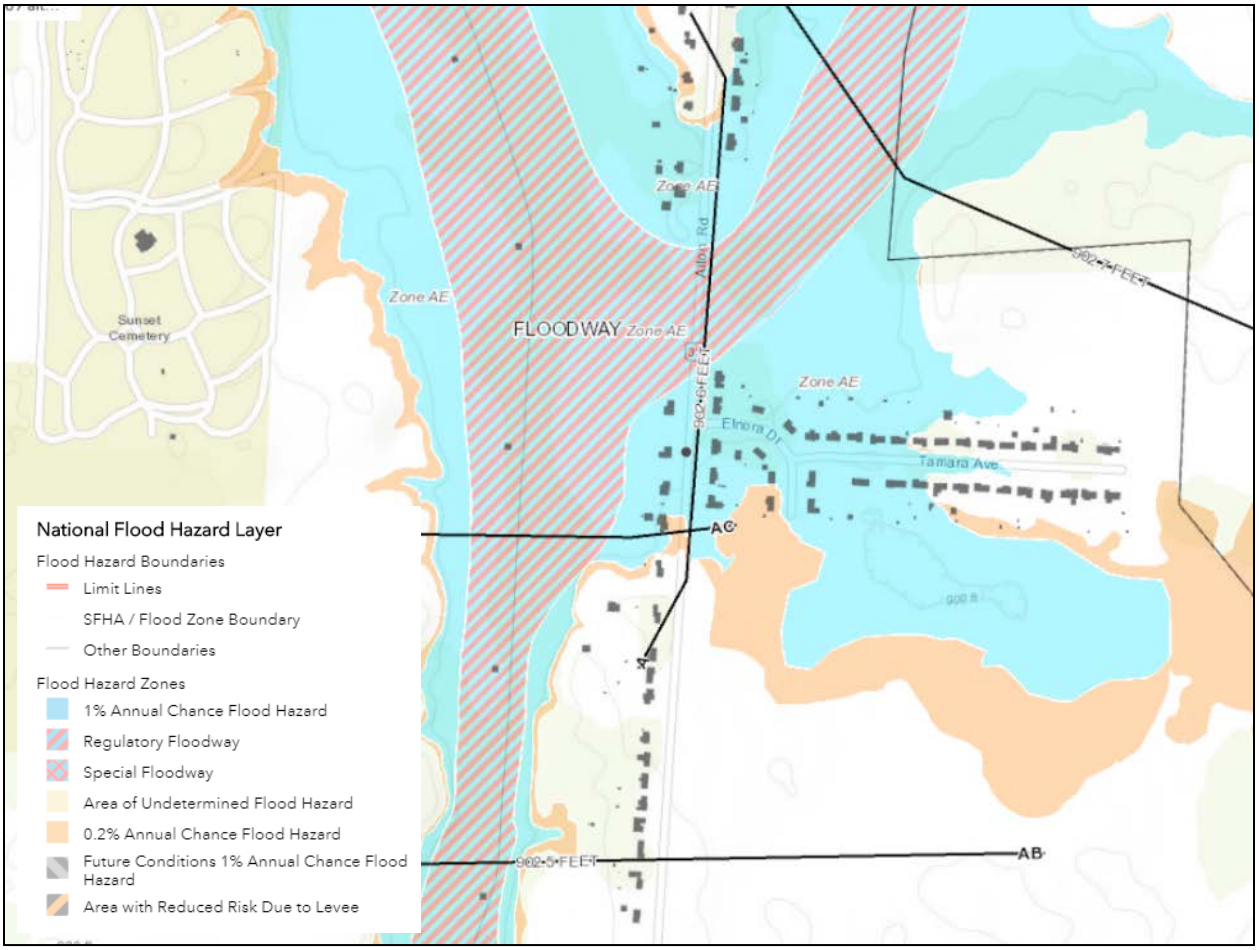
Properties in the Prairie Township area have a history of repeat flooding events that cause damage to homes and property.

ACTION ITEM:

Acquire properties in Prairie Township, which have historically been subject to repeated flooding.

FIGURE 11: FLOOD HAZARD AREA IN PRAIRIE TOWNSHIP





IDEAS FOR IMPLEMENTATION:

- Purchase the subject land/homes based upon appraised values.
- Evaluate the existing structures for asbestos and other hazards, destroying the structures, and returning the land to its pre-development state.
- Maintain the vacant land and ensure appropriate deed restrictions are in place upon the properties to prevent future development.

STATUS:

- Project is ongoing

COORDINATING ORGANIZATION(S):

- Franklin County Emergency Management & Homeland Security (FCEM&HS)
- Franklin County Engineer’s Office
- Prairie Township

TIMELINE:

2018-2019

PLAN GOALS ADDRESSED:

- Minimize Damage to Public and Private Property

BENEFIT COST REVIEW

Vulnerability	Before the Action Item is Implemented	After the Action Item is Implemented	Difference
Number of people affected by hazard	10	Less than 10	Less Impact
Area affected	Numerous	Less impact	Area still affected but less impact
Number of parcels	3	Less than 3	Less Impact
Loss of Life	none	none	NA
Injury	none	none	NA
Benefits			
Reduction in repetitive loss claims.			
Reduce expense of cleaning up after flood events.			
Costs			
Necessary time to implement entire project			
Voluntary Process			
Expensive to implement			

<u>SHORT-TERM ACTION ITEM #6</u>

PROBLEM:

Many municipalities do not have adequate lightning detection/warning systems for city parks and other outdoor recreation areas.

ACTION ITEM:

Seek funding for lightning detection/warning systems for city parks and other outdoor recreation areas.

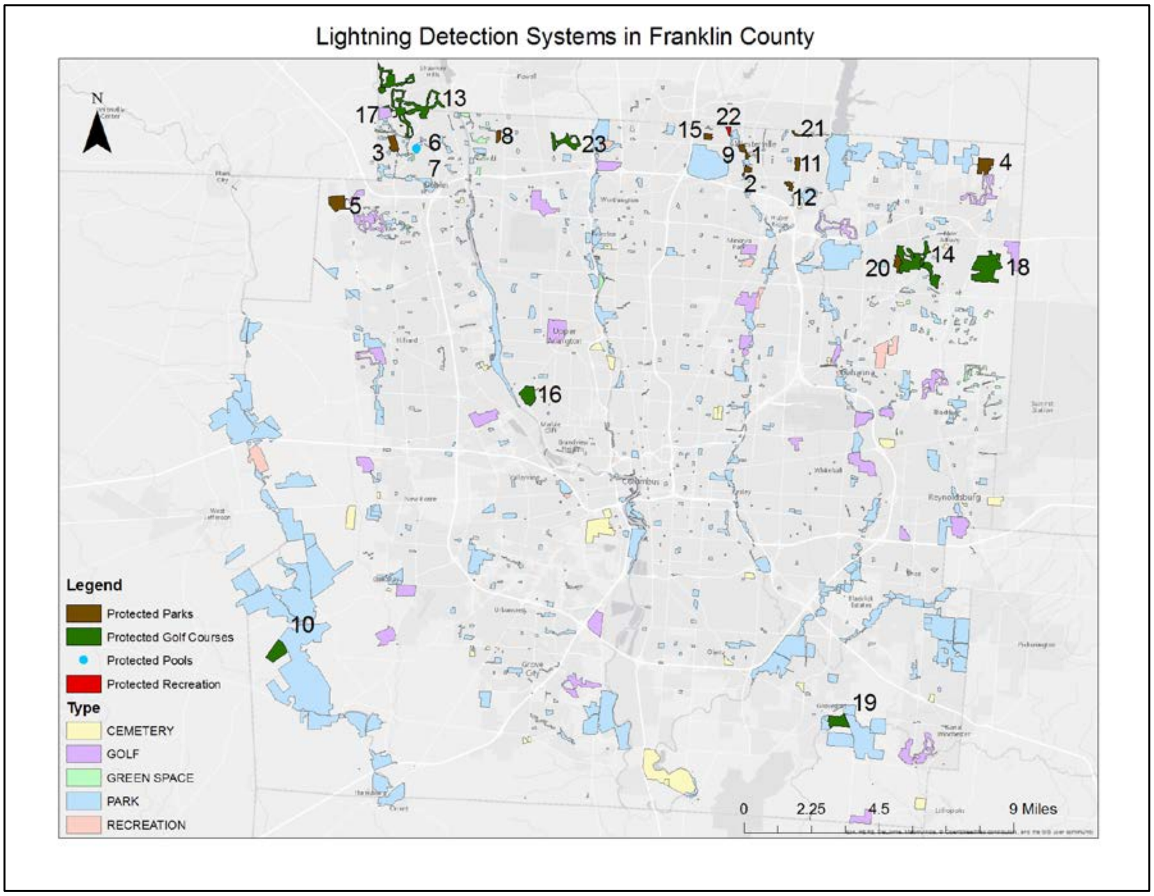
IDEAS FOR IMPLEMENTATION:

- Each community should assess lightning detection/warning needs.
- Discuss impact and funding with those jurisdictions currently operating lightning detections systems.
- Funding resources should be researched and secured.

STATUS:

- Ongoing. Individual jurisdictions have purchased lightning detection systems as they are able and budgets allow. A preliminary assessment has been completed to determine where gaps exist.

FIGURE 12: LIGHTNING DETECTION SYSTEMS



COORDINATING ORGANIZATION(S):

- Franklin County Emergency Management & Homeland Security
- All 41 local jurisdictions

TIMELINE:

- February 2007- February 2023.

PLAN GOALS ADDRESSED:

- Minimize Loss of Life from Severe Weather Hazards

BENEFIT COST REVIEW

Vulnerability	Before the Action Item is Implemented	After the Action Item is Implemented	Difference

Inadequate lightning detection systems at public recreation facilities	Most outdoor recreation areas within Franklin County do not have lightning detection systems	Significantly improved lightning detection to protect visitors at recreational facilities	Less Impact
Number of people affected by hazard	Residents and children using outdoor recreation areas	Significantly less with each detection system installed	Less Impact
Area affected	Some of Franklin County and listed municipalities mostly public parks	Significantly less with each detection system installed	Less Impact
Number of parcels	Mostly public areas	Less sites than originally identified	Less Impact
Loss of Life	NA	Significantly less probability with each detection system installed	Less potential loss of life
Benefits			
Reduction in the number of injuries from lightning strikes			
Costs			
Not a fundable FEMA project as a standalone project			
Funding is a concern, so alternate sources must be sought			

SHORT-TERM ACTION ITEM #7

PROBLEM:

Invasive plant species are quickly taking over the landscape in Central Ohio creating hazardous natural resources situations. In the U.S. alone, invasive plants cause more than $120 billion a year in damages to agriculture, industry, recreation, forestry, human health and the environment. Though there are more than 50 species on the ODNR Invasive Species list, the main species of concern in Central Ohio are:

- Bush and vine honeysuckles (Lonicera japonica, L. maackii, L. morrowii, L. tartarica)
- Wintercreeper and Winged Euonymous (Euonymous alatus, E. fortunei)
- Japanese Knotweed (Polygonum cuspidatum)
- Pragmites/Common Reed Grass (Phragmites australis)
- Bradford Pear (Pyrus calleryana)
- English Ivy, Myrtle and Asiatic Bittersweet (Hedera helix, Vinca minor, Celastrus orbiculatus)
- Japanese Barberry and Privet (Berberis thunbergii, Ligustrum sp.)
- Tree of Heaven (Ailanthus altissima)
- Garlic Mustard (Alliaria petiolata)

ACTION ITEM:

To remove and/or chemically treat 5% of the invasive plant species each year within Franklin County, targeting areas of major concern, particularly those surrounding reservoirs. Though this will not eliminate them, it would be a start to control them if the areas that have been removed in previous years are maintained free of invasive species by once a year spraying.

IDEAS FOR IMPLEMENTATION:

- Encourage those agencies that are actively removing invasive species to continue doing so.
- Encourage those Government agencies that own land to develop and start implementing an invasive species control plan.
- Encourage private land owners to remove invasive species on their properties and direct them to already existing educational materials regarding invasive plants.
- Educate land owners about grants available to help remove invasive species.
- Encourage continued partnerships and the formation of new partnerships for the removal of invasive species on public lands.

STATUS: Ongoing

COORDINATING ORGANIZATION(S):

- Ohio Invasive Plants Council
- Franklin County Soil and Water Conservation District
- City of Columbus Watershed Management
- Local Government and County Park Departments, ODOT, ODNR, Watershed Groups, Environmental Groups

TIMELINE:

- February 2012- February 2023.

BENEFIT COST REVIEW

Vulnerability	Before the Action Item is Implemented	After the Action Item is Implemented	Difference
Invasive species growing faster than able to eradicate	Several areas within Franklin County	Healthier ecosystems and less risk to public health and well-being	Less Impact
Number of people affected by hazard	Numerous	Reduced probability of significant impact on the population	Less Impact
Area affected	Pockets of Franklin County	Reduced number of impacted areas, some still at risk	Less Impact
Number of parcels	Numerous	Reduced number of parcels impacted	Less Impact
Loss of Life	NA	NA	NA
Benefits			
Healthier, more sustainable ecosystems			
Costs			
Time consuming effort remove invasive species and must keep up on it			
Expensive to upkeep			

Long-Term Action Items

Long-term action items may require new or additional resources and may take over five years to implement.

Based on the prioritization process, the Long-Term Actions were renumbered in ordered of priority.

LONG-TERM ACTION ITEM #1

Develop inventories of at-risk infrastructure and prioritize preventative measures in areas vulnerable to natural hazards.

IDEAS FOR IMPLEMENTATION:

- Work with local jurisdictions to identify at-risk, aging water and sewer systems, and estimate the replacement cost and prioritize replacement needs.
- Encourage municipalities to analyze the impact new development will have on existing infrastructure.
- Develop incentives for local governments, citizens and businesses to pursue hazard mitigation projects.
- Encourage municipalities to incorporate hazard mitigation strategies into capital improvement budget planning.
- Identify bridges and roadways vulnerable to natural hazards.

STATUS:

- Ongoing. 25% complete. FCEM&HS maintains GIS maps of the County's infrastructure including its relation to hazard areas. Each jurisdiction maintains information on the condition of their infrastructure and whether it is at-risk due to age or location.

COORDINATING ORGANIZATION(S):

- Local Jurisdiction water and sewer departments
- Franklin County Engineer's Office
- Franklin County Emergency Management & Homeland Security

TIMELINE:

- February 2007- February 2023.

PLAN GOALS ADDRESSED:

- Maintain Public & Private Infrastructure

BENEFIT COST REVIEW

Vulnerability	Before the Action Item is Implemented	After the Action Item is Implemented	Difference
Many infrastructure systems in Franklin	Much of the infrastructure is in need of	More resilient infrastructure, capable of handling future	Less

County are aging	repair/replacement	business and population growth	Impact
Number of people affected by hazard	Most of county	Reduced probability of significant impact on the population	Less Impact
Area affected	Pockets of Franklin County	Reduced number of affected areas, some still at risk	Less Impact
Number of parcels	Numerous	Reduced number of parcels impacted	Less Impact
Loss of Life	NA	NA	NA
Benefits			
Newer infrastructure better serves businesses and the population			
Newer infrastructure is better able to resist stress due to increased load and more resilient to threats from natural hazards			
Costs			
Cost prohibitive			
Disruptive to services in the community			

LONG-TERM ACTION ITEM #2

Integrate the goals and action items from the Franklin County Mitigation Plan into existing and future land use planning documents, and existing regulatory programs.

IDEAS FOR IMPLEMENTATION:

- Use the plan to influence development standards throughout Franklin County, such as flood damage reduction requirements, so that standards are in place prior to annexation.
- Incorporate goals and objectives from the plan into future regional planning documents completed by local jurisdictions, MORPC and other agencies doing planning.
- Encourage MORPC and the Franklin County Economic Development and Planning Department to be advocates of the mitigation plan, and to incorporate goals and objectives from the plan into future planning documents.
- Partner with the banking and insurance industries to sensitize them to flood issues and educate them about the mitigation plan.
- Partner with Developers and the Development Community about density and floodplain issues, and educate them about the mitigation plan.
- Townships have authority in Ohio Revised Code to pass levies to purchase land for green space. Investigate possibilities of using this tool in high hazard/risk areas.

- Incorporate storm water management strategies and standards developed by the Darby Creek Watershed Task Force into future development in Franklin County.
- Integrating planning best practices into community planning projects to ensure development is discouraged in at-risk areas and areas without existing infrastructure.
- Encourage jurisdictions to identify Priority Conservation Areas to preserve high hazard/risk areas using MORPC's "Balanced Growth Plans" and "Watershed Protection Plans".

STATUS:

- 10% Complete. Partnerships are being formed and mitigation actions are being considered in planning documents.

COORDINATING ORGANIZATION(S):

- Franklin County Emergency Management & Homeland Security (FCEM&HS)
- Franklin County Economic Development and Planning Department
- Mid-Ohio Regional Planning Commission (MORPC)

TIMELINE:

- February 2007- February 2023.

PLAN GOALS ADDRESSED:

- Manage Development

BENEFIT COST REVIEW

Vulnerability	Before the Action Item is Implemented	After the Action Item is Implemented	Difference
Many planning activities and documents do not recognize mitigation as a strategy	Sporadic coverage of mitigation efforts within other planning documents	Mitigation more widely accepted and included in county-wide planning	Less Impact
Number of people affected by hazard	Entire County	Reduced probability of significant impact on the population	Less Impact
Area affected	Entire County	Reduced number of affected areas, some still at risk	Less Impact
Number of parcels	Numerous	Reduced number of parcels impacted	Less Impact
Loss of Life	NA	NA	NA
Benefits			
The acceptance and inclusion of mitigation as a strategy in county-wide planning will lead to more			

sustainable and resilient communities in Franklin County
Costs
Time consuming effort
Participation critical from all entities involved- time commitment could be restrictive

LONG-TERM ACTION ITEM #3

Identify resources and take appropriate actions in order to mitigate the effects of the hazards identified in the Risk Assessment for Franklin County as they impact each Franklin County jurisdiction.

IDEAS FOR IMPLEMENTATION:

- Consider which resources can be utilized to mitigate natural hazards.
- Seek out resources to mitigate natural hazard damages throughout the county.
- Update floodplain modeling for Big Walnut and Blacklick Creeks.
- Conduct study to better understand the Karst/Sinkhole threat to the County

STATUS:

- Ongoing
- The initiative to study and better understand the Karst/Sinkhole threat, which is a new hazard added to the Risk Assessment for Franklin County, is a new initiative for 2018.

COORDINATING ORGANIZATIONS:

- Franklin County Emergency Management & Homeland Security (FCEM&HS)
- Franklin County Economic Development and Planning
- All 41 Jurisdiction

TIMELINE:

- February 2012- February 2023.

BENEFIT COST REVIEW

Vulnerability	Before the Action Item is Implemented	After the Action Item is Implemented	Difference
Development of feasible strategies to reduce the impacts of hazards	Entire County	More effective usage of resources for mitigating natural hazards	Less Impact
Number of people affected by hazard	Entire County	Reduced probability of significant impact on the population	Less Impact
Area affected	Entire County	Reduced number of affected	Less

		areas, some still at risk	Impact
Number of parcels	Numerous	Reduced number of parcels impacted	Less Impact
Loss of Life	NA	NA	NA
Benefits			
Understanding risks and hazards can lead to a greater ability to mitigate against them			
Potential cost savings with coordinated efforts.			
Costs			
Coordination between municipalities			
Necessary time to implement entire project			

LONG-TERM ACTION ITEM #4

Strengthen partnerships between government agencies and private sector businesses to develop public awareness of and involvement in natural hazard mitigation strategies.

IDEAS FOR IMPLEMENTATION:

- Develop a public education effort specific to winter hazards and ice, with information about tree limb branches located over electric, phone and cable lines and the importance of keeping lines clear.
- Work with residents to understand the issues related to restoring power in an emergency.
- Distribute information about natural hazards and mitigating activities to property owners in areas identified to be at risk through hazard mapping.
- Partner with investor owned utilities (IOU) to educate their customers about mitigation activities, including the removal of tree limbs around critical infrastructure, and where to plant new foliage. Information to be delivered via utility bills or direct service contact with customers.
- Encourage homeowners and IOU's to establish procedures for tree limb removal prior to winter weather.
- Partner with gas and electric utilities to encourage customers to utilize demand side management programs, such as energy efficiency and smart meter technology, that can increase comfort, health and safety of occupants along with lowering energy demand during extreme periods of heat or cold to lessen generation that may be required.

STATUS:

- Ongoing. 25% Complete.

COORDINATING ORGANIZATION(S):

- Franklin County Emergency Management & Homeland Security (FCEM&HS)
- American Electric Power

- Private and public utility companies

TIMELINE: February 2007- February 2017.

PLAN GOALS ADDRESSED:

- Minimize Damage to Public and Private Property

BENEFIT COST REVIEW

Vulnerability	Before the Action Item is Implemented	After the Action Item is Implemented	Difference
Communication lacking among private sector and public as it relates to hazards	Entire County	Reduced impact on electric, phone and cable lines by trees during severe weather	Less Impact
Number of people affected by hazard	Entire County	Reduced probability of significant impact on the population	Less Impact
Area affected	Entire County	Reduced number of affected areas, some still at risk	Less Impact
Number of parcels	Entire County	Reduced number of parcels impacted	Less Impact
Loss of Life	NA	NA	NA
Benefits			
Better coordination between public and private sector in reducing the frequency of power outages due to tree limbs damaging electric, phone and cable lines			
Potential cost savings with coordinated efforts			
Greater understanding of process during restoration efforts			
Utilizing smart meters, insulating homes and buildings, and other ways to manage energy demand can provide increased comfort and safety for occupants along with lowering overall energy demand, which reduces the need for generation during peak demand periods (e.g. heat waves) and need for fossil fuel based generation to ramp up during these times.			
Costs			
Time consuming effort			
Private sector committing time and resources to these efforts			

LONG-TERM ACTION ITEM #5

Develop and implement public education programs to increase public awareness and understanding of the risks associated with natural hazards.

IDEAS FOR IMPLEMENTATION:

- Hold the annual Weather Spotter Program training in conjunction with the National Weather Service- Wilmington.
- Obtain Storm Ready certification for Franklin County.
- Identify methods for notifying people with communications limitations about severe weather warnings.
- Develop a planning template for use by private or public sector entities that specifically address emergency snow levels and preparedness actions.
- Disseminating media kits already prepared by FEMA to increase the public's awareness of flood hazards.
- Disseminate the Risk Assessment for Franklin County to the public to ensure they are able to make risk based decisions when planning for emergencies.

STATUS:

- Ongoing. 50% complete.
- Franklin County received the Storm Ready certification.

COORDINATING ORGANIZATION(S):

- Franklin County Emergency Management & Homeland Security (FCEM&HS)
- Volunteer and Social Service organizations

TIMELINE:

- February 2007- February 2023.

PLAN GOALS ADDRESSED:

- Minimize Loss of Life from Severe Weather Hazards

BENEFIT COST REVIEW

Vulnerability	Before the Action Item is Implemented	After the Action Item is Implemented	Difference
Communication lacking among agencies and others that would benefit from hazard awareness	Entire County	Greater awareness of natural hazards, potentially increased preparedness with businesses and residents	Less Impact
Number of people affected by hazard	Entire County	Reduced probability of significant impact on the population	Less Impact

Area affected	Entire County	Reduced number of affected areas, some still at risk	Less Impact
Number of parcels	Numerous	Reduced number of parcels impacted	Less Impact
Loss of Life	NA	NA	NA
Benefits			
Better coordination between agencies and other entities that would benefit from better hazard awareness.			
Greater awareness of the risks from natural hazards with potential for increased preparedness by businesses and residents resulting in more resilient communities			
Potential cost savings with coordinated efforts.			
Costs			
Time consuming effort.			

LONG-TERM ACTION ITEM #6

Involve watershed and natural resource management, and other interested parties, in natural hazard mitigation planning to rehabilitate and maintain streams and waterways.

IDEAS FOR IMPLEMENTATION:

- Establish a group or committee made up of all individuals or entities producing localized area plans. Examples include the City of Columbus, Franklin County Economic Development and Planning, MORPC (Water Resources Working Group) and FCEM&HS. Identify clear roles for participants, meeting regularly to evaluate mitigation strategies.
- Establish and maintain a local planning library made up of all development, growth and area planning guidelines.
- Establish a group or committee made up of all parties interested in streams and waterways, including conservation groups, to focus on stream maintenance in Franklin County. Examples include Big Darby and Olentangy River watershed groups. Identify clear roles for participants, meeting regularly to evaluate mitigation strategies.
- Conduct a review of the Franklin County Natural Hazard Mitigation Plan every 5 years by evaluating mitigation successes, failures and areas that were not addressed.

STATUS:

- Ongoing. 25% complete. Watershed groups and the City of Columbus Watershed Management were all invited to participate in the planning process.

COORDINATING ORGANIZATION:

- Franklin County Emergency Management & Homeland Security (FCEM&HS)

- Mid-Ohio Regional Planning Commission: Water Resource Working Group

TIMELINE:

- February 2007- February 2023.

PLAN GOALS ADDRESSED:

- Manage Debris Along Streams and Waterways.

BENEFIT COST REVIEW

Vulnerability	Before the Action Item is Implemented	After the Action Item is Implemented	Difference
Populations and property near streams and waterways are invested in the health of the waterway	Property located adjacent to FC waterways needing to maintain waterway or needing to rehabilitate waterway	Better overall waterway health within Franklin County	Less Impact
Number of people affected by hazard	Various	Reduced probability of significant impact on the population	Less Impact
Area affected	Pockets of Franklin County	Reduced number of affected areas, some still at risk	Less Impact
Number of parcels	Numerous	Reduced number of parcels impacted	Less Impact
Loss of Life	NA	NA	NA
Benefits			
Better water quality and waterway health throughout the county			
Costs			
Relies partially on citizen participation			
Can be cost prohibitive to rehabilitate a waterway			

LONG-TERM ACTION ITEM #7

Conduct mitigation activities in repetitive loss areas through acquisition, elevation or other mitigating activity.

CURRENT REPETITIVE LOSS PROPERTIES (as of 12/31/17):

Location of Property *(Per mailing address)*	Number of Repetitive Loss Structures	Number of Severe Repetitive Loss Structures	Total Losses
Bexley	3		$12,497.45
Columbus	12		$153,454.48
Dublin	2		$323,309.27
Gahanna	1		$24,779.34
Galloway	4		$58,420.12
Grove City	5		$146,944.82
Orient	1		$8,772.28
Upper Arlington	3		$50,352.22
Westerville	2		$37,948.66
Whitehall	1		$4,322.43
Worthington	3	1	$229,436.95
Total	37	1	$1,050,238.02

Note: In some cases, the property may reside in a township or unincorporated area of Franklin County, but the mailing address may be in a City or Village of Franklin County.

IDEAS FOR IMPLEMENTATION:

- Research and assess cause of overall flooding to repetitive loss structures.
- Seek funding to permanently reduce damage to these structures.
- Assess the status of repetitive loss properties to ensure they warrant remaining on the list.

FIGURE 13: FLOOD-PRONE AREA (NORTH CENTRAL FRANKLIN COUNTY)

FIGURE 14: FLOOD-PRONE AREA (NORTH CENTRAL FRANKLIN COUNTY RIVERLEA AREA)

FIGURE 15: FLOOD-PRONE AREA (SOUTH CENTRAL FRANKLIN COUNTY)

FIGURE 16: FLOOD-PRONE AREA (SW FRANKLIN COUNTY ALTON AREA)

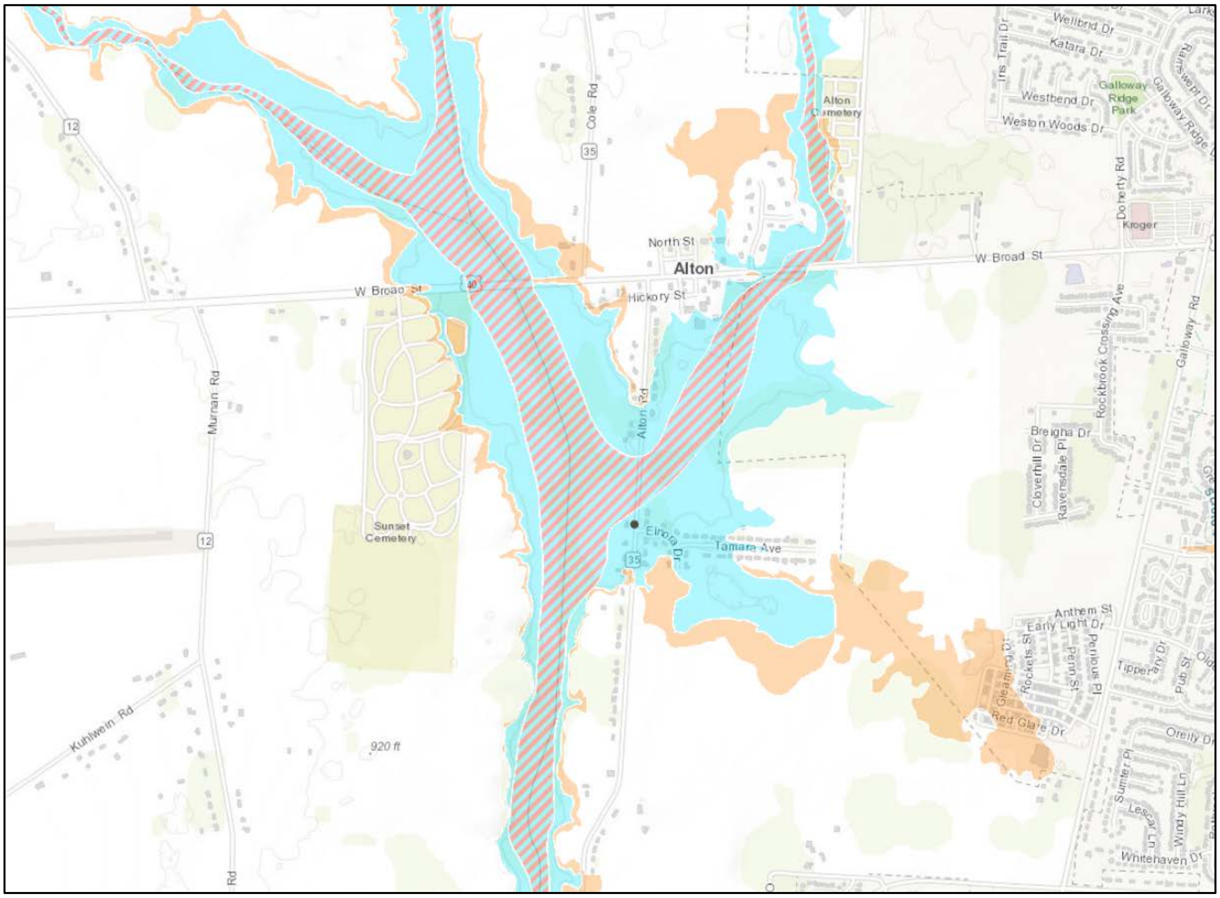


FIGURE 17: FLOOD-PRONE AREA (SW FRANKLIN COUNTY PLEASANT TWP AREA)

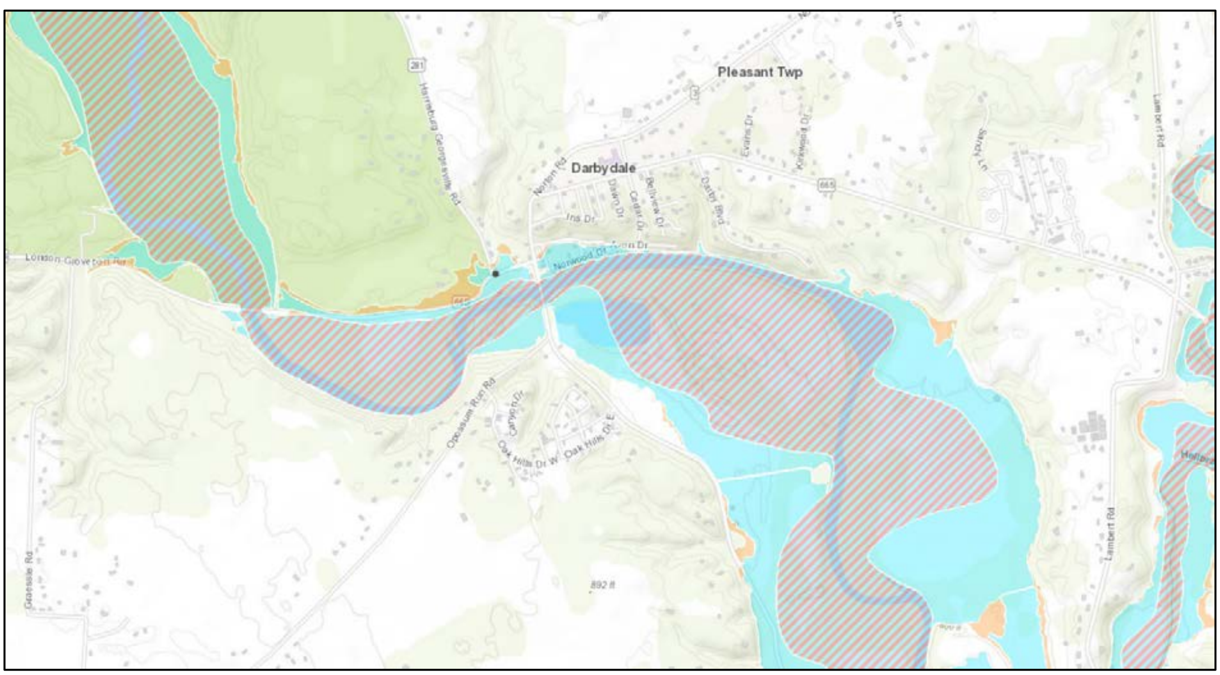


FIGURE 18: FLOOD-PRONE AREA (SE FRANKLIN COUNTY)

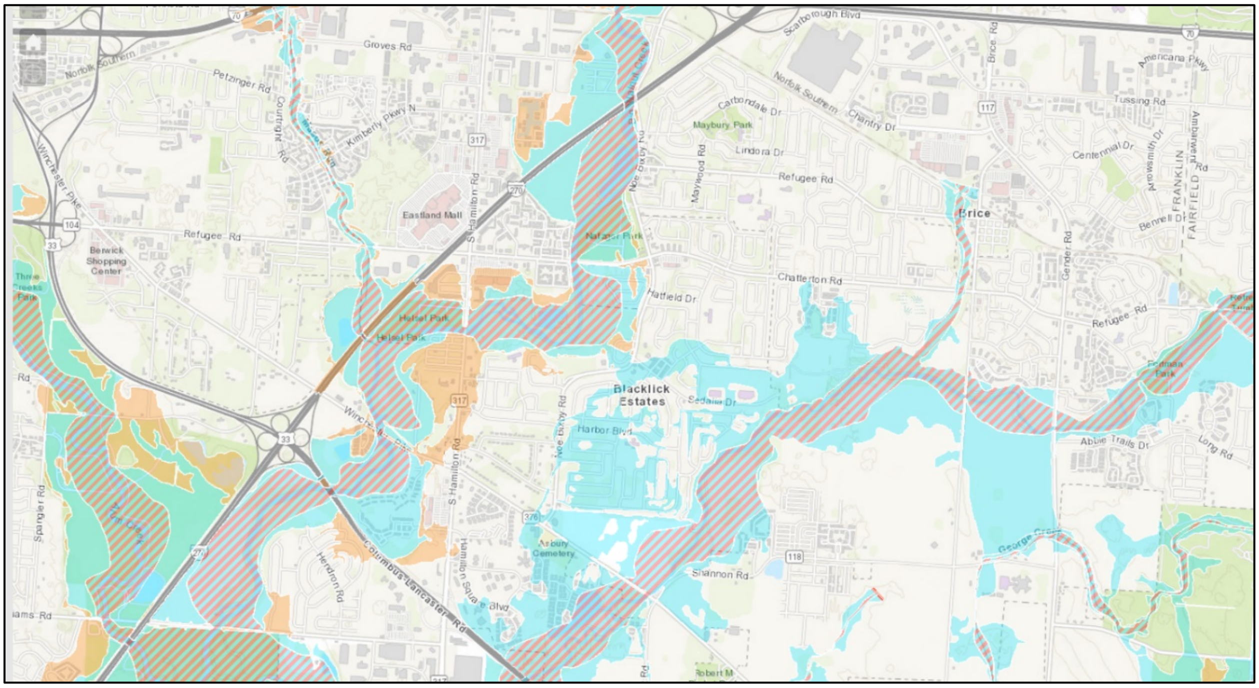


FIGURE 19: FLOOD-PRONE AREA (EAST CENTRAL FRANKLIN COUNTY)

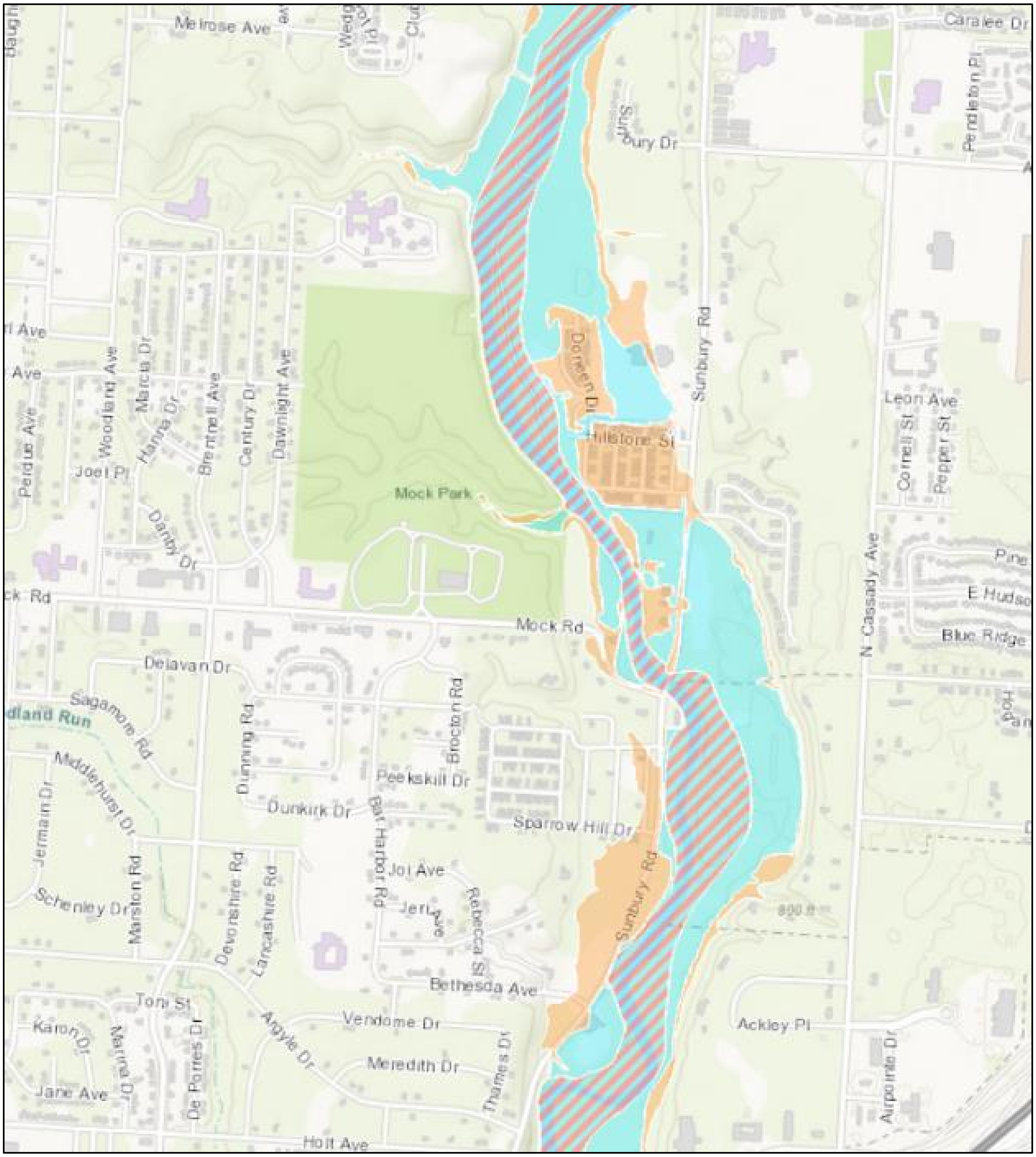


FIGURE 20: FLOOD-PRONE AREA (EAST CENTRAL FRANKLIN COUNTY WHITEHALL AREA)

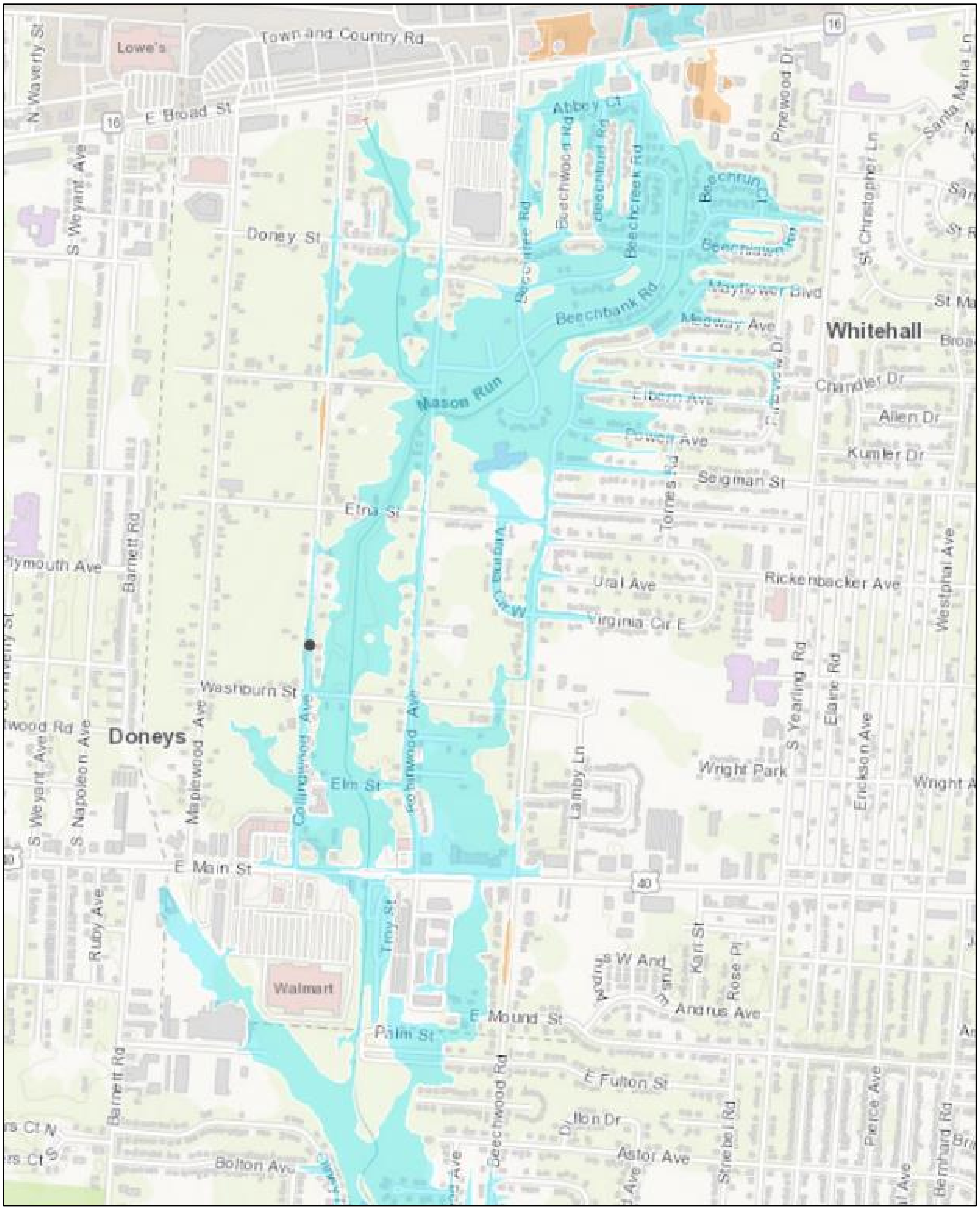


FIGURE 21: FLOOD-PRONE AREA (NW FRANKLIN COUNTY)

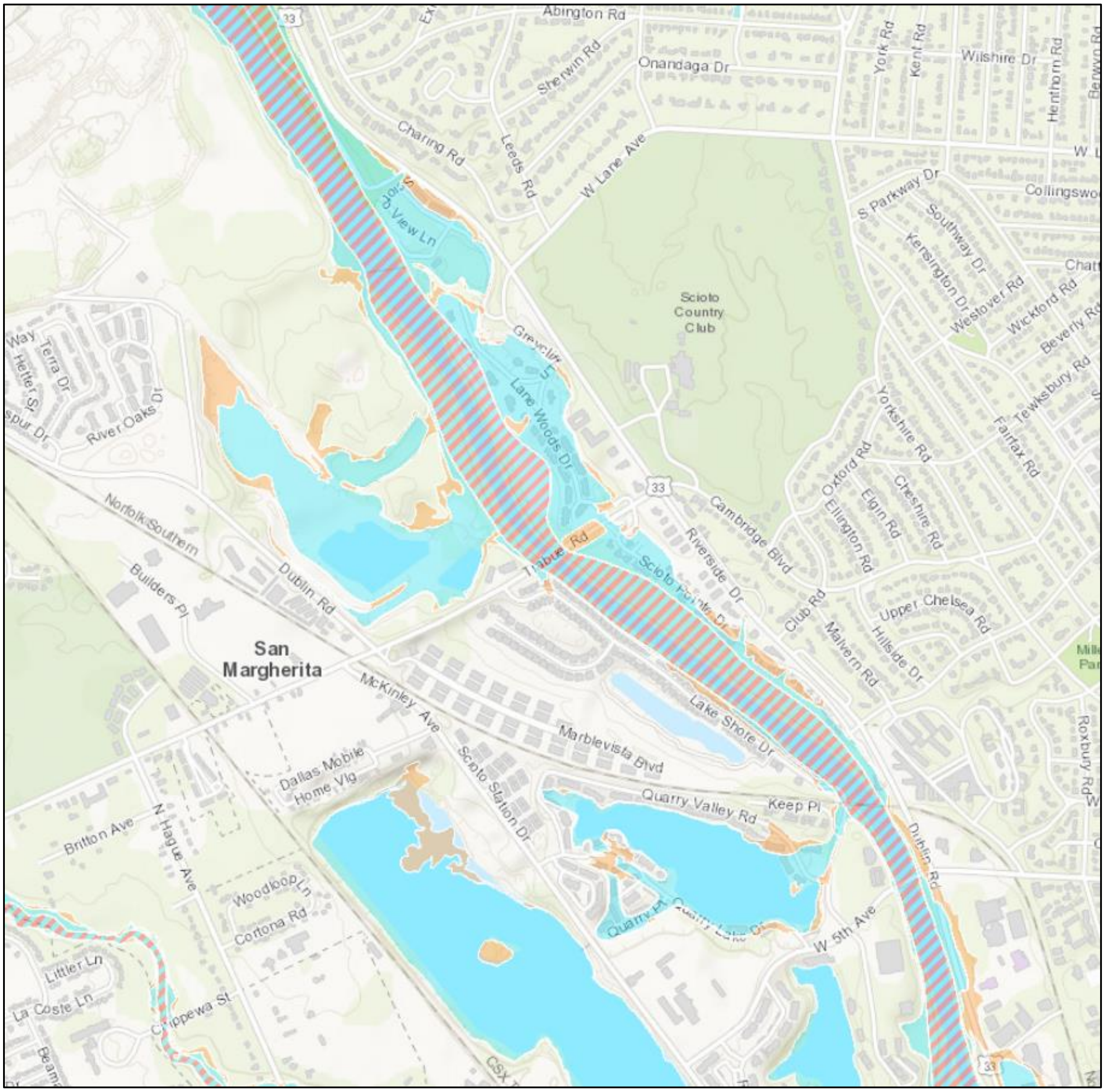


FIGURE 22: FLOOD-PRONE AREA (NW FRANKLIN COUNTY DUBLIN AREA)

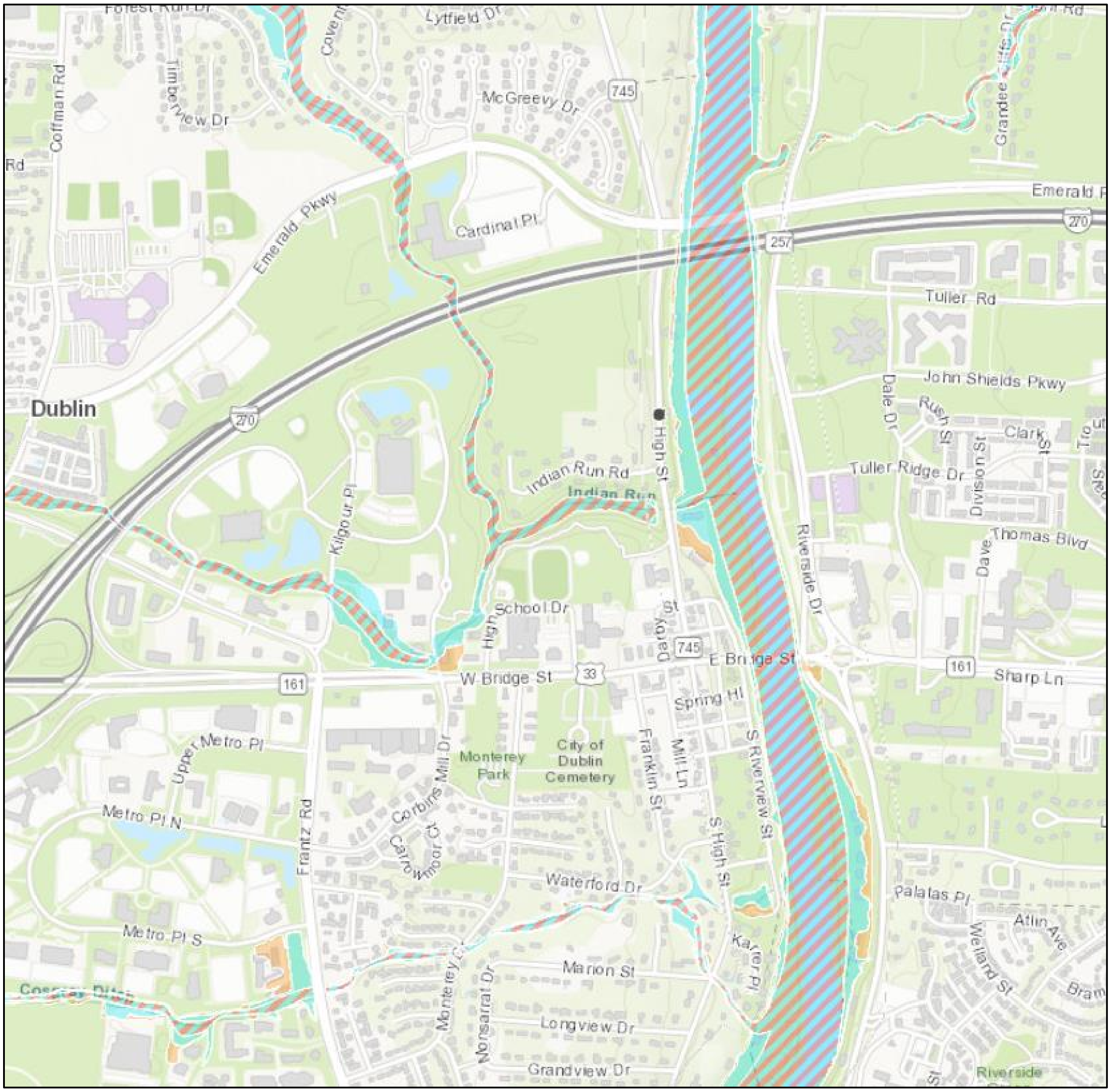
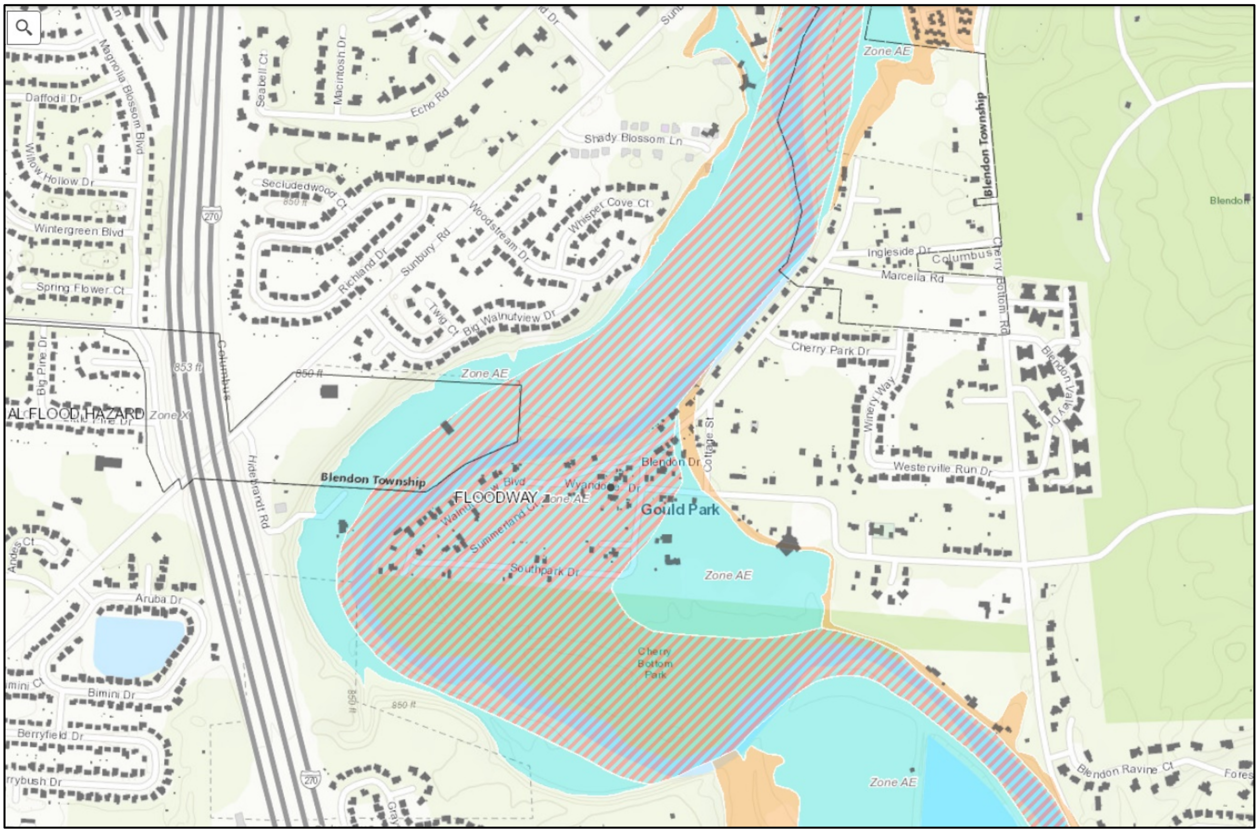


FIGURE 23: FLOOD-PRONE AREA (NE FRANKLIN COUNTY GOULD PARK AREA)



STATUS:

- Ongoing. 20% complete

COORDINATING ORGANIZATION(S):

- Franklin County Emergency Management & Homeland Security
- City of Bexley
- City of Columbus
- Franklin Township
- City of Grove City
- Madison Township
- Pleasant Township
- Prairie Township
- Sharon Township
- City of Upper Arlington
- Washington Township
- City of Westerville
- City of Whitehall
- City of Worthington

TIMELINE:

- February 2007- February 2023.

PLAN GOALS ADDRESSED:

- Reduce the Number of Repetitively Damaged Existing Structures

BENEFIT COST REVIEW

Vulnerability	Before the Action Item is Implemented	After the Action Item is Implemented	Difference
At risk structures and repetitive loss structures	Several delineated areas within Franklin County	Reduced number of repetitive loss claims and structures at risk of flooding	Less Impact
Number of people affected by hazard	Around 200	Less than 200	Less Impact
Area affected	Delineated as repetitive loss	Reduced number of affected areas, some still at risk	Less Impact
Number of parcels	Numerous	Reduced number of parcels impacted	Less Impact
Loss of Life	NA	Potentially	Less loss of life
Benefits			
Saves money in repairs to frequently damaged structures			
Minimizes disruption and risk to homeowners and responders during flooding situation			
Saves lives and properties of homeowners			
Costs			
Time consuming effort			
Process to acquire homes is voluntary			
FEMA process arduous			
Expensive process			

LONG-TERM ACTION ITEM #8

Involve watershed and natural resource management, governmental land-owning agencies and other interested parties, in natural hazard mitigation planning to control and eliminate invasive plant species.

IDEAS FOR IMPLEMENTATION:

- Educate citizens and business owners about invasive plants and the threats they pose to the communities and natural ecosystems in Central Ohio, as well as the State.
- Encourage all property owners to eliminate invasive plants on their land.
- Encourage all Government land-owning agencies to develop an invasive species control plan and to take steps to implement their plan. (i.e. City and County Parks Departments, ODOT, ODNR, etc.)
- Require new development and rezoning to include native species in plantings.

STATUS:

- Ongoing

COORDINATING ORGANIZATIONS:

- Franklin County Soil and Water Conservation District
- Ohio Invasive Plants Council
- Local Government and County Park Departments, ODOT, ODNR, Watershed Groups, Environmental Groups.

TIMELINE:

- February 2012- February 2023.

BENEFIT COST REVIEW

Vulnerability	Before the Action Item is Implemented	After the Action Item is Implemented	Difference
Coordination is key in eradicating invasive plant species	Entire County	Healthier ecosystems and reduced risk to public health and well-being	Less Impact
Number of people affected by hazard	Entire County	Reduced probability of significant impact on the population	Less Impact
Area affected	Entire County	Reduced number of affected areas, some still at risk	Less Impact
Number of parcels	Numerous	Reduced number of parcels impacted	Less Impact
Loss of Life	NA	NA	NA

Benefits
Removal of invasive species help with the natural environment
Long-term education helps land owners understand their part in eradicating invasive species
Costs
Time consuming effort remove invasive species and must keep up on it
Expensive to upkeep

JURISDICTIONAL MITIGATION ACTIONS

Jurisdictional Mitigation Update

Actions that were proposed in the previous mitigation plan were reviewed by the Franklin County Mitigation Planner and members of the Core Group to determine their status. These actions are recorded in this updated plan as having been completed, deleted, deferred, or ongoing.

These actions were part of the review of actions suggested for inclusion in this updated plan. Many of the actions proposed by the previous version of the mitigation plan are again proposed for implementation.

Although the Core Group requested that every jurisdiction submit at least one (1) new mitigation action as part of this planning process, not all jurisdictions submitted a new mitigation action. Many jurisdictions felt their existing actions sufficiently addressed their communities mitigation needs and/or the "County-Level" actions (particularly for the Townships) appropriately addressed their natural hazard risks and concerns.

Note: The unincorporated areas and townships in Franklin County rely on the services of various county departments. For example, the Franklin County Economic Development and Planning Department administers county zoning for ten of the seventeen townships in Franklin County: Brown, Clinton, Franklin, Hamilton, Madison, Mifflin, Norwich, Pleasant, Sharon and Truro Townships. The townships of Blendon, Jackson, Jefferson, Perry, Plain, Prairie and Washington administer their own zoning. Therefore, many of the "County-Level" projects apply both to the County and also to the townships.

Mitigation Action Items Prioritization Process

Prioritization Methodology

As previously noted in the plan, the mitigation strategy/action must be prioritized according to a benefit/cost analysis of the proposed projects and their associated costs (44 CFR, Section 201.6(c)(3)(iii)). The benefits of proposed actions were weighed against multiple factors as part of the project prioritization process. The benefit/cost analysis was not of the detailed variety required by FEMA for project grant eligibility under the Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation (PDM) grant program. A less formal approach was used because some actions/strategies may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time. The mitigation strategies/actions were prioritized and evaluated as shown on the individual mitigation action worksheets for each recommended mitigation initiative.

Priority was assessed by requesting that every new mitigation action submitted by participating jurisdictions go through a ranking process, which was a numbering system from 1 to 5 with 1 being much less important and 5 being much more important.

The following form "New Mitigation Action Projects Form" and the online equivalent (https://integratedsolutions.wufoo.com/forms/m1s10l811j70594/) were created to facilitate the prioritization process described above. The hard copy form was distributed and completed during the workshops. The online form was made available to plan participants via the online planning system.

Similarly, participating jurisdictions were asked to prioritize ongoing actions based on the same methodology. Ongoing actions were reformatted in the online planning system and as a hardcopy handout to facilitate the scoring and reprioritization process.

FIGURE 24: NEW MITIGATION ACTION FORM AND PRIORITIZATION PROCESS

Handout: New Mitigation Actions (Franklin County)

Name:

Organization/Department:

E-mail:

Phone:

New Mitigation Action (Please Describe):

Year Initiated	**2018 (New Mitigation Action)**
Applicable Jurisdiction	
Lead Agency/Organization	
Supporting Agencies/Organizations	
Potential Funding Source	
Estimated Cost	
Benefits (loss avoided)	
Projected Completion Date	
PRIORITY (High, Medium, Low)	

Please indicate if the mitigation goals and objectives below are applicable to the new mitigation action/project). Check All That Apply.

X	Place an "X" by the applicable goals
	Goal 1: Manage Development
	Goal 2: Maintain Public & Private Infrastructure
	Goal 3: Manage Debris Along Streams & Waterways
	Goal 4: Minimize Damage to Public & Private Property
	Goal 5: Minimize Loss of Life from Severe Weather Hazards
	Goal 6: Reduce the Number of Repetitively Damaged Existing Structures

This mitigation action:

Instructions: Circle the best option

	Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)
Technical Feasibility: This mitigation action/project is technically feasible and offers a long-term solution to the problem being mitigated.	1	2	3	4	5

Page **1** of **2**

<u>Cost Effectiveness</u>: This mitigation action/project is cost effective and that funding can be easily allocated to implement this action/project	1	2	3	4	5
<u>Ability to Accomplish/Implement and Sustain</u>: This mitigation action/project is more likely to be implemented and sustained. This action/project is not in conflict with any existing or potential legal issues and does not pose a negative impact on the environment.	1	2	3	4	5
<u>Protection of Critical Resources and Assets</u>: This mitigation action/project is likely to protect critical infrastructure, key resources, and building stock.	1	2	3	4	5
<u>Community and Political Acceptance/Support</u>: This mitigation action/project is more likely to gain community and social acceptance. This action is more likely to garner political support.	1	2	3	4	5

Place an "X" by the hazard(s) this action/project will mitigate:

	Mitigated Hazard
X	Place an "X" by the applicable hazard
	Dam/Levee Failure
	Drought
	Earthquake
	Extreme Cold
	Extreme Heat
	Flood (Riverine)
	Flood (Urban/Flash Flooding)
	Landslide
	Severe Thunderstorm
	Severe Winter Weather/Heavy Snowfall/Ice Storm
	Sinkhole
	Tornado
	Wildfire

Review of Jurisdictional Proposed Mitigation Actions

The subsequent table lists the mitigation actions that were proposed by each jurisdiction in Franklin County and the status of actions as new, ongoing, modified, completed, deleted, or deferred.

Mitigation Strategy/Action Timeline Parameters

While the preference is to provide definitive project completion dates, this is not possible for every mitigation strategy/action. Therefore, the parameters for the timeline (**Projected Completion Date**) are as follows:

- **Short Term** = to be completed in 1 to 5 years
- **Long Term** = to be completed in greater than 5 years
- **Ongoing** = currently being funded and implemented under existing programs, and/or is seeking funding and necessary approvals.

Mitigation Strategy/Action Estimated Cost

While the preference is to provide definitive costs (dollar figures) for each mitigation strategy/action, this is not possible for every mitigation strategy/action. Therefore, the estimated costs for the mitigation initiatives identified in this Plan were identified as high, medium, or low, using the following ranges:

- **Low** – less than $10,000
- **Medium** – from $10,000 to $100,000
- **High** – greater than $100,000

The full action plans for each mitigation strategy for the purposes of facilitating the annual review process are maintained in the online planning system.

TABLE 21: PROPOSED MITIGATION ACTIONS WITH UPDATED STATUS

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
City of Bexley Projects coordinated by Mayor's office	1. Research and determine cause of overall flooding in Bexley. (100,000/ 1 year)	2007	Ongoing: Study of inflow and infiltration and project prioritization has been completed.	Mayor's office	PDM	**Medium** $100,000	Short Term 1 year	Flooding
	2. Seek funding to address core problems of flooding with permanent solutions (TBD by #2)	2007	Ongoing: Major sewer upgrades have been performed, and additional upgrades are underway.	Mayor's office	PDM	**High**	Short Term	Flooding
	3. Seek funding for repetitive loss structures to permanently reduce damage to these structures. (3 known properties est. at 925,000 /2 years) *	2007	Ongoing	Mayor's office	PDM	**High** 3 known properties est. at $925,000	Short Term 2 years	Flooding
	4. Seek funding for back-up generators for critical public buildings. (10 Buildings @ 500,000 / 6 months)	2007	Ongoing: Service garage added to generator backup. Need to get school generator status.	Mayor's office	Local Funds	**High** 10 buildings @ $500,000	Short Term 6 months	All hazards
	5. Seek funding for lightning detection/warning for city parks. (100,000 / 1 year)	2007	Unchanged: No action has been taken. No funding for project	Mayor's office	PDM/HMGP/ Local Funds/	**Medium** $100,000	Short Term 1 year	Severe thunderstorms and lightning

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	7. Work with Franklin County Emergency Management and Homeland Security to develop public educational outreach regarding all natural hazards and Franklin Counties susceptibility to those hazards and make available on Bexley's website. (No costs, on going)	2007	Ongoing	Mayor's office	Local Funds	No costs	Ongoing	All hazards
	8. Seek finding for backup generators for intersections which will be utilized as evacuation routes.	2007	Complete: UPS and/or backup generator hookups have been installed at key intersections	Mayor's office	PDM/HMGP/ Local Funds/	**High**	Short Term	All hazards
Blendon Township Projects coordinated by Township Trustee's office	1. Seek funding for public information including outreach projects and technical assistance to property owners. (15,000 / 1 year)	2007	Ongoing	Township Trustee's office	Local Funds	**Medium** $15,000	Short Term 1 year	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	2. Work with Franklin County Emergency Management and Homeland Security to develop public outreach regarding all natural hazards, and the county's susceptibility to those hazards, and make available on website. (No cost, ongoing)	2007	Ongoing	Township Trustee's office	Local Funds	No Cost	Ongoing	All hazards
Village of Brice Projects coordinated by Village Administration and Mayor's office	1. Purchase NOAA weather alert radios for every hospital, parks & recreation center, public utility facility, large population venue, private/public school and government building accessed by the public. (10 facilities @ 1000 / 2 months)	2007	Ongoing	Village Administration and Mayor's office	EMPG- Special Project Funding	**Medium** 10 facilities @ $1,000	Short Term 2 months	Severe thunderstorms and lightning
	2. Purchase Tornado Sirens through the Franklin County Emergency Management & Homeland Security for community. (3 @ 60,000 / 4 months)	2007	Ongoing	Village Administration and Mayor's office	PDM/HMGP/ Local Funds	**Medium** 3 @ 60,000	Short Term 4 months	Tornadoes
Brown Township Projects coordinated by Township Trustee's office	1. Seek funding for public information including outreach projects and technical assistance to property owners. (15,000 / 1 year)	2007	Ongoing	Township Trustee's office	Local Funds	**Medium** $15,000	Short Term 1 year	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	2. Work with Franklin County Emergency Management and Homeland Security to develop public outreach regarding all natural hazards, and the county's susceptibility to those hazards, and make available on website. (No cost)	2007	Ongoing	Township Trustee's office	Local Funds	No Cost	Ongoing	All hazards
	3. In cooperation with Franklin County Emergency Management & Homeland Security, purchase tornado sirens to cover gaps in coverage in Brown Township.	2012	Ongoing	Township Trustee's office	PDM/HMGP/ Local Funds	**Medium**	Short Term	Tornadoes
	4. Study and mitigate stormwater flooding along Davis, Walker, Morris, and Patterson roads.	2012	Ongoing	Township Trustee's office	PDM/HMGP/ Local Funds/	**High**	Short Term	Flooding
Canal Winchester Projects coordinated by Mayor's office	1.Upgrade generator at water reclamation facility	2018	New	Mayor's office	PDM/HMGP/ Local Funds	**Medium**	Short Term	All Hazards
	2. Provide generator for water tower to maintain control system communication	2018	New	Mayor's office	PDM/HMGP/ Local Funds	**Medium**	Short Term	All Hazards
	3. Improve access to public service facility during flooding	2018	New	Mayor's office	Local Funds	**Medium**	Short Term	Flood (Riverine)
	4. Provide generator/backup pumps for priority pump stations	2018	New	Mayor's office	PDM/HMGP/ Local Funds	**Medium**	Short Term	Severe Thunderstorm

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	5. Purchase NOAA weather alert radios for every hospital, parks & recreation center, public utility facility, large population venue, private/public school and government building accessed by the public. (35 facilities @ 3000 / 6 months)	2007	Ongoing. All regularly staffed city-owned facilities have radios	Mayor's office	EMPG- Special Project Funding	**Low** 35 facilities @ 3000	Short Term 6 months	All hazards
	6. Develop plan to have lightning arrestors installed on all lift stations. (70,000 / 1 year)	2007	Ongoing.	Mayor's office	Local Funds	**Medium** $70,000	Short Term 1 year	Severe thunderstorms and lightning
	7. Seek funding for purchase and installation of additional tornado sirens.	2012	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**Medium**	Short Term	Tornadoes
	8. Seek permission & funding to acquire equipment to optimize interagency communications	2012	Ongoing	Mayor's office	Homeland Security Grants/ Local Funds	**Medium**	Long Term	All Hazards
Clinton Township Projects coordinated by Township Trustee's office	1. Seek funding for public information including outreach projects and technical assistance to property owners. (15,000 / 1 year)	2007	Ongoing	Township Trustee's office	Local Funds	**Medium** $15,000	Ongoing	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	2. Work with Franklin County Emergency Management and Homeland Security to develop public outreach regarding all natural hazards, and the county's susceptibility to those hazards, and make available on website. (No cost, ongoing)	2007	Ongoing	Township Trustee's office	Local Funds	No cost	Ongoing	All hazards
City of Columbus Projects coordinated by Mayor's office	1. Provide pre-identified locations for heating and cooling shelters, in events of extreme cold/extreme heat, generators and other expendable resources (blankets, water, etc.) for public consumption	2018	New	Public Health	PDM/HMGP/ Local Funds	**Medium**	Short Term	Severe Winter Weather (Extreme Cold) and Extreme Heat
	2. Seek funding for repetitive loss structures to permanently reduce damage to these structures. (3 known properties est. at $425,000 /2 years) *	2012	Ongoing	Mayor's office	PDM	**High** 3 known properties est. at $425,000	Short Term 2 years	Flooding
	3. Acquisition project in Sharon Woods (4,000,000 / 3 years)	2007	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High** $4,000,000	Short Term 3 years	Flooding
	4. Study cause of repeated flooding in Gould Park area and explore possible solutions to the flooding. (100,000 / 1year)	2007	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**Medium** $100,000	Short Term 1 year	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	5. Develop & implement an Emergency Action Plan to provide for flood protection of the North Bank Park / Arena District Area. ($750,000)	2012	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High** $750,000	Short Term	Flooding
	6. Buyout of flood prone properties in the Gould Park and Annadale / Martindale Areas. ($3.0 Mil.)	2012	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High** $3,000,000	Short Term	Flooding
	7. Retrofit of city owned detention basins for water quality and peak flows. ($1.0 Mil)	2012	Ongoing	Public Utilities-DOSD	PDM/HMGP/ Local Funds	**High** $1,000,000	Short Term	Flooding
	8. Repair of Harmon Avenue Floodwall gate sill. ($500,000)	2012	Ongoing	DPU-DOSD	PDM/HMGP/ Local Funds	**High** $500,000	Short Term	Flooding
	9. Repair S.R. 315 floodwall. ($300,000)	2012	Ongoing	Public Utilities-DOSD	PDM/HMGP/ Local Funds	**High** $300,000	Short Term	Flooding
	10. Stormwater five year capital projects ($15 Mil./yr)	2012	Ongoing	Public Utilities-DOSD	Local Funds	**High** $15 Mil/yr	Long Term	Flooding
	11. Repair of log gate across CSX Railroad. ($500,000)	2012	Ongoing	Public Utilities-DOSD	Local Funds	**High** $500,000	Short Term	Flooding
City of Dublin Projects Coordinated by Dublin Police, Operations Bureau Commander 2/20/2007	1. Install safe rooms/wind shelters in all public parks/existing buildings	2018	New	Parks/City of Dublin	HMGP (404)/local	**High**	Long Term 2025	Severe Thunderstorm and Tornado
	2. Replace wood poles with concrete ones if damaged. Wind resistant and meet specifications	2018	New	AEP; Contractor; streets and utilities/Public Works	HMGP (404)/local dollars and 406 – damage lines in 2012/2008	**High**	Long Term	Severe Winter Weather and Tornado

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	3. Bury all electric utility lines and poles	2018	New	Public Works, Engineering, City of Dublin	HMGP/Local Funds	**High**	Long Term	Severe Winter/Summer Weather and Tornado
	4. Stormwater retention pond mucking/cleaning/sediment removal	2018	Ongoing	Public Works, Engineering, City of Dublin	Capital Improvement	**Medium**	Ongoing	Drought and Flood (Urban/Flash Flooding)
	5. Seek funding for back-up generators for critical public buildings and/or infrastructure .	2007	Ongoing: The emergency generator at the Recreation Center is over 20-years-old and should be replaced soon.	Dublin Police	PDM/HMGP/ Local Funds	**Medium**	Ongoing	All hazards
	6. Seek funding for the purchase, replacement, and/or upgrading of Lightning detection/warning systems for city parks/pools,	2012	Ongoing. In 2012 Lightning Prediction Systems were added to: Avery Park North & South, Emerald Fields Park, Darree Fields Park, City's North Pool, and City's South Pool. There is additional funding to add a Lightning Prediction System to the Coffman Skate Park in 2018, but could be pushed out to 2019.	Dublin Police	PDM/HMGP/ Local Funds	**Medium**	Short Term 2019	Severe Summer Storms and Tornadoes
	7. Develop and implement public education programs to increase public awareness and understanding of the risks associated with natural	2012	Ongoing: New and existing public education and outreach efforts will be ongoing.	Dublin Police	Local Funds	**Low**	Ongoing	All hazards

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	hazards							
	8. Seek funding for the purchase of additional tornado sirens to increase coverage of the Dublin Emergency Warning System. ($50,000.00) (Narrow Band Conversion $16,200.00)	2007	Complete: Five additional sites added in 2011; all sites are being upgraded with new narrowband communications systems; all sites receiving new solar power system and upgraded electrical components. The latest outdoor tornado warning siren installation performed was near Rings Road and Churchman Road in 2014.	Dublin Police	Local Funds	**Medium** $50,000 – Narrow Band Conversion $16,200	Short Term	Tornadoes
	9. Seek funding for back-up generators for evacuation route intersections.	2007	Complete: All of the traffic signalized intersections in Dublin have back up power supplies.	Engineering	Local Funds	**Medium**	Complete	All hazards
	10. Seek funding to increase public notification capabilities (i.e. 1610 A.M. and Dublin Emergency Calling System). $15,000.00 Annual Cost (Subscription)	2007	Complete: Dublin already purchased and implemented the Dublin Emergency Calling System using Code Red as the product/vendor. In addition, Dublin also	Coordinated by Dublin Police	Local Funds	**Medium** $15,000 Annual Cost (Subscription)	Complete	All hazards

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
			pushed out to residents to also join the ALERT Franklin County system which is a state-of-the-art mass notification and warning system to warn residents about emergencies.					
	11. Seek funding to purchase equipment to support interagency communications. Estimate $2.5 million (Grant 1.529 million awarded)	2007	Complete: The City of Dublin merged the existing Dublin 800MHz radio system with the City of Worthington and Delaware County to form a regional emergency radio system called the Central Ohio Interoperable Radio System (COIRS).	Coordinated by Dublin Police	Homeland Security Grants/ Local Funds	**High** Estimate $2.5 Million (Grant 1.529 Million awarded)	Complete	All hazards
	12. Seek funding for NOAA weather radios (to provide to critical public and private facilities)	2012	Complete. The city provided NOAA weather radios to all city facilities: city hall, service center, justice center, recreation center, and development building	Dublin Police	EMPG/Local Funds	**Low**	Complete	Severe Summer Storms and Tornadoes
Franklin TownshipProjects coordinated by Township Trustee's office	1. Seek funding for three repetitive loss structures to permanently reduce damage to these structures. (3 structures @ 300,000 / 2 years)	2007	Ongoing	Township Trustee's office	PDM	**High** 3 structures @ 300,000	Short Term 2 years	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	2. Develop a comprehensive plan to address habitual flooding in the Whims Ditch area. (100,000 / 1 year)	2007	Ongoing	Township Trustee's office	PDM	**Medium** $100,000	Short Term 1 year	Flooding
	3. Mitigate Minor Flooding Throughout Township. Identify alternative strategies.	2007	Ongoing	Township Trustee's office	Local Funds	**High**	Ongoing	Flooding
	4. Increase coverage of tornado sirens in the township	2007	Ongoing	Township Trustee's office	Local Funds	**Medium**	Short Term	Tornadoes
	5. Seek funding for acquisition of properties along Whims Ditch.	2012	Ongoing	Township Trustee's office	PDM/HMGP/ Local Funds	**High**	Short Term	Flooding
City of Gahanna Projects coordinated by Mayor's office	1. Storm water five year capital projects *(3,000,000 / 3 years)*	2007	Ongoing	Mayor's office		**High** $3,000,000	Short Term 3 years	Flooding
	2. Flood routing swale for Academy Woods. *(750,000 / 2 years)*	2007	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High** $750,000	Short Term 2 years	Flooding
	3. Detention basin, flood routing swales and culverts for Industrial Zone phase 1. *(450,000 / 1 year)*	2007	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High** $450,000	Short Term 1 year	Flooding
	4. Industrial Zone phase 2, pond dredging retention basins. *(1,000,000 / 9 months)*	2007	Ongoing	Mayor's office	Local Funds	**High** $1,000,000	Short Term 9 months	Flooding
	5. Engineering of flood mitigation program. *(150,000 / 6 months)*	2007	Ongoing	Mayor's office	Local Funds	**High** $150,000	Short Term 6 months	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	6. Industrial Zone 36" pipe for Kahiki *(450,000 / 9 months)*	2007	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High** $450,000	Short Term 9 months	Flooding
	7. Construction of flood reliever piping system. *(850,000 / 2 years)*	2007	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High** $850,000	Short Term 2 years	Flooding
	8. Royal Manor BW phase 1 & 2 construction. *(1,500,000 / 18 months)*	2007	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High** $1,500,000	Short Term 18 months	Flooding
	9. Old Gahanna storm rehab, *(3,000,000 / 2 years)*	2007	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High** $3,000,000	Short Term 2 years	Flooding
	10. Storm component of East Johnstown Road *(1,500,000 / 18 months)*	2007	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High** $1,500,000	Short Term 18 months	Flooding
	11. Hunters Ridge/Claman Heights Storm Improvements (200,000/2 years)	2012	Ongoing	Mayor's office	Capital Improvement	**High** $200,000	Short Term 2 years	Flooding
	12. Royal Manor/Brentwood Storm Improvements (5,500,000/3 years)	2012	Ongoing	Mayor's office	Capital Improvement	**High** $5,500,000	Short Term 3 years	Flooding
	13. Souder Ditch Watershed – Erosion Repair Projects ($1,500,000/18 months)	2012	Ongoing	Mayor's office	Capital Improvement	**High** $1,500,000	Short Term 18 months	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
City of Grandview Heights Projects coordinated by Mayor's office	1. Purchase NOAA weather alert radios for every hospital, parks & recreation center, public utility facility, large population venue, private/public school and government building accessed by the public. (20 facilities @ 2000 / 6 months)	2007	Ongoing	Mayor's office	EMPG/Local Funds	**Medium** 20 facilities @ 2000	Short Term 6 months	All hazards
	2. Install a gate valve at the outlet of a storm sewer to remove approximately 10 acres of property from the 100 year flood plain.	2012	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High**	Short Term	Flooding
	3. Purchase Tornado Sirens through Franklin County Emergency Management & Homeland Security. (20,000 / siren)	2007	Complete	Mayor's office	Local Funds	**Medium** 20,000 / siren	Complete	Tornadoes
Grove City Projects coordinated by Mayor's office	1. Seek funding for repetitive loss structures to permanently reduce damage to these structures (2 known properties est. at 400,000 /4 years) *	2007	Ongoing	Mayor's office	PDM	**High** 2 known properties est. at 400,000	Short Term 4 years	Flooding
	2. Seek funding for back-up generators for critical public buildings (5 facilities @ 500,000 / 6 months)	2007	Ongoing	Mayor's office	Local Funds	**High** 5 facilities @ 500,000	Short Term 6 months	All hazards

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	3. Seek funding for lightning detection/warning for city parks (45,000 / 6 months)	2007	Ongoing	Mayor’s office	PDM/HMGP/ Local Funds	**Medium** 45,000	Short Term 6 months	Severe thunderstorms and lightning
	4. Seek funding for backup power generators for evacuation route intersections. (120,000 / 3 months)	2007	Ongoing	Mayor’s office	Local Funds	**High** $120,000	Short Term 3 months	All hazards
	5. Seek funding for backup power for 5 existing pump stations. (500,000 / 6 months)	2007	Ongoing	Mayor’s office	PDM/HMGP/ Local Funds	**High** $500,000	Short Term 6 months	All hazards
	6. Seek funding for backup power for existing water booster stations/water tanks. (50,000 / 6 months)	2007	Ongoing	Mayor’s office	PDM/HMGP/ Local Funds	**High** $50,000	Short Term 6 months	All hazards
	7. Work with Franklin County Emergency Management and Homeland Security to develop public educational outreach regarding all natural hazards and Franklin County's susceptibility to those hazards then make available on city's website. (5,000 / ongoing)	2007	Ongoing	Mayor’s office	Local Funds	**Low** $5,000	Ongoing	All hazards

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	8. Potential changes in the operation of the Columbus sanitary sewer system could result in the flooding of 10 homes in the southeastern section of Grove City, Scioto Meadows/Hibbs Rd. (10 homes, 300,000)	2012	Ongoing	Mayor's office	Local Funds	**High** 10 homes, $300,000	Short Term	Flooding
City of Groveport Projects coordinated by Mayor's office	1. Evaluate Groveport Road at Rager Road to avoid flooding of Groveport Road	2018	New	Franklin County Engineer	OPWC, FEMA, 404	**High** $3 Million	Short Term 2023	Flood (Riverine)
	2. Fixed permanent emergency generators for critical facilities and sanitary sewer pump stations	2018	New	Groveport City	Grants, City Sewer Capital Fund, Stormwater Utilities	**High** $750,000	Short Term 2022	Flood (Riverine) and Flood (Urban/Flash Flooding)
	3. Research and secure funding for tree trimming program.	2012	Ongoing	Mayor's office	HMGP/ Local Funds	**Medium**	Ongoing	All hazards
	4. Purchase and raise frequently flooded properties on Hanstein Ditch and add property to existing city owned parkland to the east.	2012	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High**	Short Term	Flooding
	5. Replace bridge on Little Walnut Creek to prevent current bridge from breaking free, flowing down stream and causing flooding upstream.	2012	Modified: Changed Hanstein Ditch to Little Walnut Creek	Mayor's office	PDM/HMGP/ Local Funds	**High**	Short Term	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	6. Research and secure funding to provide storm sewers on properties along Old Hamilton Road that have old collapsed tile that causes flooding.	2012	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High**	Short Term	Flooding
	7. Seek funding for back-up generator to the community recreation center that would be used as an emergency command center, emergency communication center and temporary housing facility for natural disasters.	2012	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**Medium**	Short Term	All hazards
	8. Identify resources and strategies to remove the Blacklick log jam. (2,000,000 / 1 year)	2007	Completed. Log jam was removed.	Mayor's office	State Budget	**High** $2,000,000	Complete	Flooding
Hamilton Township Project coordinated by Township Trustee's office	1. Seek funds for determining the cause and relief of flooding of Township Park located at Lockbourne Road at Big Walnut Creek *(100,000 / 1 year)*	2007	Ongoing	Township Trustee's office	PDM/HMGP/ Local Funds	**High** $1,000,000	Short Term 1 year	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	2. Fill in the property and add drainage which would help other residents and the township with road drainage along the old traction line from Daughtery Rd. to Todd Rd.	2012	Ongoing	Township Trustee's office	PDM/HMGP/ Local Funds	**High**	Short Term	Flooding
Village of Harrisburg Project Coordinated by Village Administration and Mayor's office	1. Purchase NOAA weather alert radios for every hospital, parks & recreation center, public utility facility, large population venue, private/public school and government building accessed by the public. (1500 / 3 months)	2007	Ongoing	Village Administration and Mayor's office	EMPG/Local Funds	**Low** $1,500	Short Term 3 months	Tornadoes Severe thunderstorms and lightning
	2. Purchase Tornado Sirens through Franklin County Emergency Management & Homeland Security. (60,000 / 4 months)	2007	Ongoing	Village Administration and Mayor's office	PDM/HMGP/ Local Funds	**Medium** $60,000	Short Term 4 months	Tornadoes
City of Hilliard Projects coordinated by Mayor's office	1. Develop a comprehensive plan for addressing the habitual flooding problems along the existing ditches, streams, and runs in the City of Hilliard. (100,000 / 1 year)	2007	Ongoing	Mayor's office	Hilliard Storm Water Utility Funds	**Medium** $100,000	Short Term 1 year	Flooding
	2. Operations and Maintenance of Storm Water Facilities. ($546,200 per year)	2007	Ongoing	Mayor's office	Local Funds	**High** $546,200 per year	Ongoing	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	3. Flood control evaluation on Holcomb Ditch	2007	Ongoing	Mayor's office	Hilliard Storm Water Utility Funds	**High**	Short Term	Flooding
	4. Install retention basin at Heather Ridge. (250,000, 1 year)	2007	Ongoing	Mayor's office	Hilliard Storm Water Utility Funds	**High** $250,000	Short Term 1 year	Flooding
	5. Implementation a Storm Water Management Program	2007	Ongoing	Mayor's office	Local Funds	**High**	Ongoing	Flooding
	6. Hamilton Ditch north stream restoration and water quality improvements	2007	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High**	Ongoing	Flooding
	7. Implement the Hilliard Storm Water Master Plan	2007	Complete: Adopted Fall 2011.	Mayor's office	Local Funds	**High**	Complete	Flooding
	8. Pedestrian bridge over stream at Hilliard Family Aquatic Center	2007	Complete	Mayor's office	Local Funds	**High**	Complete	Flooding
	9. Stream restoration on Clover Groff Ditch	2007	Complete	Mayor's office	Local Funds	**High**	Complete	Flooding
	10. Stream restoration on south part of Hamilton Ditch	2007	Complete	Mayor's office	Local Funds	**High**	Complete	Flooding
Jackson Township Projects coordinated by Township Trustee's office	1. Seek funding for public information including outreach projects and technical assistance to property owners. (10,000 / 1 year)	2007	Ongoing	Township Trustee's office	Local Funds	**Medium** $10,000	Short Term 1 year	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	2. Work with Franklin County Emergency Management and Homeland Security to develop public outreach regarding all natural hazards, and the county's susceptibility to those hazards, and make available on website. (5,000 /ongoing)	2007	Ongoing	Township Trustee's office	Local Funds	**Low** $5,000	Ongoing	All hazards.
Jefferson Township Projects coordinated by Township Trustee's office	1. Burying above-ground utility lines to mitigate wind/tree damage	2018	New	AEP/Utilities	HMGP/ Local Funds	**High**	Ongoing	Severe Thunderstorm and Severe Winter Weather
	2. Improve stormwater drainage system capacity at McOwen Road, Havens Road, Cob Tail Way, Dixon Road, Creek Hollow Road, Longstreth Park Place, Mann Road (Box Culvert)	2018	New	Franklin County Engineer	Local Funds	**High**	Long Term	Flood (Urban/Flash Flooding)
	3. Seek funding for public information including outreach projects and technical assistance to property owners. (10,000 / 1 year)	2007	Ongoing	Township Trustee's office	Local Funds	**Medium** $10,000	Short Term 1 year	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	4. Work with Franklin County Emergency Management and Homeland Security to develop public outreach regarding all natural hazards, and the county's susceptibility to those hazards, and make available on website. (5,000 /ongoing)	2007	Ongoing	Township Trustee's office	Local Funds	**Low** $5,000	Ongoing	All hazards.
	5. Mitigate stream flooding in Fieldstone.	2012	Ongoing: Seeking funding	Franklin Soil and Water Conservation District	PDM/HMGP/ Local Funds	**High**	Long Term	Flooding
	6. Seek funding for the purchase of additional tornado sirens to increase coverage. ($50,000.00)	2012	Ongoing	Township Trustee's office	PDM/HMGP/ Local Funds	**Medium** $50,000	Short Term	Tornadoes
	7. Incorporating CodeRed to provide all residents and businesses in the township with access to emergency notifications and severe weather alerts.	2012	Discontinued	Township Trustee's office	Local Funds	**Medium**	Short Term	All hazards
Village of Lockbourne Projects coordinated by Village Administration and Mayor's office	1. Add Emergency System to Website	2018	New	Village Administration and Mayor's office	Local Funds	**Low** $35	Short Term 2018	All Hazards
	2. Send out emergency information through website opt-in alerts	2018	New	Village Administration and Mayor's	Local Funds	**Medium**	Short Term 2019	All Hazards

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
				office				
	3. Purchase NOAA weather alert radios for every hospital, parks & recreation center, public utility facility, large population venue, private/public school and government building accessed by the public. (2000 / 3 months)	2007	Ongoing	Village Administration and Mayor's office	EMPG/Local Funds	**Low** $2,000	Short Term 3 months	Tornadoes Severe thunderstorms and lightning
	4. Purchase Tornado Sirens through Franklin County Emergency Management & Homeland Security. (40,000 / 4 months)	2007	Ongoing	Village Administration and Mayor's office	PDM/HMGP/ Local Funds	**Medium** $40,000	Short Term 4 months	All hazards.
Madison Township Projects coordinated by Township Trustee Office	1. Seek funding for one repetitive loss structure to permanently reduce damage.	2012	Ongoing	Township Trustee's office	PDM	**High**	Short Term	Flooding
	2. Conduct a study on Berger Road and at the intersection of Groveport and Rager to prevent flooding on these emergency response routes. (2 years)	2012	Ongoing	Township Trustee's office	PDM/HMGP/ Local Funds	**High**	Short Term 2 years	Flooding
	3. Install tornado sirens in the areas of Madison Township where Franklin County EMA has identified the need for sirens. (20,000 / year)	2012	Ongoing	Township Trustee's office	PDM/HMGP/ Local Funds	**Medium** $20,000/year	Short Term	Tornadoes

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	4. Identify resources and strategies to remove Blacklick Creek log jam. *(2,000,000 / 1 year)*		Completed	Township Trustee's office	State Budget	**High** $2,000,000	Complete	Flooding
Village of Marble Cliff Project coordinated by Village Administration and Mayor's office	1. Purchase NOAA weather alert radios for every hospital, parks & recreation center, public utility facility, large population venue, private/public school and government building accessed by the public. (2,000 / 3 months)	2007	Ongoing	Village Administration and Mayor's office	EMPG/Local Funds	**Low** $2,000	Short Term 3 months	All hazards
	2. Use a third party system to email residents in the event of an emergency. (zero funding, ongoing)	2007	Ongoing	Village Administration and Mayor's office	Local Funds	Zero funding	ongoing	All hazards
Mifflin Township Projects coordinated by Township Trustee's office	1. Seek funding for public information including outreach projects and technical assistance to property owners. (5,000 / 1 year)	2007	Ongoing	Township Trustee's office	EMPG	**Low** $5,000	Short Term 1 year	Flooding
	2. Work with Franklin County Emergency Management and Homeland Security to develop public outreach regarding all natural hazards, and the county's susceptibility to those hazards, and make available on website. (5,000 / 1 year)	2007	Ongoing	Township Trustee's office	Local Funds	**Low** $5,000	Ongoing	All hazards.

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
Village of Minerva Park Projects coordinated by Mayor's office	1. Purchase NOAA weather alert radios for every hospital, parks & recreation center, public utility facility, large population venue, private/public school and government building accessed by the public. (1,000 / 3 months)	2007	Ongoing	Mayor's office	EMPG/Local Funds	**Low** $1,000	Short Term 3 months	Tornadoes
	2. Purchase Tornado Sirens through the Franklin County Emergency Management & Homeland Security. (20,000 / year)		Completed	Mayor's office	PDM/HMGP/ Local Funds	**Medium** $20,000/year	Complete	Tornadoes
City of New Albany Projects coordinated by Mayor's office	1. Seek funding for repetitive loss structures within the Village of New Albany to permanently reduce damage to these structures. (1 structure at 250,000 / 1 year)	2007	Ongoing	Mayor's office	PDM	**High** 1 structure at $250,000	Short Term 1 year	Flooding
	2. Seek funding for the implementation of the Rose Run Greenway Corridor Study to control flooding of the Rose Run Stream and improve its water quality. (200,000 / 1 year)	2007	Ongoing	Mayor's office	Federal 594 Grant City Match / Federal or State Grants	**High** $200,000	Short Term 1 year	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	3. Develop and implement public education to increase public awareness and understanding of flooding hazards associated with ditches, streams, and waterways and their need for maintenance. (15,000 / 1 year)	2007	Ongoing	Mayor's office	City General Fund	**Medium** $15,000	Short Term 1 year	Flooding
	4. Seek funding to purchase 3 additional Outdoor Siren Warning Systems in New Albany. To provide adequate public emergency alerts (Tornado, Flooding, etc.) to all areas within New Albany it is necessary to install additional outdoor sirens in the south, west and north locations of the community. (3 units/ $66,000)	2012	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**Medium** 3 units/ $66,000	Short Term	Tornadoes
	5. Seek funding for a two-way radio system for utilization by the public service department. Communication with maintenance staff on the road and in the field is critical to City operations when responding to severe storm events such as snow/ice, rain and wind. (Implementation cost is	2012	Ongoing	Mayor's office	Homeland Security Grants/ Local Funds	**Medium** Implementation cost is $85,000	Short Term	All hazards.

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	$85,000)							
	6. To eradicate the infestation of the EAB in New Albany the City proposes to develop a management plan for the removal and disposal of Ash trees on City property and within the right-of-way and replace them with a better tree variety that is disease and insect resistant. (Estimated cost $200,000)	2012	Ongoing	Mayor's office	Local Funds/Grants	**High** $200,000	Ongoing	Invasive Species
	7. To alleviate the drainage problems the City proposes to install a public storm sewer system and direct the excess water flow to a nearby City own wetland park. Additionally, the rear yards would be re-graded to achieve positive drainage to newly installed storm structures. (Estimated cost $250,000)	2012	Ongoing	Mayor's office	Capital Improvement/Local Funds	**High** $250,000	Long Term	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	8. There are six (6) privately owned properties with structures that encompass the Rose Run Stream corridor which are subject to damage when stream waters reach flooding stages. The City proposes to separate this project into two parts. Part A would include the purchase of the private properties and removal of their structures threatened by flooding. Part B is the construction work to increase the streams capacity, stabilize the banks and restore vegetation within the stream corridor. (Part A $4,250,000) (Part B $350,000)	2012	Ongoing	Mayor’s office	PDM/HMGP/ Local Funds	**High** (Part A $4,250,000) (Part B $350,000)	Short Term	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	9. There are two (2) privately owned properties with structures that encompass the Head Waters of the Rose Run Stream corridor which are subject to damage when stream waters reach flooding stages. The City proposes to separate this project into two parts. Part A would include the purchase of two (2) private properties and removal of one (1) structure threatened by flooding. Part B is the construction work to increase the head water capacity, stabilize the banks and restore vegetation within the stream corridor. (Part A $200,000) (Part B $250,000)	2012	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High** (Part A $200,000) (Part B $250,000)	Short Term	Flooding
Norwich Township Projects coordinated by Township Trustee's office	1. Mitigate Power failure through the purchase of Generators	2018	New	Township Trustee's office	PDM/HMGP/ Local Funds	**Medium**	Short Term	Severe Thunderstorm
	2. Seek funding to develop interagency communications with local service departments, law and fire. (200,000 / 18 months)	2007	Complete	Township Trustee's office	Homeland Security Grants/ Local Funds	**High** $200,000	Complete	All hazards.

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	3. Establish a communications plan for the Township and the City of Hilliard (TBD see #1)	2007	Complete	Township Trustee's office	Local Funds	**Medium**	Complete	All hazards.
Village of Obetz Projects coordinated by Village Administration and Mayor's office	1. Purchase NOAA weather alert radios for every hospital, parks & recreation center, public utility facility, large population venue, private/public school and government building accessed by the public. (1500 / 1 year)	2007	Ongoing	Village Administration and Mayor's office	EMPG/Local Funds	**Low** $1,500	Short Term 1 year	Tornadoes Severe thunderstorms and lightning
	2. Purchase Tornado Sirens through the Franklin County Emergency Management & Homeland Security. (40,000 / 4 months)	2007	Ongoing	Village Administration and Mayor's office	PDM/HMGP/ Local Funds	**Medium** $40,000	Short Term 4 months	Tornadoes
Perry Township Projects coordinated by Township Trustee's office	1. Replace existing culvert and reinforce existing stonewall along dam discharge area.	2018	New	Franklin County Engineer	PDM/HMGP/ Local Funds	**High**	Short Term	Dam/Levee Flood (Urban/Flash Flooding)
	2. Seek funding for public information including outreach projects and technical assistance to property owners. (5,000 / 1 year)	2007	Ongoing: Have implemented Nixle	Township Trustee's office	General Fund/Grants	**Low** $5,000	Short Term 1 year	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	3. Work with Franklin County Emergency Management and Homeland Security to develop public outreach regarding all natural hazards, and the county's susceptibility to those hazards, and make available on website. (2,500 / 1 year)	2007	Ongoing: New web page up and running - Other Social Media outlets not started	Township Trustee's office	Local Funds	**Low** $2,500	Ongoing	All hazards.
Plain Township Projects coordinated by Township Trustee's office	1. Drainage improvement: Clouse Road stormwater system is inadequate, needs to be replaced (ditches, culvert, and tile), residents report basement flooding.	2018	New	Township Trustee's office	Road Fund/Gas Tax	**High** $125,000	Short Term	Flood (Urban/Flash Flooding)
	2. Roadway flooding: Bevelhymer Road south of Walnut Street and north of Sugar Run frequently floods during rain events. Roadside culvert/drainage needs improvement/restoration.	2018	New	Township Trustee's office	Road Fund/Gas Tax	**Medium** $100,000	Short Term	Flood (Urban/Flash Flooding)
	3. Road drainage improvement: Bevelhymer Road south of Sugar Run	2018	New	Township Trustee's office	PDM/HMGP/ Local Funds	**High**	Short Term	
	4. Seek funding for public information including outreach projects and technical assistance to property owners. Educate population about flood hazard risks. (1,000 / 1 year)	2007	Modify: Educate population about flood hazard risks.	Township Trustee's office	Local Funds	**Low** $1,000	Short Term 1 year	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	5. Mitigate flooding issues for two properties on Johnstown Rd. Creekside property floods. Floodwall to protect existing homes.	2012	Modify: Creekside property floods. Floodwall to protect existing homes.	Township Trustee's office	PDM/HMGP/ Local Funds	**High**	Short Term	Flooding
	6. Work with Franklin County Emergency Management and Homeland Security to develop public outreach regarding all natural hazards, and the county's susceptibility to those hazards, and make available on website. (1,500 / 1 year)	2007	Complete: Code Red emergency weather notification system	Township Trustee's office	Local Funds	**Low** $1,500	Complete	All hazards.
Pleasant Township	1. Study Mitigation Opportunities at Zuber Road (Homeowners' property loss due to flooding)	2018	New	Franklin County Engineer	Drainage Engineer/County Engineer/FEMA	**Medium** $100,000	Ongoing	Flood (Urban/Flash Flooding)
	2. Seek funding for repetitive loss structures to permanently reduce damage to these structures* *(1 known property est. at 100,000 /4 years) **	2007	Ongoing	Township Trustee's office	PDM	**High** 1 known property est. at $100,000	Short Term 4 years	Flooding
	3. Increase coverage of tornado sirens in the township	2012	Ongoing	Township Trustee's office	PDM/HMGP/ Local Funds	**Medium**	Short Term	Tornado

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	4. Reduce runoff flooding on Harrisburg-Georgesville Rd. and Gay Rd.	2012	Ongoing	Township Trustee's office	PDM/HMGP/ Local Funds	**High**	Short Term	Flooding
Prairie Township Project coordinated by Township Trustee's office	1. Seek funding for repetitive loss structures to permanently reduce damage to these structures (2 known properties est. at 300,000 /4 years) *	2007	Ongoing	Township Trustee's office	PDM	**High** 2 known properties est. at 300,000	Short Term 4 years	Flooding
	2. Reduce flooding along Tamara Avenue that impacts road access to twenty-two homes. (5 years)	2012	Ongoing	Township Trustee's office	PDM/HMGP/ Local Funds	**High**	Short Term 5 years	Flooding
	3. Seek funding for equipment to establish a tree trimming program to reduce the amount of fallen tree limbs along the public right-of-way.	2012	Ongoing	Township Trustee's office	HMGP/ Local Funds	**Medium**	Ongoing	All hazards.
City of Reynoldsburg Projects coordinated by Mayor's office	1. Seek funding for outdated NFIP maps for the Blacklick Creek area in coordination with areas that flood. (20,000 / 2 years)	2007	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**Medium** $20,000	Short Term 2 years	Flooding
	2. Evaluate smaller streams that are draining from newly developed areas in adjoining municipalities affecting the city.(4,000,000 / 2 years)	2007	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High** $4,000,000	Short Term 2 years	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	3. Seek funding for back-up generators for critical public buildings. (50,000 / 1 year)	2007	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**Medium** $50,000	Short Term 1 year	All hazards.
	4. Research and determine the cause of municipal building lightning strikes and why it has been hit by lightning so many times. Seek funding to permanently mitigate cause, if possible.(20,000 / 1 year)	2007	Ongoing	Mayor's office	Local Funds	**Medium** $20,000	Short Term 1 year	Severe thunderstorms and lightning
	5. Seek funding for lightning detection/warning for city parks. (40,000 / 1 year)	2007	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**Medium** $40,000	Short Term 1 year	Severe thunderstorms and lightning
	6. Seek funding for back-up generators for evacuation route intersections. (120,000 / 6 months)	2007	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High** $120,000	Short Term 6 months	All hazards.
Village of Riverlea Projects coordinated by Village Government and Mayor's office	1. Install Gas-powered Emergency Standby Generator for Riverlea Lift Station to mitigate SSOs to the Olentangy River.	2018	New	Village Government and Mayor's office	Local Funds	**Medium** Not known at this time. Depends on response to RFQs. Estimated be less than $50,000	Short Term 2018 4th Quarter	Flood (Urban/Flash Flooding)
	2. Establish a disaster recovery plan for Village records. (10,000 / 1 year)	2007	Unchanged: No action has been taken. No funding for project.	Village Government and Mayor's office	Local Funds	**Medium** $10,000	Short Term 1 year	All hazards.

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	3. Install a new sewer line to service residents now dependent on electric powered plumbing station. Connect it to the general sewage system managed by the City of Columbus. (550,000 / 1 year)	2007	Cancelled. Not feasible to connect gravity sewer from Lift Station to new Worthington Sewer in Rush Run Park.	Village Government and Mayor's office	Capital Improvement/Local Funds	**High** $550,000	Short Term 1 year	All hazards.
Truro Township Projects coordinated by Township Trustee's office	1. Extreme heat - Fan collection/distribution program for senior population	2018	New	Township Trustee's office	Donations	**Low**	Ongoing	Extreme Heat
	2. Seek funding for public information including outreach projects and technical assistance to property owners. (5000 / 1 year)	2007	Ongoing: Most flooding occurs in city limits; not township	Township Trustee's office	Local Funds	**Low** $5,000	Short Term 1 year	Flooding
	3. Work with Franklin County Emergency Management and Homeland Security to develop public outreach regarding all natural hazards, and the county's susceptibility to those hazards, and make available on website. (1,500 / 1 year)	2007	Complete: Participant in Franklin County alert system. Direct link on website. Updated website design (2017)	Township Trustee's office	Local Funds	**Low** $1,500	Complete	All hazards.
	4. Evaluate smaller streams that are draining from newly developed areas in adjoining municipalities that are affecting the township. (100,000 / 1 year)	2007	N/A: All streams in city of Reynoldsburg jurisdiction/ or Cols Jurisdiction.	Township Trustee's office	PDM/HMGP/ Local Funds	**Medium** $100,000	Short Term 1 year	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
City of Upper Arlington Projects coordinated by Mayor's office	1. Seek funding for repetitive loss structures within the jurisdiction to permanently reduce damages to these structures. (4 known properties est. at 450,000 /4 years) *	2007	Unknown: Not sure of this status	Mayor's office	PDM/HMGP/ Local Funds	**High** 4 known properties est. at $450,000	Short Term 4 years	Flooding
Village of Urbancrest Projects coordinated by Village Administration and Mayor's office	1. Purchase and construct a "SAFE HOUSE" for residents to go to in case of severe weather. (300,000 / 9 months)	2007	Ongoing	Village Administration and Mayor's office	PDM/HMGP/ Local Funds	**High** $300,000	Short Term 9 months	All hazards.
	2. Purchase NOAA weather alert radios for every hospital, parks & recreation center, public utility facility, large population venue, private/public school and government building accessed by the public. (2,000 / 4 months)	2007	Ongoing	Village Administration and Mayor's office	EMPG/Local Funds	**Low** $2,000	Short Term 4 months	All hazards.
	3. Purchase Tornado Sirens through Franklin County Emergency Management & homeland Security additional Tornado Sirens around our community. (40,000 / 4 months)	2007	Ongoing	Village Administration and Mayor's office	PDM/HMGP/ Local Funds	**Medium** $40,000	Short Term 4 months	Tornadoes

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
Village of Valleyview Projects coordinated by Mayor's office	1. Achieve acquisition of the Village Hall. This is a Village owned facility and is subject to repeat flooding as it is not only located in the Floodway, but it is subjected to runoff from homes located at a higher elevation.	2012	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High**	Short Term	Flooding
	3. Assess and mitigate the impacts of the Hague Avenue bridge reconstruction project (City of Columbus capital improvement project) on the Dry Run Creek.	2012	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High**	Short Term	Flooding
	3. Purchase NOAA weather alert radios for every hospital, parks & recreation center, public utility facility, large population venue, private/public school and government building accessed by the public. (2,000 / 6 months)		Complete	Mayor's office	EMPG/Local Funds	**Low** $2,000	Complete	All hazards.
	4. Purchase Tornado Sirens through Franklin County Emergency Management & homeland Security. (40,000 / 4 months)		Complete	Mayor's office	Local Funds	**Medium** $40,000	Complete	Tornadoes

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
Washington Township	1. Conduct regular maintenance for drainage systems and flood control structures.	2018	New	Franklin County Engineer/City of Dublin	Local Funds	**Medium**	Ongoing	Flood (Urban/Flash Flooding)
	2. Educating citizens regarding the dangers of extreme heat and cold and the steps they can take to protect themselves.	2018	New	Township Trustee's office	Local Funds	**Low**	Ongoing	Extreme Cold and Extreme Heat
	3. Educating citizens regarding severe summer weather (thunderstorms, lightning, wind, tornado), shelter in place, evacuation etc.	2018	New	Township Trustee's office	Local Funds	**Low**	Ongoing	Severe Thunderstorms and Tornadoes
	4. Purchase NOAA weather alert radios for every hospital, parks & recreation center, public utility facility, large population venue, private/public school and government building accessed by the public. (2,000 / 6 months)	2007	Ongoing	Township Trustee's office	EMPG/Local Funds	**Low** $2,000	Short Term 6 months	All hazards.
	5. Purchase Tornado Sirens through Franklin County Emergency Management & Homeland Security. (60,000 / 4 months)	2007	Ongoing	Township Trustee's office	PDM/HMGP/ Local Funds	**Medium** $60,000	Short Term 4 months	Tornadoes

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	6. Seek funding for repetitive loss structures within the jurisdiction to permanently reduce damages to these structures. (2 known properties est. at $800,000 /2 years) *	2007	Ongoing	Township Trustee's office	PDM	**High** 2 known properties est. at $800,000	Short Term 2 years	Flooding
City of Westerville	1. Install generators for critical infrastructure and emergency shelters	2018	New	City of Westerville	General fund, Grants, HMGP	**High** $2 Million	Not Scheduled	Earthquake, Extreme Heat, Extreme Cold, Flood (Riverine), Severe Thunderstorm, Severe Winter Weather, Tornado
	2. Spring Run and County Line Run have erosion issues due to extreme rainfall events. Study mitigation alternatives.	2018	New	City of Westerville	Grants, HMGP	**High** $2 Million	Short Term	Flood (Riverine) and Flood (Urban/Flash Flooding)
	3. There is a net loss of the floodplain due to increased development. Discourage development that creates a net loss of the floodplain.	2007	Ongoing: Currently undergoing zoning code update	Mayor's office	Local Funds	**Low**	Short Term	Flooding
	4. There is a lack of public awareness of the magnitude of a potential flood event. Develop public service announcements	2007	Ongoing: Focusing use of website/social media	Mayor's office	Local Funds	**Low**	Ongoing	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	(PSAs) about flooding potential.							
	5. There is debris present in the streams in public areas, i.e. parks. Develop a preventative maintenance program.	2007	Ongoing: No change, unfunded	Mayor's office	Local Funds	**Low**	Ongoing	Flooding
	6. Critical facilities exist in the floodplain. Seek funding to relocate or floodproof structures within the floodplain. ($5,000)	2007	Ongoing: Unchanged, unfunded	Mayor's office	PDM/HMGP/ Local Funds	**Low** $5,000	Long Term	Flooding
	7. The bridges at Schrock and Main are not up-to-date and are undersized. Undertake an engineering study to determine adequate floodway size.	2007	Ongoing- Unchanged, Schrock not complete	Mayor's office	Local Funds	**High**	Long Term	Flooding
	8. Westerville currently lacks a stormwater utility. Develop a stormwater utility.	2007	Ongoing: Unchanged, no funding	Mayor's office	Local Funds	**High**	Long Term	Flooding
	9. Knowledge is lacking about the locations of shelters to be used during a storm event. Establish and identify a shelter network. Develop a PSA regarding the location of pre- and post-storm shelters. ($5,000)	2007	Ongoing: More use of website/social media for PSA's	Mayor's office	Local Funds	**Low** $5,000	Ongoing	All hazards

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	10. There is a lack of a reliable warning system with total coverage as it relates to lightning especially in public areas like parks and pools. Install lightning prediction and protection systems throughout public areas.	2007	Ongoing	Mayor's office	Local Funds	**Medium**	Short Term	Severe Summer Weather
	11. There is a lack of backups for traffic lights at critical intersections after a storm event. Install backup sources for critical intersection lights. ($100,000)	2007	Ongoing: Unchanged	Mayor's office	Homeland Security Grants/Local Funds	**Medium** $100,000	Short Term	All hazards
	12. Snowstorms result in an inability to travel and also in residents not adhering to snow emergency warnings. Develop a plan to address transportation issues and research the potential for intelligent traffic systems. Increase enforcement during snow emergencies. ($7,500)	2007	Ongoing	Mayor's office	Local Funds	**Low** $7,500	Short Term	Severe Winter Weather
	13. Communications and utilities are disrupted both during and after a tornado. Bury utility lines and evaluate the possibility of a wireless network. ($20,000,000)	2007	Ongoing: Unfunded. S State Street overhead facilities buried in 2016	Mayor's office	Local Funds	**High** $20,000,000	Ongoing	Tornadoes

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	14. Severe storms have the potential to cause power outages across the city. Explore the following possibilities: backup generators, fuel cell network, alternative energy sources, burying utility lines, undertaking an assessment of mechanical load on aboveground utilities (i.e. poles).	2007	Ongoing	Mayor's office	Local Funds	**High**	Ongoing	Severe Summer Weather
	15. Bradford pear trees are an issue throughout the city each time that there is a storm event due to damage by wind, lightning, hail, etc. Implement a replacement program for Bradford pear trees for both public and private property and update the tree assessment. ($35,000/year)	2007	Ongoing	Mayor's office	Local Funds	**Medium** $35,000/year	Ongoing	Severe Summer Weather
	16. There is a need to implement watercourse easements citywide. Areas like the Huber area, Spring Grove, and areas north of the Franklin County line, currently do not have watercourse easements. Develop a citywide watercourse protection ordinance.	2007	Ongoing	Mayor's office	Local Funds	**Medium**	Long Term	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	17. Some utility poles within the city are overburdened with utility lines. Undertake a vulnerability assessment on utility poles. ($175,000)	2007	Ongoing: Pole inspections underway, 3 year inspection cycle	Mayor's office	HMGP/ Local Funds	**High** $175,000	Short Term	All hazards.
	18. There is a lack of safe spots in public areas, especially parks. Build shelters and establish a shelter network. Seek funding for multi-use facilities in public places. ($600,000)	2007	Ongoing: Unchanged.	Mayor's office	PDM/HMGP/ Local Funds	**High** $600,000	Long Term	Tornadoes
	19. There is a potential for reduction in revenues due to the after-effects of tornadoes. Work with the Chamber of Commerce for business continuity for smaller businesses.	2007	Ongoing	Mayor's office	Local Funds	**Low**	Ongoing	Tornadoes
	20. Concerns exist about private use of groundwater for irrigation purposes (tapping of aquifers for sprinkling systems). Investigate groundwater usage.	2007	Ongoing: Unchanged.	Mayor's office	Local Funds	**Medium**	Ongoing	Drought
	21. Public education is lacking on the Drought Disaster Plan produced by the Westerville Water Department. PSA on existing Drought Disaster Plan. Use existing tools to	2007	Ongoing: New utility billing system installed in 2016	Mayor's office	PSA – PIO and Water Utility Manager Billing System – Utility Billing Supervisor, Water Utility Manager	**Low**	Short Term	Drought

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	provide public education: magazine, calendar, water quality report, website. Seek funding to enhance billing system to educate the public on the plan.				and Electric Manager			
	22. There is currently a lack of public awareness about the release of water from the Alum Creek Dam, which results in flooding problems on the bikeways in the floodplain. Increase communication with the US Army Corps of Engineers regarding release of water from the Alum Creek Dam. Install signage, gates and gauges along the bikeways. ($12,000)		Complete	Mayor's office	Local Funds	**Medium** $12,000	Complete	Dam/Levee Flooding
	23. Nuisance flooding occurs in areas that do not fall within the floodplain, primarily along Spring Road. Install signage and gauges at Spring Road and improve the infrastructure. ($3,180,000)	2007	Complete- Improvements to Otterbein University property corrected the problem	Mayor's office	Otterbein University funding	**High** $3,180,000	Complete	Flooding
	24. Critical facilities throughout Franklin County are unable to handle increased loads (especially St. Ann's). Evaluate the possibility of coordination	2007	Complete	Mayor's office	Local Funds	**Medium**	Complete	All hazards.

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	at the county level to alleviate the lack of adequate emergency care and medical treatment during a large-scale disaster event.							
	25. There is a lack of a database which illustrates the location of "other" critical facilities like nursing homes and day care centers. Other places like Germain Amphitheater and several community churches also should be mapped. Create a map of "other" critical facilities.		Complete- Database created through GIS and Fire Prevention software	Mayor's office	Local Funds	**Low**	Complete	All hazards.
	26. The media creates problems as it relates to severe storm events. The media often provides a false sense of insecurity about storm events and does not always provide reliable warning. Educate the public through a public service announcement (PSA) as well as the media about relaying information.	2007	Complete- The City uses Facebook and Twitter to relay information on Traffic Delays. Weather warnings will be left to the National Weather Service for dissemination.	Mayor's office	Local Funds	**Low**	Complete	All hazards
	27. There are dead spots on the radios used by public safety personnel. Seek funding to increase coverage of radios used by	2007	Complete- Re-alignment of communications towers and additional capabilities added to radios corrected the	Mayor's office	Local Funds	**High**	Complete	All hazards

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	public safety personnel by adding additional antennas for the City of Columbus system.		issue.					
	28. The City of Westerville experiences communication systems (phone, computer network, cable, radio, etc.) disruption during severe storm events. Develop and utilize a wireless network across the city. Evaluate the use of an AM frequency for weather reports (also under Tornadoes section with burying electric lines).	2007	Completed- Private and Public Wireless Networks complete in all City buildings	Mayor's office	Local Funds	**Medium**	Complete	All hazards.
	29. No comprehensive/coordinated database of sensitive populations for reverse 911 purposes exists. Create a database of sensitive populations.	2007	Completed- City implemented Dialogic system which includes sensitive populations	Mayor's office	Local Funds	**Medium**	Complete	All hazards.
	30. There is a lack of education for things like vegetation removal and disposing of grass clippings in the streams, both of which affect proper stream function. Increase education to residents on proper stream function.	2007	Completed	Mayor's office	Local Funds	**Low**	Complete	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	31. There are concerns that many residents are unaware of the growing problem of erosion. Increase awareness through PSAs.	2007	Completed	Mayor's office	Local Funds	**Low**	Complete	Flooding
	32. There are concerns over changes in runoff caused by the erosion associated with new development. Seek funding to evaluate the effects of new development on erosion.	2007	Completed	Mayor's office	Local Funds	**Medium**	Complete	Flooding
	33. Maps identifying highly erodible areas currently do not exist. Create a map of sensitive erosion areas.	2007	Completed	Mayor's office	Local Funds	**Low**	Complete	Flooding
	34. The current siren system does not have total coverage due to the exclusion of areas within Delaware County under the Franklin County system. Increase the total number of sirens to increase total overage.	2007	Completed- 100% coverage in City	Mayor's office	Local Funds	**Medium**	Complete	Tornadoes
	35. There is a need for public education for reputable vendors providing aid following a tornado event. PSA on awareness of reputable vendors to provide aid following a	2007	Complete- list was compiled in the City disaster plan	Mayor's office	Local Funds	**Low**	Complete	Tornadoes

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	tornado event.							
	36. Temporary structures (i.e. trailers at construction sites) are not regulated. Implement regulations for temporary structures.	2007	Completed- regulations are in place	Mayor's office	Local Funds	**Low**	Complete	Tornadoes
City of Whitehall Projects coordinated by Mayor's office	1. Seek funding to evaluate and potentially resolve areas of concern with continuous localized flooding. (1 known property est. at 150,000 /4 years) *	2007	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High** 1 known property est. at $150,000	Short Term 4 years	Flooding
	2. Seek funding and coordinate with Franklin County Emergency Management and Homeland Security on the problem area near Hamilton Road railroad underpass which continuously floods. (120,000 / 1 year)	2007	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High** $120,000	Short Term 1 year	Flooding

Jurisdiction	Projects by Jurisdiction Priority	Year Initiated	Status	Lead Agency	Funding Source	Estimated Cost	Estimated Completion Date	Hazard Addressed
	3. Conduct hazard mitigation activities related to Mason Run and Turkey Run. (500,000 / 2 year)	2012	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High** $5,000,000	Short Term 2 years	Flooding
	4. Seek funding for critical facility within the City of Whitehall (police station and 911 facility) that is continuously susceptible to flooding. (250,000 / 1 year)	2007	Completed. The City installed a back-flow device in a foundation drain and that seems to have solved the problem of flooding associated with this facility.	Mayor's office	PDM/HMGP/ Local Funds	**High** $250,000	Complete	Flooding
City of Worthington Projects Coordinated by City Manager's office	1. Retrofit public buildings and critical facilities with generator service	2018	New	Public Safety	HMGP	**High** $500,000	Short Term 2023	All Hazard
	2. Retrofit structures in the Haymore Avenue Area. (1,500,000 / 1 year)	2007	Ongoing	Mayor's office	PDM/HMGP/ Local Funds	**High** $1,500,000	Short Term 1 year	Flooding
	3. Seek funding for repetitive loss structures within the jurisdiction to permanently reduce damages to these structures*(4 known properties est. at 900,000 /4 years) *	2007	Ongoing	Mayor's office	PDM	**High** 4 known properties est. at $900,000	Short Term 4 years	Flooding

Mitigation Strategy & Risk Correlation

As part of the natural hazard mitigation planning requirements, at least three (3) identifiable mitigation strategy/action items have been addressed for each **natural hazard** listed in the risk assessment. The table below depicts the identified hazards in the Plan with the associated and/or relevant mitigation strategies.

TABLE 22: RISK AND MITIGATION STRATEGY CORRELATION

Hazard	Risk Ranking	# of Mitigation Actions
Tornadoes	1	30
Flooding	2	117
Dam/Levee Failure	3	2
Severe Winter Weather	4	4
Severe Summer Weather	5	21
Extreme Heat	6	4
Earthquake	7	1
Invasive Species	8	3
Karst/Sinkhole	9	1
Drought	10	3
All Natural Hazards	N/A	62

Completed Mitigation Strategies

The 2018 Franklin County Natural Hazard Mitigation Plan is a living document and will be updated on a 5-year cycle. Franklin County officials recognize the significance of these strategies and how such actions can protect the County. Because the implementation of this Plan is critical to creating greater community resilience, the table below documents the mitigation strategies/actions that have been completed to-date. Completion is an important indicator of mitigation implementation and activity in the County.

TABLE 23: COMPLETED MITIGATION ACTIONS

2012 Mitigation Item	Hazard(s) Addressed	Jurisdiction(s)
Whims Ditch Property Acquisition	Flooding	Franklin County, Franklin Township
Obtain Storm Ready certification	Severe Summer Storms and Tornadoes	Franklin County
Seek funding for the purchase of additional tornado sirens to increase coverage of the Dublin Emergency Warning System. ($50,000.00) (Narrow Band Conversion $16,200.00)	Tornadoes	City of Dublin
Seek funding for back-up generators for evacuation route intersections.	All hazards	City of Dublin
Seek funding to increase public notification capabilities (i.e. 1610 A.M. and Dublin Emergency Calling System). $15,000.00 Annual Cost (Subscription)	All hazards	City of Dublin
Seek funding to purchase equipment to support interagency communications. Estimate $2.5 million (Grant 1.529 million awarded)	All hazards	City of Dublin

2012 Mitigation Item	Hazard(s) Addressed	Jurisdiction(s)
Seek funding for NOAA weather radios (to provide to critical public and private facilities)	Severe Summer Storms and Tornadoes	City of Dublin
Purchase Tornado Sirens through Franklin County Emergency Management & Homeland Security. (20,000 / siren)	Tornadoes	City of Grandview Heights
Stream restoration on Clover Groff Ditch	Flooding	City of Hilliard
Stream restoration on south part of Hamilton Ditch	Flooding	City of Hilliard
Implement the Hilliard Storm Water Master Plan	Flooding	City of Hilliard
Identify resources and strategies to remove Blacklick Creek log jam.	Flooding	Madison Township
Purchase Tornado Sirens through the Franklin County Emergency Management & Homeland Security. (20,000 / year)	Tornadoes	Village of Minerva Park
Seek funding to develop interagency communications with local service departments, law and fire. (200,000 / 18 months)	All Hazards	Norwich Township
Establish a communications plan for the Township and the City of Hilliard (TBD see #1)	All Hazards	Norwich Township
Work with Franklin County Emergency Management and Homeland Security to develop public outreach regarding all natural hazards, and the county's susceptibility to those hazards, and make available on website. (1,500 / 1 year)	All Hazards	Plain Township
Work with Franklin County Emergency Management and Homeland Security to develop public outreach regarding all natural hazards, and the county's susceptibility to those hazards, and make available on website. (1,500 / 1 year)	All hazards.	Truro Township
Purchase NOAA weather alert radios for every hospital, parks & recreation center, public utility facility, large population venue, private/public school and government building accessed by the public. (2,000 / 6 months)	All hazards.	Village of Valleyview
Purchase Tornado Sirens through Franklin County Emergency Management & homeland Security. (40,000 / 4 months)	Tornadoes	Village of Valleyview
There is currently a lack of public awareness about the release of water from the Alum Creek Dam, which results in flooding problems on the bikeways in the floodplain. Increase communication with the US Army Corps of Engineers regarding release of water from the Alum Creek Dam. Install signage, gates and gauges along the bikeways. ($12,000)	Flooding	City of Westerville
Nuisance flooding occurs in areas that do not fall within the floodplain, primarily along Spring Road. Install signage and gauges at Spring Road and improve the infrastructure. ($3,180,000)	Flooding	City of Westerville

2012 Mitigation Item	Hazard(s) Addressed	Jurisdiction(s)
Critical facilities throughout Franklin County are unable to handle increased loads (especially St. Ann's). Evaluate the possibility of coordination at the county level to alleviate the lack of adequate emergency care and medical treatment during a large-scale disaster event.	All hazards.	City of Westerville
There is a lack of a database which illustrates the location of "other" critical facilities like nursing homes and day care centers. Other places like Germain Amphitheater and several community churches also should be mapped. Create a map of "other" critical facilities.	All hazards.	City of Westerville
The media creates problems as it relates to severe storm events. The media often provides a false sense of insecurity about storm events and does not always provide reliable warning. Educate the public through a public service announcement (PSA) as well as the media about relaying information.	All hazards	City of Westerville
There are dead spots on the radios used by public safety personnel. Seek funding to increase coverage of radios used by public safety personnel by adding additional antennas for the City of Columbus system.	All hazards	City of Westerville
The City of Westerville experiences communication systems (phone, computer network, cable, radio, etc.) disruption during severe storm events. Develop and utilize a wireless network across the city. Evaluate the use of an AM frequency for weather reports (also under Tornadoes section with burying electric lines).	All hazards	City of Westerville
No comprehensive/coordinated database of sensitive populations for reverse 911 purposes exists. Create a database of sensitive populations.	All hazards	City of Westerville
There is a lack of education for things like vegetation removal and disposing of grass clippings in the streams, both of which affect proper stream function. Increase education to residents on proper stream function.	Flooding	City of Westerville
There are concerns that many residents are unaware of the growing problem of erosion. Increase awareness through PSAs.	Flooding	City of Westerville
There are concerns over changes in runoff caused by the erosion associated with new development. Seek funding to evaluate the effects of new development on erosion.	Flooding	City of Westerville
Maps identifying highly erodible areas currently do not exist. Create a map of sensitive erosion areas.	Flooding	City of Westerville

2012 Mitigation Item	Hazard(s) Addressed	Jurisdiction(s)
The current siren system does not have total coverage due to the exclusion of areas within Delaware County under the Franklin County system. Increase the total number of sirens to increase total overage.	Tornadoes	City of Westerville
There is a need for public education for reputable vendors providing aid following a tornado event. PSA on awareness of reputable vendors to provide aid following a tornado event.	Tornadoes	City of Westerville
Temporary structures (i.e. trailers at construction sites) are not regulated. Implement regulations for temporary structures.	Tornadoes	City of Westerville
Seek funding for critical facility within the City of Whitehall (police station and 911 facility) that is continuously susceptible to flooding. (250,000 / 1 year)	Flooding	City of Whitehall

The following is a list of the actions completed during the 2012 update process.

- **Completed Action Item #1:** Some flooding in the City of Whitehall has been alleviated by the removal of debris from nearby ditches and streams. A study on the flooding is found as Addendum #3.
- **Completed Action Item #2:** The Blacklick logjam has been removed.
- **Completed Action Item #3:** The Reverse 911 System has been purchased in cooperation with the Ohio State University and distributed.
- **Completed Action Item #4:** NOAA weather radios have been distributed to any organization that wanted one.

National Flood Insurance Program Mitigation Actions

The following mitigation strategies and actions demonstrate Franklin County and its participating jurisdictions' continued support and compliance with NFIP requirements, as appropriate. Only those actions that demonstrate specific support and compliance to the program are included. Other flood-related projects were not included in this section.

TABLE 24: NFIP-RELATED MITIGATION ACTIONS

Mitigation Action	Year Initiated
Work with communities not currently in the NFIP to adopt the program	2012
Develop a county-wide program to purchase repetitive loss properties and to develop a program to monitor locations of buy-outs. Encourage local jurisdictions to institute a buy-out plan for flood prone structures.	2012
Provide information to property owners in flood-prone areas about the need for NFIP coverage	2018

PLAN MAINTENANCE

Plan Maintenance Update

The plan maintenance of this chapter details the processes in which the Franklin County Emergency Management & Homeland Security and the Core Group will operate to ensure that the Franklin County Natural Hazard Mitigation Plan remains a current and relevant document. The plan maintenance process includes a schedule for monitoring and evaluating the plan and producing a plan revision every five years. Public meetings and participation will be integrated into the plan maintenance process. The FCEM&HS will continue to work with regional planning representatives, local governments and developers to incorporate mitigation strategies into current and future planning mechanisms.

Monitoring Mitigation Actions

Plan Adoption

The plan will be adopted by all jurisdictions choosing to participate. A sample resolution is included in **Appendix G**. Once all the jurisdictions adopt the updated plan, their signed resolutions will be found in **Appendix H**. Every effort will be made to secure the participation of all jurisdictions in the county. Once the plan has been submitted to the State Hazard Mitigation Officer at the Ohio Emergency Management Agency and approved, the Ohio EMA will submit the plan to the Federal Emergency Management Agency (FEMA) for review. Upon acceptance by FEMA, participating jurisdictions will adopt the plan. Upon formal approval, Franklin County will gain eligibility for Hazard Mitigation Grant Program funds.

Coordinating Body

The Franklin County Hazard Mitigation Core Group will be responsible for the monitoring of the plan and undertaking the formal review process. FCEM&HS has formed a Hazard Mitigation Core Group that consists of members from local agencies, organizations and citizens. The Core Group included the following:

- Appointed Officials
- Fire and Law Enforcement Officials
- Emergency Management
- Geographic Information System (GIS)
- Building and Zoning Officials
- Service Departments

Monitoring Mitigation Projects

The Franklin County Mitigation Planner will monitor the progress made on the implementation of the identified action items. Jurisdictions will be responsible for updating FCEM&HS on mitigation actions taken.

By monitoring mitigation actions, when the plan is next updated, information about the status of proposed mitigation actions will be readily available. The updated plan will include a section explaining if previously proposed mitigation actions have been implemented, completed, or deferred. The updated plan will identify actions that are no longer appropriate for the community and should be deleted. The updated plan will identify obstacles to implementation that caused proposed actions to be deferred and will recommend strategies for overcoming those obstacles.

The Core Group will not only monitor the implementation of mitigation actions proposed in this plan, but will also monitor actions of participating jurisdictions and surrounding communities that may affect the ability of Franklin County to withstand the effects of natural hazards or to recover from a disaster in the future. The method for gathering information about actions beyond those proposed in this plan will be informal; as active members of the Franklin County community, Core Group members will bring their own knowledge of the area to monitoring meetings to provide information about actions of participating jurisdictions as well as of nearby communities.

The Core Group will be responsible for monitoring the status of the plan and gathering appropriate parties to report of the status of mitigation actions. The Core Group will convene on an annual basis to determine the progress of the identified mitigation actions. As the Natural Hazard Mitigation Plan matures, new stakeholders will be identified and encouraged to join the existing steering committee.

FCEM&HS is responsible for contacting Core Group members and organizing the annual meeting. The Core Group member’s responsibilities include:

- Members of the Core Group will be readily available to engage via meetings or e-mail correspondence between annual meetings. If the need for a special meeting (due to new developments or a declared disaster) occurs in the County, the Core Group will meet to update mitigation strategies. Depending on grant opportunities and fiscal resources, mitigation projects may be implemented independently by individual communities or through local partnerships.
    - Reassess the Plan in light of any major hazard event. The committee will convene within 90 days of any major event to review all applicable data and to consider the risk assessment, plan goals, objectives, and action items given the impact of the hazard event.
- Annually reviewing each goal and objective to determine its relevance and appropriateness.
- Monitor and evaluate the mitigation strategies in this Plan to ensure the document reflects current hazard analyses, development trends, code changes and risk analyses and perceptions.
- Ensure the appropriate implementation of annual status reports and regular maintenance of the Plan. The Core Group will hear progress reports from the parties responsible for the various implementation actions to monitor progress.
- Create future action plans and mitigation strategies. These should be carefully assessed and prioritized using benefit-cost analysis (BCA) methodology that FEMA has developed.
- Ensure the public is invited to comment and be involved in mitigation plan updates.
- Ensure that the County complies with all applicable Federal statutes and regulations during the periods for which it receives grant funding, in compliance with 44 CFR.
- Review the multi-hazard mitigation plan in connection to other plans, projects, developments, and other significant initiatives.

   - Significant updates or modifications to the Plan during the five-year planning process will require a public notice and a meeting prior to submitting revisions to the individual jurisdictions for approval.
- Coordinate with appropriate municipalities and authorities to incorporate regional initiatives that transcend the boundaries of the County.
- Update the plan every five years and submit for FEMA approval.
- Amend the plan whenever necessary to reflect changes in State or Federal laws and statutes required in 44 CFR.

Implementation through Existing Programs, Communities & Organizations

Planning is conducted at the municipal level for cities and villages in Franklin County. The Franklin County Economic Development and Planning Department provides planning services for the unincorporated areas in Franklin County. The Mid-Ohio Regional Planning Commission (MORPC) provides planning, programming, and brokerage services for transportation, sustainability, data, land use, energy, air quality, water resources, and housing issues within Central Ohio. The Natural Hazards Mitigation Plan includes recommendations that can be accomplished by including mitigation activities into current and future regional planning initiatives.

Evaluating the Plan

Annual Review Process

The Franklin County Natural Hazard Mitigation Plan will be evaluated on an annual basis to determine the effectiveness of programs, and to reflect changes in land development or programs that may affect mitigation priorities. FCEM&HS, with consultation and collaboration from the Core Group, maintains overall responsibility for monitoring and evaluating the progress of the mitigation strategies in the plan. All jurisdictions will be encouraged to attend a yearly plan update meeting. These meetings will track project progress and discuss any new projects that need to be added. This will provide an opportunity for jurisdictions to discuss any current or new problems and prioritize future funding. They can also share their successes.

The committee will review the goals and action items to determine their relevance to changing situations in the county, as well as changes in State or Federal policy, and to ensure they are addressing current and expected conditions. The coordinating organizations responsible for action items will present the status of their action item, the implementation processes and the difficulties encountered, at which time strategies may need to be revised.

Plan Evaluation

To evaluate the plan, the Core Group should answer the following questions:

- Are the goals and objectives still relevant?
- Is the risk assessment still appropriate, or has the nature of the hazard and/or vulnerability changed over time?
- Are current resources appropriate for implementing this plan?
- Have lead agencies participated as originally proposed?
- Has the public been adequately involved in the process? Are their comments being heard?
- Have departments been integrating mitigation into their planning documents?

If the answer to each of the above questions is "yes," the plan evaluation is complete. If any questions are answered with a "no," the identified gap must be addressed.

Review of Mitigation Actions

Once the plan evaluation is complete, the Core Group must review the status of the mitigation actions. To do so, the Core Group should answer the following questions:

- Have the Mitigation Actions been implemented as planned?
- Have outcomes been adequate?
- What problems have occurred in the implementation process?

Each mitigation action/strategy in the online planning system includes the following table to track annual updates and progress for each mitigation action. Lead agencies/organizations will be tasked to provide an annual status update for each action.

TABLE 25: ANNUAL REVIEW DOCUMENTATION PROCESS

Mitigation Action and Project Maintenance		
Year	**Status**	**Comments**
2018	New, Ongoing, Revised, Complete	
2019		
2020		
2021		
2022		

Meeting Documentation

Each annual Core Group meeting must be documented, including the plan evaluation and review of Mitigation Actions. Mitigation Actions have been formatted to facilitate the annual review process.

Updating the Plan

This plan must be updated within 5 years and again adopted by the County and participating jurisdictions in order to maintain compliance with the regulations stated in 44 CFR Part 201.6 and ensure eligibility for applying for and receiving certain Federal mitigation grant funds.

Monitoring and evaluation will identify necessary modifications to the plan including changes in mitigation strategies and actions that should be incorporated in the next update.

The Franklin County Mitigation Planner will initiate the process of updating the plan in sufficient time to meet State and Federal deadlines.

Continued Public Involvement

The public will continue to have the opportunity to provide feedback about the plan. Copies of the plan will be available through the FCEM&HS web site.

The Franklin County Mitigation Planner will provide access to the plan to key Franklin County offices/departments. The adopted plan will be posted on the FCEM&HS web site so that the public has electronic access to the plan. The web site will include contact information for anyone to provide comment so that residents, business owners, and others who read the plan will be able to provide a comment about the plan or about the mitigation strategies. The Franklin County Mitigation Planner will maintain these comments and will provide them to the Mitigation Core Group for consideration during the update process.

The Franklin County Mitigation Planner will post notices of mitigation plan update meetings using the usual methods for posting meeting announcements in the County to invite the public to participate. In addition to posting announcements on the FCEM&HS web site, social media will also be used to announce the opportunity to participate.

The Franklin County Mitigation Planner will document the number of people who participate in the annual meetings and the results of the meeting for inclusion in the plan during the process. In this way, the public will have an opportunity to become involved in the planning process and to influence mitigation planning decisions.

LIST OF SOURCES

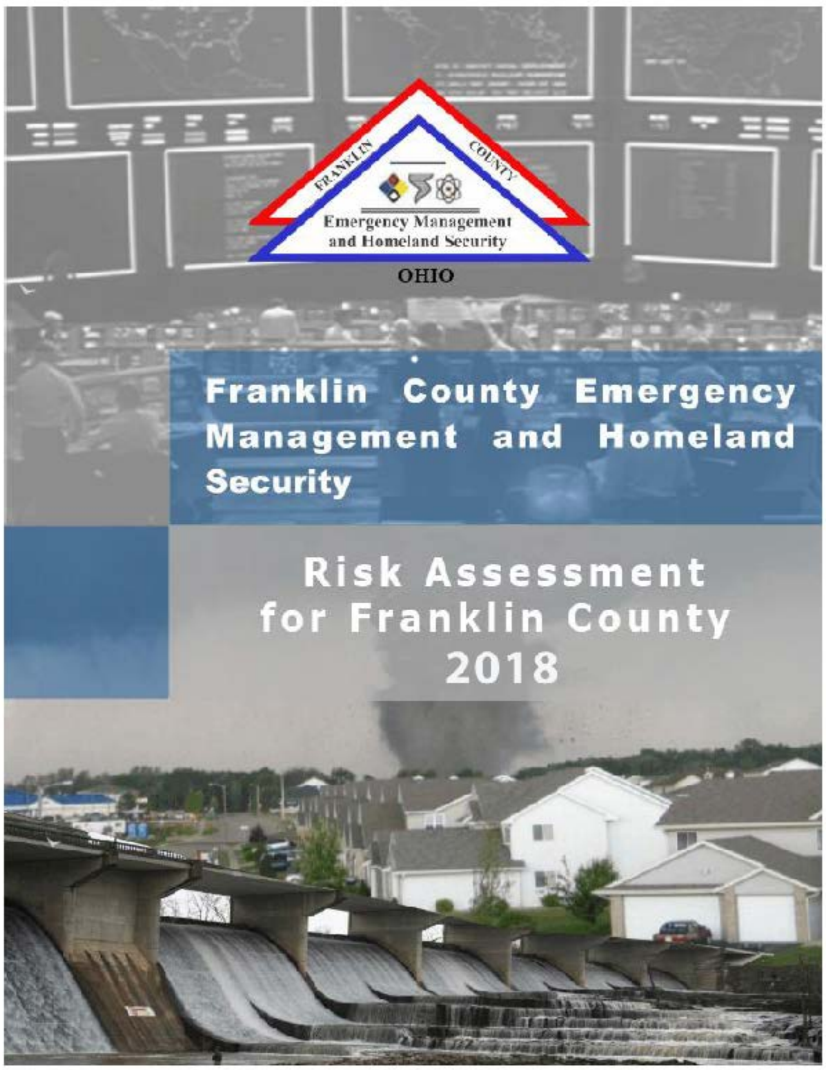
- Alum Creek Lake, Dam Safety Emergency Action Plan, U.S. Army Corps of Engineers
- American Association of States Climatologists. (http://www.stateclimate.org/)
- Big Darby Watershed (http://www.darbywatershed.com/)
- Central Ohio Greenways Implementation Guide
- City of Columbus Department of Public Utilities
- State of Ohio Enhanced Mitigation Plan, Ohio Emergency Management Agency
- Emergency Action Plan for O'Shaugnessy Dam, City of Columbus, Division of Water
- FEMA. Community Rating System (CRS) Communities and their Classes (http://www.fema.gov/library/viewRecord.do?id=3629)
- FEMA. 2018. Community Status Book Report. (http://www.fema.gov/cis/OH.pdf)
- Franklin County Emergency Management and Homeland Security (FCEM&HS). Emergency Operations Plan
- Franklin County Economic Development and Planning Department.
- Hazard Analysis for Franklin County, Emergency Management Agency for Franklin County
- National Oceanic and Atmospheric Administration (NOAA). Enhanced Fujita Scale for Tornado Damage.
- Natural Resources Conservation Service. 2018. (http://www.nrcs.usda.gov/
- National Weather Service
- Columbus Department of Development. Current Projects – Overview, (http://development.columbus.gov/planning/currentprojects.aspx)
- Ohio Department of Development. Franklin County Profile (http://development.ohio.gov/research/files/s0/Franklin.pdf)
- Ohio Insurance Institute. Newsroom (https://www.ohioinsurance.org/news/)
- State of Ohio Disaster History. Presidential Disaster Declarations (1964 - 2018).
- U.S. Army Corps of Engineers, Huntington District Web Site
- U.S. Census. 2010. (http://2010.census.gov/2010census/popmap/)
- U.S. Census. Population Census Count by County, City, Village and Township. (http://www.development.ohio.gov/research/documents/ALLSUBCOUNTY2010.pdf)
- U.S. Census. State & County QuickFacts
- U.S. Department of Agriculture (USDA). National Agricultural Statistics Service.

LIST OF ACRONYMS

CDBG	Community Development Block Grant
CRS	Community Rating System
FCEM&HS	Franklin County Emergency Management & Homeland Security
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
GIS	Geographic Information System
HUD	Housing and Urban Development
MORPC	Mid-Ohio Regional Planning Commission
NCDC	National Climate Data Center
NFIP	National Flood Insurance Rate Program
NOAA	National Oceanic and Atmospheric Administration
ODNR	Ohio Department of Natural Resources
OEMA	Ohio Emergency Management Agency
OSU	Ohio State University
PDSI	Palmer Drought Severity Index
USDA	United States Department of Agriculture
USGS	United States Geological Survey

APPENDIX A. RISK ASSESSMENT FOR FRANKLIN COUNTY 2018

If you are accessing the Microsoft Word version of this plan, please **double-click** the image below to access the PDF version of the Risk Assessment for Franklin County 2018 document.



FRANKLIN COUNTY
Emergency Management and Homeland Security
OHIO

Franklin County Emergency Management and Homeland Security

Risk Assessment for Franklin County 2018

Table of Contents

Executive Summary

Franklin County Emergency Management and Homeland Security (FCEM&HS) is a local government agency in Franklin County, Ohio, responsible for coordinating county-wide emergency/disaster planning, education, warning, response, and recovery to minimize the adverse impact of disasters on people and property in the county. Performing a risk assessment for Franklin County provides FCEM&HS with the basis for planning and implementing measures to reduce the risks associated with the greatest threats and hazards confronting the county.

This 2018 Franklin County Risk Assessment, funded by Pre-Disaster Mitigation funds administered through the Ohio Emergency Management Agency (OEMA), is a detailed study of the hazards most likely to impact Franklin County. Nineteen threats and hazards – dangerous events such as winter storms, floods and terrorist attacks – were analyzed and ranked according to the potential risk they pose.

PURPOSE: The purpose of the 2018 Franklin County Risk Assessment is to enhance the County's decision-making process in regards to homeland security and emergency management by providing decision-makers with risk-based information that differentiates various decision options under consideration. Thus, the primary users of the Risk Assessment are those within the County who are responsible for managing the risks related to natural disasters, technological failures and man-made acts of terrorism.

The U.S. DHS publication titled "DHS Risk Lexicon, September 2010", defines risk as the "potential for an unwanted outcome resulting from an incident, event, or occurrence, as determined by its likelihood and the associated consequences". Risk assessment is described as the "product or process which collects information and assigns values to risks for the purpose of informing priorities, developing or comparing courses of action, and informing decision making."[1]

In summary, an assessment of the community's threats, hazards, and risks provides the basis for planning and implementing measures to reduce the negative consequences of a disaster or catastrophic event. Directly eliminating threats or hazards is usually very difficult or even impossible. Risk reduction is more likely to be achieved by either addressing the community's vulnerabilities to the threats and hazards or by controlling their associated risks by strengthening the community's prevention, protection, mitigation, response, and recovery capabilities.

METHODOLOGY: FCEM&HS worked over an extended period to collect and assess information related to 20 potential natural, technological and human-caused threats and hazards that may occur in the future. A workgroup of representatives within the county estimated the risks posed by these threats and hazards according to a pre-determined risk

[1] "DHS Risk Lexicon," Department of Homeland Security Risk Steering Committee, last modified September 2010 http://www.dhs.gov/xlibrary/assets/dhs-risk-lexicon-2010.pdf

scoring methodology based on the probability of occurrence and associated negative consequences. The relative risk scoring methodology does not calculate absolute risk values; rather, it is a more user-friendly screening tool for estimating the level of risk that can be used to support planning and decision-making efforts. The information used to estimate the likelihood that each threat or hazard might occur included:

- A Likelihood of Occurrence Factor: The frequency at which an event has happened in the past or may happen in the future based on available intelligence.
- A Special Circumstance Factor: A condition or factor expected to have some bearing on the occurrence of a particular threat or hazard (i.e., mitigation efforts which decrease the number of homes in a floodplain, acts of terrorism directed at particular infrastructure sites, etc.).

Should the threat or hazard occur, the information used to estimate the resulting negative consequences included:

- Loss of Life Factor: The number of likely fatalities in the impacted area.
- Injury Factor**:** The number of likely casualties in the impacted area requiring hospitalization/outpatient care.
- Relocation Factor: The number of people likely to be relocated from their homes.
- Property Damage Factor: The amount of property damage expected in an impacted area.
- Economic Impact Factor: The potential total economic impact of the event including any loss in commerce, employment incomes, as well as reconstruction and recovery costs.
- Speed of Onset Factor: The length of warning time that may be expected prior to the impact of the event.

Table 1: Weight Factors

Factor	Weight
Likelihood of Occurrence	15
Special Circumstance	10
Loss of Life	30
Injuries	25
Property Damage	15
Economic Impact	15
Relocation	10
Speed of Onset	10

In addition, weighted factors were used by the Workgroup to reflect the relative importance they assigned to each of the above likelihood and consequence factors. For ease of comparison the Total Weighted Score will be used in all references to ranking.

THREAT AND HAZARD IDENTIFICATION: In response to the events of September 11, 2001, federal guidance regarding risk assessments has emphasized the need for local governments to add the threat of terrorist acts to the list of hazards evaluated as part of the risk assessment process. The FCEM&HS Workgroup assessed three terrorist events: a

CBRNE (chemical, biological, radiological, nuclear, explosive) attack where an improvised explosive device (IED) was detonated at a sporting event, a school shooting conducted by a “lone-wolf” terrorist, and a cyber-intrusion attack that successfully disrupted the power grid for a prolonged period. These types of events are referred to as “low probability, high consequence” events because 1) the likely occurrence of any one of these terrorist attacks within Franklin County is low in comparison to natural disasters and technological failures and 2) should any of these events occur, the consequences could be catastrophic.

Figure 1: Franklin County Ranked Hazards

1. **Tornadoes**
2. **Cyber-Threat**
3. **Infectious Diseases**
4. **Flooding**
5. **Lone-Wolf Terrorist Incident**
6. **Dam/ Levee Failure**
7. **Utility/Energy Interruptions or Failures**
8. **Chemical, Biological, Radiological, Nuclear and Explosive (CBRNE) Terrorist Incident**
9. **Severe Winter Weather**
10. **Hazardous Material Incident**
11. **Civil Disturbance**
12. **Severe Summer Weather**
13. **Transportation Accident – Aircraft**
14. **Space Weather**
15. **Extreme Heat**
16. **Earthquakes**
17. **Invasive Species**
18. **Air and Water Pollution/Contamination**
19. **Drought**
20. **Karst/ Sinkhole**

Franklin County has historically devoted considerable resources to addressing natural disasters. However, since the World Trade Center attacks on 9/11, the overall federal direction has been to place an increased emphasis on domestic and international acts of terrorism. Additionally, more recent events such as the Boston Marathon Bombing and many mass shootings including those in Chattanooga, Charleston, and Aurora have highlighted the rising trend of lone wolf terrorism wherein a terrorist act is perpetrated by one or two individuals acting outside the realm of an organized terrorist group. Cyber-attacks are also increasing with many different companies and governmental agencies targeted by terrorists and hackers in recent years. Thus, based on the need to provide added emphasis on acts of terrorism which would otherwise be overshadowed by frequently occurring natural hazards, FCEM&HS chose a risk scoring methodology whereby 1) the likelihood factors outnumber the number of consequence factors and 2) the consequence factors are associated with slightly higher weighted factors. Figure 1 provides the risk ranking for the 20 threats and hazards evaluated by the Workgroup. The higher the numerical order for a threat or hazard, the greater the relative risk based on the total weighted score. The hazards in order of greatest risk are as follows:

No. 1: Tornadoes are nature’s most violent windstorms – even weak ones can cause significant damage and fatalities. A tornado is defined as a rotating column of air, in contact with the surface, pendant from a cumuliform cloud, and often visible as a funnel cloud and/or circulating debris/dust at the ground. According to the National Climactic Data Center, 32 tornadic events were reported in Franklin County from January 1950 through December 2017, all of which were rated F3 (or EF3) and under.

No. 2: Cyber-Threat is the possibility of a malicious attempt to damage or disrupt a computer network or system. A sharp increase in the number of cyber incidents involving government and corporate computer networks has caused the United States and Franklin County to launch initiatives to combat cyber threats. Many of the initiatives have focused on protecting critical infrastructure command and control systems, preventing access to sensitive government information, and thwarting acts of fraud and theft targeting business financial systems.

No. 3: Infectious Diseases are illnesses caused by the entrance into the body of harmful microbial organisms which grow and multiply. The diseases of most concern to the health and welfare of communities are those that are communicable. Communicable diseases are caused by microorganisms such as bacteria, viruses and parasites and are transmitted from an infected person/animal and/or contaminated food or water source to another person or animal. Franklin County is susceptible to many common infectious diseases, such as seasonal flu, as well as diseases that are newly emerged or re-emerging, such as H5N1 Influenza (avian flu).

No. 4: Flooding occurs in many forms, from naturally occurring to human-induced. Common to all flooding is the accumulation of too much water in too little time in too small a place. From 1950 to December 2017, 116 flood and flash flood events were reported in Franklin County according to the NOAA National Climactic Data Center Storm Events Database. From 1999 to 2017 Franklin County was subject to many different types of flooding and received as many as 10 flood warnings in a single year. Flash flooding is the deadliest form of flooding in the United States.

No. 5: Lone-Wolf Terrorist Incident is defined by DHS as an individual motivated by extremist ideology to commit acts of criminal violence independent of any larger terrorist organization. In recent years, the United States has certainly seen an emerging threat from lone wolf terrorists. The Holocaust museum shooter, the Little Rock recruiting station, the Ft. Hood shooting, the attack on Representative Giffords in Tucson, the Boston Marathon bombing, the Emanuel African Methodist Episcopal Church in Charleston, the South Carolina Shooting as well as the shooting of 5 Marine Recruiters in Chattanooga, Tennessee clearly demonstrate the lone wolf phenomenon is gaining popularity amongst would be terrorists. Lone wolf attacks such as these are easy to execute, cost very little, and make headlines. This lone wolf threat is a great challenge to our first responders and therefore has been included in the Risk Assessment as a potential hazard to Franklin County.

No. 6: Dam/ Levee Failure is defined as an uncontrolled release of impounded water. A dam is defined as an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material, for the purpose of storage or control of water. The causes of dam failures include overtopping caused by floods that exceed the capacity of the dam, deliberate acts of sabotage, structural failure of materials used in dam construction, movement and/or failure of the foundation supporting the dam, settlement and cracking of concrete or embankment dams, piping and internal erosion of soil in embankment dams, and inadequate maintenance and upkeep. Despite efforts to provide sufficient structural integrity and to perform inspection and maintenance, problems can develop that can lead to failure. While most dams have storage volumes small enough that failures would have little or no consequences, dams with large storage amounts could cause significant flooding downstream. The O'Shaughnessy Dam and the Hoover Dam are the two dams impacting Franklin County that are found on the Ohio EMA's list of the ten most potentially hazardous dams in the state, based on the possible catastrophic consequences should they fail.

A levee is any artificial barrier together with appurtenant works that will divert or restrain the flow of a stream or other body of water for the purpose of protecting an area from inundation by flood waters. Generally, a levee is subjected to water loading during a few days or weeks in a given year; unlike a dam that is retaining water most days in the same year. A levee breach results when a portion of the levee breaks away, providing an opening for water to flood the landward side of the structure. Such breaches can be caused by surface erosion due to water velocities, or they can be the result of subsurface actions. Levee overtopping is similar to dam overtopping in that the flood waters simply exceed the design capacity of the structure, thus flowing over the lowest crest of the system. Such overtopping can lead to erosion on the landward side which, subsequently, can lead to breaching. The National Levee Database lists the West Columbus Local Protection Project (LPP), Agg Rok Reach Levee, and King Ave Levee as the three levees in Franklin County.

No. 7: Utility/Energy Interruptions or Failures may involve electrical power, natural gas, public water and communications systems. These systems are vulnerable to natural hazards as well as intentional disruptions. Franklin County has experienced interruptions and failures of various kinds. Remnant winds of Hurricane Ike in 2008 caused over one-third of the county to lose power. The derecho on June 29, 2012 knocked out power to 720,000 Ohioans and was the most destructive and expensive storm in AEP Ohio history.

No. 8: Chemical, Biological, Radiological, Nuclear and Explosive (CBRNE) Terrorist Incident is defined as a violent act or an act dangerous to human life, in violation of the criminal laws of the U.S. or any segment, to intimidate or coerce a government, the population or any segment thereof, in furtherance of political or social objectives. Specifically, a CBRNE event is one caused by the introduction of a Chemical, Biological, Radiological, Nuclear or Explosive utilized as a weapon. Franklin County has never been the victim of a direct terrorist attack, yet has a history of terrorist activity. This, along with the difficulties in predicting which U.S. cities are future targets and the potential impact of a terrorist attack on the county's population, property and economy, makes terrorism more of a "wild card" than other hazards and therefore more difficult to prioritize.

No. 9: Severe Winter Weather is classified as snow, ice and extremely cold conditions. Winter storms are events in which the dominant forms of precipitation occur only at cold temperatures. According to the NOAA National Climactic Data Center's Storm Events Database, there were reports of 94 winter weather events for Franklin County from January 1996 to December 2017.

No. 10: Hazardous Material Incident is the release of a hazardous material from its container or package in a sufficient concentration to pose a threat. Hazardous materials may be explosive, flammable, combustible, corrosive, reactive, poisonous, biological, or radioactive, as well as solid, liquid or gaseous. As of May 2015, Franklin County has 764 facilities required to report their hazardous materials. Out of the 764 sites, 373 are Extremely Hazardous Substance (EHS) sites. The most common chemical for the EHS sites is sulfuric acid primarily found in batteries. In 2014 there were 279 spills in Franklin County reported to the Ohio EPA.

No. 11: Civil Disturbance is a planned or random uproar or disturbance of ordinary community life by persons choosing to ignore laws, often to bring attention to a cause, concern, or agenda. Franklin County has seen many types of civil disturbances through the years, from prison riots to university campus disturbances to political rallies.

No. 12: Severe Summer Weather is classified as thunderstorms, hail, lightning, and damaging wind. Each of these hazards has its own severity measure and often all four occur in one storm system, causing much more damage than each would have alone. According to the NOAA National Climactic Data Center's Storm Events Database, there were 436 strong/high/thunderstorm wind, and lightning events, as well as 212 hail events, for Franklin County from January 1950 to December 2017.

No. 13: Transportation Accident – Aircraft is defined as an occurrence associated with the operation of an aircraft which takes place between the times any person boards with the intent to fly and all persons have disembarked, in which a person is fatally or seriously injured, the aircraft sustains damage or structural failure, and/or the aircraft is missing or is completely inaccessible. Franklin County has four operational airports, all located in densely populated areas. According to the National Transportation Safety Board, since 1982 there have been 92 aviation accidents in the Columbus, Ohio area.

No. 14: Space Weather includes major disturbances of Earth's magnetosphere that occur when there is a very efficient exchange of energy from the solar wind into the space environment surrounding Earth. These storms result from variations in the solar wind that produce major changes in the currents, plasmas, and fields in Earth's magnetosphere. Space Weather can disrupt navigation systems such as the Global Navigation Satellite System (GNSS) and create harmful geomagnetic induced currents (GICs) in the power grid and pipelines. Generally, power outages due to space weather are very rare events, but evidence suggests that significant effects could occur.

No. 15: Extreme Heat events, or heat waves, are prolonged periods of excessively hot weather, which may be accompanied by high humidity. In 2012, three people died as a result of extreme heat in Ohio. From 2004-2013, the average number of heat related deaths per year exceeded all other weather related fatalities.

No. 16: Earthquakes are caused by the movement of the earth's crustal plates along faults. Franklin County is not located on a fault line, nor have any epicenters been located in Franklin County. Earthquakes occurring in other areas have been felt in Franklin County; however, no damage has been reported.

No. 17: Invasive Species are defined as any species that is not native to an ecosystem and whose introduction causes or is likely to cause harm to the economy, environment, or human health. An increasing threat of exotic diseases, such as the dangerous West Nile virus, exists because of increased transportation and encroachment of humans into previously remote ecosystems. Two events that have caused substantial economic and environmental damage in Ohio are the introduction of zebra mussels into waterways and the infestation of the emerald ash borer, responsible for killing ash trees.

No. 18: Air and Water Pollution/Contamination refers to the contamination of water, land or the air by substances that can adversely impact the environment and human health. Franklin County is subject to point and nonpoint water pollution of streams, as well as ground level ozone.

No. 19: Drought is defined as a prolonged period of abnormally dry weather, where the lack of sufficient precipitation causes a serious hydrologic imbalance with economic and/or social consequences. Franklin County is primarily impacted by drought relating to shortages in the water supply as well as a decrease in overall water quality. Drought also greatly impacts land throughout the county that is utilized as cropland or pasture.

No. 20: Karst refers to a landform that develops on or in limestone, dolomite, or gypsum by dissolution and that is characterized by the presence of characteristic features such as sinkholes, underground (or internal) drainage through solution-enlarged fractures (joints), and caves. Sudden collapse of an underground cavern or opening of a sinkhole can cause surface subsidence that can severely damage or destroy any overlying structure such as a building, bridge, or highway. A sinkhole is a hole that forms in the Earth's surface as a result of the chemical weathering of carbonate rocks like limestone, as well as salt beds or rocks that can be severely weathered as water runs through them and erosion.

Section 1 - Risk Assessment Concept and Purpose

Risk Assessment Concept

There is no universally valid definition of risk. Risk perception and the level of risk acceptance varies from one individual to another. As could be expected, approaches, concepts, methods, and terminology for risk assessment found in literature and in practice are very diverse, and in some cases contradictory.

The National Strategy for Homeland Security states:

> *"The assessment and management of risk underlies the full spectrum of our homeland security activities… We must apply a risk-based framework across all homeland security efforts in order to identify and assess potential hazards (including their downstream effects), determine what levels of relative risk are acceptable, and prioritize and allocate resources among all homeland security partners… We as a Nation must organize and help mature the profession of risk management by adopting common risk analysis principles and standards, as well as a professional lexicon."*

National Fire Prevention Association 1600, A.5.2 states:

> *"A comprehensive risk assessment identifies the range of hazard/risk exposures, including threats, hazards, or disruptive incidents, that have impacted or might impact the entity, the surrounding area, or the critical infrastructure supporting the entity. The potential impact of each threat, hazard/risk exposure, or disruptive incident is determined by the capabilities of the perpetrator, the magnitude of the hazard, and the scope of the incident, as well as the vulnerability of people, property, technology, the environment, and the entity's operations to the threat, hazard, or incident and the adequacy of existing mitigation."*[2]

Presidential Policy Directive 8 (PPD-8): National Preparedness

PPD-8 was signed by the President on March 30, 2011 and is based on the concept that when the whole community comes together to tackle a challenge—and everyone plays a role—the end result is more effective. The policy requires that entire communities, and not just the government, plan for emergencies in a systematic effort to keep the nation safe from harm and resilient when struck by hazards such as natural disasters, acts of terrorism and pandemics.

This policy directive is comprised of six elements:

1. <u>The National Preparedness Goal:</u> states the goal the president has set for the nation:

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[2] "NFPA 1600 Standard on Disaster/Emergency Management and Business Continuity Programs," National Fire Prevention Association, accessed August 28, 2015, http://www.nfpa.org/assets/files/AboutTheCodes/1600/1600-13-PDF.pdf

"A secure and resilient nation with the capabilities required across the whole community to prevent, protect against, mitigate, respond to, and recover from the threats and hazards that pose the greatest risk."

Included in the National Preparedness Goal is a set of core capabilities that are needed within each community in order to reach the national goal.

2. The National Preparedness System: outlines the approach to be taken in reaching the National Preparedness Goal, including an analysis of the greatest risks confronting the community and an analysis of any gaps between the community's current and needed core capabilities.

3. National Planning Frameworks: define how all levels of government will best work together to achieve the National Preparedness Goal. There is one framework for each mission area: prevention, protection, response, recovery, and mitigation.

4. National Preparedness Report: summarizes progress in building, sustaining, and delivering the 31 core capabilities described in the 2011 National Preparedness Goal.

5. Federal Interagency Operational Plans: serve as the federal government's concept of operations for each of the five mission areas and how the federal government can work to support state and local plans.

6. Building and Sustaining Preparedness: efforts that will support the entire program through grants, outreach programs, technical assistance as well as research and development.

Threat and Hazard Identification

A ***hazard*** is a natural or man-made source or cause of harm or difficulty (Risk Lexicon, 2010)[3]. A hazard is often measured and described by its nature (type of hazard), location and extent, scope and intensity (potential negative consequences) as well as frequency of occurrence.

A ***threat*** is a natural or man-made occurrence, individual, entity, or action that has or indicates the potential to harm life, information, operations, the environment, and/or property. Threat as defined refers to an individual, entity, action, or occurrence; however, for the purpose of calculating risk, the threat of an intentional hazard is generally estimated as the likelihood of an attack (that accounts for both the intent and capability of the adversary) being attempted by an adversary; for other hazards, threat is generally estimated as the likelihood that a hazard will manifest (Risk Lexicon, 2010).

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[3] "DHS Risk Lexicon," Department of Homeland Security Risk Steering Committee, last modified September 2010 http://www.dhs.gov/xlibrary/assets/dhs-risk-lexicon-2010.pdf

The difference between a hazard and a threat is that a threat is directed at an entity, asset, system, network, or geographical area, while a hazard is not directed.

Communities face a variety of threats and hazards that can generally be categorized as one of three types:

- ***Natural Hazards****:* Natural hazards are those resulting from an environmental, meteorological, or geological phenomenon such as hurricanes, earthquakes or tornadoes as well as disease outbreaks or epidemics.
- ***Technological Hazards:*** Technological hazards are those resulting from accidents or the failure of systems and structures such as hazardous material spills or dam failures. In technological hazards, the source of harm or difficulty is created by negligence, error or unintentional structural or system failure.
- ***Threats or Human Caused Hazard:*** Threats or human-caused hazards include those resulting from the intentional actions of an adversary such as a threatened or actual chemical, biological or cyber-attack.

Threat and hazard identification is the process of finding, recognizing and describing actual or potential threats and hazards confronting a community. For example, tornadoes, floods and power outages due to technological failures as well as various acts of terrorism can be identified as potential hazards of concern because of their potentially high consequences or because of some particular vulnerability.

The purpose of the threat and hazard identification is to determine which hazards are deemed most severe and warrant further assessment of the associated risks. FCEM&HS identified 20 hazards that will comprise the updated risk assessment. Of these 20 hazards, eleven are natural hazards, four are technological hazards and five are man-made hazards.

The 20 evaluated hazards include (in no particular order):

Natural Hazards:

Tornadoes are nature's most violent windstorms – even weak ones can cause significant damage and fatalities. A tornado is defined as a rotating column of air, in contact with the surface, pendant from a cumuliform cloud, and often visible as a funnel cloud and/or circulating debris/dust at the ground. According to the National Climactic Data Center, 32 tornadic events were reported in Franklin County from January 1950 through December 2017, all of which were rated F3 (or EF3) and under.

Infectious Diseases are illnesses caused by the entrance into the body of harmful microbial organisms which grow and multiply. The diseases of most concern to the health and welfare of communities are those that are communicable. Communicable diseases are caused by microorganisms such as bacteria, viruses and parasites and are transmitted from an infected person/animal and/or contaminated food or water source to another person or animal. Franklin County is susceptible to many common infectious diseases, such as seasonal flu, as well as diseases that are newly emerged or re-emerging, such as H5N1 Influenza (avian flu).

Flooding occurs in many forms, from naturally occurring to human-induced. Common to all flooding is the accumulation of too much water in too little time in too small a place. From 1950 to December 2017, 116 flood and flash flood events were reported in Franklin County according to the NOAA National Climactic Data Center Storm Events Database. From 1999 to 2017 Franklin County was subject to many different types of flooding and received as many as 10 flood warnings in a single year. Flash flooding is the deadliest form of flooding in the United States.

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Severe Summer Weather is classified as thunderstorms, hail, lightning, and damaging wind. Each of these hazards has its own severity measure and often all four occur in one storm system, causing much more damage than each would have alone. According to the NOAA National Climactic Data Center's Storm Events Database, there were over 600 hail, strong/high/thunderstorm wind, and lightning events for Franklin County from January 1950 to December 2017.

Space Weather includes major disturbances of Earth's magnetosphere that occur when there is a very efficient exchange of energy from the solar wind into the space environment surrounding Earth. These storms result from variations in the solar wind that produce major changes in the currents, plasmas, and fields in Earth's magnetosphere. Space Weather can disrupt navigation systems such as the Global Navigation Satellite System (GNSS) and create harmful geomagnetic induced currents (GICs) in the power grid and pipelines. Generally, power outages due to space weather are very rare events, but evidence suggests that significant effects could occur.

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Invasive Species are defined as any species that is not native to an ecosystem and whose introduction causes or is likely to cause harm to the economy, environment, or human health. An increasing threat of exotic diseases, such as the dangerous West Nile virus, exists because of increased transportation and encroachment of humans into previously remote ecosystems. Two events that have caused substantial economic and environmental damage in Ohio are the introduction of zebra mussels into waterways and the infestation of the emerald ash borer, responsible for killing ash trees.

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Technological Hazards:

Dam/ Levee Failure is defined as an uncontrolled release of impounded water. A dam or levee is an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material, for the purpose of storage or control of water. The causes of dam failures include overtopping caused by floods that exceed the capacity of the dam, deliberate acts of sabotage, structural failure of materials used in dam construction, movement and/or failure of the foundation supporting the dam, settlement and cracking of concrete or embankment dams, piping and internal erosion of soil in embankment dams, and inadequate maintenance and upkeep. Despite efforts to provide sufficient structural integrity and to perform inspection and maintenance, problems can develop that can lead to failure. While most dams have storage volumes small enough that failures would have little or no consequences, dams with large storage amounts could cause significant flooding downstream. The O'Shaughnessy Dam and the Hoover Dam are the two dams impacting Franklin County that are found on the Ohio EMA's list of the ten most potentially hazardous dams in the state, based on the possible catastrophic consequences should they fail.

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Man-made Hazards:

Cyber-Threat is the possibility of a malicious attempt to damage or disrupt a computer network or system. A sharp increase in the number of cyber incidents involving government and corporate computer networks has caused the United

States and Franklin County to launch initiatives to combat cyber threats. Many of the initiatives have focused on protecting critical infrastructure command and control systems, preventing access to sensitive government information, and thwarting acts of fraud and theft targeting business financial systems.

Chemical, Biological, Radiological, Nuclear, Explosive (CBRNE) Terrorist Incident is defined as a violent act or an act dangerous to human life, in violation of the criminal laws of the U.S. or any segment, to intimidate or coerce a government, the population or any segment thereof, in furtherance of political or social objectives. Specifically, a CBRNE event is one caused by the introduction of a Chemical, Biological, Radiological, Nuclear or Explosive utilized as a weapon. Franklin County has never been the victim of a direct terrorist attack, yet has a history of terrorist activity. This, along with the difficulties in predicting which U.S. cities are future targets and the potential impact of a terrorist attack on the county's population, property and economy, makes terrorism more of a "wild card" than other hazards and therefore more difficult to prioritize.

Civil Disturbance is a planned or random uproar or disturbance of ordinary community life by persons choosing to ignore laws, often to bring attention to a cause, concern, or agenda. Franklin County has seen many types of civil disturbances through the years, from prison riots to university campus disturbances to political rallies.

Lone-Wolf Terrorist Act is defined by DHS as an individual motivated by extremist ideology to commit acts of criminal violence independent of any larger terrorist organization. In recent years, the United States has certainly seen an emerging threat from lone wolf terrorist. The Holocaust museum shooter, the Little Rock recruiting station, Ft. Hood shooting, attack on Representative Giffords in Tucson, the Boston Marathon bombing, Emanuel African Methodist Episcopal Church in Charleston, South Carolina Shooting as well as the shooting of 5 Marine Recruiters in Chattanooga, Tennessee clearly demonstrate the lone wolf phenomenon is gaining popularity amongst would be terrorists. Lone wolf attacks such as these are easy to execute, cost very little, and make headlines. This lone wolf threat is a great challenge to our first responders and therefore has been included in the Risk Assessment as a potential hazard to Franklin County.

Air and Water Pollution/Contamination refers to the contamination of water, land or the air by substances that can adversely impact the environment and human health. Franklin County is subject to point and nonpoint water pollution of streams, as well as ground level ozone.

The threat and hazard identification process includes the following steps, the details of which are presented for each hazard in Section 3:

1. Identification and classification of the hazards

2. Identification of the causes and impact chains (i.e., torrential rain can have a direct impact on poorly constructed roofs, but the consequences of torrential rain – flooding, landslides, erosion, etc. – can create a more severe and far reaching impact)
3. Identification and characterization of hazard prone locations and vulnerabilities (i.e., structures in low lying areas are more vulnerable to flooding)
4. Identification of the historical frequency of occurrence (pertaining to natural disasters and technological failures) or probability of occurrence (pertaining to acts of terrorism)
5. Estimation of the possible magnitude or severity of the threat or hazard event

Threat and hazard identification takes into account the source or cause of the hazard, the likelihood of occurrence in the context of location and time, the intensity and duration of the event, and any vulnerabilities in regards to the general population, property, the economy, and/or the environment.

Purpose of the Risk Assessment

The overarching purpose of the 2018 Franklin County Risk Assessment is to enhance the County's decision-making process in regards to homeland security and emergency management by providing decision-makers with risk-based information that differentiates various decision options under consideration. Thus, the primary users of the Risk Assessment are those government officials within the County that are responsible for managing the risks related to natural disasters, technological failures, and man-made acts of terrorism. The following table identifies potential uses for the 2018 Risk Assessment and the associated users; factors that are important in designing an appropriate risk assessment methodology.

Table 2: Risk Assessment Uses and Users

Uses	Users
Serves as the foundation of homeland security and emergency management planning and programs within the County; provides information to key decision-makers for the evaluation, prioritization and treatment of risks.	Emergency Management Personnel Local Government Officials Public Safety and Public Works
Provides an awareness of threats and hazards as well as the resulting risks confronting local governments and the general public in Franklin County.	Civic Associations Local Government Officials Emergency Response Agencies Private Industry
Provides justification for the commitment of funding and resources needed to address the County's greatest risks.	Emergency Management Personnel Budget and Logistics Planners

Identifies opportunities for risk mitigation by describing the County's greatest risks from the threats and hazards facing the County.	Emergency Management Personnel Land Use Planners Public Safety and Public Works
Promotes the concept of identifying protection, prevention, mitigation, response and recovery capabilities that can effectively reduce the County's greatest risks.	Emergency Management Personnel Emergency Response Agencies
Instill public confidence in the County having exercised "due diligence" in identifying and addressing the greatest risks facing the County.	Civic Associations Public Information Officials

In summary, the 2018 Franklin County Risk Assessment is the foundation of the County's emergency management program, providing information for the evaluation, prioritization, and treatment of the County's threats and hazards. The risk assessment allows elements of the County's emergency management program to be based on a realistic appraisal of the types of natural, technological and man-made threats and hazards in terms of the probability and consequences of their occurrence.

Users of the risk assessment can find many other uses beyond the assessments' primary objective of providing risk-based information to local government decision-makers, including:

- Creating an awareness of the threats and hazards and the resulting risks confronting the County,
- Providing a confident basis for emergency management planning,
- Providing information to be used in crafting a strategy for using limited resources to address the greatest risks first,
- Identifying who and what may be at risk,
- Providing justification for the commitment of funding and resources,
- Highlighting opportunities for mitigation efforts,
- Identifying gaps and weaknesses in current protective measures,
- Improving existing capabilities,
- Developing effective warning and evacuation systems,
- Contributing to land use planning, and
- Enhancing public confidence.

Vulnerability and Consequence Assessments

A vulnerability assessment is the process for identifying physical features or operational attributes that render an entity, asset, system, network, or geographical area susceptible or exposed to a threat or hazard. Although the community's vulnerabilities were not a specific component of the semi-quantitative risk scoring methodology, they were considered in estimating the potential consequences of an event. The types of direct or indirect vulnerabilities considered were:

- Sensitive geographical location
- Close proximity to potential adversaries or adversarial groups
- Response capabilities
- Warning and notification times
- Lack of resilience or redundancy in infrastructure systems
- Relatively high historical frequency or projected occurrence
- General lack of security systems
- Proportion of County likely impacted

A consequence assessment is the process for identifying or evaluating the potential or actual effects of an event, incident or occurrence. Typically, the consequence assessment includes at a minimum the impacts on human health and the environment, physical property damage and any impacts on the economy.

Consequences may also be assessed on the basis of an entity or organization's ability to carry out its mission, the number of people to be relocated from their homes, the social or psychological impacts on the public, the amount of warning time residents have in regards to the event or the public's confidence that government is able to govern. "Loss of life," "injury," "relocation from homes," "property damage," "economic impact," and "speed of onset" were consequence factors in the semi-quantitative risk scoring methodology used to rank Franklin County's risks.

- *Loss of Life:* The greater the number of projected lives lost from an event the greater the risk associated with a particular hazard or threat. The estimated loss of lives is based on the expected number of residents or occupants impacted as well as visitors and workers.
- *Injuries:* Similarly, the greater the number of injuries incurred because of the event, the greater its assigned level of risk. The number of injured individuals refers to the number of individuals requiring emergency room care, hospitalization or out-patient treatment.
- *Relocation:* The greater the number of residents that require relocation to shelters or alternative housing for an extended period of time, the greater the risk associated with the particular threat or hazard. This includes those who may decide to seek shelter from relatives or friends, which is more often the case.

- *Property Damage:* The greater the extent of projected property damage, typically measured in dollars, the greater the assigned risk. Property damage may include replacement or restoration costs needed to return the damaged property and/or environment to its condition and/or operational capacity before the event occurred.
- *Economic Impact:* The greater the impact to the economy the greater the risk associated with the threat or hazard. The impact on the economy is often determined in terms of the lost revenue from closed establishments, the lost wages of those losing their jobs, any loss in tax revenues or the impact on gross domestic product (GDP).
- *Speed of Onset:* The shorter the length of warning time between when a community is first made aware of an impending threat or hazard, and the onset of negative consequences resulting from the threat or hazard, the more severe the negative consequences are likely to be and the greater the risk. This will generally be a function of time as those being warned will not have sufficient time to fully implement protective measures.

Probability Assessment

A probability assessment refers to an estimation of the likelihood that a specific threat or hazard will occur.

"Historical or projected frequency of occurrence" and "special circumstances" that can increase the probability of occurrence were two risk factors in the semi-quantitative risk scoring methodology used to rank Franklin County's risks.

- *Frequency of Occurrence:* The assumption is made that threats and hazards that have occurred with relatively high frequency in the past are more likely to occur in the future. Similarly, intelligence information suggesting that adversaries are targeting assets similar to those found in the community and have the resources and skills to successfully carry out the threat suggest a successful attack against the community is more likely.

- *Special Circumstances:* The assumption is also made that special circumstances or conditions can increase the likelihood that the community would experience a particular threat or hazard. For example, climate change is expected to result in more severe storms, an aging infrastructure could lead to more technological failures and knowledge that terrorists are targeting a particular asset found within the community all suggest the greater possibility of occurrence.

Risk Assessment

A risk assessment estimates the level of risk associated with a particular threat or hazard. Risk is directly proportional to the probability of occurrence of an event and the consequences associated with the event. A semi-quantitative risk assessment uses a system of scales and weighted factors to assign a numerical relative risk value to each threat and hazard being evaluated. The threat or hazard being evaluated is typically defined in terms of a "plausible worse-case scenario." Representatives from the community, commonly those with backgrounds in emergency management, then assign a value from ranking from 0 to 5 for each probability and each consequence factor based on a pre-defined scale (see section on Risk Factors). The selected scale value for each factor is then multiplied by its respective weighted value. The product of all of the scale and weighted values are then summed across all factors to produce the relative risk value.

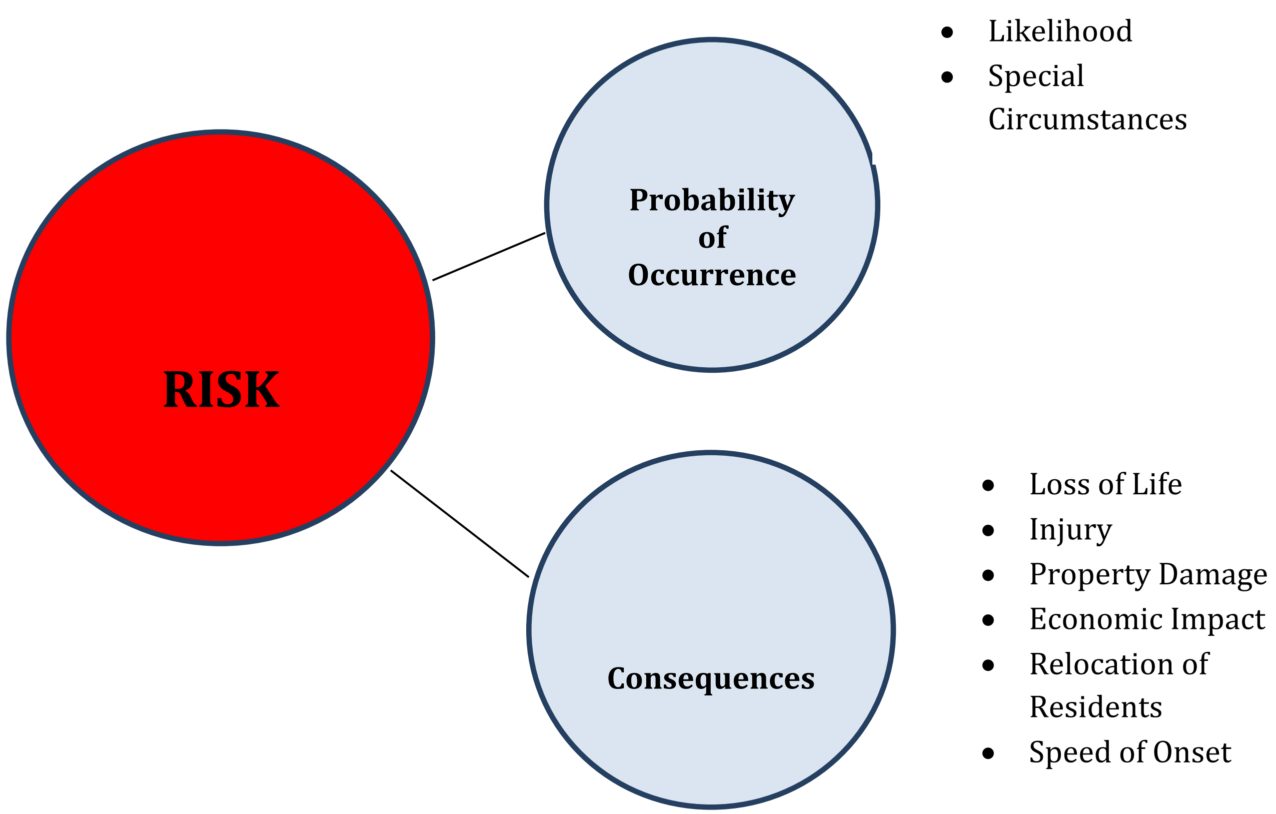
Risk Assessment Model

The Department of Homeland Security (DHS) offers several considerations in developing a risk assessment model (Risk Management Fundamentals, DHS, 2011):

- No one risk scoring methodology fits all risk assessments; the most important factor in designing the risk scoring methodology is determining the types of decisions the risk assessment is to inform.
- Homeland security risks are assessed in terms of their *likelihood* (i.e., *probability of occurrence*) and *consequences* where care is taken to ensure risk factors are relatively independent so as not to overestimate the risk.
- As a rule, simple but defensible methodologies are preferred over more complicated methods as they are less prone to error.
- Risks that are highly unlikely, but carry relatively high consequences (e.g. acts of terrorism), should be identified and incorporated into the risk assessment when possible.
- A discussion of uncertainty regarding any data assumptions is an important part of a risk assessment. One option is to not just provide an average of any risk scores, but to provide a range (low, high, and average) of values so that end-users reviewing the estimates can get a sense of the variability in the raw data. An alternative option is to score the hazard based on a "plausible worst-case" scenario. Justification for this option is based, in part, on the premise that by addressing a reasonable worst-case scenario you are addressing all less intense scenarios. This is particularly relevant when discussing the needed capabilities to prevent, protect, mitigate, respond, and recover from an event.
- In the 2006 to 2007 time period DHS risk analysis approach (in support of grant funding) switched from an additive model to a multiplicative model. Justification seems to have been, in part, because 1) vulnerability and consequence assessments often seemed to overlap causing an overestimation of the risk and 2) by multiplying vulnerability and consequence scores one was in effect causing a "weighting" of the consequence score, which seemed scientifically more justifiable.
- By the end of 2007, DHS further altered its risk analysis approach upon observing the difficulty of comparing the vulnerabilities in one location with another. Ultimately the decision was made to assign the vulnerability component of the risk evaluation a value of one, thus reducing the calculation of risk to the product of two factors: the probability of occurrence and the consequences of an event. In the Franklin County assessment, the community's vulnerabilities were not totally discarded but considered as a special circumstance that would influence the probability of occurrence.

The above concepts (as detailed in the Department of Homeland Security: Risk Management Fundamentals (2011) ; a CRS Report: Department of Homeland Security's Risk Assessment Methodology, Evolution, Issues, and Options for Congress (2007) ; and the National Research Council: Review of the Department of Homeland Security's Approach to Risk Analysis (2010) were considered in the design of the Franklin County Risk Assessment.

Figure 2: Risk Assessment Model



Risk Assessment Methodology

The purpose of this risk assessment is not to predict the occurrence of a particular threat or hazard, but to quantify the risk of one compared to another in a manner that enhances the identification of "relative risk" being provided to local decision-makers for consideration. In this regard, the risk assessment prioritizes the threats and hazards facing the county in terms of their relative risk (i.e. the probability of their occurrence and the magnitude of the associated consequences). **The relative risk score of any single threat or hazard is not as important as how it compares to the scores of the other threats and hazards. Comparing the scores of all threats and hazards provides a method for their prioritization based on where the relative risk is greatest.** That is, the relative risk scores derived from a semi-quantitative risk assessment based on the use of scales and weighted factors do not represent actual risk values. Actual risk is based on precise numbers representing the probability of occurrence and the consequences of the event.

Relative risk scores indicate that one hazard or threat is greater than or less than another, and a relative risk score twice that of another does not necessarily indicate that the actual risk is twice as great. In essence, relative risk yields a prioritization of threats and hazards for consideration by decision-makers.

Due to the extremely low likelihood of occurrence, without some adjustment in the scoring methodology, terrorist events would be of lowest priority when ranked with non-terrorist disasters suggesting that no preventive, protective, response or recovery preparedness activities would be warranted. Additionally, like most counties, Franklin County has historically devoted considerable resources to addressing natural disasters. However, since the World Trade Center attacks on 9/11, the overall federal direction has been to place an increased emphasis on domestic and international acts of terrorism. Additionally, more recent events such as the Boston Marathon Bombing and many mass shootings including those in Chattanooga, Charleston, and Aurora have highlighted the rising trend of lone wolf terrorism wherein a terrorist act is perpetrated by one or two individuals acting outside the realm of an organized terrorist group. Cyber attacks are also increasing with many different companies and governmental agencies targeted by terrorists and hackers in recent years. Thus, based on the need to provide added emphasis on acts of terrorism, FCEM&HS chose a risk scoring methodology whereby 1) the likelihood factors outnumber the number of consequence factors and 2) the consequence factors are associated with slightly higher weighted factors. The higher the numerical order for a threat or hazard, the greater the relative risk based on the likelihood and consequence factors. Subject matter expertise and judgment were also used to ensure this list accurately reflects the reality of the risks facing Franklin County and are not merely a reflection of numbers derived from scientific methods. For ranking and scoring purposes the total weighted score will be used.

Threat and Hazard Scenarios

Determining the relative risk posed by each threat and hazard facing the community requires the development of a planning scenario that provides the basis for determining the consequences of the event. The scenario describes the situation and conditions under which the particular threat or hazard is projected to occur. Such conditions may include the location, severity of the event, time of day or season, etc. The developed scenario is intended to represent a “plausible worst-case” event in terms of the projected negative consequences. The justification for using a worst-case scenario is based upon the concept that, in developing the response and recovery capabilities needed to address a worst-case event, the likelihood exists that all less intense events will be addressed also. The 2018 Franklin County Risk Assessment is based on the following scenarios (not in priority sequence):

Flooding: A large storm producing heavy rain, high winds and hail is followed by several additional storms causing continued downpours lasting for several days. The result is an unprecedented amount of rainfall that leads to severe flooding across the region; in some areas water levels exceed the 500-year flood predictions.

Tornadoes: An F4 category tornado coming out of the southwest traverses the northern portion of Franklin County leaving an 800 yard wide path of destruction.

Hazardous Material Incidents: A large release of a toxic substance in Franklin County.

Cyber-Threat: Cyber intrusion into systems controlling the electrical power grid results in a massive loss of electrical power and internet capability for much of central Ohio and neighboring states for a prolonged period.

Dam/ Levee Failure: A major dam/levee breach occurs with little or no warning, impacting multiple downstream communities.

Utility/Energy Interruption or Failure: A utility interruption causes a power outage for a period of five days.

Infectious Diseases: A highly infectious disease epidemic resulting in a large number of severe illnesses and deaths as well as causing disruption to schools and businesses.

Severe Winter Weather: A serious ice storm brings high winds and covers most of Franklin County in as much as two (2) inches of ice.

Extreme Heat: A heat event with a heat index of at least 105°F for more than three (3) hours per day occurs over a five (5) consecutive day period.

Severe Summer Weather: A severe thunderstorm with hail and winds over 50 miles per hour lasts over several hours with total rainfall of three (3) inches.

Air and Water Pollution/Contamination: An incident occurs in which sewage contaminates drinking water supplies.

Transportation Accident-Aircraft: An incident occurs where a passenger airplane crashes into a Franklin County neighborhood.

Invasive Species: An infestation of Ash Borer impacts multiple communities throughout the county.

Drought: An 8-week period with no rain severely impacts the growing season.

Earthquakes: A magnitude five (5) earthquake in southeast Ohio causes minor to moderate damage to several communities within Franklin County.

Lone Wolf Terrorist Incident: A school shooting takes place at a Franklin County School.

Chemical, Biological, Radiological, Nuclear, Explosive (CBRNE) Terrorist Incident: An IED is exploded at a major sporting event.

Civil Disturbance: Civil unrest resulted in mass protests at several Franklin County government facilities.

Space Weather: A severe space weather storm will impact the Northeastern United States causing the disruption of sensitive navigational systems, primary communication disruptions, and power outages to the electrical grid. The storm will impact 13 states in the region. In central Ohio, It is estimated that major disruptions to advanced navigation systems in the transportation sector, disruption to primary communications systems, and approximately 80% of homes and businesses will be without power. The full impact of damage produced by this storm is unknown at this time. The amount of time needed for full restoration of these systems and services may be weeks to months.

Karst/ Sinkhole: Open spaces develop under ground's surface. Once the open spaces become too large to support the weight of the land above them, the surface soil collapses, and a large sinkhole is created in an industrial park in Franklin County.

Risk Factors

Each risk factor is scored on a scale of 0 – 5. Benchmark descriptions for each rating's numerical value are shown in the tables below. The ratings are based largely on historical data in regards to natural disasters, whereas man-made threats are largely based on intelligence information. The objective of scoring the threats and hazards is to obtain ordinal data so the threats and hazards can be compared to one another, in accordance with the FCEM&HS stated objectives.

Likelihood Factor: For natural hazards the historical incidence, when readily available, was used to estimate the likelihood of an event occurring in Franklin County. For acts of terrorism, the likelihood factor was based on the historical occurrence of similar acts within the United States (when available) and in consideration of the act being both attempted and successfully carried out. When data was not readily available, the Workgroup's collective opinion was used to estimate the likelihood of the threat or hazard occurring.

Likelihood Factor: The frequency at which an event has happened in the past or may happen in the future based on available intelligence.	
Rating	**Description**
0	**Very Low Probability:** • Natural/Technological Hazards: Where the natural hazard or infrastructure failure historically happens at a frequency of one every 125 years or more. • Manmade/Terrorist Threats: Where the potential threat to an act of sabotage, terrorism or criminal intent is directed against an inconsequential target.
1	**Low Probability Event:** • Natural/Technological Hazards: Where the anticipated frequency of a natural hazard or infrastructure failure within the County is once every 26 to 124 years. • Manmade/Terrorist Threats: Where a potential threat involves an existing but unlikely target by terrorists (foreign or domestic).
2	**Relatively Low Probability Event:** • Natural/Technological Hazards: Where the anticipated frequency of a natural hazard or infrastructure failure within the County is once every 5 to 25 years. • Manmade/Terrorist Threats: Where there is some indication that an act of sabotage, terrorism or criminal intent (foreign or domestic, external or internal) directed against similar targets within the United States.
3	**Relatively Moderate Probability Event:** • Natural/Technological Hazards: Where the anticipated frequency of a natural hazard or infrastructure failure within the County is once every 1 to 4 years. • Manmade/Terrorist Threats: Where there exists direct intelligence information that an act of sabotage, terrorism or criminal intent (foreign or domestic, external or internal) is being directed towards similar targets in the United States.
4	**Relatively High Probability Event:** • Natural/Technological Hazards: Where a natural hazard or infrastructure failure within the County is expected to occur more than twice but no more than 5 times a year. • Manmade/Terrorist Threats: Where there is some indication of an act of sabotage, terrorism, or criminal intent being planned or directed against targets located within the County.
5	**Relatively Very High Probability Event**:

	• Natural/Technological Hazards: Where the anticipated frequency of a natural hazard or infrastructure failure within the County is greater than 5 times a year. • Manmade/Terrorist Threats: Where there is direct intelligence information that there is an act of sabotage, terrorism, or criminal intent being directed against targets within the County.

Special Circumstance Factor: Specifically, for acts of terrorism, while such an event is considered as a "very low frequency, high consequence" event, the ability for a terrorist element to successfully reach its target and then being capable of carrying out a successful attack are important modifying risk factors. For non-terrorist hazards, events or conditions that may increase the historical occurrence of natural disasters (e.g. climate change) or technological failures (aging infrastructure) are also important risk modifying factors. Incorporating these factors into the risk scoring methodology is based, in part, on a policy decision to emphasize relatively new threats (i.e. acts of terrorism) as opposed to more traditional hazards (e.g. natural disasters) where Franklin County has historically undertaken considerable effort to address these types of risks.

Special Circumstance Factor: A condition or factor having some bearing on an event, potentially either decreasing or increasing the impact (i.e. moving homes out of a floodplain, climate change, an aging infrastructure).	
Rating	**Description**
0	**Actual reduction in likelihood of negative consequences**. • Natural/Technological Hazards: For natural disaster and technological failures where mitigation measures (e.g. relocation of homes in flood plain) have been implemented that greatly minimize the potential for negative consequences. • Manmade/Terrorist Threats: Regarding acts of sabotage where there is demonstrated evidence that there is likely to be a sufficient deterrent force to stop an adversary (foreign or domestic, internal or external) from achieving their mission.
1	**No Special Circumstances** • Natural/Technological Hazards: There is no expected change in the historical incidence or severity of a natural disaster or technological failure. • Manmade/Terrorist Threats: There is no evidence to suggest a specific act of sabotage is expected.
2	**Slight increase in the likelihood of negative consequences.** • Natural/Technological Hazards: For natural disasters & technological failures there exist circumstances (e.g. climate change, aged infrastructure) that are likely to slightly (1 -5%) increase the frequency or severity of an event.

	• Manmade/Terrorist Threats: Where intelligence information suggests a possible heightened level of terrorist activities, in general.
3	**Moderate increase in the likelihood of negative consequences**: • Natural/Technological Hazards: Where there are factors that are expected to result in a moderate increase (6-10%) in the frequency or severity of a natural disaster or an infrastructure failure. • Manmade/Terrorist Threats: Where terrorists (foreign or domestic, internal or external) have relatively open access to an intended target.
4	**Significant increase in the likelihood of negative consequences** • Natural/Technological Hazards: Where there are factors that are expected to result in a significant increase (11-20%) in the historical frequency or severity of a natural disaster or an infrastructure failure. • Manmade/Terrorist Threats: Where terrorists (foreign or domestic, internal or external) have open access to the target and are believed to possess the skills and resources needed to carry out their mission.
5	**Substantial increase in the likelihood of negative consequences.** • Natural/Technological Hazards: Where there are factors or a multiple of factors that are expected to result in a substantial increase (>20%) in the historical frequency or severity of a natural disaster or technological failure. • Manmade/Terrorist Threats: Where terrorists (foreign or domestic, internal or external) have open access to the target, have the skills and resources needed to carry out their mission, and where evidence exists of terrorists having specifically planned this type of event.

Loss of Life Factor: An estimation of the number of lives lost, based on the severity of the event, historical data, and the maximum amount of workers, visitors, and general public that are expected to be at the location of an event at the time of its proposed occurrence.

Loss of Life Factor: The number of people in a given area who are likely to die during an event.	
Rating	**Description**
0	**None:** No expected loss of life
1	**Very Few:** Where loss of life from a natural disaster, technological failure or manmade/terrorist act is expected to be between 1 and 10.
2	**Minimal:** Where the estimated loss of life from a natural disaster, technological failure or manmade/ terrorist act is greater than 10 but less than or equal to 100.
3	**Moderate:** Where the estimated loss of life from a natural disaster, technological failure or manmade/terrorist act is greater than 100 but less than or equal to 1000.
4	**Significant:**

	Where the estimated loss of life from a natural disaster, technological failure or manmade/terrorist act is greater than 1,000 but less than or equal to 10,000.
5	**Substantial:** Where the estimated loss of life from a natural disaster, technological failure or manmade/terrorist act is greater than 10,000.

Injury Factor: An estimation of the total number of individuals (workers, visitors, and general public) that are likely to require hospitalization and/or outpatient care until full recovery.

Injury Factor: The number of people in a given area who are likely to be injured and need hospitalization/outpatient care during an event.	
Rating	**Description**
0	**Virtually none:** few or injuries that are only minor in severity
1	**Relatively Few:** Where the number of individuals requiring hospitalization or outpatient care from a natural disaster, technological failure or manmade/terrorist act is greater than 1 but less than or equal to 50.
2	**Minimal:** Where the number of individuals requiring hospitalization or outpatient care from a natural disaster, technological failure or manmade/terrorist act is greater than 50 but less than or equal to 250.
3	**Moderate:** Where the number of individuals requiring hospitalization or outpatient care from a natural disaster, technological failure or manmade/terrorist act is greater than 250 but less than or equal to 1,250.
4	**Significant:** Where the number of individuals requiring hospitalization or outpatient care from a natural disaster, technological failure or manmade/terrorist act is greater than 1,250 but less than or equal to 62,500.
5	**Substantial:** Where the number of individuals requiring hospitalization or outpatient care from a natural disaster, technological failure or manmade/terrorist act is greater than 65,500.

Property Damage Factor: An estimation in dollars of the total cost for the restoration of damaged property, including replacement of physical structures, demolition and waste removal, and any restoration activities following any event.

Property Damage Factor: The likely amount of damage that will occur to property in the impacted area due to a given event.	
Rating	**Description**
0	**Virtually None:** Where property damages are likely to be less than $1,000.
1	**Relatively Little:**

	Property damages are likely to be greater than $1,000, but less than or equal to $25,000.
2	**Minimal:** Property damages are likely to be greater than $25,000 - $625,000, but less than or equal to $625,000.
3	**Moderate:** Property damages are likely to be greater than between $625,000, but less than or equal to $15 million.
4	**Significant:** Property damages are likely to be greater than $15 million - $375 but less than or equal to $375 million.
5	**Substantial**: Property damages are likely to be greater than $375 million.

Economic Impact Factor: An estimation of the impact, expressed in terms of dollars, on the local economy is based on a loss of business revenue, worker wages and local tax revenues or on the impact on the local gross domestic product (GDP).

Economic Impact Factor	
Rating	**Description**
0	**Virtually None:** Where economic impact is less than $100,000.
1	**Relatively Little:** Total economic impact is likely to be greater than $100,000, but less than or equal to $1 million.
2	**Minimal:** Total economic impact is likely to be greater than $1 million, but less than or equal to $10 million
3	**Moderate:** Where the total economic impact is likely to be greater than $10 million, but less than or equal to $100 million.
4	**Significant:** Where the total economic impact is likely to be greater than $100 million, but less than or equal to $1 billion.
5	**Substantial** : Where the total economic impact is likely to be greater than $1 billion.

Relocation Factor: An estimation of the total number of households (not individuals) requiring relocation for more than a week from their primary residence. Households falling within this category will likely experience psychological stress attributable to the event. Additionally, the number of household requiring relocation provides an indirect indication of the extent of property damage.

Relocation Factor: The number of people likely to be relocated from their homes due to a given event.

Rating	Description
0	**Virtually none:** Where anticipated households requiring relocation is less than 5.
1	**Relatively Few:** The number of households requiring relocation is greater than 5 but less than or equal to 50.
2	**Minimal:** The number of households requiring relocation is greater than 50, but less than or equal to 100.
3	**Moderate:** The number of households requiring relocation is greater than 100, but less than or equal to 2,000.
4	**Significant:** The number of households requiring relocation is greater than 2,000, but less than or equal to 40,000.
5	**Substantial** : The number of households requiring relocation is greater than 40,000.

Speed of Onset: An estimation of the duration in time from when those impacted by the event are first warned of the event and the time for when the associated negative consequences cannot be avoided. It is presumed that the greater the speed of onset, the more severe the likely negative consequences.

Speed of Onset: The length of warning time that may be expected prior to the impact of a hazard. Longer lead time for protecting lives and property allows the community to be prepared versus reacting to a no-notice event.	
Rating	**Description**
0	**Substantial:** Warning given over 48 hours prior to the event.
1	**Significant:** Warning given is between 25 and 48 hours prior to the event.
2	**Moderate:** Given is given between 13 and 24 hours prior to event
3	**Minimal:** Warning is given between 7 and 12 hours prior to event.
4	**Relatively Little:** Warning is given is between 1 hour and 6 hours prior to event
5	**Virtually None:** Warning is given is less than 1 hour prior to event, or no warning is given.

Weighted Factors

Each of the risk factors were then weighted according to their perceived importance by the FCEM&HS Workgroup charged with conducting the risk evaluations. The weighed value represents how significant the specific risk factor is relative to the overall risk rating. The total weighted score was used for ranking purposes. The weighted risk values for each risk factor are as follows:

Risk Factor	Weighted Factor
Likelihood of Occurrence	15
Special Circumstance	10
Loss of Life	30
Injuries	25
Property Damage	15
Economic Impact	15
Relocation	10
Speed of Onset	10

Risk Scoring

The overall relative risk score for a particular threat or hazard scenario is then determined by multiplying the 0 to 5 scaled risk factor value (RF) by the appropriate weighted value (W) and then summing the resulting product across all eight risk factors, as follows:

Relative Risk Score = RF_1 x W_1 + RF_2 x W_2+….+ RF_8 x W_8

For example, the following scenario received a relative risk score (425) as calculated in the following table:

Risk Factor	Risk Factor Score (RF)	Weighted Value (W)	RF x W
Likelihood of Occurrence	1	15	15
Special Circumstances	2	10	20
Loss of Life	3	30	90
Injuries	4	25	100
Property Damage	4	15	60
Economic Impact	4	15	60
Relocation	3	10	30
Speed of Onset	5	10	50
		Relative Risk Score	425

Franklin County Scores

As discussed in the previous sections, Franklin County Emergency Management & Homeland Security led an effort to assess and score the risks facing Franklin County utilizing a scientific methodology coupled with subject matter expertise. While utilizing a defensible scientific methodology is crucial to the risk management process, subject matter expertise and discretion also play a critical role. Limitation on the methodology and scenarios developed can artificially raise or lower a hazard score. Utilizing subject matter expertise to truly examine the hazards facing Franklin County yields the best product to guide efforts towards preparedness.

	Methodology Derived Scores	Raw Score
1	Tornadoes	379.17
2	Cyber Threat	371.67
3	Infectious Diseases	358.24
4	Flooding	355.83
5	Lone Wolf Terrorist Incident	345.00
6	Dam Failure	338.82
7	Utility/Energy Interruption or Failure	336.18
8	Chemical, Biological, Radiological, Nuclear, and Explosive (CBRNE) Terrorist Incident	282.06
9	Severe Winter Weather	281.76
10	Hazardous Material Incidents	269.12
11	Civil Disturbance	260.59
12	Severe Summer Weather	260.59
13	Transportation Accident-Aircraft	239.71
14	Space Weather	208.24
15	Extreme Heat	204.12
16	Earthquakes	182.94
17	Invasive Species	168.24
18	Air and Water Pollution/Contamination	155.29
19	Karst/ Sinkhole	140.00
20	Drought	135.59

Uncertainty Analysis

A description of the uncertainties in any risk assessment is an important component of that assessment. Knowing the uncertainties in the risk assessment is intended to give the reader a sense of the completeness and accuracy of the data upon which any conclusions area reached.

Citing the uncertainties is particularly appropriate when attempting to predict what might happen in the future. There are also uncertainties in trying to assess what happened in the past. The source of these uncertainties includes:

- Incomplete or missing data
- The “statistical variability” when quantifying or measuring any one data point
- A lack of understanding or misinterpretation of the data or of the assumptions used to generate the data and
- The inability to develop accurate forecasting models.

In the case of incomplete or missing data it is common to obtain the opinion of subject matter experts. The fact that the data is incomplete may be attributed to the non-existence of the data, an inability to locate the data, or the financial constraints associated with finding the data. It is an accepted practice to substitute human judgment as would be gained from experts, but such judgment is expected to be less accurate than actual physical measurement, thus increasing the uncertainties associated with the assessment’s final conclusions. In the Franklin County Risk Assessment, the Workgroup used semi-qualitative scales of 0 to 5 to assess the probability of occurrence and the consequences of an event. The assignment of a scaled value as opposed to using an absolute value creates a degree of uncertainty. Also, the background and level of knowledge of those providing the opinion can contribute to the magnitude of the uncertainty.

The variability inherent in the measurement (i.e. average or mean) of any measured endpoint is often statistically conveyed in terms of standard deviations. More sophisticated tools such as probability analysis also can describe the variability in a measured or forecasted value. However, these statistical methods have less utility when employing a semi-qualitative risk scoring methodology as used in this assessment. The resulting numeric estimates of risk are, therefore, not actual risk estimates but are more relative risk values allowing one to conclude that the risk of one evaluated event is higher or lower depending upon the relative risk score of the event to which it is being compared. These comparisons are valid only within the context of this particular assessment and have little meaning when used outside the context of this assessment. They do, however, allow for a meaningful prioritization of the risks associated with various threats and hazards; a comparison that decision-makers can use within the County as justification as to why they might consider an investment in risk reduction for one threat or hazard over another.

A lack of understanding of the underlying science or processes involved in assessing the probability or consequences of an event can also lead to uncertainties. For example, when assessing the risk to an event, the event needs to be specific in regards to its magnitude, time of day, associated demographics, etc. when estimating the negative consequences of the event. As it is common to describe a "plausible worst-case scenario" for an event, it is important that the scenario be well conceived, otherwise there could be an underestimation or overestimation of the relative risk score. Again, the human judgment used to develop an event scenario can contribute to uncertainties associated with the final conclusion of the assessment. Similarly, when looking at the consequences of an event, uncertainties in the conclusion can arise if the assessment does not include a thorough evaluation of those consequences. For example, in estimating the impact of a power outage, an event that has the potential to affect many other critical infrastructures located within the community as well as essential services provided by the community, it is important that these effects be considered insofar as their impact on human health and property damage as well as economic impact.

Finally, the choice of models supporting the risk assessment can lead to uncertainties. In the Franklin County Risk Assessment, a model was employed for estimating relative risks based on eight Risk Factors. The choice of risk factors, the degree of independence between Risk Factors and whether to use a multiplicative or additive model to estimate the risk each in their own way can contribute to the assessment's uncertainties. An initial risk analysis conducted by FCEM&HS in 2010 was based on an additive model where the probability and consequence factors were multiplied by a weighted factor and then summed to arrive at a relative risk value. Historically, the Department of Homeland Security (DHS) has promoted similar models; more recently, DHS has proposed the use of multiplicative models. In 2010, the DHS' risk analysis approach was evaluated by a committee of experts (Review of the Department of Homeland's Security's Approach to Risk Analysis, National Academies Press, 2010). The committee pointed out that the DHS approach to risk analysis has evolved over time from a model based strictly on impacted population; to an additive model where "the sum of threat, critical infrastructure vulnerability and population density"; to finally a multiplicative model where Risk = Threat x Vulnerability x Consequence. The evaluating committee points out that the R=T x V x C model has many unresolved issues. The committee concluded that the multiplicative formula, Risk = $T \times V \times C$, is not an adequate calculation tool for estimating risk for the terrorism domain, within which independence of threats, vulnerabilities, and consequences does not typically hold. The committee went on to say:

> "While the basic structure of the $R = f(T,V,C)$ framework is sound, its operationalization by DHS has been seriously deficient in a number of respects. In particular, problems exist with how each term of the equation has been conceptualized and measured, beginning with defining and estimating the probabilities of particular threats in the case of terrorism. The variables, indicators, and measures employed in calculating T, V, and C can be crude, simplistic, and misleading."

While DHS works to resolve these issues it was deemed premature to fully endorse the R=T x V x C model. Largely on this basis, FCEM&HS will retain the additive model, a model which is relatively straightforward and understandable as a relative risk model. In addition, the final ranking is plausible and well serves as a "management tool" in screening the County's potential hazards and threats.

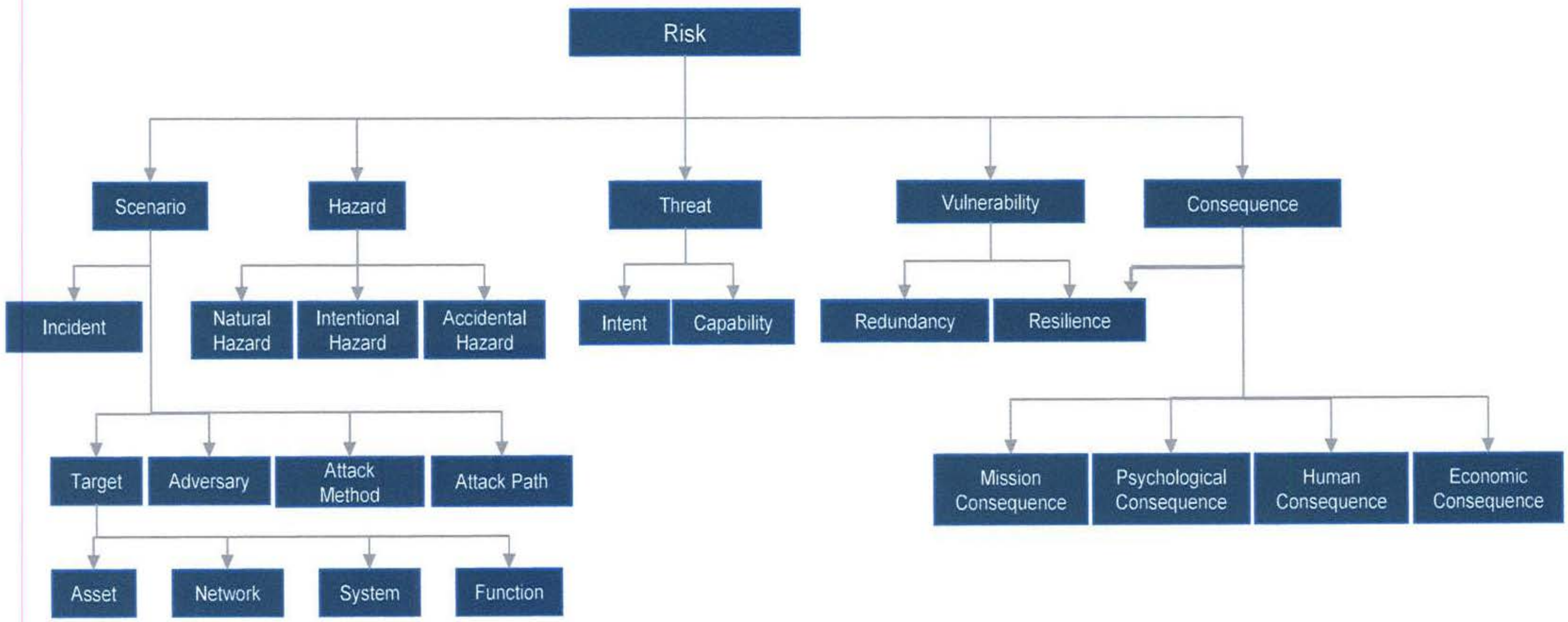
Risk Management Taxonomy

Risk assessment, the specific process that is at the core of this document, is part of the larger discipline of risk management, described in the U.S. Department of Homeland Security publication *DHS Risk Lexicon, September 2010* as the "process of identifying, analyzing, assessing, and communicating risk and accepting, avoiding, transferring or controlling it to an acceptable level at an acceptable cost associated costs and benefits of any actions taken."[4]

The 2010 *DHS Risk Lexicon* provided a series of taxonomy charts intended to show conceptual relationships among key risk management terms and foster better understanding of which concepts are broad and which are more specific. Toward that same end, two of those charts are displayed below.

[4] "DHS Risk Lexicon," Department of Homeland Security Risk Steering Committee, last modified September 2010 http://www.dhs.gov/xlibrary/assets/dhs-risk-lexicon-2010.pdf

CHART III: RISK BRANCH



U.S. DEPARTMENT OF HOMELAND SECURITY
DHS RISK LEXICON

Definitions

Hazard: A natural or man-made source or cause of harm or difficulty (e.g. tornado, chemical spill).

Threat: A natural or man-made occurrence, individual, entity, or action that has or indicates the potential to harm life, information, operations, the environment and/or property (e.g. an act of domestic or international terrorism).

Risk: The potential for an unwanted outcome resulting from an incident, event, or occurrence, as determined by its likelihood and the associated consequences. (In the classical sense, risk associated with a particular threat or a hazard is directly proportional to the likelihood of the hazard or threat actually occurring and the consequences of that occurrence.)

Vulnerability: Physical feature or operational attribute that renders an entity, asset, system, network, or geographic area open to exploitation or susceptible to a given hazard. (In those instances where the community displays a particular vulnerability to an event, this third factor could be considered in the calculation of risk.)

Risk Assessment: Product or process which collects information and assigns values to risks for the purpose of informing priorities, developing or comparing courses of action, and informing decision making. (Prioritization of the risk scores is a means by which decision-makers are informed about the greatest risks confronting the community and where investments in risk reduction are likely to be of most benefit.)

Risk Management: The process of identifying, analyzing, assessing, and communicating risk and accepting, avoiding, transferring or controlling it to an acceptable level at an acceptable cost. (By looking at the level of risk reduction achieved with each alternative, decision-makers are better able to identify the optimal risk reduction effort for the dollar expended.)

Semi-Quantitative Risk Assessment Methodology: Set of methods, principles, or rules to assess risk that uses bins, scales, or representative numbers whose values and meanings are not maintained in other contexts. (A semi-quantitative assessment uses an approach avoiding more costly and labor-intensive quantitative assessments while still providing for a meaningful prioritization of relative risks versus actual risks.)

Residual Risk: Risk that remains after risk management measures have been implemented.

Risk-Informed Decision Making: Determination of a course of action predicated on the assessment of risk, the expected impact of that course of action on that risk, as well as other relevant factors. (The ultimate objective is for the community's key decision makers to be made aware of the risks confronting the community, and to select the best option for reducing the risk given the available resources and resulting residual risk.)

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Section 2 – Franklin County Profile

History

The earliest history of the Franklin County region describes evidence of Native American mound-building societies near the confluence of the Scioto and Olentangy rivers. Mound Street in Columbus was so named because of its proximity to a large burial mound. The ancient civilizations were later followed by the people of the Miami, Delaware, Wyandot, Shawnee, and Mingo nations--all familiar names today in Central Ohio. These nations resisted the expansion of the United States as explorers began moving into the region south of Lake Erie. After years of bitter conflict, the decisive battle at Fallen Timbers resulted in the Treaty of Greenville, which finally opened the way for new settlements.

In 1797, a new settlement founded by a young surveyor from Virginia, Lucas Sullivant, flourished on the west bank of the forks of the Scioto River. Sullivant named his new settlement Franklinton, after Benjamin Franklin. His success was short lived when in 1798 the first of many floods wiped out the new settlement. Sullivant persevered and rebuilt the village, again in the same place so as to be near the navigable rivers. Over the years, Franklinton was flooded repeatedly until the building of the Franklinton Flood Wall was finished in 2004.

Ohio achieved statehood in 1803. Shortly thereafter, Franklin County was created. Originally part of Ross County, it extended north to Lake Erie until Ohio further subdivided into more counties. The state capital was originally in Chillicothe, moved to Zanesville, then back to Chillicothe. The legislature finally decided a new capital would be located in the middle of the state. As a result, Columbus was founded in February 1812. Lessons had been learned, however, and the new city was located on the high banks opposite Franklinton at the forks of the Scioto known as Wolf's Ridge.

The National Road, now known as US Route 40, reached Columbus from Baltimore in 1831, complementing the city's new link to the 308 mile Ohio and Erie Canal system. During the Ohio and Erie Canal Era (1832-1904), many factories, warehouses and homes were built along both banks of the Scioto. Columbus was officially chartered as a city on March 3, 1834. Rail service reached Columbus in 1850, further enhancing the city as a transportation center.

From March 23 to March 27, 1913, a catastrophic flood reaching 22 feet inundated Franklinton, leaving 96 dead and thousands homeless. To stem future flooding, the Army Corps of Engineers recommended widening the Scioto through downtown and building a retaining wall along its banks. The only bridge to survive the flood was the new earth-filled concrete arch bridge at King Avenue. The survival of this bridge changed the way bridges were built throughout Franklin County. The devastating flood also led to several urban renewal projects, including the building of the O'Shaughnessy Dam and Reservoir and many structures that are now downtown landmarks.

Rapid suburban development in the county started in 1948 with the building of the Town and Country Shopping Center in Whitehall. The arrival of the interstate highway system led to continued growth of the suburbs. Widespread urbanization of the county has continued, as well as revitalization efforts in downtown Columbus.

Geography

Franklin County is located near the geographic center of the state, in the Till Plains and the Appalachian Plateau land regions.

Franklin County's major drainage basin is the Scioto River, fed by four major tributaries called the Olentangy River, Alum Creek, Big Darby Creek and Big Walnut Creek. It contains approximately 339 linear miles of major streams and rivers. The confluence of the Scioto and Olentangy rivers is just west of downtown Columbus. The county has relatively flat topography due to large glacial coverage during the Wisconsin Ice Age. The highest point in Franklin County is 1132 feet above sea level, near New Albany, and the low point is 670 feet, where the Scioto River leaves the county near Lockbourne. The county does have some variety in landscape due to numerous ravine areas near the creeks and rivers. Tributaries to Alum Creek and the Olentangy River cut through shale, while tributaries to the Scioto cut through limestone.

Topographical Land Cover Percentages

Climate

Franklin County is located in an area of changeable weather with four distinct seasons. Cold air masses from central and northwest Canada frequently invade the region. Tropical Gulf air masses reach central Ohio often during the summer and to a lesser extent in fall and winter. Annual averages are:

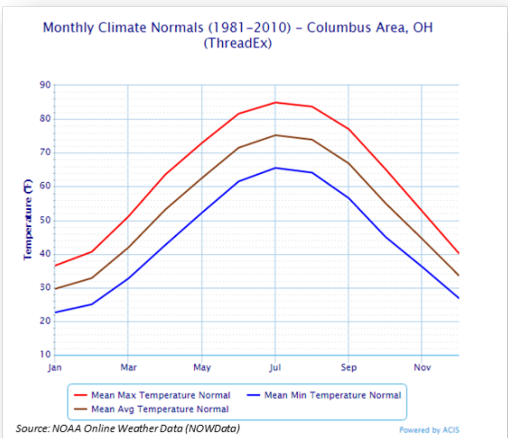
Land Use/Land Cover	Percent
Developed, Lower Intensity	40.16%
Developed, Higher Intensity	22.90%
Barren (strip mines, gravel pits, etc.)	0.50%
Forest	9.36%
Shrub/Scrub and Grasslands	0.74%
Pasture/Hay	5.24%
Cultivated Crops	19.23%
Wetlands	0.22%
Open Water	1.65%

Annual Franklin County Averages	
Temperature	53 degrees
High Temperature	62 degrees

Low Temperature	44 degrees
Rainfall	39 inches
Snow	27 inches

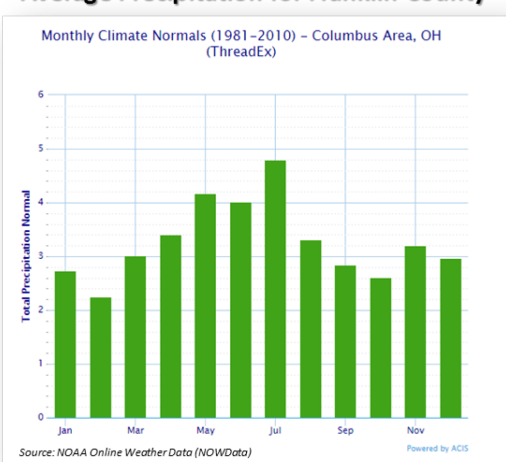
The hottest temperature ever recorded was 106ºF, which occurred twice during the Dust Bowl drought of the 1930s. The coldest temperature ever recorded was -22º F on January 19, 1994. The county is subject to severe weather typical in the Midwest. Tornadoes are possible, as are floods, blizzards and severe thunderstorms.

Average Temperatures for Franklin County



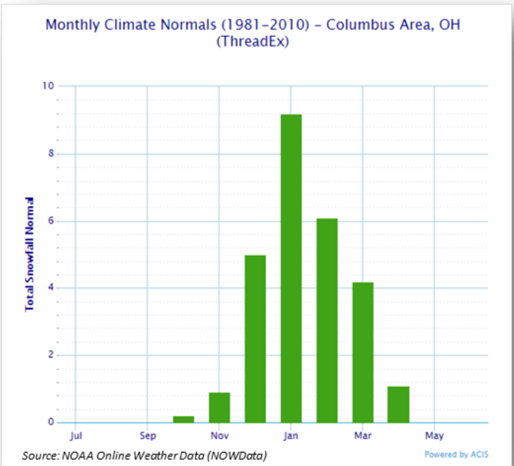
Month	Low (°F)	Average (°F)	High (°F)
January	22.6	29.6	36.5
February	25.0	32.8	40.6
March	32.7	41.9	51.1
April	42.6	53.1	63.5
May	52.2	62.5	72.9
June	61.5	71.5	81.6
July	65.5	75.2	84.9
August	64.1	73.9	83.7
September	56.5	66.8	77.0
October	45.0	55.0	65.1
November	36.1	44.4	52.6
December	26.8	33.5	40.1

Average Precipitation for Franklin County



Month	Precipitation (in.)
January	2.73
February	2.25
March	3.02
April	3.40
May	4.17
June	4.01
July	4.79
August	3.32
September	2.84
October	2.61
November	3.20
December	2.97

Average Snowfall for Franklin County



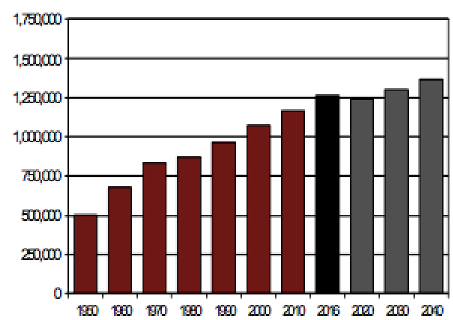
Month	Snowfall (in.)
July	0.0
August	0.0
September	0.0
October	0.2
November	0.9
December	5.0
January	9.2
February	6.1
March	4.2
April	1.1
May	0.0
June	0.0

Demographics

Franklin County has experienced steady population growth to 1,231,393, according to the U.S. Census Bureau's 2014 Population Estimates. This makes it the second largest county in Ohio after Cuyahoga, and the 34th largest county in population in the country. Columbus makes up about 66.5% of the population of the county, the rest being provided by various suburbs and townships. Below are charts detailing the county's total population, population by age, and by race.

Total Population

Census				Estimated	
1800		1910	221,567	2011	1,180,021
1810	3,486	1920	283,951	2012	1,197,640
1820	10,292	1930	361,055	2013	1,214,774
1830	14,741	1940	388,712	2014	1,233,388
1840	25,049	1950	503,410	2015	1,250,269
1850	42,909	1960	682,962	2016	1,264,518
1860	50,361	1970	833,249		
1870	63,019	1980	869,132	Projected	
1880	86,797	1990	961,437	2020	1,237,960
1890	124,087	2000	1,068,978	2030	1,302,110
1900	164,460	2010	1,163,414	2040	1,366,200



Ohio Department of Development: County Profiles

Population by Age	Number
ACS Total Population	1,215,761
Under 5 years	87,607
5 to 17 years	200,518
18 to 24 years	130,469
25 to 44 years	374,338
45 to 64 years	294,140
65 years and more	128,689
Median Age	33.8

Population by Race	Number	Percent
ACS Total Population	1,215,761	100.0%
White	836,912	68.8%
African-American	259,534	21.3%
Native American	1,991	0.2%
Asian	52,431	4.3%
Pacific Islander	466	0.0%
Other	20,139	1.7%
Two or More Races	44,288	3.6%
Hispanic (may be of any race)	60,943	5.0%
Total Minority	415,740	34.2%

Source: Ohio Department of Development: County Profile

Land Use

The chart below outlines the largest jurisdictions in Franklin County including a comparison of the estimated 2016 population to the 2010 census.

Largest Places	Est. 2016	Census 2010
Columbus city (part)	841,563	770,122
Grove City city	39,721	35,575
Dublin city (part)	38,622	35,367
Upper Arlington city	34,997	33,771
Gahanna city	34,956	33,248
Hilliard city	34,905	28,435
Westerville city (part)	30,560	28,328
Reynoldsburg city (part)	27,424	26,157
Whitehall city	18,736	18,062
Prairie twp	17,172	16,498

Source: Ohio Department of Development: County Profile

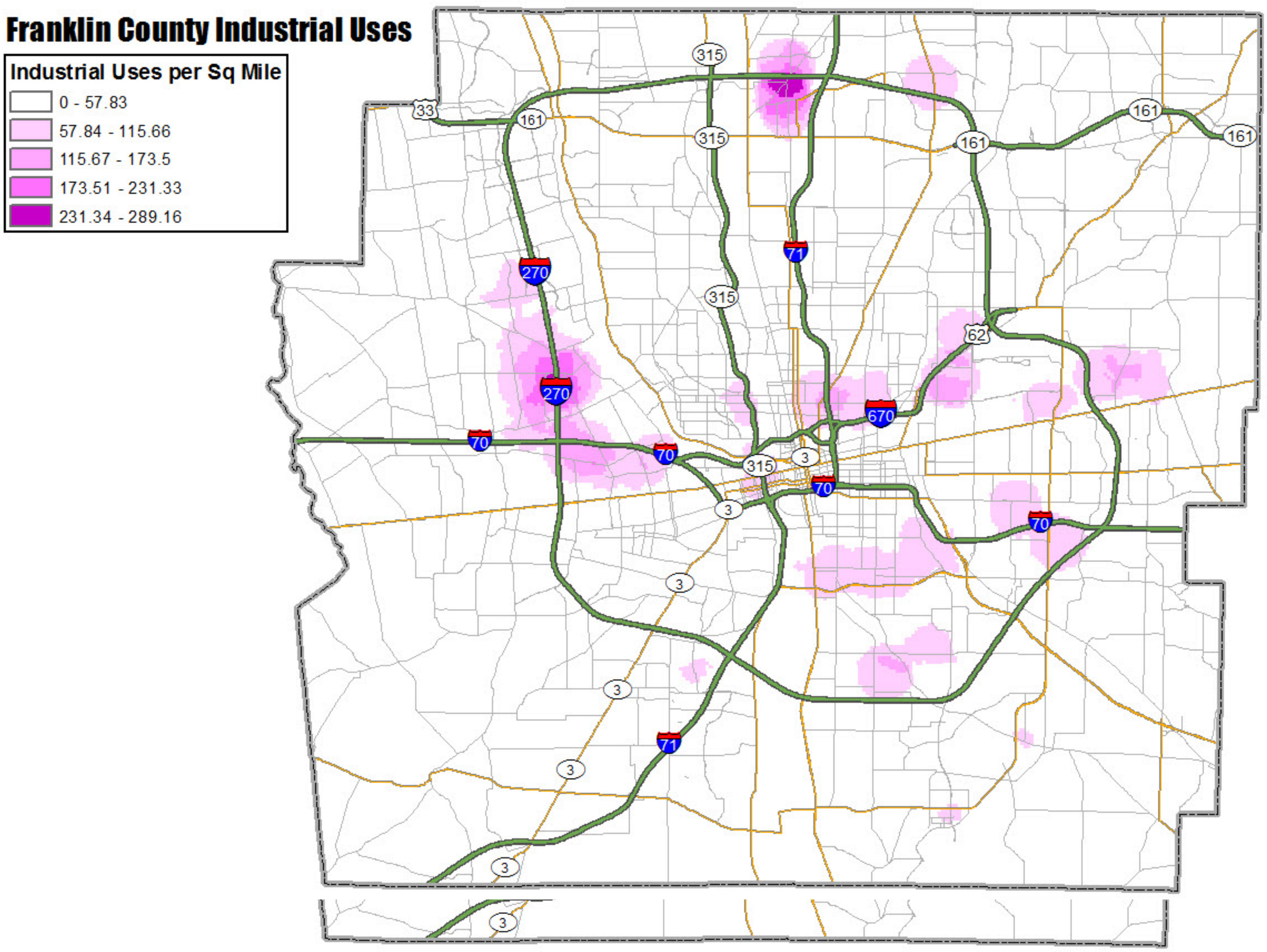
The following chart details the number of housing units in Franklin County by type.

Housing Units	Number	Percent
Total housing units	536,811	100.0%
Occupied housing units	480,946	89.6%
Owner occupied	258,868	53.8%
Renter occupied	222,078	46.2%
Vacant housing units	55,865	10.4%

Ohio Department of Development: County Profiles

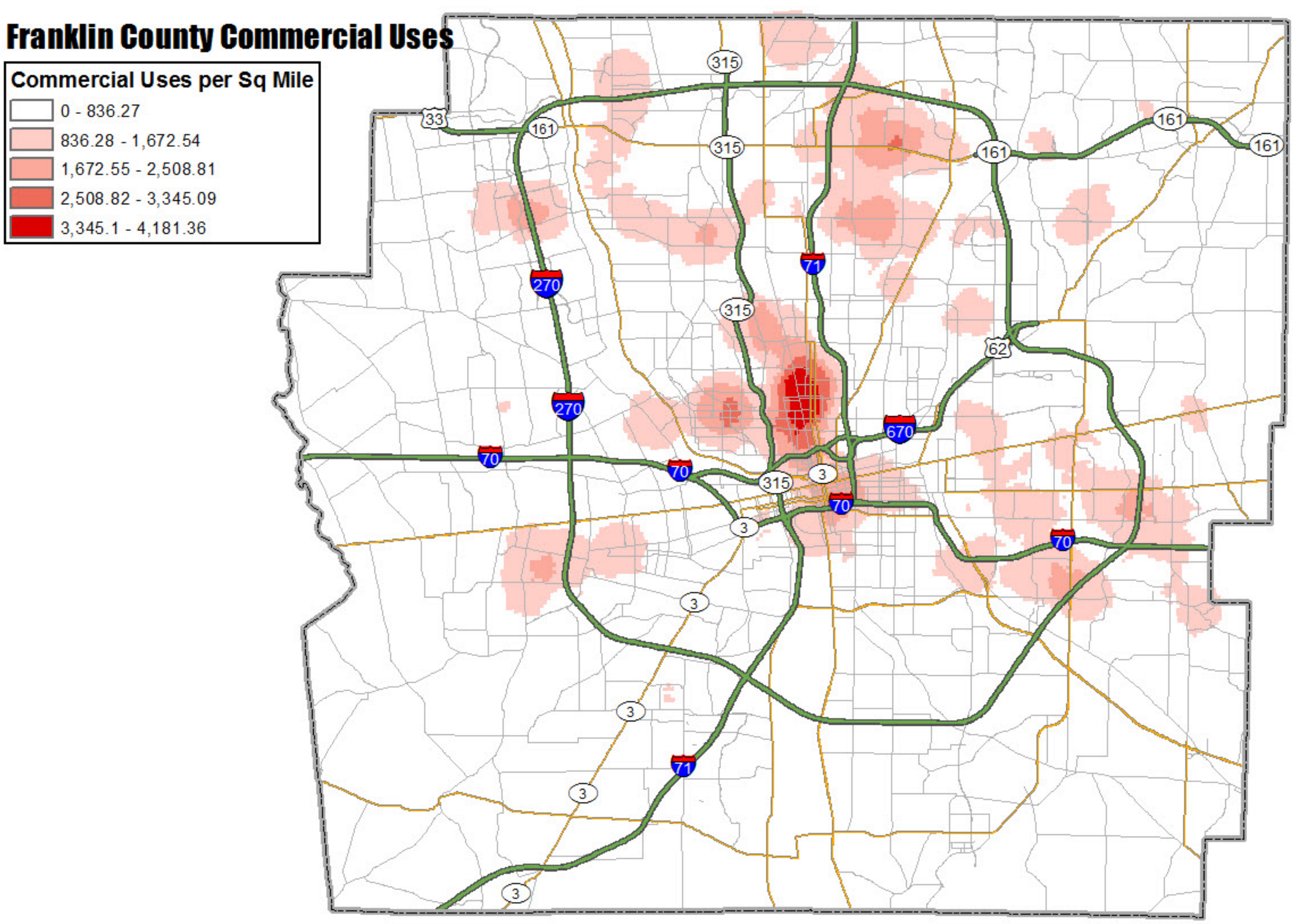
The maps on the following pages illustrate the categories of land use by percentages including industrial, residential, commercial, and all land use types. These maps were produced by the FCEM&HS GIS department utilizing readily available data.

Map of Industrial Land Use in Franklin County

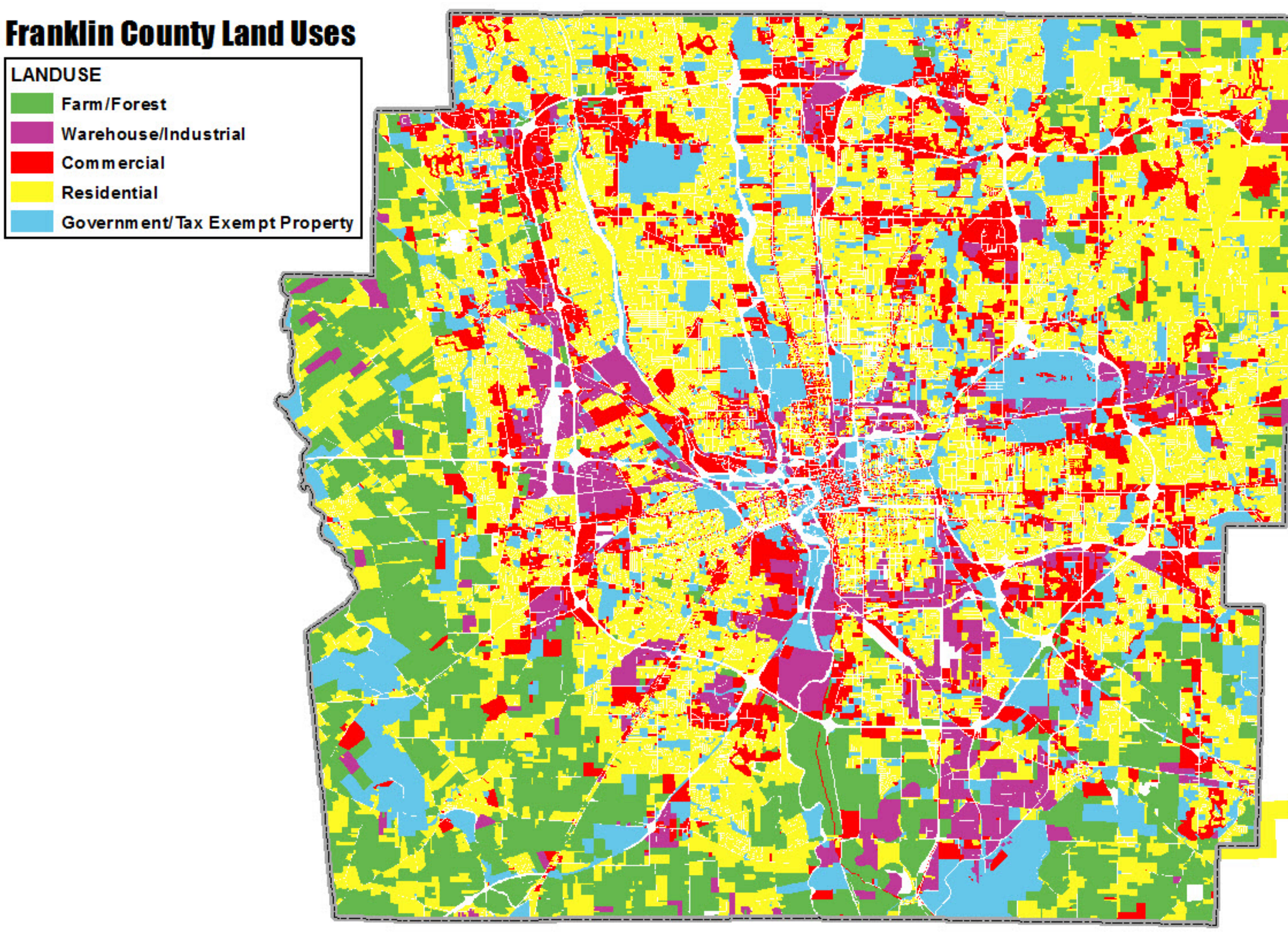


Map of Residential Land Use in Franklin County

Map of Commercial Land Use in Franklin County



Map of Various Land Uses in Franklin County

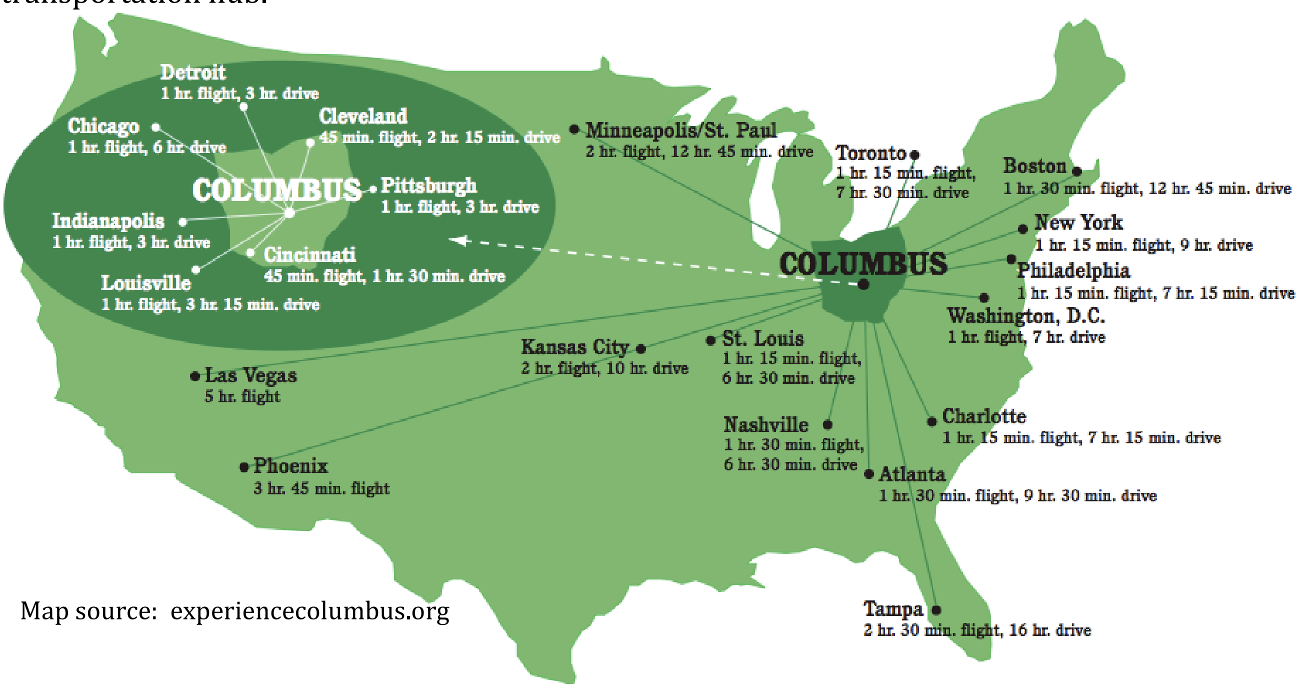


Transportation

The county has 118.05 interstate highway miles, 117.17 U.S. highway miles, 122.26 state highway miles and 4,247.06 county, township and municipal road miles.

Franklin County is bisected by two major interstate highways, Interstate 70 running east-west, and Interstate 71 running north to southwest. The two highways run together for 1.5 miles through the city, creating a major traffic congestion point. The Interstate 270 Outerbelt encircles the vast majority of the city, providing traffic flow to and from suburban communities and surrounding counties. The Interstate 670 spur on the north side of the city continues to the east past the airport and west to a merger with I-70.

These highways are commuting routes for people in surrounding counties. According to 2006-2010 estimates, 170,507 commuters traveled into Franklin County from nearby counties to work. Due to its central location within the state, the abundance of outbound roadways makes nearly all of the state's destinations within a 2-hour drive.
The county is also within 550 miles of half the U.S. population, making it a major transportation hub.



Map source: experiencecolumbus.org

In addition to commuters, Franklin County has the largest daily truck volume of any county in the state. Sixty-six percent of the truck traffic passes through the county, to and from external destinations. In addition to Interstates 70 and 71, I-270 has very heavy truck traffic, especially in the Northwest quadrant. This area draws a large number of trucks due to the Buckeye Intermodal Yard and the large volume of warehouses in the area.
Franklin County is also considered a hub for rail activity in Ohio. The county has two intermodal rail facilities, CSX Buckeye Yard and Norfolk Southern Discovery Park Yard. There are also two classification yards, one at Buckeye Yard and one on Parsons Avenue. These are switching yards and serve the two major railroads plus regional and short-line railroads.

The Central Ohio Transit Authority (COTA) provides bus service for limited routes throughout Franklin County. Commuter points are located in outlying suburbs to encourage the use of bus service to downtown businesses.

The county is served by two major airports. Port Columbus International Airport, on the east side of the county, provides passenger service and is a hub for NetJets, the world's largest fractional ownership carrier. Rickenbacker Inland Port, in southern Franklin County, is a major cargo facility and services the Ohio National Guard. The Ohio State University's Airport (Don Scott Field) and Bolton Field are significant general aviation facilities. The county also has several small airstrips and heliports.

Economy

Columbus has historically had a strong and diverse economy. In 2012, Columbus Business First reported Columbus as having the strongest economy in Ohio and the seventh strongest in the country. These rankings were based on data from On Numbers reported in American City Business Journals Inc.

In 2014 Business First reported that a near-doubling of money spent on residential construction projects last year has Franklin County economic development officials touting the overall health of the local economy.

The county's annual building services report shows the cost of all construction climbed 87 percent to nearly $61 million during calendar-year 2014, up from $32.7 million a year earlier. Dollar volume of projects for which Franklin County issued permits including new builds, reconstruction, repairs, more than doubled from $27 million in 2012.

Franklin County has a large government presence, providing the largest single source of employment in the county with 16% of all workers. This includes the state government as well as city, county and federal facilities and The Ohio State University. One of the largest facilities is the Defense Finance and Accounting Service (DFAS). Other sources of employment in the county are banking, insurance, research and development, manufacturing, healthcare, and technology.

The Mid-Ohio Regional Planning Commission (MORPC) projects the majority of growth in retail and office development will occur in the northern tier of the region, while new industrial warehouse and distribution centers will be located in the southern half of the county near Rickenbacker Airport.

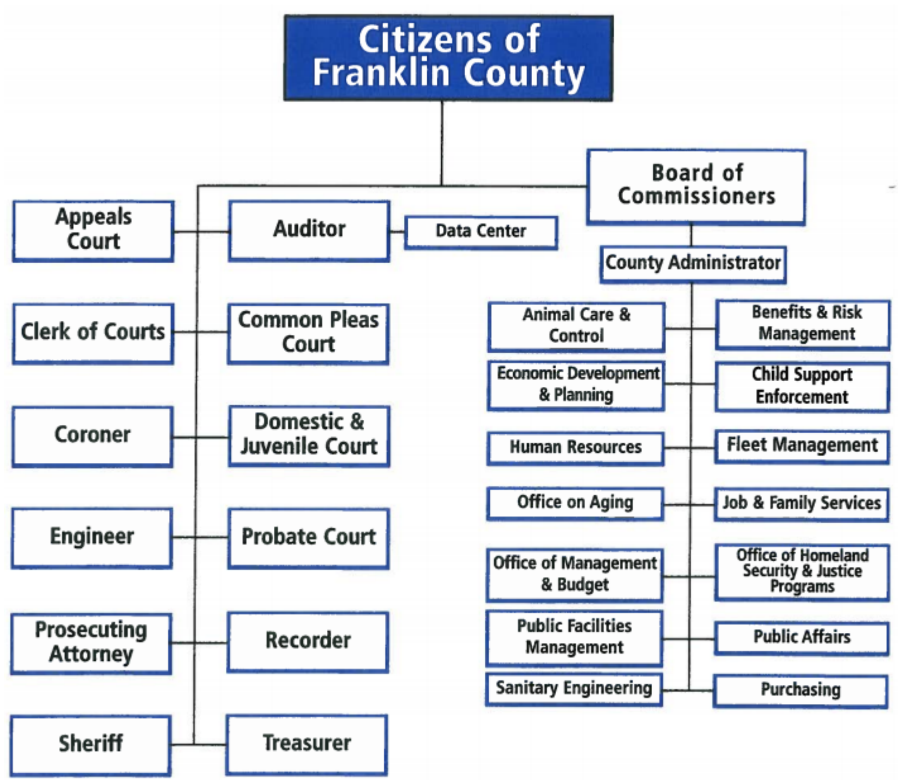
The Ohio Department of Development published the following statistics, which continue onto the next page.

Business Numbers	2012	2013	2014	2015	2016
Business starts	3,328	2,876	3,022	2,749	2,751
Active businesses	21,494	21,704	21,901	22,075	19,620

Civilian Labor Force	2012	2013	2014	2015	2016
Civilian labor force	630,200	639,800	647,500	654,100	663,600
Employed	589,700	598,600	616,100	627,500	636,800
Unemployed	40,500	41,300	31,500	26,600	26,800
Unemployment rate	6.4	6.4	4.9	4.1	4.0

Government

The Franklin County Board of Commissioners serves as the administrative head of Franklin County Government. The three-member board manages county funds, oversees more than 130 county-owned buildings, and serves as the county's sole contracting and taxing authority. The following is the organization of county government.



Franklin County is currently made up of 15 cities, 9 villages and 17 townships.

Cities:

- Bexley
- Canal Winchester
- Columbus
- Dublin
- Gahanna
- Grandview Heights
- Grove City
- Groveport
- Hilliard
- New Albany
- Reynoldsburg
- Upper Arlington
- Westerville
- Whitehall
- Worthington

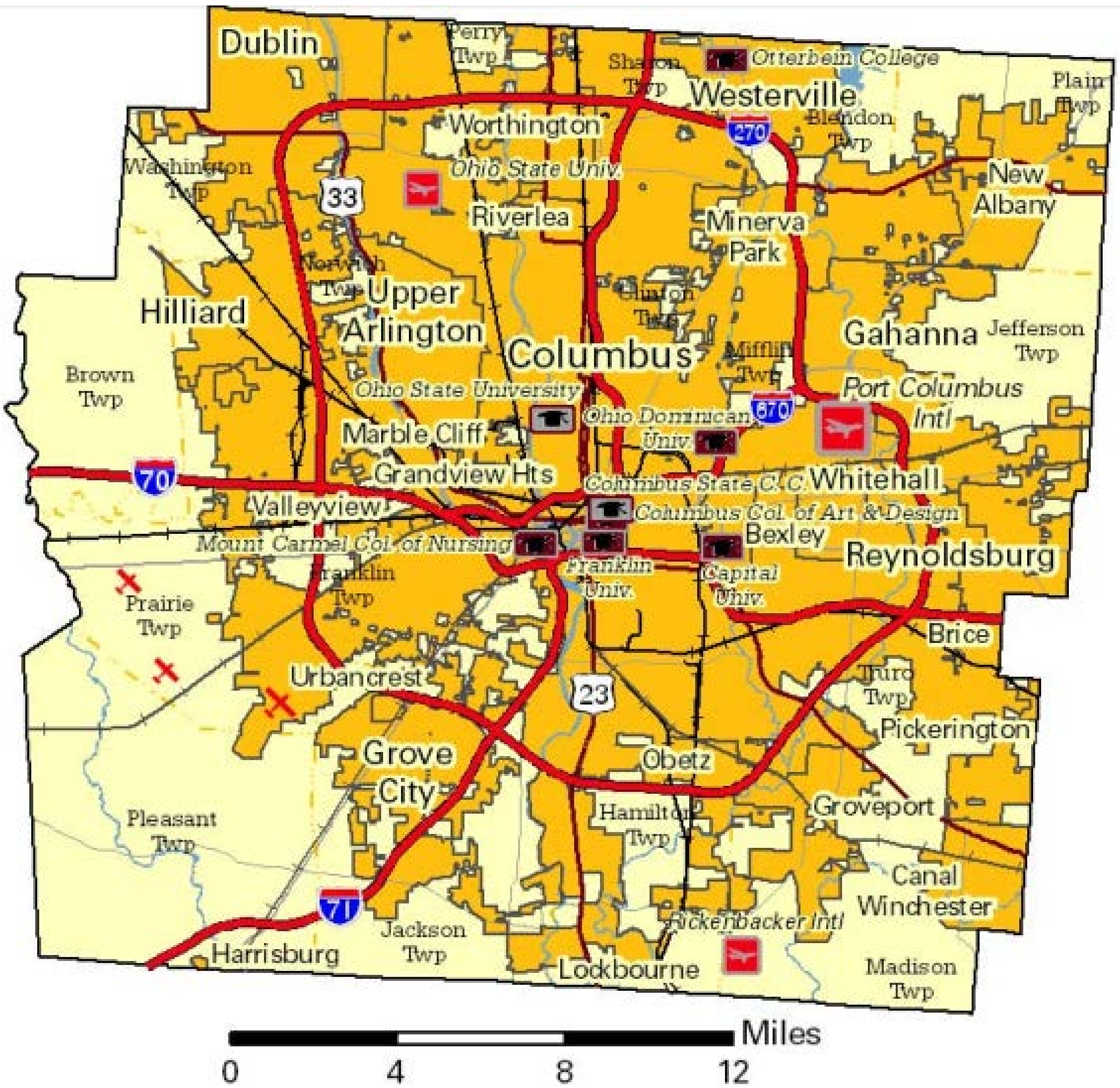
Villages:

- Brice
- Harrisburg
- Lockbourne
- Marble Cliff
- Minerva Park
- Obetz
- Riverlea
- Urbancrest
- Valleyview

Townships:

- Blendon
- Brown
- Clinton
- Franklin
- Jackson
- Jefferson
- Hamilton
- Madison
- Mifflin
- Norwich
- Perry
- Plain
- Pleasant
- Prairie
- Sharon
- Truro
- Washington

Franklin County Cities, Villages, Townships[5]



Source: Ohio County Profiles - ODOD

[5] "Ohio County Profiles", Ohio Department of Development, accessed on 8 April 2018, http://www.development.ohio.gov/files/research/C1026.pdf

Critical Facilities

The following is a generic list of critical facilities in Franklin County. For security purposes specific addresses and descriptions are not included. While not all inclusive, this list illustrates the multitude of critical sites that could be affected in a disaster.

Emergency Response Facilities

- Hospitals/Medical Clinics
- Communications/Emergency Operations Centers
- Other Direction and Control Operations Centers
- Essential Government Buildings
- Fire Departments/EMS Services
- Law Enforcement/Sheriff, Police
- Jails/Correction Centers
- Emergency Shelters
- Disaster Recovery Centers/Disaster Field Offices
- Public Health Departments

Public Services and Utilities

- Emergency Alert System Stations and Towers: Radio, Television and Cable
- Other Radio and Television Stations and Towers
- Government Communications Towers and Repeaters
- Telephone System Distribution Points and Towers: Land Line, Cellular, Microwave
- Sewage Treatment and Plants
- Potable Water Distribution Systems, Treatment Plants, and Lift Stations
- Electrical Power Generating Plants and Electrical Substations
- Major Electrical Distribution Systems/Routes
- Essential Public Service Offices

Vital Private/Commercial Facilities

- Private Potable Water Treatment and Distribution Systems
- Private Sewage Treatment and Waste Systems
- Commercial Distribution Centers
- Building/Construction Materials
- Potable Water and Ice Suppliers
- Food Retailers
- Power Generators
- Suppliers of Fuels (Gasoline, Diesel, Propane, Natural Gas, etc.)
- Suppliers of Light Equipment (Chain Saws, Shovels, Barricades, etc.)
- Suppliers of Heavy Equipment (Bulldozers, Forklifts, etc.)
- Medical Supply Companies
- Food Processing Plants
- Restaurants/Cafeterias
- Community Centers/Auditoriums
- Major Fuel Pipelines and Terminals/Fuel Storage and Tank Farms

<u>Transportation Facilities</u>

- Airports/Heliports
- Response Operations Staging Areas
- Critical Transportation Routes
- High Risk Intersections/Critical Links/Bridges
- Railroad Stations

<u>Other Facilities</u>

- Churches/Synagogues
- Fellowship and Recreation Halls
- Colleges/Universities
- Public and Private Schools
- Motels/Hotels
- Nursing/Convalescent/Group Homes
- Animal Care/Animal Shelters
- Hazardous Materials Facilities
- Flood Control Stations and Devices

Major Events

There are several locations and facilities in Franklin County that are venues for many major festivals and events. As large congregate areas, these sites are of major consideration in emergency planning.

Downtown Columbus is the site of several events that draw huge crowds in the midst of the major State government center, as well as city, county and federal government facilities. These events include: The Ohio State Fair; Red, White and Boom; Columbus Arts Festival; Columbus Jazz and Ribs Festival and many others. Some of these events draw as many as 500,000 people to the center of Columbus.

Downtown Columbus is also the site of the Columbus Convention Center, Nationwide Arena, outdoor gathering spaces including Columbus Commons and Scioto Mile, and several theaters which host large crowds regularly.

In addition to the events in Columbus, several suburban communities also hold annual large-scale events, including the Dublin Irish Festival, the Tomato Festival in Reynoldsburg, and the Franklin County Fair in Hilliard.

Franklin County hosts a variety of sporting events throughout the year. Ohio Stadium, with a capacity of over 100,000, is home to the Ohio State football games. The Columbus Crew professional soccer team facility and the Ohio Expo Center are located along I-71 north of downtown Columbus. The Schottenstein Center on the Ohio State University Campus and Nationwide Arena in Columbus host sporting events, family shows and touring productions throughout the year.

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Section 3 – Hazard Identification

Hazard Identification

A hazard is a source of harm to a community, including its population, environment, private and public property, infrastructure and businesses. In the days of Civil Defense, hazards were thought of in two categories: natural hazards and enemy attack. Later, as hazardous materials began to be a problem, technological hazards were added as a category. Since the end of the Cold War, hazards have been classified into three groups: natural, technological, and human-caused.

NFPA 1600 5.2.2.1 describes the following types of hazards:[6]

(1) Natural hazards (geological, meteorological, and biological)
(2) Human-caused events (accidental and intentional)
(3) Technology-caused events (accidental and intentional)

Hazards in one category may cause a secondary hazard or disaster in the same or another category that increases the impact. Some examples:

A hurricane may produce tornadoes.

A major flood may cause a dam to break.

A highway accident may lead to a hazardous materials spill.

A train derailment may produce a wildfire.

Excessive flooding may result in infectious disease.

A bombing may lead to a fire.

Computer sabotage may lead to a power failure.

A terrorist attack may spread deadly disease.

Almost any combination of hazards is possible. The relationships between many types of hazards may become complex. One or more secondary, tertiary, or even further events may occur. The following table illustrates these relationships. The table also shows that an event may be either a primary or secondary event depending on circumstances.

[6] "NFPA 1600 Standard on Disaster/Emergency Management and Business Continuity Programs," National Fire Prevention Association, accessed August 28, 2015, http://www.nfpa.org/assets/files/AboutTheCodes/1600/1600-13-PDF.pdf

Hazard Relationships

Primary Event \ Secondary Events	Aircraft Accident	Animals-Loss/injured/dead	Crop Damage	Dam/Dike Failure	Epidemic	Explosion	Fallout	Fire	Flash Flood	Food Shortage	Fuel Shortage	Hazardous Materials Incident	Housing Shortage	Human Injured/Dead	Industrial Accident	Power/Gas Failure	Radiological Incident	Structural Collapse	Train Derailment	Vehicular Wreck	Water Shortage
Natural																					
Flood																					
River		X	X	X	X	X		X				X	X	X		X		X	X	X	X
Creeks		X	X	X	X	X		X				X	X	X		X		X	X	X	X
Flash		X	X	X	X	X		X				X	X	X		X		X	X	X	X
Tornadoes	X	X	X		X	X		X		X		X	X	X	X	X		X	X	X	X
Storms																					
Lightning	X	X	X			X		X				X	X	X							X
Hail	X	X	X							X				X	X					X	
Wind	X	X	X			X						X	X	X	X	X		X		X	
Blizzard																					
Heavy Snow	X	X	X		X			X	X	X	X	X	X	X	X	X		X	X	X	X
Ice	X	X	X			X		X	X	X		X	X	X						X	X
Drought		X	X		X					X				X							X
Earthquake				X	X	X		X			X	X	X	X	X	X		X	X	X	X
Fog	X											X		X					X	X	
Infectious Disease		X			X									X							
Space Weather											X					X					X
Karst/ Sinkhole						X		X				X		X	X	X		X		X	X
Human-caused																					
Hazardous Materials																					
Transportation																					
Vehicular Wreck		X				X		X				X		X			X		X	X	
Train Derailment		X				X		X				X		X							
Downed Aircraft		X				X		X				X		X							
Industrial																					
Explosion						X	X	X				X		X	X	X	X	X			
Fire						X		X				X		X	X	X	X	X			
Accidental Release		X			X							X		X	X		X				
Theft/Loss												X					X				
Nuclear Emergencies		X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Infectious Disease		X			X									X							
Fire																					
High Rise													X	X				X			

Primary Event / Secondary Events	Aircraft Accident	Animals-Loss/injured/dead	Crop Damage	Dam/Dike Failure	Epidemic	Explosion	Fallout	Fire	Flash Flood	Food Shortage	Fuel Shortage	Hazardous Materials Incident	Housing Shortage	Human Injured/Dead	Industrial Accident	Power/Gas Failure	Radiological Incident	Structural Collapse	Train Derailment	Vehicular Wreck	Water Shortage
Multiple Buildings						X		X					X	X				X			
Fire (cont)																					
Industrial						X		X				X		X	X	X	X	X			
Gas Lines						X		X			X	X		X	X						
Chemical Plant			X		X	X		X				X		X	X						
Health Care Facility					X			X				X		X		X					
Explosion																					
Pipelines						X		X			X	X		X	X	X		X	X		
Industrial						X		X				X		X	X	X	X	X	X		
Chemical						X						X		X		X			X		
Dam Failure		X	X	X				X	X				X	X		X		X	X	X	X
Transportation Accidents																					
Highway		X				X		X			X	X		X			X	X	X	X	
Rail		X				X		X			X	X		X			X	X	X		
Air	X	X				X		X				X		X			X				
Civil Disturbance																					
Riot						X		X		X	X		X	X						X	
Bomb Threat	X			X		X		X				X		X					X	X	X
Terrorism/Sabotage	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Technological-Caused																					
Computer Related	X										X	X			X	X	X		X		X
Telecommunications	X											X			X		X				
Utility																					
Power/Light						X		X			X					X					
Natural Gas						X		X			X	X	X			X					
Water System																					
Water Plant											X					X					X
Water Mains																					X
Storm Drainage																					
Sanitary Drainage																					
Disposal Plant					X						X					X					
Mains						X												X			
Lift Stations					X											X					

Adapted from Sedgwick, Kansas *Hazard Analysis* 2006

Types of Hazards

Natural Hazards

Natural hazards are an ever present risk to life and property throughout the United States. Often, natural hazards can be predicted. They tend to occur repeatedly in the same geographical locations because they are related to weather patterns or physical characteristics of an area. Natural hazards can be classified into three groups:

> Geological Hazards – related to the geographical characteristics or natural earth processes of the area, e.g. earthquakes, volcano, landslides.
>
> Meteorological Hazards – natural processes or phenomena of an atmospheric, hydrological or oceanographic nature, including weather patterns of the area, e.g. floods, tornadoes, winter storms.
>
> Biological Hazards – processes of organic origin or those conveyed by biological vectors, including exposure to pathogenic microorganisms, toxins and bioactive substances; these include epidemics and insect infestations. May be intentionally caused.

Human-caused Events

Human-caused events are divided into two groups: accidental and intentional. Accidental human-caused events include hazardous material spills, transportation accidents, air/water pollution and dam failure. Intentional human-caused events include civil disturbances, criminal activity and terrorism.

Technological Hazards

Technological hazards are events that can be unrelated to natural or human-caused events, such as central computer, mainframe, software or application failure; telecommunication system failure; and energy, power or utility failure.

Ohio Hazards

There is a wide range of hazards and disasters to consider when preparing a risk assessment for a specific area. Many hazards are large and obvious; however, there are many everyday emergency situations at the local level that need attention.

Ohio EMA reviewed the hazard analysis literature and identified nearly sixty hazards. These hazards include those listed in NFPA 1600, the 15 National Planning Scenarios, the National Plan Review and Ohio EMA's Enhanced Mitigation Plan. These hazards are listed in the following table. Those not considered by OEMA as Ohio hazards are not considered as hazards for Franklin County. Some Ohio hazards are not germane to Franklin County and not likely enough a scenario to warrant consideration. Those that are identified for Franklin County are included in this risk assessment.

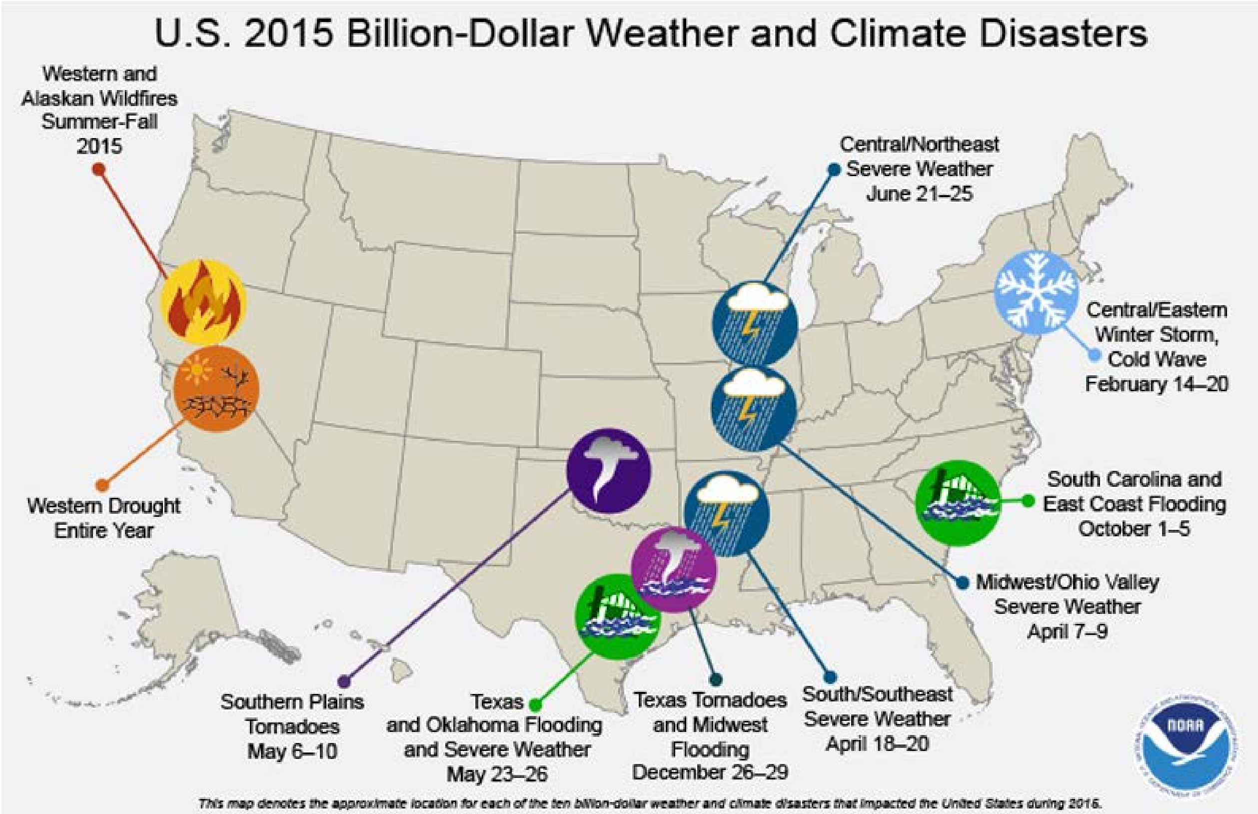
Hazards Identified in OEMA's Hazard Identification and Risk Analysis: Update 2011

Natural Hazards/Events	Human Caused Events
Biological Animal or Insect Infestation or Damage Disease – Human Disease - Animal Geological Earthquake Landslide, Mudslide, Subsidence Meteorological Drought Extreme Temperatures Fire Flood, Areal and Riverine Flash Flood, Seiche Wave Lightning Strikes Geomagnetic Storm Snow, Ice, Hail, Sleet Windstorm, Tornado	Accidental Air/Water Pollution, Contamination Building/Structure Collapse Communications System Interruptions Energy/Power/Utility Failure Explosion/Fire Fuel/Resource Shortage Hazardous Material Transportation Accident Water Control Structure Intentional Civil Disturbance, Public Unrest, Mass Hysteria Criminal Activity Cyber Attack Terrorism
Technological Hazards/Events	
Energy/Power/Utility Failure Communications Systems Interruptions	

Disasters and Declarations

In 2015, there were 79 disaster declarations across the United States recognized by FEMA. Of those 79 events, 10 weather and climate disaster events had losses exceeding $1 billion each across the US. These events included a drought event, 2 flooding events, 5 severe storm events, a wildfire event, and a winter storm event. Overall, these events resulted in the deaths of 155 people and had significant economic effects on the areas impacted. The 1980–2015 annual average is 5.2 events (CPI-adjusted); the annual average for the most recent 5 years (2011–2015) is 10.8 events (CPI-adjusted).

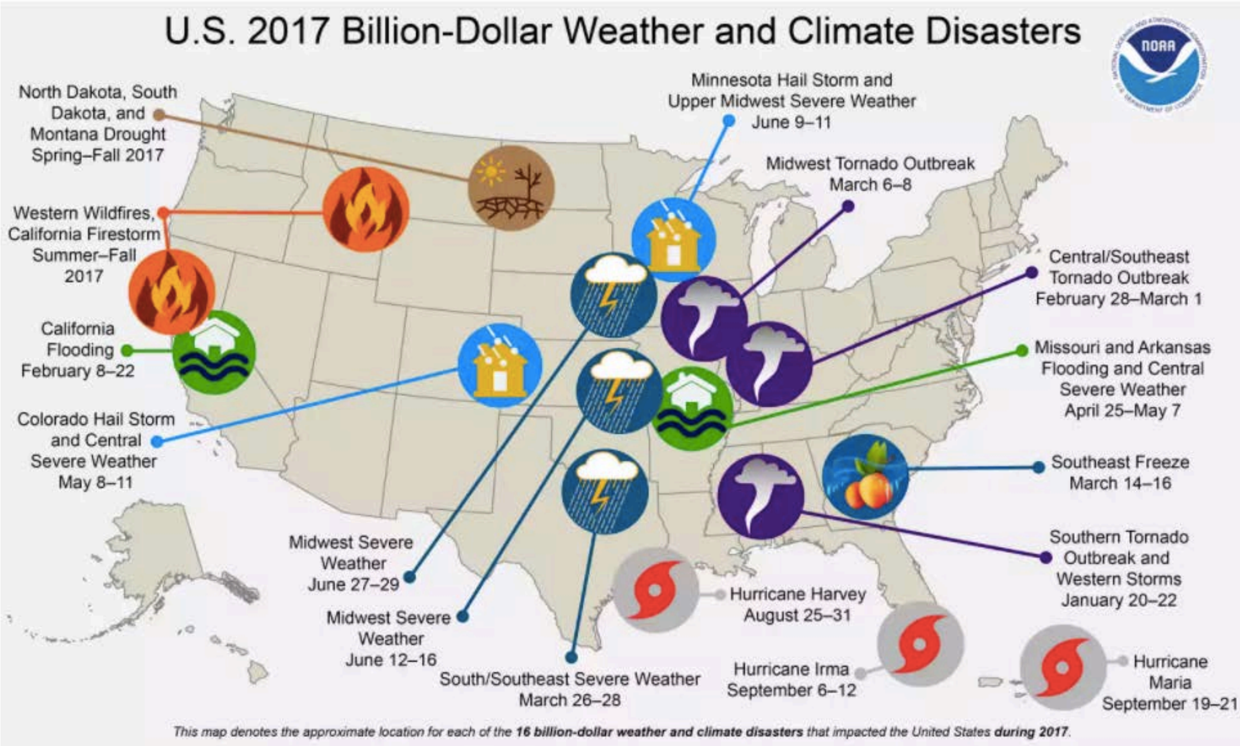
Additionally, the U.S. experienced five distinct disaster event types in 2015. It is more common to observe three or four disaster event types in a given year. Five or more disaster event types exceeding $1 billion in the same year occurs less frequently (i.e., 2015, 2011, 2008, 1998, 1994 and 1989). The information on billion dollar disasters can be found via the NOAA National Centers for Environmental Information at: http://www.ncdc.noaa.gov/billions/. The map below shows the 10 weather related events in excess of $1 billion in losses.



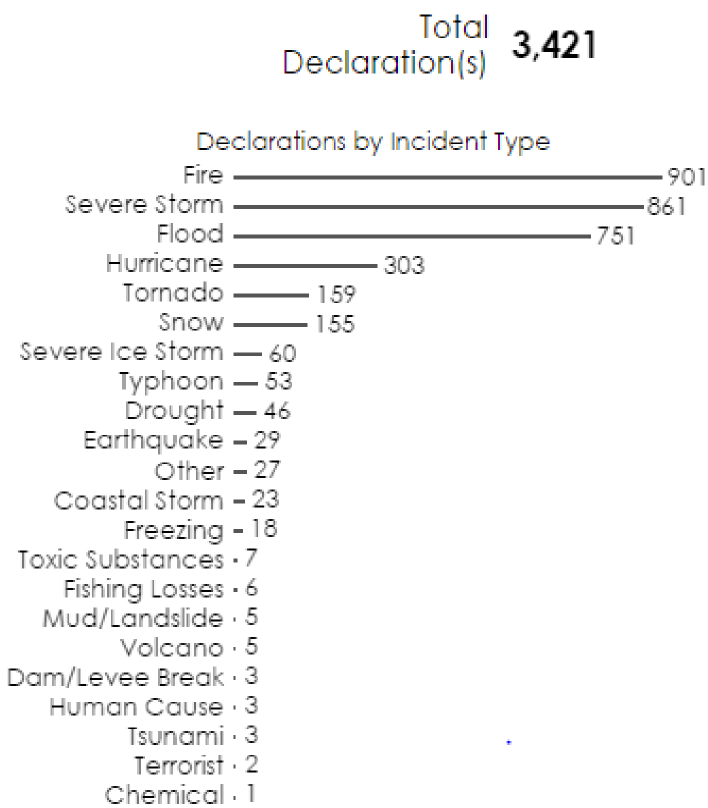
The following charts illustrate the number and type of Presidential Declarations in the United States from 1953-2015. Additional data for the US, Ohio and Franklin County can be viewed and analyzed by clicking here: http://www.fema.gov/data-visualization-summary-disaster-declarations-and-grants.

2017 brought record-breaking disaster declarations for the United States. NOAA reported that Hurricanes Harvey, Irma and Maria combined with devastating Western wildfires and other natural catastrophes made 2017 the most expensive year on record for disasters in the United States. The disasters caused $306 billion in total damage in 2017, with 16 events that caused more than $1 billion in damage each. The bulk of the damage, at $265 billion, came from hurricanes.

Hurricane Harvey, which sparked extreme flooding in Houston and the surrounding area in August and September, caused $125 billion in damage, the year’s most expensive disaster. Hurricane Maria, which in September set off a fatal and ongoing humanitarian crisis in the U.S. territory of Puerto Rico and elsewhere, caused $90 billion in damage. Hurricane Irma raked across the Caribbean and hit Florida in September, causing $50 billion in total damage, NOAA reports.

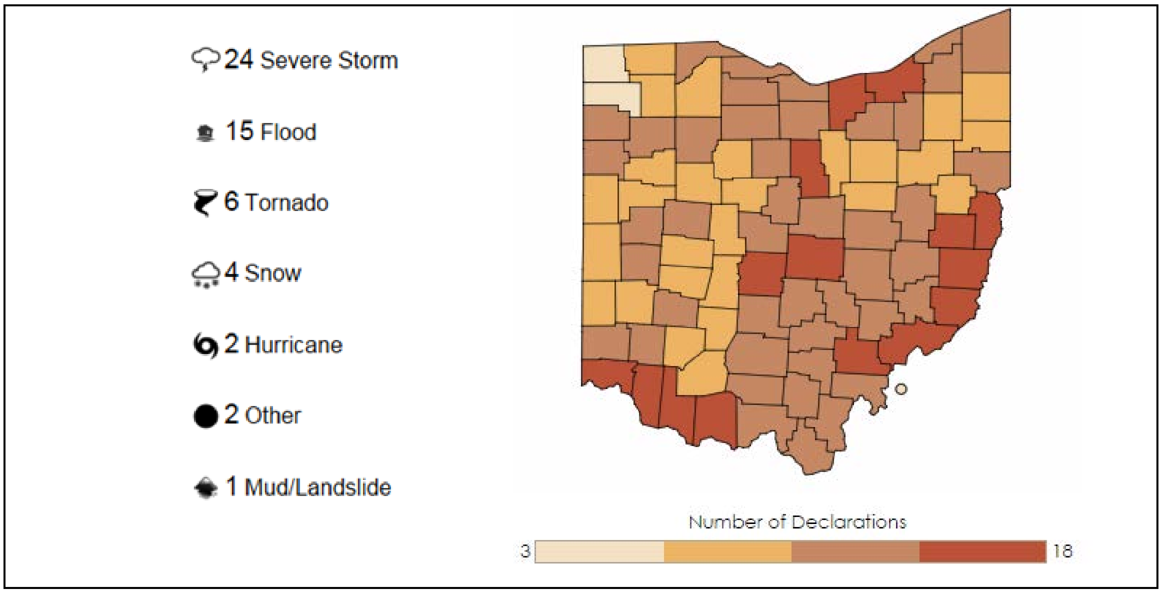


Total Declarations in the United States 1953-2015



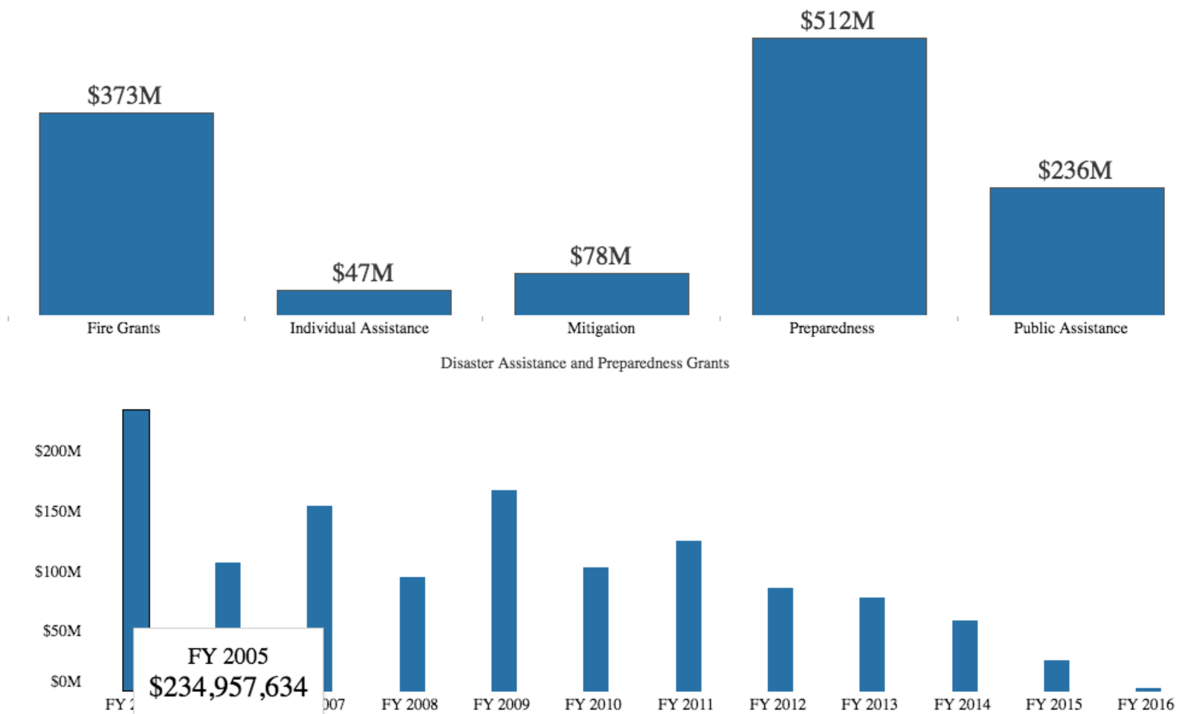
Ohio Declarations

From 1953-2017 there have been 54 federally declared disasters in Ohio.



Source: FEMA

FEMA assistance to Ohio FY 2005- FY 2016



History of Declared Disasters

The following was provided by the Ohio Emergency Management Agency (OEMA) detailing disasters declared in Franklin County since 1992. The chart also shows the amount of public assistance funding returned to the jurisdictions after each disaster.

Federal Public Assistance Grants Awarded per Presidentially-Declared Disaster

County: Franklin			
Disaster Number	Disaster Type	Declared	Public Assistance
DR-951	Tornadoes, Flooding, Severe Storms	8/14/1992	$433,411.00
DR-1453	Winter Storms	3/15/2003	$814,006.17
DR-1580	Flood, Mud/Landslide, Winter Storm	2/15/2005	$905,711.62
DR-1805	Severe Windstorm Associated with Tropical Depression Ike	10/24/2008	$4,612,691.75
DR-4077	Severe Summer Storm, Straight Line Winds	8/20/2012	$2,118,635.00
EM-3250	Hurricane Katrina Shelter Operations	9/13/2005	$93,343.00
EM-3198	Snow Storm	11/1/2005	$673,968.38
EM-3286	Record/Near Record SnowStorm	4/24/2008	$1,568,327.42
		Total:	$11,220,094.34

Sources: Ohio Emergency Management Agency

Note: Some declarations were for multiple events in multiple counties in the state.

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Section 4 – Hazards

Tornadoes - #1

Hazard Summary

Tornadoes are nature's most violent windstorms – even weak ones can cause significant damage and fatalities. A tornado is defined as a rotating column of air, in contact with the surface, pendant from a cumuliform cloud, and often visible as a funnel cloud and/or circulating debris/dust at the ground.[7] According to the National Climactic Data Center, 32 tornadic events were reported in Franklin County from January 1950 through December 2017, all of which were rated F3 (or EF3) and under.[8] This hazard was ranked No. 1 out of 20.

[7] "Tornado", Meteorological Glossary, American Meteorological Society, last modified on 8 Oct 2013 http://glossary.ametsoc.org/wiki/Tornado

[8] "Query Results, Tornadoes, Franklin County, Ohio," NCDC – NOAA, accessed on 1 February 2018 http://www.ncdc.noaa.gov/stormevents/

Hazard Profile

Note: Unless otherwise noted, all photos and tables in this section are attributed to NOAA.

According to the *Glossary of Meteorology*, a tornado is "a rotating column of air, pendant from a cumuliform cloud, and often visible as a funnel cloud and/or circulating debris/dust at the ground."[9]

A funnel cloud is a condensation cloud, typically funnel-shaped and extending outward from a cumuliform cloud, associated with a rotating column of air (a vortex) that may or may not be in contact with the surface. If the rotation is violent and in contact with the surface, the vortex is a tornado.[10] Funnel clouds have no detectable debris or damage at ground level. Tornadoes often begin as funnel clouds with no associated strong surface winds; however, not all of these funnel clouds evolve into a tornado. Many tornadoes produce strong winds at the surface while the visible funnel is still above ground, so it is difficult to discern the difference between a funnel cloud and a tornado from a distance.

Occasionally, a single storm will produce more than one tornado, either simultaneously or in succession. A series of tornadoes produced by a single supercell, resulting in damage path segments along to same general line, are referred to as a tornado family.[11] Sometimes, several tornadoes are spawned from the same large-scale storm system, this is considered a tornado outbreak. A tornado outbreak has been defined as ten or more tornadoes.[12]

Tornado Life Cycle

Tornadoes often develop from a class of thunderstorms known as supercells. Supercells contain a mesocyclone, an area of organized rotation a few miles up in the atmosphere, usually 1 to 6 miles across. The most destructive and deadly tornadoes occur from supercells. Supercells can also produce damaging hail, severe non-tornadic winds, lightning and flash floods.

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[9] "Tornado," Meteorological Glossary, American Meteorological Society, last modified on 8 Oct 2013 http://glossary.ametsoc.org/wiki/Tornado

[10] "Funnel Cloud," Meteorological Glossary, American Meteorological Society, accessed on 1 February 2018, http://glossary.ametsoc.org/wiki/Funnel_cloud

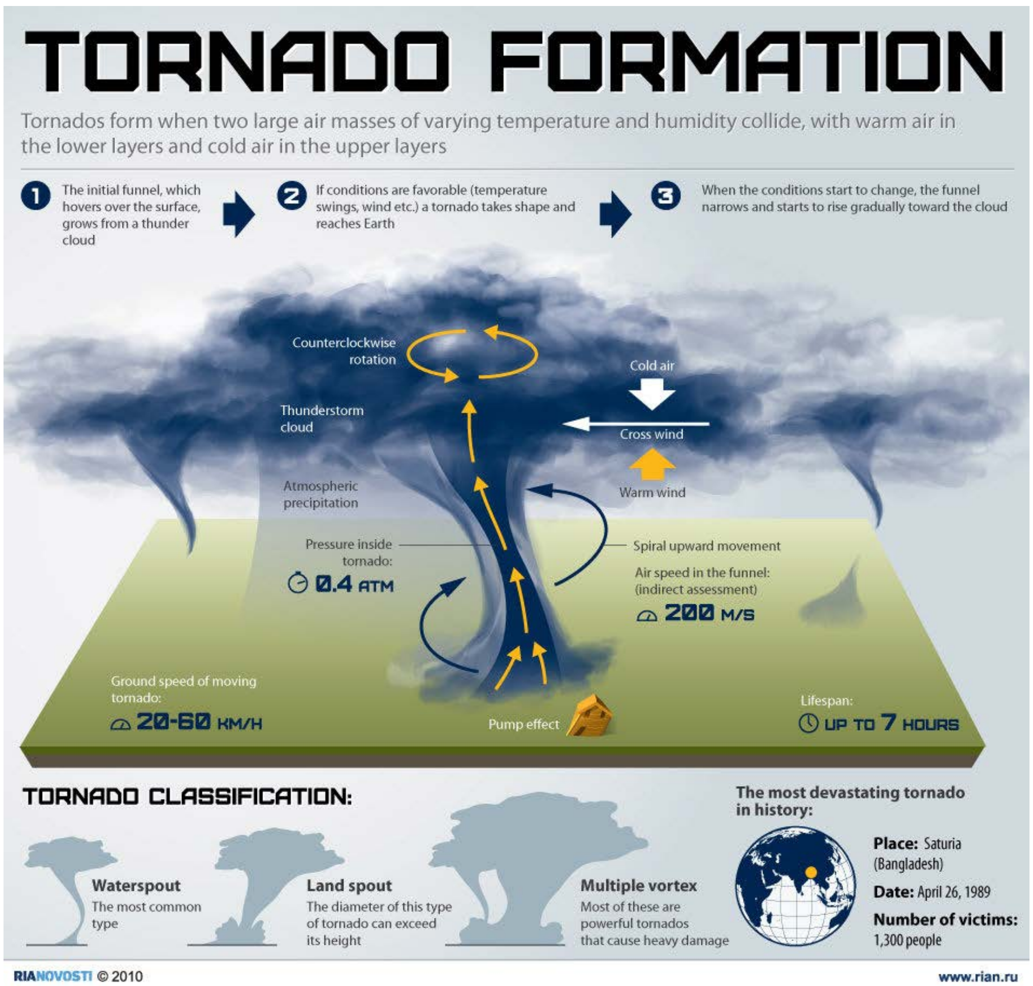
[11] "A Comprehensive Glossary of Weather Terms for Storm Spotters," NWS, accessed on 1 February 2018, https://www.weather.gov/oun/spotterglossary

[12] "Tornado Outbreak," Meteorological Glossary, American Meteorological Society, last modified on 25 Apr 2012, http://glossary.ametsoc.org/wiki/Tornado_outbreak

Thunderstorms develop in warm, moist air in advance of eastward-moving cold fronts. These thunderstorms often produce large hail, strong winds, and tornadoes.[13] Initially, the tornado has a good source of warm, moist inflow to power it, so it grows until it reaches the mature stage. This can last anywhere from a few minutes to more than an hour, and it is during that time that a tornado often causes the most damage.

As the tornado enters the dissipating stage, its associated mesocyclone often weakens as well. Even though the tornado is dissipating, it is still capable of causing damage. The storm is contracting into a rope-like tube, and like an ice skater who pulls her arms in to spin faster, winds can increase at this point.

Tornado Formation



[13] "Tornadoes-Nature's Most Violent Storms," NWS, accessed on 17 Sept 2015, http://www.nws.noaa.gov/os/brochures/tornado.shtml

Types of Tornadoes

Multiple Vortex Tornadoes

Multiple vortex tornadoes contain two or more small, intense columns of spinning air orbiting the center of the larger tornado circulation. These vortices may form and die within a few seconds, sometimes appearing to train through the same part of the tornado one after another. They can happen in all sorts of tornado sizes. These vortices often create small areas of heavier damage along the main tornado path.

Satellite Tornadoes

A satellite tornado develops independently from the primary tornado, not inside it. The tornadoes remain separate and distinct as the satellite tornado orbits its much larger companion within the same mesocyclone.[15]

Waterspouts

A waterspout is a non-supercell tornado over a body of water.[14] They are common along the southeast U.S. coast, especially off southern Florida and the Keys. They can happen over seas, bays, and lakes worldwide. They are smaller and weaker than the most intense Great Plains tornadoes but can still be dangerous. They can overturn boats, damage larger ships, and do significant damage when they hit land.

A landspout near North Platte, Nebraska on May 22, 2004.

Landspout

A landspout is storm chaser slang for a non-supercell tornado. Landspouts resemble waterspouts in that way, and also in their typically small size and weakness compared to the most intense supercell-spawned tornadoes. However, landspouts are tornadoes by definition; and they are capable of doing significant damage resulting in injuries and fatalities.[15]

Tornado-like Circulations

A *gustnado* or gust front tornado is a short-lived, ground-based swirling wind that can form on the leading edge of a thunderstorm.[16] Because they are not associated with the cloud base, there is some question as to whether or not gustnadoes are actually tornadoes. They are formed when fast moving cold, dry outflow air from a thunderstorm is blown through a mass of stationary, warm, moist air near the outflow boundary, resulting in a "rolling " effect (often exemplified through a roll cloud). If the low level wind shear is strong enough, the rotation can be turned horizontally or diagonally and make contact with the ground.

[14] "Waterspout," Meteorological Glossary, American Meteorological Society, accessed on 29 Oct 2015, http://glossary.ametsoc.org/wiki/waterspout

[15] "Tornado FAQ," Storm Prediction Center, accessed on 29 Oct 2015, http://www.spc.noaa.gov/faq/tornado/

[16] "What is a Gustnado," Accuweather, accessed on 29 Oct 2015, http://www.accuweather.com/en/weather-news/what-is-a-gustnado/49554

The result is a gustnado. They usually cause small areas of heavier rotational wind damage among areas of straight-line wind damage.

A *dust devil* is well-developed dust whirl; a small but vigorous whirlwind, usually of short duration, rendered visible by dust, sand, and debris picked up from the ground. Dust devils are occasionally strong enough to cause minor damage.[17]

Tornado Characteristics

Shape

Most tornadoes take on the appearance of a narrow funnel, a few hundred yards across, with a small cloud of debris near the ground. However, tornadoes can appear in many shapes and sizes. Large single vortex tornadoes can look like a large wedge stuck into the ground, and so are known as *wedge tornadoes*. Wedge tornadoes appear to be at least as wide as they are tall from ground to ambient cloud base. A wedge can be so wide that it appears to be a block of dark clouds, making it difficult to tell the difference between a wedge tornado and a low-hanging cloud. Many, but not all, major tornadoes are wedges.

A *wedge tornado*, nearly a mile wide. This tornado hit Binger, Oklahoma.

Rope tornadoes are very narrow or snake-like. Many tornadoes assume the rope shape in their last stage. Rope tornadoes often curl or twist into complex shapes. Even though they may be in the last stage of the tornado, they can still do violent damage of an EF4 or EF5. Tornado shape and size does not say anything about its strength.


A *rope tornado* in its dissipating stage. Tecumseh, OK.

Size

[17] "Dust devil," Meteorological Glossary, American Meteorological Society, accessed on 29 Oct 2015, http://glossary.ametsoc.org/wiki/dust_devil

In the United States, tornadoes average around 500 feet across and stay on the ground for five miles.[18] However, there is an extremely wide range of tornado sizes. Weak tornadoes, or strong dissipating tornadoes, can be exceedingly narrow, sometimes only a few feet across. On the other hand, wedge tornadoes can have a damage path a mile wide or more.

As for path length, many tornadoes which appear to have path lengths of 100 miles or longer are actually a family of tornadoes which have formed in quick succession. One exception, the Tri-State Tornado, which affected parts of Missouri, Illinois, and Indiana on March 18, 1925, was officially on the ground continuously for 219 miles.

Color

Tornadoes can have a wide range of colors, depending on the environment in which they are formed. In a dry environment, a tornado can be nearly invisible, marked only by swirling debris at the base of the funnel. Water spouts can turn white or even blue. Funnels, which move slowly and pick up a lot of debris, are usually darker, taking on the color of their debris. Tornadoes in the Great Plains can turn red from the reddish tint of the soil.

Lighting conditions are also a major factor in the appearance of a tornado. A tornado which is back-lit (viewed with the sun behind it) appears very dark. The same tornado, viewed with the sun at the observer's back may appear gray or brilliant white. Tornadoes which occur near sunset can be many different colors, appearing in hues of yellow, orange, and pink.

Photographs of the Waurika, Oklahoma tornado of May 30, 1976, taken at nearly the same time by two photographers. In the top picture, the tornado is *front-lit*, with the sun behind the east-facing camera, so the funnel appears nearly white. In the lower image, where the camera is facing the opposite direction, the tornado is *back-lit*, with the sun behind the clouds.[27]

Dust, rain, hail, and the darkness of night can reduce the visibility of tornadoes. Tornadoes occurring in these conditions are especially dangerous as only radar observations or possibly the sound of the tornado can provide any warning to those in the storm's path. Fortunately, most tornadoes form in the rain-free base of the storm where there is little or no rain. Most tornadoes occur in the late afternoon, when the bright sun can illuminate the dark clouds.

Sound

The most common tornado sound reported is a continuous rumble, like a nearby train. Sometimes a tornado will produce a loud whooshing sound, like a waterfall or open car window. Tornadoes moving through densely populated areas may produce all kinds of noises at once, producing a loud roar. Small tornadoes or funnel clouds may produce whistling, humming or buzzing sounds.

[18] Walter A Lyons (1997). "Tornadoes". The Handy Weather Answer Book (2nd ed.). Detroit, Michigan: Visible Ink press. pp. 175–200. ISBN 0-7876-1034-8.

Direction and Rotation
Tornadoes can appear from any direction. Most move from southwest to northeast or west to east. Some have changed direction mid-path or even backtracked. Tornadoes normally rotate cyclonically in one direction (counterclockwise in the northern hemisphere, clockwise in the southern).

Climatology
The United States has the most tornadoes of any country, about 1,200 yearly[19]. This is mostly due to the unique geography of the continent. (Discussed further in the Tornadoes in the United States section.)

In the northern plains and upper Midwest, tornado season is in June and July, although tornadoes can happen any time of year. Tornadoes are most common in spring and least common in winter. Since fall and spring are transitional seasons (warm to cool and vice versa), there are more chances of cooler air meeting with warmer air, resulting in thunderstorms. However, favorable conditions can occur any time of the year. Tornadoes have been reported in all months. Most tornadoes occur between 4-9pm.

Tornado Intensity and Damage
Tornadoes vary in intensity regardless of shape, size, and location. Typically, strong tornadoes are larger than weak tornadoes. Any tornado of any size or shape can cause major damage and loss of life. For many years scientists had nothing more than educated guesses as to the speed of the winds in a tornado. The only evidence indicating the wind speeds was in the damage left behind.

In 1971, Dr. Tetseya Theodore Fujita introduced the idea for a scale of tornado winds which came to be known as the Fujita scale in 1973. The scale was designed to correlate the intensity of the wind with the degree of damage. Research into the accuracy of the Fujita scale was conducted in the late 1980s and1990s and suggested tornado winds were typically overestimated, especially in significant and violent tornadoes. In 2006, the American Meteorological Society introduced the Enhanced Fujita Scale to help assign realistic wind speeds to tornado damage. The scale was designed so that a tornado assessed on the Fujita scale would receive the same ranking on the Enhanced Fujita scale. The EF-scale is more specific in detailing the degrees of damage on different types of structures for a given wind speed. It classifies F0-F5 damage as calibrated by engineers and meteorologists across 28 different types of damage indicators. The Enhanced Fujita scale went into effect in the United States in 2007.

NOTE: For many of the following picture illustrations the F Number Fujita scale is used. Use the below table to make the comparison to the Enhanced Fujita Scale.

[19] "Tornadoes 101," NOAA, accessed on 16 Oct 2016, http://www.noaa.gov/stories/tornadoes-101

Fujita vs. Enhanced Fujita Scale

Fujita Scale			Derived EF Scale		Operational EF Scale	
F Number	Fastest 1/4 mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	EF Number	3 Second Gust (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

Important note about the Enhanced F-Scale winds: The Enhanced F-Scale is still a set of wind estimates (not measurements) based on damage. It uses 3 second gusts estimated at the point of damage based on a judgement of 8 levels of damage to the 28 indicators found in the table below. These estimates vary with height and exposure.

Damage Indicators[20]

The EF scale currently has 28 damage indicators which are used when assessing a tornado's degree of damage.

1	Small barns, farm outbuildings
2	One- or two-family residences
3	Single-wide mobile home (MHSW)
4	Double-wide mobile home
5	Apt, condo, townhouse (3 stories or less)
6	Motel
7	Masonry apt. or motel
8	Small retail bldg. (fast food)
9	Small professional (doctor office, branch bank)
10	Strip mall
11	Large shopping mall
12	Large, isolated ("big box") retail bldg.
13	Automobile showroom
14	Automotive service building
15	School - 1-story elementary (interior or exterior halls)
16	School - jr. or sr. high school
17	Low-rise (1-4 story) bldg.
18	Mid-rise (5-20 story) bldg.
19	High-rise (over 20 stories)
20	Institutional bldg. (hospital, govt. or university)
21	Metal building system

[20] "Enhanced F Scale for Tornado Damage," NOAA, accessed on 29 Oct 2015, http://www.spc.noaa.gov/faq/tornado/ef-scale.html

22	Service station canopy
23	Warehouse (tilt-up walls or heavy timber)
24	Transmission line tower
25	Free-standing tower
26	Free standing pole (light, flag, luminary)
27	Tree - hardwood
28	Tree - softwood

Weak Tornadoes

The vast majority of tornadoes are designated EF0 or EF1, also known as weak tornadoes. However, even weak tornadoes can cause significant damage and fatalities. EF0 and EF1 tornadoes are typically short lived and stay on the ground for one mile or less.

An example of **F0** damage. The only significant damage to structures in this picture was caused by falling tree branches. Even though well-built structures are typically unscathed by **F0** tornadoes, falling trees and tree branches can injure and kill people, even inside a sturdy structure.

An example of **F1** damage. **F1** tornadoes cause major damage to mobile homes and automobiles, and can cause minor structural damage to well-constructed homes. This particular mobile home appears to be a double-wide, and it was still moved off its foundations, with its roof badly damaged. A mobile home or car is a very poor shelter, even during severe thunderstorms which do not contain a tornado.

Strong Tornadoes

Strong Tornadoes, EF2 and EF3, are stronger than most tropical cyclones, although cyclones affect a much larger area. A tropical cyclone is a rotating, organized system of clouds and thunderstorms that originates over tropical or subtropical waters and has a

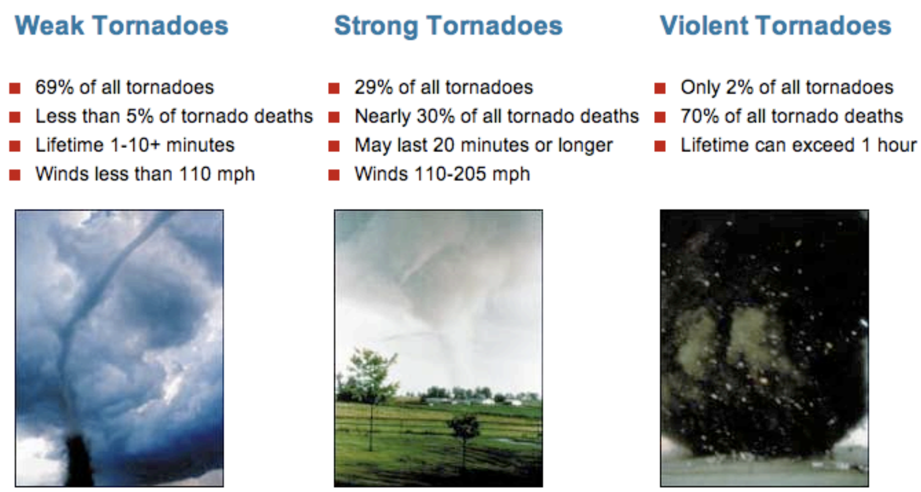
An example of **F2** damage. At this intensity, tornadoes have a more significant impact on well-built structures, damaging roofs, collapsing walls, and generating large amounts of flying debris. This wood-frame home was unroofed, with many outer walls collapsed or destroyed.

An example of **F3** damage. Here, the roof and some inner walls of this brick building have been demolished. While taking shelter in a basement, cellar, or inner room improves your odds of surviving a tornado drastically, occasionally even this is not enough. **F3** and stronger tornadoes only account for about 6% of all tornadoes in the United States, and yet since 1980 they have accounted for more than 75% of tornado-related deaths.

closed low-level circulation.[21] An EF2 tornado can remove the roof of a well-built structure. EF3 damage is a serious risk to life. Few parts of affected buildings are left standing. Wooded areas will suffer almost total loss of vegetation.

Violent Tornadoes

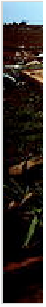
Violent tornadoes are the EF4s and EF5s. EF4 damage typically results in a total loss of the affected structure. No matter how well built, homes are most often destroyed. Even heavy vehicles can become airborne and thrown through the air.



EF5 damage is almost always total. EF5 tornadoes demolish well-built houses and sweep the foundation clean. Since 1950, only 59 F/EF5 tornadoes have been reported in the United States, with 4 of those in Ohio.[22] In recorded history, F/EF5 tornadoes have performed awesome displays of power, including twisting skyscrapers, leveling entire communities, and stripping asphalt from the ground.

[21] "Tropical Cyclone Climatology", National Hurricane Center, accessed on 15 January 2016, http://www.nhc.noaa.gov/climo/

[22] "F5 and EF5 Tornadoes of the United States", Storm Prediction Center NOAA, accessed on 26 May 2015 http://www.spc.noaa.gov/faq/tornado/f5torns.html



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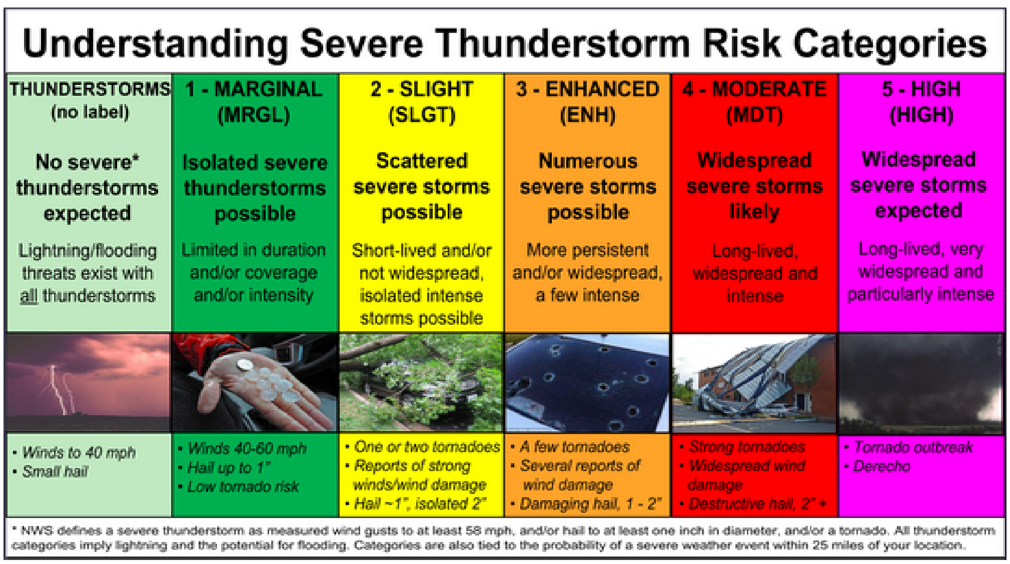
Severe Weather Risks

The level of categorical risk in the Day 1-3 Convective Outlooks is derived from probability forecasts of tornadoes, damaging winds, and large hail on Day 1, and a combined severe weather risk on Days 2 and 3.

TSTM (light green) - General or non-severe thunderstorms - Delineates, to the right of a line, where a 10% or greater probability of thunderstorms is forecast during the valid period.
1-**MRGL** (dark green) - Marginal risk - An area of severe storms of either limited organization and longevity, or very low coverage and marginal intensity.
2-**SLGT** (yellow) - Slight risk - An area of organized severe storms, which is not widespread in coverage with varying levels of intensity.
3-**ENH** (orange) - Enhanced risk - An area of greater (relative to Slight risk) severe storm coverage with varying levels of intensity.
4-**MDT** (red) - Moderate risk - An area where widespread severe weather with several tornadoes and/or numerous severe thunderstorms is likely, some of which should be intense. This risk is usually reserved for days with several supercells producing intense tornadoes and/or very large hail, or an intense squall line with widespread damaging winds.
5-**HIGH** (magenta) - High risk - An area where a severe weather outbreak is expected from either numerous intense and long-tracked tornadoes or a long-lived derecho-producing thunderstorm complex that produces hurricane-force wind gusts and widespread damage. This risk is reserved for when high confidence exists in widespread coverage of severe weather with embedded instances of extreme severe (i.e., violent tornadoes or very damaging convective wind events).

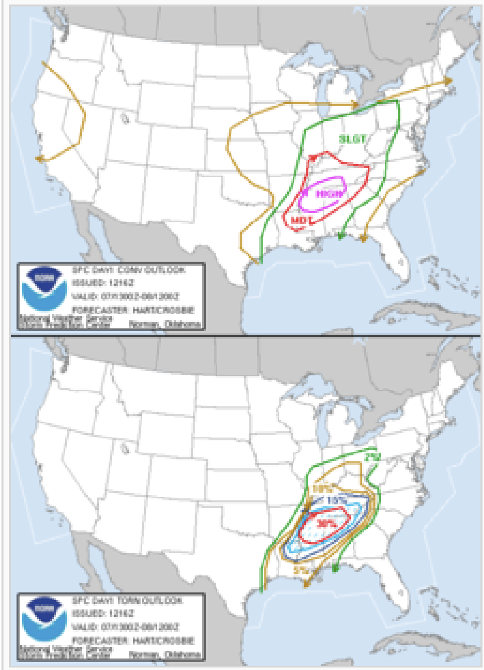


Source: NOAA[23]

[23] "SPC Products", NOAA, accessed on 15 January 2016, http://www.spc.noaa.gov/misc/about.html

Tornado Forecasting

The Weather Channel Severe Weather Expert, Dr. Greg Forbes developed the TOR:CON index to estimate the risk of a tornado on a given day or night.



Probabilistic maps issued by the Storm Prediction Center during the heart of the April 6-8, 2006 Tornado Outbreak. The top map indicates the risk of general severe weather (including large hail, damaging winds, and tornadoes), while the bottom map specifically shows the percent risk of a tornado forming within 25 miles (40 km) of any point within the enclosed area. The hashed area on the bottom map indicates a 10% or greater risk of an F2 or stronger tornado forming within 25 miles (40 km) of a point.

TOR:CON Value Descriptions

8+ Very high probability of a tornado
6 - High probability of a tornado
4 - Moderate chance of a tornado nearby, but hail and/or high wind gusts possible
2 - Low chance of a tornado, but hail and/or high wind gusts possible
0 - Near-zero chance of a tornado or a severe thunderstorm

The TOR:CON index ranges from 0 to 10. Multiply the value by 10 to get your percentage chance of a tornado within 50 miles of a location. For example, a TOR:CON index of 6 means there's a 60% chance of a tornado within 50 miles of any location in the indicated area.[24]

Until the 1950s, the word "tornado" was not used during weather forecasting. Tornado watches and warnings were not issued due to fear that predicting tornadoes might cause public panic. Now, the National Weather Service issues more than 1,000 watches and nearly 30,000 warnings for severe storms and tornadoes each year.

According to NOAA, the current average lead-time for tornado warnings is 13 minutes.[25] This means that from the time a warning is issued to the time it is predicted to hit an area, residents have 13 minutes to seek shelter.

NOAA's Storm Prediction Center (SPC) in Norman, Okla., is responsible for hazardous-weather forecasting across the contiguous United States and supports NWS Forecast Offices by providing short-to-medium range guidance and watch products.[26]

[24] "Tor Con Index," The Weather Channel, accessed on 17 September 2015, http://www.weather.com/tv/shows/amhq/news/tornado-torcon-index
[25] "Tornadoes 101," NOAA, accessed on 29 August 2015, http://www.noaa.gov/features/protecting/tornados101.html
[26] "Forecasting Tornadoes," NOAA, accessed on 29 Oct 2015, http://www.publicaffairs.noaa.gov/grounders/tornadoforecast.html

Every tornado and severe thunderstorm watch issued in the U.S. originates at the SPC. Watches issued by the SPC are disseminated through local National Weather Service Forecast Offices. National Weather Service Forecast Office issues severe weather forecasts and warnings. Warnings are issued when a severe thunderstorm or tornado is occurring or is imminent. Each NWS office uses output from at least one Doppler radar to help determine if a warning is needed. Doppler radar indicates strong winds blowing toward and away from it in a way that tells forecasters an intense circulation probably exists in the storm, and a tornado is possible. Possible doesn't mean certain, so local forecasters also depend on spotter reports.

When predicting severe weather (including tornadoes) a day or two in advance, the NWS looks for the development of temperature and wind flow patterns in the atmosphere, which can cause enough moisture, instability, lift, and wind shear for tornadic thunderstorms. Those are the four needed ingredients.

A tornado *watch* means that conditions are favorable for the development of a tornado. Watches are issued by the SPC, usually for four to eight hour periods. A tornado *warning* means a tornado has been sighted or indicated by weather radar. Warnings are issued by the local NWS Forecast Office.

The first public tornado warnings were issued in 1950 and the first tornado watches and convective outlooks in 1952. In 1953, it was confirmed that hook echoes are associated with tornadoes. By recognizing these radar signatures, meteorologists could detect thunderstorms that were likely producing tornadoes from dozens of miles away.

In the mid-1970s, the NWS increased its efforts to train storm spotters to spot severe weather signs indicating hail, damaging winds and tornadoes, as well as flood damage. When severe weather is anticipated, local weather service offices request these spotters observe and report any tornadoes immediately to assist the offices in issuing a timely warning.

Storm spotters are trained to identify supercell storms. The vast majority of intense tornadoes occur within a wall cloud on the backside of a supercell. Only wall clouds that rotate spawn tornadoes, and they usually precede the tornado by five to thirty minutes. Tornadoes may also occur without wall clouds, under flanking lines, and on the leading edge. Spotters watch all areas of a storm, as well as the cloud base and surface.

Tornadoes in the United States

The United States has the most tornadoes of any country. Over the last ten years, an average of 1,200 tornadoes occurred across the continental United States. This is mostly due to the unique geography of the continent. North America is a relatively large continent that extends from the tropical south into arctic areas and has no major east-west mountain range to block air flow between these two areas. Nearly a third of the tornadoes occur in Texas, Oklahoma, Kansas, and Nebraska, an area known as "Tornado Alley." In this area during the springtime and early summer, conditions combine for the formation of supercell thunderstorms and tornadoes. Over 55% of a year's tornadoes occur between the months of April and June, when cool, dry air from Canada clashes with warm, moist air from the Gulf of Mexico. The most tornadoes in one year to date occurred in 2004, when 1,819 tornadoes were reported.

The deadliest tornado in the United States was the "Tri-state" tornado of March 18, 1925. It killed 695 people as it raced along at 60-73 mph in a 219 mile long track across parts of Missouri, Illinois and Indiana. This tornado also holds the record for the most tornado fatalities in a single city; at least 234 people died in Murphysboro, Illinois.

The largest tornado outbreak occurred on April 3 and 4, 1974. This tornado outbreak, known as the "Super Outbreak," produced 148 tornadoes in less than 24 hours from Michigan to Alabama. Ohio was one of the hardest hit states. The Super Outbreak is discussed in more detail in the Ohio Tornado History section of this document.

One of the largest known tornadoes is the Hallam, Nebraska, F4 tornado of May 22, 2004. It is the record holder for width at 2.5 miles. The Tri-state tornado holds the record for longest path, 219 miles. The strongest tornado wind speed ever recorded was 318 mph at Bridge Creek, Oklahoma. However, ground speeds of the most violent tornadoes have never been directly measured because they destroyed weather instruments.

The 10 Costliest U.S. Tornadoes since 1950 in event-year and 2015 Dollars

NOTE: Prior to 1994, Storm Data used categories for "Damage Class." The pre-1994 values used here are inflation-adjusted medians within that particular damage class, except where corrected for averaging errors.* [27]

1	**22 May 2011**		**Joplin MO**	**2,800,000,000**	**2,921,780,000**
2	**27 April 2011**		**Tuscaloosa AL**	**2,450,000,000**	**2,556,550,000**
3	**20 May 2013**		**Moore OK**	**2,000,000,000**	**2,086,980,000**
4	**8 Jun 1966**		**Topeka KS**	**250,000,000**	**1,811,130,000**
5	**11 May 1970**		**Lubbock TX**	**250,000,000**	**1,512,380,000**
6	**3 May 1999**		**Moore/Oklahoma City OK**	**1,000,000,000**	**1,408,900,000**
7	**27 Apr 2011**		**Hackleburg AL**	**1,290,000,000**	**1,346,100,000**
8	**3 Apr 1974**		**Xenia OH**	**250,000,000**	**1,190,270,000**
9	**6 May 1975**		**Omaha NE**	**250,603,000**	**1,093,346,420**
10	**10 Apr 1979**		**Wichita Falls TX**	**277,841,000**	**898,283,680**

[27] "The 10 Costliest U.S. Tornadoes since 1950," Storm Prediction Center, accessed on 1 February 2018 http://www.spc.noaa.gov/faq/tornado/damage$.htm

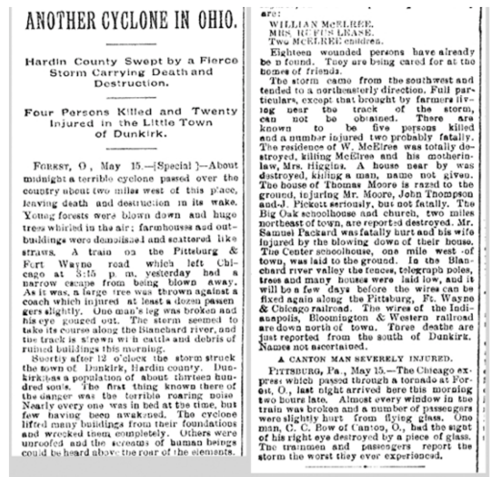
Over the past 50 years, severe weather forecast and warning systems have improved substantially. Combined with increased awareness and education, many lives have been saved.

Tornadoes in Ohio

Tornadoes are a fairly common occurrence in Ohio. Located on the eastern edge of Tornado Alley, Ohio averages 19 tornadoes a year.[28] The peak tornado season for Ohio is April through July. June has the most tornado occurrences, but many of the state's major tornado outbreaks have taken place in April and May. Most tornadoes occurred between 2 and 10 p.m. However, history has proven that tornadoes can occur during any month of the year at any time of the day or night.

Significant Tornadic Events in Ohio

Information and articles of the below mentioned events including pictures can be seen on the Ohio Historical Society web site at the following link: http://ohsweb.ohiohistory.org/swio/index.htm


ANOTHER CYCLONE IN OHIO.

Hardin County Swept by a Fierce Storm Carrying Death and Destruction.

Four Persons Killed and Twenty Injured in the Little Town of Dunkirk.

FORREST, O., May 15.—[Special.]—About midnight a terrible cyclone passed over the country about two miles west of this place, leaving death and destruction in its wake. Young forests were blown down and huge trees whirled in the air; farmhouses and outbuildings were demolished and scattered like straws. A train on the Pittsburg & Fort Wayne road which left Chicago at 3:15 p. m. yesterday had a narrow escape from being blown away. As it was, a large tree was thrown against a coach which injured at least a dozen passengers slightly. One man's leg was broken and his eye gouged out. The storm seemed to take its course along the Blanchard river, and the track is strewn with cattle and debris of ruined buildings this morning.

Shortly after 12 o'clock the storm struck the town of Dunkirk, Hardin county. Dunkirk has a population of about thirteen hundred souls. The first thing known there of the danger was the terrible roaring noise. Nearly every one was in bed at the time, but few having been awakened. The cyclone lifted many buildings from their foundations and wrecked them completely. Others were unroofed and the screams of human beings could be heard above the roar of the elements.

... are:

WILLIAN McELREE.
MRS. RUFUS LEASE.
Two McELREE children.

Eighteen wounded persons have already been found. They are being cared for at the homes of friends.

The storm came from the southwest and tended to a northeasterly direction. Full particulars, except that brought by farmers living near the track of the storm, can not be obtained. There are known to be five persons killed and a number injured two probably fatally. The residence of W. McElree was totally destroyed, killing McElree and his mother-in-law, Mrs. Higgins. A house near by was destroyed, killing a man, name not given. The house of Thomas Moore is razed to the ground, injuring Mr. Moore, John Thompson and J. Pickett seriously, but not fatally. The Big Oak schoolhouse and church, two miles northeast of town, are reported destroyed. Mr. Samuel Packard was fatally hurt and his wife injured by the blowing down of their house. The Center schoolhouse, one mile west of town, was laid to the ground. In the Blanchard river valley the fences, telegraph poles, trees and many houses were laid low, and it will be a few days before the wires can be fixed again along the Pittsburg, Ft. Wayne & Chicago railroad. The wires of the Indianapolis, Bloomington & Western railroad are down north of town. Three deaths are just reported from the south of Dunkirk. Names not ascertained.

A CANTON MAN SEVERELY INJURED.

PITTSBURG, Pa., May 15.—The Chicago express which passed through a tornado at Forest, O., last night arrived here this morning two hours late. Almost every window in the train was broken and a number of passengers were slightly hurt from flying glass. One man, C. C. Bow of Canton, O., had the sight of his right eye destroyed by a piece of glass. The trainmen and passengers report the storm the worst they ever experienced.

Cleveland Plain Dealer, Saturday evening, May 15, 1886.

Ohio Historical Society microfilm collection, roll #37131

May 14, 1886 was part of a deadly month in Ohio weather. Floods killed 28 people at Xenia on May 12, and two days later, on May 14, Ohio's deadliest tornado outbreak of the 19th century occurred. Three separate tornadoes cut a path 110 miles long, killing 17 people, in Mercer, Wyandot and Seneca counties.

Notice the headline from the Cleveland Plain Dealer found to the right. The storm was called a cyclone, not a tornado. At that time the word tornado was not used for fear of causing panic.

March 28, 1920: Western Tornadoes


TOLEDO BLADE.

HOME EDITION

RECONSTRUCTION WORK STARTS IN STORM AREA WHERE 22 DIED

-L, CITY, MEN DEADLOCK ON WAGE BOOST

DANES DEMAND REPUBLIC BE ESTABLISHED

TWO WRECKED HOMES NEAR DEFIANCE

WORKERS START MOVING DEBRIS IN GALE'S WAKE

PALMER-BLAIR IN $225,000 DEAL

DEFENDS FIRM RULE OF IRISH

DEATH TAKES 158 IN SUNDAY STORM

Toledo Blade, March 30, 1920 Cover.

Ohio Historical Society microfilm collection, roll #15404

March 28, 1920 was the first of two Palm Sunday tornado outbreaks to hit Ohio. This outbreak of 30 tornadoes across eight states killed 153 people. Four killer tornadoes moved into western Ohio from Indiana and another moved across Wood and Ottawa Counties. There were 29 deaths in Ohio from these tornadoes.

June 28, 1924, the deadliest tornado in Ohio history struck Lorain and Sandusky. It struck an urban area where 85 people were killed, 72 in Lorain. Buildings were damaged for 35 blocks along Broadway and at least 200 automobiles

[28] "U.S. Tornado Climatology," NOAA, accessed on 29 August 2015, https://www.ncdc.noaa.gov/climate-information/extreme-events/us-tornado-climatology

were buried in bricks and rubble. More than 1,000 homes were damaged and 500 destroyed in Lorain. The death toll of 15 in the State Theater is the most ever killed by a tornado in one building in Ohio.

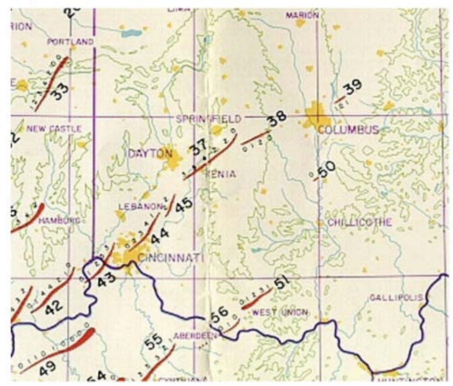
April 11, 1965 was the second Palm Sunday tornado outbreak. Thirty-seven tornadoes killed 256 people, mostly in Ohio, Michigan, and Indiana. The 55 people killed in Ohio made this the second deadliest tornado day in Ohio history, after the 1924 Lorain tornado. Nineteen tornadoes in this outbreak were of F4 or F5 intensity, with the strongest tornadoes occurring in Elkhart, Indiana and Strongsville, Ohio. Damage estimates were over $200 million for the event.

June 28, 1924: Lorain Tornado

First Congregational Church, Lorain
Ohio Historical Society collection
Call Number: SC 169

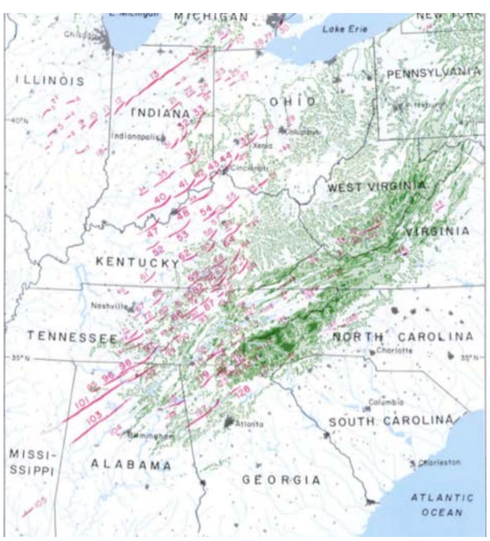
April 3 - 4, 1974 the most intense and widespread tornado outbreak in recorded history occurred. Known as the Super Outbreak, a total of 148 tornadoes spanned 13 states, producing about 900 square miles of tornado damage in less than 18 hours.

April 3, 1974: Xenia Tornado



Tornado tracks of the historic 1974 Tornado Superoutbreak. This outbreak included the devastating storm that nearly destroyed Xenia, Ohio. This storm killed 30, injured 1100, and destroyed over 1000 homes. NWS/Forecast Offices and River Forecast Centers; WFO Wilmington, Ohio.

This tornado outbreak represented a rare occurrence. Several factors came together at the right time to allow for the magnitude of the outbreak. These factors include: (1) the location and energy of the upper level wave (disturbance) with respect to the surface low pressure region; (2) the relatively warm Gulf region providing an abundance of warm, moist surface air; (3) the extent of the upper level dry air and the resulting subsidence (lid effect); and (4) the extent of the solar heating. Take away one or more of these factors and the enormity of the outbreak would likely have been greatly reduced. Speculation is that it might be several hundred years before such a confluence of factors occurs again.



The most deadly tornado in the entire Super Outbreak devastated Xenia (pop 25,000) in Greene County, Ohio, shortly after 3:30 p.m. Thirty-four people were killed and more than 1,600 injured. The F5 tornado destroyed around 1,300 buildings and damaged 2,000 others, causing losses of over $130 million.

The Xenia tornado was rated an F5. It was one of two F5s that affected Ohio during the outbreak, the other struck the Cincinnati area and was known as the Sayler Park tornado.

In Ohio, 12 tornadoes touched down, killing 36 people. The last tornado in the outbreak touched down in Franklin County, just west of New Albany (number 39 on the above map). This tornado destroyed one home and three barns and damaged 20 houses along a 25 mile path. [29]

Twenty-six years later, on September 20, 2000, Xenia was hit again. This time an F4 tornado struck at an unusual time, in autumn after dark. This tornado cut a path roughly parallel to and just north of the 1974 tornado, killing one, injuring nearly 100, and damaging over 300 homes. Some homes damaged or destroyed in the 1974 tornado were hit again.

Xenia, named after the Greek word for "hospitality," has a long history of severe storms going back to the early 1800s. Local records show 20 tornadoes in Greene County since 1884. It is said that before the area now known as Xenia was settled, the Shawnee tribe who lived close by referred to the area as the "Land of Devil Winds" and refused to settle there.

EF5 Tornado Damage - Xenia, Ohio 04/03/1974

Photographer's description not available.

Photographer	Unknown, Berrien County Michigan Emergency Management
Date taken	Unknown
Location	Xenia, OH (Greene County) map
Event	Tornado damage

EF3 Tornado Damage - Xenia, Ohio 09/20/2000

Photographer's description: This photo was taken September 21, 2000. Xenia, Ohio. The building was Grocery Land, a grocery collapsed by the storm with a person trapped in building. The rescue crew I was assigned with searched the building for the person who used his cell phone to report his location behind coolers . Dayton Police canine searched the building, however, the trapped person self extricated himself from building. Notice the undisturbed soft drinks on shelves.

Photographer	Don Parker, Dayton Skywarn Coordinator
Date taken	September 21, 2000
Location	Xenia, Ohio (Greene County) map
Event	Tornado damage

The 1974 Super Outbreak was especially significant for several reasons. Prior to the 1974 Super Outbreak, researchers were unable to characterize the intensity distribution within a tornado's path. Fujita's extensive aerial survey after the outbreak provided the necessary data to develop an empirical relationship for the width of each F-scale damage area within a tornado path. This survey data provided a new means for assessing tornado intensity probabilities that accounted for the gradation of damage within the tornado path. To this

[29] "The Widespread Tornado Outbreak of April 3-4, 1974," NOAA, accessed on 29 Oct 2015, http://www.publicaffairs.noaa.gov/storms/description.html

day, this relationship remains the basis for estimating the intensity distribution within tornadoes.

Research from the 1974 event also provided further evidence of intense vortices embedded inside a tornado and led to the discovery of downbursts (small scale damaging downdrafts) that were recognized as the cause of several major airline accidents in the following decade.

In addition to the scientific advances, the outbreak also led to NOAA's rapid expansion of its weather radio network. During the 1974 event, tornado warnings were being posted so frequently, they could not be transmitted from the NWS offices fast enough using teletype. Commercial radio stations also had difficulty re-transmitting the information. After the outbreak, NOAA initiated an immediate expansion of its weather radio network across the country, along with a modernization program that allowed the National Weather Service to adopt new technology, improving weather warning lead-times and accuracy.

There have also been great advances in weather radar capabilities since 1974. At that time, NWS forecasters could see only green blobs on their radar scopes and relied on visual confirmation to issue tornado warnings. The NWS depended on 1950s and 1970s vintage radar technology to operate a combination of network and local warning radars to monitor weather systems. They were obsolete and difficult to service, and large areas were not served by any NWS radar.[30]

May 31, 1985: Northeastern Tornadoes

This video still shows a beam that penetrated the roof of a residence during the tornado.
Video still courtesy of WBNS-TV Film Archives Department

After a $4.5 billion modernization program and explosive growth in technology, today's NWS has significantly advanced its warning capabilities. NWS forecasters now warn of severe weather events threatening life and property using Doppler Weather Surveillance Radars. Doppler radar observes the presence and calculates the speed and direction of severe weather elements such as tornadoes and thunderstorms. They also provide quantitative area precipitation measurements, important in hydrologic forecasting of potential flooding. The severe weather and motion detection capabilities offered by radars contribute toward an increase in the accuracy and timeliness of NWS warning services.

[30] "Radar Technology – Then and Now," NOAA, accessed on 29 Oct 2015, http://www.publicaffairs.noaa.gov/storms/radar.html

May 31, 1985, 14 killer tornadoes struck northeastern Ohio, western Pennsylvania, and southern Ontario. With 11 dead in Trumbull County, Ohio, this was Ohio's deadliest tornado outbreak since the Xenia Tornado of 1974. The most famous Ohio tornado of this outbreak touched down in Portage County and cut a 47 mile path through Newton Falls, Niles, and Hubbard before entering Pennsylvania. This was the only F5 tornado in the United States in 1985.

July 12, 1992, 28 tornadoes occurred in Ohio, the most recorded in a single day. They also contributed to the July 1992 record of 44 tornadoes in one month and a record annual total of 61 tornadoes. Fortunately, summer tornadoes tend to be weaker than spring storms and none of the 44 tornadoes were violent. There were no fatalities and only 36 injuries from this record number of tornadoes.

April 9, 1999, a tornado struck the Cincinnati area in the early morning hours. It killed four people in the Blue Ash and Montgomery area. The storm was classified as an F4. Two fatalities were in vehicles and two others in homes. The storm was a quarter mile wide and destroyed 91 homes and apartments and 37 businesses in Hamilton County. Another 674 homes and apartments and 44 businesses were damaged. Several homes, garages and barns were damaged in Warren County.

EF4 Tornado Damage - Blue Ash, Ohio **04/09/1999**

Photographer's description not available

Photographer	Mary Jo Parker, NWS Wilmington, OH
Date taken	April 9, 1999
Location	Blue Ash, Ohio (Hamilton County) map
Event	Tornado damage

November 10, 2002, an F4 tornado moved through Van Wert, Ohio, destroying the entire northwest corner of the city. This tornado was part of a large outbreak of 70 tornadoes occurring over two days. Four people died and 26 were injured. The storm caused $490 million in damages.

The manager of a Van Wert movie theater received a tornado warning through a system directly tied to the Van Wert County siren system. He and his staff got more than 50 people to safety in hallways and restrooms. The theater was destroyed. The county had just become a Storm Ready county on January 22, 2002, which was credited with saving many lives.

Source: Toledo News Now

June 5, 2010, 7 people were killed in Lake Township and Millbury (Wood County). More than 100 structures, including Lake High School, were destroyed when five tornadoes touched down during the night.[31]

Tornadoes in Franklin County

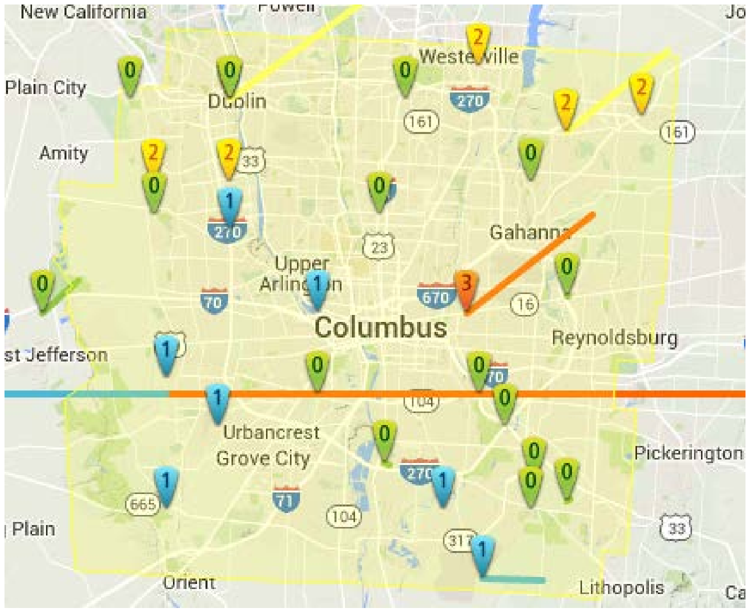
Tornadoes are a county-wide hazard and can impact any jurisdiction in Franklin County. The National Weather Service National Climatic Data Center reported 32 tornadoes in Franklin County from January 1950 to December 2017.[32] This ranks Franklin County #1 in the state of Ohio for tornadic activity. There were five tornadoes reported in 1973, the most of any year, followed by 2006 with three tornadoes.

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	11	57.230M	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	06/26/1954	11:15	CST	Tornado	F0	0	0	25.00K	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	10/11/1954	17:30	CST	Tornado	F1	0	0	2.50K	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	04/28/1958	05:45	CST	Tornado	F1	0	0	25.00K	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	07/05/1959	15:20	CST	Tornado	F1	0	0	2.50K	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	07/28/1961	22:30	CST	Tornado	F0	0	0	25.00K	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	09/12/1963	12:45	CST	Tornado	F0	0	0	2.50K	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	04/02/1970	07:06	CST	Tornado	F2	0	0	250.00K	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	02/22/1971	15:55	CST	Tornado	F3	0	7	2.500M	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	05/08/1973	13:10	CST	Tornado	F2	0	0	250.00K	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	05/10/1973	18:00	CST	Tornado	F3	0	3	2.50K	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	05/25/1973	17:30	CST	Tornado	F2	0	0	250.00K	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	05/30/1973	12:55	CST	Tornado	F2	0	1	2.500M	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	07/26/1973	15:00	CST	Tornado	F1	0	0	0.25K	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	04/03/1974	16:05	CST	Tornado	F2	0	0	250.00K	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	06/17/1975	15:45	CST	Tornado	F1	0	0	25.00K	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	09/11/1975	18:40	CST	Tornado	F1	0	0	25.00K	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	06/13/1981	13:30	CST	Tornado	F0	0	0	2.50K	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	08/07/1984	13:00	CST	Tornado	F1	0	0	250.00K	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	06/10/1986	17:50	EST	Tornado	F1	0	0	250.00K	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	06/02/1991	16:00	EST	Tornado	F0	0	0	25.00K	0.00K
FRANKLIN CO.	FRANKLIN CO.	OH	08/27/1992	15:50	EST	Tornado	F0	0	0	25.00K	0.00K
DUBLIN	FRANKLIN CO.	OH	07/02/1997	17:30	EST	Tornado	F0	0	0	30.00K	0.00K
GROVE CITY	FRANKLIN CO.	OH	08/28/2006	18:10	EST	Tornado	F0	0	0	1.00K	0.00K
BEXLEY	FRANKLIN CO.	OH	08/28/2006	18:28	EST	Tornado	F0	0	0	1.00K	0.00K
NEW ALBANY	FRANKLIN CO.	OH	10/11/2006	17:49	EST-5	Tornado	F2	0	0	50.000M	0.00K
MUDSOCK	FRANKLIN CO.	OH	05/11/2008	12:12	EST-5	Tornado	EF0	0	0	5.00K	0.00K
TAYLOR	FRANKLIN CO.	OH	09/22/2010	15:58	EST-5	Tornado	EF0	0	0	0.00K	0.00K
GROVEPORT	FRANKLIN CO.	OH	10/26/2010	13:05	EST-5	Tornado	EF0	0	0	40.00K	0.00K
(LCK)RCKENBCKR ARPT	FRANKLIN CO.	OH	04/20/2011	01:22	EST-5	Tornado	EF1	0	0	35.00K	0.00K
GROVEPORT	FRANKLIN CO.	OH	04/20/2011	01:26	EST-5	Tornado	EF0	0	0	30.00K	0.00K
COLUMBUS SO COLUMBUS	FRANKLIN CO.	OH	10/31/2013	23:40	EST-5	Tornado	EF0	0	0	300.00K	0.00K
COLUMBUS	FRANKLIN CO.	OH	06/04/2016	17:06	EST-5	Tornado	EF0	0	0	100.00K	0.00K
Totals:								0	11	57.230M	0.00K

Query results of tornado incidents in Franklin County, National Climactic Data Center

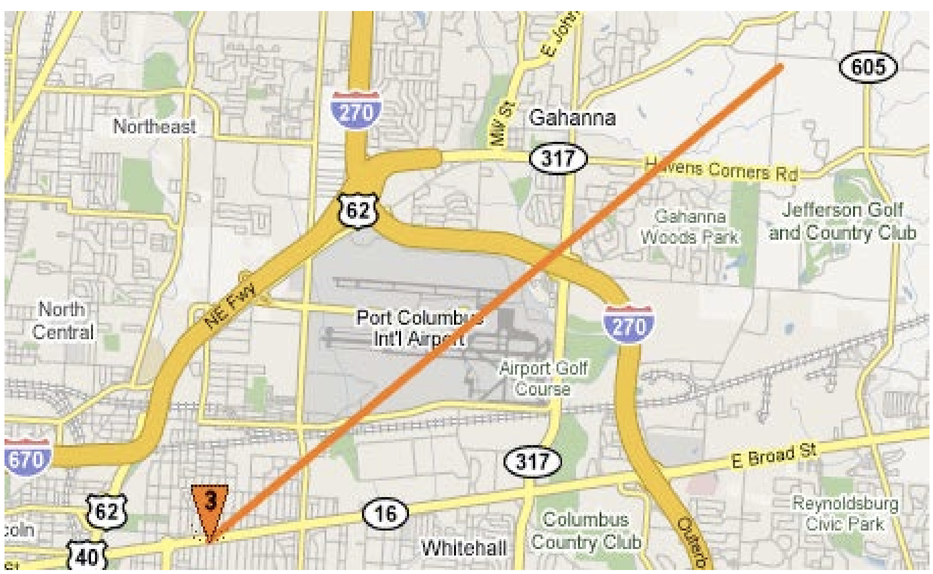
[31] "3 Years After Deadly Tornadoes, Wood County Residents Prepare," Toledo News Now, accessed on 5 June 2013 http://www.toledonewsnow.com/story/22505828/3-years-after-deadly-tornados-wood-county-residents-prepare

[32] "Query Results, Tornadoes, Franklin County, Ohio," NCDC – NOAA, accessed on 1 February 2018 http://www.ncdc.noaa.gov/stormevents/



Map of Franklin County Tornadoes, The Tornado History Project
(Note: The tornadoes are scattered throughout the entire county.)

The strongest tornadoes reported in the county were F3s. On February 22, 1971, an F3 moved northeast across the east side of Columbus, near Port Columbus through Gahanna. The path of this tornado was 7 miles long and 100 yards wide. Seven people were injured and $2.5M in damage was reported. Below is a map of the path of this tornado.



The other F3 tornado to touchdown in Franklin County was two years later on May 10, 1973. This tornado entered the county north of Hilliard and moved through the northern suburbs of Columbus, Gahanna and Pataskala, lifting up on the Licking/Perry County line east of Buckeye Lake. This tornado appeared to skip throughout its path. The tornado was

300 yards wide and traveled 90 miles through five counties. Eight people were injured and damage was reported at $5,000.

Six F2 tornadoes have been reported in Franklin County. One F2 tornado, on October 11, 2006, was one of the most expensive in damages. The tornado touched down and moved through the Upper Albany West subdivision one mile northwest of New Albany. Sixty-seven homes were damaged, sixteen of them severely, and an additional eight were destroyed. Many homes sustained significant roof, siding and window damage. Property damage was estimated at $50M.[33]

The following is detailed information on three of the more costly tornado events as reported by the NCDC. Detailed information can be found at the following site: http://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Tornado&beginDate_mm=07&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=07&endDate_dd=31&endDate_yyyy=2015&county=FRANKLIN%3A49&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=39%2COHIO

[33] "Franklin County Query," Tornado History Project, accessed on 23 May 2015 http://www.tornadohistoryproject.com

Event Details

Event	Tornado
-- Scale	F2
-- Length	0.5 Miles
-- Width	150 Yards
State	OHIO
County/Area	FRANKLIN
WFO	ILN
Report Source	NWS Storm Survey
NCDC Data Source	CSV
Begin Date	2006-10-11 17:49:00.0 EST-5
Begin Location	1NW NEW ALBANY
Begin Lat/Lon	40.09/-82.79
End Date	2006-10-11 17:55:00.0 EST-5
End Location	1NNW NEW ALBANY
End Lat/Lon	40.09/-82.79
Deaths Direct/Indirect	0/0 (fatality details below, when available...)
Injuries Direct/Indirect	0/0
Property Damage	50.00M
Crop Damage	0.00K
Episode Narrative	A squall line moved through central Ohio during the evening. Two tornadoes occurred in the Columbus metro area as the squall line moved through.
Event Narrative	A tornado touched down and moved through the Upper Albany West subdivision. Sixty-seven homes were damaged, sixteen of those severely and an additional eight completely destroyed. Many of the homes sustained significant roof, siding and window damage. Much of the damage was F1, with some low end F2 damage to around 120 mph.

Event Details

Event	Tornado
Magnitude	0
-- Scale	F3
-- Length	6.8 Miles
-- Width	100 Yards
State	OHIO
County/Area	FRANKLIN
NCDC Data Source	PUB
Begin Date	1971-02-22 15:55:00.0 CST
Begin Location	0
Begin Lat/Lon	39.97/-82.93
End Date	1971-02-22 15:55:00.0 CST
End Lat/Lon	40.03/-82.83
Deaths Direct/Indirect	0/0 (fatality details below, when available...)
Injuries Direct/Indirect	7/0
Property Damage	2.5M
Crop Damage	0

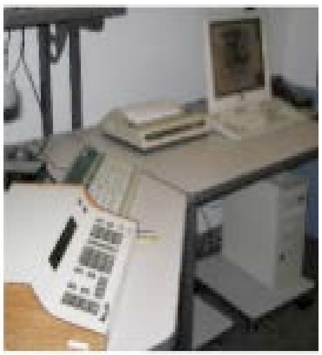
The tornado first touched ground in the vicinity of Alum Creek Drive and Main Street. The storm moved toward the north northeast. Damage at the southern end of this nearly continuous line branches into a Y with scattered damage more than 2 miles to the southwest of the junction and 2 miles south of the intersection of Alum Creek Drive and Main Street. Many persons watched as the storm demolished entire warehouses, uprooted trees, collapsed homes and tore roofs off other buildings. Residents along or near the storm's path reported lawns covered by hail long after the storm had passed. Total damage was set at $2.8 million.

Event Details

Event	Tornado
Magnitude	0
-- Scale	F2
-- Length	2 Miles
-- Width	17 Yards
State	OHIO
County/Area	FRANKLIN
NCDC Data Source	PUB
Begin Date	1973-05-30 12:55:00.0 CST
Begin Location	0
Begin Lat/Lon	40.05/-83.12
End Date	1973-05-30 12:55:00.0 CST
Deaths Direct/Indirect	0/0 (fatality details below, when available...)
Injuries Direct/Indirect	1/0
Property Damage	2.5M
Crop Damage	0

The tornado was observed 1.5 miles southwest of Columbus Airport around 1:55 pm which damaged the North American Rockwell Corp. Parts of the roof collapsed causing around $1,000,000 damages. The Defense Construction Supply Center was severely damaged. Seven warehouses were hit. Several cars were damaged mostly with broken windows and tires that exploded. Damage was estimated at $2.3 million to the Defense Construction Supply Center.

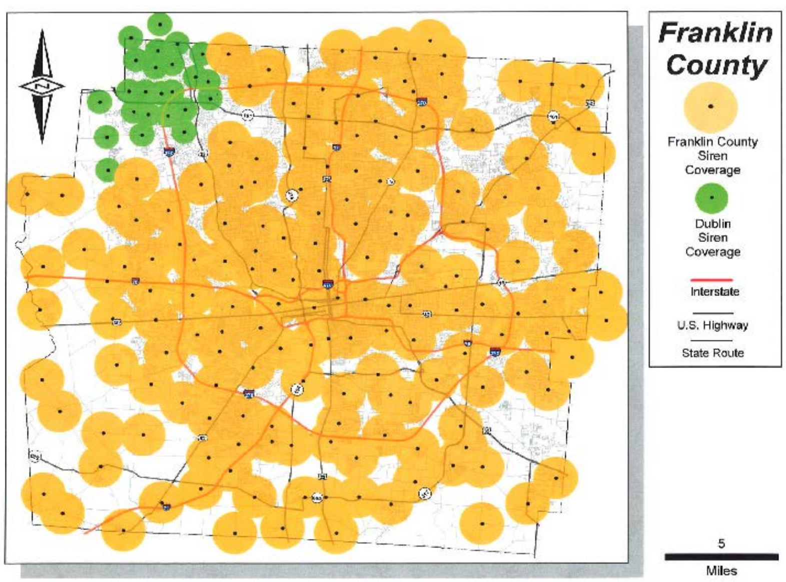
Franklin County Outdoor Warning System



FCEM&HS OUTDOOR WARNING SYSTEM ACTIVATION POINT

With 196 sirens, Franklin County has one of the largest siren systems in Ohio.[34] The system is complemented by 30 sirens operated by the City of Dublin, the green sirens on the map below. These numbers are accurate as of 2015.[35]

The siren system is an outdoor warning system; the sirens are not intended to be heard indoors. The sirens are activated when the National Weather Service issues a tornado warning in Franklin County. Citizens are also strongly encouraged to purchase and use a Weather Alert Radio for reliable tornado watch and warning notifications when they are indoors.



[34] "Tornado Safety," Franklin County Emergency Management and Homeland Security, accessed on 16 July 2015, http://fcemhs.com/Warning.aspx
[35] "Tornado Sirens-Emergency Warning System", City of Dublin, accessed on 11 May 2015 http://dublinohiousa.gov/emergency-preparedness/emergency-warning-system/

Climate Change Impacts

In a recent article from Climate Central, it was noted that days with more tornadoes have become more common over the past 60 years, a trend that new research says could have a climate change connection.

Understanding the connection between climate change and tornadoes, if any, is one of the most fraught areas of research. But a study recently released suggests that changes in heat and moisture content in the atmosphere, brought on by a global warming, could be playing a role in making tornado outbreaks more common and severe in the U.S. Part of the difficulty in examining the climate-tornado link is that individual tornadoes occur on such a small scale. There is a lot of year-to-year variability that adds noise for researchers trying to look at the big picture.[36] Several types of extreme weather events have already increased in frequency and/or intensity due to climate change, and further increases are projected.[37]

Vulnerability Assessment – Tornadoes

**Note: all information in this vulnerability assessment can be attributed to the Franklin County GIS department, 2012 Natural Hazards Mitigation Plan and National Climatic Data Center searches accessed via https://www.ncdc.noaa.gov/stormevents/*

This hazard is considered to be a "Relatively Moderate Probability Event", meaning the anticipated frequency of the hazard within the County is once every 1 to 4 years. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability

Anything in the path of a tornado is at risk. For tornadoes, aged and dilapidated structures or structures not built to applicable building codes are more susceptible to damage. Mobile homes and campgrounds are especially susceptible to damage due to tornadoes. Strong winds can rip roofs off of any dilapidated structures and overturn mobile homes. Rural areas are more exposed to tornadoes, but the destructive capability increases in urban areas, as was demonstrated in Xenia, Ohio.

While there have been zero deaths since 1950 in Franklin County (2 deaths in 1916) and a low number of injuries due to tornadoes, the potential for severe destruction and death remains. Population increases and further expansion of the outdoor siren warning system will also necessitate a continued emphasis on public education.

Potential Impact of Tornadoes

[36] "Tornado Outbreaks Could Have a Climate Change Assist," Climate Central, accessed on 4 Nov 2015, http://www.climatecentral.org/news/climate-change-tornado-outbreaks-17861

[37] Extreme Weather," U.S. Global Change Research Program. " accessed on 1 August 2015, http://nca2014.globalchange.gov/report/our-changing-climate/extreme-weather

Vulnerability to the effects of a tornado is somewhat dependent upon the age of a structure because as building codes become more stringent, buildings are more capable of enduring greater wind forces.

In a worst-case scenario, Franklin County could be hit with an EF-5 tornado that would travel from one side of the county to the other. No matter the path, if an EF-5 tornado went through the county, tens of thousands of buildings would be destroyed. Even with the current building codes, most buildings cannot withstand the forces of an EF-5 tornado. Apart from the devastation within the path of the tornado, large regions of the county would be expected to be without power.

Identifying Structures

Exposure of Existing Buildings to Tornadoes
All structures and infrastructure could potentially be affected by a tornado. Depending upon the severity of a tornado, any existing structures could be damaged or destroyed. However, in Franklin County there are 169,283 structures that were built before 1960; thus, the percentage of existing buildings considered at particular risk of damage due to a tornado or high wind is 32.5%.

To predict the structural cost associated with a worst-case scenario for a tornado; an EF-5 tornado traveling on a straight path through the most densely populated and developed areas within the county was analyzed utilizing a 2015 GIS query. This analysis uses a tornado with a destructive path of three quarters of a mile wide traveling approximately 25 miles across Franklin County from the southwest side to the northeast side of the county. An assessment shows the amount of damage that is expected per type of structure. It also shows the value of damage that is expected for this worst-case scenario.

Type	# of Structures	Value
Residential	10,931	$575,693,600
Commercial	1,174	$722,213,600
Industrial	90	$78,213,600
Critical Infrastructure		
Hospital	3	$109,821,100
Total	**12,198**	**$1,486,042,100**

**This is the potential loss for this worst-case scenario.*

Exposure of Future Buildings to Tornadoes
Any future structures have the same potential for exposure to a tornado or high winds as this hazard does not occur in specific locations. Future buildings will be slightly more resistant to the effects of a tornado or high winds as they will meet the most current building code requirements for bracing and roof design.

Estimating Potential Loss

Methodology
The Franklin County Risk Assessment data is used to support the NCDC data to estimate potential losses from this nonspecific hazard. According to the NCDC, estimated property damage in Franklin County attributable to major tornadoes and wind from 1950 through 2017 is $186.206 million. The major tornadoes listed above are responsible for a combined $57 million of these damages, leaving $129 million attributable to wind events. Wind events and the associated $129 million in high wind damages are addressed in the section titled: Severe Summer Weather: Thunderstorms, Lightning, Wind and Hail - #12.

The tornado data is used to estimate potential annual dollar losses due to a tornado.

Estimated Potential Dollar Losses
Since the total loss to major tornadoes over these 67 years is $57 million, the average annual loss is $57 million / 67 = $850,746.

The damage in dollars represented in this vulnerability statement only quantify the damage to structures and does not reflect ancillary costs associated with this hazard.

Cyber-Threat - #2

Hazard Summary

A cyber threat is the possibility of a malicious attempt to damage or disrupt a computer network or system. A sharp increase in the number of cyber incidents involving government and corporate computer networks has caused the United States and Franklin County to launch initiatives to combat cyber threats. Many of the initiatives have focused on protecting critical infrastructure command and control systems, preventing access to sensitive government information, and thwarting acts of fraud and theft targeting business financial systems. This hazard was ranked 2 out of 20.

Hazard Profile

"America must face the rapidly growing threat from cyber-attacks. We know hackers steal people's identities and infiltrate private emails. We know foreign countries and companies swipe our corporate secrets. Now our enemies are also seeking the ability to sabotage our power grid, our financial institutions, and our air traffic control systems. We cannot look back years from now and wonder why we did nothing in the face of real threats to our security and our economy."

President Barack Obama
February 12, 2013

A cyber-attack is defined as "an attempt to gain unauthorized access to system services, resources, or information, or an attempt to compromise system integrity (US-CERT, 2014)." The number of cyber-attacks against government and private organizations is increasing at an alarming rate. According to Symantec "the total number of breaches in 2013 was 62 percent greater than in 2012," and the risk of a large enterprise being targeted by a cyber-attack in 2013 was 1 in 2.3 (Symantec Corporation, 2014). These attacks come in many forms and are perpetrated by a variety of threat agents (e.g. state sponsored, organized crime, and individuals acting on their own). But the threat is real and is increasing.[38]

On April 1, 2015, President Obama signed an Executive Order[39] blocking the property of certain persons engaging in significant malicious cyber-enabled activities. In that Order, President Obama states "I, BARACK OBAMA, President of the United States of America, find that the increasing prevalence and severity of malicious cyber-enabled activities originating from, or directed by persons located, in whole or in substantial part, outside the United States constitute an unusual and extraordinary threat to the national security, foreign policy, and economy of the United States. I hereby declare a national emergency to deal with this threat."

Cyber incidents can be unintentional or intentional. Unintentional incidents can be caused when businesses and organizations attempt to upgrade their software or maintenance procedures and inadvertently disrupt their systems when no malice had been intended. Intentional threats include both targeted and untargeted attacks from a variety of sources, including criminal groups, hackers, disgruntled employees, foreign nationals engaged in espionage, and terrorists intent on inflicting mass causalities or destroying critical infrastructure.

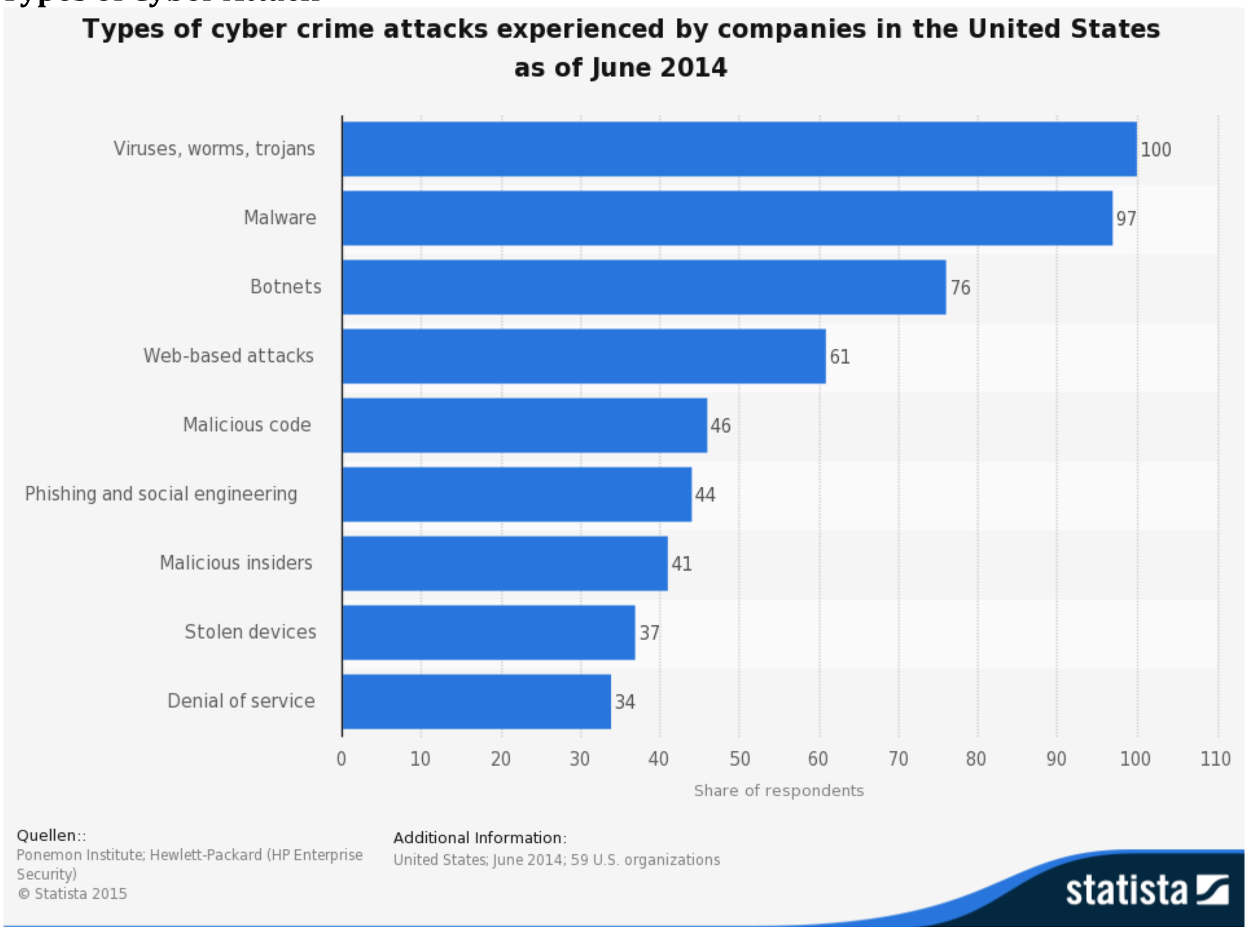
The sources of cyber-threats can use various means to exploit system vulnerabilities –such as compromising a particular computer, a software application, an IT network, or military and critical infrastructure command and control systems. Individuals or groups may intentionally target a specific cyber asset or indiscriminately attack a broad range of assets

[38] "2015 Central Ohio Cyber Security Strategy", Franklin County Emergency Management & Homeland Security, pg. 4

[39] "Executive Order Blocking the Property of Certain Persons Engaging in Significant Malicious Cyber-Enabled activities", The White House, retrieved 16 July 2015, https://www.whitehouse.gov/the-press-office/2015/04/01/executive-order-blocking-property-certain-persons-engaging-significant-m

using a virus, worm, or malware distributed over the Internet. Thus, connectivity to the Internet poses a significant vulnerability and amplifies the threat to telecommunications systems, electrical power grid, transportation, and other systems providing essential services to the nation.

Types of Cyber Attack



Source: Secure Trading

Cyber-attacks are largely achieved through one of three means: 1) through wired and wireless Internet connections, 2) through the uploading of malicious software, and 3) through hardware transfer devices such as thumb drives. The following list comprises various types of cyber-threats.

Crypto- Ransomware: Crypto-ransomware encrypts your personal files and holds the private keys to their decryption for ransom at a remote site. This is a much more vicious attack than traditional ransomware. Methods of infection vary, but commonly it's via a malicious email attachment purporting to be an invoice, energy bill, or image. The delivery often forms part of a service actually provided by different criminals from those executing the crypto-ransomware.

Distributed Denial of Service Attack (DDoS): Used by Anonymous and other activist groups whereby followers are instructed to direct tools, such as the low orbit ion cannon

(LOIC), at a specific targeted website with the intent to generate sufficient traffic on the website so that normal users cannot gain access.

Doxing: The practice whereby an activist organization will gain access to personal information on a targeted individual or organization and then publish, or threaten to publish, the information over the Internet with the intent to harass, intimidate, or blackmail.

Passive Wiretapping: The collecting of data, such as passwords, by attackers monitoring communication links.

Phishing: The act of issuing an authentic looking but fake email to request information from users or to direct them to a fake website that requests such information.

Website Hacking: The practices of accessing a corporate or business website with the intent of either defacing the site, stealing credit card or account information and/or deleting the site.

Cross-Scripting: This occurs when a browser visits a malicious website or link. Third-party web resources are used to install a script within the victim's web browser to exploit additional vulnerabilities that enable the attacker to steal cookies (data exchanged between a web server and browser), log key strokes, capture screen shots, collect network information and/or remotely control the victim's computer.

Logic Bombs: The installation of programming into a software application such that when one or more pre-defined conditions or actions are met, a malicious function occurs.

Ransomware: Criminals use malware to encrypt the data on victims' hard drives—family pictures, homework, music, and other valuable files—demanding payment to unlock the files. The only defense is to keep a separate backup of your files, preferably offline, to restore from.

SQL (Structured Query Language) Injection: The unauthorized access to a sensitive database by injection of code altering a database search in a web-based application.

Spamming: Spamming involves flooding the Internet with as many copies of the same message as possible in order to force people to receive the message that otherwise would not have chosen to receive the message. Most spam is commercial advertising, often for dubious products, get-rich-quick schemes or quasi-legal services. Spammers will use automated tools to subscribe to as many mailing lists as possible and then use those mailing lists to target their attacks.

Trojan Horse: Where the intended uploading of a useful software application also carries malicious code enabling the attacker to evade security measures.

Virus: Where a computer user is unwittingly involved in spreading malicious code to other programs largely through email exchanges, such that the virus can now delete data on the targeted computer or erase data stored on a hard drive.

Worm: Similar to a virus except that the user is not involved and the malicious code is capable of self-replicating and self-propagating across a computer network.

Drive-by-Downloading: Drive-by downloads are malicious pieces of software that are downloaded to a computer, tablet or smartphone when the user views a compromised Web page.

Botnets: Typically through an internet connection, a personal computer can be accessed and recruited to perform operations in collaboration with other similarly infected computers. The malware that is installed allows for an outside party to control and direct the activities of these compromised computers. Collectively this malicious network of compromised computers can be directed to send out spam, viruses, spyware or just stay "hidden" until directed to perform some activity. Botnets can also be used to steal personal and private information (i.e. credit card numbers, social security numbers, bank credentials) or to extort money by denying service. Examples of the more malicious botnets are provided in the following table:

Stuxnet	In July 2010, a sophisticated computer attack known as Stuxnet was discovered. It targeted control systems used to operate industrial processes in the energy, nuclear and other critical industry sectors. It is designed to exploit a combination of vulnerabilities to gain access to its target and then to modify code as part of changing how critical infrastructure operates.
ZeuS/Zbot	Designed to intercept browser keystrokes and form collection, ZeuS was estimated to infect 3.6 million computers in the US alone. Although ZeuS allows full control by an unauthorized remote user, its primary function is financial gain stealing online credentials such as online banking account numbers, passwords, etc.
Conflicker	Conflicker infected an estimated 7 million government, business and home computers in over 200 countries, making it the largest known computer worm. First detected in 2007, Conflicker uses flaws in Windows software to gain computer access.
SpyEye	Coming to prominence in 2011, SpyEye captures keystrokes through a method known as "form grabbing." SpyEye sends captured data to a remote attacker and hides malicious activities from network administrators by injecting code into running processes.
BredoLab	BredoLab involves mostly a viral email spam, having seized control of 143 command and control servers and recruiting 30 million computers into the botnet. Computers were recruited to the botnet upon opening the email reaching a collective capacity to send 3.6 million viral emails per day.

Mariposa	Discovered in 2008, Mariposa is involved largely in cyber scamming and denial of service attacks. Having recruited over 12 million computers to the botnet, Mariposa is one of the largest botnets. The botnet uses a malware program entitled "Butterfly bot" that installs itself on a personal computer, monitoring activity for passwords, bank credentials and credit cards.
Asprox	The Asprox botnet is mostly involved in phishing scams and performing SQL injections into websites in order to spread malware. The botnet propagates itself by searching for and infecting vulnerable websites using active server pages. Asprox has been involved in multiple high-profile attacks involving websites for Sony and Adobe as well as government, healthcare and business websites.
Kelihos	Discovered in 2010 when it was determined to have infected 45,000 computers and was capable of sending 4 million spam messages per day. By January 2012 a second version had recruited 110,000 computers. The botnet was reportedly created by a former Russian IT security professional. A third version is known to infect computers through Facebook where the botnet is able to spread itself by sending malware links to users that results in a Trojan Horse recruiting the user's computer to the botnet

In summary, the means to conduct cyber-attacks are numerous and continually growing. Many of the more significant cyber-threats involve botnets that are capable of recruiting an army of computers to propagate the distribution of malware that can either collect vital information or disrupt operation of command and control systems.

Sources of Cyber Threats

The sources of cyber-threats include criminal groups seeking financial gain, nation states involved with espionage and plans to undermine foreign governments through a weakening of national defenses, activist groups bent on gaining public opinion or punishing those who disagree with their agenda as well as lone individuals seeking fame or fortune. Terrorist groups can also be a source of cyber-threats, 2015 has seen an increase in cyber related activity surrounding ISIS, most notably the March 2015 Doxing of over 100 United States service members personal information, with messages to sympathizers to attack these service members' loved ones.[40]

Cyber Criminals: Cyber criminals are simply those individuals or organizations that conduct illegal activities using a computer, network or hardware device. Cyber criminals commit acts of fraud, unauthorized access to computer networks, cyber stalking, theft, manipulation of data, identify theft, extortion, blackmail, harassment and stock market manipulation.

[40] "ISIS has new Terrorism Tactic: Doxing US Soldiers", Retrieved September 22, 2015 from http://gizmodo.com/isis-has-a-new-terrorism-tactic-doxing-us-soldiers-1693078782

Eastern European criminal rings have used "drive-by downloads" to corrupt popular websites such as NBC.[41] Though the malicious programs vary, they often include software for recording keystrokes as computer users enter financial account passwords.

The group ShadowCrew stole over 1.5 million credit card numbers and sold them online for profit. The group also fabricated fraudulent passports, health insurance cards, and birth certificates for identify theft crimes extracting $4.2 million.[42]

In 2015, Evgeniy Mikhailovich Bogachev was charged with numerous violations for his role as an administrator of the GameOver Zeus botnet[43]. This software was used to capture bank account numbers, passwords, personal identification numbers, and other information utilized to log into online banking accounts GameOver Zeus is believed to be responsible for more than 1 million computer infections, resulting in financial losses of more than $100 million.

Nation States: Nation states known to be actively developing cyber intrusion capabilities include China, Russia, Iran, Israel, India, Pakistan, and the United States. These states use cyberspace to conduct acts of espionage in attempts to gain access to critical infrastructure control systems, to acquire information on advanced technologies, to gain access to confidential government documents, and to identify vulnerabilities in defense systems.

According to Western cyber investigators, Chinese hackers targeted the largest US corporations and most innovative technology companies, using trick emails that appear to come from trusted colleagues but bear attachments tainted with viruses, spyware and other malicious software. The Chinese government has also attempted to access US government systems in order to acquire information on national defenses, advanced technologies and infrastructure vulnerabilities.

The United States and Israel are suspected in the production of electronic worms including Stuxnet, which involved a successful attempt to undermine Iran's uranium enrichment program.

Iran itself has been implicated in a series of unusually effective denial-of-service attacks against major U.S. banks that blocked their online banking operations. Iran also is suspected of penetrating at least one U.S. oil company.

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[41] "Analysis: The near impossible battle against hackers everywhere", Reuters Online, Retrieved 4 November 2015 from http://www.reuters.com/article/us-cybersecurity-battle-idUSBRE91N03520130224#tDcwdtoHCOBcgPhT.97

[42] "Shadowcrew: Web Mobs", Baseline Magazine, Retrieved online 4 November 2015 from http://www.baselinemag.com/c/a/Security/Shadowcrew-Web-Mobs

[43] "Reward Announced for Cyber Fugitive", United States Department of Justice, Retrieved online 14 July 2015 from http://www.justice.gov/opa/pr/reward-announced-cyber-fugitive

In November 2010, a group calling itself the Indian Cyber Army hacked the websites belonging to the Pakistan Army, the Ministry of Foreign Affairs, the Ministry of Education, the Ministry of Finance, the Pakistan Computer Bureau, and the Council of Islamic Ideology. The attack was done in revenge of the Mumbai terrorist attacks.[44]

Activist Groups: Cyber activism is the means by which advanced information and communication technologies, e.g. email, list-serve, and the Internet, are used by individuals and groups to communicate with large audiences, galvanizing individuals around a specific issue or set of issues in an attempt to build solidarity towards a collective action.

Activist groups often use cyber-attacks to promote their agenda or sway public opinion against an organization they have accused of wrongdoing. Anonymous, a decentralized group of attackers sharing common interests, favor "denial-of-service" attacks that temporarily block websites from view. Anonymous also uses automated search tools to identify vulnerabilities that give them access to corporate information.

A group known as LulzSec has taken credit for a number of cyber-raids against corporations, political parties and governments. LulzSec claimed responsibility for several high profile attacks, including the compromise of user accounts from Sony Pictures in 2011. The group also claimed responsibility for taking the CIA website offline.

Individual "Lone Wolf" Hackers: A number of individuals have committed cyber-attacks that have resulted in significant consequences.

Jonathan James was known as "comrade" on the Internet. He was convicted of hacking into a number of networks, including those belonging to Bell South, Miami-Dade, and the U.S. Department of Defense. In addition, James hacked into NASA's network and downloaded enough source code to learn how the International Space Station worked. The total value of the downloaded assets equaled $1.7 million.

Kevin Mitnick has been called by the U.S. Department of Justice "the most wanted computer criminal in U.S. history." After serving a year in prison for hacking into Digital Equipment Corporation's network, he went on a 2 ½ -year hacking spree that involved breaching the national defense warning system and stealing corporate secrets.

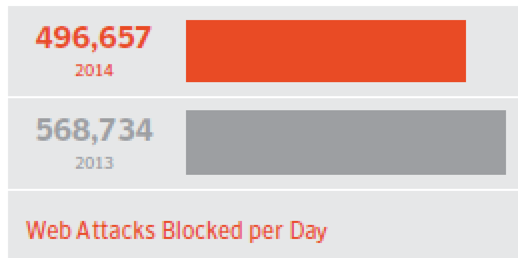
Gary McKinnon was known by his Internet handle, "Solo." Using that name, he coordinated what would become the largest military computer hack of all time. The allegations are that he, over a 13-month period from February 2001 to March 2002, illegally gained access to 97 computers belonging to the U.S. Armed Forces and NASA. According to U.S. authorities

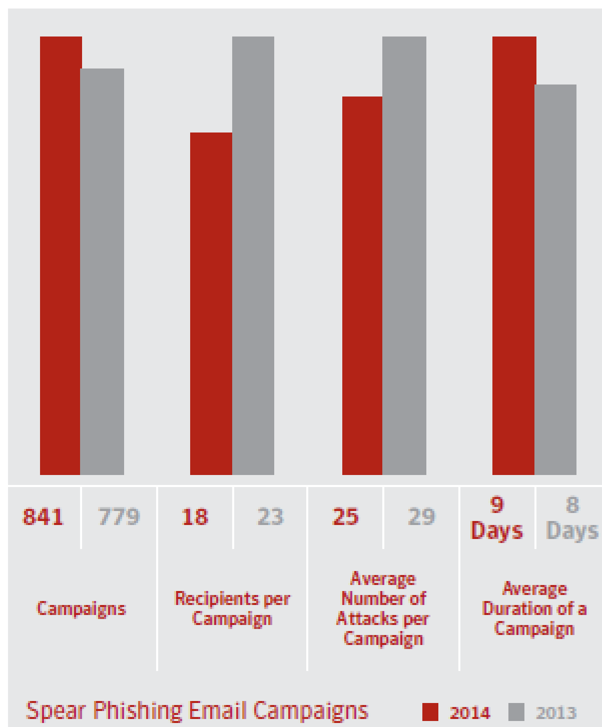
[44] "36 Government Sites Hacked by 'Indian Cyber Army'", The Express Tribune, Retrieved 4 November 4, 2015 from http://tribune.com.pk/story/83967/36-government-websites-hacked-by-indian-cyber-army/

he deleted a number of critical files, rendering over 300 computers inoperable and resulting in over $700,000 in damages.

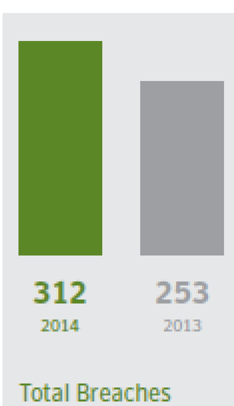
Targets of Cyber Attack

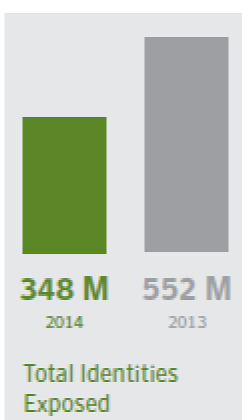
Cyber Threats and intrusion attempts are increasing at an alarming rate, according to Symantec, a worldwide leader in information assurance, and their *"2014 Internet Security Threat Report"* that was published in April 2015. This report is a compilation of Symantec data broken out by multiple attack categories. A notable statistic in this report is the 113% increase in "Ransomware" attacks in 2014 when compared to similar attacks in 2013. The following is a representation of the increase in various cyber related attacks and vulnerabilities from 2013 to 2014 according to Symantec:





DATA BREACHES

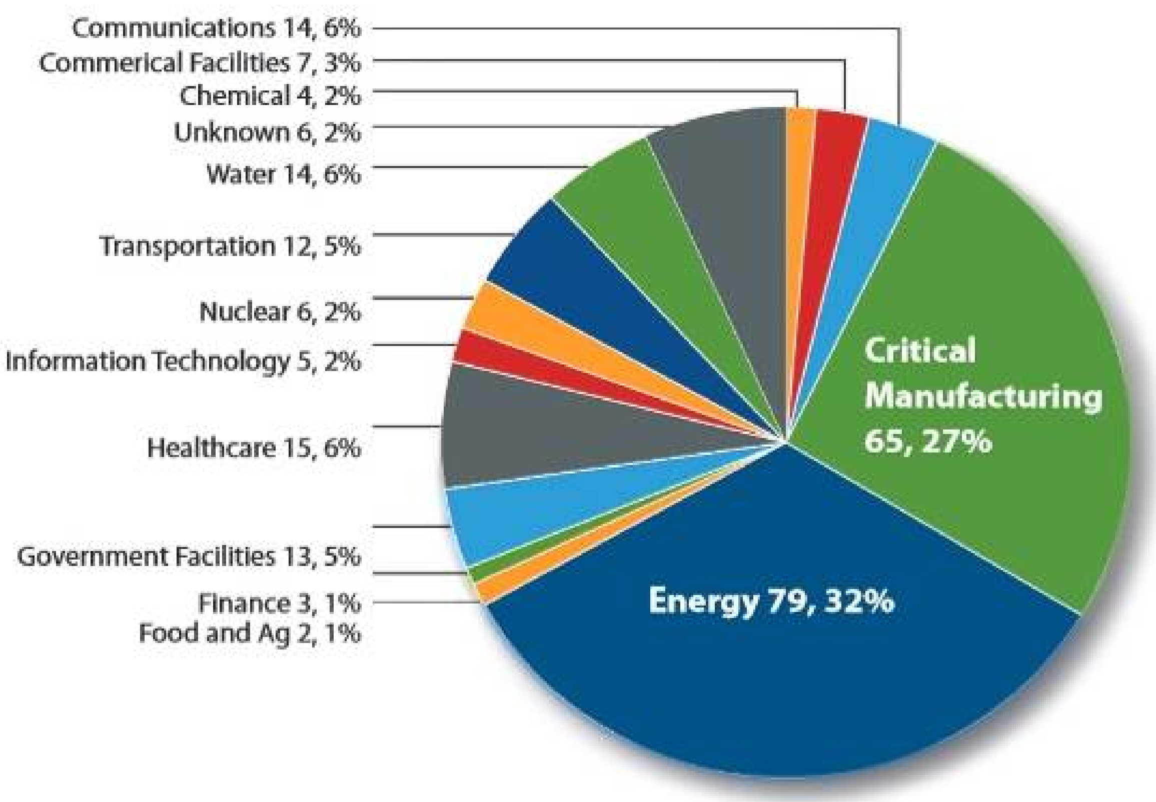




On March 12, 2015, a report was issued by the US Department for Homeland Security stating that in 2014 the Industrial Control Systems Cyber Emergency Response Team (ICS-CERT) responded to 245 incidents reported by asset owners and industry partners.

The energy sector led all others again in 2014 with 79 reported incidents, followed by manufacturing at 65 and healthcare at 15 reported incidents. ICS-CERT's continuing partnership with the Energy sector reportedly provides many opportunities to share information and collaborate on incident response efforts.

FY 2014 Incidents Reported by Sector (245)



Source: M2M Now

Also noteworthy in 2014 were the incidents reported by the Critical Manufacturing sector, some of which were from control systems equipment manufacturers. The ICS vendor community may be a target for sophisticated threat actors for a variety of reasons, including economic espionage and reconnaissance. Of the total number of incidents reported to ICS-CERT, roughly 55% involved advanced persistent threats (APT) or sophisticated actors.

Vulnerability to Cyber Threats
In the vast area of cyberspace a variety of vulnerabilities occur because of human, hardware, software and connection points that provide access to such systems.

The United States Computer Emergency Readiness Team (US-CERT) has provided a "high level overview" of cyber vulnerabilities for control systems. Common vulnerabilities include: wireless access points, network access points, unsecured SQL databases, poorly configured firewalls and interconnectedness with the Internet. Similarly, the National Institute of Standards and Technology (NIST) published the "Guide for Conducting Risk Assessments" (2012). This guide provides IT managers with a process to assess their network vulnerabilities, measure the potential of each vulnerability, and recommendations to counteract the found vulnerabilities.

This review on vulnerabilities focuses on two perspectives. First, those vulnerabilities found in Industrial Control Systems and, second, those vulnerabilities commonly found in local government computer systems. The rationale for focusing on these two perspectives comes from the likelihood that a significant cyber-attack on Franklin County would be directed at the county's computer systems or at critical infrastructure owned and operated within the county.

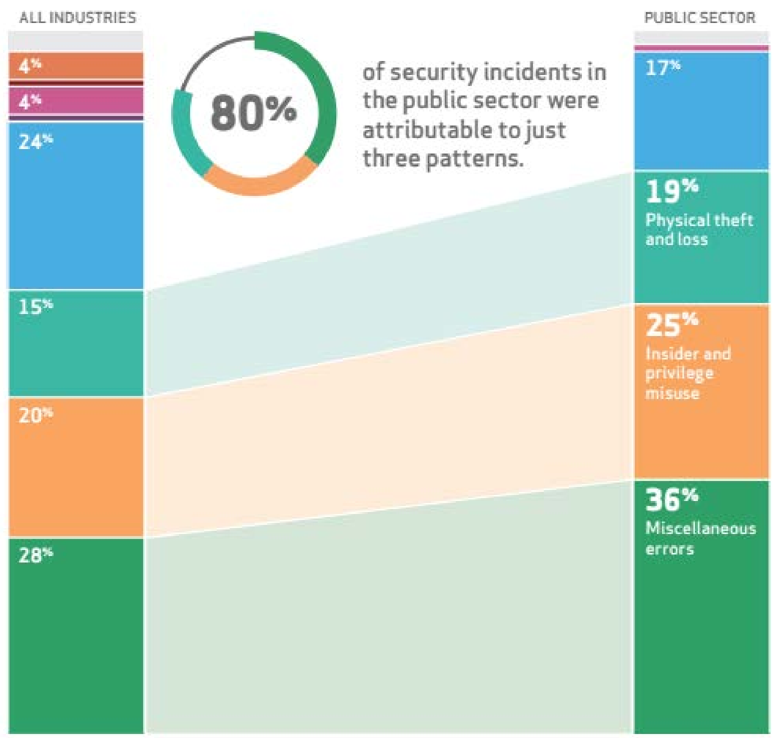
Industrial Control Systems: The Department of Homeland Security (DHS) analyzed data from three different sources regarding the vulnerability of Industrial Control Systems (ICS). The three sources of information included: Assessment of ICS products by DHS's Control Systems Security Program (CSSP), Assessment of ICS products by DHS's Industrial Control System Cyber Emergency Response Team (ICS-CERT), and Self-Assessments using DHS's Cyber Security Evaluation Tool (CSET)

On May 14, 2015, the website securityzap.com identified the following list of common vulnerabilities according to research and reports of the United States Computer Emergency Readiness Team:

- Buffer overflow
- Cross Site Scripting
- Lack of proper access control policy
- Lack of password policy
- Poor or No patch management
- Lack of data protection policy
- No maintenance of OS and security patches
- Outdated software utilization

- Lack of testing facilities
- Dual NIC usage
- Lack of remote access security
- DoS and DDoS vulnerabilities
- Clear text utilization
- Lack of Intrusion Detection System (IDS) and Intrusion Prevention System (IPS)
- Poor log maintenance
- Lack of proper AV or Malware Protection software

Expanding on data presented during the 2014 version, the 2015 Verizon Wireless Data Breach Investigations Report (DBIR) states that 80% of all attacks on the public sector can be assigned to three main patterns.[45]



Source: 2015 Verizon Data Breach Investigations Report

The most prominent cause of data loss in the public sector is miscellaneous errors. These errors are caused by unintentional actions that lead to a compromise and can be attributed to staff in 80% of cases. This includes sending information to the wrong recipient, either by post or email; incorrect disposal of assets, such as failure to shred physical documents; and publishing private data to a public site. Insider and privilege misuse made up 25% of the security incidents affecting the public sector organizations. Insider and privilege misuse is when employees use unapproved hardware, such as flash drives, to take data out of the organization. Finally, the third biggest threat to the public sector is the physical theft or loss of assets. This can be due to carelessness, like leaving a laptop on a train, or to malice.

Internet Connectivity: Connections to the Internet are widely known as a significant vulnerability for any ICS system. DHS's ICS-CERT program, using a freely available search engine (SHODAN), identified some 7,200 critical infrastructure sites with Internet connections. In addition, currently there are published tools that help attackers target so-

[45] "Verizon Wireless 2015 Data Breach Investigations Report – Industry Reports – Critical Infrastructure" Verizon Wireless, Retrieved August 4, 2015 from http://www.verizonenterprise.com/DBIR/2015/resources/#Industry

called programmable logic controllers, which are the building blocks for many industrial control systems. In February 2012 several new tools that were released and used to attack programmable logic controllers were used to attack General Electric, Rockwell Automation Inc., and Schneider Electric.

Local Government Systems: Many local governments lack the cyber security expertise to keep pace with the advancements being made by groups and organizations intent on taking advantage of the vulnerabilities that exist in most computer systems. The following list of vulnerabilities is common to many local governments and, if addressed, would enhance community resilience to any cyber-threat.

<u>Employee training</u>: Often employees are not made aware of their IT system vulnerabilities, many of which involve actions undertaken or not undertaken by the employees themselves. Employees made aware of suspicious emails, spam, irregular software operations, etc. are more likely to notify cyber security personnel.

<u>Improper Access, Authentication and Authorization policies:</u> These policies determine which groups or individuals can connect and use specific resources on the organization's IT systems. Access, authentication and authorization allow the right people to interface with the proper segments of the network, the right servers and the appropriate data.

<u>Lack Intrusion Detection/Prevention</u>: Intrusion detection systems and intrusion prevention systems, along with firewalls, form the basic security against cyber-threats. They are typically supplemented with other layers of protection. These systems generate information that can identify what components of the network are being targeted by adversaries.

<u>Lack Distributed Denial of Service Protection:</u> Hackers have become adept at commanding armies of "robot" computers they've managed to infect over time. These botnets can suddenly bring down a website, leading to disruption in business processes and compromises in data integrity. Software installed to prevent such attacks are able to detect traffic anomalies and filter out only the attack traffic while maintaining the uninterrupted flow of legitimate traffic.

In summary, vulnerabilities to government, corporate, business, and industrial computer networks are numerous. However, recognition of those vulnerabilities is one of the first steps to enhancing cyber security. An assessment of industrial control systems and government computer networks can identify the specific vulnerabilities to be addressed.

Consequences of Cyber Attack

Cybersecurity **–** the safeguarding of computer systems and the integrity, confidentiality and availability of the data they contain has long been recognized as a critical national policy issue whose importance continues to grow as computers are integrated into more and more aspects of our daily lives. As this growth continues, so will the potential consequences of a successful attack upon any one computer network. Actions that individuals, organizations or nation states can deliberately undertake with the intent to do harm can be broadly classified as: fraud, sabotage, theft or vandalism.

Fraud – a deliberate action taken to benefit an individual or organization at the expense of others. The most common forms of cyber fraud are the online acquisition and use of credit cards. Other forms of cyber fraud directed at acquiring financial assets includes the non-delivery of products paid for through online auctions and non-delivery of software purchased online. Cyber fraud can also include the unauthorized access to confidential information, identity theft, concocting of phony personas and intimidation of individuals particularly through social networks

Sabotage - a deliberate action taken to cause failure, damage or defeat of a process, organization or government. The worst cyber-attacks would be those that physically destroy critical infrastructures: destroying electric generators, oil refineries and pipelines; crashing trains in tunnels and on bridges; causing leakages of toxic substances from chemical plants and so on. In addition to the direct loss of human life, these attacks are intended to deprive large populations of essential goods and services for extended periods of time. Some of them would cause the economy in the attacked region to shut down. Those attacks with national implications could cost in the trillions of dollars and undermine national defense.

Theft – the intentional unauthorized taking of physical, informational or financial assets. Of primary concern is the theft of intellectual property. The theft of such property is not viewed as a single event; rather, as a wholesale transfer of wealth from the targeted economy to those conducting the attack. The intended consequences of these activities over time will be to reduce economic growth, reduce competitiveness and cause a loss in jobs.

Vandalism – the act of editing, defacing or destroying information and/or processes so as to perpetrate a hoax, cause embarrassment or to deny access to an essential service. Most cyber acts of vandalism are committed on impulse, often by those who are bored and/or malicious. Frequent targets of vandalism include corporations, politicians, celebrities, or information devoted to a controversial topic or current event.

The types and magnitude of negative consequences from an individual cyber-attack are numerous, depending on the entity under attack, the conditions under which the attack is undertaken, and the time at which the attack occurs. For example, without the proper controls in place, a virus on a personal computer used for surfing the Web and managing a home area network might migrate to the owner’s electric vehicle which, in turn, might spread to an electric charging station and then to other charging stations. The malware maliciously installed as a result of the virus’ migration could cause a car's computer systems to fail or cause the electrical power grid to destabilize by using a time-synchronized attack to charge/discharge many grid-connected vehicles' batteries at the same time.

In conclusion, acts of fraud, sabotage, theft, and vandalism are likely to grow in number as cyber systems continue to expand into all aspects of life.

Cyber Attacks in the United States

At the national level, cyber-attacks are often categorized as those affecting national security, those affecting commerce and intellectual property, and those affecting individuals. An example of each is provided:

National Security: In February of 2012 NASA's Inspector General testified that computers with Chinese-based internet protocol addresses had gained full access to key systems at the NASA's Jet Propulsion Laboratory. The attackers were successful in deleting sensitive files, altering code within files, creating user accounts associated with mission-critical laboratory systems, and uploaded hacking tools enabling user credentials to be stolen.

Intellecutal Property: In 2009, a Dupont research chemist downloaded proprietary information to a personal email account with the intent of transferring sensitive information to the Peking University in China. The individual also attempted to secure funding from the Chinese government as part of a commerical venture related to the information he had stolen.

Washington state health insurer Primera Blue Cross said up to 11 million customers could have been affected by a cyberattack in 2014.[46] Hackers gained access to its computers on May 5, 2014 and the breach was not discovered until January 29, 2015. The breach could have exposed members' names, dates of birth, Social Security numbers, mailing and email addresses, phone numbers and bank account information. The company is working with the F.B.I. and a cybersecurity firm to investigate.

Personal Information: In March 2012, attackers infiltrated a server at the Federal Retirement Investment Board resulting in 43,600 people having their personal information accessed, including their names, addresses and social security numbers.

Cyber Attacks in Ohio

Reported incidents strictly within the State of Ohio are few in number; however, incidents are most likely to be under reported as organizations may be reluctant to report an incident so as not to bring further attention to any vulnerability in their systems. The few incidents found in the general literature include:

The Nuclear Regulatory Commission confirmed that in January of 2003 the Microsoft SQL Server worm know as Slammer infected the control system at the Davis-Besse nuclear power plant in Oak Harbor, Ohio. The plant's safety monitoring system was disabled and the plant's process computer failed taking about 6 hours to repair.

[46] "9 Recent Cyber Attacks against Big Business", NY Times Online, Retrieved online 5 February 2015 from http://www.nytimes.com/interactive/2015/02/05/technology/recent-cyberattacks.html?_r=2

In 2010, hackers were able to gain access to The Ohio State University computer network reaching some 700,000 records of former and current students.

In 2013 in Steubenville, Ohio, cyber threats and subsequent attacks were launched at targeting the local High School during judiciary hearings following a high-profile rape case involving local high school students.

In June, 2017, the Governor's website was the target of a successful cyber attack – as well as 10 other Ohio State websites and 2 servers. Pro-ISIS messages directed towards President Trump were posted and attempted attacks on other Ohio government websites took place as well.

Cyber Attacks in Franklin County

Much like other large metropolitan areas, Franklin County, the City of Columbus and other county jurisdictions are not immune to the growing risk presented by cyber threats. However, to date none of the intrusions have resulted in a significant data loss.

The focus of cyber security moved to the forefront of FCEM&HS during the 2013 Risk Assessment Update. Prior to the 2013 Risk Assessment update, cyber security was not listed as a separate hazard, but lumped together within the all-encompassing "Terrorism" hazard. With a tremendous amount of foresight, FCEM&HS chose to separate various terrorism related hazards, which ultimately led to cyber-terrorism being ranked number five during the 2013 Risk Assessment Update. Based on this ranking, FCEM&HS received funding support to establish a private/public sector working group in 2014, known as the Central Ohio Cyber Security Working Group. This group was chaired by Mr. Jack Partridge, Chief Policy Officer, NiSource; Ms. Paula Brooks, Franklin County Commissioner; and Mr. Zach Klein, City of Columbus Councilman. The group met seven times over ten months during late 2014 and into 2015. The group was tasked with developing a vision, mission and goals and objectives for the working group.

In May of 2015, the Working Group presented two documents, the first being the Central Ohio Cyber Security Strategy which outlines the cyber security threat, the vision and mission statement of the group, goals and objectives of the group, as well as a process flow chart for information exchange during a possible cyber incident and an established threshold for the classification of a large scale cyber emergency. The second document was The Local Jurisdictions Guide to Cyber Security, a blueprint for other Ohio County Emergency Management Directors wishing to establish a similar project in their respective counties. Finally, as a capstone to phase one of the working group, a private/public sector Tabletop Exercise (TTX) took place in July of 2015 to vet and evaluate the flow and exchange of information during a potential cyber emergency. Both the Central Ohio Cyber Security Strategy as well as The Local Jurisdictions Guide to Cyber Security are available through the FCEM&HS website.

Vulnerability Assessment – Cyber Terrorism

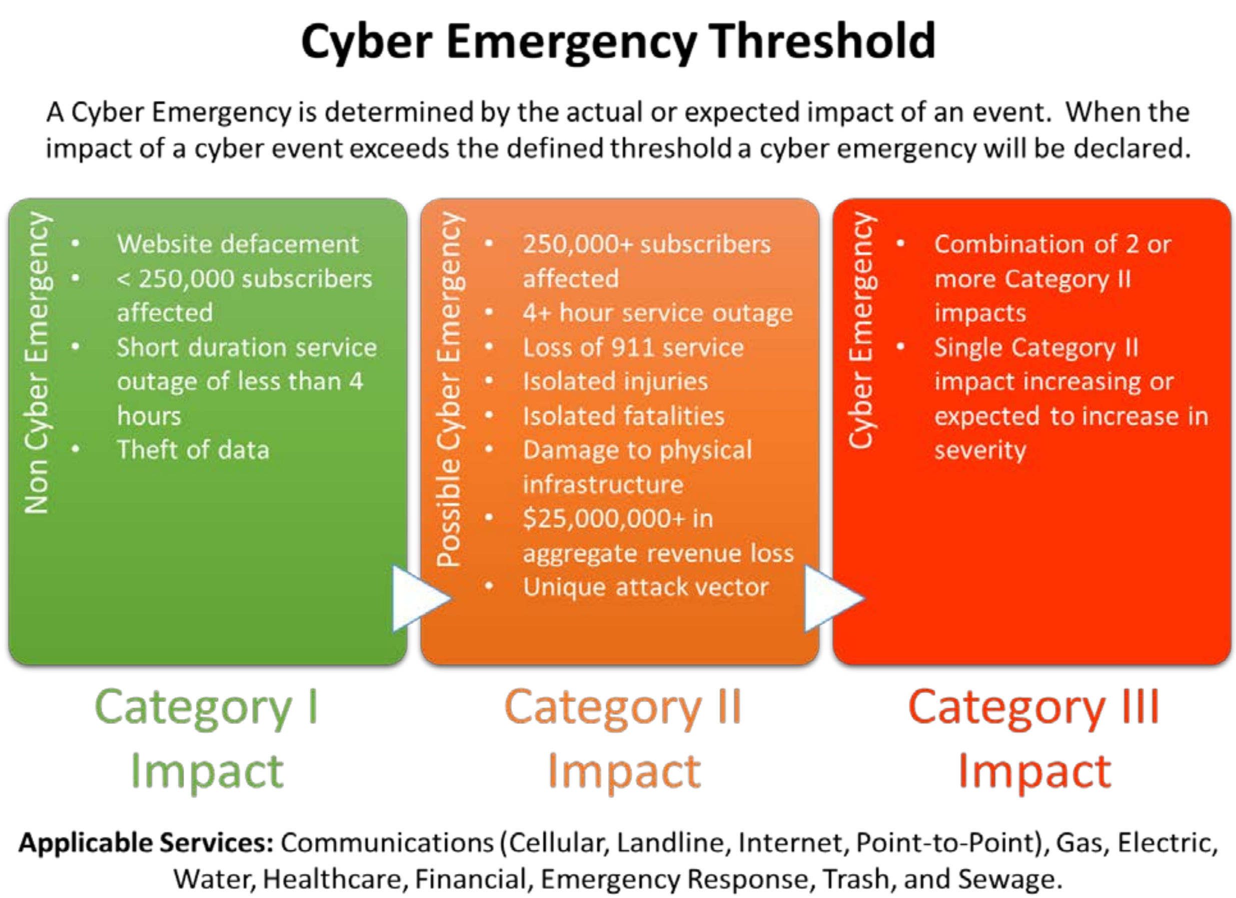
This hazard is considered to be a "Relatively Moderate Probability Event", meaning there exists direct intelligence information that an act of sabotage, terrorism or criminal intent (foreign or domestic, external or internal) is being directed towards similar targets in the United States. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability

Franklin County is at risk of a cyber terrorism event as is the entire country. No structural damage due to cyber terrorism in Franklin County is expected.

Potential Impact of Cyber Terrorism

A cyber terrorism event could cause a major impact and have a long-lasting effect. No damage to structures is anticipated due to cyber terrorism; however, a major economic impact would be expected. According to the "CYBER TERRORISOM THRESHOLD MATRIX" used by Franklin County Emergency Management and Homeland Security, a cyber emergency exists when the economic loss threshold of $25,000,000 is realized.



Identifying Structures

No structures would experience damage due to cyber terrorism; therefore, this updated risk assessment does not identify existing or future buildings at risk of loss due to cyber terrorism.

Exposure of Existing Buildings to Damages Due to Cyber Terrorism

No existing buildings are exposed to damage due to cyber terrorism.

Exposure of Future Buildings to Damages Due to Cyber Terrorism

No future buildings will be exposed to damage due to cyber terrorism.

Estimating Potential Loss

Methodology

Estimated potential structural dollar loss due to cyber terrorism is estimated to be $0.00 because no historical data is available for losses due to cyber terrorism. However, impact to Franklin County could be significant. The potential impact threshold as described above is $25,000,000.

Estimated Potential Dollar Losses

The estimated potential dollar loss annually in Franklin County for structural damage due to cyber terrorism is $0.00.

For this assessment, the FCEM&HS approved threshold of $25,000,000 is the potential impact and dollar loss.

Infectious Diseases - #3

Hazard Summary

Infectious diseases are illnesses caused by the entrance into the body of harmful microbial organisms which grow and multiply. The diseases of most concern to the health and welfare of communities are those that are communicable. Communicable diseases are caused by microorganisms such as bacteria, viruses and parasites and are transmitted from an infected person/animal and/or contaminated food or water source to another person or animal. Franklin County is susceptible to many common infectious diseases, such as seasonal flu, as well as diseases that are newly emerged or re-emerging, such as H5N1 Influenza (avian flu). This hazard was ranked No. 3 out of 20.

Hazard Profile

According to the Centers for Disease Control (CDC), infectious diseases are illnesses caused by germs (such as bacteria, viruses, and fungi) that enter the body, multiply, and can cause an infection. Some infectious diseases are contagious/communicable; that is, spread from one person to another. Other infectious diseases can be spread by germs carried in air, water, food, or soil. They can also be spread by vectors such as insects or by animals which is referred to as zoonotic disease.

Emerging means infections that have increased recently or are threatening to increase in the near future. These infections could be:

- completely new (e.g. Bourbon virus, Middle East Respiratory Syndrome (MERS)).
- new to an area (e.g. chikungunya in Florida).
- reappearing in an area (e.g. dengue in south Florida and Texas).
- caused by bacteria that have become resistant to antibiotics (e.g. methicillin-resistant Staphylococcus aureus (MRSA), C. difficile, or drug-resistant tuberculosis)[47].

Infectious diseases are a major threat to public health and cause devastating outbreaks. H1N1 influenza, AIDS, SARS, drug-resistant bacteria, and Ebola virus are recent examples.

Emerging diseases have roughly quadrupled over the past 50 years. Disease emergence has been viewed as a two-step procedure:

1. Introduction of an agent into a new host group or population.
2. Adoption (i.e., establishment and dissemination of the agent in the new host population.

The process by which these agents may be transferred across populations has been called “microbial traffic,” defined as the process by which infectious agents may transfer from animals to humans or disseminate from isolated groups into new populations. A variety of natural and human activities promote microbial traffic. They include:

- Changes in human and animal demographics, living/husbandry conditions, and behavior. (e.g., population growth and migration due to economic or cultural changes, civil unrest and war, disease, poverty, sexual behavior).
- Ecological changes, including those due to economic development and land use through agricultural and industrial expansion, and resulting pollution.
- Advances in technology and industry, including changes in food production, processing, and distribution; advances in medical techniques (transplantation) and products (drugs).
- Increased global travel and commerce.
- Microbial adaptation and change.

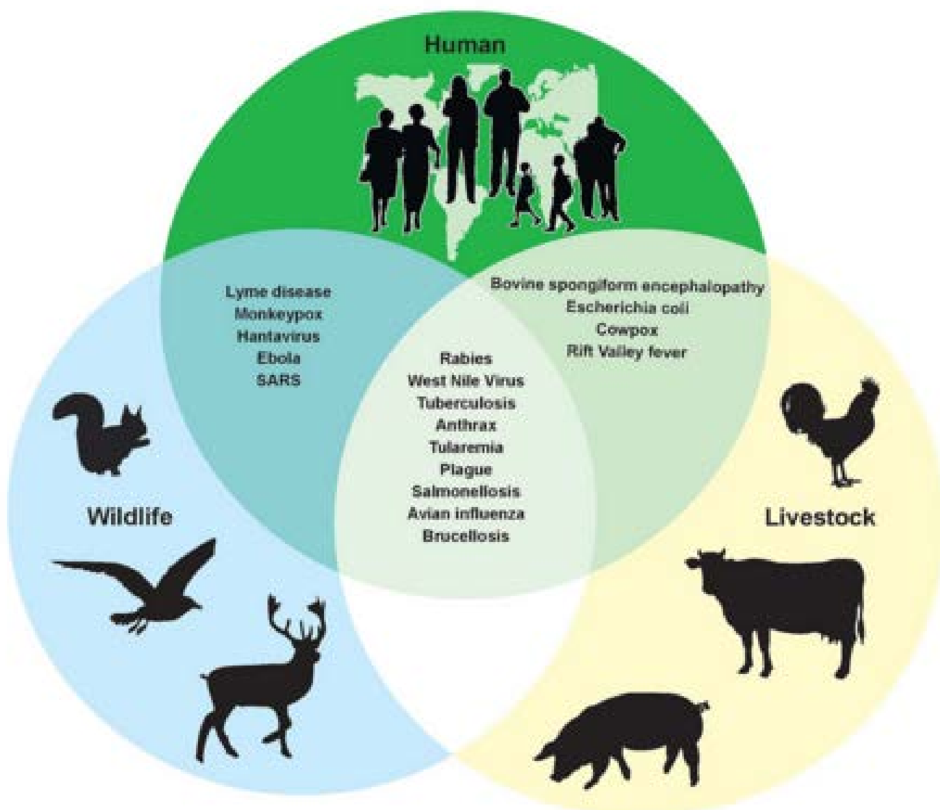
Emerging diseases are often zoonotic which means they are diseases that may be transmitted between animals and humans. These include:

[47] CDC National Center for Emerging and Zoonotic Infectious Diseases (NCEZID), accessed on 28 July 2015 http://www.cdc.gov/ncezid/who-we-are/about-our-name.html

- Those which can be transmitted directly from animals to humans (e.g., rabies)
- Diseases that can be acquired indirectly by humans through ingestion, inhalation, or contact with infected animal products, soil, water, or other environmental surfaces which have been contaminated with animal waste or a dead animal (e.g., anthrax)
- Vector-borne diseases which require a mosquito or other arthropod to transmit the disease from animals to humans (e.g., West Nile Virus)

Zoonotic diseases cannot usually be eradicated due to the fact that it is not possible to eliminate all of the animal reservoirs or vectors that might be carrying the zoonosis.

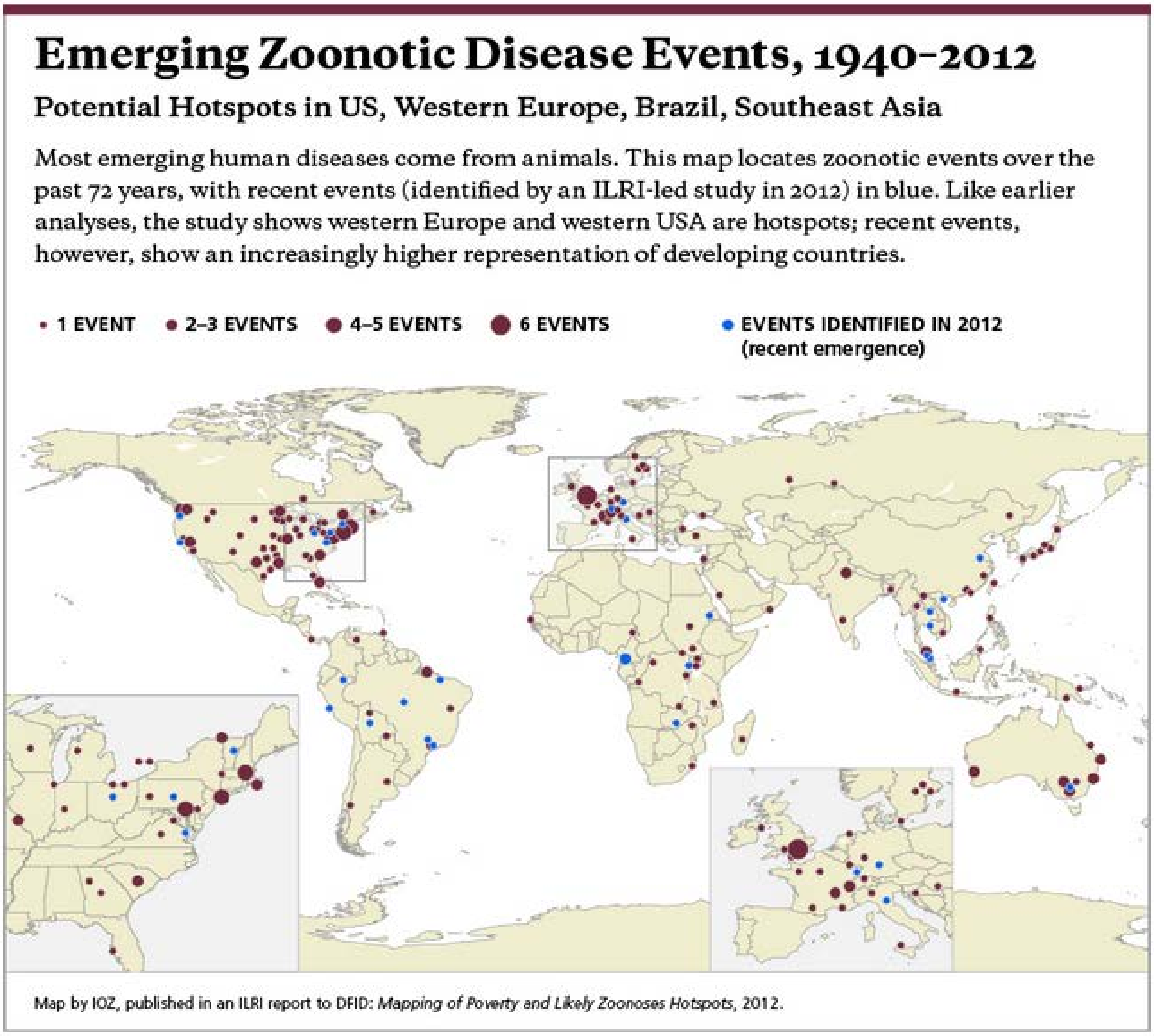
Some 60% of all diseases are zoonotic.[48]



Source: US GAO report GAO-12-55

The map below, originally published in an International Livestock Research Institute (ILRL) report, illustrates zoonotic events from 1940-2012.

48 "Zoonotic Diseases," CDC, accessed on 5 September 2015, http://www.cdc.gov/onehealth/zoonotic-diseases.html



The recent analysis found that top hotspots include Ethiopia, Nigeria, Tanzania, and India and that increased demand for livestock products is likely to fuel the spread of zoonotic disease. Researchers found a strong association between poverty, hunger, livestock keeping, and zoonoses[49].

Currently, the World Health Organization (WHO) is monitoring about 40 emerging infectious diseases which have been around only a few decades. The list includes acquired immune deficiency syndrome (AIDS), Ebola, dengue hemorrhagic fever, Lassa fever, Nipah, Hendra, hantavirus, Marburg, monkeypox, mad cow disease, severe acute respiratory syndrome (SARS), West Nile virus, Lyme disease, Legionnaires' disease, the cyclospora parasite, Middle East Respiratory Syndrome (MERS), and the latest pandemic (H1N1) 2009 influenza A virus. These pathogens – or disease-causing agents – have either mutated or

[49] "Mapping of poverty and likely zoonoses hotspots," International Livestock Research Institute, last modified on 2 July 2012, https://cgspace.cgiar.org/bitstream/handle/10568/21161/ZooMap_July2012_final.pdf?sequence=4

genetically recombined to become new strains or novel microbes, or they may have existed for millennia but were not discovered until recent years. According to the WHO, at least one new infectious disease has emerged every year since 1980, many of which evade traditional therapies and have no vaccine or cure. At the same time, old infectious diseases once believed to be controlled, such as tuberculosis, are reemerging as deadly new, often drug-resistant strains, or are springing up in new regions of the world. 16% of all deaths worldwide are caused by infectious diseases[50].

Left unchecked, today's emerging diseases can become the endemic diseases of tomorrow. This is what happened with HIV/AIDS, which emerged in a remote part of Africa during the 1970s, spread throughout the world during the 1980s, and is now entrenched on all continents.

Infectious Diseases in the United States

Recent outbreaks underscore the potential for the sudden appearance of infectious diseases in currently unaffected populations. Each year approximately 23.6 million physician visits and 3.9 million hospital outpatient visits in the U.S. are attributed to infectious and parasitic diseases, with costs for treating infectious diseases estimated at more than $120 billion per year[51].

Contamination of the municipal water supply in Milwaukee, Wisconsin, in 1993 resulted in an outbreak of cryptosporidiosis that sickened an estimated 400,000 people; approximately 4,400 persons required hospitalization. In the 1990s, epidemic cholera reappeared in the Americas after being absent for nearly a century. During the 1980s, tuberculosis reemerged in the United States after decades of decline, and drug-resistant strains have made its control more difficult. The increasing prevalence of antibiotic-resistant strains suggests rising treatment and control problems. Many other cases of emerging infections can be identified. The CDC reports the following new disease cases as of 2014.

- Number of new tuberculosis cases: 9,421
- Number of new salmonella cases: 51,455
- Number of new Lyme disease cases: 33,461
- Number of new meningococcal disease cases: 433[52]

Intentional releases of biologic agents in the United States have also intensified concerns about bioterrorism. This will be discussed in the CBRNE Terrorist Incident hazard profile.

Lyme Disease

[50] "Infectious Diseases," Center for Strategic & International Studies, accessed on 5 September 2015, http://www.smartglobalhealth.org/issues/entry/infectious-diseases

[51] "FastStats Infectious Disease," CDC, accessed on 20 June 2015, http://www.cdc.gov/nchs/fastats/infectious-disease.htm

[52] "Infectious Diseases," CDC, accessed on 1 December 2017, https://www.cdc.gov/nchs/data/hus/hus16.pdf#033

Lyme disease is transmitted to humans through the bite of infected blacklegged ticks. Typical symptoms include fever, headache, fatigue, and a characteristic skin rash called erythema migrans. If left untreated, infection can spread to joints, the heart, and the nervous system.[53]

In 1975, two concerned mothers from Lyme, Connecticut, reported a cluster of children thought to have juvenile rheumatoid arthritis. A surveillance system was created to identify children with inflammatory joint disease, and a study was undertaken at Yale University to determine the cause.

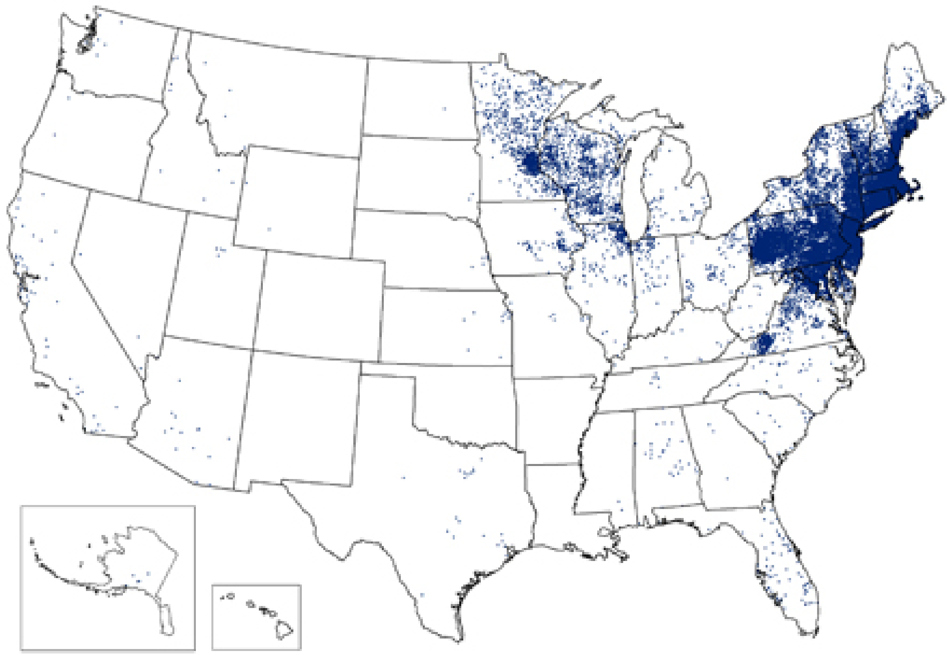
The study showed that the cases were clustered with a frequency rate 100 times that of juvenile rheumatoid arthritis. Some families had more than one affected member. Half the affected residents lived in heavily wooded areas on two adjoining county roads. The majority of patients noted onset of symptoms in the summer or early fall. These features seemed most compatible with an arthropod-vectored illness (carried by insects or arachnids.)

Many patients reported an expanding lesion around the area thought to be an insect bite. Many remembered being bitten by a tick at the site of the lesion about 12 days before the symptom onset. One patient had saved the tick, identified as the black-legged tick found on white-footed mice and white-tailed deer. Subsequent studies into the vector and affected patients revealed the disease agent, the spirochete *Borrelia burgdoferi,* in the early 1980s.

Since its discovery, Lyme disease has become the most reported vector-borne disease in the United States. In 2014, it was the fifth most common Nationally Notifiable disease; however, this disease does not occur nationwide and is concentrated heavily in the northeast and upper Midwest. In 2013, over 35,000 confirmed and probable cases were reported to the CDC. In 2014, 96% of confirmed Lyme disease cases were reported from 14 states: Connecticut, Delaware, Maine, Maryland, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and Wisconsin.

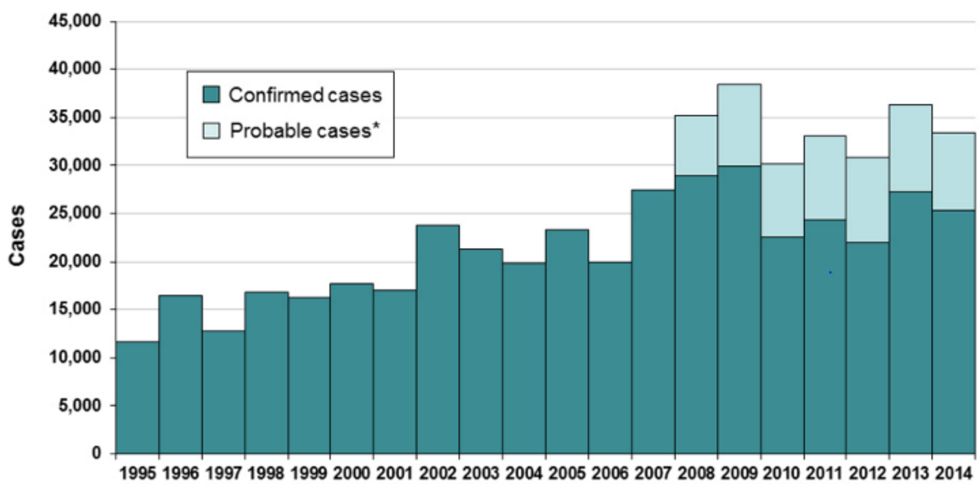
[53] "Lyme," CDC, accessed on 20 June 2015, http://www.cdc.gov/lyme/

Reported Cases of Lyme Disease -- United States, 2014



1 dot placed randomly within county of residence for each confirmed case

Reported Cases of Lyme Disease by Year, United States, 1995-2014



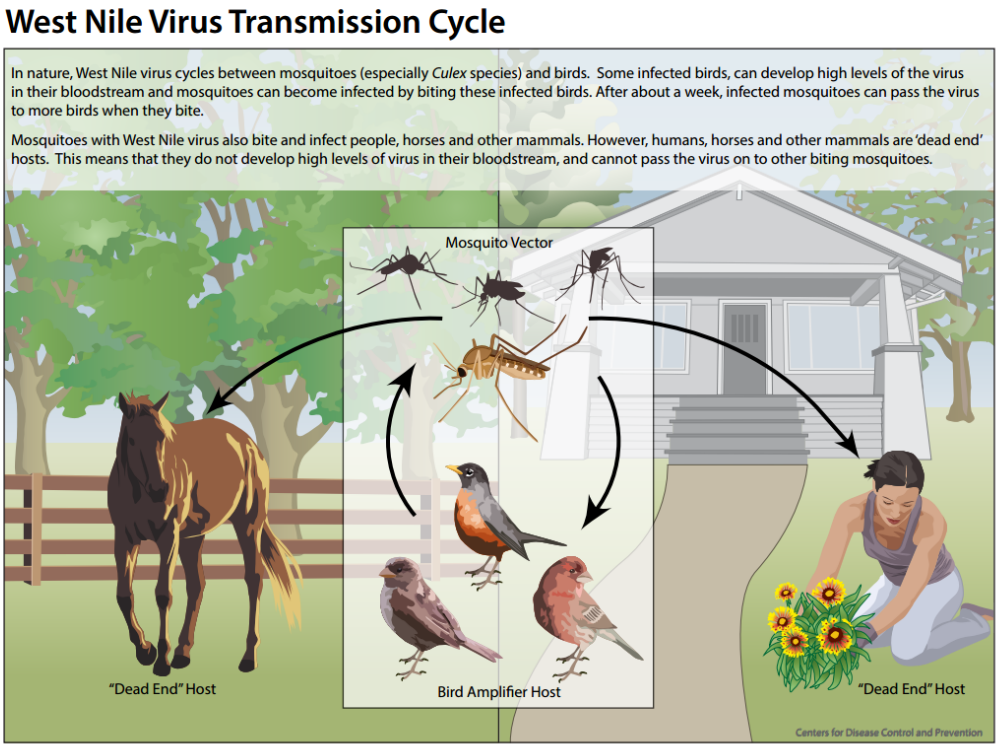
Source: CDC

Lyme disease is diagnosed based on symptoms, physical findings, and the possibility of exposure to infected ticks. Most cases of Lyme disease can be treated successfully with antibiotics. Steps to prevent Lyme disease include using insect repellent, removing ticks promptly, applying pesticides, and reducing tick habitat[54].

West Nile Virus

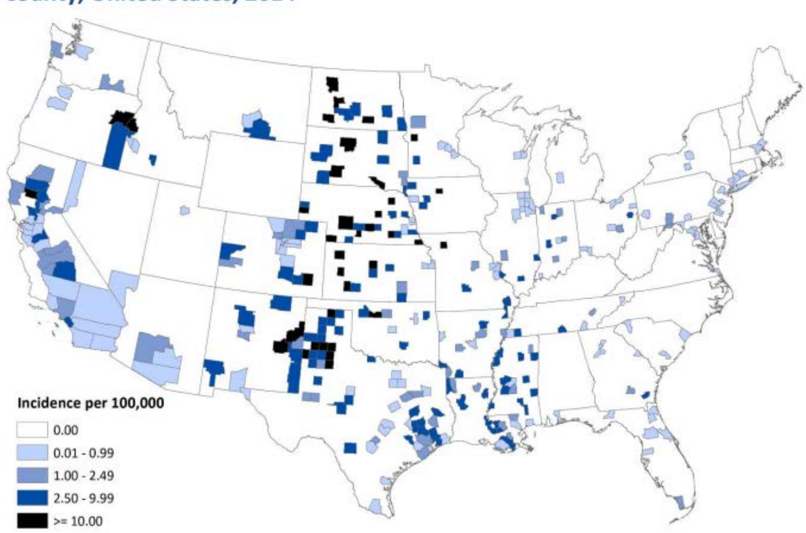
[54] "Lyme," CDC, accessed on 21 October 2015, http://www.cdc.gov/lyme/

West Nile Virus (WNV) is a mosquito-borne virus that can cause encephalitis (inflammation of the brain) and/or meningitis (inflammation of the lining of the brain and spinal cord). Outbreaks of the disease caused by WNV have occurred in Egypt, Asia, Israel, South Africa, some parts of Europe and Australia. The virus was first seen in the U.S. in the fall of 1999 in New York City and has since spread across the country to the Pacific Ocean, into several Canadian Provinces, and possibly into Mexico.



West Nile Virus primarily infects and multiplies in birds, mostly through the bite of an infected mosquito, which serve as reservoirs for the virus. It has been detected in more than 162 species of birds; however, crows and blue jays are more severely affected than other species and often die as a result of their infection. When the level of the virus circulating among birds and mosquitoes becomes high, horses and humans can be infected.

West Nile virus neuroinvasive disease incidence reported to ArboNET, by county, United States, 2014



Source: ArboNET, Arboviral Diseases Branch, Centers for Disease Control and Prevention

In humans who become infected, 70-80% do not develop any symptoms. About 20% of people who are infected will develop a fever with other symptoms such as headache, body aches, joint pains, vomiting, diarrhea, or rash. Most people with this severity of illness recover completely, but fatigue and weakness can last for weeks or months. Less than 1%

of people who are infected develop a serious neurologic illness such as encephalitis or meningitis (inflammation of the brain or surrounding tissues). The symptoms of neurologic illness can include headache, high fever, neck stiffness, disorientation, coma, tremors, seizures, or paralysis. Recovery from severe disease may take several weeks or months, and some neurologic effects may be permanent. About 10% of people who develop neurologic infection due to West Nile virus will die.

In the United States since 1999 West Nile Virus outbreaks have occurred every summer and activity has been reported in all states except Hawaii and Alaska[55].

Pandemic (H1N1) 2009 Influenza A

Pandemic influenza has occurred naturally throughout history. There have been four flu pandemics in the last 100 years.

- 1918 – 1919: Spanish Flu, 675,000 deaths in the U.S.
- 1957 – 1958: Asian Flu, 70,000 deaths in the U.S.
- 1968 – 1969: Hong Kong Flu, 34,000 deaths in the U.S.
- 2009: H1N1, 12,469 deaths in the U.S.[56]

The 2009 H1N1 influenza was a virus of swine origin that first caused human illness in Mexico and the United States in March and April 2009. It is thought H1N1 flu spread in the same way regular seasonal flu viruses spread, mainly through the coughs and sneezes of people who are sick, but also by touching infected objects and then touching your nose or mouth.

H1N1 infection has been reported to cause a wide range of flu-like symptoms, including fever, cough, sore throat, runny or stuffy nose, body aches, headache, chills and fatigue. In addition, many people also have reported nausea, vomiting and/or diarrhea.

From April 15, 2009 to July 24, 2009, states reported a total of 43,771 confirmed and probable cases of novel influenza A (H1N1) infection. Of these cases reported, 5,011 people were hospitalized and 302 people died.

On July 24, 2009, confirmed and probable case counts were discontinued. The CDC has not updated H1N1 information on its website since the outbreak ended in 2009/2010.

Ebola

Ebola is a rare and deadly disease caused by infection with a virus of the family Filoviridae, genus Ebolavirus. Ebola can cause disease in humans and nonhuman primates (monkeys, gorillas, and chimpanzees).

[55] "West Nile Virus," CDC, accessed on 20 June 2015, http://www.cdc.gov/westnile/

[56] "CDC Estimates of 2009 H1N1 Influenza Cases, Hospitalizations and Deaths in the United States, CDC, accessed on 13 June 2016, http://www.cdc.gov/h1n1flu/estimates_2009_h1n1.htm

Ebola viruses are found in several African countries. Ebola was first discovered in 1976 near the Ebola River in the Democratic Republic of the Congo. Since then, outbreaks have appeared sporadically in Africa.

The natural reservoir host of Ebola virus remains unknown. However, on the basis of evidence and the nature of similar viruses, researchers believe that the virus is animal-borne and that bats are the most likely reservoir.

People get Ebola through direct contact (through broken skin or mucous membranes) with blood or body fluids of a person who is sick with or has died from Ebola, objects that have been contaminated with body fluids from a person who is sick with or has died from Ebola, infected fruit bats or primates, and possibly from contact with semen from a man who has recovered from Ebola.

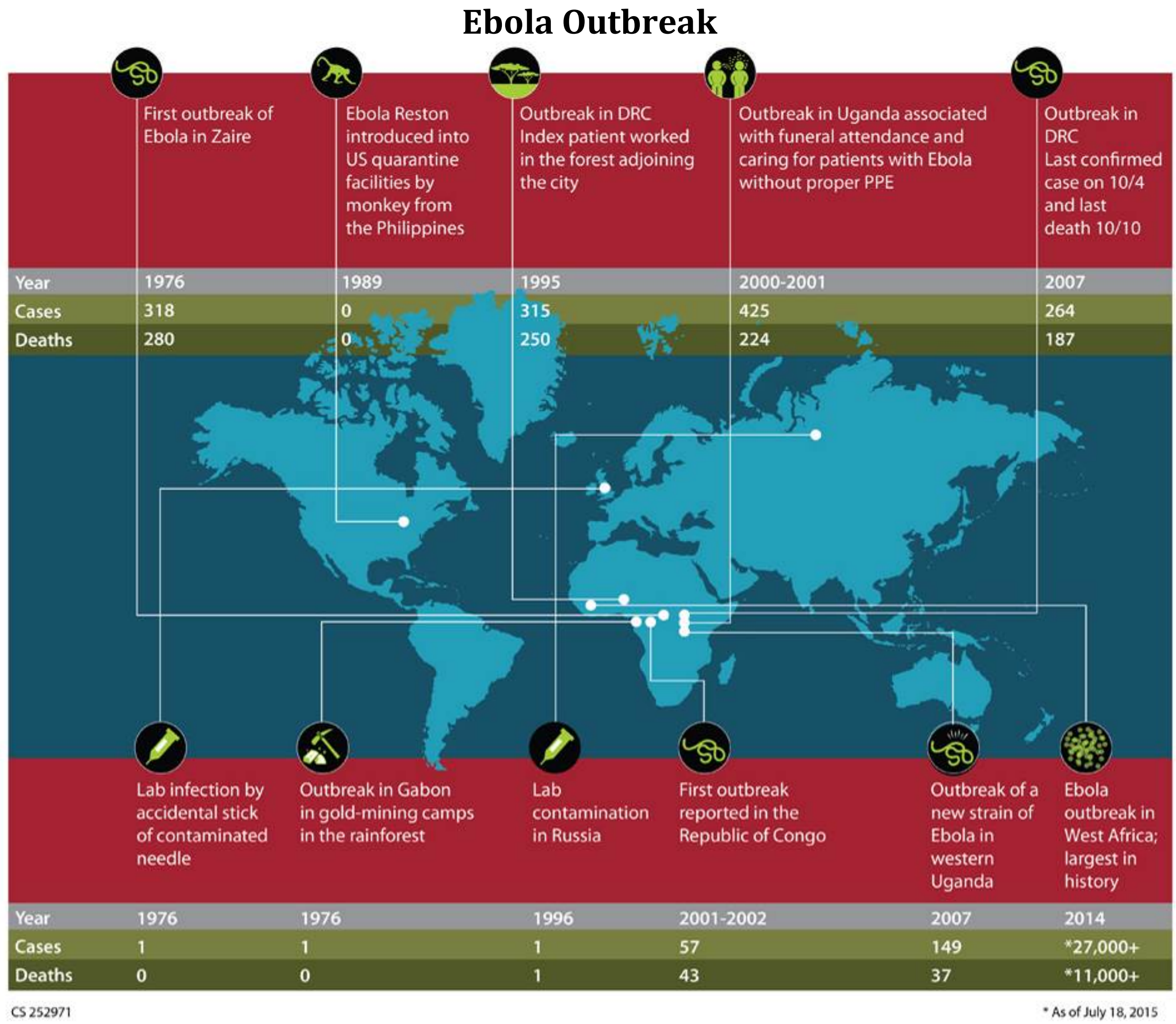
The 2014 Ebola epidemic was the largest in history, affecting multiple countries in West Africa. Two imported cases, including one death, and two locally acquired cases in healthcare workers were reported in the United States. On September 30, 2014, the CDC confirmed the first travel-associated case of Ebola to be diagnosed in the United States in a man who had traveled from West Africa to Dallas, Texas, and later sought medical care at Texas Health Presbyterian Hospital of Dallas after developing symptoms consistent with Ebola. That patient died of Ebola on October 8, 2014.

Two healthcare workers who had cared for the patient at Texas Health Presbyterian tested positive for Ebola on October 10 and 15, 2014. Both of these healthcare workers have recovered and were discharged from the hospital. On October 23, 2014, a medical aid worker who volunteered in Guinea was hospitalized in New York City with Ebola. The diagnosis was confirmed by CDC on October 24, 2014. The patient has recovered and was discharged from Bellevue Hospital Center.
Ebola is not spread through casual contact; therefore, the risk of an outbreak in the U.S. is very low[57].

<u>WHO Data Regarding Worldwide Ebola Case Counts as of October 24, 2015</u>[58]
Total Cases (Suspected, Probable, and Confirmed): 28,616
Laboratory-Confirmed Cases: 15,227
Total Deaths: 11,310

[57] "Ebola," CDC, accessed on 30 July 2015, http://www.cdc.gov/vhf/ebola/about.html
[58] "2014 Ebola Outbreak in West Africa," CDC, accessed on 1 February 2018, https://www.cdc.gov/vhf/ebola/outbreaks/2014-west-africa/case-counts.html

The below chart illustrates the outbreak of the ebola virus on a global level beginning in 1976.



Avian Flu

Beginning in 2015, H5 viruses have been detected in some U.S. commercial poultry flocks. CDC is monitoring this situation and continues to work with public and animal health partners to minimize the risk to human health. No human infections have been detected at this time and the CDC considers the risk to people from these infections in poultry to be low, but has developed interim guidance on testing and prophylaxis. It is important to note that similar viruses have infected people in the past and it is possible that human infections may occur.[59]

[59] "Avian Flu," CDC, accessed on 20 July 2015, http://www.cdc.gov/flu/avianflu/avian-flu-summary.htm

The 2015 avian flu outbreak had caused the death of over a million chickens and turkeys in the Midwest as of July 2015. The State of Ohio banned poultry shows from the Ohio State Fair and county fairs as a precaution to prevent the spread of the disease among poultry in Ohio.[60]

Infectious Diseases in Ohio

Infectious diseases know no geographic boundaries. The information on emerging infectious diseases in the United States also applies to Ohio and Franklin County.

Pandemic Influenza

Ohio was impacted by the four 20th and 21st century pandemics:

- 1918 – 1919: Spanish flu, 8,602 deaths
- 1957 – 1958: Asian flu, outbreaks reported in 71 counties with deaths in 63 counties.
- 1968 – 1969: Hong Kong flu, milder pandemic, similar to seasonal flu.
- 2009: H1N1 flu

Ohio created a comprehensive pandemic flu plan in 2004. An operational plan was written during a 120-day planning period from Mid-December 2005 to mid-March 2006 to ensure the Ohio pandemic flu response is operationally consistent with federal and local issues and concerns. The document brought together the efforts of several Ohio state agencies, led by the Ohio Department of Health.

The Ohio Department of Health has extensive human monitoring and reporting systems in place that include medical practitioners, hospitals and local health departments to detect and monitor flu outbreaks, and year-round laboratory testing capability.

West Nile Virus

Some birds and mosquitos in Ohio tested positive in 2002 with the first human case of West Nile Virus in humans in the same year. Ohio eventually reported 441 human cases of West Nile Virus that year. The chart below shows the number of human West Nile virus cases per year as indicated by the Ohio Department of Health (ODH).

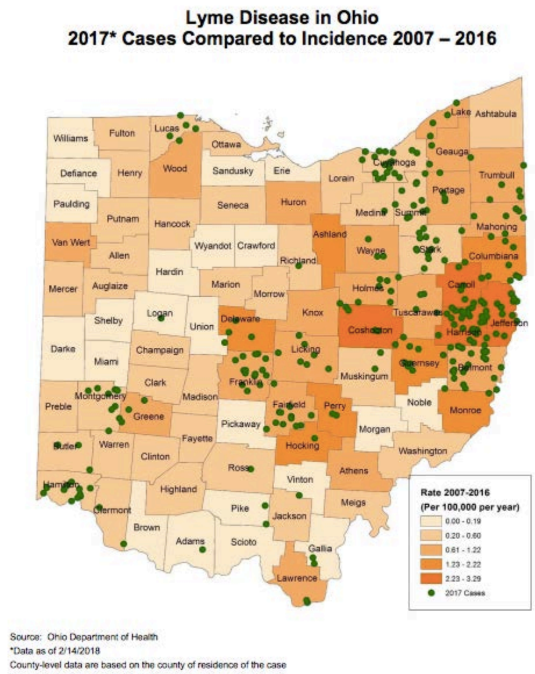
West Nile Virus Disease Incidence, Ohio 2002 – 2017

Year	# Cases
2002	441
2003	108
2004	12
2005	61
2006	48
2007	23
2008	15
2009	2
2010	5
2011	21
2012	122
2013	24
2014	11
2015	35
2016	17
2017	34
Total	**979**

Source: Ohio Department of Health
Data as of 11/16/2017

[60] "Avian Flu Outbreak Posing Threat to Ohio," WHIZ News, accessed on 27 July 2015, https://www.whiznews.com/content/news/local/2015/07/27/avian-flu-outbreak-posing-threat-to-ohio

The ODH Vector-borne Disease Lab monitors the occurrence of disease vectors, provides programs for surveillance of vector-borne diseases through laboratory testing of mosquitoes for infectious viruses, conducts laboratory testing of animal tissues for evidence of infection, provides consultation in prevention and control of arthropod vectors and pests, and provides a service of arthropod identification.



Lyme Disease

From 2007 – 2017, there have been 1,078 incidences of Lyme Disease in Ohio, rising steadily from 33 in 2007 go 251 as of November, 2017.[61] The incidence rate per 100,000 people has also increased in Ohio in recent years. In 2014 the incidence rate was .8, in 2015 it was 1.0, and in 2016 it was 1.1.[62]

Infectious Diseases in Franklin County

Columbus Public Health (CPH) and Franklin County Public Health (FCPH) are committed to reducing the risk and impact of the hazards presented by infectious diseases to its residents. The hazard analysis described below is an essential part of these efforts and serves to inform and shape the departments' risk reduction activities. These activities include:

- Detection and disruption of infectious diseases that threaten the health of the residents of Columbus and Franklin County – Prevent.
- Reduction of the vulnerability of the public in order to mitigate or neutralize the impact of infectious diseases – Protect.
- Action to address the short-term, direct effects of an outbreak of infectious disease – Response.
- Provision of public health services to identify health needs, define health resources, and address the long-term health and treatment of affected persons – Recovery.

[61] "Lyme Disease Incidence-Ohio," ODH, accessed on 1 November 2017, https://www.odh.ohio.gov/~/media/ODH/ASSETS/Files/bid/zdp/Diseases/lyme/lymemap.pdf

[62] "Lyme Disease Data and Statistics," CDC, accessed on 1 February 2018, https://www.cdc.gov/lyme/stats/tables.html#modalIdString_CDCTable_1

Infectious Disease Summary

This summary represents the 2013-2016 infectious disease data, the latest available for this publication, reported to state and local public health agencies as required by Ohio Administrative Code 3701-3-02. Only selected communicable diseases determined to be of public health significance are reportable; therefore, the data presented here does not represent all cases of communicable disease that occur among residents in Columbus and Franklin County. Additionally, only confirmed cases of disease have been analyzed for this summary. The data are considered provisional but provide valuable insight into these diseases.

Key findings are summarized below:

- In 2016, 3,454 cases of infectious disease* were reported among Columbus City and Franklin County residents, compared to 2,281 cases reported in 2015.
- Franklin County's total rate of infectious disease* increased from 182.2 cases per 100,000 population in 2015 to 273.1 cases per 100,000 in 2016. ƒ The rate of cryptosporidiosis increased annually from 2014 to 2016. Outbreaks in Central Ohio led to an unusually high rate in 2016 (75.8 cases per 100,000 population).
- The rate of shigellosis increased for the second year in a row, from 3.7 cases per 100,000 in 2014 to 32.2 cases per 100,000 in 2016.
- Rates of chlamydia, gonorrhea, hepatitis C and syphilis increased annually from 2014 through 2016.

The below charts are the counts and rates of the cited diseases among Franklin County Residents from 2013-2016.

ENTERIC DISEASES

	Year:	2013				2014				2015				2016			
	Population:	1,212,263				1,231,393				1,251,722				1,264,518			
		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses	
CLASS	DISEASE NAME	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†
B	Amebiasis	2	0.2	2	0.2	2	0.2	2	0.2	3	0.2	3	0.2	8	0.6	8	0.6
B	Campylobacteriosis	130	10.7	138	11.4	78	6.3	89	7.2	113	9.0	113	9.0	172	13.6	172	13.6
A	Cholera	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	Cryptosporidiosis	24	2.0	30	2.5	35	2.8	37	3.0	75	6.0	107	8.5	931	73.6	958	75.8
B	Cyclosporiasis	3	0.2	3	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	*Escherichia coli* O157:H7 and Shiga toxin-producing *E. coli* (STEC)	48	4.0	57	4.7	46	3.7	52	4.2	51	4.1	60	4.8	47	3.7	83	6.6
B	Giardiasis	65	5.4	65	5.4	46	3.7	46	3.7	69	5.5	71	5.7	90	7.1	97	7.7
B	Hemolytic uremic syndrome (HUS)	1	0.1	1	0.1	1	0.1	1	0.1	1	0.1	1	0.1	1	0.1	2	0.2
B	Hepatitis A*	7	0.6	11	0.9	5	0.4	12	1.0	6	0.5	6	0.5	13	1.0	19	1.5
B	Hepatitis E*	0	0.0	0	0.0	0	0	1	0.1	0	0.0	0	0.0	1	0.1	3	0.2
B	Listeriosis	2	0.2	2	0.2	4	0.3	4	0.3	2	0.2	3	0.2	2	0.2	2	0.2
B	Salmonellosis	147	12.1	149	12.3	148	12.0	158	12.8	150	12.0	156	12.5	185	14.6	194	15.3
B	Shigellosis	290	23.9	292	24.1	46	3.7	46	3.7	172	13.7	176	14.1	385	30.4	407	32.2
B	Trichinellosis	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.1	1	0.1	1	0.1
B	Typhoid fever	0	0.0	3	0.2	2	0.2	3	0.2	3	0.2	4	0.3	3	0.2	3	0.2
B	Vibriosis	1	0.1	1	0.1	0	0.0	0	0.0	1	0.1	1	0.1	1	0.1	1	0.1
B	Yersiniosis	6	0.5	6	0.5	6	0.5	6	0.5	4	0.3	4	0.3	5	0.4	5	0.4

† Rate per 100,000 population

*In previous Annual Summaries, hepatitis A and hepatitis E were included in the "Hepatitis" disease table.

HEPATITIS B & C

	Year:	2013				2014				2015				2016			
	Population:	1,212,263				1,231,393				1,251,722				1,264,518			
		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses	
CLASS	DISEASE NAME	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†
B	Hepatitis B, acute	*	*	*	*	*	*	*	*	72	5.8	72	5.8	73	5.8	73	5.8
B	Hepatitis B, chronic	*	*	*	*	*	*	*	*	533	42.6	533	42.6	464	36.7	464	36.7
B	Hepatitis B, perinatal**	0	--	0	--	2	--	2	--	0	--	0	--	0	--	0	--
B	Hepatitis C, acute	4	0.3	4	0.3	1	0.1	1	0.1	2	0.2	2	0.2	46	3.6	46	3.6
B	Hepatitis C, chronic	1,297	106.9	1,297	106.9	1,513	122.8	1,513	122.8	1,877	149.9	1,877	149.9	2,366	187.1	2,366	187.1

† Rate per 100,000 population

* Data in the Ohio Disease Reporting System may not be accurate for this time period and are not included in this report.

**This report includes changes to perinatal hepatitis B reporting. Please see Technical Notes for more details.

-- Population data are not available for children 0-24 months old.

SEXUALLY TRANSMITTED INFECTIONS

	Year:	2013				2014				2015				2016			
	Population:	1,212,263				1,231,393				1,251,722				1,264,518			
		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses	
CLASS	DISEASE NAME	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†
^	HIV/AIDS*	227	18.7	227	18.7	215	17.5	215	17.5	197	15.7	197	15.7	199	15.7	199	15.7
B	Chancroid	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	*Chlamydia trachomatis* infections	8,106	668.7	8,106	668.7	8,353	678.3	8,353	678.3	9,442	754.3	9,442	754.3	9,892	782.3	9,892	782.3
B	Gonorrhea *(Neisseria gonorrhoeae)*	2,988	246.5	2,988	246.5	2,898	235.3	2,898	235.3	3,264	260.8	3,264	260.8	4,276	338.2	4,276	338.2
B	Syphilis**	162	13.3	162	13.3	227	18.4	227	18.4	252	20.1	252	20.1	278	22.0	278	22.0

† Rate per 100,000 population.

^Report on forms and in a manner prescribed by the director, described in Ohio Administrative Code Chapter 3701-3-12.

*Case counts obtained from the Ohio Department of Health. (See Technical Notes.)

**Syphilis data include primary and secondary cases only.

VACCINE-PREVENTABLE DISEASES																	
	Year:	2013				2014				2015				2016			
	Population:	1,212,263				1,231,393				1,251,722				1,264,518			
		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses	
CLASS	DISEASE NAME	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†
A	Diphtheria	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	*Haemophilus influenzae* (invasive disease)	10	0.8	10	0.8	14	1.1	15	1.2	12	1.0	12	1.0	10	0.8	10	0.8
B	Influenza-associated hospitalization	339	28.0	340	28.0	829	67.3	833	67.6	639	51.0	641	51.2	288	22.8	290	23.0
B	Influenza-associated pediatric mortality	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
A	Measles	0	0.0	0	0.0	1	0.1	2	0.2	1	0.1	2	0.2	0	0.0	0	0.0
A	Meningococcal disease	2	0.2	2	0.2	1	0.1	1	0.1	4	0.3	4	0.3	1	0.1	1	0.1
B	Mumps	3	0.2	4	0.3	415	33.7	458	37.2	6	0.5	21	1.7	2	0.2	14	1.1
B	Pertussis	324	26.7	423	34.9	279	22.7	365	29.6	230	18.4	332	26.5	372	29.4	535	42.3
B	Poliomyelitis (including vaccine-associated cases)	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	Rubella (congenital)	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
A	Rubella (not congenital)	1	0.1	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	*Streptococcus pneumoniae*, invasive disease (ISP)*	126	10.4	126	10.4	96	7.8	96	7.8	105	8.4	106	8.5	119	9.4	121	9.6
B	Tetanus	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	Varicella	73	6.0	78	6.4	69	5.6	71	5.7	56	4.5	63	5.0	69	5.5	78	6.2

† Rate per 100,000 population

*In previous Annual Summaries, this condition was included in the "Other reportable infectious diseases" table.

VECTORBORNE AND ZOONOTIC DISEASES

	Year:	2011				2012				2013				2014			
	Population:	1,178,799				1,195,537				1,212,263				1,231,393			
		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses	
CLASS‡	DISEASE NAME	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†
B	Babesiosis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0.0	0	0.0
B	Brucellosis	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	Dengue	0	0.0	0	0.0	1	0.1	1	0.1	2	0.0	3	0.0	2	0.2	2	0.2
B	Eastern equine encephalitis virus disease	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	Ehrlichiosis/ Anaplasmosis	2	0.2	2	0.2	1	0.1	1	0.1	1	0.1	2	0.2	0	0.0	2	0.2
B	Hantavirus	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	La Crosse virus disease	0	0.0	2	0.2	0	0.0	0	0.0	0	0.0	0	0.0	1	0.1	2	0.2
B	Leptospirosis	0	0.0	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	Lyme disease	8	0.7	19	1.6	9	0.8	24	2.0	22	1.8	53	4.4	19	1.5	43	3.5
B	Malaria	18	1.5	18	1.5	18	1.5	18	1.5	11	0.9	11	0.9	67	5.4	67	5.4
B	Other arthropod-borne disease	1	0.1	1	0.1	0	0.0	0	0.0	0	0.0	1	0.1	4	0.3	5	0.4
A	Plague	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	Powassan virus disease	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	Psittacosis	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	Q fever	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
A	Rabies, human	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	Spotted fever rickettsiosis, including Rocky Mountain spotted fever (RMSF)	0	0.0	1	0.1	5	0.4	7	0.6	5	0.4	10	0.8	1	0.1	7	0.6
B	St. Louis encephalitis virus disease	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
A	Tularemia	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	Typhus fever	1	0.1	1	0.0	0	0.00	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0
A	Viral hemorrhagic fever (VHF)	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	West Nile virus infection	0	0.0	0	0.0	6	0.5	6	0.5	2	0.2	2	0.2	0	0.0	0	0.0
B	Western equine encephalitis virus diseases	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
A	Yellow fever	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

† Rate per 100,000 population N/A = not a reportable condition

OTHER REPORTABLE INFECTIOUS DISEASES

	Year:	2013				2014				2015				2016			
	Population:	1,212,263				1,231,393				1,251,722				1,264,518			
		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses	
CLASS	DISEASE NAME	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†
A	Anthrax	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
A	Any unexpected pattern of cases, deaths or disease	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.1	1	0.1
A	Botulism, foodborne	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	Botulism, infant	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.1	1	0.1
B	Botulism, wound	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	Coccidioidomycosis	1	0.1	4	0.3	3	0.2	3	0.2	4	0.3	9	0.7	2	0.2	6	0.5
B	Creutzfeldt-Jakob disease	1	0.1	2	0.2	2	0.2	4	0.3	0	0.0	1	0.1	2	0.2	2	0.2
A	Influenza A- novel virus infection	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	Legionnaires' disease	149	12.3	170	14.0	120	9.7	123	10.0	97	7.7	97	7.7	106	8.4	111	8.8
B	Leprosy (Hansen's disease)	0	0.0	1	0.1	1	0.1	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0
B	Meningitis, aseptic (viral)	165	13.6	165	13.6	67	5.4	67	5.4	83	6.6	86	6.9	85	6.7	86	6.8
B	Meningitis, bacterial (not N. meningitidis)	4	0.3	4	0.3	12	1.0	13	1.0	8	0.6	9	0.7	11	0.9	12	0.9
A	Middle East Respiratory Syndrome (MERS)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0.0	0	0.0	0	0.0	0	0.0
A	Severe acute respiratory syndrome (SARS)	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
A	Smallpox	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	*Staphylococcus aureus*, with resistance or intermediate resistance to vancomycin (VRSA, VISA)	1	0.1	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
B	Streptococcal disease, group A, invasive (IGAS)	57	4.7	57	4.7	36	3.0	36	3.0	47	3.8	47	3.8	51	4.0	55	4.3

OTHER REPORTABLE DISEASES

	Year:	2013				2014				2015				2016			
	Population:	1,212,263				1,231,393				1,251,722				1,264,518			
		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses		Confirmed & Probable		All Statuses	
CLASS	DISEASE NAME	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†	# of Cases	Case Rate†
B	Streptococcal disease, group B, in newborn	5	0.3	5	0.3	8	0.4	8	0.4	17	0.9	17	0.9	12	0.6	12	0.6
B	Streptococcal toxic shock syndrome (STSS)	0	0.0	0	0.0	2	0.2	2	0.2	3	0.2	3	0.2	5	0.4	5	0.4
B	Toxic shock syndrome (TSS)	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.1	1	0.1
B	Tuberculosis (TB), including multi-drug resistant TB (MDR-TB)	50	4.2	50	4.2	49	4.0	49	4.0	40	3.2	40	3.2	50	4.0	50	4.0

† Rate per 100,000 population for all diseases except "streptococcal disease, group B, in newborn," which is per 1,000 live births.[2]
N/A = not a reportable condition

Please see Columbus Public Health and Franklin County Public Health Infectious Disease Reporting System Annual Summaries for additional information related to spotlighted diseases. These reports can be found at http://idrsinfo.org/data.php

Climate Change Impacts

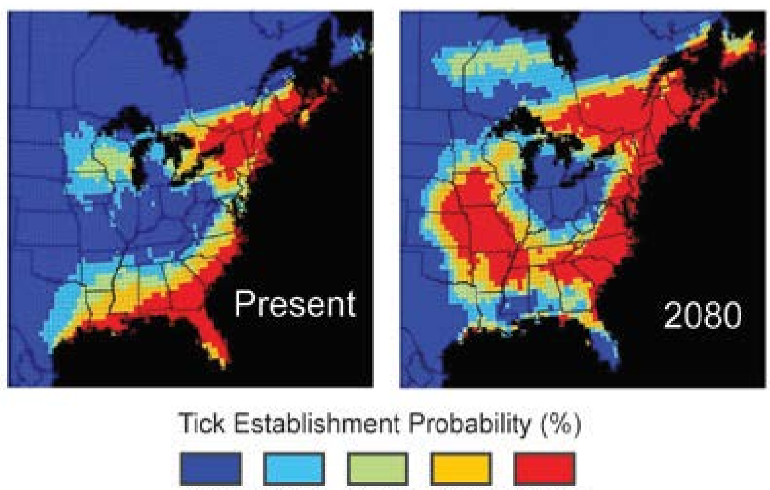
Climate is one of the factors that influence the distribution of diseases borne by vectors (such as fleas, ticks, and mosquitoes, which spread pathogens that cause illness). The geographic and seasonal distribution of vector populations, and the diseases they can carry, depend on climate, land use, socioeconomic and cultural factors, pest control, access to health care, human responses to disease risk, etc.

Numerous vector-borne diseases such as Lyme, dengue fever, West Nile virus, Rocky Mountain spotted fever, plague, and tularemia currently pose a threat to the United States. Additionally, vector-borne diseases not currently found in the United States, such as chikungunya, Chagas disease, and Rift Valley fever viruses, are also potential threats. Climate change has the potential to affect the geographical distribution and number of instances of vector-borne diseases in other countries where these diseases are already found. This in turn can affect the United States due to increasing trade with and travel to tropical and subtropical areas.

Lyme Disease

The development and survival of blacklegged ticks, their animal hosts, and the bacterium that causes Lyme disease, are strongly influenced by climatic factors, especially temperature, precipitation, and humidity. Potential impacts of climate change on the Lyme disease include:

- changes in the geographic distribution of the disease due to the increase in favorable habitat for ticks to survive off their hosts;
- a lengthened transmission season due to earlier onset of higher temperatures in the spring and later onset of cold and frost;
- higher tick densities leading to greater risk in areas where the disease is currently observed due to milder winters and potentially larger rodent host populations;
- changes in human behaviors, including increased time outdoors, which may lead to a higher risk of exposure to infected ticks.



Source: U.S. Global Climate Change Research Program

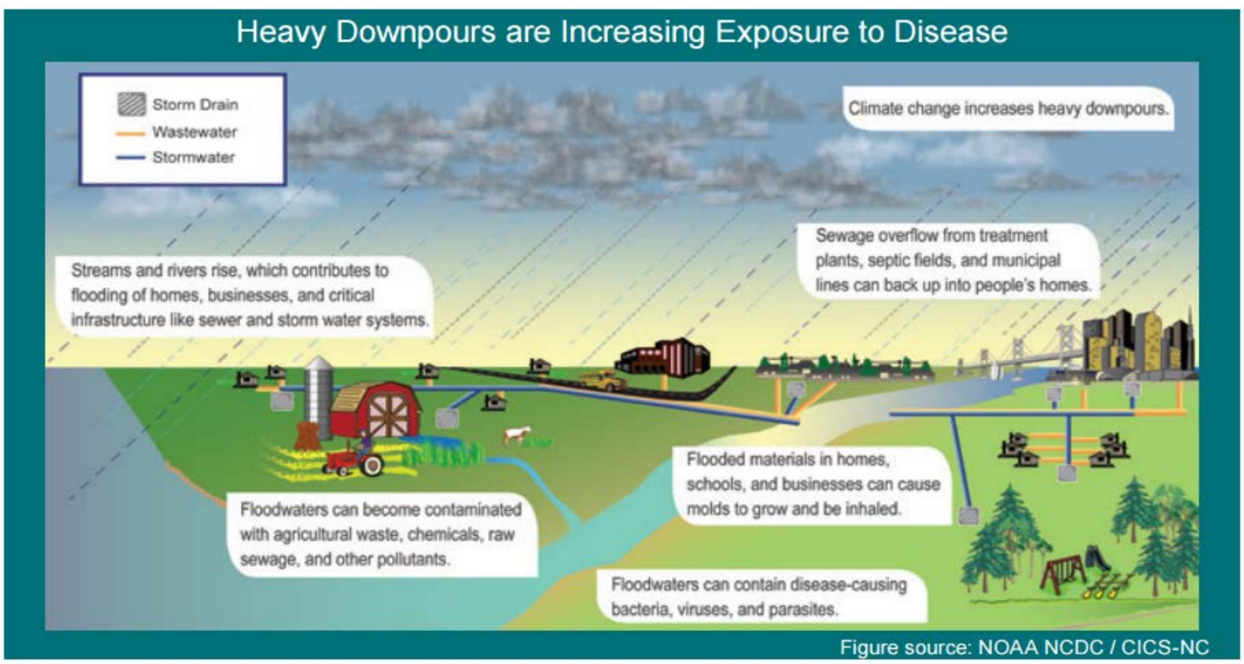
The maps to the right show the current and projected (for 2080) probability of establishment of tick populations (*Ixodes scapularis*) that transmit Lyme disease. The projected expansion of tick habitat includes much of the eastern half of the country by

2080. For some areas around the Gulf Coast, the probability of tick population establishment is projected to decrease by 2080.

Food and Waterborne Diarrheal Disease

Diarrheal disease is a major public health issue in developing countries. Although incidence of this disease is not generally increasing in the United States, it remains a persistent concern. Diarrheal disease is caused by exposure to a variety of pathogens in water and food. Disease transmission is affected by air and water temperatures, precipitation patterns, extreme rainfall events, and seasonal variations. In the United States, children and the elderly are most vulnerable to serious outcomes, and those exposed to inadequately treated or untreated groundwater are usually those most affected.

In general, diarrheal diseases such as Salmonellosis and Campylobacteriosis are more common when temperatures are higher, although patterns differ by place and pathogen. Diarrheal diseases also occur more frequently when precipitation is either unusually high or unusually low. Outbreaks of diarrheal disease have also been preceded by sporadic increases in streamflow rates, often caused by rapid snowmelt, and changes in water treatment. Risks of waterborne illnesses and beach closures resulting from heavy rain and rising water temperatures are expected to increase in the Great Lakes region due to projected climate change[63].



Source: U.S. Global Climate Change Research Program

[63] "Climate Change Impacts in the United States," U.S. National Climate Assessment, accessed on May 2014, http://s3.amazonaws.com/nca2014/low/NCA3_Highlights_LowRes.pdf?download=1

Vulnerability Assessment – Infectious Disease

This hazard is considered to be a "Relatively Moderate Probability Event", meaning the anticipated frequency of the hazard within the County is once every 1 to 4 years. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability

Franklin County is always at risk of a potential infectious disease. Local, County and State health departments continuously monitor this potential threat. However, there has been no structural damage due to infectious disease in Franklin County.

Potential Impact of Infectious Disease

Negative impacts of an infectious disease event would be experienced by many through increased health concerns. There would be a potentially high cost associated with tracking and monitoring people who had contact with those infected. Ebola is a recent example of a high cost associated with infectious disease. For example, during the Ebola scare of 2014, Summit County Health Department used $85,000 to find and monitor those who had contact with the infected individual.[64] Additionally, the state approved $800,000 for the Ohio Department of Health to help hospitals deal with lingering Ebola issues or future cases.[65]

No damage to structures is anticipated due to infectious disease.

Identifying Structures

No structures would experience damage due to infectious disease; therefore, this updated risk assessment does not identify existing or future buildings at risk of loss due to infectious disease.

Exposure of Existing Buildings to Damages Due to Infectious Disease

No existing buildings are exposed to damage due to infectious disease.

Exposure of Future Buildings to Damages Due to Infectious Disease

No future buildings will be exposed to damage due to infectious disease.

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[64] "Summit County spends $85,000 on Ebola tracking; hospital director recalls panic and preparation," Cleveland.com, last updated on 18 Nov 2014, http://www.cleveland.com/akron/index.ssf/2014/11/what_did_summit_county_and_akr.html

[65] "Columbus Public Health Still Spends Time, Money on Ebola Monitoring," Columbus Dispatch, last updated on 31 May 2015, http://www.dispatch.com/content/stories/local/2015/05/31/columbus-public-health-still-spends-time-money-on-ebola-monitoring.html

Estimating Potential Loss

Methodology
Potential structural dollar loss due to infectious disease is estimated to be zero because no historical data is available for losses due to infectious disease.

The economic loss could be extensive, depending on the exact disease as well as how pervasive it is. Using the 2014 Ebola data, a county might spend $85,000 and the state has been approved to spend $800,000.

Estimated Potential Dollar Losses
The estimated potential dollar loss annually in Franklin County due to structural damage due to infectious disease is $0.00.

The estimated economic impact could be up to $885,000 or more depending on the disease and how far reaching it is.

Flooding - #4

Hazard Summary

Flooding occurs in many forms, from naturally occurring to human-induced. Common to all flooding is the accumulation of too much water in too little time in too small a place. From 1950 to December 2017, 116 flood and flash flood events were reported in Franklin County according to the NOAA National Climactic Data Center Storm Events Database. From 1999 to 2017 Franklin County was subject to many different types of flooding and received as many as 10 flood warnings in a single year.[66] In 2016, flooding caused the most weather-related deaths in the United States.[67] This hazard was ranked No. 4 out of 20.

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[66] "Flood Query Results for Franklin County," NOAA – NCDC, accessed on 1 February 2018, https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=39%2COHIO

[67] "Weather Fatalities," NWS, 1 February 2018, http://www.nws.noaa.gov/om/hazstats.shtml

Hazard Profile

Throughout history, people have found it desirable to live along streams. Streams provide water for consumption, agriculture and industry; transportation routes; energy; and a means of waste disposal. All these resources are essential for sustaining communities. However, streams also put people at risk of the most frequent and costly natural hazard worldwide, flooding.

During the 20th century, floods were the number one natural disaster in the United States in terms of lives lost and property damage. Floods have caused the deaths of more than 10,000 people since 1900. Floods can roll boulders the size of cars, tear out trees and destroy buildings and bridges.

Flooding happens during heavy rains, when rivers overflow, when ocean waves come onshore, when snow melts too fast or when dams or levees break. The National Flood Insurance Program (NFIP) states that anywhere it rains, it can flood. A flood is a general and temporary condition where two or more acres of normally dry land or two or more properties are inundated by water or mudflow. Many conditions can result in a flood: hurricanes, overtopped levees, outdated or clogged drainage systems and rapid accumulation of rainfall. [68] Flooding can consist of two or more properties from:

- overflow of inland or tidal waters;
- unusual and rapid accumulation or runoff of surface water from any source;
- a mudflow; or
- a collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood.

Flood Terms

100 Year Flood Plain: The area that has a 1% chance, on average, of flooding in any given year. (Also known as the Base Flood)

500 Year Flood Plain: The area that has a 0.2% chance, on average, of flooding in any given year.

Base Flood: A flood having a 1% chance of being equaled or exceeded in any given year.

Floodplain: Any land area susceptible to being inundated by floodwaters from any source.

Floodway: A "Regulatory Floodway" means the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height. Communities must regulate development in these floodways to ensure that there are no increases in upstream flood elevations. For streams and other watercourses where FEMA has provided Base Flood Elevations (BFEs), but no floodway has been designated, the community must review floodplain development on a case-by-case basis to ensure that increases in water surface elevations do not occur, or identify the need to adopt a floodway if adequate information is available.

Source: FEMA (http://www.fema.gov/national-flood-insurance-program/definitions)

[68] "Flooding & Flood Risks," NFIP, accessed on 1 Nov 2015, https://www.floodsmart.gov/floodsmart/pages/flooding_flood_risks/ffr_overview.jsp

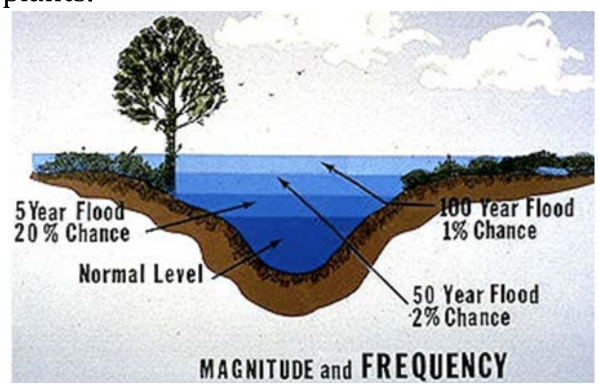
Watersheds

A watershed is an area of land that drains all the streams and rainfall to a common outlet such as the outflow of a reservoir, mouth of a bay, or any point along a stream channel.[69] Every watershed combines with other adjacent watersheds to form a basin, and basins combine to form larger watersheds.

A "watershed approach" uses hydrologically defined areas (watersheds) to coordinate the management of water resources. The approach is advantageous because it considers all activities within the landscape that affect the watershed.[70] Movement within the watershed is defined by the physical boundaries, hills, ridgelines, valleys; vegetative cover; urbanization; mining; transportation; agriculture; and, construction of dams. Other human impacts on the watershed are large- volume users, primarily municipal water systems that divert large quantities of water from the stream on a regular basis, and large releases into the stream by municipal wastewater treatment plants.

Floodplains

Floodplains along the banks of a river or stream also serve as an important storage site for water during periods of heavy runoff. When the runoff becomes too big, the stream widens its channel by overtopping its banks and flooding the low-lying areas surrounding the stream. The areas that become flooded are called floodplains.



Source: ODNR[71]

Floodplains serve as a storage area for increased water quantities during and after large rain or snow-melt events. A floodplain allows water to slowly infiltrate into the ground, recharging groundwater levels. The most important function of floodplains to people is the ability to keep floodwaters away from structures, unless, of course, we have built in the floodplain.

The 100-year flood has become the accepted national standard for regulatory purposes. It is defined as the flood event that has a 1% chance of occurring in any given year or, on

Flood Severity Categories

The NWS characterizes flood severity to more effectively communicate the impact of flooding. It uses the following categories:

Minor Flooding: minimal or no property damage, but possibly some public threat or inconvenience.

Moderate Flooding: some inundation of structures and roads near streams. Some evacuation of people and/or transfer of property to higher elevations.

Major Flooding: extensive inundation of structures and roads. Significant evacuation of people and/or transfer of property to higher ground.

[69] "What is a Watershed?" USGS, accessed on 1 Nov 2015, http://water.usgs.gov/edu/watershed.html
[70] "Why Watersheds?" EPA, accessed on 1 Nov 2015, http://water.epa.gov/type/watersheds/outreach/upload/2003_07_24_protecting_chap1.pdf
[71] "Floodplain Management," ODNR, accessed on 7 September 2015, http://soilandwater.ohiodnr.gov/water-use-planning/floodplain-management

average, occurs once in a 100-year period. However, 100-year floods can and do occur more frequently.

For regulatory purposes, the floodplain is divided into two areas based on water velocity: the floodway and the flood fringe. The floodway includes the channel and the portion of the adjacent floodplain required to pass the 100-year flood without increasing flood heights. Typically, this is the most hazardous portion of the floodplain where the fastest flow of water occurs. Due to the high degree of hazard, most floodplain regulations require that proposed floodway developments do not block the free flow of flood water as this could dangerously increase that water's depth and velocity.

The flood fringe is the remaining portion of the floodplain, outside of the floodway, that usually contains slow-moving or standing water. Development in the fringe will not normally interfere as much with the flow of water. Therefore, floodplain regulations for the flood fringe typically allow development to occur but require protection from the flood waters through the elevation of the buildings above the 100-year flood level, or floodproofing buildings so that water cannot enter the structure.[72]

What is the Likelihood of Flooding?

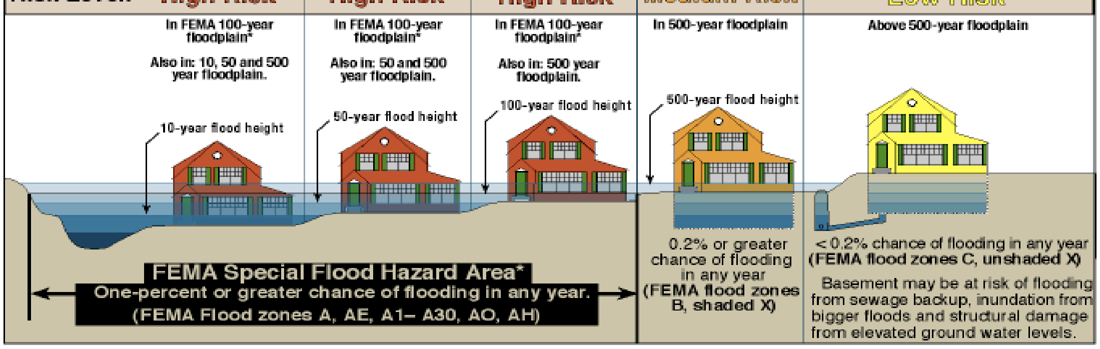
Years in floodplain	Chance of at least one **10-year flood**	Chance of at least one **50-year flood**	Chance of at least one **100-year flood**	Chance of at least one **500-year flood**
1	10%	2%	1%	<1%
2	19%	4%	2%	<1%
3	27%	6%	3%	1%
4	34%	8%	4%	1%
5	41%	10%	5%	1%
10	65%	18%	10%	2%
15	79%	26%	14%	3%
20	88%	33%	18%	4%
25	93%	40%	22%	5%
30	96%	45%	26%**	6%
Risk Level:	**High Risk**	**High Risk**	**High Risk**	**Medium Risk**

The longer you occupy the floodplain, the greater your chance of being flooded.

FEMA has not identified all areas that may be at risk of flooding. Between 20%–25% of flood insurance claims are from areas OUTSIDE of the FEMA Special Flood Hazard Area in supposedly "low risk" areas.

**Over a 30 year mortgage, there is a 26% chance of a 100-year flood.

Low Risk



*The Special Flood Hazard Area has a 1% or greater chance of flooding in any year. On average floodwaters will get high enough to flood this area once in every 100 years. It is known as the 100-year floodplain. A 100-year flood can occur more than once in a 100-year period. Refer to the FEMA Flood Insurance Study and Flood Insurance Rate Map for your community to help determine your flood risk.

Source: FEMA

[72] "Floods and Flood Damage Prevention," ODNR, accessed on 1 Nov 2015, http://dublinohiousa.gov/dev/dev/wp-content/uploads/2012/10/FloodplainRegulationsFactSheet.pdf

Types of Floods

Floods are the result of a multitude of naturally occurring and human-caused factors, but all can be defined as the accumulation of too much water, in too little time, in too small a place. There are many ways to classify floods. Below are examples.

> ### Flood Advisory Definitions
>
> **Flash Flood Watch:** Issued generally when there is the possibility of flash flooding or urban flooding over an area within the next 36 hours.
>
> **Flash Flood Warning:** Issued when flash flooding is imminent, generally within the next 1 to 3 hours. Usually issued based on observed heavy rainfall (measured or radar estimated), but may also be issued for significant dam breaks that have occurred or are imminent.
>
> **Flood Watch:** Issued when there is the possibility of widespread general flooding over an area within the next 36 hours.
>
> **Flood Warning for River Forecast Point:** Issued when a river gauge has exceeded, or is forecast to exceed, a predetermined flood stage.
>
> **Flood Advisory:** Issued when flooding is imminent or occurring, generally within the next 1 to 3 hours, but is not expected to substantially threaten life and property.
>
> *Source: NOAA (http://www.srh.noaa.gov/oun/?n=spotter-wwa-definitions*

Regional flooding sometimes occurs seasonally when winter or spring rains coupled with melting snow fill river basins with too much water too quickly. Excess runoff can be amplified by frozen ground or saturated soil conditions.[73] Regional floods are associated with slow-moving, low-pressure or frontal storm systems, including decaying hurricanes or tropical storms. Persistent, wet meteorological patterns are usually responsible for very large regional floods such as the Mississippi River Basin flood in 1993, with $20 billion in damages reported.

Riverine flooding is a high flow or overflow of water from a river or similar body of water. Riverine flooding is a function of excessive precipitation levels and water runoff volumes within the watershed of a stream or river. Riverine flooding can range from minor overbank events to massive, widespread inundation. Such flooding may be caused by excessive rainfall alone or a combination of heavy rainfall and snowmelt, and it occurs over a period of time too long to be considered a flash flood.

Flash floods are quick-rising floods that usually occur as the result of heavy rain over a short period of time, often only several hours or less.[74] Flash floods can happen within several seconds to several hours and with little warning. Several factors can contribute to flash flooding: rainfall intensity, rainfall duration, surface conditions and topography and slope of the receiving basin. Year in and year out, flash floods take more lives than any other type of flooding.

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[73] "Significant Floods in the United States During the 20th Century," USGS, accessed on 1 Nov 2015, http://ks.water.usgs.gov/pubs/fact-sheets/fs.024-00.pdf

[74] "Flooding," The Weather Channel, accessed on 1 Nov 2015, http://dw.weather.com/safeside/flood/

Urban flooding happens when land is converted from fields or woodlands to roads and parking lots, thus losing its ability to absorb rainfall.[75] Urbanization of a watershed changes the hydrologic systems of the basin. Heavy rainfall collects and flows faster on impervious concrete and asphalt surfaces. Water moves from clouds to ground and into streams at a much faster rate in urban areas. Streets can become swift moving rivers, while basements and viaducts can become dangerous as they fill with water. Storm drains often back up with vegetative debris, causing additional localized flooding.

Urban Flooding - Columbus, Ohio **10/04/2006**

Photographer's description: A severe autumn thunderstorm struck the Ohio State campus in Columbus causing urban flooding, quarter sized hail, and widespread wind damage.

Photographer	Brett Hartley
Date taken	October 4, 2006
Location	Columbus, Ohio (Franklin County) map
Event	Urban flooding

Source: National Weather Service

Ice-jam flooding occurs on rivers that are partially or completely frozen.[76] When rivers clogged with ice rise rapidly due to rainfall and/or snowmelt, the ice breaks up into chunks, some can be larger than an automobile. These chunks of ice move downstream and can jam at constrictions in rivers such as bends, bridge abutments or shallow areas. The jam can act as a dam, causing water to back up behind it. River levels behind the ice jam can rise rapidly. On occasion, the ice jam can release quickly, sending huge chunks of ice downstream in the torrent, leaving destruction in its wake.

Snowmelt floods. Snow typically melts slowly enough that it seldom causes flooding. However, warm, moist conditions and heavy rain can combine with snowmelt to cause dramatic winter and spring flooding. In relatively flat areas in the Midwest, river beds drop very slowly along the length of the river. As a result, the water in the river glides slowly downstream. In such areas, accumulation of melt water from extensive snow-covered areas can cause significant flooding. This situation is often compounded by the effects of ice jams.[77]

Debris, landslide, and mudflow flooding is created by the accumulation of debris, mud, rocks, and/or logs in a channel, forming a temporary dam. Flooding occurs upstream as

[75] "Questions and Answers about Floods," USGS, accessed on 1 Nov 2015, http://water.usgs.gov/edu/qafloods.html

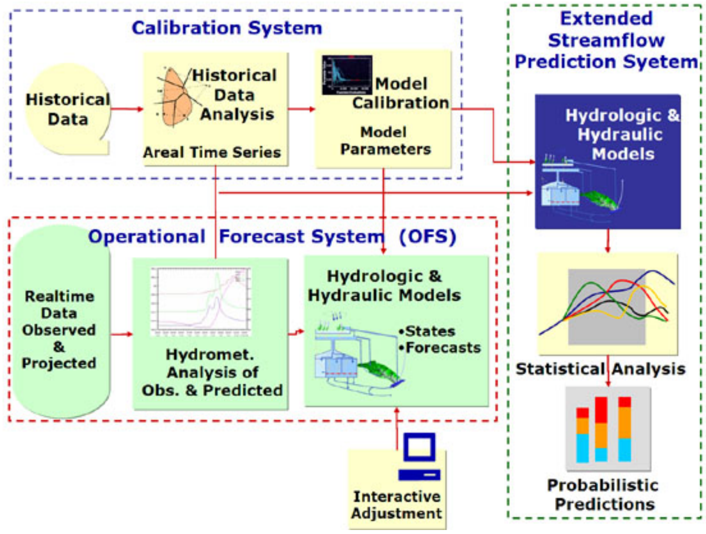
[76] "Significant Floods in the United States During the 20th Century," USGS, accessed on 1 Nov 2015, http://ks.water.usgs.gov/pubs/fact-sheets/fs.024-00.html#HDR4

[77] "Floods: Among the Greatest Natural Disasters," NOAA, accessed on 1 Nov 2015, http://www.noaanews.noaa.gov/stories/s600c.htm

water becomes stored behind the temporary dam and then becomes a flash flood when the dam is breached and rapidly washes away. Landslides can create large waves on lakes or embayments and can also be deadly.[78]

Flood Monitoring

The National Weather Service is responsible for providing our nation's flood warnings and water resource forecasts. These warnings and forecasts are critical to public safety and the economy. The NWS is improving these warnings and forecasts with the Advanced Hydrologic Prediction Service (AHPS).



Source: National Weather Service Advanced Hydrologic Prediction Service

AHPS is a web-based suite of accurate and information-rich forecast products which display the magnitude and uncertainty of occurrence of floods or droughts, from hours to days and months in advance. These new products will enable government agencies, private institutions, and individuals to make more informed decisions about risk based policies and actions to mitigate the dangers posed by floods and droughts.[79]

AHPS's major themes include:

- Short-term through long-term forecasts (from minutes to months) including probabilistic products for risk management decisions.
- Real-time flood forecast maps depicting a real extent of flooding.
- More timely and accurate flash flood warnings through the use of enhanced flash flood decision assistance tools.

This includes forecast information such as:

- How high a river will rise
- When a river will reach its peak
- Where property will be flooded
- How long flooding will continue
- How long a drought will last

[78] "Significant Floods in the United States During the 20th Century," USGS, accessed on 1 Nov 2015, http://ks.water.usgs.gov/pubs/fact-sheets/fs.024-00.html#HDR4

[79] "Advanced Hydrological Prediction Service," NWS, accessed on 1 Nov 2015, http://water.weather.gov/ahps/about/about.php

This information helps minimize flooding impacts by allowing communities more time to mitigate and prepare for flood events, as well as improve reservoir management and better predict how long drought conditions will affect river levels.

For more than 100 years, the U.S. Geological Survey (USGS) has played a critical role in reducing flood losses by operating a nationwide stream-gauge network that monitors the water level and flow of the nation's rivers and streams. The USGS works closely with the NWS, the Army Corps of Engineers, and other federal agencies and partners in every state, as well as many local governments, to fund and maintain about 7,400 stream-gauging stations nationwide.

Through satellite and computer technology, stream-gauges transmit real-time information, which the National Weather Service uses to issue warnings so local emergency managers can get people out of harm's way, and operators of flood-control dams and levees can take action to reduce flood impacts.

The basic building block for a streamflow data network is the stage-discharge relation that is developed at each gauging station location. Measurements of the flow (discharge) are related graphically to the respective water depths (stage), which then enables discharge to be determined from stage data. USGS streamflow gauges in Franklin County are:
Scioto River at 5th Ave at Columbus, Olentangy River near Worthington, Olentangy River at J H Herrick Dr. at Columbus, Scioto River at Columbus, Scioto River above Shadeville, Big Walnut Creek at Central College, Alum Creek at Columbus, Big Walnut Creek at Rees, and Hellbranch Run near Harrisburg.[80]

Flooding Impact

In most years, flooding causes more deaths and damage than any other hydro-meteorological phenomena. In many years, it is common for three-quarters of all federally declared disaster declarations to be due, at least in part, to flooding.[81]

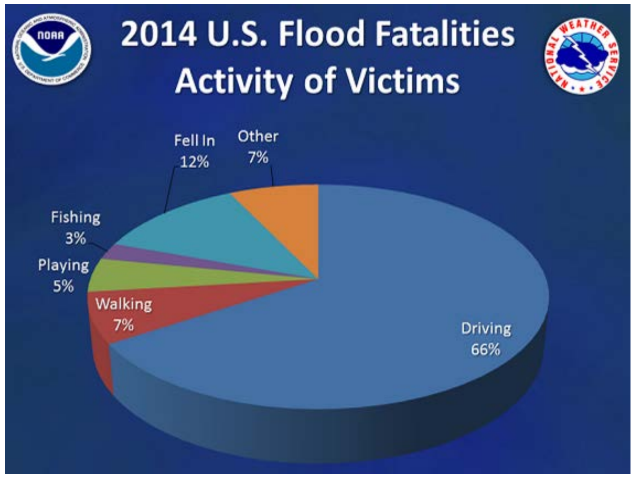
Trying to characterize what these losses mean in terms of impacts over time is difficult at best. Loss/damage estimates are reported in many different ways, from several sources. There is usually not enough information to easily determine the degree of overlap among the various sources of loss estimates. For example, NWS flood damage estimates do not include flooding due to winds, such as coastal flooding (e.g. hurricane storm surges).

However, there is no question that flooding is one of the most frequent and costly natural hazards in the United States and continues to escalate. According to the National Weather Service, direct flood damages during Water Year 2014 (October 1, 2013 – September 30, 2014) totaled $2.86 billion, 36% of the thirty-year average (1984 – 2013) of $7.95 billion

[80] "National Weather Information System Web Interface," USGS, accessed on 7 September 2015, http://waterdata.usgs.gov/oh/nwis/current/?type=flow&group_key=county_cd

[81] "Disaster Medicine", Kristi L. Koenig and Carl H. Schultz

(adjusted to 2014 inflation). There were 55 flood-related deaths (65% of the 30-year average of 85). Of these fatalities, 29 were vehicle-related incidents, and 39 were attributed to flash flood events. In 2014, 66% of all flood fatalities in the United States occurred while driving.[82]

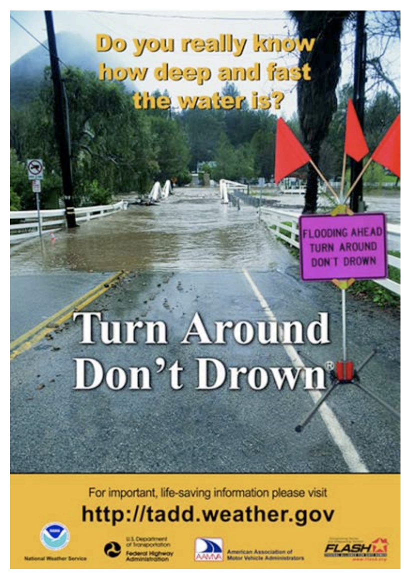


Year	Annual Total	Vehicle Related	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	38	19	2	3	0	7	4	9	0	6	9	0	0	0
2013	80	41	1	1	2	4	26	5	4	9	10	8	1	9
2012	29	16	2	0	5	1	3	1	3	4	6	2	1	1
2011	113	68	0	6	4	17	15	5	10	29	18	0	9	0
2010	103	50	3	1	2	3	36	25	12	5	13	2	0	2

Source: National Weather Service

Six inches of fast-moving water can knock an adult off their feet. Most cars can be swept away in 18-24 inches of water. Trucks and SUVs do not fare much better with an additional 6-12 inches of clearance. In moving water, vehicles can easily become buoyant enough for the force of the moving water to push it sideways, often resulting in vehicles flipping onto their sides or tops.

Many flood fatalities are preventable. To that end, the National Weather Service has developed an awareness campaign to warn people of the hazards of walking or driving a vehicle through flood waters, "Turn Around Don't Drown."[83]



[82] "United States Flood Loss Report Data Year 2014," National Weather Service, accessed on 14 June 2015, http://www.nws.noaa.gov/hic/summaries/WY2014.pdf

[83] "Turn Around Don't Drown," National Weather Service, accessed on 13 June 2015, http://tadd.weather.gov

Flooding in the United States

Floods are one of the most chronic and costly natural disasters in the United States. Despite advances in flood science and implementation of federal hazard-reduction policies, damage from flooding continues. Flood damage is the result of the great power of flowing water and the concentration of people and property along rivers and streams.

In the United States, about 3,800 towns and cities are on floodplains.[84] Generations of Americans have continued to settle along waterways, risking periodic floods for the opportunity and convenience that comes with easy access to water. Floods become problems when people occupy space that streams require for their own natural flood patterns. The problems have become so great over the years that the federal government has increasingly become involved in flood control throughout the nation.

Starting in 1917, a series of laws known as the Flood Control Acts was passed by Congress. These laws are typically administered by the United States Army Corps of Engineers. The Flood Control Act of 1917 was the first act aimed exclusively at controlling floods and was passed after extensive flooding on the Mississippi and Ohio Rivers.

In the late 1950's and 1960's, the country moved away from a "we can build our way out of almost any problem" attitude toward floodplain management, leading to the passage of the National Flood Insurance Program in 1968. A list of participating Ohio communities can be viewed here: http://www.fema.gov/cis/OH.html.

Flooding is the only disaster insured against by the federal government.

[84] "Large Floods in the United States: Where They Happen and Why," 2003, http://pubs.usgs.gov/circ/2003/circ1245/pdf/circ1245.pdf

Significant Floods of the 20th Century

[M, million; B, billion]

Flood type	Map no.	Date	Area or stream with flooding	Reported deaths	Approximate cost (uninflated)	Comments
Regional flood	1	Mar.–Apr. 1913	Ohio, statewide	467	$143M	Excessive regional rain.
	2	Apr.–May 1927	Mississippi River from Missouri to Louisiana	unknown	$230M	Record discharge downstream from Cairo, Illinois.
	3	Mar. 1936	New England	150+	$300M	Excessive rainfall on snow.
	4	July 1951	Kansas and Neosho River Basins in Kansas	15	$800M	Excessive regional rain.
	5	Dec. 1964–Jan. 1965	Pacific Northwest	47	$430M	Excessive rainfall on snow.
	6	June 1965	South Platte and Arkansas Rivers in Colorado	24	$570M	14 inches of rain in a few hours in eastern Colorado.
	7	June 1972	Northeastern United States	117	$3.2B	Extratropical remnants of Hurricane Agnes.
	8	Apr.–June 1983 June 1983–1986	Shoreline of Great Salt Lake, Utah	unknown	$621M	In June 1986, the Great Salt Lake reached its highest elevation and caused $268M more in property damage.
	9	May 1983	Central and northeast Mississippi	1	$500M	Excessive regional rain.
	10	Nov. 1985	Shenandoah, James, and Roanoke Rivers in Virginia and West Virginia	69	$1.25B	Excessive regional rain.
	11	Apr. 1990	Trinity, Arkansas, and Red Rivers in Texas, Arkansas, and Oklahoma	17	$1B	Recurring intense thunderstorms.
	12	Jan. 1993	Gila, Salt, and Santa Cruz Rivers in Arizona	unknown	$400M	Persistent winter precipitation.
	13	May–Sept. 1993	Mississippi River Basin in central United States	48	$20B	Long period of excessive rainfall.
	14	May 1995	South-central United States	32	$5-6B	Rain from recurring thunderstorms.
	15	Jan.–Mar. 1995	California	27	$3B	Frequent winter storms.
	16	Feb. 1996	Pacific Northwest and western Montana	9	$1B	Torrential rains and snowmelt.
	17	Dec. 1996–Jan. 1997	Pacific Northwest and Montana	36	$2-3B	Torrential rains and snowmelt.
	18	Mar. 1997	Ohio River and tributaries	50+	$500M	Slow-moving frontal system.
	19	Apr.–May 1997	Red River of the North in North Dakota and Minnesota	8	$2B	Very rapid snowmelt.
	20	Sept. 1999	Eastern North Carolina	42	$6B	Slow-moving Hurricane Floyd.
Flash flood	21	June 14, 1903	Willow Creek in Oregon	225	unknown	City of Heppner, Oregon, destroyed.
	22	June 9–10, 1972	Rapid City, South Dakota	237	$160M	15 inches of rain in 5 hours.
	23	July 31, 1976	Big Thompson and Cache la Poudre Rivers in Colorado	144	$39M	Flash flood in canyon after excessive rainfall.
	24	July 19–20, 1977	Conemaugh River in Pennsylvania	78	$300M	12 inches of rain in 6-8 hours.
Ice-jam flood	25	May 1992	Yukon River in Alaska	0	unknown	100-year flood on Yukon River.
Storm-surge flood	26	Sept. 1900	Galveston, Texas	6,000+	unknown	Hurricane.
	27	Sept. 1938	Northeast United States	494	$306M	Hurricane.
	28	Aug. 1969	Gulf Coast, Mississippi and Louisiana	259	$1.4B	Hurricane Camille.
Dam-failure flood	29	Feb. 2, 1972	Buffalo Creek in West Virginia	125	$60M	Dam failure after excessive rainfall.
	30	June 5, 1976	Teton River in Idaho	11	$400M	Earthen dam breached.
	31	Nov. 8, 1977	Toccoa Creek in Georgia	39	$2.8M	Dam failure after excessive rainfall.
Mudflow flood	32	May 18, 1980	Toutle and lower Cowlitz Rivers in Washington	60	unknown	Result of eruption of Mt. St. Helens.

Source: USGS

Flooding in Ohio

No area in Ohio is free from the threat of flooding. Flooding occurs in Ohio every year, although the location and severity vary according to weather and ground conditions. Large floods in Ohio, such as those experienced in 1913, 1937, 1959, 1963, 1964, 1969, 1990, 1997 and 1998 have caused the loss of many lives as well as cost billions of dollars in property damage. The most recent data indicates that in 2014, Ohio experienced $71,149,000 in damages and one fatality due to flooding.[85]

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85 "United States Flood Loss Report Data Year 2014," National Weather Service, accessed on 14 June 2015, http://www.nws.noaa.gov/hic/summaries/WY2014.pdf

Ohio Lakes, Rivers and Water Resources

Ohio Rivers Shown on the Map: Auglaize River, Big Darby Creek, Big Walnut Creek, Blanchard River, Cuyahoga River, Grand River, Great Miami River, Hoking River, Killbuck Creek, Licking River, Little Miami River, Mad River, Mahoning River, Maumee River, Muskingum River, Ohio River, Olentangy River, Paint Creek, Raccoon Creek, Sandusky River, Scioto River, St. Mary's River and Tuscarawas River.

Ohio Lakes Shown on the Map: Grand Lake, Indian Lake, Mohawk Reservoir, Mosquito Creek Lake, Piedmont Lake, Pymatuning Reservoir, Senecaville Lake and William H. Harsha Lake.

Source: Geoscience News[86]

Numerous factors can cause flooding in Ohio, including heavy and/or prolonged periods of rainfall, snowmelt, soil saturation, ground freeze, severe wind events and inadequate drainage systems. Ohio floods can be of several types: riverine, flash flooding, coastal flooding, and urban flooding.

[86] "Ohio Lakes, Rivers, and Water Resources," Geoscience News and Information, accessed on 25 July 2015, http://geology.com/lakes-rivers-water/ohio.shtml

There are two major drainage basins in Ohio, the Lake Erie and Ohio River basins. Streams in the northern third of the state flow into Lake Erie; those in the southern two-thirds of the state flow into the Ohio River.

Ohio's Appalachian Region is particularly vulnerable to flash flooding because of the steep terrain and narrow stream valleys. Ohio has several highly urbanized counties susceptible to urban flooding. Coastal flooding occurs along the shores and islands of Lake Erie.

Historically Significant Floods in Ohio

May 12, 1886: Xenia Flood

Runoff from 7 to 9 inches of rain poured into Shawnee Creek and a wall of water several feet high moved through Xenia. The waters rose so quickly that sleeping families had little time to escape. Sixteen people died in two homes that were carried into the flood and collapsed. A total of 28 people were killed. The flood left 300 people homeless. Debris collected at bridges through Xenia and caused a temporary rise in floodwater that washed downstream with renewed vigor when the debris and bridge gave way. After the flood, the city council announced it intended to widen Shawnee Creek and asked residents not to rebuild houses along the creek.

March 14-18, 1907

All rivers flowing southward into the Ohio River flooded when more than 4 inches of rain fell across the southern third of Ohio; the heaviest rain was 5 to 6 inches in a band from Cincinnati to Athens and Noble County. There were 32 deaths in Ohio; 15 were along the Hocking River at Athens and Nelsonville. The Scioto washed out every railroad leading into the city of Waverly. Six hundred people were forced from their homes in Zanesville. As the waters flowed into the Ohio River, the flood extended from Pittsburgh to past Cincinnati. At Marietta, the Ohio River rose 30 feet in two days, leaving 5,000 homeless. Portsmouth was inundated by the flood.

March 23-27, 1913

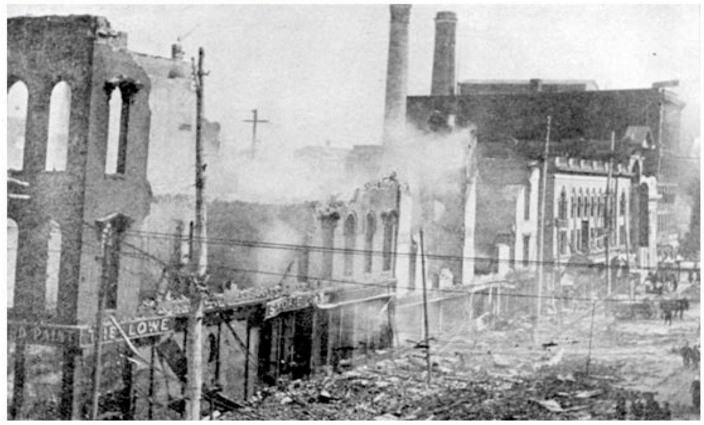
The Flood of 1913 is known as the greatest natural disaster in Ohio history. The extent of death and destruction exceeds all other weather events in Ohio: 467 deaths and more than 40,000 homes flooded.

March 23-27, 1913: Statewide Flood

Broad St. looking northwest, Columbus.
Ohio Historical Society collections.
Call Number: SC4670

Heavy rains exacerbated usual spring flooding conditions. Most communities along rivers in the state experienced flooding. The most severe flooding occurred along the Great Miami River. At Dayton, the river flooded 14 square miles of the city, killing 123 people. Downstream on the Miami River, there were about 100 deaths in Hamilton, where water was 10 to 18 feet deep. Approximately 100 people died in Columbus when the Scioto River reached record levels and poured 9 to 17 feet of water through neighborhoods. Many Columbus residents escaped to the safety of rooftops and trees. Thirteen people were rescued from a single tree. Downstream, most of Chillicothe was under water.

March 23-27, 1913: Statewide Flood



Scene in the heart of the business section of Dayton, showing houses destroyed by flood and fire.

The Muskingum River at Zanesville crested 27 feet above flood stage and water was 20 feet deep at several downtown intersections. The Cuyahoga River washed away docks, lumberyards, trains and rail yards in Cleveland. Seven locks were dynamited on the Ohio Canal at Akron, allowing the floodwaters to pour into the Cuyahoga. Levees along the Ohio River at Portsmouth were topped. The Ohio River at Cincinnati rose 21 feet in 24 hours.

After the flood, the Vonderheide Act, also known as the Ohio Conservancy Law, was passed in 1914. The law gave the state the authority to establish watershed districts and to raise funds for improvements through taxes. The Miami Conservancy District was created in response to the Vonderheide Act in 1915. It became the first major watershed district in the nation.

<u>January 26, 1937 Ohio-Mississippi Valley Flood</u>

All Ohio River communities were flooded on January 26-27, 1937 by the greatest volume of water ever known to pass along Ohio's southern boundary from Gallipolis downstream past Cincinnati. In all, 196 counties in 12 states were flooded. Two hundred and fifty people died, a comparatively low number for such a devastating flood when compared to the 467 people who died in the 1913 flood.

January 26, 1937: Statewide Flood

The Grant Memorial Bridge in Point Pleasant.

Ohio Historical Society collection

January 1937 was the wettest month ever recorded in Ohio. Six to 12 inches of rain fell during January 12-25 over a large area of Ohio. The Ohio River crested at 80 feet at Cincinnati. The rising river at Portsmouth overtopped a floodwall erected 10 feet above flood stage. Floodgates were opened to allow water to flow into the business district to prevent catastrophic breaching of the floodwall. The river eventually crested at 14 feet over the top of the floodwall.

January 21, 1959
Classic winter flood conditions existed across Ohio during January 1959. Soil frozen a foot deep was overlain by a snow cover. A band of heavy rain fell across central Ohio on the headwaters of many of the state's largest rivers, causing the snow to melt, and, with frozen ground, nearly all of the water poured into streams. For many of the streams, flood levels were the highest since March 1913. Columbus was the most severely affected of Ohio's major cities. One-third of Chillicothe was flooded, and ice jams on the Sandusky River flooded Upper Sandusky, Tiffin and Fremont. Flood-control reservoirs built after 1913 helped reduce deaths and damage.

June 14, 1990 Shadyside Flood
A deadly flash flood occurred in the steep Appalachian valleys of Belmont County near the town of Shadyside on the evening of June 14, 1990. Three to four inches of rain fell in an hour onto the steep-sided valleys and saturated soils along Pipe and Wegee Creeks. With the soil already saturated, nearly all the water ran off the slopes directly into the creeks, creating a wall of water, reported by some witnesses at between 10 and 30 feet, rapidly moving downstream about 45 minutes after the onset of the heavy rain. Trees, cars, and collapsed buildings carried in the flow created debris dams at bridges along the creeks, causing higher flood levels and greater flows as the dams broke. Most residents lived along the narrow flat land along the creek. About 80 houses were destroyed, 79 sustained major damage and 172 sustained minor damage, according to the National Weather Service. Twenty-six people were killed. Most were found downstream in the Ohio River.

June 14, 1990: Shadyside Flood

A fifteen-acre "raft" of debris formed at Hannibal Locks and Dam thirty miles downstream on the Ohio River.

Photo courtesy of Belmont County Emergency Management Office

March 1-2, 1997
Heavy rains resulted in severe flooding in 18 southern Ohio counties. The largest accumulations of rainfall were in Adams and Brown Counties, ranging from 10 to 12 inches. Parts of Athens and Vinton Counties received about 6 inches of rainfall. Amounts of 4 or more inches fell on most of the counties along or near the southern border of Ohio.

The most severe flooding was observed in streams located within 50-70 miles north of the Ohio River. Flood damage estimates were over $180 million. Nearly 20,000 people were evacuated, and about 6,500 residences and 833 businesses were affected. Five deaths were attributed to the flooding, all the result of attempts to drive through flooded roads.

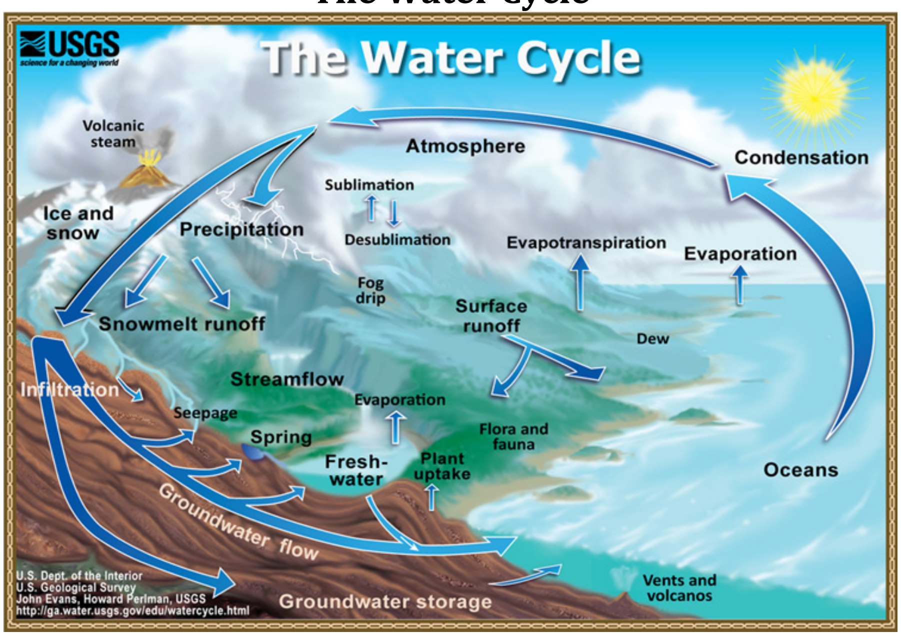
August 19-21, 2007
Heavy rainfall inundated multiple communities across Northern Ohio during a two-day period. The heaviest rains redeveloped each night from August 19 to August 21. The 24-hour rainfall totals at 8 a.m. on August 21 exceeded the 1000/year 24-hour frequency. Peak flood stage of the Blanchard River in Findlay was just 0.04 less than the flood of record in 1913. Approximately 2,500 structures were flooded.

Flooding in Franklin County

Franklin County receives approximately 38 inches of precipitation every year. January, February and October are the months that receive the least amount of precipitation, while July is the wettest month. The average monthly precipitation recorded is approximately 3.2 inches.[87]

Of these 38 inches, about 10 inches become run-off, which moves immediately to surface-water bodies. Most of the precipitation eventually returns to the atmosphere through evaporation and transpiration. The bulk of the flow of water in streams and rivers is from surface water run-off, augmented to varying degrees by groundwater discharge to these surface waters.

The Water Cycle



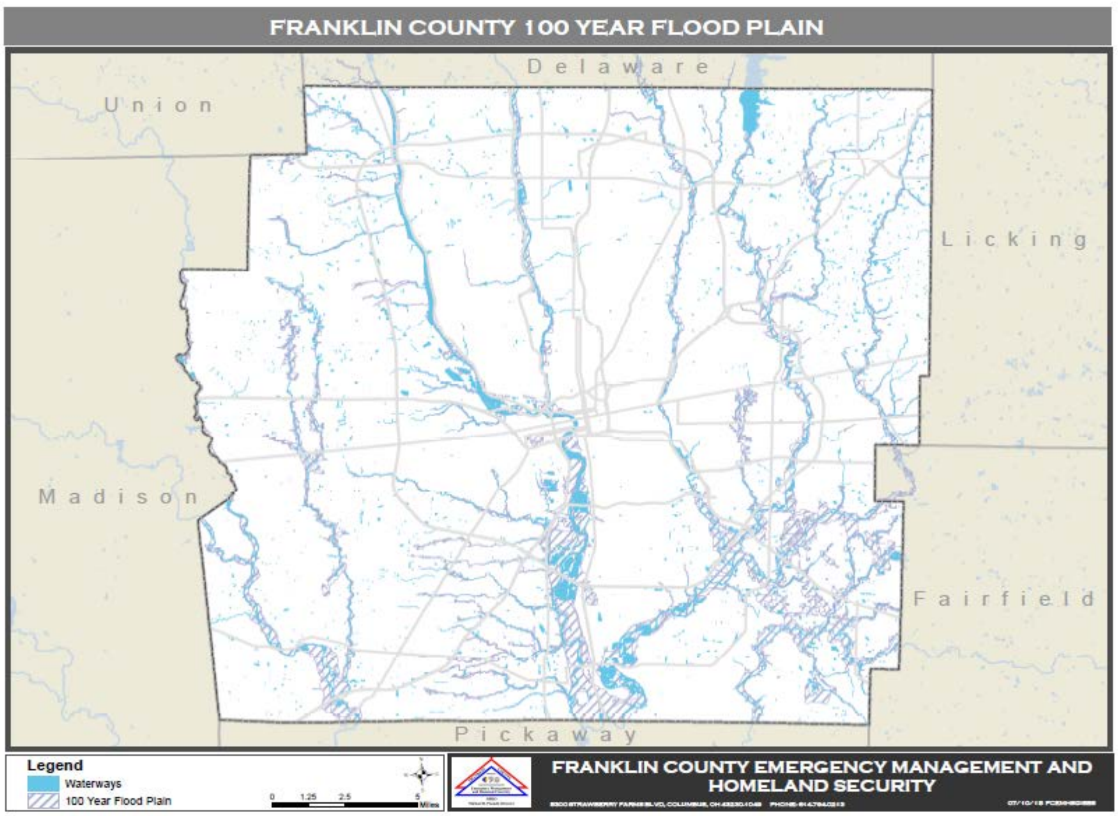
Source: USGS[88]

[87] "Water Resources of Franklin County," Ohio State University Extension, accessed on 1 Nov 2015, http://ohioline.osu.edu/aex-fact/0480_25.html

[88] "The Water Cycle, A Quick Summary," USGS, accessed on 7 September 2015, http://water.usgs.gov/edu/watercyclehi.html

In Franklin County, the Scioto River Basin drains into the Ohio River, which in turn drains into the Mississippi, which makes its way south to the Gulf of Mexico. Watersheds are characterized by the pour-point, or mouth, of the main flow of water to which all other points flow. The four major watersheds in Franklin County are the Scioto River, Olentangy River, Alum Creek and Big Walnut Creek. A distinguishing feature of these waterways is the sub-parallel, nearly straight, north-south direction of flow through the county. Another significant stream, the Big Darby, flows diagonally, northwest- southeast through the southwest corner of the county.

Floodplains in Franklin County

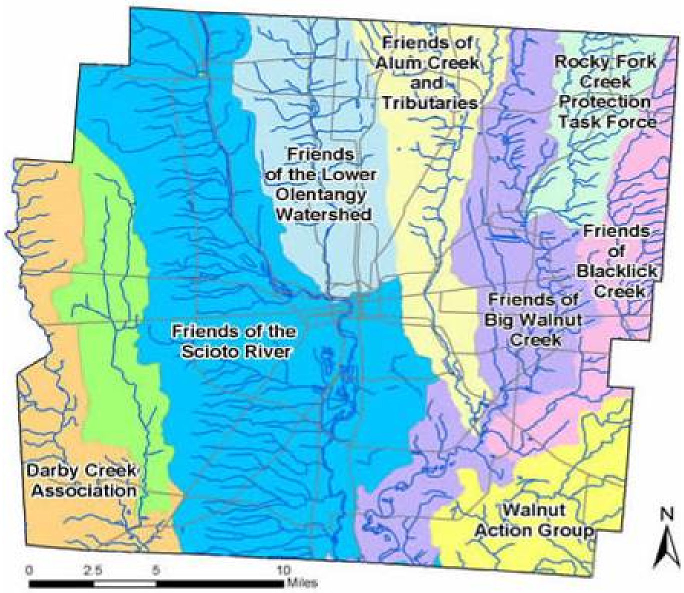


Source: FCEMHS

The National Climatic Data Center reported 116 flood events for Franklin County from 1950 to December of 2017, resulting in $1.567 million in property damage. No deaths or injuries were reported.[89]

[89] "Flood Query Results for Franklin County," NOAA – NCDC, accessed on 1 February 2018, https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=39%2COHIO

Franklin County Watersheds



Source: Midwestern Regional Climate Center[90]

Source: Friends of Alum Creek[91]

Scioto River Watershed

The upper Scioto River begins in west central Ohio and flows southeast to the confluence with the Olentangy River in Columbus. Over 1,000 square miles of drainage flows into the upper Scioto River watershed before completing its journey to the Ohio River. At more than 231 miles in length, the Scioto is one of the largest rivers in the state. The river and its 3,000 miles of tributaries flow 6,300 miles through all or part of 31 central and southern Ohio counties, draining nearly a half million acres before it joins the Ohio at Portsmouth.[92]

The Scioto River basin is the second largest watershed in Ohio. Flowing almost due north to south, the river collects all the water from Franklin County rivers, streams, and ditches by the time it reaches Circleville. The watershed is home to nearly two million Ohioans and a major source of public drinking water. More than twenty municipal water systems use surface water, while others draw water from wells adjacent to tributaries and the river.

Upstream from Columbus, the Scioto River is impounded by two major reservoirs, O'Shaughnessy near Dublin and Griggs near Upper Arlington. There are about five miles of free-flowing water between these reservoirs, and a similar stretch between Griggs Dam and the confluence with the Olentangy. The entire Scioto River corridor from the Delaware

[90] "The Rivers," Midwestern Regional Climate Center, accessed on 7 September 2015, http://mrcc.isws.illinois.edu/1913Flood/storms_wx/rivers.shtml

[91] "Lower Alum Creek Watershed Action Plan," Friends of Alum Creek and Tributaries, accessed on 25 July 2015, http://www.friendsofalumcreek.org/sitev2/aboutFACT.html

[92] "Scioto River Watershed," Ohio EPA, accessed on 1 Nov 2015, http://www.epa.state.oh.us/dsw/tmdl/SciotoRiver.aspx

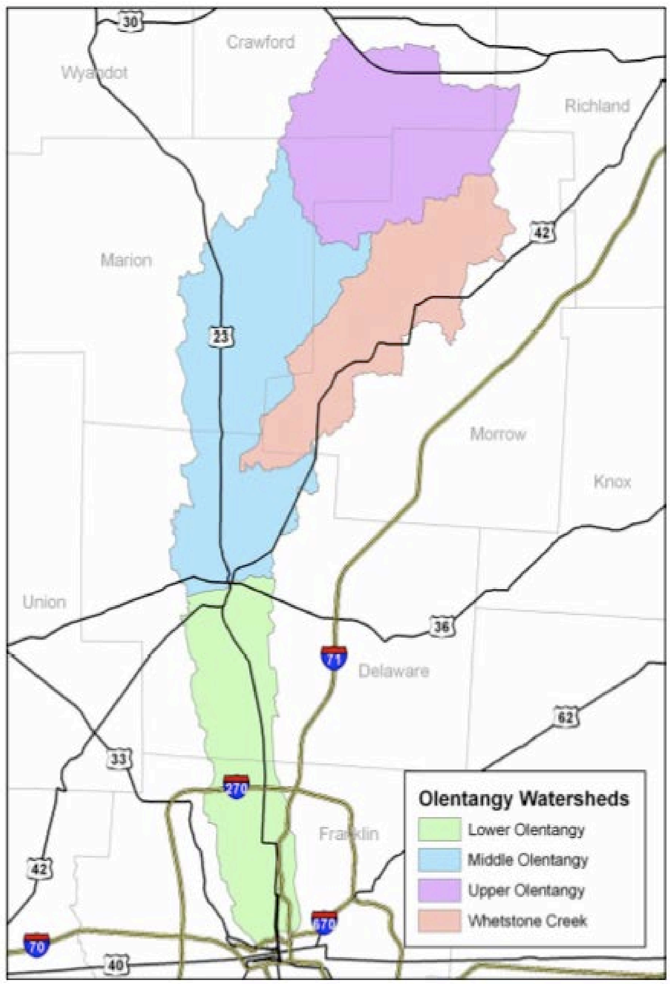
County line south through Dublin to Trabue Road in Upper Arlington is visible from Riverside Drive.

Below the confluence with the Olentangy River, the Scioto serves a drainage area of 1,629 square miles, larger at this point than any other Franklin County stream as it opens out into a wide floodplain. This wide floodplain has made the region vulnerable to flooding. Franklinton, the region's first settlement, was built on the floodplain and has suffered flooding on numerous occasions, with 1913 being the most severe.

The West Columbus Local Protection Project, better known as the Franklinton Floodwall, began construction in 1993 and was completed in 2004. The floodwall protects downtown's west riverbank area and the Franklinton neighborhood. In the event of a major flooding event along the Scioto River, the wall would serve as a dam to hold back water rising from the river.

The river is considerably wider than it would be naturally due to lowhead dams, which make navigation by anything but small craft quite difficult. In its natural state, the Scioto would barely keep a canoe afloat during periods of drought.

Many miles of the Scioto River corridor are owned by the City of Columbus, including lands adjacent to the two reservoirs and the corridor from the Olentangy confluence south to Frank Road. Most of the Columbus acreage is along the east bank of Griggs Reservoir. Dublin also has significant riverfront holdings.



Olentangy River Watershed

The Olentangy River is 88.5 miles long and spans five counties, including Franklin, Delaware, Marion, Morrow and Crawford.[93] A portion of the Olentangy was dammed in 1948 by the U.S. Corps of Engineers, creating Delaware Lake, a flood control

[93] "History," Olentangy Watershed Alliance, accessed on 1 Nov 2015, https://sites.google.com/site/olentangywatershedalliance/history

reservoir. The lower Olentangy River is the last 32-mile stretch, extending from the Delaware Dam to the confluence with the Scioto in downtown Columbus.

The lower Olentangy flows north to south for 13 miles in Franklin County, connecting the two oldest settled areas in central Ohio, Worthington and Franklinton. The lower Olentangy watershed encompasses about 150 square miles of land that drains into the river and its streams. The watershed is home to 250,000 people, and the population is growing.

The Olentangy flows all year long and has a steeper slope than many other central Ohio waterways. Many ravines are formed by the river's tributary streams. Exposed bedrock, steep slopes and in a few cases rock ledges and small waterfalls along these tributaries are unique in the otherwise flat terrain of the region. Stream flow in the Olentangy is directly influenced by rainfall events in the watershed. The lack of forest cover in the Upper Olentangy sub-basin and the high percentage of impermeable surface in the Lower Olentangy sub-basin allow rainfall events to generate short pulses of high surface-water flow.

The Delaware Dam also controls downstream flow in the river, mitigating the impact of flood events generated by heavy rainfall events in the Upper Olentangy sub-basin and maintaining a minimum rate of flow during droughts.

Ohio has approximately 1,000 low-head dams. In Franklin County, five low-head dams remain on the Olentangy River with one in Worthington and four in Columbus. Two low-head dams in Columbus have been removed in recent years: the Main Street dam on the Scioto River Downtown and the 5th Avenue dam on the Olentangy River just south of Ohio State University.

Flood Impacts – Worthington Gauge

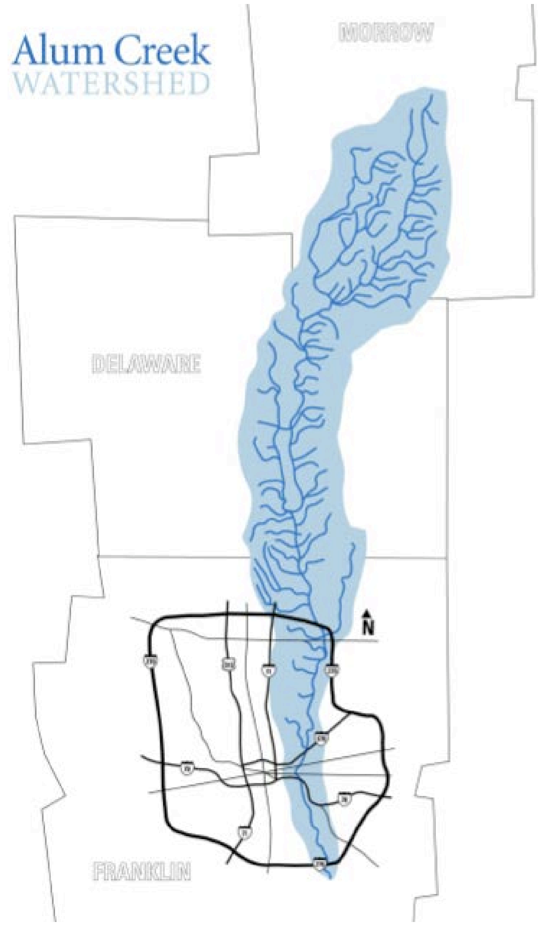
8.0' Flooding of property begins along the river at Mount Air in northern Franklin County.

10.0' Flood waters approach residences along the river in Mount Air. Flooding does not occur in Worthington until stage near 13 feet.

13.0' Flooding worsens in low areas along the river at Mount Air and Worthington experiences flooding.

Flood Categories (in feet)	
Major Flood Stage	18
Moderate Flood Stage	15
Flood Stage	13
Action Stage	7

The Alum Creek Watershed



The Alum Creek watershed is located in central Ohio, running through portions of Morrow, Delaware, and Franklin Counties.[94] The creek is 55.8 miles long and the watershed basin drains 199 square miles. The lower Alum Creek watershed extends from the Alum Creek Lake Reservoir in southern Delaware County to the creek's mouth and confluence with Big Walnut and Blacklick Creeks in southeastern Franklin County at Three Rivers Park.

The lower Alum Creek watershed drains 100 square miles and contains almost 27 miles of Alum Creek. Along the mainstem of Alum Creek, the boundary between the upper and lower sub-watersheds falls near Schrock Road in Westerville. The lower Alum Creek watershed contains portions of 11 political jurisdictions in Franklin County, including the cities of Westerville, Columbus and Bexley. Alum Creek's surface water is the primary source of Westerville's public water system.

Streamflow in the lower Alum Creek watershed is highly affected by the presence of Alum Creek Lake, a 10½ mile long, 3,400-acre reservoir located in south-central Delaware County between I-71 and US 23. The dam was built in 1974, spurred by the tremendous flood in 1959. The reservoir is operated by the Army Corps of Engineers, which maintains specific pool levels for summer and winter to accommodate seasonal variations in precipitation. The winter pool level is kept lower in anticipation of spring rains and snow melt, while the optimal summer pool is kept higher to maintain drinking water supplies and opportunities for recreation. Often large rain events are passed through the dam, especially in late winter and early spring in preparation for accommodating heavy spring rains.

The existence of this structure and its operation in accordance with flood control and water supply needs has dramatically altered Alum Creek stream flow compared with pre-dam flows, both within the current reservoir area and downstream of the reservoir. Water flow has been smoothed out to avoid both flood and drought events.

The major impetus for the construction of the dam was the devastating flood of January 1959. Damages were estimated at $37 million (in current dollar value), including about

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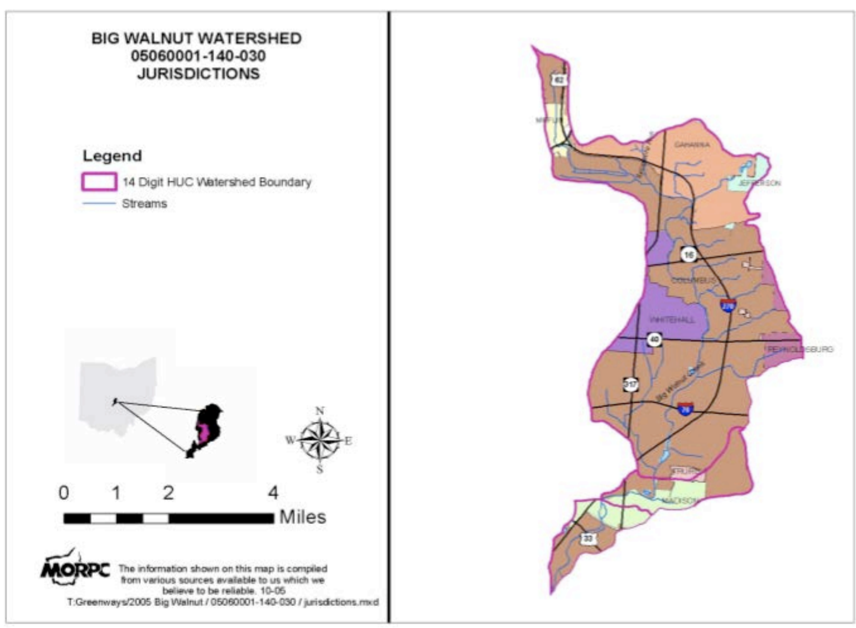
[94] "Lower Alum Creek Watershed Action Plan," Friends of Alum Creek and Tributaries,

$17 million in the Alum Creek watershed. Compared to average annual flow rates that have ranged from 39.1 cubic feet per second (cfs) in 1934 to 329 cfs in 1979, the 1959 flow of 26,400 cfs was indeed monumental. Instantaneous peak flows associated with 10-year storm events typically range near 6,000 – 8,000 cfs. Incredibly, the flow associated with this storm was only about half that which could be estimated for a realistic worst-case event for a watershed of its size in Ohio, according to ODNR.

Based on geographical interpretation of other severe flood events in Ohio, it is probable that a reasonable 50-year storm event could still cause peak flow rates in the lower watershed portion of the river in the order of 20,000+ cfs. Due to channel constraints and floodplain filling, the potential high water elevations during this type of flood event could conceivably equal or exceed those in 1959. Damage from such an event would be undoubtedly severe.

Beyond the reservoir, other impoundments within the watershed include five lowhead dams on the Alum Creek mainstem and numerous small dams on tributaries. Two lowhead dams, Nelson Park Dam and Wolfe Park Dam, were removed in 2008.

The majority of the watershed is now dominated by urban and suburban land uses. The most heavily urbanized portion of the watershed is located roughly along the Interstate 70 corridor, which is close to downtown Columbus. Much of the rest of the watershed is covered by suburban or industrial development. The construction of two large regional shopping centers in the watershed helps illustrate the growth trend: Polaris Fashion Place and surrounding shopping area, north of I-270, on either side of I-71, and the Easton Town Center, south of Morse Road between Sunbury Road and I-270. Growth is expected to continue in the watershed, especially in southern Delaware County.



Big Walnut Creek Watershed

Big Walnut Creek originates near Mount Gilead, Ohio, in Morrow County. The stream flows due south across Morrow County, continues into Delaware County and enters the Hoover Reservoir at Galena.[95] Lower Big Walnut Creek is 37.6 miles long, begins at the Hoover Reservoir Dam and flows south through eastern Franklin County to its confluence with the Scioto River, 0.25 miles south of the Pickaway County line. The creek flows through Gahanna, then to east of Port Columbus before bisecting the communities of Whitehall and Reynoldsburg. Two major tributaries, Alum Creek and Blacklick Creek, conjoin with Big Walnut at Three Rivers Park. Rocky Fork Creek joins Big Walnut in Gahanna.

Hoover Dam, built in 1955, impounds Big Walnut Creek near Westerville. The reservoir holds 20.8 billion gallons of water and has a surface area of 3,272 acres. The reservoir supplies roughly 50% of the region's drinking water. The dam has no flood control function.

The land area drained by the Big Walnut system is 556.7 square miles. The Lower Big Walnut watershed encompasses 145.4 square miles of drainage area, almost entirely in Franklin County. The stream falls 148 feet or 3.9 feet per mile. The watershed is flanked by rolling elevations that separate it from the watersheds of Blacklick Creek to the east and Alum Creek directly to the west. Six townships in Franklin County have areas in the watershed. Whitehall and Lockbourne are entirely within the watershed. Westerville, Gahanna, Columbus, Obetz, and Groveport are partly within the watershed.

Source: Ohio Department of Natural Resources

The Lower Big Walnut Creek Watershed experiences areas of flooding during high water events. In January 2005, several major precipitation events occurred within a short time period and caused extensive flooding in Franklin County. Within the Big Walnut watershed, the Gould Park subdivision, located west of Cherry Bottom Road in Columbus, was flooded so badly that residents had to be evacuated from their rooftops. The southern portion of the watershed also experienced flooding but, being more agricultural than the north, was affected less severely by floodwaters. The record flood along Big Walnut Creek in January 1959 produced the second highest crests in Columbus.

Significant land use activity centering along the Big Walnut includes the Limited Distribution Center, Port Columbus International Airport, several sand and gravel quarries, two Columbus water treatment plants, and Rickenbacker Airport.

[95] "Total Maximum Daily Loads for the Big Walnut Creek Watershed," Ohio EPA, accessed on 1 Nov 2015, http://www.epa.state.oh.us/portals/35/tmdl/BWC_Final%20081505.pdf

Rocky Fork and Blacklick Creeks are major tributaries to the Big Walnut. They are located within a mile and a half of each other and are similar in size. Rocky Fork begins as a small rural stream in Harlem Township in Delaware County. It flows about 13 miles until it reaches the confluence with Big Walnut Creek in suburbanized Gahanna, approximately three miles downstream of the intake of the City of Columbus' Hap Cremean Water Treatment Plant. It drains approximately 30 square miles. This sub-watershed of the Big Walnut is within the townships of Plain, Jefferson and Harlem and the municipalities of New Albany, Gahanna and Columbus.

Blacklick Creek begins in the northwest edge of Licking County and continues south and west until it joins the Big Walnut and Alum Creek confluence at Three Rivers Park. Blacklick is a pastoral, meandering stream, 30 miles long and fed by a 63 square mile watershed. It flows through four counties and 17 jurisdictions. The Blacklick Creek watershed forms the eastern-most secondary drainage system for the Upper Scioto River Basin. The Blacklick watershed is the smallest and the highest topographically of the Scioto Basin watersheds.

The Big Darby Watershed

Another major waterway in Franklin County is Big Darby Creek, which originates in Logan County and flows more than 80 miles before joining the Scioto River near Circleville. It flows along the Madison County–Franklin County border, then northwest to southeast across the southwest corner of Franklin County. The entire Darby watershed is 580 square miles in portions of six counties. Historically, land use in the watershed has been mostly row crop agriculture, except for the suburbanized eastern edges along the border of Madison and Franklin counties. Low lying areas along the Big Darby have a history of flooding in Franklin County, particularly at Darbydale in the southwestern part of the county.

The Big Darby is part of state and federal wild and scenic river systems, and has long been the focus of protection groups. The watershed contains some of the most biologically diverse streams of their size in the Midwest. It also provides habitat for several state and federally listed endangered species. The most visible threat to the watershed is conversion of farmland to suburban and commercial land uses.[96]

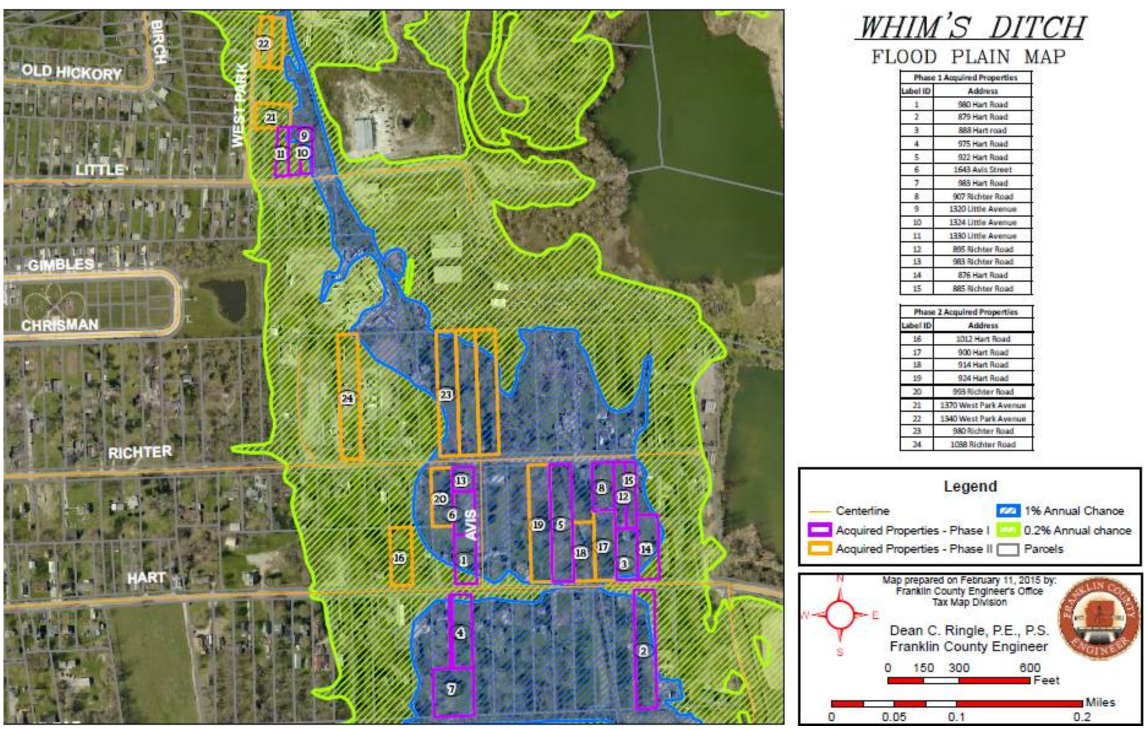
[96] "Big Darby Creek Watershed-General Permit," Ohio EPA, accessed on 1 Nov 2015, http://www.epa.state.oh.us/dsw/permits/GP_ConstructionSiteStormWater_Darby.aspx

Whims Ditch Acquisition Project

Interior photo of the Little Avenue home prior to demolition. Exterior walls and flooring shows water stains, mold and mildew.

Ohio EMA File Photo

Twenty-one homes in Franklin Township located in Southwest Franklin County were proposed for acquisition and demolition by the county. This neighborhood was developed between 1950-1970, prior to local floodplain delineation and flood risk management measures. The homes were built on low lying land and have experienced flooding from the nearby Whims Ditch during heavy rain events. The residential structures in the area have experienced significant property damage when Whims Ditch overflows. Franklin County, through funding associated with the Ohio Severe Wind Storm associated with Tropical Depression Ike (DR-1805), proposed to purchase 21 of the homes in this neighborhood for relocation and demolition. Fifteen of the buyout offers were accepted by home owners, while six declined. In September of 2012, the Franklin County Engineer's Office received additional funds through the Pre-Disaster Mitigation program to acquire and demolish 17 homes. Of those 17, 9 homes participated in the program. In October of 2015, the remaining 8 homeowners will be given a final opportunity to participate in the buyout program.[97]



Phase 1 Acquired Properties	
Label ID	Address
1	980 Hart Road
2	879 Hart Road
3	888 Hart road
4	975 Hart Road
5	922 Hart Road
6	1643 Avis Street
7	983 Hart Road
8	907 Richter Road
9	1320 Little Avenue
10	1324 Little Avenue
11	1330 Little Avenue
12	895 Richter Road
13	983 Richter Road
14	876 Hart Road
15	885 Richter Road

Phase 2 Acquired Properties	
Label ID	Address
16	1012 Hart Road
17	900 Hart Road
18	914 Hart Road
19	924 Hart Road
20	993 Richter Road
21	1370 West Park Avenue
22	1340 West Park Avenue
23	980 Richter Road
24	1088 Richter Road

Map prepared on February 11, 2015 by Franklin County Engineer's Office, Tax Map Division

[97] "Success Stories in Mitigation," Ohio EMA, accessed on 1 Nov 2015, http://ohiosharpp.ema.state.oh.us/OhioSHARPP/Documents/EducationAndResources/Success%20Stories/Whims_Success_Story.pdf

Repetitive Loss Properties:

COMMUNITY	Number	TYPE	Number of Losses	Building Payments	Contents Payments	Total Payments
Franklin County	20	Residential	47	$ 504,641.96	$ 121,451.85	$ 626,093.81
	1	Non-Residential	4	$ 13,865.60	$ 1,790.52	$ 15,656.12
City of Bexley	3	Residential	6	$ 496.74	$ 7,536.71	$ 8,033.45
	0	Non-Residential	0	$ -	$ -	$ -
City of Gahanna	1	Residential	3	$ 24,779.34	$ -	$ 24,779.34
	0	Non-Residential	0	$ -	$ -	$ -
City of Grove City	4	Residential	8	$ 50,334.17	$ 16,369.59	$ 66,703.76
	0	Non-Residential	0	$ -	$ -	$ -
City of Upper Arlington	3	Residential	6	$ 19,003.46	$ 31,348.76	$ 50,352.22
	0	Non-Residential	0	$ -	$ -	$ -
City of Whitehall	1	Residential	2	$ 4,322.43	$ -	$ 4,322.43
	0	Non-Residential	0	$ -	$ -	$ -
City of Worthington	4	Residential	11	$ 125,075.76	$ 64,891.14	$ 189,966.90
	0	Non-Residential	0	$ -	$ -	$ -
County and Jurisdictional Totals:	**36**	**Residential**	**83**	**$ 728,653.86**	**$ 241,598.05**	**$ 970,251.91**
	1	**Non-Residential**	**4**	**$ 13,865.60**	**$ 1,790.52**	**$ 15,656.12**
					Data is current as of:	August 1, 2015

Severe Repetitive Loss Properties:

COMMUNITY	Number	TYPE	Number of Losses	Building Payments	Contents Payments	Total Payments
City of Worthington	1	Residential	5	$ 86,726.96	$ 35,215.27	$ 121,942.23
	0	Non-Residential	0	$ -	$ -	$ -
County and Jurisdictional Totals:	**1**	**Residential**	**5**	**$ 86,726.96**	**$ 35,215.27**	**$ 121,942.23**
	0	**Non-Residential**	**0**	**$ -**	**$ -**	**$ -**
					Data is current as of:	February 1, 2015

Source: Ohio Emergency Management

The following is detailed event information for Franklin County as found in a search of the National Climate Data Center. Information on all events is available at the following site: http://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Flash+Flood&eventType=%28Z%29+Flood&beginDate_mm=09&beginDate_dd=01&beginDate_yyyy=2014&endDate_mm=09&endDate_dd=30&endDate_yyyy=2015&county=FRANKLIN%3A49&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=39%2COHIO

Franklin county contains the following zones:
'Franklin'

116 events were reported between 01/01/1950 and 12/30/2017 (24836 days)

Summary Info:

Number of County/Zone areas affected:	2
Number of Days with Event:	76
Number of Days with Event and Death:	0
Number of Days with Event and Death or Injury:	0
Number of Days with Event and Property Damage:	38
Number of Days with Event and Crop Damage:	0
Number of Event Types reported:	2

Below are details of three of the more significant events as reported by NCDC.

Event	**Flash Flood**
State	**OHIO**
County/Area	**FRANKLIN**
WFO	**ILN**
Report Source	**LAW ENFORCEMENT**
NCDC Data Source	**PDC**
Begin Date	**1998-06-29 00:15:00.0 EST**
End Date	**1998-06-29 06:25:00.0 EST**
End Location	**WEST PORTION**
Deaths Direct/Indirect	**0/0** (fatality details below, when available...)
Injuries Direct/Indirect	**0/0**
Property Damage	**1M**
Crop Damage	
Event Narrative	**Nearly 10 inches of rain fell in southwestern parts of the county causing significant flooding, especially near Wrightsville, Darbydale, Pleasant Corners, and Grove City. Numerous roads were closed, including Interstate 71. Several homes were flooded and some evacuations occurred.**

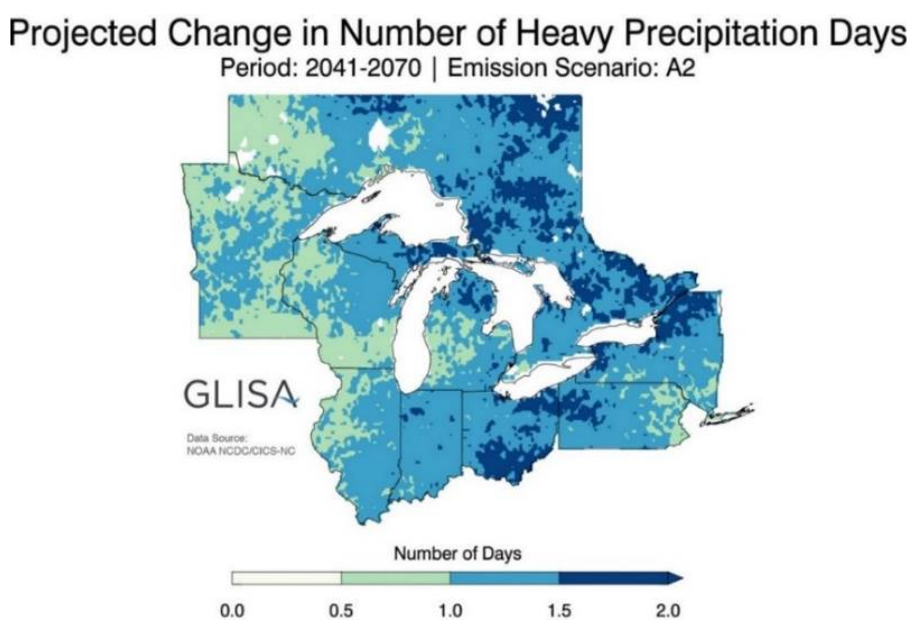
Event	Flood
-- Flood Cause	Heavy Rain
State	OHIO
County/Area	FRANKLIN
WFO	ILN
Report Source	Amateur Radio
NCDC Data Source	CSV
Begin Date	2014-06-24 17:50:00.0 EST-5
Begin Location	1WSW HOMEDALE
Begin Lat/Lon	40.06/-83.04
End Date	2014-06-24 18:50:00.0 EST-5
End Location	1WSW HOMEDALE
End Lat/Lon	40.0671/-83.0376
Deaths Direct/Indirect	0/0 (fatality details below, when available...)
Injuries Direct/Indirect	0/0
Property Damage	100.00K
Crop Damage	0.00K
Episode Narrative	Thunderstorms developed across the region in a very moist airmass ahead of a cold front. These storms were capable of producing damaging winds, heavy rainfall, and localized flooding.
Event Narrative	High standing water was reported on Bethel Road near State Route 315 due to heavy rainfall. Some cars were partially submerged on Bethel Road and in an adjacent parking lot.

Event	Flash Flood
State	OHIO
County/Area	FRANKLIN
WFO	ILN
Report Source	LAW ENFORCEMENT
NCDC Data Source	PDS
Begin Date	2003-08-15 19:30:00.0 EST
End Date	2003-08-15 20:30:00.0 EST
End Location	BEXLEY
Deaths Direct/Indirect	0/0 (fatality details below, when available...)
Injuries Direct/Indirect	0/0
Property Damage	80K
Crop Damage	
Event Narrative	Thunderstorms that produced locally five to seven inches of rain inundated the east side of Columbus during the evening. Street flooding occurred from Bexley north to Gahanna with numerous road closures. Several homes in Bexley neighborhoods had flooded basements, with high water forcing 25 families out of their homes. Seventeen structures sustained major damage from flooding.

Climate Change Impacts

Many uncertainties exist in efforts to detect flood-statistic changes attributable to climate change, because a wide range of local factors (e.g. dams, land-use changes, river channelization) also affect flood regimes and can mask, or proxy for, climate change induced alterations. It is especially difficult to detect trends in rare and extreme events. The response of floods to climate changes are fairly idiosyncratic from basin to basin, because of the strong influences of within-storm variations and local, basin-scale topographic, soil and vegetation, and river network characteristics that influence the size and extent of flooding associated with any given storm or season.

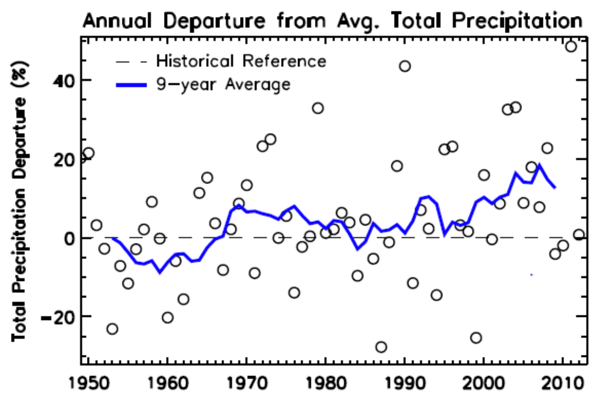
It is also uncertain as to how well climate models can represent and project future extremes of precipitation. Until recently, this uncertainty has limited efforts to project future flood frequencies using climate model outputs directly or as direct inputs to hydrologic models. However, precipitation extremes are expected to intensify as the atmosphere warms, and many floods result from larger portions of catchment areas receiving rain as snowlines recede upward. Rain runs off quicker than snowfall which results in increased flood potential. This trend is expected to increase in frequency under general warming trends, particularly in mountainous catchments. Rising sea levels and a projected increase in hurricane-associated storm intensity and rainfall rates provide for expected intensified flood regimes in coastal settings.



Additionally, it is projected that the average number of days per year that experience heavy precipitation will increase in 2041-2070 as compared to the time period of 1971-2000, assuming emissions of greenhouse gases continue to rise (see below graph for details). Heavy precipitation is defined as the 2% heaviest precipitation events in a given area. Projections of precipitation are highly variable by location, individual model, the timeframe considered, and the threshold of precipitation used. Heavy precipitation events are generally anticipated to increase throughout the region.[98]

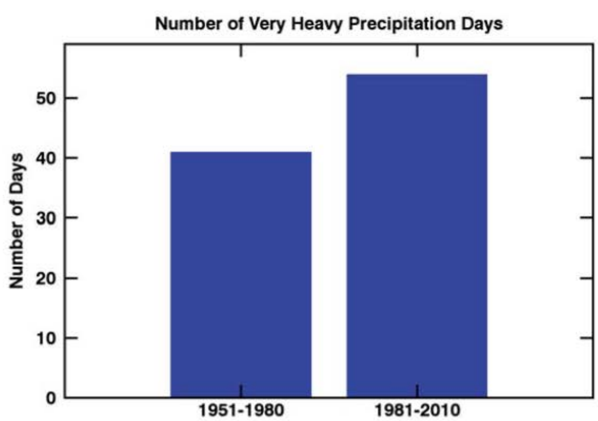
[98] "Great Lakes Regional Climate Change Maps," Great Lakes Integrated Sciences and Assessments (GLISA), accessed on 25 July 2015, http://glisa.umich.edu/resources/great-lakes-regional-climate-change-maps

Related specifically to the Columbus, Ohio area, total precipitation increased 19.8% from 1951 to 2012 with a dramatic increase in fall precipitation of 43.5% (3.2 inches). Additionally, from the 1951-1980 period to the 1981-2010 period, the amount of precipitation falling during the heaviest 1% of precipitation events increased by 36.2%.[99] Below are additional statistics from GLISA.

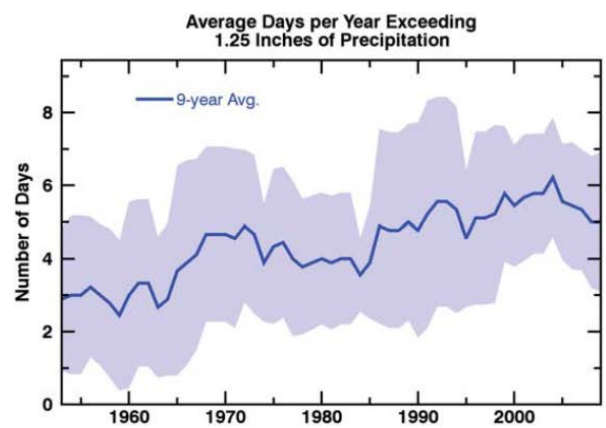


Annual departures from the 1951-1980 average of total annual precipitation. The solid blue line is the 9-year moving average. Open circles are departures from the 1951-1980 average for single years.

Changes in Heavy Precipitation



The number of daily precipitation totals for the 1951-1980 and 1981-2010 periods that exceeded the size of the heaviest 1% of storms as defined by the 1951-1980 period.



The blue line represents the 9-year moving average of the number of days per exceeding a daily total of 1.25 inches of precipitation. The shaded band represents the standard deviation.

[99] Historical Climatology: Columbus, Ohio," GLISA

Increasing Precipitation

Total Precipitation

Total precipitation increased by 19.8% from 1951 through 2012, similar to changes observed in other major Ohio cities. Fall precipitation increased dramatically, by 43.5% (3.2 inches).

19.8%
1951-2012

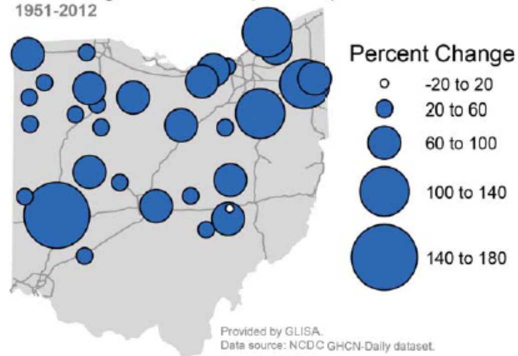
Heavy Precipitation

Between the 1951-1980 and 1981-2010 periods, the number of very heavy precipitation events increased by 32%.

The number of days per year that saw more than 1.25" of precipitation increased by 130% from 1951-2012.

32%
1951-2012

Percent Change in the Number of Days Exceeding 1.25" of Precipitation per Year
1951-2012



Nuisance flooding and other impacts begin to occur more frequently with daily precipitation totals over 1.25 inches.

Shown above is the percent change in the number of days per year exceeding 1.25" of precipitation recorded at high-quality weather observation stations from 1951-2012. All but two stations have observed a change greater than 20%. Long-term, contiguous climate records are limited in much of southern Ohio.

GLISA states that many of the observed trends in temperatures and precipitation are expected to continue or accelerate in the future. Most models project that precipitation will increase overall, although the magnitude of these increases are uncertain. Many models predict that summer precipitation will decline or remain stable. Heavy precipitation events will likely continue to become more intense and more frequent.

What Increasing Precipitation Means for Columbus:

Greater Flood Risk: Ohio has seen large increases in heavy storms that can lead to flooding. Models project those trends will continue, increasing flood damage risks to infrastructure and public health.

Changing Seasonal Precipitation: As temperatures warm and precipitation increases, the form and timing of precipitation will likely change. The number of days dry enough to plant crops in the spring may be reduced, and the potential for rain on semi-frozen ground may increase.

Reduced Water Quality: With stronger storms come flashier flows, more runoff, and greater chances of sewer overflows that can contaminate water supplies.

Summer Water Availability: Many models project summer precipitation will decline even as precipitation increases during other seasons. This raises the potential for summer droughts and seasonal water shortages, particularly for agricultural and industrial use.

Source: GLISA

Vulnerability Assessment – Flooding

**Note: all information in this vulnerability assessment can be attributed to the Franklin County 2012 Natural Hazards Mitigation Plan, FEMA's HAZUS data print date May 2014 as received from the Ohio Emergency Management Agency, and National Climatic Data Center (NCDC) searches accessed via https://www.ncdc.noaa.gov/stormevents/*

This hazard is considered to be a "Relatively Low Probability Event", meaning the anticipated frequency of the hazard within the County is once every 5 to 25 years. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability

Flood vulnerability is described in terms of the community assets, structures, and infrastructure located where flooding is anticipated. The below data provides a vulnerability overview of damage due to flood/flash flood data provided by NCDC.

Potential Impact of Flooding

Summary of Past Losses Due to Flooding Estimated Property Damages	
Total Losses Due to Flooding 1995–2017	$1,567,000
Average Annual Losses for 22 years	$71,227.00

According to NCDC, estimated significant property damage in Franklin County attributable to flooding during the years 1995 through 2017 is $1,567,000. Thus, the average annual loss for these 22 years is $1,567,000 / 22 = $71,227.

Identifying Structures

Exposure of Existing Buildings to Damages Due to Flooding

As of September 2015, HAZUS estimates that there are 386,078 buildings in the region which have an aggregate total replacement value of $91,875 million (2006 dollars; 2015 values are not available in HAZUS). For a 100-year flood, HAZUS estimates that about 3,006 buildings will be at least moderately damaged. This is over 25% of the total number of buildings in the scenario. There are an estimated 673 buildings that will be completely destroyed, having over 50% damage to the structure, per the most current HAZUS report. 22 buildings would be considered critical facilities. Table 1 below shows total building exposure. Table 2 shows building exposure for this 100 year flood scenario.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	64,930,418	70.7%
Commercial	18,793,273	20.5%
Industrial	4,107,298	4.5%
Agricultural	238,751	0.3%
Religion	1,764,907	1.9%
Government	712,163	0.8%
Education	1,328,522	1.4%
Total	**91,875,332**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	8,301,727	67.85%
Commercial	2,847,042	23.10%
Industrial	562,455	4.65%
Agriculture	32,382	0.25%
Religion	**225,525**	**1.85%**
Government	**101,650**	**0.8%**
Education	**184,108**	**1.5%**
Total	**12,254,889**	**100%**

Estimating Potential Loss

Methodology

The method utilized for estimating potential losses due to flooding is based upon historical data provided by NCDC and HAZUS. Damages due to one flooding event in the Franklin County have varied from no cost for damages to $1 million.

According to NCDC, estimated property damage in Franklin County attributable to flooding or flash floods over the period 1995 through 2017 is $1,567,000. Past losses provided from NCDC are used to estimate the potential for annual losses due to flooding.

Estimated Potential Dollar Losses

Since the total loss over these 20 years is $1,567,000, the average annual loss is $1,567,000 / 22 = $71,227.

HAZUS estimates the potential dollar loss for a 100-year flood would be $12,254,889. Therefore, in any given year there is a one percent chance there could be an estimated damage of $12,254,889, which gives an average annual loss of $12,254,889/ 100 years = $122,548.

Because the NCDC records are over a relatively small time period for a hazard that has greater risks over a longer period of time, the HAZUS estimation should be incorporated to get a realistic estimated potential dollar loss for flooding. Therefore, the annual average loss from HAZUS is $122,548 plus the annual estimated loss per NCDC is $71,227 = $193,775/2 = $96,887.50. By combining both annual losses, the total average annual loss due to flooding is $96,887.50.

The damage in dollars represented in this vulnerability statement only quantify the damage to structures and does not reflect ancillary costs associated with this hazard.

Lone Wolf Terrorism- #5

Hazard Summary

According to the Department of Homeland Security (DHS), Lone Wolf Terrorism is defined as an individual motivated by extremist ideology to commit acts of criminal violence independent of any larger terrorist organization. In recent years, the United States has certainly seen an emerging threat in lone wolf terrorist. The Holocaust museum shooter, the Little Rock recruiting station, Ft. Hood shooting, attack on Representative Giffords in Tucson, the Boston Marathon bombing, Emanuel African Methodist Episcopal Church in Charleston, South Carolina Shooting as well as the shooting of 5 Marine Recruiters in Chattanooga, Tennessee clearly demonstrate the lone wolf phenomenon is gaining popularity amongst would be terrorists. Lone wolf attacks such as these are easy to execute, cost very little, and make headlines. This lone wolf threat is a great challenge to our first responders and therefore has been included in the Risk Assessment as a potential hazard to Franklin County. This hazard was ranked 5 out of 20.

Hazard Profile

The Domestic Extremism Lexicon, released by DHS in 2009, defines lone wolf terrorism as an individual motivated by extremist ideology to commit acts of criminal violence independent of any larger terrorist organization.[100] The term "lone wolf" is used by law enforcement agencies and the media to refer to individuals undertaking violent acts of terrorism outside a command structure. While the lone wolf acts to advance the ideological or philosophical beliefs of an extremist group, they act on their own, without any outside command or direction. The lone wolf's tactics and methods are conceived and directed solely on their own. In many cases, the lone wolf never even has personal contact with the group with which they identify. As such, it is considerably more difficult for counter-terrorism officials to gather intelligence on lone wolves, since they may not come into contact with routine counter-terrorist surveillance. In the United States, lone wolves may present a greater threat than organized groups.

Lone wolf terrorists come in all shapes, sizes and ideologies and operate all over the world. Islamic extremists, religious zealots, environmental and animal rights extremists, and white supremacists have all conducted lone wolf attacks. There is no single common denominator or profile for who becomes a lone wolf.

Despite this, there are some characteristics/traits shared amongst many lone wolves. One common characteristic is the exploration of extremist media (i.e. books and internet websites). Another common trait is lone wolves often do not "work and play well with others". A classic example is Ted Kaczynski who lived alone in a log cabin deep in the Montana wilderness. Many join extremist groups only to leave due to having a separate agenda or ideas, which are too extreme even for the other members of the group. Many lone wolves publish their own manifestos. Today the internet allows anyone with a Facebook account or personal web page to post their extremist ideology.

Components of Lone Wolf Terrorists

Self-Radicalization

Though lone wolf terrorists are self-radicalized, their motivation may not always be political or religious. In some instances, they may be motivated by personal agendas in response to some real or perceived organizational or institutional event.

The lone wolf terrorist concept emerged in the 1970s and 1980s as an outgrowth of reactionary right-wing, anti-government activities. The neo-Nazi, anti-Semitic and anti-Black ideologies of The Order, Posse Comitatus, Identity Christian and the Klu Klux Klan provided motivation for individual acts of terrorism not only by groups, but also by un-affiliated individuals who were self-radicalized by their exposure to teaching, writings and publications.

[100] "Domestic Extremism Lexicon, 2009," U.S. Department of Homeland Security, http://www.constitution.org/abus/dhs/hsra-domestic-extremismlexicon_165213935473.pdf

Single-issue protest groups such as the Animal Liberation Front (ALF), the Environmental Liberation Front (ELF), and anti-abortionist groups also have spawned a number of lone wolf terrorist attackers. Because of their historic roots in Great Britain, both ALF and ELF are international, leaderless resistance groups that have been engaged in direct action. Both groups claim to be non-violent, but they both have been associated with a number of single individual-type attacks which have resulted in extensive property damage, especially in the United States. As a consequence, they have been placed on the terrorist watch list by the Department of Homeland Security.

The one thing that various lone wolf terrorists have in common has been their self-radicalization. Though a number of lone wolf terrorists have had some contact with extremist groups, they have not committed themselves to continuous membership or group involvement. Therefore, the majority of their identification and internalization has taken place through secondary sources. Historically, books, writings, and manifestos were frequent sources of self-radicalization. In some cases an incident, such as the standoff and final confrontation between the federal government and the Branch Davidians in Waco, Texas or the event at Ruby Ridge, can radicalize an individual. More recently, the advent of the internet has created a fertile environment for the self-radicalization of lone wolf terrorists by providing ideological justification and direction from a distance. Nevertheless, self-radicalization is a matter of degree and may be considered as one end of a continuum in the process of ideological commitment.

<u>Leaderless Resistance</u>
The concept of "leaderless resistance" is another important component of the lone wolf terrorist. Leaderless resistance is defined in the Domestic Extremism Lexicon as a strategy that stresses the importance of individuals and small cells acting independently and anonymously outside formalized organizational structures to enhance operational security and avoid detection. It is used by many types of domestic extremists.

The concept of leaderless resistance also has been picked up as a tactical component by a number of groups and has been called the wave of the future. Though it might be less lethal in each instance, lone wolf terrorism will be more difficult to combat as there are fewer indicators to lead to its discovery.

The increasingly effective dissemination of extremist ideology has contributed to the rise of the leaderless lone wolf terrorist. Individuals with extremist interests or leanings are now easily self-educated and radicalized through the acquisition of not only an ideology, but also justifications and tactics for its use. Leaderless resistance not only mobilizes, it also provides inspiration for a single individual to become a leader by deed.

<u>Chaos (single event) or Career (serial) Terrorism</u>
Lone wolf terrorism can take either of two forms, chaos or career. Chaos lone wolf terrorism is characterized by a single event in which the lone wolf appears as if from nowhere and engages in a singular disruptive event. Suicide terrorism is a major form of chaos lone wolf terrorism. A single event is planned and conducted in such a manner that

maximum impact in terms of casualties and/or public visibility is achieved. The lone wolf suicide terrorist, a form of ultimate altruism, not only damages a target or target population, but also establishes the cause for which the terrorist sacrifices his life as one worthy of great respect and even fear. For the most part, chaos or single event terrorism has been the domain of political and religious extremists who consider their dramatic act as a valued sacrifice to a higher cause. In many ways, chaos terrorism is very similar to mass murder. In most cases, a mass murder episode ends with the murderer dying at the scene of a dramatic event.

Career or serial terrorism by a lone wolf operative usually involves a continuous series of lower-level acts of violence over an extended period of time. Ted Kazinsky, the Unabomber, is an example of a career or serial lone wolf terrorist. Kazinsky engaged in a mail bombing campaign that spanned almost 20 years that killed 3 people and injured more than two dozen others. Lone wolf operatives engaged in career or serial terrorism see their violent protests as a long-term strategy in which their survival is a prerequisite for the continued visibility and viability of their campaign. This type of lone wolf terrorist has a strong egoistic belief in his ability to continue to outsmart the agencies of control. Social profiles of serial lone wolf terrorists are quite similar to those of serial killers, and that profile suggests that most lone wolf terrorists are relatively normal, ordinary individuals. However, some researchers have noted that there may be some factors that link the type of terrorism to certain types of individuals.

The social character of the serial lone wolf terrorist is often linked to personality and social traits associated with other isolated individuals. They tend to be above average in intelligence, self-centered and to some degree paranoid, especially in regard to the forces of social control. Because of their need to justify their extreme actions over an extended period of time, serial lone wolf terrorists often create public justifications of their actions. For example, Ted Kazinsky published his own manifesto and wrote frequent letters to the media denouncing technology. He stated, "In order to get our message before the public…we had to kill people".

Consistent with the behavior of terrorist groups, lone wolves may not have been direct victims of the actions of their target group. Nevertheless, lone wolves are committed to correcting some perceived injustice befalling someone, whether that be the environment, animals, unborn children, the white race, or an ethnic or religious group.

Terrorism, whether the single episode resulting in chaos and destruction or the serial practice of smaller-scale ongoing attacks, is increasingly the result of the self-radicalized lone wolf committed to creating a public performance in support of a cause.

Definitions from the Domestic Extremism Lexicon[101]

[101] "Domestic Extremism Lexicon, 2009," U.S. Department of Homeland Security, http://www.constitution.org/abus/dhs/hsra-domestic-extremismlexicon_165213935473.pdf

Aboveground: A term used to describe extremist groups or individuals who operate overtly and portray themselves as law-abiding.

Alternative media: A term used to describe various information sources that provide a forum for interpretations of events and issues that differ radically from those presented in mass media products and outlets.

Anarchist Extremism: A movement of groups or individuals who advocate a society devoid of government structure or ownership of individual property. Many embrace some of the radical philosophical components of anti-capitalist, anti-globalization, communist, socialist, and other movements. Anarchist extremists advocate changing government and society through revolutionary violence. (also: *revolutionary anarchists*)

Animal Rights Extremism: A movement of groups or individuals who ascribe equal value to all living organisms and seek to end the perceived abuse and suffering of animals. They believe animals are sentient creatures that experience emotional, physical, and mental awareness and deserve many of the same rights as human beings; for example, the right to life and freedom to engage in normal, instinctive animal behavior. These groups have been known to advocate or engage in criminal activity and plot acts of violence and terrorism in an attempt to advance their extremist goals. They have targeted industries, businesses, and government entities that they perceive abuse or exploit animals, including those that use animals for testing, human services, food production, or consumption. (also: *animal liberation*)

Antiabortion Extremism: A movement of groups or individuals who are virulently antiabortion and advocate violence against providers of abortion-related services, their employees, and their facilities. Some cite various racist and anti-Semitic beliefs to justify their criminal activities.

Anti-Immigration Extremism: A movement of groups or individuals who are vehemently opposed to illegal immigration, particularly along the U.S. southwest border with Mexico, and who have been known to advocate or engage in criminal activity and plot acts of violence and terrorism to advance their extremist goals. They are highly critical of the U.S. Government's response to illegal immigration and oppose government programs that are designed to extend "rights" to illegal aliens, such as issuing driver's licenses or national identification cards and providing in-state tuition, medical benefits, or public education.

Anti-technology Extremism: A movement of groups or individuals opposed to technology. These groups have been known to advocate or engage in criminal activity and plot acts of violence and terrorism in an attempt to advance their extremist goals. They have targeted college and university laboratories, scholars, biotechnology industries, U.S. corporations involved in the computer or airline industry, and others. (also: *Neo-Luddites*)

Aryan Prison Gangs: Individuals who form organized groups while in prison and advocate white supremacist views. Group members may continue to operate under the auspices of the prison gang upon their release from correctional facilities.

Black Bloc: An organized collection of violent anarchists and anarchist affinity groups that band together for illegal acts of civil disturbance and use tactics that destroy property or strain law enforcement resources. Black blocs operate in autonomous cells that infiltrate nonviolent protests, often without the knowledge of the organizers of the event.

Black Nationalism: A term used by black separatists to promote the unification and separate identity of persons of black or African American descent and who advocate the establishment of a separate nation within the United States.

Black Power: A term used by black separatists to describe their pride in and the perceived superiority of the black race.

Black Separatism: A movement of groups or individuals of black or African American descent who advocate the separation of the races or the separation of specific geographic regions from the rest of the United States; some advocate forming their own political system within a separate nation. Such groups or individuals also may embrace radical religious beliefs. Members have been known to advocate or engage in criminal activity and plot acts of violence directed toward local law enforcement in an attempt to advance their extremist goals.

Christian Identity: A racist religious philosophy that maintains non-Jewish whites are "God's Chosen People" and the true descendants of the Twelve Tribes of Israel. Groups or individuals can be followers of either the Covenant or Dual Seedline doctrine; all believe that Jews are conspiring with Satan to control world affairs and that the world is on the verge of the Biblical apocalypse. Dual Seedline adherents believe Jews are the literal offspring of Satan and that nonwhites, who are often referred to as "mud people," are not human beings. (also: *Identity, CI, Anglo-Israel*)

Cuban Independence Extremism: A movement of groups or individuals who do not recognize the legitimacy of the Communist Cuban Government and who attempt to subvert it through acts of violence, mainly within the United States. (also: *anti-Castro groups*)

Decentralized Terrorist Movement: A movement of groups or individuals who pursue shared ideological goals through tactics of leaderless resistance independent of any larger terrorist organization.

Denial-of-Service Attack: An attack that attempts to prevent or impair the intended functionality of computer networks, systems, or applications. Depending on the type of system targeted, the attack can employ a variety of mechanisms and means. (also: *DoS attack*)

Direct Action: Lawful or unlawful acts of civil disobedience ranging from protests to property destruction or acts of violence. This term is most often used by single-issue or anarchist extremists to describe their activities.

Environmental Extremism: A movement of groups or individuals who use violence to end what they perceive as the degradation of the natural environment by humans. Members have advocated or engaged in criminal activity and plot acts of violence and terrorism in an attempt to advance their extremist goals. They target industries, businesses, and government entities that they allege are engaged in habitat destruction, citing urban sprawl and development, logging, construction sites and related equipment, and man-made sources of air, water, and land pollution. (also: *ecoterrorism*)

Ethnic-based Extremism: A movement of groups or individuals who are drawn together and form extremist beliefs based on their ethnic or cultural background. Members have advocated or engaged in criminal activity and have plotted acts of violence and terrorism in an attempt to advance their extremist goals.

Extremist Group: An ideologically driven organization that advocates or attempts to bring about political, religious, economic, or social change through the use of force, violence, or ideologically motivated criminal activity.

Green Anarchism: A movement of groups or individuals who combine anarchist ideology with an environmental focus. They advocate a return to a preindustrial, agrarian society, often through acts of violence and terrorism.

Hacktivism: (A portmanteau of "hacking" and "activism.") The use of cyber technologies to achieve a political end, or technology-enabled political or social activism. Hacktivism might include website defacements, denial-of-service attacks, hacking into the target's network to introduce malicious software (malware), or information theft.

Hate Groups: A term most often used to describe white supremacist groups. It is occasionally used to describe other racist extremist groups.

Jewish Extremism: A movement of groups or individuals of the Jewish faith who are willing to use violence or commit other criminal acts to protect themselves against perceived affronts to their religious or ethnic identity.
en.wikipedia.org

Leaderless Resistance: A strategy that stresses the importance of individuals and small cells acting independently and anonymously outside formalized organizational structures to enhance operational security and avoid detection. It is used by many types of domestic extremists.

Leftwing Extremism: A movement of groups or individuals that embraces anti-capitalist, Communist, or Socialist doctrines and seeks to bring about change through violent revolution rather than through established political processes. The term also refers to leftwing, single-issue extremist movements that are dedicated to causes such as environmentalism, opposition to war, and the rights of animals. (also: *far left, extreme left*)

Lone Terrorist: An individual motivated by extremist ideology to commit acts of criminal violence independent of any larger terrorist organization. (also: *lone wolf*)

Mexican Separatism: A movement of groups or individuals of Mexican descent who advocate the secession of southwestern U.S. states (all or part of Arizona, California, New Mexico, and Texas) to join with Mexico through armed struggle. Members do not recognize the legitimacy of these U.S. states, including the U.S. Government's original acquisition of these territories.

Militia Movement: A rightwing extremist movement composed of groups or individuals who adhere to an antigovernment ideology often incorporating various conspiracy theories. Members oppose most federal and state laws, regulations, and authority (particularly firearms laws and regulations) and often conduct paramilitary training designed to resist perceived government interference in their activities or to overthrow the U.S. Government through the use of violence. (also: *citizens militia, unorganized militia*)

Neo-Nazis: Groups or individuals who adhere to and promote Adolph Hitler's beliefs and use Nazi symbols and ideology. Subjects subscribe to virulently racist as well as anti-Semitic beliefs, many based on national socialist ideals derived from Nazi Germany. Neo-Nazis may attempt to downplay or deny the Jewish Holocaust. (also: *national socialists, Nazis*)

Patriot Movement: A term used by rightwing extremists to link their beliefs to those commonly associated with the American Revolution. The patriot movement primarily comprises violent antigovernment groups such as militias and sovereign citizens. (also: *Christian patriots, patriot group, Constitutionalists, Constitutionist*)

Phineas Priesthood: A Christian Identity doctrine derived from the Biblical story of Phinehas, which adherents interpret as justifying inter-racial killing. Followers of this belief system also have advocated martyrdom and violence against homosexuals, mixed-race couples, and abortion providers.

Primary Targeting: Plans or attacks directed by extremists against parties that are the focus of an organized campaign.

Puerto Rican Independence Extremists: Groups or individuals who engage in criminal activity and advocate the use of violence to achieve Puerto Rican independence from the United States.

Racial Nordic Mysticism: An ideology adopted by many white supremacist prison gangs who embrace a Norse mythological religion such as Odinism or Asatru. (also: *Odinism, Asatru*)

Racialist: A term used by white supremacists intended to minimize their extreme views on racial issues.

Racist Skinheads: Groups or individuals who combine white supremacist ideology with a skinhead ethos in which “white power” music plays a central role. Dress may include a shaved head or very short hair, jeans, thin suspenders, combat boots or Doc Martens, a bomber jacket (sometimes with racist symbols), and tattoos of Nazi-like emblems. Some are abandoning these stereotypical identifiers. (also: *skins*)

Radicalization: The process by which an individual adopts an extremist belief system leading to his or her willingness to advocate or bring about political, religious, economic, or social change through the use of force, violence, or ideologically motivated criminal activity.

Rightwing Extremism: A movement of rightwing groups or individuals who can be broadly divided into those who are primarily hate-oriented, and those who are mainly antigovernment and reject federal authority in favor of state or local authority. This term also may refer to rightwing extremist movements that are dedicated to a single issue, such as opposition to abortion or immigration. (also known as *far right, extreme right*)

Secondary Targeting: Plans or attacks directed against parties (secondary targets) that provide direct financial, logistic, or physical support to the primary target of an organized campaign, with the goal of coercing those parties to end their engagement with a primary target. Secondary targets can include customers of or suppliers to a primary target or employees of a primary target organization.

Single-issue Extremist Groups: Groups or individuals who focus on a single issue or cause—such as animal rights, environmental or anti-abortion extremism—and often employ criminal acts. Group members may be associated with more than one issue. (also: *special interest extremists*)

Skinheads: A subculture composed primarily of working-class, white youth who embrace shaved heads for males, substance abuse, and violence. Skinheads can be categorized as racist, anti-racist or “traditional,” which emphasizes group unity based on fashion, music, and lifestyle rather than political ideology. Dress often includes a shaved head or very short hair, jeans, thin suspenders, combat boots or Doc Martens, and a bomber jacket. (also: *skins*)

Sovereign Citizen Movement: A rightwing extremist movement composed of groups or individuals who reject the notion of U.S. citizenship. They claim to follow only what they believe to be God’s law or common law and the original 10 amendments (Bill of Rights) to the U.S. Constitution. They believe they are emancipated from all other responsibilities associated with being a U.S. citizen, such as paying taxes, possessing a driver's license and motor vehicle registration, or holding a social security number. They generally do not recognize federal or state government authority or laws. Several sovereign citizen groups in the United States produce fraudulent documents for their members in lieu of legitimate government-issued forms of identification. Members have been known to advocate or engage in criminal activity and plot acts of violence and terrorism in an attempt to advance their extremist goals. They often target government officials and law enforcement. (also: *state citizens, freemen, preamble citizens, common law citizens*)

Tax Resistance Movement: Groups or individuals who vehemently believe taxes violate their constitutional rights. Among their beliefs are that wages are not income, that paying income taxes is voluntary, and that the 16th Amendment to the U.S. Constitution, which allowed Congress to levy taxes on income, was not properly ratified. Members have been known to advocate or engage in criminal activity and plot acts of violence and terrorism in an attempt to advance their extremist goals. They often target government entities such as the Internal Revenue Service and the Bureau of Alcohol, Tobacco, Firearms and Explosives. (also: *tax protest movement, tax freedom movement, anti-tax movement*)

Tertiary Targeting: Plans or attacks against parties with indirect links to the primary target of an organized campaign. Tertiary targets can include employees, customers, investors, and other participants in a company (the secondary target) that does business with or provides support services to the primary target; or parties who provide direct financial, logistic, or physical support to the secondary target.

Underground: A term used to describe clandestine extremist groups, individuals, or their activities.

Violent Antiwar Extremism: A movement of groups or individuals who advocate or engage in criminal activity and plot acts of violence and terrorism in an attempt to voice their opposition to U.S. involvement in war-related activities. They often target the military, seats of government power, and defense industry personnel, facilities, and activities.

Violent Religious Sects: Religious extremist groups predisposed toward violence. These groups often stockpile weapons, conduct paramilitary training, and share a paranoid interpretation of current world events, which they often associate with the end of the world. They perceive outsiders as enemies or evil influences; display intense xenophobia and strong distrust of the government; and exercise extreme physical or psychological control over group members, sometimes isolating them from society or subjecting them to physical or sexual abuse and harsh initiation practices.

White Nationalism: A term used by white supremacists to emphasize what they perceive as the uniquely white (European) heritage of the United States.

White power: A term used by white supremacists to describe their pride in and the perceived superiority of the white race.

White Separatism: A movement of groups or individuals who believe in the separation of races and reject interracial marriages. Some advocate the secession of specific geographic regions from the rest of the United States. Members have been known to advocate or engage in criminal activity and plot acts of violence and terrorism in an attempt to advance their extremist goals.

White Supremacist Movement: Groups or individuals who believe that whites—Caucasians—are intellectually and morally superior to other races and use their racist ideology to justify committing crimes, acts of violence, and terrorism to advance their cause. Some advocate racial separation/segregation. White supremacists generally fall into six categories: Neo-Nazi, Ku Klux Klan, Christian Identity, racist skinhead, Nordic mysticism, or Aryan prison gangs. White supremacists have been known to embrace more than one of these categories.

Motivation
The motivation of lone wolves is not dissimilar to all terrorists which are striving to accomplish several things:

- To send a message to policy makers, adversaries, or supporters
- To raise awareness for their cause
- To influence the political process
- To instill fear
- To destroy key or symbolic infrastructure
- To correct a perceived injustice

Like other terrorists the lone wolves may never have been victimized by their target group. However, the lone wolves believe they must correct some injustice on an individual or thing whether that be animals, the environment, unborn children, or an ethnic or religious group. The lone wolf's hatred of others drives them to right this wrong through intimidation and violence. In short, lone wolves don't just talk about correcting an injustice, they take action with force. By taking action the lone wolf hopes to become a hero for his/her cause and correct a perceived injustice.

Lone Wolf Terrorism Threat
According to Jeffrey Simon*, author of* *Lone Wolf Terrorism: Understanding the Growing Threat*, the lone wolf terrorist is a very serious threat, in part because the lone wolf is not accountable to anybody but himself or herself. In groups such as al-Qaeda, there is a group decision-making process. Somebody may come up with an idea and it may be shot down. But a lone wolf, if they feel they have the capability to do something, will just do it.

U.S. officials have acknowledged the increased threat and frequency of domestic lone-wolf terrorism. In February 2011, U.S. Department of Homeland Security (DHS) Secretary Janet Napolitano announced to the U.S. House of Representatives Committee on Homeland Security that a primary threat was domestically radicalized individuals. She reiterated that

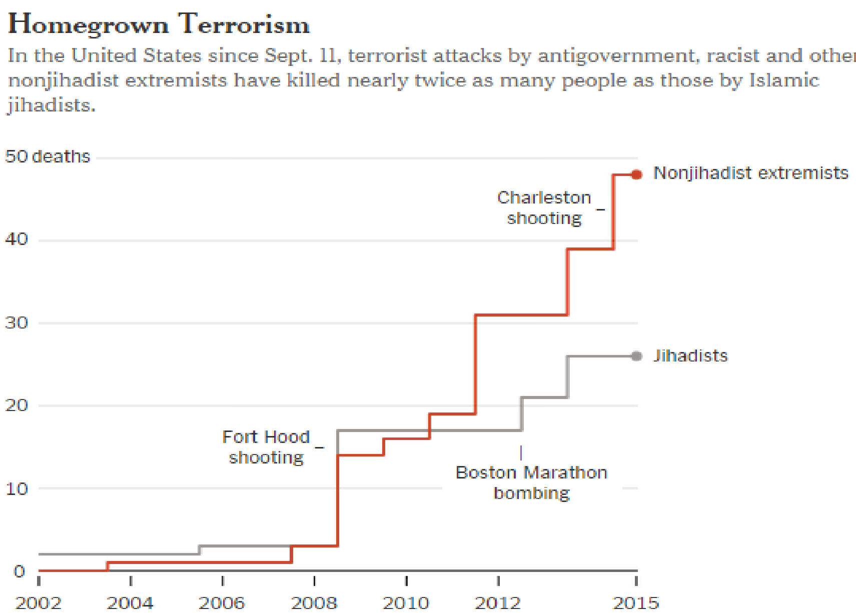
these individuals would be ready, willing, and able to conduct terrorist attacks with little or no warning.
Although all extremism groups continue to be a concern in the United States, Islamist lone-wolf attacks in the United States have dominated national attention. In fact, these attacks may be becoming more prevalent. *Inspire* magazine, a digitally available publication geared towards inciting jihad in extremists, overtly promotes lone-wolf terrorism as an effective method against the western world.

Identifying, targeting, and arresting a lone wolf is very difficult due to legal and operational issues. After all, U.S. citizens have a constitutional right to express themselves. In addition, law enforcement agencies cannot simply monitor or collect information on someone who does not have a direct nexus to crime. Law enforcement officers face the additional challenge of lone wolf attacks occurring all over the United State and the world. There is no ground zero for a lone wolf the way New York City or the Pentagon have been for other terrorist groups.

By their very nature, lone wolves operate by themselves or in very small groups. This makes collecting intelligence on their operations difficult at best since oftentimes no one else even knows about their intentions. Unlike an organized crime group or criminal gang, there is no hierarchical structure to target.

Given this information, it is safe to summarize that the threat of lone wolf terrorism is very real and the prevention of such acts is extremely difficult.

Lone Wolf Terrorism in the United States



Source: New York Times[102]

Specific Cases:

- 1978 – 1995: Theodore Kaczynski, known as the "Unabomber", engaged in a mail bombing campaign that killed three and wounded 23. He threatened to continue the bombings unless his anti-industrial manifesto was published by the *New York Times*, which acquiesced.
- April 19, 1995: Timothy McVeigh is often given as a classic example of the "lone wolf". McVeigh was convicted and executed for the April 19, 1995 Oklahoma City bombing, which killed 168 people and injured hundreds with a truck bomb. Though McVeigh conceived of, planned and carried out the bombing, he did not act totally alone. Terry Nichols was convicted of conspiring with him, though his involvement was limited to helping mix the fertilizer and other bomb ingredients; McVeigh had threatened to harm him and his family if he did not help.
- 1996 – 1998: Eric Robert Rudolph, a Christian Identity adherent, engaged in a series of bombings against civilians in the Southern United States, resulting in the deaths of three people and injuries to at least 150 others. His targets included abortion clinics, gay nightclubs, and the 1996 Olympics in Atlanta.
- February 23, 1997: Ali Hassan Abu Kamal opened fire in the observation deck of the Empire State Building, killing one and wounding six others before committing suicide.
- August 10, 1999: Buford O. Furrow, Jr., a member of the white supremacist group Aryan Nations, attacked a Jewish daycare in Los Angeles, injuring five, and subsequently shot dead a Filipino American mail carrier.

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[102] "Homegrown Extremists Tied to Deadlier Toll Than Jihadists in U.S. Since 9/11," New York Times, accessed on 31 August 2015, http://www.nytimes.com/2015/06/25/us/tally-of-attacks-in-us-challenges-perceptions-of-top-terror-threat.html?_r=0

- January 2002: Fifteen-year-old Charles Bishop intentionally crashed a Cessna airplane into a Tampa office building. Bishop acted alone and committed suicide in the attack. No additional casualties occurred. A note retrieved from the plane wreckage indicated that Bishop sympathized with al Qaeda and Osama bin Laden.
- April – May 2002: Lucas John Helder was indicted by a grand jury for planting eighteen pipe bombs in five states over a five-day period. Six of the bombs exploded and injured six total people. Helder had penned a politically fueled manifesto prior to commencing the attacks.
- July 4, 2002: Egyptian-American Hesham Mohamed Hadayet opened fire at an El Al ticket stand at Los Angeles International Airport (LAX), killing two.
- March 3, 2006: Mohammed Reza Taheri-azar drove a Jeep Cherokee into a crowd of students at University of North Carolina at Chapel Hill, injuring nine people. Press accounts said that he "matches the modern profile of the unaffiliated, lone-wolf terrorist."
- July 28, 2006: Naveed Afzal Haq, saying "I am a Muslim American, angry at Israel", perpetrated the Seattle Jewish Federation shooting in the Belltown neighborhood of Seattle, killing one woman and wounding five others.
- July 27, 2008: a politically motivated fatal shooting took place at the Tennessee Valley Unitarian Universalist Church in Knoxville, Tennessee. Motivated by a desire to kill liberals and Democrats, gunman Jim David Adkisson fired a shotgun at members of the congregation during a youth performance of a musical, killing two people and wounding seven others.
- May 31, 2009: anti-abortion activist Scott Roeder murdered obstetrician George Tiller.
- June 1, 2009: Abdulhakim Mujahaid Muhammad, an American who had converted to Islam opened fire on a United States military recruiting office in Little Rock, Arkansas, known as the 2009 Little Rock recruiting office shooting. Muhammad killed Private William Long and wounded Private Quinton Ezeagwula. Muhammad pled guilty to charges of capital murder, attempted capital murder, and unlawful discharge of a weapon, and was sentenced to life in prison on July 25, 2011.
- June 10, 2009: James von Brunn fired a weapon into the Washington D.C. Holocaust Museum, resulting in the death of security guard Stephen Tyrone Johns. James von Brunn died while awaiting trial.
- November 5, 2009: Nidal Malik Hasan shot and killed 13 people in an attack at Fort Hood that wounded 30 others.
- February 18, 2010: Joseph Andrew Stack III flew a small personal plane into an office complex containing an IRS office in Austin, Texas after posting a manifesto on his website stating his anti-government motives and burning his house. One person other than Stack died; 13 were injured.
- January 8, 2011: U.S. Representative Gabrielle Giffords and eighteen others were shot by Jared Lee Loughner during a constituent meeting held in a supermarket parking lot in Casas Adobes, Arizona, in the Tucson metropolitan area. Six people were killed during the political attack.

- August 5, 2012: Wade Michael Page, an American white supremacist, fatally shot six people and wounded four others in a mass shooting at a Sikh temple in Oak Creek, Wisconsin.
- April 15, 2013: Dzhokhar and Tamerlan Tsarnaev set off two pressure cooker bombs at the finish line of the 2013 Boston Marathon, killing three people and wounding over 260 others.
- June 17, 2015: White supremacist Dylann Storm Roof killed nine people at a predominantly African American church in Charleston, South Carolina.
- July 16, 2015: 24 year old engineering graduate Mohammad Youssuf Abdulazeez killed four U.S. Marines, one Naval officer, and wounded two other people when he opened fire at a military recruiting station and a Naval reserve office in Chattanooga, Tennessee[103].
- On June 12, 2016, Omar Mateen opened fire in a gay nightclub, pledging allegiance to ISIL and killing 49 people; 53 others were wounded.
- On November 28, 2016, Somali refugee, Abdul Razak Ali Artan, conducted a car ramming attack and mass stabbing at Ohio State University; 11 people were injured in total. The terrorist was inspired by IS propaganda and was killed on the scene by a responding officer.

Terrorism in Ohio

According to Ohio Homeland Security, the most recent terrorism connections to Ohio include:

- 2010: Jerry and Joe Kane, father and son anti-government extremists from Forest, Ohio, were killed in a shoot-out with Arkansas law enforcement after fatally shooting two West Memphis police officers during a traffic stop on May 20, 2010.
- 2010: Hor and Amera Akl, a married couple residing in Toledo, Ohio, were arrested in 2010 and charged with providing material support to the designated terrorist organization Hizballah.
- 2011: Ahmed Hussein Mahamud, a 26-year-old American citizen from Columbus, Ohio, was charged in an indictment, unsealed in June 2011, with providing material support to Al Shabaab.
- 2012: Five men were arrested in April 2012 and accused of plotting to blow up a bridge near Cleveland, Ohio.
- On November 28, 2016, Somali refugee, Abdul Razak Ali Artan, conducted a car ramming attack and mass stabbing at Ohio State University; 11 people were injured in total. The terrorist was inspired by IS propaganda and was killed on the scene by a responding officer.

Additionally, 21 year old Christopher Lee Cornell of Green Township in southwest Ohio, was arrested on January 14, 2015 and charged with attempting to kill officers and employees of the U.S., solicitation to commit a crime of violence and possession of a firearm

[103] "4 Guns Seized After Chattanooga Shooting, Official Says," CNN, accessed on 18 July 2015, http://www.cnn.com/2015/07/17/us/tennessee-naval-reserve-shooting/index.html

in furtherance of a crime of violence. Officials say Cornell planned to attack the U.S. Capitol Building. In May 2015, Cornell called a Cincinnati news outlet from jail and stated he intended to kill President Obama, members of Congress, and attack the Israeli embassy[104].

Vulnerability Assessment – Lone Wolf Terrorism

This hazard is considered to be a "Relatively High Probability Event", meaning there is some indication of an act of sabotage, terrorism, or criminal intent being planned or directed against targets located within the County. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability
Franklin County is at risk of a lone wolf terrorism event as is the entire country. As has been seen in past events damage can be extensive and varied. Many times, structures are involved in this type of attack; however, this type of hazard is very unpredictable and Franklin County does not have any historical data referring to structural damage due to a lone wolf terrorist attack. For this vulnerability assessment, the scenario being utilized for a lone wolf terrorist incident is an active shooter such as in a school shooting. No structural damage due to lone wolf terrorism is anticipated in Franklin County.

Using a worst-case scenario for a lone wolf terrorist detonating a nuclear device would require using the data from the CBRNE terrorist hazard.

Potential Impact of Lone Wolf Terrorism
The impact of a lone wolf terrorism event could be major and have a long-lasting effect.

Identifying Structures

According to FEMA, the effects of a 10 KT surface blast would damage structures up to 1.5 miles away.

Exposure of Existing Buildings to Damages Due to Lone Wolf Terrorist Incident
The following is the expected exposure to a 10 KT blast according to FEMA.

0.5 miles	Total destruction
0.9 miles	Total destruction to residential structures and major damage to commercial structures.
1.1 miles	Severe damage to residential structures and moderate damage to commercial structures.

[104] "TV station wins fight to air interview with terror plot suspect from Ohio," Fox8 Cleveland, last modified on 7 March 2015, http://fox8.com/2015/03/07/tv-station-wins-fight-to-air-interview-with-terror-plot-suspect-from-ohio/

1.5 miles	Moderate damage to residential structures and light damage to commercial structures.[105]

Exposure of Future Buildings to Damages Due to Lone Wolf Terrorist Incident
The exposure to future buildings would be the same as for existing buildings.

Estimating Potential Loss

Methodology
Franklin County Emergency Management and Homeland Security provided information through their GIS representative. The following is from the data received from this report. For this report we used the intersection of High Street and Broad Street as ground zero. Building numbers and valuation apply to this area.

According to the Franklin County GIS report there are 525 structures within the 0.5 range with a value of $871,252,300. 1,985 structures within the 0.9 range with a value of $1,169,407,100. 4,089 structures within the 1.1 range with a value of $1,443,955,600 and 11,480 structures within the 1.5 range with a value of $2,100,047,100.

There are 568,157 structures in Franklin County. 1005 would be considered Critical Facilities which is .17%

Estimated Potential Dollar Losses

0.5 mile 100% loss 525 structures at	$871,252,300
0.9 miles 75% loss 1489 structures at	$877,055,325
1.1 miles 50% loss 2,045 structures at	$721,977,800
1.5 miles 25% loss 2,870 structures at	$525,011,775
Total structure loss 6,929 structures with a value of	$2,995,297,200

Twelve of these structures would be considered critical facilities at a potential value of $5,187,410.

$2,995,297,200/6,929 = 432,284 X 12 = $5,187,410

** Note: Residential and commercial housing structure figures were obtained from http://quickfacts.census.gov/qfd/states/39/39049.html*

The damage in dollars represented in this vulnerability statement only quantify the damage to structures and does not reflect ancillary costs associated with this hazard.

[105] "Nuclear Threat," FEMA, accessed on 13 October 2015, http://training.fema.gov/emiweb/downloads/is3unit4.pdf

Dam/ Levee Failure - #6

Hazard Summary

A dam is defined as an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material, for the purpose of storage or control of water.[106] A dam failure is defined as an uncontrolled release of that impounded water. The causes of dam failures include overtopping caused by floods that exceed the capacity of the dam, deliberate acts of sabotage, structural failure of materials used in dam construction, movement and/or failure of the foundation supporting the dam, settlement and cracking of concrete or embankment dams, piping and internal erosion of soil in embankment dams, and inadequate maintenance and upkeep.[107] Despite efforts to provide sufficient structural integrity and to perform inspection and maintenance, problems can develop that can lead to failure. While most dams have storage volumes small enough that failures would have little or no consequences, dams with large storage amounts could cause significant flooding downstream.[108]

A levee is any artificial barrier together with appurtenant works that will divert or restrain the flow of a stream or other body of water for the purpose of protecting an area from inundation by flood waters. Generally, a levee is subjected to water loading during a few days or weeks in a given year; unlike a dam that is retaining water most days in the same year.

A levee breach results when a portion of the levee breaks away, providing an opening for water to flood the landward side of the structure. Such breaches can be caused by surface erosion due to water velocities, or they can be the result of subsurface actions. Subsurface actions usually involve sand boils whereby the upward pressure of water flowing through porous soil under the levee exceeds the static pressure of the soil weight above it (i.e., underseepage). These boils can indicate instability of the levee foundation given the liquefied substrate below it, leading way to breaching. Levee overtopping is similar to dam overtopping in that the flood waters simply exceed the design capacity of the structure, thus flowing over the lowest crest of the system. Such overtopping can lead to erosion on the landward side which, subsequently, can lead to breaching. In order to prevent this type landward erosion, many levees are reinforced or armored with rocks or concrete. [109]
The O'Shaughnessy Dam and the Hoover Dam are the two dams impacting Franklin County that are found on the Ohio EMA's list of the ten most potentially hazardous dams in the

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[106] "Federal Guidelines for Dam Safety," FEMA, April 2004, http://www.fema.gov/media-library-data/20130726-1516-20490-9730/fema-148.pdf
[107] "Why Dams Fail," FEMA, accessed on 1 Nov 2015, http://www.fema.gov/why-dams-fail
[108] "Hazard Mitigation Plan," Ohio Emergency Management Agency, updated May 2014, http://ema.ohio.gov/Mitigation_OhioPlan.aspx
[109] "Hazard Mitigation Plan," Ohio Emergency Management Agency, updated May 2014, http://ema.ohio.gov/Mitigation_OhioPlan.aspx

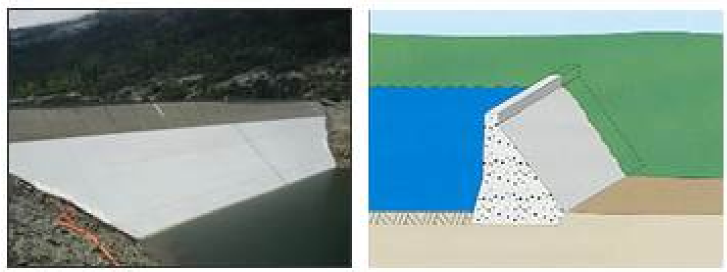
state, based on the possible catastrophic consequences should they fail. This hazard was ranked 6 out of 20.

Hazard Profile

A dam is an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material, for the purpose of storage or control of water.[110] A levee is an elongated naturally occurring ridge or artificially constructed fill or wall, which regulates water levels. It is usually earthen and often parallel to the course of a river in its floodplain or along low-lying coastlines.

Source: Association of Dam Safety Officials

There are different types of dams and levees classified by the material and design used in construction. Embankment dams are the most common type of dam in use today. Materials used for embankment dams include natural soil or rock, or waste materials obtained from mining or milling operations. An embankment dam is also referred to as an "earthfill" or "rockfill" dam, depending on whether it is comprised of compacted earth or dumped rock. The ability of an embankment dam to resist the reservoir water pressure is primarily a result of the mass weight, type and strength of the materials from which the dam is made.


Source: Association of Dam Safety Officials

Concrete dams may be categorized into gravity and arch dams according to the designs used to resist the stress due to reservoir pressure. Concrete gravity dams are the most common form of concrete dam. The mass weight of concrete and friction resist the reservoir water pressure. A buttress dam is a specific type of gravity dam in which the large mass of concrete is reduced and the forces are diverted to the dam foundation through vertical or sloping buttresses. Gravity dams are constructed of vertical blocks of concrete with flexible seals in the joints between the blocks.[111]

<u>Why Dams and Levees Fail</u>

Dam and levee failure can occur with little warning and for one or a combination of several reasons:

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110 "Federal Guidelines for Dam Safety," FEMA, April 2004, http://www.fema.gov/media-library-data/20130726-1516-20490-9730/fema-148.pdf

111 "Introduction to Dams," Association of Dam Safety Officials, accessed on 18 September 2015, http://www.damsafety.org/news/?p=e4cda171-b510-4a91-aa30-067140346bb2

- Overtopping – accounts for 34% of all dam failures nationally.[112] Overtopping failures result from the erosive action of water on the embankment. Erosion is due to uncontrolled flow of water over, around and adjacent to the dam. Once erosion has begun during overtopping, it is almost impossible to stop. Overtopping is caused by inadequate spillway design, debris blockage of spillway or settlement of dam crest.
- Foundation defects and slope instability – accounts for 30% of all dam failures nationally.[113] Structural failures can occur either in the embankment or the appurtenances such as spillways or lake drains. Cracking, settlement, and slides are the more common signs of structural failure and usually require emergency measures to ensure safety. Structural failures can be caused by earthquakes, sliding and slope instability, or faulty construction.
- Piping (internal erosion caused by seepage) – accounts for 20% of all dam failures nationally.[113] Seepage failures are caused by uncontrolled seepage from water percolating slowly through the dam and its foundation. Progressively eroding the soil from the embankment or its foundation can result in rapid failure of the dam. The erosion starts on the downstream side of the embankment, eventually develops a "pipe," and if fully developed is impossible to control and will likely cause failure. Seepage and erosion can occur along hydraulic structures such as outlet conduits or spillways.

These types of dam and levee failures are often interrelated. For example, uncontrolled seepage may weaken the soil and lead to structural failure.

Dam Classification

The classification of dams in Ohio is defined in the Ohio Administrative Code. Despite the name, the classification system includes levees as well. This classification covers dams and levees regulated by the Ohio Department of Natural Resources, Division of Soil and Water Resources. The classification system for dams and levees in Ohio was modeled after the Federal Guidelines for Dam Safety and are based on three parameters: height of the dam, storage volume of the pool, and potential downstream hazard.

Class I – Dams having a total storage volume greater than 5,000 acre-feet or a height of greater than 60 feet. A dam shall be placed in Class I when sudden failure of the dam would result in one of the following conditions.

- Probable loss of human life.
- Structural collapse of at least one residence or one commercial or industrial business.

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[112] "Dam Failures and Incidents," Association of Dam Safety Officials," accessed on 18 September 2015, http://www.damsafety.org/news/?p=412f29c8-3fd8-4529-b5c9-8d47364c1f3e

[113] "Federal Guidelines for Dam Safety," FEMA, April 2004, http://www.fema.gov/media-library-data/20130726-1516-20490-9730/fema-148.pdf

Class II – Dams having a total storage volume greater than 500 acre-feet or a height of greater than 40 feet. A dam shall be placed in Class II when sudden failure of the dam would result in at least one of the following conditions, but loss of human life is not probable.

- Disruption of a public water supply or wastewater treatment facility, release of health hazardous industrial or commercial waste or other health hazards.
- Flooding of residential, commercial, industrial or publicly owned structures.
- Flooding of high-value property.
- Damage or disruption to major roads including but not limited to interstate and state highways, and the only access to roads to residential or other critical areas such as hospitals, nursing homes or correctional facilities.
- Damage or disruption to railroads or public utilities.
- Damage to downstream Class I, II, or III dams or levees, or other dams or levees of high value. Damage to dams or levees can include but is not limited to overtopping or failure of the structure.

Class III – Dams having a total storage volume greater than 50 acre-feet or a height of greater than 25 feet. A dam shall be placed in Class III when sudden failure of the dam would result in at least one of the following conditions, but loss of human life is not probable.

- Property losses include but is not limited to rural buildings not otherwise described, and Class IV dams and levees not otherwise listed as high-value property.
- Damage or disruption to local roads includes but is not limited to roads not otherwise listed as major roads.

Class IV – Dams which are 25 feet or less in height and have a total storage volume of 50 acre-feet or less. A dam shall be placed in Class IV when sudden failure of the dam would result in property losses restricted mainly to the dam and rural lands, and loss of human life is not probable.[114]

The federal classification of dams uses three categories: low, significant, and high, in order of increasing adverse incremental consequences. The classification levels build on each other; the higher order classification levels add to the list of consequences for the lower classification levels.

Low Hazard – dams where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the dam owner's property.

Significant Hazard – dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, or disruption of lifeline facilities, or can impact other concerns. Significant-hazard dams are often located in

[114] Ohio Administrative Code, accessed on 1 Nov 2015, http://codes.ohio.gov/oac/1501:21-13-01

predominately rural or agricultural areas but could be located in areas with population and significant infrastructure.
High Hazard – dams where failure or mis-operation will probably cause loss of human life.[115]

The two classification systems are compared in the table below.

Ohio and Federal Dam Classification Systems

Corresponding Federal Classification	Ohio Dam Classification	Description
Class I	Probable loss of life, serious hazard to health, structural damage to high value property (i.e., homes, industries, major public utilities)	High
Class II	Flood water damage to homes, businesses, industrial structures (no loss of life envisioned), damage to state and interstate highways, railroads, only access to residential areas	Significant
Class III	Damage to low value non-residential structures, local roads, agricultural crops and livestock	Significant
Class IV	Losses restricted mainly to the dam	Low

Source: State of Ohio Hazard Mitigation Plan

Dams in the United States

There are 87,000 dams in the United States, according to the 2013 update to the National Inventory of Dams. Approximately one third of these pose a high or "significant" hazard to

[115] "Federal Guidelines for Dam Safety Risk Management," FEMA, updated on Jan 2015, http://www.fema.gov/media-library-data/1423661058965-58dfcecc8d8d18b7e9b2a79ce1e83c96/FEMAP-1025.pdf

life and property if failure occurs[116]. 2,000 of these high hazard dams are considered to be deficient. The Association of State Dam Safety Officials estimates it will require an investment of $21 billion to repair these high-hazard dams. The majority of dams in the U.S. are privately owned. In general, very large dams are owned and regulated by the federal government. The safety and security of a dam can affect persons and property across local, state and even national borders. As a result, there is a substantial federal role in coordinating federal, state and local dam safety efforts.

According to the Ohio Department of Natural Resources Dam Safety Program, there have been about 200 notable dam and reservoir failures in the world so far in the 20th century. More than 8,000 people have died in these disasters.[117] The potential for dam related disasters continues to grow with increasing residential and commercial development of lands downstream of dams. In many cases, existing dams will need to be modified to keep downstream areas safe. In other cases, dams will have to be removed. Some notable dam failures in the United States:
2006 - A dam failure in Kauai, Hawaii, caused several homes and vehicles to be swept out to sea and other infrastructure was badly damaged. Causes include possible illegal modifications to the dam, insufficient maintenance, and lack of inspections. Eight people were killed in this event.[118]

1977 – The Kelly Barns Dam, an old earthen dam in Georgia, gave way in the middle of the night, probably as a result of internal erosion. Thirty-nine people were killed at a small bible college below the dam.

1976 – The Teton Dam, a massive $100 million dollar earthen dam had just been built by the U.S. government in southeast Idaho, collapsed as it was being filled for the first time. Poor construction had caused the dam face to erode. Water swept into several small towns, destroying thousands of homes and killing eleven people.

1972 – In West Virginia, a coal slurry dam, weakly constructed and with an inadequate spillway, collapsed during a period of moderately heavy rain, killing 125 people in Buffalo Creek Hollow.

1963 – The Baldwin Hills reservoir in Los Angeles gave way, destroying 277 homes and killing five people.

1889 – The Johnstown, Pennsylvania dam failure, by far the most famous failure and one of the worst disasters in U.S. history resulted in 2,209 fatalities. An old, abandoned earthen dam was restored by a hunting and fishing club to create Lake Conemaugh, a pleasure lake used for sailing and ice boating and stocked with expensive fish. The water outlet at the base of the dam had been filled in, and the emergency spillway had been reduced in size

[116] "Dam Safety," FEMA, accessed August 25, 2015, http://www.fema.gov/dam-safety
[117] "Ohio Dam Safety Program," ODNR, accessed on 1 Nov 2015, http://water.ohiodnr.gov/safety/dam-safety
[118] "Kauai Dam Breach Killed 7 People Five Years Ago, But Criminal Charges Against Dam Owner are Still Pending." Hawaii Reporter, March 15, 2011. Accessed November, 2017.

and covered with screens to prevent the fish from escaping, causing a buildup of debris. In May of 1889, after several days of extraordinarily heavy rains, the dam overtopped and eventually gave way. Twenty million tons of water crashed down the valley, hit the city of Johnstown, flattening everything in its path.

Dams and Levees in Ohio

The Ohio Department of Natural Resources has records for more than 5,000 dams in Ohio. A number of smaller structures do not fall under the jurisdiction of Ohio's dam safety laws. There are 365 dams classified as Class 1dams, 544 classified as Class II dams, 608 classified as Class III dams, and 1,033 classified as Class IV dams. There are nearly 1,000 additional Class IV dams.[119] There is also an undetermined number of mostly small dams for coal mining ponds regulated by ODNR.

Ohio EMA lists the following as the top ten dams in Ohio whose failure could have catastrophic consequences.

- Salt Fork Dam – Guernsey County
- Hoover Dam – Franklin County
- O'Shaughnessy Reservoir Dam – Delaware County
- Indian Lake Dam – Logan County
- Grand Lake St. Mary's Dam – Auglaize County
- Mineral Ridge Dam – Trumbull County
- Lake Milton Dam – Mahoning County
- Bridge Creek Dam – Geauga County
- Rocky Fork Lake Dam – Highland County
- Wolf Run Lake Dam – Noble County

According to ODNR's Dam Safety Program, there has been little property damage resulting from a dam failure alone. However, there has been property damage that was a combination of downstream flooding due to excessive precipitation and dam failure. It is difficult to assess which property damage was a direct result of the dam failure and which damage was a result of downstream flooding due to excessive precipitation. There has been some infrastructure loss in terms of roads washing away, but there has been no loss of critical facilities due to dam failure.

The Dam Safety Program provides oversight for dam/ and levee repairs, oversees and issues construction permits, enforces safety standards and mandates, conducts periodic safety inspections, and provides public information to dam and levee owners, engineers, and the general public. This proactive approach to managing dam safety reduces the number of losses to property and life as a result of dam failure or near failure. However, for reasons uncontrollable by humans, it is possible a dam can fail at any time, given the right circumstances.

[119] "Dam & Levee Definition, Classification & Statistics," ODNR Division of Soil & Water Resources, accessed August 25, 2015, http://water.ohiodnr.gov/safety/dam-safety

Dams and Levees in Franklin County

Below is a list of all Class I, II, and III dams and levees located in Franklin County as identified by The Ohio Dam Safety Program. Class IV dams and levees are not listed here but can be viewed at https://gis.ohiodnr.gov/MapViewer/?config=ohiodams.

Also included is the classification of each dam/levee, a description of risk, and the potential impacts to surrounding areas.

Dam/ Levee Name	Class	Description	Impact
Hoover Dam	I	High	Probable loss of life, serious hazard to health, structural damage to high value property (i.e., homes, industries, major public utilities)
Thoreau Pond Dam	I	High	Probable loss of life, serious hazard to health, structural damage to high value property (i.e., homes, industries, major public utilities)
Julian Griggs Dam	I	High	Probable loss of life, serious hazard to health, structural damage to high value property (i.e., homes, industries, major public utilities)
West Columbus Local Protection Project (LPP)	I	High	Probable loss of life, serious hazard to health, structural damage to high value property (i.e., homes, industries, major public utilities)
Agg Rok Reach Levee	I	High	Probable loss of life, serious hazard to health, structural damage to high value property (i.e., homes, industries, major public utilities)
Hap Cremean Lagoon #1	II	Significant	Flood water damage to homes, businesses, industrial structures (no loss of life envisioned), damage to state and interstate highways, railroads, only access to residential areas
Hap Cremean Lagoon #2	II	Significant	Flood water damage to homes, businesses, industrial structures (no loss of life envisioned), damage to state and interstate highways, railroads, only access to residential areas

North Broadway Low Head Dam	II	Significant	Flood water damage to homes, businesses, industrial structures (no loss of life envisioned), damage to state and interstate highways, railroads, only access to residential areas
OSU Golf Course Lake Dam	II	Significant	Flood water damage to homes, businesses, industrial structures (no loss of life envisioned), damage to state and interstate highways, railroads, only access to residential areas
King Ave Levee	II	Significant	Flood water damage to homes, businesses, industrial structures (no loss of life envisioned), damage to state and interstate highways, railroads, only access to residential areas
Shrock Lake Dam	II	Significant	Flood water damage to homes, businesses, industrial structures (no loss of life envisioned), damage to state and interstate highways, railroads, only access to residential areas
Twin Lakes Upper Dam	II	Significant	Flood water damage to homes, businesses, industrial structures (no loss of life envisioned), damage to state and interstate highways, railroads, only access to residential areas
Parsons Avenue Sludge Lagoons	II	Significant	Flood water damage to homes, businesses, industrial structures (no loss of life envisioned), damage to state and interstate highways, railroads, only access to residential areas
Timberlake #1 Dam	II	Significant	Flood water damage to homes, businesses, industrial structures (no loss of life envisioned), damage to state and interstate highways, railroads, only access to residential areas
Anderson Lake Dam	II	Significant	Flood water damage to homes, businesses, industrial structures (no loss of life envisioned), damage

			to state and interstate highways, railroads, only access to residential areas
Greenlawn Avenue Low Head Dam	II	Significant	Flood water damage to homes, businesses, industrial structures (no loss of life envisioned), damage to state and interstate highways, railroads, only access to residential areas
Campden Lakes South Dam	II	Significant	Flood water damage to homes, businesses, industrial structures (no loss of life envisioned), damage to state and interstate highways, railroads, only access to residential areas
Brookside County Club Lake Dam	III	Significant	Damage to low value non-residential structures, local roads, agricultural crops and livestock
Minerva Park Lake Dam	III	Significant	Damage to low value non-residential structures, local roads, agricultural crops and livestock
Smith-Lin Lake Dam	III	Significant	Damage to low value non-residential structures, local roads, agricultural crops and livestock
Alkire Lake Dam	III	Significant	Damage to low value non-residential structures, local roads, agricultural crops and livestock
Kagey Lake Dam	III	Significant	Damage to low value non-residential structures, local roads, agricultural crops and livestock

Many of the above dams are small, less than 25 feet in height. However, one Franklin County dam, Hoover Dam, is on Ohio EMA's list of the ten most potentially hazardous dams in the state. In addition to Hoover Dam, there are several other dams in Franklin County and in Delaware County of significant interest. Below are more in-depth profiles of several of the important dams/levees identified above.

Important Dams in Franklin County

Hoover Dam

Hoover Dam, near Westerville, dams Big Walnut Creek to form the Hoover Memorial Reservoir. It is named after two brothers, Charles and Clarence Hoover, to honor their careers with the City of Columbus Waterworks.

Owned by the City of Columbus, construction began in 1953 and was completed in 1956, with spillway gates added in 1969. The dam has a concrete gravity overflow spillway section flanked by zoned, rolled earth embankment sections. It is 2,525 feet long and 90 feet high. The reservoir has a surface area of 3,024 acres and holds 20.8 billion gallons of water at normal pool. It supplies water for much of the northeast portion of Franklin County. In addition to its function as a water supply reservoir, the area is used for recreation.

OEMA estimates discharge from failure of the dam would be at least 10 times greater than the 1% flood discharge. Communities downstream include Gould Park at 4 miles, Gahanna at 7 miles, Whitehall at 10 miles, and Columbus at 12 miles and Groveport at 22 miles. Inundation is expected to be noticed in Circleville 30 miles downstream. Damage is expected to be extensive and would include many residential structures, state routes, local roads, interstate highways and businesses. Loss of life would be expected.[120]

Julian Griggs Dam

The Julian Griggs Dam is located on the Scioto River near Upper Arlington, 6 .5 miles upstream of the Olentangy River confluence and 9.3 miles downstream of O'Shaughnessy Dam. The dam was named after the City's chief engineer, Julian Griggs. The dam is a concrete gravity structure about 1,006 feet long and 46 feet high at the maximum section. Construction was completed in 1905. Flashboards were added onto the 500 foot long curved spillway in 1945. The reservoir is almost six miles long with a 1.4 billion gallon capacity at normal pool. It was the first major reservoir supplying drinking water for the City of Columbus and served as the only one for 20 years.

Dam failure could result in severe property damage with possible loss of life. Many buildings downstream are within an area which was inundated by the floods of 1959 and 1913.

[120] Ohio Hazard Mitigation Plan, OEMA, accessed on 1 November 2015, http://ema.ohio.gov/Documents/OhioMitigationPlan/SOHMP_Sec_2_6.pdf

The Ohio State University (OSU) Golf Course Dam
The OSU Golf Course dam is located on Turkey Run Stream on the OSU Golf Course in Upper Arlington. It was built in 1935-36 as a Works Progress Administration (WPA) project. The dam is an earthen embankment with a spillway system consisting of a concrete drop box connected to concrete box culvert with an asphalt-lined overflow channel. Dam height at maximum section is about 17 feet.

The dam is owned by The Ohio State University and supplies water for golf course irrigation. Failure would flood 16 or more dwellings between Kenny Road and the railroad embankment, resulting in possible loss of life.

O'Shaughnessy Reservoir Dam
The O'Shaughnessy Dam is located on the Scioto River in Concord and Liberty Townships in Delaware County. The dam is 4 miles upstream from Dublin, 9.3 miles upstream from the Griggs Dam, and 16.5 miles upstream from downtown Columbus. The Columbus Zoo is located on the east bank of the reservoir, near the dam.


Source: City of Columbus

The dam was constructed between 1922 and 1925 at the urging of Superintendent of Waterworks Jerry O'Shaughnessy. He fought efforts to add to Griggs dam, pressing the city to build an additional storage dam further up the river. Unfortunately, Mr. O'Shaughnessy did not live to see the completion of the project. In 1990, the dam was placed on the U.S. National Register of Historic Places.

The dam is a concrete masonry, gravity overflow structure flanked by rolled earth embankments. The dam is 1,750 feet long, containing a central concrete masonry section of 879 feet in length and 75 feet high. A reinforced concrete bridge crosses the dam above the spillway, serving vehicular traffic on Glick Road.

The reservoir holds 4.8 billion gallons of water covering a surface area of 943 acres and could supply water for half a million people. The dam has no flood control function.

In 1987, the City of Columbus installed a pair of hydroelectric turbines. They can only be operated when there is sufficient flow, so they can only intermittently provide power, producing up to 5 megawatts.

The dam is on Ohio EMA's list of the ten most potentially hazardous dams in the state. Failure of the dam could result in severe property damage with the possible loss of many lives. Significant encroachments on the Scioto River floodplain including residences; commercial establishments; routes 257, 745 & I-270; and the Julian Griggs Dam are located within the first 15 miles downstream. Many of these structures are within the area inundated by the floods of 1959 and 1913. Failure of the O'Shaughnessy Dam is not expected to cause failure of the Julian Griggs Dam.

Thoreau Pond Dam

The Thoreau Pond Dam is a 9.7-acre dam and spillway located inside of the Blendon Woods Metro Park on a tributary of Big Walnut Creek. It was completed in 1964 and is an earthfill structure measuring 685 feet long and 25.2 feet high. The Blendon Woods Metro Park is just east of Interstate 270, three miles south of the Hoover Reservoir Park, where the Hoover Dam is located. It is also 5.4 miles upstream via Big Walnut Creek of the City of Gahanna.

The top storage volume of the Thoreau Pond Dam is 165-acre feet, or 53.8 million gallons. The neighborhoods of Blendon Woods and Trouville directly border the dam and surrounding park. Failure of the dam could result in severe damage to these neighborhoods. Thoreau Pond Dam is listed as a high hazard dam on the National Performance of Dams Program, though little other information is available about the risk this particular dam poses.

Delaware Dam

The Delaware Dam is located on the Olentangy River in Delaware County, 4 miles upstream of the City of Delaware and 32 miles north of Columbus. Authorized by the Flood Control Act of 1938 for the purposes of flood reduction, low-flow control for pollution reduction, water supply, and recreation, the project was constructed between 1947 and 1951 at a cost of $4,307,000. The project was constructed and is operated by the U.S. Army Corps of Engineers, Huntington District.

Source: US Army Corps of Engineers

The dam is a rolled earth-fill type with a concrete gated spillway section. It is 3 ½ miles long and 92 feet high. It controls a drainage area of 386 square miles through the use of five gated sluices and six 25 foot by 32 foot Tainter/radial gates. The Delaware Dam is a unit in the larger comprehensive flood control plan for the Ohio River Basin.

Dam failure would result in extensive property damage and possible loss of life in the many population centers downstream.

Alum Creek Dam

The Alum Creek Dam is located in Delaware County, between I-71 and U.S. 23, 12 miles southeast of the city of Delaware and 25 miles northeast of Columbus. It was built and is operated by the U.S. Army Corps of Engineers to reduce the flood hazard along Alum and Big Walnut Creeks, the Scioto River and the Ohio River. The City of Columbus shared part of the additional project cost for water supply. The majority of the

Source: US Army Corps of Engineers

recreational area is leased to ODNR and operated as a state park.

The dam was constructed between 1970 and 1974. It is a rolled earth-fill embankment, 10,000 feet in length, with a maximum height of 93 feet. The spillway is located high on the right abutment with the raceway dropping off in front of it to the stilling basin below. Control is provided by three 34 by 25-foot Tainter gates, supported by 8 foot wide concrete piers resting on concrete ogee sections. In 1978, the dam was retrofitted by installing seven cable anchors deep into the bedrock to secure the concrete monolith.

Dam failure would result in property damage with possible loss of life, as development continues to grow south of the lake. When the dam was built, it was considered “out in the country.” Today, homes reach nearly to the base of the dam.

January 2005 Flooding

In January of 2005, after record snowfall in December, 2004, a rapid warm-up of temperatures into the upper 50s allowed for rapid melting of snow pack. A frontal boundary brought heavy rain into the region. In Columbus, the monthly rainfall total was 8.95 inches, 6.42 inches above normal. The total rainfall from January 1 to 13 was 8.25 inches.

Rivers rose to levels that had not been reached in several years. Record levels were also reached at the U.S. Army Corps of Engineers reservoirs. On January 13, 2005, Delaware Lake was in danger of overtopping. The lake normally sits at 905 feet above sea level. On this day, it peaked at 946 feet, one foot away from overtopping the spillway and requiring main spill gates to be opened. These gates have never been used.

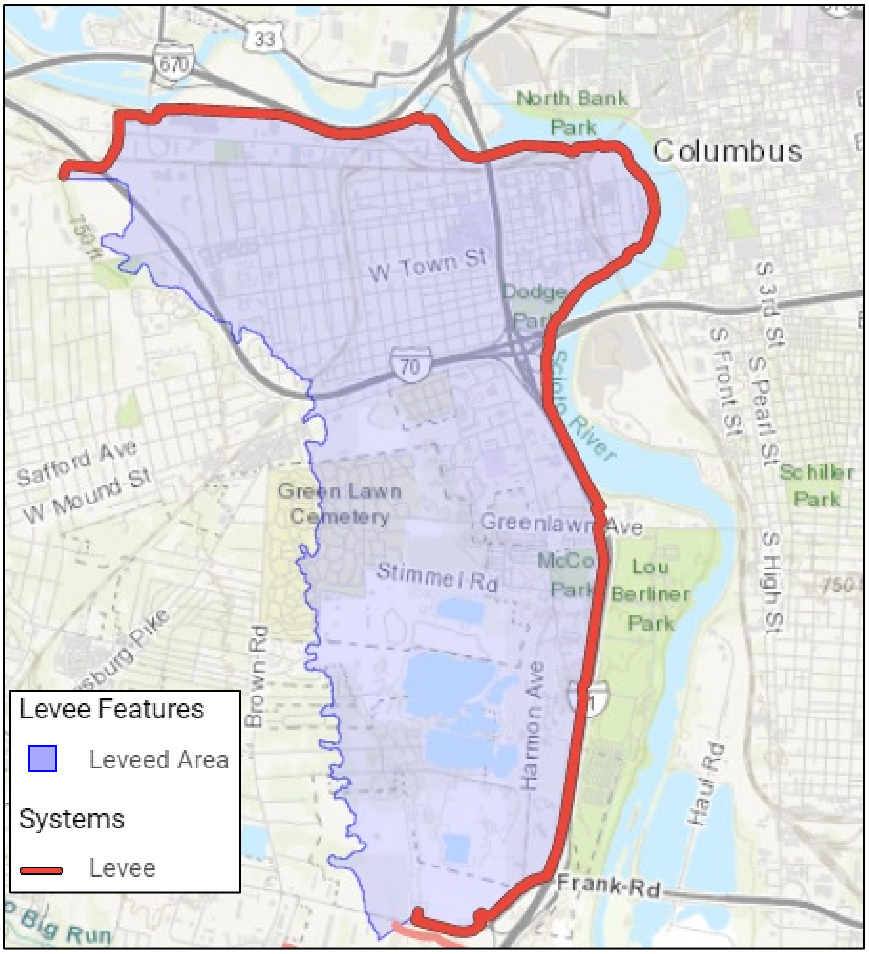
Delaware Dam on Olentangy River.
Viewed at typical normal pool, and near peak pool elevation on January 15, 2005

Source: Sky Scoop, NWS Wilmington, OH, Spring/Summer 2006

On January 16, Alum Creek Reservoir reached its highest level since construction was completed. Control was maintained through the discharge pipe, and it was not necessary to open the three main spillway gates.

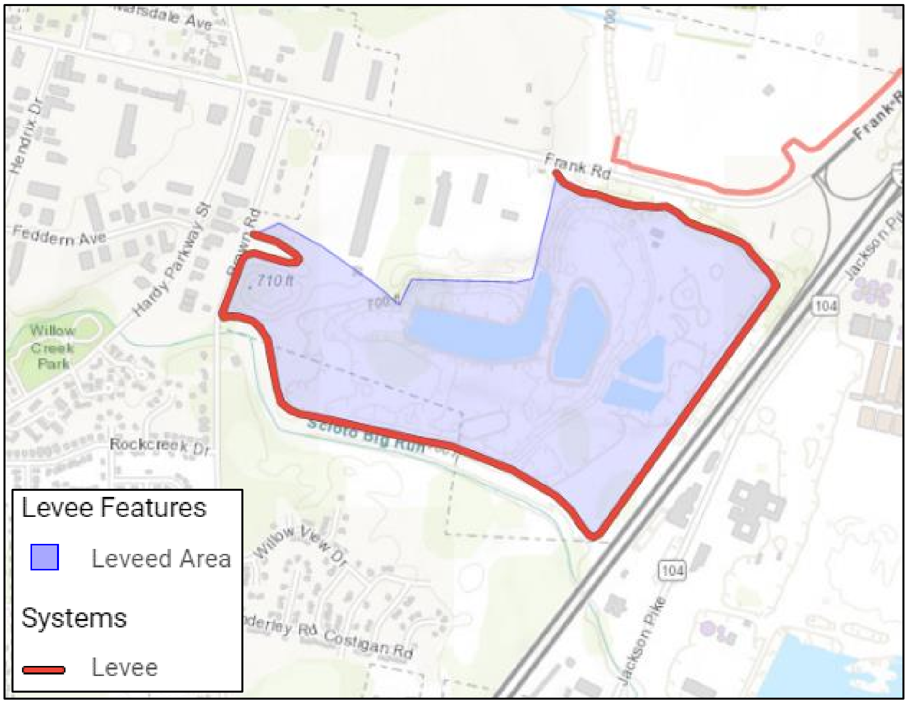
Important Levees in Franklin County

<u>West Columbus Local Protection Project (LPP)</u>
The West Columbus Local Protection Project, better known as the Franklinton Floodwall, began construction in 1993. The floodwall protects downtown's west riverbank area and the Franklinton neighborhood. In the event of a major flooding event along the Scioto River, the wall would serve as a dam to hold back water rising from the river. The West Columbus LPP is discussed further in the Flood profile.



Source: National Levee Database

<u>Agg Rok Reach Levee</u>
The Agg Rok Reach Levee is a privately owned industrial earthfill structure owned by Celina Equipment. It is 4000 ft. in length and 40 ft. in height. This levee is classified as Class I by the Ohio Dam Safety Program. Its flooding source is the Scioto Big Run. Neighborhoods adjoining this levee include Southwest Columbus, Willow Creek, and Greenleaf.



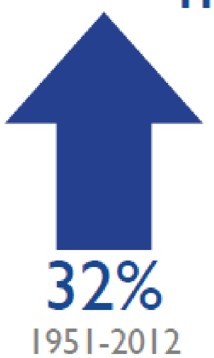
Source: National Levee Database

Climate Change Impacts

As stated earlier in this section, 34% of dam failures are due to overtopping. With the possible increased precipitation as stated below the potential for this increases.

Greater Flood Risk: Ohio has seen large increases in heavy storms that can lead to flooding. Models project those trends will continue, increasing flood damage risks to infrastructure and public health.

Heavy Precipitation



Between the 1951-1980 and 1981-2010 periods, the number of very heavy precipitation events increased by 32%.

The number of days per year that saw more than 1.25" of precipitation increased by 130% from 1951-2012.

Summer Water Availability: Many models project summer precipitation will decline even as precipitation increases during other seasons. This raises the potential for summer droughts and seasonal water shortages, particularly for agricultural and industrial use. With the potential decrease in summer precipitation dams become even more important as they retain water for use during these times.[121]

[121] "Climate Change and Impacts in Columbus, Ohio", GLISA

Vulnerability Assessment – Dam/ Levee Failure

**Note: all information in this vulnerability assessment can be attributed to the Franklin County 2012 THIRA, FEMA's HAZUS data print date May 2014 as received from the Ohio Emergency Management Agency and the Franklin County Emergency Management and Homeland Security GIS department.*

This hazard is considered to be a "Low Probability Event", meaning the anticipated frequency of the hazard or infrastructure failure within the County is once every 26 to 124 years. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability

As stated in this hazard section, according to the ODNR's Dam Safety Program, there has been little property damage resulting from a dam/levee failure alone. However, a combination of downstream flooding due to excessive precipitation and dam/levee failure has caused property damage. It is difficult to assess which property damage was a direct result of the dam/levee failure and which damage was a result of downstream flooding due to excessive precipitation. There has been some infrastructure loss in terms of roads washing away, but there has been no loss of critical facilities due to dam/levee failure in Franklin County.

A dam/levee failure in Franklin County could cause a significant loss of life and property. Specific impacts and vulnerabilities are identified in each Franklin County dam/levee profile.

For this vulnerability assessment we will use the most extreme case of dam failure in Franklin County: failure of the Hoover Dam as was presented in the profile section.

Identifying Structures and Potential Impact of Dam Failure

Exposure of Existing Buildings to Dam Failure

According to the Franklin County 2012 THIRA report, 28,000 households and 1,005 critical infrastructure and key resources (CIKR) would be in the inundation zone. THIRA estimates economic loss would be $1.8 billion.

Exposure of Future Buildings to Dam Failure

Future buildings' exposure would remain much the same as existing buildings.

Estimating Potential Loss

Methodology

There is no historical data on structural loss from a dam failure; however, we know that if one would occur the losses could be extremely high. According to the Franklin County 2012 THIRA, economic loss could be $1.8 billion.

According to the Franklin County Auditor's Office's real estate report as of 2015, which contains information for tax year 2012, the total value of residential and commercial structures is $68.4 billion. The total number of structures, residential and commercial, is 568,157.[122] Therefore, $68,400,000,000 / 568,157 = $120,389 average value per structure.

Estimated Potential Dollar Losses
The number of structures in the inundation zone according to the THIRA is 28,000 households and 1,005 CIKR for a total of 29,005.

29,005 (structures) X $120,389 (Value per structure) = $3,491,882,945. For this vulnerability assessment $3,491,882,945 would be the potential dollar loss for a worst-case dam failure in Franklin County.

The damage in dollars represented in this vulnerability statement only quantify the damage to structures and does not reflect ancillary costs associated with this hazard.

Identifying Structures and Potential Impact of Levee Failure

To determine the following loss estimation for levee failure, the planning team identified the area(s) protected by the levees and utilized data from the National Levee Database. Analysts estimated the number of people at-risk, structures at-risk and potential losses based on property value in the areas protected by the levees.

Segment Name	Location	Length (miles)	People At-Risk	Structures At-Risk	Property Value/ Potential Losses
West Columbus Local Protection Project	Columbus, Ohio	6.97	13,684	4,680	2.03B
Agg Rok Reach Levee	Columbus, Ohio	1.91	15	5	$3.13M
King Avenue Levee	Columbus, Ohio	0.46	786	10	$164M
Totals	-	**9.34**	**14,485**	**4,695**	**2.36B**

Source: National Levee Database

[122] Franklin County Auditor's Office, accessed on 13 October 2015, https://www.franklincountyauditor.com/real-estate/real-estate-info

Utility/Energy Interruption/Failure - #7

Hazard Summary

Utility interruptions and failures may involve electrical power, natural gas, public water and communications systems. These systems are vulnerable to natural hazards as well as intentional disruptions. Franklin County has experienced interruptions and failures of various kinds. Remnant winds of Hurricane Ike in 2008 caused over one-third of the county to lose power. The derecho on June 29, 2012 knocked out power to 720,000 Ohioans and was the most destructive and expensive storm in AEP Ohio history.[123] This hazard was ranked 7 out of 20.

[123] "AEP Gets OK to Pass on Derecho Costs to Customers," Columbus Business First, last modified on 2 April 2014, http://www.bizjournals.com/columbus/news/2014/04/02/aep-gets-ok-to-pass-on-derecho-costs-to-customers.html

Hazard Profile

Utility interruptions and failures may involve electrical power, natural gas, public water and communications systems. All of these systems, or a combination of these utility systems, exist virtually everywhere in the country where there are people. Many utilities are localized and serve only one community, while others are regional, often dispersed over a wide area.

To rise to the level of a major emergency or disaster, a utility failure would typically be an extended-duration event impacting a significantly populated area. Such might be the case in an extended power outage, a disruption in natural gas delivery, loss of water supply or loss of communication service.

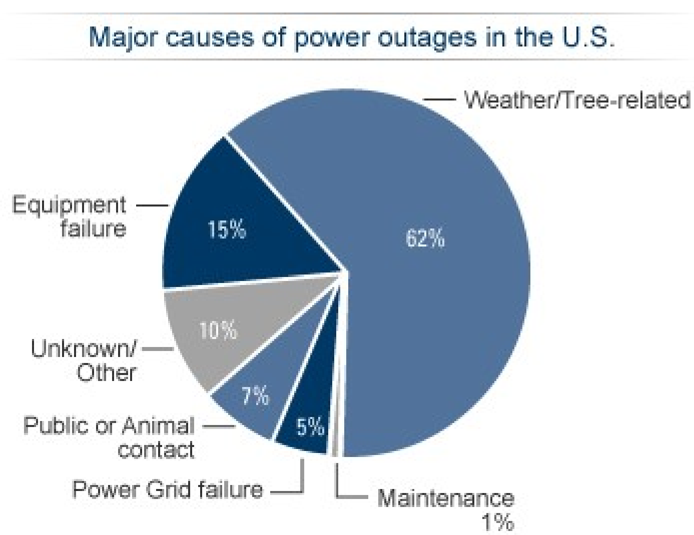
There is increasing interdependency among utility sectors. Electric generation is dependent on the availability and deliverability of natural gas. Telecommunications systems rely on electricity to run. Electric industry communications rely on telecommunications infrastructure.

Energy infrastructure is potentially vulnerable not only to natural disasters but also to cyber and physical attack. Energy emergencies may develop over time and may impact some groups more than others. An energy supply or price event may develop slowly; effects may seem to be scattered, but they accumulate over time. Energy events may not be regarded as emergencies, but as economic or personal problems.

Utility or Energy Interruption or Failure in the United States

Causes

The majority of power outages in the U.S. are caused by weather-related events, including thunderstorms, ice storms, heavy winds, and lightning strikes, as well as other natural disasters such as floods, hurricanes, or tornadoes. Animals contacting live wires, auto accidents damaging poles or other equipment, and other unknown factors can also cause power outages.



Power outages may vary by season and can last from minutes to hours, and even days or weeks, depending on the severity of the event. If a storm causes severe widespread damage, it can take several days to assess the damage and restore power.[124]

[124] "Outage Causes," DTE Energy, 1 August 2015, https://www2.dteenergy.com

Because utilities exist everywhere, damage may occur frequently. Many small events may go unreported. Damage to electrical equipment is not always obvious or immediately visible. Any interruption in electricity will have an immediate impact on those affected. Sudden power outages can be frustrating and troublesome, especially when they are prolonged.

Cause and effect are interrelated in telephone system failure. There are two types of communication system failures: call volume overload and infrastructure damage and failure. Which happens first depends on the event. In a hurricane, the first to occur is call volume overload, followed by infrastructure damage and failure. In a tornado, typically infrastructure damage will happen first and the effect will be almost immediate.

Factors that could separately or in combination result in energy events include weather, world events, and industry conditions. For example, here are some plausible scenarios:

- Severe winter cold creates an increased demand for heating fuels at the same time as iced-in ports delay terminal deliveries.
- A natural disaster such as a hurricane or ice storm destroys energy delivery infrastructure or hinders its use.
- High summer gasoline demand results in continued refinery production of gasoline and delayed production of home heating oil; cold weather creates demand for home heating oil before inventories are built.
- Political events result in actions against the U.S., such as the oil embargo imposed in the 1970s.
- Terrorist acts or acts of war destroy energy infrastructure or supply, or slow deliveries to key ports due to safety concerns.
- Unexpected refinery outages delay just-in-time production and/or delivery of fuels at a time when storage levels are already low.

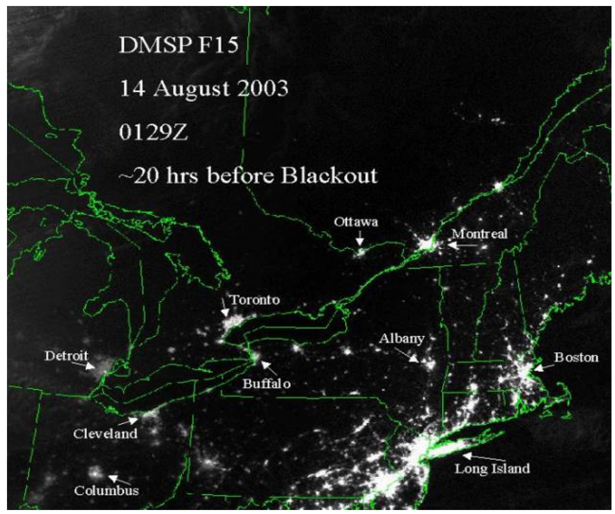
Energy resources are interrelated, and disruptions in one type of energy may result in disruptions or issues in other energy markets. Energy disruptions may affect other utility sectors; the electricity and telecommunications sectors in particular are increasingly inter-dependent.

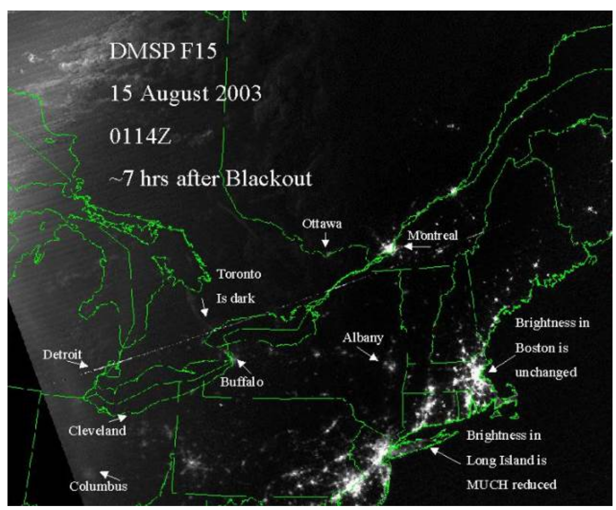
Impact

Utility outages and interruptions can be localized or region-wide. Their greatest impact is generally upon the very young or elderly, who can be expected to have greater health risks associated with resultant loss of heating/cooling systems and with loss of medical equipment that requires a power source. Loss of communications can also adversely affect the provision of emergency services, making it difficult to contact utility providers for emergency assistance. In addition, utility outages can cause significant problems within the financial community should there be a long-term loss of their data communications.

An energy event may stress certain resources which are already stressed (e.g., public assistance programs, shelters) or resources which are not available in all areas (e.g., outreach to elderly and those with special needs), and redirection of other community resources may be necessary.

Utility or Energy Interruption or Failure in Ohio





The Northeast Blackout of 2003[125]

The Northeast Blackout of 2003 was a massive widespread power outage throughout parts of the northeastern and Midwestern United States and Ontario, Canada, on August 14, 2003. At the time, it was the most widespread electrical blackout in history. The blackout affected an estimated 10 million people in Ontario and 45 million people in eight U.S. states. Eventually, a large triangular area bounded by Lansing, Michigan; Sault Ste. Marie, Ontario; the shore of James Bay, Ottawa; New York; and Toledo was left without power. More than 508 generating units at 265 power plants shut down during the outage.[126]

A joint federal task force was formed by the governments of Canada and the U.S. to oversee the investigation. In February 2004, the U.S. – Canada Power System Outage Task Force released its final report, placing the

[125] NOAA. "NOAA Posts Images Online of Northeast Blackout". 15 August 2003. http://www.noaanews.noaa.gov/stories/s2015.htm

[126] "Interim Report on the Aug 14, 2003 Blackout," NY Independent System Operator, 8 Jan 2004, http://www.hks.harvard.edu/hepg/Papers/NYISO.blackout.report.8.Jan.04.pdf

main cause of the blackout on FirstEnergy Corporation's failure to trim trees in part of its Ohio service area. The report said that a generating plant in Eastlake, Ohio, a suburb of Cleveland, went offline amid high electrical demand that strained high-voltage power lines located in a distant rural setting. Power lines will sag when overloaded. The overloaded power lines later went out of service when they came in contact with "overgrown trees." The cascading effect ultimately forced the shutdown of more than 100 power plants. A software bug that prevented alarms from showing on their control systems exacerbated the situation. After the alarm system failed, the backup server also failed. Therefore, other control centers were not warned until it was too late.[127]

With the power fluctuations on the grid, power plants automatically went into "safe mode" to prevent damage in the case of an overload. This put much of the normally available nuclear power offline. Some areas lost water pressure because pumps didn't have power. This loss of pressure caused potential contamination of the water supply. Four million people in Detroit were under a boil water advisory for four days. Cleveland and New York had sewage spills into waterways, requiring beach closures.

Amtrak's northeast corridor railroad service was stopped north of Philadelphia, and all trains running in and out of New York City were shut down. Passenger screenings at affected airports ceased. Regional airports were shut down for this reason. In New York, flights were cancelled even after power had been restored to the airports because of difficulties accessing electronic ticket information.

Many gas stations were unable to pump fuel due to lack of electricity. This held up transport trucks, unable to continue without refueling. Many oil refineries on the East Coast shut down as a result of the blackout and were slow to resume gasoline production, increasing gasoline prices.

Cellular communication devices were disrupted. This was mainly due to the loss of backup power at the cellular sites, where generators ran out of fuel or cell phone batteries ran out of charge. Wired telephone lines continued to work, although some systems were overwhelmed by the volume of traffic, and millions of home users had only cordless telephones depending on house current.
Cable television systems were disabled, and areas that had power restored could not receive information until power was restored to cable providers. Internet services were similarly disrupted.

Large numbers of factories were closed in the affected area, and others outside the area were forced to close or slow work because of supply problems and the need to conserve energy. Freeway congestion in affected areas disrupted "just-in-time" supply systems.

[127] "Technical Analysis of the August 14, 2003 Blackout Investigation, Final Report," North American Electric Reliability Corporation (NERC), 13 July 2004, http://www.nerc.com/docs/docs/blackout/NERC_Final_Blackout_Report_07_13_04.pdf

In Ohio, over 540,000 homes and businesses were without power. In Cleveland, water service stopped because the city is supplied by electric pumps, and backup electricity was available only on a very limited basis. Portions of Akron, Mansfield, Marion and Ashland were without power.

Utility or Energy Interruption or Failure in Franklin County

Hurricane Ike, September 14, 2008

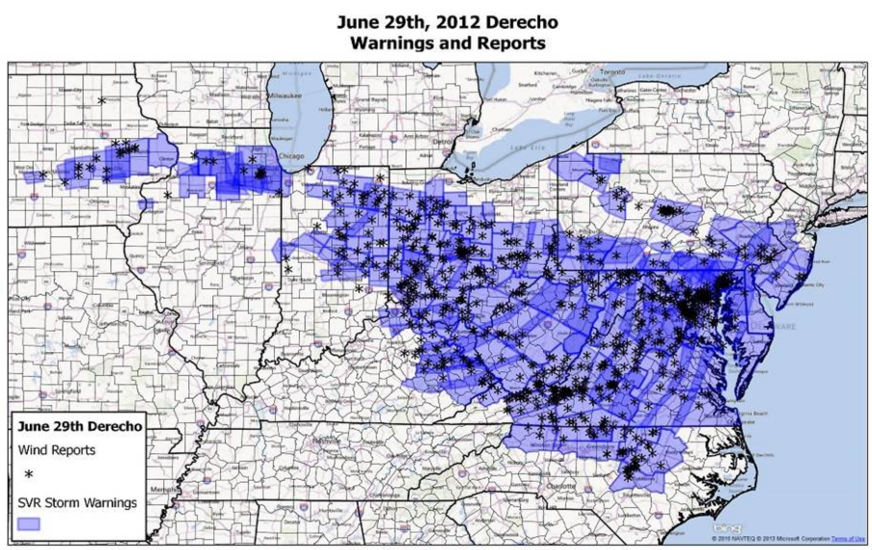
The remnants of Hurricane Ike caused massive power outages across Ohio and Kentucky and into western Pennsylvania. The power failure went on record as Ohio's biggest storm-related blackout. Over a million customers were affected. Almost one third of Franklin County was without power.

The National Weather Service issued a high wind warning, forecasting wind gusts of up to 65 mph. The damage rivaled that of the 1974 Xenia tornado. Franklin County's municipalities, schools, and some nonprofit agencies incurred $6.9 million in costs.

Ohio homeowners filed 108,600 claims totaling about $460 million for damage from wind and falling trees, according to the Ohio Insurance Institute. There were 9,254 automobile claims representing $22.7 million and 13,564 commercial property claims totaling $69.1 million.

Derecho June 29, 2012[128]

On June 29, 2012, a major storm system called a derecho moved across Illinois through the Ohio Valley and Mid-Atlantic States, travelling roughly 600 miles in about 10 hours. During the event, the National Weather Service received over 800 preliminary thunderstorm wind reports with peak wind gusts ranging from 80-100 miles per hour. More than 4 million customers lost power in the District of Columbia, Delaware, Illinois, Indiana, Kentucky, Maryland, New Jersey, North Carolina, Ohio,



Source: Washington Post

[128] "June 29, 2012 Derecho Warnings and Reports," Washington Post, 1 Aug 2015, http://www.washingtonpost.com/blogs/capital-weather-gang/files/2013/05/Resized-Derecho-Map.jpg

Pennsylvania, Virginia, and West Virginia. After the derecho, it took up to 7-10 days to restore power to all customers in the midst of a heat wave with temperatures topping 100 degrees in some areas.

In August 2012, the United States Department of Energy released a report reviewing the power outages and restoration process. Excerpted below are the conclusions found on page 12 of this report which can be viewed in its entirety at http://www.oe.netl.doe.gov/docs/Derecho%202012_%20Review_080612.pdf [129]

1. The 2012 Derecho was a severe storm with a wide geographic area. The storm brought sustained winds of 60 miles per hour with wind gusts ranging from 80-100 miles per hour across a 600-mile swath of the country. The storm damaged electric infrastructure, leaving 4.2 million customers without power the morning after the storm— more outages than any other storm to hit the Ohio Valley or Mid-Atlantic regions over the past five years. Restoration efforts were further complicated in many of the impacted areas as extensive debris and tree removal were required before power repairs could be made.

2. Utilities had minimal preparation time before the 2012 Derecho, as weather forecasts did not indicate a major storm event was likely. Due to the suddenness of the storm, utilities had virtually no time to develop restoration plans and pre-stage resources in expected areas of impact. Furthermore, access to repair crews from outside the expected storm area could not be arranged and positioned in advance of the storm. The suddenness of the 2012 Derecho contrasts with Hurricanes Ike and Irene, for which there was considerable advance warning, and other summer and spring storms in this report that weather forecasts may have predicted.

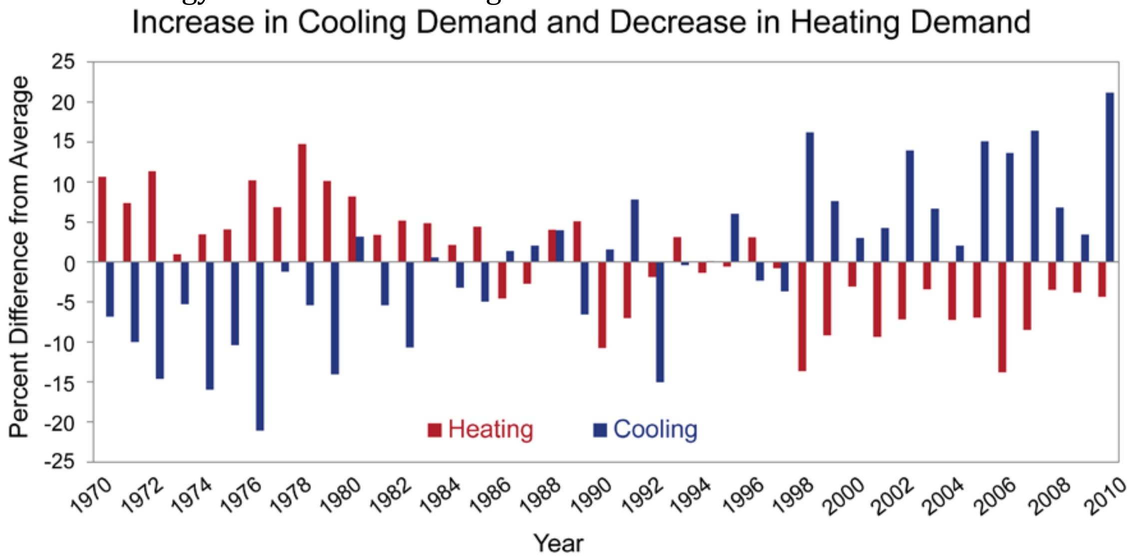
3. Post-storm issues during the restoration period, including additional storms and excessive heat in the impacted areas, lengthened restoration times causing additional power outages and complicating restoration efforts.

Climate Change Impacts

Projected impacts of climate change, such as higher summer temperatures and more heat waves, will increase energy use in the summer which will in turn cause higher summer peak loads. This will result in additional risks to reliable energy supply. Extreme weather events and water shortages are already interrupting energy supply, and impacts are expected to increase in the future. Most vulnerabilities and risks to energy supply and use are unique to local situations; others are national in scope. Net electricity use is projected to increase.

[129] "A Review of Power Outages and Restoration Following the June 2012 Derecho," United Stated Department of Energy, August 2012, http://www.oe.netl.doe.gov/docs/Derecho%202012_%20Review_080612.pdf

The frequency of cold waves is expected to continue decreasing and warmer winters will decrease energy demands for heating.



Source: U.S. Global Change Research Program

Projected climate changes include increases in various types of extreme weather events, particularly heat waves, longer and more intense drought, and extreme coastal high water due to heavy-precipitation storm events coupled with sea level rise. This extreme coastal high water will increasingly disrupt infrastructure services in some locations. Service disruptions within one infrastructure system (e.g. energy) will lead to disruptions in other infrastructure systems (e.g. communications and transportation). Infrastructure exposed to extreme weather and also stressed by age or by demand that exceeds designed levels is particularly vulnerable.[130]

[130] "Energy Supply and Use," U.S. Global Change Research Program, 1 Aug 2015 http://nca2014.globalchange.gov/report/sectors/energy

Vulnerability Assessment – Utility or Energy Interruption or Failure

This hazard is considered to be a "Relatively Moderate Probability Event" meaning the anticipated frequency of the infrastructure failure within the County is once every 1 to 4 years. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability
Franklin County has been affected by utility or energy interruption or failure events many times in the past but there is no historical data that utility or energy interruptions or failures have caused structural damage in the county.

For this vulnerability assessment we will use the scenario of the June 2012 summer wind (derecho) event. Pertaining to this storm, Matthew Satterwhite said in a PUCO filing that the derecho was "the most destructive and expensive storm" in AEP Ohio history.

Potential Impact of Utility/Energy Interruption/Failure
Negative impacts of a utility or energy interruption or failure event could be experienced by many county wide and cause many concerns. No damage to structures is anticipated due to utility or energy interruption or failure.

The 2012 storm had an impact of $57.5 million for all AEP customers as reported by The Columbus Business First on April 2, 2014. Ohio has 720,000 AEP customers. Franklin County has 516,569 AEP customers.[131] For these 516,569 residents the impact was $22,847,846.

$57.5 million divided by 1.3 million customers = $44.23 X 516,569 Franklin County customers = $22,847,846

Identifying Structures
No structures are expected to experience damage due to utility or energy interruption or failure.

Since no structures would experience damage due to utility or energy interruption or failure, this updated risk assessment does not identify existing or future buildings at risk of loss due to utility or energy interruption or failure.

Exposure of Existing Buildings to Damages from Utility/Energy Interruption/Failure
No existing buildings are exposed to damage due to utility or energy interruption or failure.

Exposure of Future Buildings to Damages from Utility/Energy Interruption/Failure
No future buildings will be exposed to damage due to utility or energy interruption or failure.

[131] "Outage Map," AEP Ohio, accessed on 24 Nov 2015, https://aepohio.com/outages/outageMap.aspx

Estimating Potential Loss

Methodology
$57.5 million (impact) divided by 1.3 million (customers without power) = $44.23 X 516,569 (Franklin County AEP customers) = $22,847,846.

Potential dollar loss due to utility or energy interruption or failure is estimated to be $22,847,846.

Estimated Potential Dollar Losses
The estimated potential dollar loss annually in Franklin County due to structural damage from utility or energy interruption or failure is $0.00.

Potential impact is $22,847,846.

Chemical, Biological, Radiological, Nuclear, and Explosive (CBRNE) Terrorist Incident - #8

Hazard Summary

Terrorism is defined as the unlawful use of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives.[132] Franklin County and the City of Columbus have consistently received federal dollars for projects fostering terrorism preparedness. Franklin County has never been the victim of a direct terrorist attack yet has a history of terrorist activity. This, along with the difficulties in predicting which U.S. cities are future targets and the potential impact of a terrorist attack on the county's population, property, and economy, makes terrorism more of a "wild card" than other hazards and therefore more difficult to prioritize. This hazard was ranked 8 out of 20.

[132] "Terrorism," National Institute of Justice, accessed on 1 Nov 2015, http://www.nij.gov/topics/crime/terrorism/pages/welcome.aspx

Hazard Profile

The Federal Bureau of Investigation (FBI) defines terrorism as:

"The unlawful use of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives."[133]

Terrorism has become a fact of life in today's society. Terrorists' acts may result in the destruction of public confidence in the ability of government to protect its citizens. Mass casualties and fatalities; catastrophic damage to buildings, physical infrastructure, or other types of property; contamination of buildings and property; psychosomatic responses from non-affected citizens; contamination/targeting of first responders – all could have a major impact on the county's ability to respond and could place a major burden on the medical system and area hospitals.

Local emergency-response agencies frequently train for the reality that terrorists may employ secondary or multiple devices intended to injure responders, impede response actions, or divert attention and resources from other activities. Devices may be employed at numerous locations in any combination or sequence and are often designed with anti-tampering devices.

Historically, terrorist events have occurred at places of special significance, against identifiable segments of the population, on dates of interest to the terrorist or the intended victims, and at special events. However, any place people gather could be a terrorist target.

Federal, state and local governments each have a role in terrorism prevention, protection, response and recovery. The federal government is the investigative lead and the prosecutor of terrorism cases. The first responder agencies of Franklin County must be equipped and trained to respond immediately and effectively to any incident. Significant help from the federal government will be 24 to 48 hours, or longer, in arriving. Local and State agencies are the first line of defense when responding to the consequences of terrorism.

Terrorism Risk

Determining the risk of a terrorist attack requires an assessment of the threat and an evaluation of the probable target's vulnerability to attack. Threat assessment requires cooperation between various local, state and federal agencies to collect, evaluate, and disseminate intelligence concerning terrorist and extremist groups. Such information may include:

- Terrorist movements or operations in a given geographical area
- Preferred terrorist targets, methods, tactics, and weapons

133 "Terrorism," National Institute of Justice, accessed on 1 Nov 2015, http://www.nij.gov/topics/crime/terrorism/pages/welcome.aspx

- Indications that terrorists have been collecting intelligence in a given area or near a particular target
- Political, social and economic changes or ongoing criminal or subversive activities which could lead to or support terrorism

Such information is law enforcement sensitive. In Franklin County, the Columbus Police Counter Terrorism Unit (formally the Terrorism Early Warning Group), in communication with the Joint Terrorism Task Force, monitors, compiles and evaluates this information continuously.

Estimating Terrorism Risk, published by the RAND Center for Terrorism Risk Management Policy, describes three components of terrorism risk: threat, vulnerability and consequences.[134]

Threat

The Department of Homeland Security's Risk Lexicon defines threat as "a natural or man-made occurrence, individual, entity or action that has or indicates the potential to harm life, information, operations, the environment, and/or property." It further states that "Threat as defined refers to an individual, entity, action, or occurrence; however, for the purpose of calculating risk, the threat of an intentional hazard is generally estimated as the likelihood of an attack (that accounts for both the intent and capability of the adversary) being attempted by an adversary. For other hazards, threat is generally estimated as the likelihood that a hazard will manifest."[135] Specific information on threat groups or individuals is sensitive and beyond the scope of this document. However, there are some noteworthy generalizations outlined below.

Terrorism is divided into two broad categories, domestic terrorism and international terrorism. Domestic terrorism involves groups or individuals whose terrorist activities are directed at elements of the government or population without foreign direction. International terrorism involves groups or individuals whose terrorist activities are foreign based and directed by countries or groups outside the United States or whose activities transcend national boundaries. The bombings of the World Trade Center in New York (1993), the Murrah Federal Building in Oklahoma City and the infamous attacks of September 11, 2001 proved the United States is not immune to domestic and international terrorism.

Motivation is a key consideration when analyzing the potential for a group or individual to commit an act of terrorism. Motivations provide insight into the specific sites that a terrorist may consider a target.

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[134] "Estimating Terrorist Risk," RAND Institute, accessed on 1 Nov 2015, http://www.rand.org/pubs/monographs/MG388.html

[135] "DHS Risk Lexicon," Department of Homeland Security, accessed on 1 Nov 2015, https://www.dhs.gov/xlibrary/assets/dhs_risk_lexicon.pdf

The FBI established four major classifications of terrorist groups:

- Anti-government-groups want no government or a very weak central government, are pro-socialist or anti-capitalist, desire Nazi/fascist government or are anarchists.
  - Right Wing – groups commonly associated with militia movements or groups opposing government control and power.
  - Left Wing – political motivations that are commonly associated with socialist ideology.
- Religious Radicals– terrorist motivated by religious causes, often considered the most dangerous because of their fanaticism and willingness to die for their cause.
- Racist/Hate-Based – often referred to as hate groups. These groups have a belief in a social order based on the supposed superiority of a particular race.
- Special Interest/Single Issue – includes a variety of causes, each with a single focus not included in the previous categories, e.g., animal rights, anti-abortion and environmental extremism.

Vulnerability and Consequence

Franklin County is a large, heavily populated and diverse jurisdiction. The county has many sites that are potential terrorist targets. There are several ways to address potential targets. Some locations are considered targets because they are associated with common terrorist motives.

Terrorist Groups	Potential Targets
Religious Radicals - Islamic - Catholic - Protestant - Jewish - Cults	- Opposing religions and houses of worship - Financial institutions - Women's health clinics
Racist/Hate-Based - Separatist Groups	- Ethnic facilities or symbols - Organizations that promote equality - Places of worship
Special Interest/Single Issue - Environmental Protection Groups - Animal Rights Groups - Anti-technology Groups - Anti-abortion Groups	- Mining, logging or oil explorations sites - Construction sites - Sources of water or air pollution - Women's health clinics - University animal research facilities - Animal breeders - Research and technology companies

The following list is an example of the kinds of facilities that could be vulnerable strictly by their function. These facilities are not listed because of specific threat, only due to their purpose:

- Locations of special significance – In Franklin County this could include the Federal Courthouse, other courts of law, religious buildings, financial centers, Statehouse and other government offices, Battelle and other research and medical facilities, Ohio State University (OSU) and other universities or schools, and police and fire stations.
- Transportation infrastructure – Particularly significant: Port Columbus, Rickenbacker and OSU Don Scott airports; Interstates 70, 71, 270 & 670; other major roadways; rail yards; and natural gas and petroleum transmission pipelines.
- Public utilities – Electricity, water, natural gas, waste treatment plants (e.g., American Electric Power stations, Dublin Road Water Treatment Plant, Columbia Gas).
- Health care facilities – All hospitals and other public and private health care facilities.
- Cyber/information technology service facilities – Discover Card, Verizon.
- Defense and defense–related sites – Defense Supply Center Columbus, military recruiting facilities.
- Large gathering places – Franklin County has many large sports arenas: Schottenstein Center on the Ohio State University campus; Nationwide Arena in downtown Columbus; Ohio Stadium and other school stadiums. Other venues include the Columbus Convention Center, State Fairgrounds, Easton Town Center, Polaris Fashion Place, and several smaller shopping centers. Columbus Commons and the Scioto Mile area along the river in downtown Columbus are the scenes of several festivals and events throughout the year.

Any potential target's vulnerability is also affected by the strengths and weaknesses of each location. These include: level of visibility, ingress and egress routes, security, individual systems within the facility such as hazardous materials, and degree of preparedness planning.

Potential target populations include:

- Religious or ethnic minorities
- Political opposition groups
- Controversial groups
- Government agencies or workers, including first responders

Dates or anniversaries of significance may include:

- Government holidays
- Days of special religious observances
- Dates related to famous or controversial figures, or celebrated martyrs.

- Famous anniversaries such as: April 19–Waco Texas raid and Oklahoma bombing, September 11–World Trade Center and Pentagon Attack, January 22–Roe vs. Wade.

Vulnerability can also be time-related when damage would be greatest and response the most difficult: morning or evening rush hour, after OSU football games, during response to a natural disaster, during Presidential or other dignitary visits.

Consequence is the magnitude and type of damage resulting from a successful terrorist attack. Consequence can be expressed in terms of fatalities, injuries, economic losses, or other types of damage. In other words, consequence is the impact of the attack on the target. The impact may be limited to a specific target site or may be of a magnitude to affect a large area or community.

When analyzing the potential impact of a terrorist event, in addition to considering the characteristics of the target, number of possible victims, criticality of the facility and economic importance, the type of terrorist weapon employed must also be considered. The impact on the community will vary greatly depending on the nature of the weapon employed.

CBRNE Weapons

The Department of Justice (DOJ) uses the acronym CBRNE to describe the five categories of Weapons of Mass Destruction (WMD):

Chemical
Biological
Radiological
Nuclear
Explosive (including incendiary devices)

Chemical Weapons

Chemical weapons are man-made mixtures or compounds used to kill or disable people. The deliberate release of a chemical warfare agent would have a highly debilitating and largely unpredictable impact within a community. The probable target choice would be a densely populated, highly visible site, such as a place of public assembly, public buildings, mass transit system, or a location with historical or symbolic significance. Such a site would put large numbers of people in danger and stress support and infrastructure systems. Victims in the target area could suffer the effects of a chemical agent immediately, or, with some agents, the effects can be delayed, causing casualties hours or days after the initial impact.

Introduction of a chemical agent into a vital segment of a community's infrastructure (such as the water distribution system) could be a means of further dissemination of the agent. An agent placed inside a ventilation system can be disseminated by the system itself, contaminating an entire structure.

The psychological effects of a chemical weapons attack could have a severe impact on the community as well. The implications of such an attack could cause panic among a wider population than actually affected, with greater numbers of people seeking treatment than have been physically harmed. Frightened citizens could clog medical facilities, hampering the treatment of the victims suffering physical effects of the agent and overwhelming emergency medical capabilities.

The unpredictability of a chemical attack with regard to the choice of target, the difficulty of agent identification, the danger of widespread contamination, the damage to infrastructure and the reaction of victims and responders all complicate emergency response efforts.

There are four ways that chemical (and biological) agents can enter the body: ingestion, inhalation, absorption and injection. Inhalation and absorption are the most effective means of contaminating large numbers of individuals. The process of weaponizing chemical agents is relatively simple compared to the difficult process of weaponizing a biological agent. A biological agent requires a specific particle size to be effective, while a chemical agent does not have to be as precise.

Categories of Chemical Agents

- Nerve Agents – effective as military weapons because of their formulation. They are extremely toxic to the intended target but break down rapidly. Chemical agents were used extensively in World War I.
- Blister Agents – also developed and used during World War I. They are capable of causing extreme pain and large blisters on contact. If the vapors are inhaled, lung tissue forms large obstructing blisters. Once the blisters break, a large open wound results that allows the establishment of overwhelming infections, which may cause death.
- Blood Agents – chemicals commercially used by industry for heat treating, plating, fumigation and plastics production. Military applications include hydrogen cyanide and cyanogen chloride. These compounds interfere with the ability of hemoglobin in red blood cells to bond with oxygen for transport to the cells throughout the body, resulting in cellular suffocation.
- Choking Agents – respiratory irritants such as chlorine, phosgene and diphosgene. These agents have a long history of military use and remain in military arsenals around the world. These agents destroy the alveolar tissue in the lungs, resulting in fluid from the bloodstream advancing into the airways. The victim drowns in his own blood.

<u>Biological Weapons</u>

Bioterrorism involves the release of infectious microorganisms or toxins intended to kill or cause disease in a large number of people in an unsuspecting population. The result is not immediate, becoming apparent over several hours or days. Biological agents are a variety of either microorganisms or biological toxins.

The deliberate release of a biological agent such as anthrax would have a highly debilitating and largely unpredictable impact within a community. The probable target choice would be a densely populated, highly visible site, similar to that of a chemical attack.

The lag time from exposure to the exhibition of initial symptoms, plus the potential for misdiagnosis, could enable widespread dispersion of victims far beyond the initial target area and for an unpredictable period of time after release.

A widespread outbreak of an infectious disease would threaten the ability of emergency and medical facilities to respond. Response personnel could be at risk of infection themselves, especially prior to a definitive diagnosis of the disease. The collection and disposal of contaminated material, including human remains, would present additional long-term problems.

The psychological effects of a biological agent release could have a severe impact. A panicked response by the population, including widespread psychosomatic reactions, could magnify the crisis by further overwhelming treatment facilities and possibly clogging transportation systems as people search for treatment or escape.

Biological agents may be living bacteria, rickettsia or viruses that are able to establish deadly infections in their victims. Biological toxins include poisonous chemical compounds produced by plants, animals or microbes.

Categories of Biological Agents

- Bacterial Agents – totally self-sufficient, single celled living microorganisms that may infect the body tissue, e.g., anthrax, cholera, plague, tularemia and salmonella.
- Viral Agents – smaller than bacteria and live on or within other cells, e.g., smallpox, viral hemorrhagic fevers, and viral encephalitis.
- Biological Toxins – naturally occurring, poisonous substances produced by an animal, plant or microbe, e.g., Botulinum toxin, Ricin.
- Rickettsia – Viral agents between bacteria and viruses in size with characteristics of both, e.g., Typhus, Rocky Mountain Spotted Fever.

Radiological Weapons

The use of a radiological dispersion device (RDD), or "dirty bomb," is more likely than a thermonuclear fusion bomb or atomic bomb. An RDD is a conventional explosive charge laced with radioactive materials, which are dispersed over a wide area upon detonation of the explosive charge. Weapons-grade fissionable material is not required for this type of device. Radioactive materials used to test bridges and buildings and radioactive medical material can be used to contaminate an area. Cesium, a radioactive material used legally for the treatment of cancer, can be weaponized and dispersed by an explosive device to contaminate the surrounding area.

Nuclear Weapons

A nuclear weapon is one that releases nuclear energy in an explosive manner as a result of a chain reaction involving fusion or fission. Nuclear weapons are considered the most unlikely CBRNE weapon to be used because of extreme expense and enormous amount of technology needed.

Few ideas instill as much fear as the thought of nuclear capability in the wrong hands. Considering the difficulty in producing a nuclear warhead, the most feasible, and therefore most likely, form of nuclear terrorism is a direct assault on a nuclear facility, such as a power station. Considering the amount of radiation housed at such a facility, the magnitude of a single attack of this kind could cause thousands of deaths and ruin surrounding land for decades.

Explosives

Historically, explosives have been the weapons of choice for terrorists. The materials and technology needed are readily available. Instructions to build an explosive device can be found on the internet. These types of bombs, also known as homemade explosives (HMEs), have been detonated in Franklin County as recently as mid-2015. Bombs have the potential to generate mass casualties depending on the type, amount and placement of the material.

Explosives are defined as unstable chemical compounds and mixtures that, when detonated, undergo a rapid reaction, producing large amounts of gas under pressure. Explosives have the potential for producing mass casualties, depending on several factors, including:

- Type and amount of explosive
- Placement of explosive in relation to intended target
- Secondary chemicals or other hazards that could enhance a device's effectiveness, either as part of the device or present at the target
- Surrounding structures' susceptibility to blast overpressure
- Immediate surroundings of device that may influence detonation (i.e. containment)

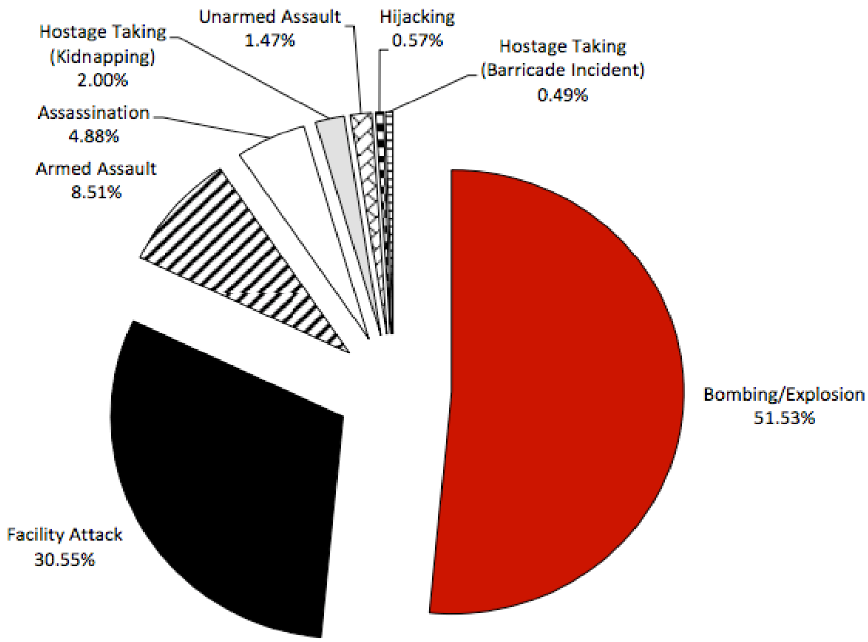
Incendiary devices also fall in the explosives category. An incendiary device is any mechanical, electrical or chemical device used to intentionally start a fire, e.g., gasoline, lighter fluid.

CBRNE Terrorism in the United States

The conclusion of the FBI publication *Terrorism 2002-2005* gives a good summary of terrorism in America.

"During the first 75 years of its history the FBI encountered a predominatly domestic terrorist threat that underlay larger criminal trends. Between the World Wars, this threat came primarily from right-wing extremists, then shifted to left-wing, socialist-oriented groups beginning in the 1950s and continuing into the 1980s. In the early 1980s, international terrorism sponsored primarily by states or organizations began to impact US interests overseas and led to legislation that extended the FBI's responsbilities to cover terrorist threats originating outside the United States and its territories. The 1990s saw a new era of domestic and international terrorism in which terrorists sought to inflict massive and indiscriminate casualties upon civilian populations. This threat grew as terrorists began to seek out unconventional weapons and weapons of mass destruction. The 1990s also saw the rise of terrorism pursued by loosely-affiliated extremists, with examples ranging from terrorists involved with domestic special interest causes to militants engaged in international jihad. These terrorism trends combined into the September 11, 2001, attack that has set in motion an international effort to counter the global terrorist threat and elevated counterterrorism to the FBI's preeminent mission."[136]

Tactics Used in Terrorist Attacks in the United States, 1970-2011



Source: The Washington Post[137]

[136] "Terrorism 2002-2005, FBI, accessed on 1 Nov 2015, https://www.fbi.gov/stats-services/publications/terrorism-2002-2005

[137] "Eight facts about terrorism in the United States," The Washington Post, modified on 16 April 2013, http://www.washingtonpost.com/blogs/wonkblog/wp/2013/04/16/eight-facts-about-terrorism-in-the-united-states/

The terrorist events of 9/11 in New York, at the Pentagon, and in Pennylvania marked a dramatic escalation toward more detructive attacks. These incidents, coupled with a series of anthrax-related incidents occuring after 9/11, are indicative of an increasing interest in using CBRNE to target the United States. There has been a tremendous increase in the number of hoaxes involving the use of chemical, nuclear, or biological agents perpetrated by individuls and/or terrorists wishing to instill fear and disrupt communities.

ISIS Islamic State of Iraq and Syria

Born from an especially brutal al Qaeda faction, the Islamic State of Iraq and Syria (ISIS) has grown from relative obscurity in recent years to overshadow its extremist patrons. It now terrorizes large swaths of Syria and Iraq, has become the target of the largest U.S. military operation in Iraq in years and, with the public, cold-blooded execution of multiple Westerners, dominates headlines around the world.

Is ISIS a Threat to the U.S.?

Though ISIS leader Abu Bakr al-Baghdadi had previously threatened the U.S. in general, ISIS primarily focused its attention on its regional ambitions prior to the 2015 U.S.-led bombing campaign. But as the U.S. and others continue to bombard ISIS targets, the group has repeatedly called on its followers in Western nations to conduct deadly attacks at home[138].

One of the gunmen in a dual terror attack in Paris in January 2015 claimed that he was part of ISIS, though the other shooters in that attack were linked to an al Qaeda affiliate. Days after the Paris incident, authorities in the U.S. announced they had arrested an Ohio man and ISIS supporter who planned to bomb the U.S. Capitol.

On July 29, 2015, Arafat M. Nagi, 42, of Lackawanna, New York, was arrested and charged with attempting to provide material support and resources, namely personnel, to ISIS. The charge carries a maximum penalty of 15 years in prison and a $250,000 fine.[139]

CBRNE Terrorism in Ohio

Despite the fact that events such as the Boston Marathon Bombing in 2013, the World Trade Center attacks of 1993 and 2001 and the Oklahoma City bombing in 1995 have not happened in Ohio, based upon historical review of terrorism-related incidents in the state, the threat of terrorism in Ohio is real.

There are groups representing all four main FBI terrorist group classifications operating in Ohio. Below are many of them, along with websites with information showing the potential threat they pose:

Anti-government groups:

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[138] "ISIS Trail of Terror," ABC News, accessed on 7 July 2015, http://abcnews.go.com/WN/fullpage/isis-trail-terror-isis-threat-us-25053190

[139] "Columbus, Ohio man charged with providing material support to terrorists," U.S. Department of Justice, modified on 16 April 2015, https://www.fbi.gov/cincinnati/press-releases/2015/columbus-ohio-man-charged-with-providing-material-support-to-terrorists

Common law courts:
https://www.adl.org/sites/default/files/documents/assets/pdf/combating-hate/adl-report-1997-vigilante-justice.pdf

Sovereign Citizens:
https://www.adl.org/education/resources/backgrounders/sovereign-citizen-movement

The Militia Movement:
https://www.adl.org/education/resources/backgrounders/militia-movement

New Black Panther Party (NBPP):
https://www.adl.org/education/resources/reports/report-new-black-panther-party-for-self-defense-nbpp
http://cbpm.org/nbpp.html

Religious radicals:
Christian Identity:
http://www.christianidentityministries.com/
https://www.adl.org/education/resources/backgrounders/christian-identity
https://vault.fbi.gov/Christian%20Identity%20Movement%20/Christian%20Identity%20Movement%20Part%201%20of%201/view

Phineas Priesthood:
http://www.adl.org/combating-hate/hate-on-display/c/phineas-priest.html#.VYNvqHnD_IU
http://www.splcenter.org/get-informed/intelligence-files/ideology/Phineas-Priesthood

World Church of the Creator/Creativity Movement:
https://www.adl.org/education/resources/profiles/creativity-movement

Church of Jesus Christ Christian:
https://www.adl.org/sites/default/files/documents/assets/pdf/combating-hate/Aryan-Nations-CJCC-Extremism-in-America.pdf
https://www.adl.org/education/resources/profiles/aryan-nations

Odinism:
http://www.odinistfellowship.co.uk/
http://www.odinbrotherhood.com/
http://www.splcenter.org/get-informed/intelligence-report/browse-all-issues/1998/winter/the-new-barbarians

Islamic Terror Groups—al-Qaeda:
http://www.globalsecurity.org/military/world/para/al-qaida.htm

Racist/Hate Based Groups:
National Socialist Movement:
http://www.nsm88.org/
https://www.adl.org/education/resources/profiles/national-socialist-movement
http://www.nsm88.org/units/ohio.html

American Nazi Party:
http://www.americannaziparty.com/
http://anpohio925.blogspot.com/

Blood and Honour:
http://www.adl.org/combating-hate/hate-on-display/c/blood-honour.html#.VYNyyXnD_IU
http://www.bloodandhonour.org/

National Alliance:
https://www.adl.org/education/references/hate-symbols/national-alliance
http://www.natvan.com/

KKK:
https://www.adl.org/education/resources/reports/state-of-the-kkk

Skinheads:
http://www.adl.org/racist_skinheads/
http://www.splcenter.org/get-informed/intelligence-files/ideology/racist-skinhead

Aryan Nations:
http://www.adl.org/combating-hate/hate-on-display/c/ohio-aryan-brotherhood.html#.VYNwcHnD_IU

Special Interest/ Single Issue Groups:
Earth Liberation Front (ELF):
http://www.splcenter.org/get-informed/intelligence-report/browse-all-issues/2001/summer/by-any-means-necessary

CBRNE Terrorism in Franklin County

Columbus was one of the original 120 cities to receive funding under the Nunn-Lugar-Domenici Domestic Preparedness Program. However, Columbus was removed from its designation as an Urban Areas Security Initiative (UASI) city for Federal Fiscal Year (FFY) 2011, 2012, 2013. Columbus did once again receive UASI funding for FFY 2014.
While Franklin County has not suffered a serious terrorist attack to date, the area has a history of terrorist related activity:

International

Below are several examples of individuals from or living in central Ohio who have been connected to terrorism:

Abdirahman Sheik Mohamud

On April 16, 2015, Abdirahman Sheik Mohamud of Columbus, originally a native of Somalia, was indicted by a federal grand jury after an investigation by the FBI and the Joint Terrorism Task Force concluded that he planned to carry out an act of terrorism in the United States and was trying to recruit others. Mohamud wrote to an unnamed person that he planned to go overseas and kill U.S. allies on the battlefield. He planned to join his brother, Aden, in Syria to fight for Al-Nusrah Front which was formed by al-Qaida in Iraq in late 2011 as a front for activities in Syria. In February 2014, Mohamud offered to send Aden money, and last April he traveled overseas to take $1,000 to his brother and to train in Syria. During the training, Mohamud learned hand-to-hand combat, how to use explosives and how to shoot weapons. According to the indictment, he was about to begin fighting for a Syrian organization when a cleric with the group told him to return to the U.S. and carry out an act of terrorism. He returned on June 8, four days after his brother Aden was killed.[140]

Iyman Faris

Iyman Faris was born in Pakistan and was a naturalized US citizen working as a truck driver in Columbus. In 2003, Farris began cooperating with the FBI and admitted to having gone to an Afghan training camp and scouting the Brooklyn Bridge for al-Qaida, and was linked to Khalid Sheikh Mohammed (one of the 9/11 terrorists). Faris was convicted of material support and conspiracy to provide material support to al-Qaida and is serving a 20 year prison sentence. He is no longer cooperating with the FBI. Prosecutors said he provided al-Qaida with plane tickets and cell phones and traveled to Afghanistan in 2000 to meet with Osama bin Laden in a terrorist training camp. Faris identified Nuradin Abdi and Christopher Paul as his associates.

Nuradin Abdi

Nuradin Abdi, a native of Somalia, was arrested in November of 2003 as a national security threat. Until February 2004 he cooperated with the FBI, admitting he falsified travel documents to attend an al-Qaida-linked training camp and that he initiated a plot to blow up a Columbus shopping mall. In July 2007 he pled guilty to material support to terrorism and was sentenced to 10 years in prison. Prosecutors said he trained in Ethiopia and supplied Christopher Paul with credit-card numbers stolen from his cell phone business to help fund their activities.

Christopher Paul

[140] "Columbus man indicted on terrorism charges by federal grand jury," Columbus Dispatch, modified on 17 April 2015, http://www.dispatch.com/content/stories/local/2015/04/16/columbus-man-terrorism-indictment.html

Christopher Paul is a native of Worthington who attended training camps in Pakistan and Afghanistan. Around 1991 he joined al-Qaida and was selected for advanced training. Paul returned to the United States and conducted his own trainings in Burr Oak State Park with other co-conspirators. During the investigation of Paul, authorities discovered contact information for al-Qaida leaders and associates and materials on how to make explosive devices. Paul pled guilty to conspiring with others to use a weapon of mass destruction, namely explosive devices, against targets in Europe and the United States. He was sentenced to 20 years in prison.[141]

Paul was the last of the three Columbus associates to be convicted and sentenced for terrorist plots against the United States. Mahjir Sherif, Abdi's attorney, said in a Columbus Dispatch article in 2007 that the three men were part of a larger group of nine or ten men, several of whom have left the country. All three of these men were radicalized at a mosque in Franklin County and had ties to The Ohio State University.

Franklin County currently operates two separate Joint Terrorism Task Forces (JTTF). One task force deals solely with issues related to the Horn of Africa, while the other focuses on all other terrorism related issues. The task force dealing with the Horn of Africa was developed out of a need for close monitoring and careful attention to a growing population with the potential for radical behaviors in Central Ohio.

Domestic

Environmental Extremist Activity

Franklin County is not immune to environmental extremists. These groups use violence to end what they perceive as degradation of the environment. In the recent past, roughly 100 members of the group Earth First! deployed to the office of American Municipal Power (AMP) Ohio in Columbus. In protest of the construction of a new coal-fired power plant in Meigs County, members of this group demonstrated in the lobby while others locked themselves together with a home-made device known as "sleeping dragon," designed to make it difficult for law enforcement to separate them. During this protest, two members attempted to climb flagpoles in order to hang a protest banner but were stopped by an AMP Ohio employee. Eight members were arrested.[142]

The Ohio State University

The Ohio State University home football games are held at Ohio Stadium. This venue is seen as one of the largest vulnerabilities in the state as there are over 105,000 fans in attendance on any given game day and an additional 40,000 fans within close proximity of the stadium.

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141 "20 year, scolding for local terrorist," Columbus Dispatch, last modified on 27 February 2009, http://www.dispatch.com/content/stories/local/2009/02/27/cpaul.ART_ART_02-27-09_A1_GPD282T.html

142 "Utility protest ends in arrests," Columbus Dispatch, last modified on 7 July 2008, http://www.dispatch.com/live/content/local_news/stories/2008/07/07/protest.html?sid=101

Subscribing to the National Incident Management System (NIMS) model, the Homeland Security contingency for OSU football is made up of many different elements. The team consists of members from the Ohio State University Police Division, the Columbus Division of Police, the Ohio Highway Patrol, the FBI JTTF, the US Army 52nd Civil Support Division, the Columbus Division of Fire, the Ohio State University Environmental Health and Safety, the Ohio State University Department of Public Safety and the Department of Homeland Security.

This program has been viewed as a model program by federal, state, and other university agencies. OSU DPS recently completed a best-practices video that will be used to train other agencies on large-venue event management.

Vulnerability Assessment – CBRNE Terrorist Incidents

This hazard is considered to be a "Relatively Low Probability Event" meaning there is some indication that an act of sabotage, terrorism or criminal intent (foreign or domestic, external or internal) directed against similar targets within the United States. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability

Franklin County is at risk of a CBRNE Terrorist Incident event as is the entire country. As has been seen in past events, damage can be extensive and varied. Many times, structures are involved in this type of attack; however, this type of hazard is very unpredictable and Franklin County does not have any historical data referring to structural damage due to a CBRNE Terrorist incident. For this vulnerability assessment, the worst-case scenario of a 10 kiloton (KT) nuclear detonation in downtown Columbus was used.

Potential Impact of CBRNE Terrorist Incident

The impact of a CBRNE Terrorist Incident could be major and have a long-lasting effect. It would cause a significant loss of life and major structural loss.

Identifying Structures

According to FEMA, the effects of a 10 KT surface blast would damage structures up to 1.5 miles away.

Exposure of Existing Buildings to Damages Due to CBRNE Terrorist Incident

The following is the expected exposure to a 10 KT blast according to FEMA.

0.5 miles	Total destruction
0.9 miles	Total destruction to residential structures and major damage to commercial structures.
1.1 miles	Severe damage to residential structures and moderate damage to commercial structures.
1.5 miles	Moderate damage to residential structures and light damage to commercial structures.[143]

Exposure of Future Buildings to Damages Due to CBRNE Terrorist Incident

The exposure to future buildings would be the same as for existing buildings.

Estimating Potential Loss

Methodology

Franklin County Emergency Management and Homeland Security provided information through their GIS representative. The following is from the data received from this report.

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143 "Nuclear Threat," FEMA, accessed on 13 October 2015, http://training.fema.gov/emiweb/downloads/is3unit4.pdf

For this report we used the intersection of High Street and Broad Street as ground zero. Building numbers and valuation apply to this area.

According to the Franklin County GIS report there are 525 structures within the 0.5 range with a value of $871,252,300. 1,985 structures within the 0.9 range with a value of $1,169,407,100. 4,089 structures within the 1.1 range with a value of $1,443,955,600 and 11,480 structures within the 1.5 range with a value of $2,100,047,100.

There are 568,157 structures in Franklin County. 1005 would be considered Critical Facilities which is .17%.

Estimated Potential Dollar Losses

0.5 mile 100% loss 525 structures at	$871,252,300
0.9 miles 75% loss 1489 structures at	$877,055,325
1.1 miles 50% loss 2,045 structures at	$721,977,800
1.5 miles 25% loss 2,870 structures at	$525,011,775
Total structure loss 6,929 structures with a value of	$2,995,297,200

Twelve of these structures would be considered critical facilities at a potential value of $5,187,410.

$2,995,297,200 (Total structure loss)/ $6,929 (Total number of damaged structures) = 432,284 X 12 = $5,187,410

** Note: Residential and commercial housing structure figures were obtained from* *http://quickfacts.census.gov/qfd/states/39/39049.html*

The damage in dollars represented in this vulnerability statement only quantify the damage to structures and does not reflect ancillary costs associated with this hazard.

Severe Winter Weather: Snow, Ice, Extreme Cold - #9

Hazard Summary

Severe winter weather is classified as snow, ice and extremely cold conditions. Winter storms are events in which the dominant forms of precipitation occur only at cold temperatures.[144] According to the NOAA National Climatic Data Center's Storm Events Database, there were reports of 94 winter weather events for Franklin County from January 1996 to December 2017.[145] This hazard was ranked 9 out of 20.

This is a county-wide hazard that can affect all areas and jurisdictions of the county.

[144] "Reference Terms," Science Daily, accessed on 28 February 2018, http://www.sciencedaily.com/terms/winter_storm.htm

[145] "Query Results; Blizzard, Cold/Wind Chill, Extreme Cold/Wind Chill, Heavy Snow, Ice Storm, Winter Storm, Winter Weather; Franklin County, Ohio," NCDC – NOAA, accessed on 28 February 2018, http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=39%2COHIO

Hazard Profile

A winter storm is an event in which the dominant varieties of precipitation are forms that only occur at cold temperatures.[146] Every year, winter weather kills hundreds of people in the U.S., primarily from automobile accidents, overexertion, and exposure. Winter storms are often accompanied by strong winds, creating blizzard conditions with blinding wind-driven snow, drifting snow, extreme-cold temperatures and dangerous wind chill. Heavy accumulations of ice can bring down trees and power lines, disabling electric power and communications for days or weeks. Heavy snow can immobilize a region and paralyze a city. The economic impact of winter weather each year is substantial, with costs for snow removal, damage and loss of business in the millions.

Winter Storm - Buckeye Lake, Ohio **02/14/2007**

Photographer's description not available

Photographer	James Kurtz
Date taken	February 14, 2007
Location	Buckeye Lake, OH (Licking County) map
Event	Winter storm

Additional notes

A significant winter storm on February 13, 2007 dropped several inches of snow on central Ohio, then glazed everything over with up to a half inch of ice as warmer air moved in aloft.

Source: NWS, Wilmington Ohio

<u>Winter Storm Formation</u>

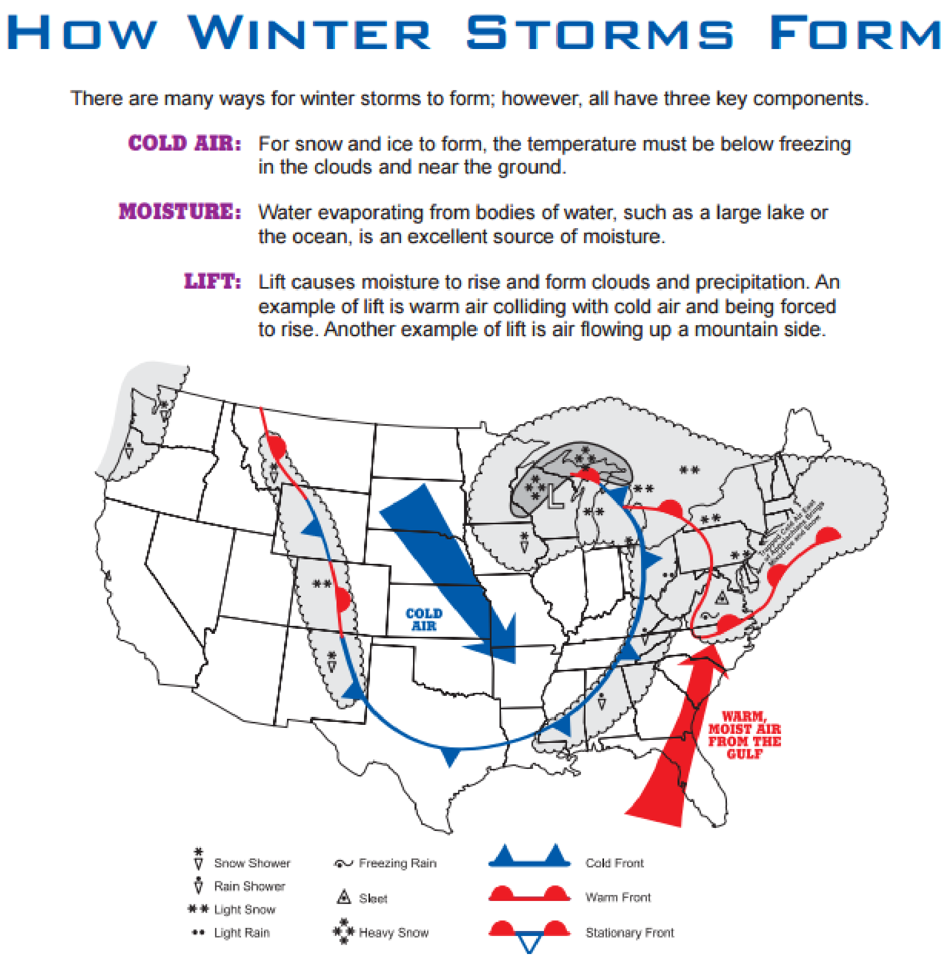
Just like any other storm, the right set of circumstances is necessary for a winter storm to develop. The three necessary ingredients are:

- *Cold air* – Below-freezing temperatures (<32°F) above the surface are necessary to make snow and/or ice. If temperatures rise well-above freezing near the surface, ice and snow will melt and precipitation will fall as rain.
- *Lift* – A mechanism to elevate the moist air. As air rises, it cools and condenses to form clouds (liquid/ice). Once the particles become too heavy to stay elevated, they fall as precipitation. Lifting mechanisms include a cold front or air flowing up a mountainside.
- *Moisture* – Water vapor is needed to form precipitation in an air mass. A major source is air blowing across a body of water. A large lake or the ocean is an excellent source of moisture.

[146] "Reference Terms," Science Daily, accessed on 1 Nov 2015, http://www.sciencedaily.com/terms/winter_storm.htm

The intensity of a storm depends upon several conditions, such as the strength and positioning of the jet stream and associated upper air disturbances, the related strength of the horizontal temperature gradients, and the availability of moisture. If cold temperatures are in place and a significant amount of moisture is pumped into a storm system, the result could be a major winter storm.

Winter storms have various components including low pressure centers, warm fronts, and cold fronts. In the continental United States, winter storms are common from November through April, and sometimes as early as October or as late as May.
The winter dip in the jet stream allows polar air to surge south. This cold, dry air brings with it temperatures cold enough for snow, sleet, or freezing rain. Warm tropical air from the Gulf of Mexico often continues to flow up from the south during the winter months. When this warm, moist air mass from the south meets the cold, dry air from the north, winter storms can result.

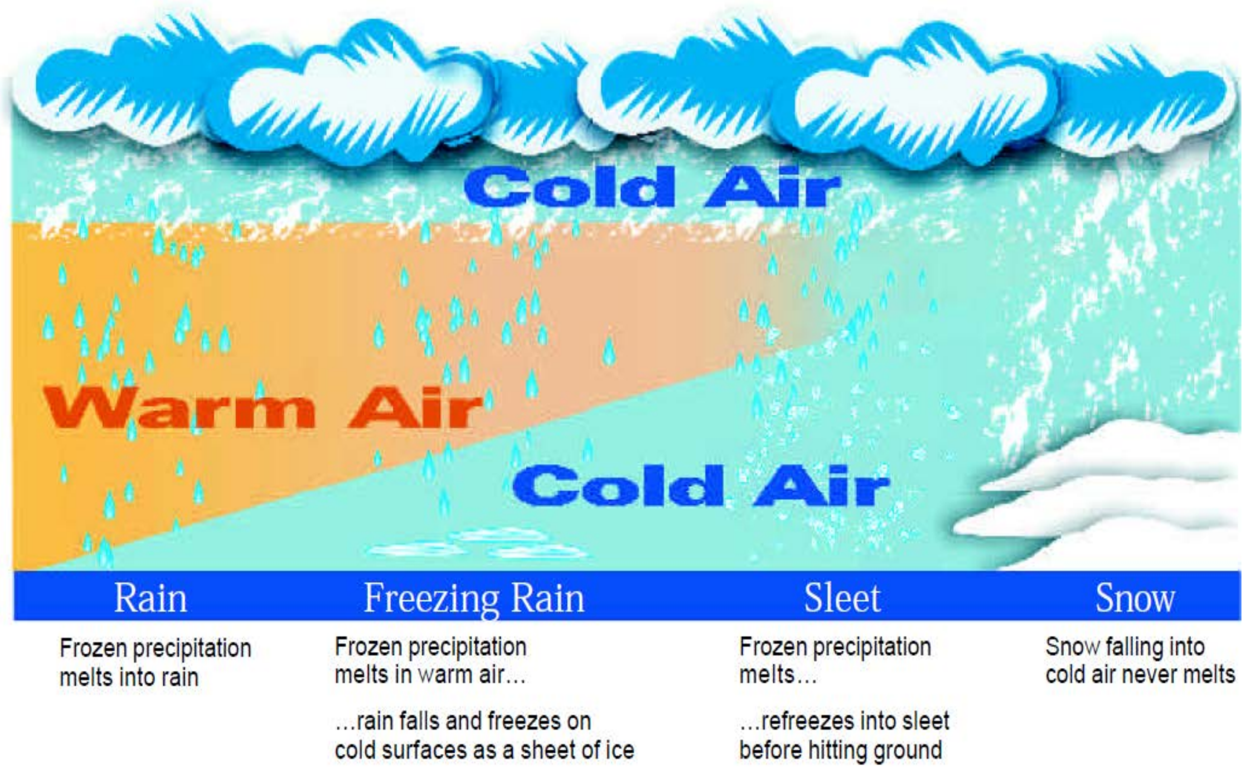


Source: NOAA[147]

Types of Winter Precipitation

[147] "Winter Storms: Deceptive Killers," NOAA – NWS, last modified in 2008, http://www.nws.noaa.gov/om/winter/resources/Winter_Storms2008.pdf

Precipitation type is defined by the mode (snow/ice/rain) of particles near the ground. The way precipitation is classified depends on: (1) the temperature of the layer of air between the clouds and the surface and (2) the temperature of the ground. A breakdown of precipitation by type is outlined below.



Source: NOAA[148]

Rain – Wintertime rain is generally produced by nimbostratus or stratus clouds. All precipitation starts out as ice or snow crystals at cloud level. When this frozen precipitation falls into a layer of sufficiently warmer air (with temperatures above freezing), it melts into rain. If this warm air extends all the way to the surface of the earth, rain will be the observed precipitation type.

Freezing Rain – Rain droplets that fall into a shallow layer of cold air near the earth's surface can freeze upon contact with the ground, leaving a coating of glaze. This is known as freezing rain. Freezing rain occurs most often when mild, moist air moves over a cold polar or arctic air mass near the earth's surface. Lower elevations are often vulnerable to ice storms – significant and damaging accumulations of ice – because cold, dense air will naturally settle into lower elevations.
Freezing rain causes dangerous weather conditions. Rain can freeze on anything it contacts, including roads, bridges and overpasses, which typically freeze quicker than other surfaces,

[148] "Winter Storms: Deceptive Killers," NOAA – NWS, last modified in 2008, http://www.nws.noaa.gov/om/winter/resources/Winter_Storms2008.pdf

creating hazardous conditions for drivers. Power outages are also common in an ice storm. The weight of ice caused by freezing rain often brings down power lines and tree limbs.

Sleet: Often confused with freezing rain or hail, sleet is caused by a deep layer of cold air near the ground. After falling through a layer of warm air and melting, water droplets refreeze through a deep layer of cold air to form ice pellets. Freezing rain falls as liquid and refreezes on the surface while sleet falls as ice pellets.

Hail and sleet both form through refreezing of liquid water, but hail occurs in thunderstorms with warm surface temperatures while sleet occurs in winter with cold surface temperatures.

Snow – Snow is frozen precipitation in the form of a six-sided ice crystal. Snow requires temperatures to be below freezing in all or most of the atmosphere from the surface to cloud level. Most precipitation that forms in wintertime clouds starts out as ice crystals because the top layer of the storm is usually cold enough to create them. Snowflakes are collections of ice crystals that cling to each other as they fall toward the ground. Precipitation continues to fall as snow when the temperature remains at or below 32^0F from the cloud base to the ground. On average, 10 inches of snow will melt into one inch of water, but ratios can vary widely based on the moisture and temperature of the air mass.

Heavy Snow - Kettering, Ohio **03/08/2008**

Photographer's Description: County Line Road at Patterson Road

Photographer	Ken LeBlanc
Date taken	March 8, 2008
Location	Kettering, OH (Montgomery County) map
Event	Heavy snow

Additional notes

A major late winter snowstorm dropped 12 to 20 inches of snow across much of the region March 7 and 8, 2008. Combined with 20-30 mph winds, substantial blowing and drifting occurred, with drifts up to 4 feet. Countless schools and businesses closed, and about half of the counties in ILN's CWA went into a level 3 snow emergency.

This photo shows visibility near a quarter of a mile, which classifies the snowfall as heavy snow.

Source: NWS, Wilmington Ohio

- Snow Flurries – Light snow falling for short durations. No accumulation or light dusting is all that is expected.
- Snow Showers – Snow falling at varying intensities for brief periods of time. Some accumulation possible.
- Snow Squalls – Brief, intense snow showers accompanied by strong, gusty winds. Accumulation may be significant. Snow squalls are best known in the Great Lakes Region.

- Blowing Snow – Wind-driven snow that reduces visibility and causes significant drifting. Blowing snow may be snow that is falling and/or loose snow on the ground picked up by the wind.
- Blizzard – Winds over 35 mph with snow and blowing snow, reducing visibility to ¼ mile or less for at least 3 hours.
- Sleet – Occurs when snowflakes only partially melt when they fall through a shallow layer of warm air. These slushy drops refreeze as they next fall through a deep layer of freezing air above the surface, and eventually reach the ground as frozen raindrops that bounce on impact. Sleet can accumulate like snow and cause a hazard to motorists.

Types of Winter Storms

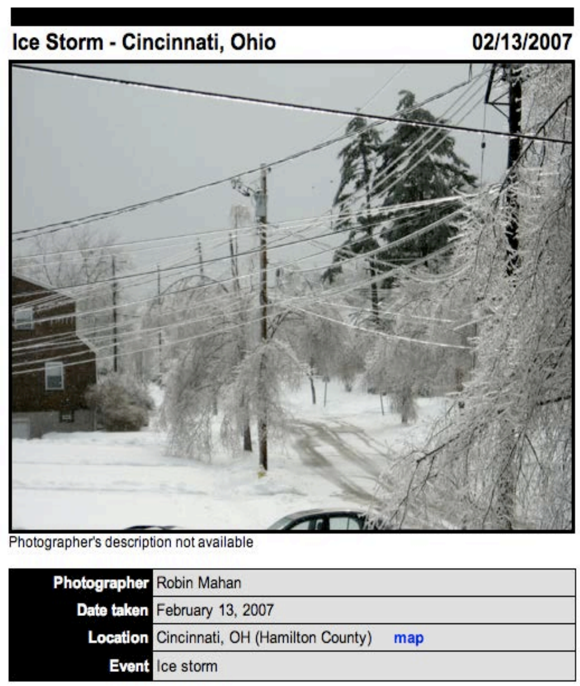
Wherever they occur, classic winter storms can differ in their characteristics, intensities, and paths. Some storms can be characterized specifically.

<u>Blizzards</u>

A severe weather condition characterized by high winds and reduced visibilities due to falling or blowing snow. The National Weather Service specifies sustained wind or frequent gusts of 35 miles per hour or greater, accompanied by falling and/or blowing snow, frequently reducing visibility to less than 0.25 miles for 3 hours or longer. Earlier definitions also included a condition of low temperatures, on the order of 20°F or lower, or 10°F or lower (severe blizzard).[149]

<u>Ice Storms</u>

An ice storm is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually accumulations of ¼" or greater.[150] Ice can disrupt communications and power for days while utility companies repair extensive damage.



Source: NWS Wilmington

<u>Lake Effect Storms</u>

Lake effect snow storms occur when a mass of sufficiently cold air moves over a large body of warmer water. As warm, moist air rises it condenses to form liquid and cools to form ice

[149] "Blizzard," American Meteorological Society Glossary of Meteorology, last modified on 20 January 2014, http://glossary.ametsoc.org/wiki/Blizzard

[150] "Glossary," NOAA, accessed on 1 Nov 2015, http://w1.weather.gov/glossary/index.php?letter=i

particles. As a result, clouds build up over the lake and eventually develop into snow showers and squalls as they move downwind. The intensity of lake effect snow is increased when higher elevations downwind of the lake force the cold, snow-producing air to rise even further. The amount of snow resulting from lake effect storms depends on the fetch, or the distance a cold, dry air mass travels over a warm, moist body of water.

<u>Nor'easter</u>

Nor'easters are among winter's most ferocious storms. A Nor'easter gets its name from its continuously strong northeasterly winds blowing in from the ocean ahead of the storm and over coastal areas. They are strong areas of low pressure that often form either in the Gulf of Mexico or off the East Coast in the Atlantic Ocean. Nor'easters are notorious for producing heavy snow, rain and oversized waves that crash onto Atlantic beaches, often causing beach erosion and structural damage. Wind gusts associated with these storms can exceed hurricane force.

Other Severe Winter Weather Events

<u>Extreme Cold</u>

Extreme cold often accompanies a winter storm and often remains after the storm has passed. What constitutes extreme cold varies across different areas of the U.S. In areas unaccustomed to winter weather, near freezing temperatures are considered "extreme cold." Freezing temperatures can cause severe damage to citrus fruit crops and other vegetation. Pipes may freeze and burst in homes that are poorly insulated or without heat. In the north, below-zero temperatures may be considered extreme cold. Extreme cold is a dangerous situation that can cause health issues in susceptible people, such as those without shelter or who are stranded, or those who live in a poorly insulated home or one with no heat.[151]

The wind chill is the temperature your body feels when the air temperature is combined with the wind speed. It is based on the rate of heat loss from exposed skin caused by the effects of wind and cold. As the speed of the wind increases, it can carry heat away from the body much more quickly, causing skin temperature to drop. Animals are also affected by wind chill; however, cars, plants and other

WINDCHILL CHART *(NOAA)*

Wind (mph)	Temperature (#F)																	
	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40
60	-98	-91	-84	-76	-69	-62	-55	-48	-40	-33	-26	-19	-11	-4	3	10	17	25
55	-97	-89	-82	-75	-68	-61	-54	-46	-39	-32	-25	-18	-11	-3	4	11	18	25
50	-95	-88	-81	-74	-67	-60	-52	-45	-38	-31	-24	-17	-10	-3	4	12	19	26
45	-93	-86	-79	-72	-65	-58	-51	-44	-37	-30	-23	-16	-9	-2	5	12	19	26
40	-91	-84	-78	-71	-64	-57	-50	-43	-36	-29	-22	-15	-8	-1	6	13	20	27
35	-89	-82	-76	-69	-62	-55	-48	-41	-34	-27	-21	-14	-7	0	7	14	21	28
30	-87	-80	-73	-67	-60	-53	-46	-39	-33	-26	-19	-12	-5	1	8	15	22	28
25	-84	-78	-71	-64	-58	-51	-44	-37	-31	-24	-17	-11	-4	3	9	16	23	29
20	-81	-74	-69	-61	-55	-48	-42	-35	-29	-22	-15	-9	-2	4	11	17	24	30
15	-77	-71	-64	-58	-51	-45	-39	-32	-26	-19	-13	-7	0	6	13	19	25	32
10	-72	-66	-59	-53	-47	-41	-35	-28	-22	-16	-10	-4	3	9	15	21	27	34
5	-63	-57	-52	-46	-40	-34	-28	-22	-16	-11	-5	1	7	13	19	25	31	36

Frostbite Times:		
5 Minutes	10 Minutes	30 Minutes

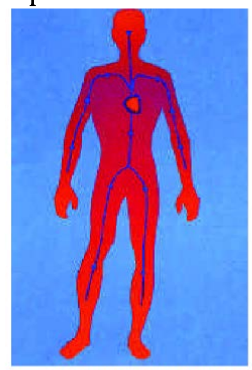
[151] "Extreme Cold," CDC, accessed on 18 September 2015, http://www.bt.cdc.gov/disasters/winter/pdf/extreme-cold-guide.pdf

objects are not. The wind chill chart shows the difference between the actual air temperature and perceived temperature, and amount of time until frostbite occurs.

Exposure to cold can cause frostbite or hypothermia and become life-threatening. Infants and the elderly are the most susceptible.

Frostbite is damage to body tissues caused by extreme cold. A wind chill of -20^{0}F will cause frostbite in just 30 minutes. Frostbite causes a loss of feeling and a white or pale appearance in extremities, such as fingers, toes, ear lobes or the tip of the nose. Medical help is immediately required.

Hypothermia occurs when the extremities are excessively cold (blue)



Improperly warming the body will drive cold blood from the extremities to the heart, leading to heart failure

Hypothermia is a condition brought on when the body temperature drops to less than 95^{0}F. It can kill. For those who survive, there are likely to be lasting kidney, liver and pancreas problems. Warning signs include uncontrollable shivering, memory loss, disorientation, incoherence, slurred speech, drowsiness and apparent exhaustion. Medical attention is needed immediately.

<u>Winter Flooding</u>

Winter storms can also generate flooding including:

- Coastal Floods: Winds generated from intense winter storms can cause widespread tidal flooding and severe beach erosion along coastal areas.
- Ice Jams: Long cold spells can cause rivers and lakes to freeze. A rise in the water level or a thaw breaks the ice into large chunks that become jammed at man-made and natural obstructions. Ice jams can act as a dam, resulting in severe flooding.
- Snowmelt: Sudden thaw of heavy snowpack often leads to flooding.

Detecting and Forecasting Winter Weather

From the ground, a winter storm just looks like a cloudy, gray day. However, winter storms are usually easily detected by satellite, and areas of precipitation are visible on radar. Unlike thunderstorms, we can usually tell well in advance that a winter storm will be coming.

A useful tool in winter weather forecasting and determining cloud patterns and movement of winter storms is satellite imagery. Satellite imagery can be very helpful when used by forecasters to monitor rapidly developing winter storms off the east and west coasts of the U.S. By looping a series of satellite pictures, forecasters can monitor a storm's development and its movement with greater accuracy.

Using satellite evidence, meteorologists look for jet streaks and dry slots, areas of greatest spin, shear zones, areas of sinking air and cold cloud tops, among others. Comma clouds are a little easier seen on satellite by the untrained eye and can be associated with winter storms.

Radar is particularly successful in tracking the motion of precipitation, allowing forecasters to make accurate short-term forecasts of when and where winter storms will strike. Radar can give clues as to what type of precipitation is falling. Sleet shows up well on radar because it is a solid ball of ice. Sometimes it can be mistaken for heavy snow. Extremely light snow can go undetected because snowflakes have lower moisture and higher air content than other types of precipitation. Forecasters must combine both surface observations and information from Doppler radar to determine where and how fast the snow is falling and accumulating.

Another way weather data is gathered is by weather observation balloons launched from selected NWS observation sites. Weather balloons record air pressure, wind flow, moisture, dew point and temperature at various levels within the atmosphere from the ground to above the jet stream. Forecasters track winter storms in much the same way they track any other type of weather. However, because the heaviest snow usually falls on the north, northwest or northeast side of most winter storms, the forecaster must know where and how quickly the storm is moving to know what area will get the heaviest snow. The forecaster must also know where the rain, snow, or icy areas are and how they might change over time. Analyzing current conditions and identifying areas of low pressure, wind flow patterns, surface temperatures and dew points help forecasters answer those questions.

Winter Weather Products

Winter Storm Warning: Issued when hazardous winter weather in the form of heavy snow, heavy freezing rain, or heavy sleet is imminent or occurring. Usually issued 12-24 hours before event is expected to begin.

Winter Storm Watch: Alerts public to possibility of a blizzard, heavy snow, heavy freezing rain, or heavy sleet. Winter Storm Watches are usually issued 12 to 48 hours before the beginning of a Winter Storm.

Winter Storm Outlook: Issued prior to a Winter Storm Watch. The Outlook is given when forecasters believe winter storm conditions are possible and are usually issued 3 to 5 days in advance of a winter storm.

Blizzard Warning: Issued for sustained or gusty winds of 35 mph or more, and falling or blowing snow creating visibilities at or below ¼ mile; these conditions should persist for at least three hours.

Lake Effect Snow Warning: Issued when heavy lake effect snow is imminent or occurring.
Lake Effect Snow Advisory: Issued when accumulation of lake effect snow will cause significant inconvenience.

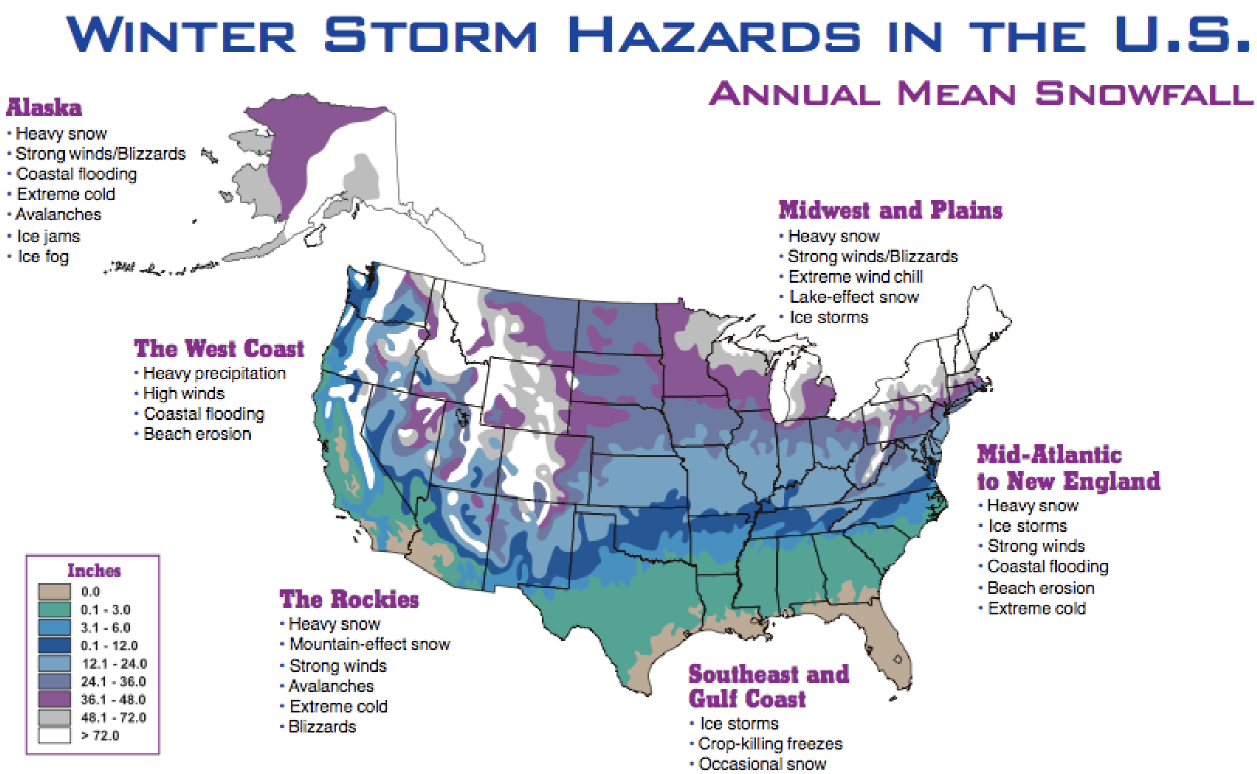
Wind Chill Warning: Issued when wind chill temperatures are expected to be hazardous to life within several minutes of exposure.

Wind Chill Advisory: Issued when wind chill temperatures are expected to be a significant inconvenience to life with prolonged exposure and, if caution is not exercised, could lead to hazardous exposure.

Winter Weather Advisory: Issued for accumulations of snow, freezing rain, freezing drizzle, and sleet which will cause significant inconveniences and, if caution is not exercised, could lead to life-threatening situations.

Severe Winter Weather in the United States

Winter storms can affect all areas of the United States, including the Deep South and the Desert Southwest. They also come in various sizes and are created by different combinations of atmospheric conditions and local geography.



Source: Winter Storms – The Deceptive Killers, NOAA

Winter storms vary greatly across the United States. In the Mid-Atlantic Coast and New England region, Nor'easters are common. Storms tap moisture from the Atlantic and dump heavy snow over the densely populated area. Ice storms are also a problem in this region. The area along the Gulf Coast and Southeast is generally unaccustomed to snow, ice, and freezing temperatures. Once in a while, cold air will penetrate the region, killing tender vegetation and damaging citrus crops. People in this region are not accustomed to driving on slick roads, and accidents increase.

The Midwest and Plains states experience severe winter weather, including heavy snow and sometimes blizzards, as well as extremely low wind chill temperatures. The Midwest is also subject to lake-effect snow around the Great Lakes.

Strong storms off the north Pacific sometimes slam into the coast from California to Washington. If cold enough, snow falls over Washington and Oregon and sometimes in northern California. Strong winds through canyons or over ridges can reach 100 mph and combine with the snow to cause blizzards.

Source: U.S. Global Change Research Program

In Alaska, intense storms crossing the Bering Sea can produce coastal flooding and drive large chunks of ice inland, causing damage to buildings and shoreline. Alaska's Arctic coast experiences blinding blizzards and wind chill temperatures to -90^{0}F. Extreme cold and ice fog may last a week at a time. Snow accumulates through the winter months, and if thawed too quickly, flooding occurs.

Severe Winter Weather in Ohio

Severe winter weather in Ohio consists of below freezing temperatures and heavy precipitation, usually in the form of snow, freezing rain or sleet. All parts of Ohio experience severe winter weather. Ohio residents are accustomed to winter storms; however, occasionally a severe event can be very disruptive. Heavy snow volumes make removal difficult and costly. Ice storms can be extremely damaging, causing telecommunications and power outages that last for days.

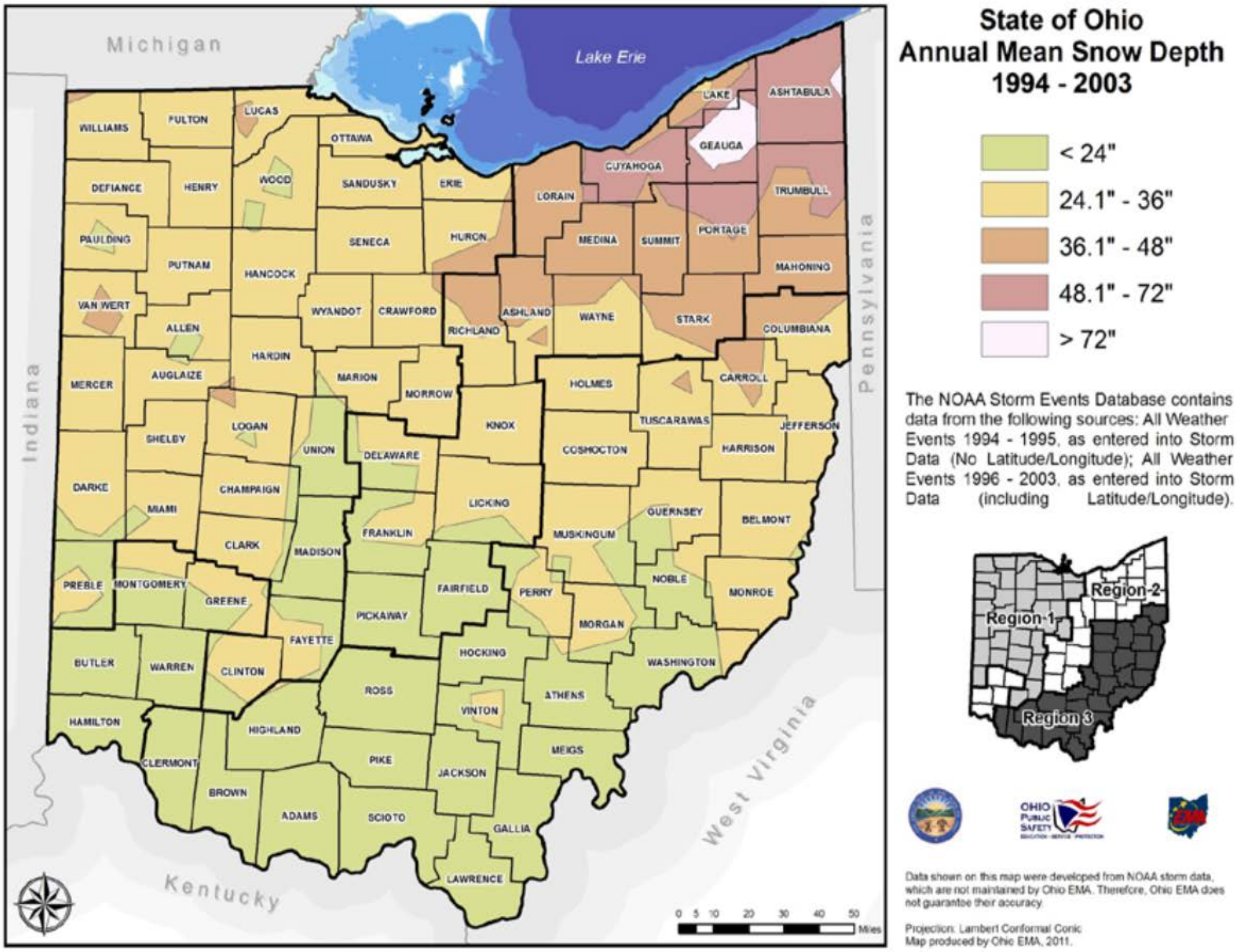
Northeastern Ohio near the Great Lakes experiences lake-effect snow. The worst of these storms are generally during late autumn/early winter. Lake-effect snowfall can vary greatly, with areas of deep snowfall adjacent to areas with relatively little snow.

The Ohio Emergency Management Agency mapped the annual mean snowfall depth for Ohio from 1961 to 2003. (See map below.) The map divides the State into three regions.

Most of the counties in Region 1 experienced a mid-level of snow during these years. Higher snow levels were experienced in sparse areas of Lucas, Van Wert, Auglaize, Logan, and Hardin counties.

Region 2 contains all the counties that have experienced the highest annual mean snow depth. Parts of Geauga and Ashtabula counties have had the highest levels in the state.

Region 3 counties have had moderate snow depth. The upper section of this region has higher snow levels than the lower part of the region. The counties with the lowest snow depths in the state are in the lower part of Region 3.



Source: State of Ohio Hazard Mitigation Plan, OEMA

Historic Winter Events

Ohio experienced more than 280 severe winter storms between 1925 and 2014.[152] Several were considered notable storms:

November 23-27, 1950: The Thanksgiving snowstorm of 1950 left at least 10 inches of snow over the entire state, with the counties in the eastern half of Ohio receiving 20 to 30 inches of snow. Winds increased to over 40 mph, and a severe cold wave swept the state, dropping temperatures to near zero. Eastern Ohio had snow drifts 25 feet deep. Bulldozers were used to clear roads for emergency vehicles. Many buildings collapsed under the weight of 2 to 3 feet of snow.

January 26, 1978: The storm of January 26, 1978, was a rare and dangerous storm. It was declared a severe blizzard by the NWS. Winds gusted to more than 100 mph over much of the state, with sustained winds in the 50 to 70 mph range. Enormous snowdrifts covered cars and houses, blocked highways and railways, and closed all airports for two days.

February 1994: Heavy freezing rain and sleet fell across southern and central Ohio counties. Ice accumulations averaged 0.75 to 2 inches, leading to downed trees and power lines. Very low temperatures slowed ice removal. Six vehicular fatalities and one death due to exposure occurred.

March 7-8, 2008: Though technically not a blizzard, this storm was a record-setting event. The storm dumped 20.4 inches of snow on Columbus, breaking the city's previous record of 15.3 inches, set in 1910. Cincinnati and Cleveland also received about a foot of snow. At the peak of the storm, approximately two-thirds of Ohio's counties had declared Level Two or Level Three Snow Emergencies, restricting automobile travel.

Severe Winter Weather in Franklin County

The National Climactic Data Center reports 94 winter weather events for Franklin County from January 1996 to December 2017, with four injuries and $1.38 million in damages.[153]

Franklin County has been affected by many widespread snowstorms.

January 25 - January 27, 1978: the Ohio Valley was struck by a major blizzard which is also known as the White Hurricane. The blizzard was the worst in Ohio history where 51 people died as a result of the storm.[154]

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[152] "State of Ohio Enhanced Hazard Mitigation Plan," Ohio Emergency Management Agency, http://ohiosharpp.ema.state.oh.us/ohiosharpp/Documents/OhioMitigationPlan/2014/Section_24_WinterStorm.pdf

[153] "Query Results; Blizzard, Cold/Wind Chill, Extreme Cold/Wind Chill, Heavy Snow, Ice Storm, Winter Storm, Winter Weather; Franklin County, Ohio," NCDC – NOAA, accessed on 1 February 2018, http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=39%2COHIO

[154] "1978 Ohio Statewide Blizzard," Ohio History Connection, accessed on 16 Jan 2016, http://www.ohiohistorycentral.org/w/1978_Ohio_Statewide_Blizzard?rec=1649

The following are portions of a news article printed in the Columbus Dispatch on Thursday January 26, 1978. The complete article can be accessed at:
http://www.dispatch.com/content/stories/local/2008/01/25/bliz_day_story.html

About 3 a.m. a blizzard roared through the Franklin County area with winds that gusted up to 65 miles per hour. The winds blew drifting snow across highways glazed with about an inch of ice resulting from rains Wednesday evening, when the temperatures were in the mid-30s.
The storm left thousands of Ohioans without electric power and heat and many more were stranded on dangerous roadways to fend for themselves.

Schools and businesses closed and Mayor Tom Moody told citizens to stay home as he operated in a nearly empty city hall fighting that structure's power problems.

Emergency situation in Columbus by 7 a.m. included:

- All Columbus, state and county offices closed with the exception of people involved in 24-hour emergency services.
- COTA buses not operating because buses, parked outside, were iced over and doors were frozen shut.
- Firefighters had difficulty opening automatic doors so vehicles could leave.
- All schools were closed.
- A major power failure downtown knocked out lights and some radio stations for a while.
- Many businesses closed.
- Almost 30,000 customers were without electricity at 7:30 a.m., and some had been for up to six hours.
- Residents were urged not to use telephones except for emergencies.
- Residents also were asked to call police or fire department only in emergency situations.
- Airlines had canceled morning flights but the runways at Port Columbus were described as in "reasonably good shape."
- Customers without electricity who have gas furnaces were advised to turn thermostats down to prevent a massive surge of electricity when the power was restored.
- The Columbus Fire Department held over its entire shift at 8 a.m. essentially running a double shift to handle emergencies. Almost every vehicle in the city was out between 3 and 6 a.m.
- The entire Municipal Court system was closed down.
- Gov. Rhodes declared a state of emergency across the state at 8 a.m. "This is the worst storm ... blizzard ... we've ever had statewide," the governor said.

Electrical power was knocked out in some 14 areas of Franklin County, including a large section of the Downtown area west of 3rd Street.

March 7-8, 2008: A storm dumped more than 20 inches of snow on Columbus. Blizzard-like conditions shut down highways and stranded air travelers. At Port Columbus International Airport, a plane skidded a few hundred feet off a runway while landing. Many flights in and out of Columbus were delayed or canceled. Luckily, the storm struck over the weekend, which helped minimize closures and disruptions. This storm resulted in a Presidential Disaster Declaration for Franklin County.

The following are examples of severe winter weather events as reported from the National Climate Data Center. More information is available at the following site: http://goo.gl/OynwfN.

Example Event Summaries as provided by NCDC

Event Details

Event	Winter Storm
State	OHIO
County/Area	FRANKLIN
WFO	ILN
NCDC Data Source	PDC
Begin Date	1996-01-06 15:00:00.0 EST
End Date	1996-01-08 02:00:00.0 EST
Deaths Direct/Indirect	0/0 (fatality details below, when available...)
Injuries Direct/Indirect	0/0
Property Damage	.5M
Crop Damage	
Episode Narrative	The Blizzard of '96 developed near the Gulf Coast and moved up the East Coast. This massive system produced the greatest total and 24 hour snowfall at Greater Cincinnati\Northern Kentucky airport. This one storm brought 14.3 inches of snowfall to the airport which normally receives 23 inches for an entire season. The heaviest snow fell near the Ohio river in the extreme south. The worst blizzard conditions occurred over West Central areas as dry and powdery snow was blown around by high winds causing whiteouts. Some areas had more than 30 continuous hours of snowfall, and many people in Southern Ohio felt this was the worst winter storm since the Blizzard of '78. In Fayette county, the airport reported a wind gust to 56 mph during the height of the storm. By the end of the storm many homes and businesses had their roof collapse or partially collapse from the weight of the new snow, and snow from a storm earlier in the week. By late in the day on the 7th arctic air was pouring into the region. A 47 year old man died of exposure under an overpass in Miami county. A 76 year old man died of exposure on his front porch in Montgomery county.

Event Details

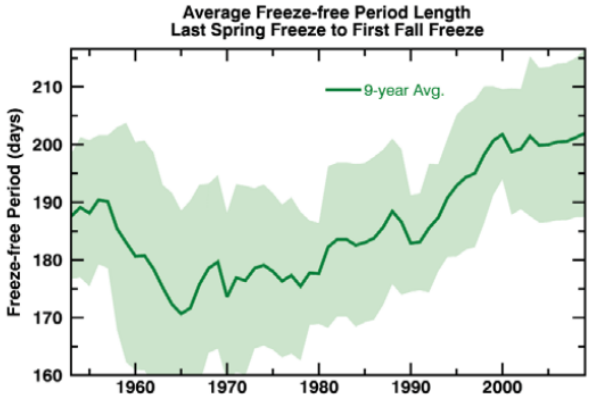
Event	Winter Weather
State	OHIO
County/Area	FRANKLIN
WFO	ILN
Report Source	Broadcast Media
NCDC Data Source	CSV
Begin Date	2013-01-21 10:00:00.0 EST-5
End Date	2013-01-21 18:00:00.0 EST-5
Deaths Direct/Indirect	0/0 (fatality details below, when available...)
Injuries Direct/Indirect	4/0
Property Damage	700.00K
Crop Damage	
Episode Narrative	A highly unstable airmass produced deep convective snow showers that produced snow squalls during the late morning into the afternoon. These isolated squalls caused whiteout conditions on area roadways. Three major pileups and one minor pileup resulted in over 175 vehicle crashes on the interstate system, causing numerous injuries and one fatality.
Event Narrative	Snow squalls in the region caused whiteout conditions, resulting in a 29 car pileup in the southbound lanes of I-270 on the northeast side of Columbus. Four people were hospitalized as a result. Later in the afternoon, I-71 at the intersection of I-670 saw an accident involving two semi-trailers and other vehicles.

Climate Change Impacts

Winter storms have increased in frequency and intensity since the 1950s, and their tracks have shifted northward over the United States. Additional trends in storms are uncertain and are being studied intensively.[155]

Changing winter precipitation: With warmer temperatures rain may fall in place of snow, and mixed winter precipitation events, like freezing rain, may become more likely in some areas.

[155] 2014 National Climate Assessment, "U.S. Global Change Research Program," accessed on 4 September 2015, http://nca2014.globalchange.gov/downloads



The freeze-free season (growing season), lengthened by 25.5 days from 1951-2012. Both the average date of first freeze in the fall and last freeze in the winter changed by more than 10 days.

Left: The green line represents the 9-year moving average of length of the time between the last freeze of spring and the first freeze of fall, the freeze-free period. The shaded band represents the standard deviation.

Source: GLISA[156]

Vulnerability Assessment – Severe Winter Weather

**Note: all information in this vulnerability assessment can be attributed to the Franklin County 2012 Natural Hazards Mitigation Plan and National Climatic Data Center (NCDC) searches accessed via* [*http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=39%2COHIO*](http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=39%2COHIO)

This hazard is considered to be a "Relatively High Probability Event" meaning the anticipated frequency of the hazard within the County is expected to occur more than twice but no more than 5 times a year. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability

Vulnerability to the effects of winter storms is related to how prepared and accustomed an area is for this type of severe weather. Franklin County normally receives about 28 inches of snow a season, which varies from season to season, so residents are accustomed to this type of weather.

The impact of winter storms varies by different weather conditions such as blinding wind storms and dangerous wind chills. Strong winds can knock down trees, utility poles, and power lines. Extreme cold can cause frostbite or hypothermia and become life threatening for infants and the elderly. Freezing temperatures can cause pipes to freeze and ice jams may form in freezing and thawing rivers, resulting in flash flooding.

Winter storms can also bring heavy accumulations of ice which can down trees, electrical wires, telephone poles and lines, and communication towers. Utilities and communications can be impacted for several days. Heavy snowfall can immobilize a community and create economic impacts related to the cost of snow removal and loss of business. Most deaths related to severe winter weather result from traffic accidents on icy roads, heart attacks while shoveling snow, and hypothermia from prolonged exposure to the cold.

156 "Historical Climatology: Columbus, Ohio," GLISA

Vulnerability to the effects of winter storms on buildings is considered to be somewhat dependent on the age of a building because as building codes become more stringent, buildings are capable of supporting heavier loads and as buildings age, various factors may deteriorate their structural integrity. Vulnerability also depends upon the type of construction and the degree to which a structure has been maintained. Commercial buildings, warehouses, and municipal structures with large span roofs are also susceptible to a collapse under the weight of heavy snow or ice buildup.

Potential Impact of Severe Winter Weather

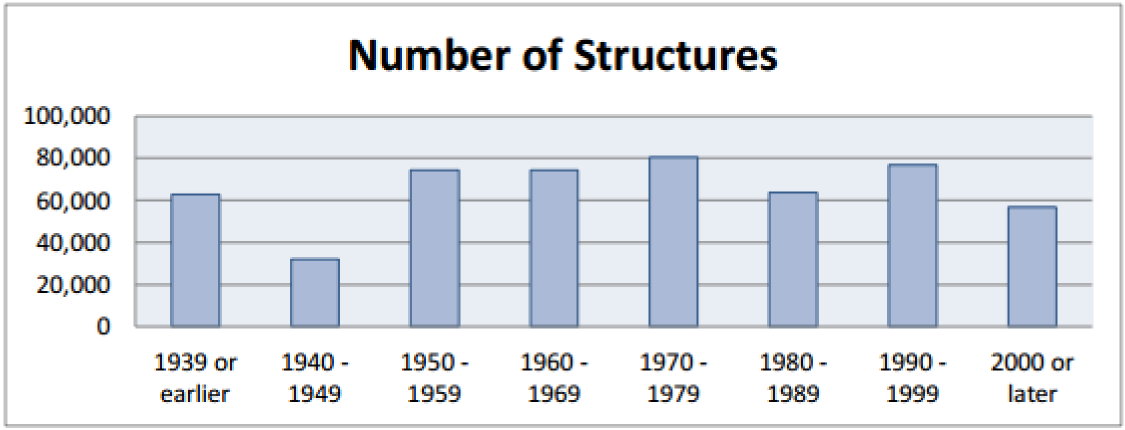
In Franklin County, accumulations of snow and/or ice during winter months are expected and normal. The most common detrimental effects of snow and/or ice are not collapsed structures but traffic accidents and interruptions in power supply and communications services.

As demonstrated by the ice storm in 2011, which accumulated over a half inch of ice and produced strong winds, hundreds of thousands lost power, including hundreds who were out of power for over a week. In a worst case scenario, a large ice storm that devastates the entire state and hits Franklin County the hardest with large ice buildups will cause downed trees and power lines. In this scenario, in the majority of communities many will be without power and completely shut down due to hazardous conditions. Power recovery will be delayed due to utility crews being spread over the state. This would leave sensitive populations at extreme risk and delay overall recovery. If a large snow event were to happen in this scenario, either before or after the ice storm, and the precipitation accumulation were to build up, then a large number of structures would be at risk of roof collapse. Because roof failure is dependent upon many factors, it is impossible to predict how many structures would be affected by an individual event. Age is one factor which can affect roof failure, and it is discussed in detail in the next section.

Identifying Structure Exposure of Existing Buildings to Severe Winter Weather

Structures identified as potentially vulnerable to damage from heavy snow or ice are those that are older than 50 years that may have deteriorated over time. Data is only available for housing units; therefore, only housing unit structures will be evaluated.

It is not necessarily the case that older structures are at greater risk of damage due to heavy snow or ice. 12.1% of structures in Franklin County were built before 1939, and approximately one third of the structures in the county are more than 50 years old. These structures have withstood many heavy snow and ice storms; nevertheless, because the National Trust for Historic Preservation identifies structures greater than 50 years old as being eligible for designation as historic, for this analysis the assumption is structures built before 1960 are at some risk of at least minor damage due to heavy snow and/or ice. There are a total of 520,870 housing unit structures in Franklin County. 169,283 of these structures were built before 1960, thus the percent of structures considered to be particularly vulnerable to damage due to heavy snow or ice is 32.5%. According to the Franklin County Threat and Hazard Identification and Risk Assessment (THIRA) report there are 1005 critical facilities in this same area. Using the same 32.5% there would be approximately 326 critical facilities. The graph below shows the number of structures built in Franklin County and illustrates the fact that a large number of structures in the County are more than 50 years old.



Numbers of Structures and When Built
To predict the structural cost associated with a worst-case scenario snow storm, it will be assumed that all structures older than 50 years will be damaged significantly. This analysis is based on the perception that building codes have become more stringent and that new buildings can withstand the 30 pounds per square foot snow loads expected for Ohio. To estimate the commercial values, the same percentage of structures (32.5%) will be assumed to be built over 50 years ago. According to the Franklin County Auditor's Office's real estate report as of 2015, with information for tax year 2012, the total value of residential and commercial structures is $50.8 billion and $17.6 billion.[157] Therefore, the estimated maximum damage that is expected for a worst-case scenario winter storm is $16.51 billion and $5.72 billion, respectively. This estimate does not represent the total cost associated with the winter storm, which would also include damaged utilities and emergency services.

Exposure of Future Buildings to Severe Winter Weather
All structures and infrastructure in Franklin County will be exposed to heavy snow and ice. However, in 2009 Franklin County adopted the International Building Code (IBC) and International Residential Code (IRC) standard. It is assumed that buildings built after this date can further withstand heavy snow and ice loads.

Estimating Potential Loss

157 Franklin County Auditor's Office, accessed on 13 October 2015, https://www.franklincountyauditor.com/real-estate/real-estate-info

Methodology
According to NCDC, estimated property damage in Franklin County attributable to major heavy snow, winter storms and/or ice storms over the period 1996 through 2017 is $1.380 million.

Past losses provided by NCDC are used to estimate the potential for annual losses due to heavy snow and/or ice.

Estimated Potential Dollar Losses
Since the total commercial and residential and critical facility loss over these 21 years is $1.38 million, the average annual loss is $1.38 million / 21 = $65,714. This is for a worst-case scenario.

The damage in dollars represented in this vulnerability statement only quantifies the damage to structures and does not reflect ancillary costs associated with this hazard.

Hazardous Material Incidents - #10

Hazard Summary

A hazardous materials incident is the release of a hazardous material from its container or package in a sufficient concentration to pose a threat. Hazardous materials may be explosive, flammable, combustible, corrosive, reactive, poisonous, biological, or radioactive, as well as solid, liquid or gaseous. As of May 2015, Franklin County has 764 facilities required to report their hazardous materials. Out of the 764 sites, 373 are Extremely Hazardous Substance (EHS) sites. The most common chemical for the EHS sites is sulfuric acid primarily found in batteries[158]. In 2014 there were 279 spills in Franklin County reported to the Ohio EPA[159]. In 2013, this hazard was ranked 10 out of 20.

In an effort to better understand the flow of Hazardous Materials through Franklin County, Franklin County Emergency Management and Homeland Security (FCEM&HS) conducted a comprehensive commodities flow study in 2015. A complete copy of this document is available on the FCEM&HS website.[160]

As a result of this study the following information was obtained:

- The top 5 commodities observed on the roadways were: Gasoline, Liquefied Petroleum Gas, Diesel Fuel, Elevated Temperature Liquid, and Nitrogen.
- Of the roads and areas observed the average was 3.3% of the vehicles placarded as carrying hazardous materials.
- The top 5 commodities observed on the railways were: Petroleum Crude Oil, Liquefied Petroleum Gas, Combustible Liquids, Hydrochloric Acid, and Alcohols.
- 14% of rail cars were transporting hazardous commodities

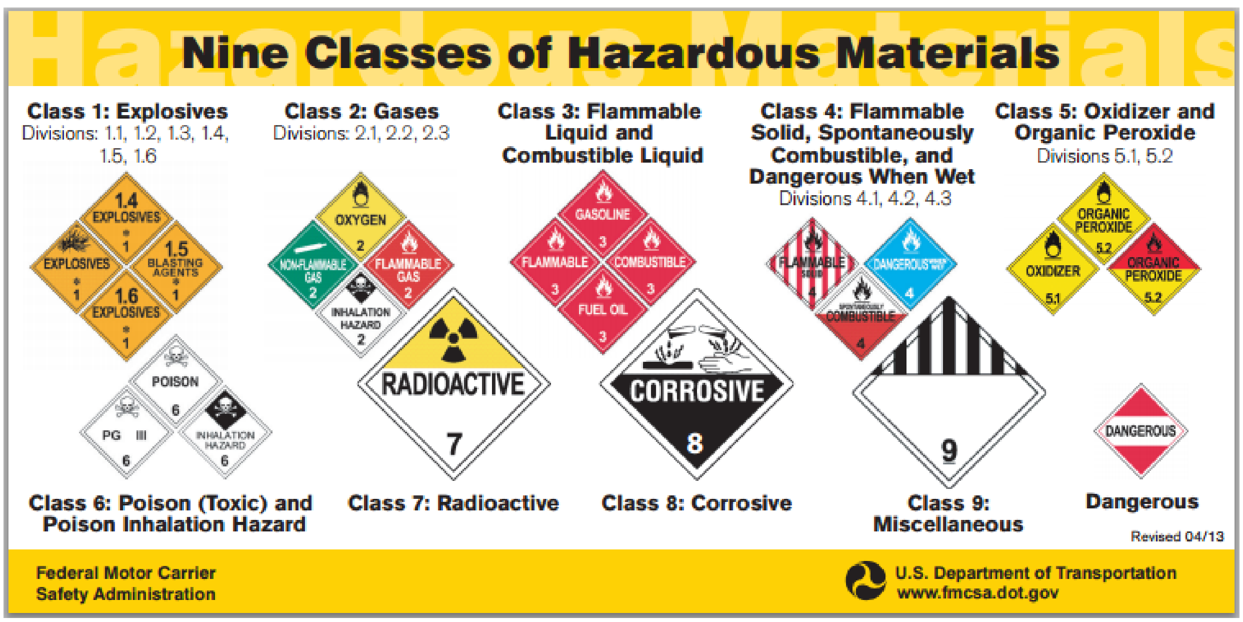
[158] Email from Peter Kowal, CEPAC/LEPC of Franklin County, sent on 4 May 2015
[159] "Spill Report", Ohio Environmental Protection Agency, last modified 2014
[160] "Hazardous Materials Commodity Flow Study," FCEMHS, last modified April 2015, http://fcemhs.com/Portals/0/Planning/Documents/2015%20Franklin%20County%20Commodity%20Flow%20Study.pdf

Hazard Profile

Hazardous materials are prevalent throughout society. While industrial use is the most common, they are also present in homes, cars, places of work and recreational areas. Hazardous materials move through the country on highways and rail lines, in pipelines, and by ship and barge.

A hazardous materials incident is the release of a hazardous material from its container or package in a sufficient concentration to pose a threat. When not properly contained, the chemical, physical, and biological properties of hazardous materials pose a potential risk to life, health, the environment, and property. Most incidents are small in scope and only require a limited response. Occasionally, there will be a large incident or one involving a chemical or other material that requires evacuation of the surrounding area.

Hazardous materials may be explosive, flammable, combustible, corrosive, reactive, poisonous, biological, or radioactive, as well as, solid, liquid or gaseous. The U.S. Department of Transportation classification of hazardous materials and the required signage is as follows:



Source: U.S. Department of Transportation[161]

Types of Hazardous Material Incidents

Most hazardous materials incidents fall into two general categories, fixed site and transportation related incidents. Additional potential types of hazardous material releases may include terrorism incidents (discussed in the Terrorism Section of this document),

[161] "Nine Classes of Hazardous Materials," U.S. Department of Transportation – Federal Motor Carrier Safety Administration, revised on April 2013, http://www.fmcsa.dot.gov/sites/fmcsa.dot.gov/files/docs/Nine_Classes_of_Hazardous_Materials.pdf

illegal drug labs, illegal dumping, and incidents as a result of a natural hazard event such as an earthquake or flood.

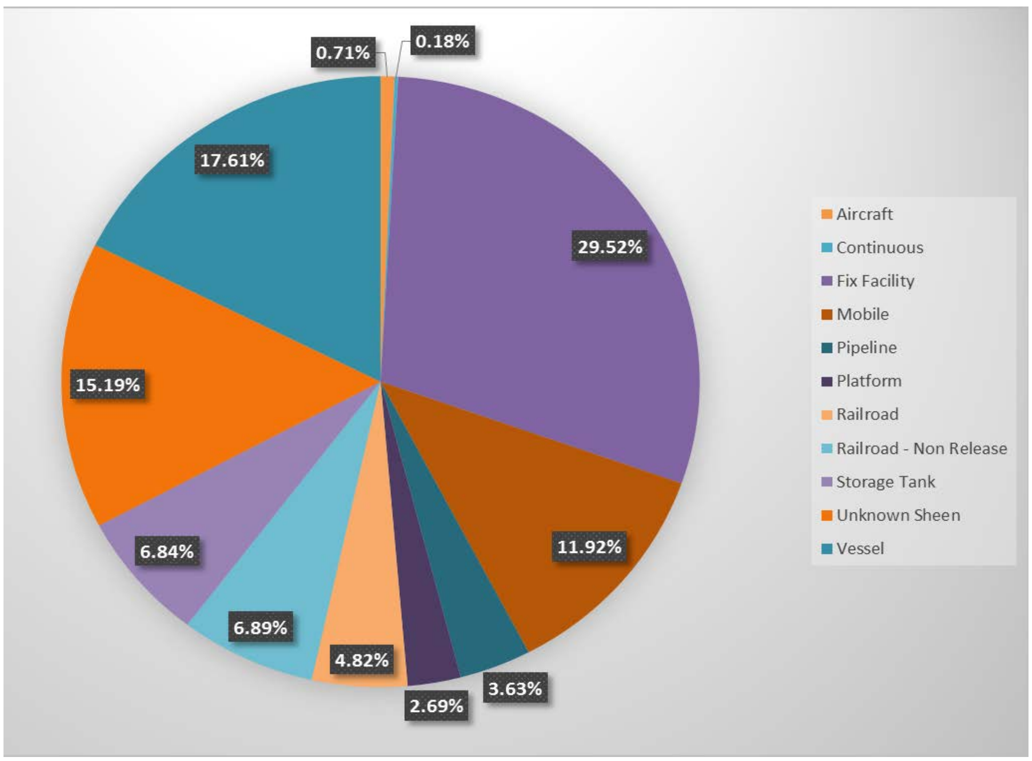
Fixed Site Incidents

More hazardous materials incidents are reported from fixed sites than from other causes. Varying quantities of hazardous materials are manufactured, used, or stored at an estimated 4.5 million facilities in the United States – from major industrial plants to local dry-cleaning establishments or gardening supply stores. Communities located near chemical manufacturing plants are particularly at risk. Generally with a fixed facility, the hazards are pre-identified, and the facility is required by law to report the chemicals on site and prepare a risk management plan.

Transportation Related Incidents

The most common type of transportation hazardous material incident is from highway crashes, followed by railroad incidents. Discharges may also come from pipelines, storage tanks and aircraft. The exact location of a transportation incident is impossible to predict as hazardous materials are transported on our roadways, railways and waterways daily. Any area is vulnerable to an accident.

The National Response Center, the national point of contact for reporting all oil, chemical, radiological, biological, and etiological discharges, reported the following types of hazardous material incidents in 2016.[162]



SARA Title III and Hazardous Substances Reporting

162 "National Response Center Spills and Accidents Database," retrieved 2 December 2016, http://nrc.uscg.mil/

The Superfund Amendment and Reauthorization Act (SARA) was passed in 1986, in part due to concerns following the incident at a Union Carbide plant in Bhopal, India. In December 1984, a methyl isocyanate gas leak from the plant killed or injured thousands of people. SARA Title III and the Clean Air Act of 1990 mandate "cradle to grave" tracking of specific hazardous materials by requiring users to report what chemicals they are using or releasing into the air and how they will respond to an emergency. EPA delegates implementation to the states.

SARA Title III requires reporting for over 350 specific chemicals designated as "extremely hazardous substances" and others designated as hazardous chemicals. Extremely hazardous substances are substances that when released from their container are considered immediately dangerous to life or health. Chlorine gas is an example. A specific "threshold planning quantity" (TPQ) is specified for each chemical. TPQs vary, the average being 500 pounds; however, some are as low as one pound. When a facility meets or exceeds the TPQ for a chemical, it must notify the response community, the State Emergency Response Commission, and the Local Emergency Planning Committee.

SARA Title III also establishes spill reporting requirements, triggered when the release of a chemical reaches a specific "reportable quantity" for that chemical. Sara also requires chemical inventory reporting: the location, quantity, storage conditions, and properties of EHSs or "hazardous chemicals," Tier II Reports.

The Toxic Release Inventory Reporting is another feature of SARA Title III. Toxic Release Inventory (TRI) requires certain facilities to report information on chemical use, release, recycling, energy recovery and treatment information, as well as pollution prevention activities.

These reporting programs overlap depending upon whether the materials are oils, hazardous chemicals, hazardous substances, extremely hazardous substances or toxic chemicals.

Hazardous Material Incidents in the United States

Between 2014 and 2015 the number of hazardous materials incidents decreased 3.9 %, from 17,400 to 16,711. The number of Class 1 incidents decreased 4.4% from 45 to 43. During the five-year period 2011-2015, the percentage of all incidents attributable to Class 1 material (196) was 0.25%. 16 states and the District of Columbia reported no Class 1 incidents.

From 2011 to 2015 there were 2,593 serious incidents attributable to hazardous materials, of which 8 (0.38%) involved Class 1 material. During the same five-year period, the number of serious hazardous materials incidents fell 0.07 % and the number of serious Class 1 incidents fell 11% compared to the 2010-2014 reporting period. During the five-year period, 2011-2015, 45 states and the District of Columbia reported no serious Class 1 incidents.

During the same five-year period, the number of Class 1 incidents resulting from rollover/derailment was 1. The corresponding number of hazardous materials incidents attributable to accident/derailment was 701. 80% of Class 1 incidents (156) involved undeclared packages, while the undeclared package rate for all hazmat runs at 8.2%. No undeclared packages involved commercial explosives. During this timeframe, no fatalities were attributed to commercial explosives; 71 deaths have been attributed to other non-Class 1 hazardous material exposures.

From 2011-2015, 32.6% (64) of Class 1 incidents occurred during transportation-related storage, followed by 29.5% (58) en route, followed by 25% (49) during unloading, and 12.7% (25) during loading. Correspondingly, 49.5% (39,963) of all hazardous materials incidents occurred during unloading, followed by 26.9% en route (21,734), and 19.9% during loading (16,072) and 3.5% (2,839) during temporary transportation-related storage.

During the five-year period 2011-2015, 63.2% (124) of all Class 1 incidents occurred in the air mode, followed by 33.6% (66) in the highway mode and 3% (6) in the water mode, and none (0) in the rail mode. Correspondingly, 87.1% (70,268) of all hazardous materials incidents occurred in the highway mode, followed by 8.3% (6,729) by air, 4.1% (3,366) for rail, and 0.3% (275) by water.

Between 2011 and 2015, 87.1% of all hazardous materials serious incidents occurred in the highway mode. All 8 of the serious Class 1 incidents during this period occurred in this mode. Five of the eight events involved commercial explosives. None of the Class 1 incidents resulted in injuries or fatalities.[163]

The United States Environmental Protection Agency maintains a list of Toxic Chemicals which are released in industry. This list is called the TRI (Toxic Release List).

TRI On-site and Off-site Reported Disposed of or Otherwise Released (in pounds), for All industries, for All chemicals, U.S., 2014. For the most current report released September 2015, Dataset 2014, there were 3,894,946,757 pounds of on and off site releases. This figure is slightly lower than the 2013 report of 4,128,926,454 pounds released.[164]

Hazardous Material Incidents in Ohio

Incidents involving hazardous materials can occur almost anywhere and at any time in Ohio, and greatly affect people, animals, the environment, and property. There are tens of thousands of hazardous materials produced, transported, used, and stored throughout

[163] "PHMSA Hazardous Materials Incident Data," Institute of Makers of Explosives, accessed on 21 September 2015, https://www.ime.org/content/phmsa_hazardous_materials_incident_data

[164] "TRI On-site and Off-site Reported Disposed of or Otherwise," US EPA, accessed on 21 September 2015, http://iaspub.epa.gov/triexplorer/release_chem?p_view=USCH&trilib=TRIQ1&sort=_VIEW_&sort_fmt=1&state=All+states&county=All+counties&chemical=All+chemicals&industry=ALL&year=2013&tab_rpt=1&fld=RELLBY&fld=TSFDSP

Ohio. Ohio is a transportation crossroads, with several major cross country interstate highways and railroads crossing the state.

Chapter 3750 of the Ohio Revised Code provides for the implementation of the Emergency Planning Community Right-to-Know Act (SARA Title III) in Ohio. The administrative body is the State Emergency Response Commission (SERC). SERC is made up of nine state agencies plus ten appointed members and two members of the state legislature. Of the appointed members, two shall represent environmental advocacy organizations, one shall represent the interests of petroleum refiners or marketers or chemical manufacturers, one shall represent the interests of another industry subject to this chapter, one shall represent the interests of municipal corporations, one shall represent the interests of counties, one shall represent the interests of chiefs of fire departments, one shall represent the interests of professional firefighters, one shall represent the interests of volunteer firefighters, and one shall represent the interests of local emergency management agencies. SERC is co-chaired by Ohio Emergency Management Agency and Ohio Environmental Protection Agency (EPA).

The Ohio EPA's Emergency Response Program is available to respond 24 hours a day, seven days a week, with on-scene coordinators available to help first responders address environmental emergencies and pollution incidents, including chemical and petroleum spills. Statewide, Ohio EPA records more than 5,000 incident reports annually through calls to the Ohio EPA emergency response spill hotline from citizens, companies, law enforcement, emergency responders and other agencies.[165]

The chart below indicates the top five substances released in Ohio in 2016

Diesel Fuel	54
Sewage	35
Oil	11
Orphan Drum	9
Transformer Oil	9

Source: Ohio EPA[166]

Hazardous Material Incidents in Franklin County

There is a large number of chemicals manufactured, used, stored and transported in Franklin County. The Chemical Emergency Preparedness Advisory Council (CEPAC) serves as the Local Emergency Planning Committee (LEPC) for Franklin County. CEPAC receives over 600 chemical inventory reports each year. In addition to fixed site facilities, Franklin County, located in the center of the state, is the crossroads for major interstate highways and railways transporting hazardous materials every day.

165 "Emergency Response Program," Ohio Environmental Protection Agency, accessed on 4 September 2015, http://www.epa.state.oh.us/derr/ersis/er/er.aspx

166 Emailed data from Greg Lauck, Environmental Specialist II, Ohio EPA, sent 7 December 2016

Franklin County has 764 reporting facilitates as of 2015. There are a variety of reportable substances. Out of the 764 sites, 373 are EHS (Extremely Hazardous Substances). The list of EHS Chemicals is developed by the United States EPA in section 302 of the Emergency Planning and Community Right-to-Know Act (EPCRA). The most common chemical reported by EHS sites is sulfuric acid primarily found in batteries. At time of print, 235 unique hazardous material spills were reported in Franklin County.[167]

[167] Emailed data from Greg Lauck, Environmental Specialist II, Ohio EPA, sent 7 December 2016

Vulnerability Assessment – Hazardous Materials Incidents

This hazard is considered to be a "Relatively High Probability Event" meaning the anticipated frequency of the hazard within the County is expected to occur more than twice but no more than 5 times a year. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability

As stated above in the narrative section of this hazard profile, hazardous materials are used in many ways in Franklin County and are present in both fixed facilities and transportation. Hazardous materials incidents do happen and much effort is put into the planning and mitigation of these incidents. The effects of a hazardous materials incident can be devastating and have very long-lasting effects.

There is no historical data that hazardous materials incidents have caused structural damage in Franklin County.

Potential Impact of Hazardous Materials Incidents

No damage to structures is anticipated due to hazardous materials incidents. However, to show the potential impact of a Hazardous Materials Event we will use a recent incident which happen on the I270 SB Ramp to I70 EB on the Westside, HOC Tanker explosion/fire happened on 7/01/2015. First response costs were $48,353.68. This incident also caused a major reconstruction of the bridge at this location. Bridge reconstruction was expected to be approximately $1.2 million.[168] [169] The total cost of this incident is approximately $1,248,353.68.

Identifying Structures

No structures would experience damage due to hazardous materials incidents; therefore, this updated risk assessment does not identify existing or future buildings at risk of loss due to hazardous materials incidents.

There is a $1.2 million bridge replacement associated with the 2015 tanker explosion/fire incident.

Exposure of Existing Buildings to Damages Due to Hazardous Materials Incidents

No existing buildings are exposed to damage due to hazardous materials incidents.

Exposure of Future Buildings to Damages Due to Hazardous Materials Incidents

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[168] "Contractor Hired to Fix I-70 Bridge; Temporary Repair Planned," Columbus Dispatch, last updated on 2 Jul 2015, http://www.dispatch.com/content/stories/local/2015/07/02/ODOT_completing_I70_crossover_ramp_for_Red_White_Boom.html

[169] "$1 Million Fund to Repair I-270 in Columbus," Ohio Bids, accessed on 28 Nov 2015, http://www.ohiobids.com/business-news/43171-1-million-fund-to-repair-i70-in-columbus-ohio.html

No future buildings will be exposed to damage due to hazardous materials incidents

Estimating Potential Loss

Methodology
Estimated potential dollar loss due to hazardous materials incidents is estimated to be $0.00.

Total impact of $48,353.68 for responder cost and $1.2 million for bridge reconstruction for a total of $1,248,353.68.

Estimated Potential Dollar Losses
The estimated potential dollar loss annually in Franklin County for structural damage due to hazardous materials incidents is $0.00.

Total economic impact is estimated to be $1,248,353.68

Civil Disturbance - #11

Hazard Summary

A civil disturbance is a planned or random uproar or disturbance of ordinary community life by persons choosing to ignore laws, often to bring attention to a cause, concern, or agenda. Franklin County has seen many types of civil disturbances through the years, from prison riots to university campus disturbances to political rallies. This hazard was ranked 11 out of 20.

Hazard Profile

A civil disturbance is a planned or random public uproar or disturbance of ordinary community life. Civil disturbance refers to groups of people purposely choosing not to observe laws, usually to bring attention to their cause, concern, or agenda.

Civil disturbances can take the form of small gatherings or large groups that disrupt normal activities by generating noise and intimidating people. They can range from a peaceful sit-in to a full-scale riot in which a mob burns or destroys property and terrorizes individuals. Generally, there are two types of large gatherings typically associated with disturbances: a crowd and a mob. A crowd may be defined as a casual, temporary collection of people. Crowds can be classified into four categories:

- Casual Crowd – A casual crowd is a group of people who merely happen to be in the same place at the same time. The likelihood of violent conduct is non-existent.
- Cohesive Crowd – A cohesive crowd consists of people who are involved in some type of unified behavior, such as worshiping, dancing, or watching a sporting event. This type of crowd would require substantial provocation to arouse to action.
- Expressive Crowd – An expressive crowd is one held together by a common commitment or purpose. Although they may not be formally organized, they are assembled as an expression of common sentiment of frustration. Members wish to be seen as a formidable influence.
- Aggressive Crowd – An aggressive crowd is comprised of individuals who have assembled for a specific purpose. This crowd often has leaders who attempt to arouse the members or motivate them to action. Members are noisy and threatening and often taunt authorities. They tend to be impulsive and highly emotional and require only minimal stimulation to arouse them to violence.

A mob can be defined as a large, disorderly crowd or throng. Mobs are usually emotional, loud, tumultuous, violent, and lawless. Like crowds, mobs have different levels of commitment and can be classified into four categories. Mobs are more committed than crowds.

- Aggressive Mob – An aggressive mob is one that attacks, riots, and terrorizes. The object of violence may be a person, property, or both. An aggressive mob is distinguished from an aggressive crowd only by lawless activity.
- Escape Mob – An escape mob attempts to flee from something such as a fire, bomb, flood, or other catastrophe. They are characterized by terror.
- Acquisitive Mob – An acquisitive mob is one motivated by a desire to acquire something. Riots often caused by other factors often turn into looting sprees. This mob exploits a lack of control by authorities in safeguarding property, such as the looting mobs in New Orleans after Hurricane Katrina.
- Expressive Mob – An expressive mob is one that expresses fervor or revelry following some sporting event, religious activity, or celebration.

Civil disturbance spans a wide variety of actions and includes but is not limited to: labor unrest, strikes, civil disobedience, demonstrations, riots, prison riots, rebellions, and celebrations.

Consequences of Civil Disturbance
Civil disturbance threatens the safety and well-being of safety forces, the population at-large, and can cause substantial damage to property. Local government operations and the delivery of services in the community may experience short-term disruptions. First responders are often overwhelmed and unable to respond to both the disturbance and normal day-to-day calls for service. Environmental impact is likely to be limited, unless acts of sabotage are performed.

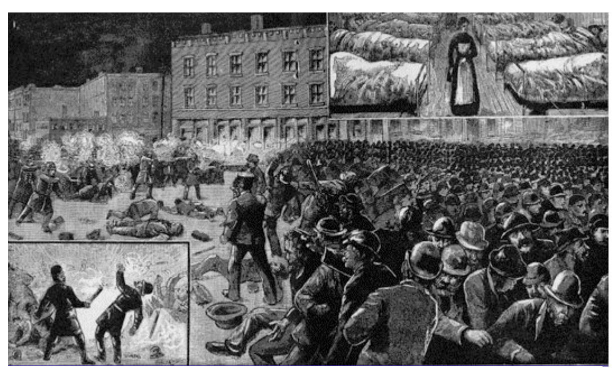
The economic impact to urban areas during civil unrest, and following such events, can be profound. Direct impacts include looting and vandalism, as well as endangerment of shop owners and customers. Looting and general vandalism are the most common activities associated with civil disturbance. Arson is also quite common and can quickly spread due to slow response times of overwhelmed fire departments. Transportation routes can become blocked, making it difficult for non-rioters to leave the area and for the emergency responders to arrive.

Indirect economic impacts result from the loss of business and customer base due to evacuations and looting. More serious acts of vandalism may result in limited power failure or hazardous material spills, leading to a possible public health emergency. Altered traffic patterns may increase the probability of a transportation accident.

Civil Disturbance in the United States

There was rioting in North America even before there was a United States. The right to protest peacefully is a hallmark of our nation's liberties handed down from the 18th century. Depending on perspective, the Boston Tea Party was a mob action or a heroic insurrection.

In 2014 and 2015, a number of racially motivated riots broke out across the United States following the deaths of African American citizens during interactions with police officers. Many of the rioters following these incidents traveled to the aforementioned locations from out of town. The lengthy riots and unrest were exacerbated by social media and continuous news coverage.



Haymarket Square Riot
Source: Chicago Historical Society

On August 9, 2015, black teenager Michael Brown was fatally shot by Darren Wilson, a white police officer in Ferguson, Missouri. This incident sparked protests, riots, looting and arson.[170]

On April 19, 2015, 25-year-old Freddie Gray sustained a fatal spinal injury while in police custody in Baltimore, Maryland. This incident sparked unrest and riots resulting in hundreds of arrests and injuries.[171] In the wake of the unrest, Baltimore's homicide rate has sky rocketed. In August 2015, it was reported that Baltimore's homicide rate (34 per 100,000 people) had far exceeded New York City (2.5) and Chicago (10.4). As of August 2015, Baltimore (population 622,000) had experienced 212 homicides while New York City (population 8.2 million) had only had 208 homicides.[172]

On July 17, 2014, 43-year-old Eric Garner died in New York City after a police officer put him in a chokehold, a maneuver which is prohibited by the police department. A Staten Island Grand Jury decided not to indict the officer, and weeks of demonstrations followed. In December 2014, two police officers in Brooklyn were shot by a man who claimed to be avenging the death of Mr. Garner. In July 2015, New York City agreed to pay Mr. Garner's family a settlement of $5.9 million.[173]

The Los Angeles riots in 1992, in response to the Rodney King case, were some of the deadliest in U.S. history, with 52 deaths, 2,500 injuries, and $446 million in property damage.

The rise of civil disobedience in the1960s was in the form of racially motivated rioting in Los Angeles, Newark, Detroit and Washington, among many other cities. The 1970s saw demonstrations against the Vietnam War, especially on college campuses across the country.

The late 1800s and early 1900s saw an increase in labor strikes as labor unions began to grow. A riot in 1886 resulted when someone threw a bomb into the ranks of Chicago policemen drawn up at a labor rally, and the ensuing mayhem has gone down in history as the Haymarket Square riot. The 1894 strike against Pullman Palace Car Co., which shut down the Nation's railroads, wasn't settled until the President sent federal troops into Chicago, provoking widespread violence and arson.

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170 "A Look at the Destruction after Ferguson Riots," ABC News, last modified on 25 November 2014, http://abcnews.go.com/US/tour-destruction-ferguson-riots/story?id=27163962

171 "Baltimore Mayor Lifts Curfew 6 Days After Riots," Associated Press, accessed on 31 August 2015, http://news.yahoo.com/baltimore-relieved-charges-weary-curfew-064228534.html

172 "Baltimore surpasses New York City in homicides for the year," New York Post, published on 20 Aug 2015, http://nypost.com/2015/08/20/baltimore-surpasses-new-york-city-in-homicides-for-the-year/

173 "Eric Garner Case is Settled by New York City for $5.9 million," New York Times, published on 13 July 2015, http://www.nytimes.com/2015/07/14/nyregion/eric-garner-case-is-settled-by-new-york-city-for-5-9-million.html?_r=0

The New York Draft Riot in 1863 was in response to a new draft law. What began as political violence turned into a generalized sacking, with arson and attacks on firefighters. Throughout the 19th century, countless people died in episodes of racial, religious, ethnic, labor and political conflict, including the anti-Chinese riots in San Francisco during the 1870s.

Civil Disturbance in Ohio

The history of civil disturbance in Ohio parallels events in the rest of the country. On May 1, 1886, an estimated 32,000 workers in Cincinnati took part in a nationwide work stoppage to demand the adoption of a standard eight-hour workday. The May Day strikes continued throughout the 1880s, helping convince President Grover Cleveland to implement Labor Day, a holiday to celebrate the American Worker.

In the mid-1960s, Cleveland was the scene of several nationally prominent civil disturbances that were racially charged. The first disturbance, the Hough Riots, lasted for several days in 1966. It took 2,200 Ohio National Guardsmen to reestablish order. The Cleveland disturbances were similar to other disturbances throughout the country at that time.[174]

One of the most nationally prominent Ohio civil disturbance events was the Kent State shootings on May 4, 1970. By 1970, the protests escalated on college campuses when it was announced that college deferments from the Vietnam War draft would end. The following account of the Kent State Shootings was taken from two sources, *The May 4 Shootings at Kent State University: The Search for Historical Accuracy*, published in the Ohio Council for the Social Studies Review, Summer 1998, and *Kent State Shootings*, published by the Ohio Historical Society:

On April 30, 1970, President Nixon announced the movement toward an invasion of Cambodia. Protests occurred the next day across the United States on college campuses where anti-war sentiment ran high. At Kent State University, an anti-war rally was held on campus. Friday night, what began as peaceful socializing in downtown Kent bars escalated to bonfires, cars stopped, police cars hit with bottles, and store windows broken. The mayor declared a state of emergency and contacted the Governor's office to request assistance from the Ohio National Guard.

Source: Ohio Historical Society

[174] "Cleveland Civil Disorders, 1966-1968." Ohio Historical Society, 4 July 2015, http://ohiohistorycentral.org/w/Cleveland_Civil_Disorders_(1966_-_1968)

The Guard mobilized quickly to move into Kent. When they arrived, they found the ROTC building ablaze and over 1,000 demonstrators surrounding it. Confrontations between the Guard and the demonstrators continued into the night, with tear gas filling the campus and numerous arrests.

A rally had been planned for noon on May 4. Although university officials attempted to inform the campus that the rally was prohibited, a crowd began to gather as early as 11 AM. Shortly before noon, an announcement was made ordering the demonstrators to disperse. There is still much controversy over what actually led to the shootings. The protestors did not disperse and began throwing rocks at Guardsmen. The Guard members fired tear gas at the demonstrators, which was ineffective due to wind. Eventually 77 Guardsmen advanced on the protestors with loaded rifles and bayonets. Twenty-nine solders eventually opened fire. The gunfire lasted only thirteen seconds, leaving 4 students dead and nine wounded.

The University was closed immediately, and classes did not resume until summer of 1970. Colleges and universities across the United States cancelled classes and actually closed their doors for the remainder of the academic year. The Ohio State University dismissed its Spring Quarter classes.[175]

In April 2001, the biggest riots in the nation since the Los Angeles Rodney King riots occurred in Cincinnati after the police involved shooting of 19 year old Timothy Thomas. Rioting and unrest ravaged the city for three full nights following Thomas' death with dozens of people injured and more than 800 arrested.[176]

In November 2014, 12-year-old African American Tamir Rice was killed by a Cleveland police officer. Rice was reaching for a pellet gun in his waistband when he was shot. The orange tip indicating it was not a real gun had been removed, and the police Chief said it was indistinguishable from a real firearm.[177] Protesters marched in downtown Cleveland disrupting downtown traffic and pedestrian access.

Civil Disturbance in Franklin County

As in the State of Ohio, civil disturbance in Franklin County has followed the same pattern as the rest of the country. The county has been the site of labor strikes, civil rights demonstrations, and anti-war protests. All have been discussed previously in this section.

There have been other events unique to the county. Columbus was the location of the former Ohio Penitentiary. The facility was the site of numerous prison riots before being closed in 1984.

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175 ''Kent State Shootings," Ohio Historical Society, 4 July 2015, http://ohiohistorycentral.org/entry.php?rec=1595&nm=Kent-State-Shootings

176 "How Cincinnati Learned From Riots in 2001," MSNBC, published on 30 July 2015, http://www.msnbc.com/msnbc/how-cincinnati-learned-its-2001-riots

177 "Cleveland police: Slain youth held air gun 'indistinguishable from a real firearm'," CNN, updated on 24 November 2014, http://www.cnn.com/2014/11/24/justice/cleveland-police-shooting/index.html

The Ohio State University campus area in Columbus has long been the site of demonstrations, protests and celebratory disturbances. An OSU Task Force on Preventing Celebratory Riots, published in 2003, reported that during the last two decades, student disturbances have seldom been related to protests and have been almost exclusively celebratory in nature. Between the years of 1996 and 2002, in the neighborhoods east of High Street, eight riots involving violent confrontation between students, guests, community residents, "outsiders," and the Columbus police were identified by the task force. In addition, 10 disturbances that did not end in violent confrontation were identified.

At Ohio State, police estimate that on football game days, 190,000 people gather adjacent to the university stadium. During one year's eight home football games, Ohio State spent nearly $1 million for police, an average of $108,000 per game.

Celebratory Riots

- Are sometimes, but not always, associated with sporting events.
- Typically occur very late at night and extend into the early morning hours.
- Involve fire setting as a common practice along with destruction of public and private property, such as overturning and burning cars.
- Involve active participants who are nearly all white, young adult males with a large crowd of onlookers who are predominantly white, young adults of both sexes. Many are students of the "host" institutions, but other young adults (students and non-students) are often involved.
- Involve eventual police intervention that is met with considerable resistance and lack of respect for authority.

Source: The Ohio State University Task Force on Preventing Celebratory Riots

As an example of how costly these events can be, following the November 2002 Ohio State–Michigan game, fans rushed the stadium field and attempted to tear down the goal post to celebrate securing a place in the Bowl Championship Series title game. The mob began to tear up the turf on the field when they were faced with a barrage of pepper spray from authorities. That night, a celebratory riot ensued on the streets of Columbus, costing the city almost $125,000 in overtime police pay. According to Columbus Police, 250 officers were working the university district dressed in riot gear and armed with tear gas.

OSU Riot November 2002; Source: Education Law Consortium

Subsequently, 48 people were arrested, nine of whom were students. During the riot, approximately 20 vehicles were burned or damaged in a 10-block area east of campus. In addition, firefighters responded to 107 small fires, which resulted in damage to property that was estimated to exceed $400,000.[178]

In January 2015, thousands of celebrating fans converged on Ohio State football stadium with several hundred forcing their way inside and tearing down a goalpost. At least a dozen small fires were also reported and a handful of arrests made.[179]

In addition to the university, Franklin County is home to types of facilities that commonly see disturbances including state and local government buildings, a federal courthouse, abortion clinics, and correctional facilities.

Franklin County has experienced some small-scale protests related to the current nationwide civil unrest, such as a "Columbus to Ferguson" march from the OSU oval to the Columbus Police Headquarters in December 2014[180]; however, as of this publication Franklin County has not experienced large scale riots outside of the celebratory riots discussed above.

Climate Change Impacts

There is moderate evidence that suggests a correlation of higher temperatures with greater degrees of human aggression. Although scholarly disagreement surrounds the implications of these findings, it is possible that rising temperatures could cause or exacerbate the severity of civil unrest. In addition, conflicts and disturbances certainly could result from the passionate nature of many concerning the climate change issue itself.

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[178] "An Analysis of Issues Related to Celebratory Riots at Higher Education Institutions," Van Slyke, Jeffrey, M. Education Law Consortium Forum, 2005, http://www.educationlawconsortium.org/forum/2005/papers/VanSlyke2005.pdf

[179] "Riot Cops Use Tear Gas on Columbus Crowds After Ohio State Win." NBC News. Jan 13, 2015. Accessed February, 2018. https://www.nbcnews.com/news/us-news/riot-cops-use-tear-gas-columbus-crowds-after-ohio-state-n284976

[180] "Groups March in Columbus to Protest Police Aggression," WBNS-10TV, updated 9 December 2014, http://www.10tv.com/content/stories/2014/12/08/columbus-ohio-groups-march-in-columbus-to-protest-police-aggression.html

Vulnerability Assessment – Civil Disturbance

This hazard is considered to be a "Relatively Moderate Probability Event" meaning the anticipated frequency of the hazard within the County is once every 1 to 4 years. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability

As referenced in the above sections, Franklin County has been the location of many and varied civil disturbances. The impacts of these have been high in personnel cost as well as property damage, most of which has been the result of fires. However, these incidents have been isolated and do not provide a good basis to predict future property loss due to civil disturbances. For this vulnerability assessment, it should be considered that there has been no definite measurable structural damage due to civil disturbance in Franklin County.

Potential Impact of Civil Disturbance

Negative impacts of civil disturbance events are high and affect a large amount of Franklin County residents either directly or indirectly through the media. No damage to structures is anticipated due to civil disturbance.

For this assessment we will use the figures from the 2002 disturbance which occurred after a football game at Ohio State University. Personnel cost for overtime was approximately $125,000. Property damage was $400,000. Total impact was $525,000 for this event.

Identifying Structures

No structures would experience damage due to civil disturbance; therefore, this updated risk assessment does not identify existing or future buildings at risk of loss due to civil disturbance.

Exposure of Existing Buildings to Damages Due to Civil Disturbance

No existing buildings are exposed to damage due to civil disturbance.

Exposure of Future Buildings to Damages Due to Civil Disturbance

No future buildings will be exposed to damage due to civil disturbance.

Estimating Potential Loss

Methodology

Potential structural dollar loss due to civil disturbance is estimated to be $0.00 because the historical data is isolated; therefore, the future potential structural loss due the civil disturbance is inconclusive.

Personnel cost for overtime for the 2002 incident at the Ohio State University was approximately $125,000 and property damage totaled $400,000. Total impact was $525,000 for this event.

Estimated Potential Dollar Losses
The estimated potential dollar loss annually in Franklin County due to structural damage due to civil disturbance is $0.00.

Total potential impact is $525,000.

Severe Summer Weather: Thunderstorms, Lightning, Wind and Hail - #12

Hazard Summary

Severe summer weather is classified as thunderstorms, hail, lightning, and damaging wind. Each of these hazards has its own severity measure and often all four occur in one storm system, causing much more damage than each would have alone. According to the NOAA National Climactic Data Center's Storm Events Database, there were 436 strong/high/thunderstorm wind, and lightning events, as well as 212 hail events for Franklin County from January 1950 to December 2017.[181] This hazard was ranked 12 out of 20.

This is a county-wide hazard that can affect all areas and jurisdictions of the county.

[181] "Query Results; Franklin County, Ohio," NCDC – NOAA, accessed on 1 February 2018, http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=39%2COHIO

Hazard Profile

Thunderstorms
Thunderstorms can occur at any time of the year and just about anywhere in the world. A thunderstorm forms when moist, unstable air is lifted vertically into the atmosphere. Every thunderstorm needs:

- Moisture – to form clouds and rain,
- Unstable air – warm air that can rise rapidly, and
- Lifting mechanism – cold or warm fronts, sea breezes, mountains, or the sun's heat capable of lifting air to help form the storm.

Thunderstorms affect relatively small areas when compared with hurricanes and winter storms. Thunderstorms are typically about 15 miles in diameter and last an average of 30 minutes. Regardless of their size, all thunderstorms are dangerous. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10% are classified as severe.

A severe thunderstorm is a thunderstorm that contains one or more of the following three weather conditions:

- Hail that is one inch or greater in diameter
- Winds 58 miles per hour or greater
- Tornadoes[182]

Severe thunderstorms are the most prevalent during the spring and summer in the afternoon and evening hours, but they can occur any time of year at any hour of the day.[183] Air mass thunderstorms are usually associated with certain geographic regions, and others are associated with frontal systems. An air mass thunderstorm is typically associated with a warm, moist air mass that is in place over a region and usually occurs during the summertime. Thunderstorms associated with approaching frontal systems are characteristically more severe than air mass thunderstorms. The National Weather Service states that a Severe Thunderstorm Warning is issued when either a severe thunderstorm is indicated by radar or a spotter reports a thunderstorm producing hail one inch or larger in diameter and/or winds equal or exceed 58 miles an hour. Severe thunderstorm warnings mean people in the affected area should seek shelter immediately. Severe thunderstorms can produce tornadoes with little or no advance warning. Lightning frequency is not a criteria for issuing severe thunderstorm warnings, which are usually issued for a duration of one hour. They can be issued without a Severe Thunderstorm Watch already being in effect.

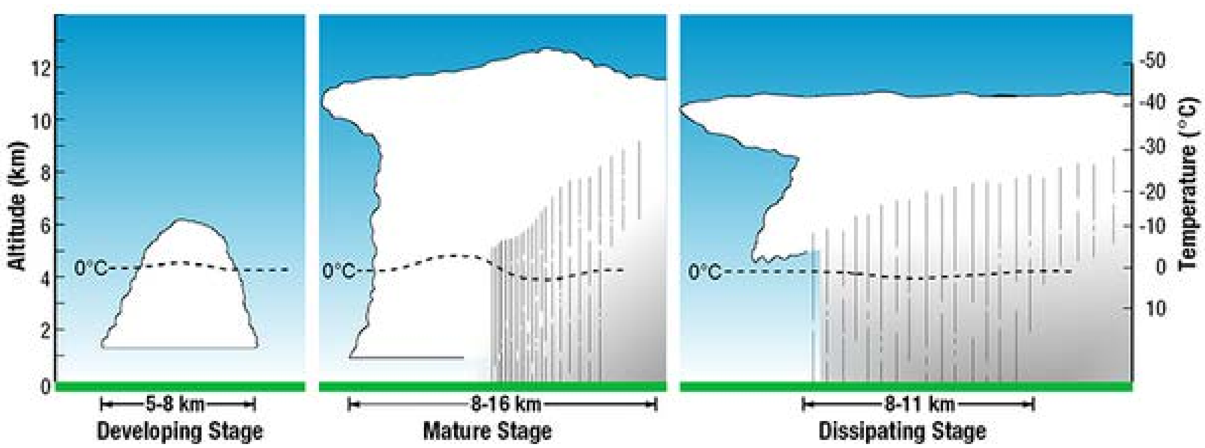
Thunderstorm Life Cycle

182 "Frequently Asked Questions," Storm Prediction Center, accessed on 19 September 2015, http://www.spc.noaa.gov/faq/#4.2
183 "Severe Weather 101," NSSL, 2 July 2015, http://www.nssl.noaa.gov/education/svrwx101/thunderstorms/

Many thunderstorms go through a three-stage life cycle. The first stage is the developing stage. At this stage, the storm consists only of updrafts (upward moving air currents). Updraft heights can reach 20,000 feet above the ground. As moisture becomes more plentiful, the base of the storm may lower. At this stage, parcels of warm humid air rise and cool to form clusters of puffy white cumulus clouds. Added heat energy from condensation and deposition keeps the air inside the cloud warmer than the air around it. The cloud continues to develop as long as more humid air is added to it from below. Updrafts dominate the patterns within the cloud. There is little to no rain during this stage, but lightning might be visible.

The mature stage is the strongest and most dangerous stage of the storm's life cycle. At this stage, the storm contains both upward and downward moving air currents (updrafts and downdrafts), with precipitation in the downdraft area. The downdraft results from precipitation evaporating, which causes cooling. When the cool downdraft hits the ground, it spreads out and forms a gust front, which may include damaging winds called a downburst. At the top of the storm, the updraft rapidly decelerates, and clouds spread out to form an anvil. If the updraft is strong, a "bubble" of cloud, called an "overshooting top," will be pushed above the anvil. This stage is the most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes.

During the third stage, the dissipating stage, excessive precipitation and downdraft weakens the updraft. Downdrafts dominate the storm, and any overshooting top disappears. At the surface, the gust front will move away from the storm and cut off the inflow of energy into the storm. Rainfall decreases at this point, but lightning is still dangerous.[184]



Source: NOAA

Thunderstorm Categories

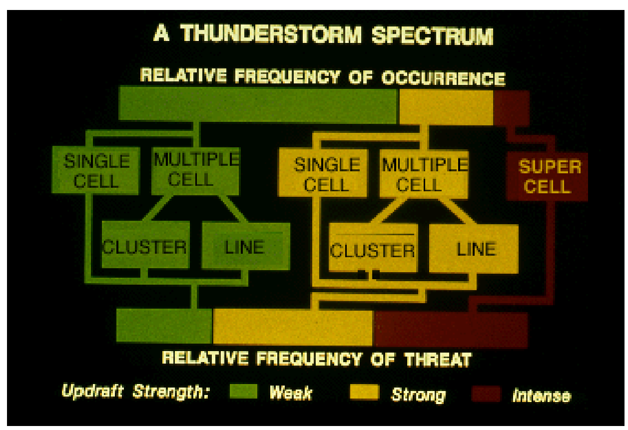
[184] "Severe Thunderstorms and Tornadoes," NOAA, accessed on 2 Nov 2015, http://www.wrh.noaa.gov/fgz/science/svrwx.php

Single cell storms are generally weak, short-lived, and poorly organized. They usually do not produce severe weather. These are local, isolated thunderstorms, mostly occurring in the late afternoon and early evening when surface temperatures are highest. Each thunderstorm's life cycle occurs over a period of 30-60 minutes. They may contain heavy rain and can also produce occasional downbursts, small hail, and (rarely) weak tornadoes, but these are fairly rare in single cell storms.

Multi-cell cluster storms are the most common type of storm and consist of a series of cells moving along as one unit. Within the cluster, one cell dominates for a time before weakening, and then another cell repeats the cycle, which can go on for hours. Multi-cell thunderstorms are usually just heavy rain makers but are capable of producing hail, strong winds, and occasionally tornadoes.

Multi-cell line storms, commonly called "squall lines," consist of a long line of storms with a continuous gust front at the leading edge. In squall lines, thunderstorms form in an organized line and create a single, continuous gust front. The most intense region of convection tends to be rather narrow, and the line can extend for hundreds of miles. Squall lines contain numerous individual cells but can contain a few supercell storms. The most dangerous feature with squall lines are often the winds, which can exceed over 70 miles per hour. Other threats include isolated tornadoes, hail, and flash flooding.

Supercell storms have a single, intense updraft, are very strong, and always produce significant severe weather. When environmental winds are favorable, the updraft and downdraft of a storm become organized and twist around and reinforce each other. The result is a long-lived supercell storm. In the central United States, supercells typically have a broad, intense updraft that enters from the southeast and brings moist surface air into the storm. The updraft rises, rotates counterclockwise, and exits to the east, forming an anvil. Updraft speeds in supercell storms can exceed 130 feet per second and are capable of suspending hailstones as large as grapefruit. Supercells can last two to six hours. They are the most likely storm to produce spectacular wind and hail damage as well as powerful tornadoes.[185]



Source: NOAA

Lightning

185 "Thunderstorm Types," NOAA, accessed on 2 Nov 2015, http://www.nssl.noaa.gov/education/svrwx101/thunderstorms/types/

Lightning Facts

- Lightning causes an average of 33 fatalities and 297 injuries each year.
- Lightning occurs in all thunderstorms; each year lightning strikes the Earth 25 million times.
- The energy from one lighting flash could light a 100-watt light bulb for more than 3 months.
- Most lightning fatalities and injuries occur when people are caught outdoors in the summer months during the afternoon or evening.
- Lightning can occur from cloud-to-cloud, within a cloud, cloud-to-ground, or cloud-to-air.
- Many fires in the western United States and Alaska are started by lightning.
- The air near a lightning strike is heated to 50,000°F – hotter than the surface of the sun. The rapid heating and cooling of the air near the lightning channel causes a shock wave that results in thunder.

Source: NOAA

Lightning occurs in all thunderstorms. It is estimated that lightning hits the Earth 100 times each second. That's 8.6 million strikes per day and over 3 billion each year. The frequency of lightning over land tends to peak in the mid-afternoon between 3:00 p.m. and 6:00 p.m. local time. Lightning is five times hotter than the sun. A single bolt can reach 50,000 degrees Fahrenheit.[186]

Lightning is an electrical discharge produced to balance the differences between positive and negative charges within a cloud, between two clouds, or between a cloud and the ground. Rising and descending air within a thunderstorm separates these positive and negative charges. Water and ice particles also affect charge distribution.

A cloud-to-ground lightning strike begins as an invisible channel of electrically charged air moving from the cloud toward the ground. When one channel nears an object on the ground, a powerful surge of electricity from the ground moves upward to the clouds and produces the visible lightning strike. During a thunderstorm, not only is the ground positively charged, so is everything on it. The tallest object in the area is most likely to be struck, whether it is a building, a tree, or a person standing alone in a field.

Although cloud-to-ground lightning strikes pose the most danger to people on the ground, they make up only about 20% of all lightning strikes. The most common type of lightning in a thunderstorm is in-cloud lightning, which occurs within the cloud itself. Cloud-to-cloud lightning is a common occurrence in which opposite electrical charges in one cloud attract those in another.

There is a common misconception that heat lightning is harmless lightning caused by extreme heat in the atmosphere. There is no such thing as heat lightning. It is actually lightning seen from a distant thunderstorm too far away for the thunder to be heard.

[186] "Lightning," The Weather Channel, accessed on 2 Nov 2015, http://dw.weather.com/encyclopedia/thunder/light.html

Damaging Winds

The rotating winds of tornadoes usually come to mind when thinking of the worst storm damage. However, high winds can cause damage whether they are rotating or not. In fact, straight-line winds are responsible for most thunderstorm wind damage and can exceed 100 mph.

Damage from a severe thunderstorm is far more common than damage from tornadoes. The paths of these storms could extend for hundreds of miles and create widespread damage. Severe thunderstorm wind damage accounts for half of all severe weather reports in the U.S. Winds meeting or exceeding 58 mph are categorized as severe.

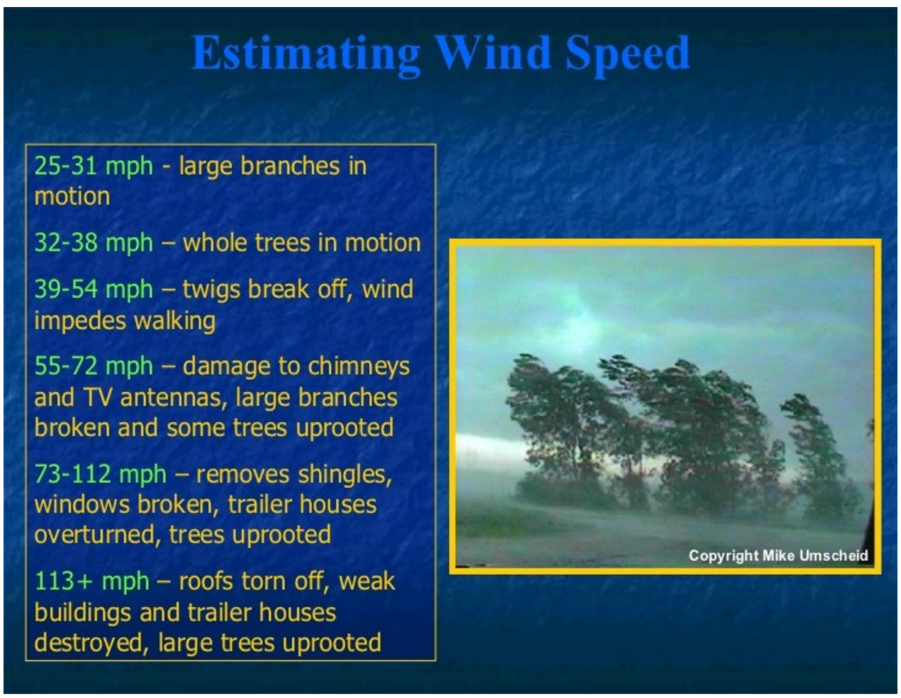
Air moves up and down vertically in a thunderstorm. Updrafts (air moving up) tend to take warmer air aloft, while downdrafts (air moving down) tend to bring cooler air to the warmer surface. The stronger these updrafts and downdrafts are, the easier it is for the formation of strong straight-line winds. If the storm system as a whole is moving quickly, this will add to the strength of the straight-line winds. The speed of the downdraft will combine with the forward motion of the storm to create strong to severe winds out ahead of the storm.

The National Severe Storms Laboratory defines several types of damaging winds:[187]

Straight–line winds – a term used to define any thunderstorm wind that is not associated with rotation and is used mainly to differentiate from tornadic winds.

Downdrafts – A small-scale column of air that rapidly sinks toward the ground. A downburst is a result of a strong downdraft.

Downbursts – A strong downdraft with horizontal dimensions larger than 2.5 miles resulting in an outward



Source: NOAA

187 "Types of Damaging Winds," NOAA, accessed on 2 Nov 2015, http://www.nssl.noaa.gov/education/svrwx101/wind/types/

burst of damaging winds on or near the ground, similar to the way water comes out of a faucet and hits the bottom of the sink. Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado.

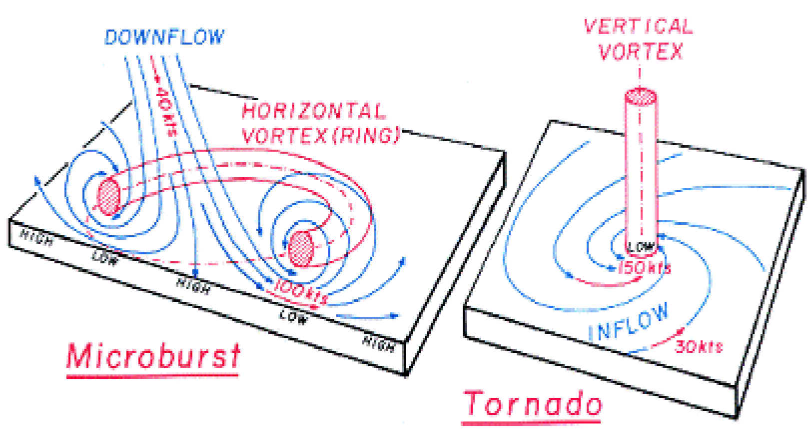
Microbursts – A small concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are generally small, extending 2 ½ miles or less, lasting 5 to 15 minutes, with winds as high as 168 mph. Microbursts can be accompanied by heavy rain or with no rain in places like the high plains. Macrobursts are larger downbursts.

Gust Front – A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by wind shift, temperature drop, and gusty winds out ahead of the thunderstorm. Sometimes the winds push up air above them, forming a shelf cloud or detached roll cloud.

Derecho – A derecho is a widespread thunderstorm/wind event caused when new thunderstorms form along the leading edge of an outflow boundary. The thunderstorms feed on this boundary and continue to reproduce themselves. Usually these thunderstorms produce heavy rain and severe wind reports as they rumble across several states during the night. They are particularly dangerous because the damaging winds can last a long time and can cover a large area. If the swath of wind damage extends for more than 240 miles, includes wind gusts of at least 58 mph along most of its length, and several, well-separated 75 mph or greater gusts, then the severe event may be classified as a derecho.[188]

Bow Echo – A radar echo which is linear but bent outward in a bow shape. Damaging straight-line winds often occur near the "crest" or center of a bow echo. Bow echoes can last for several hours and produce extensive swaths of wind damage at the ground.

Downburst vs Tornado?
Downbursts and tornadoes both produce damaging winds. Tornado winds range from 40 to over 300 mph. Downburst winds can exceed 165 mph. Wind speeds of 75 mph or more, straight-line or tornadic, will often sound very loud, leading some to believe they heard a tornado



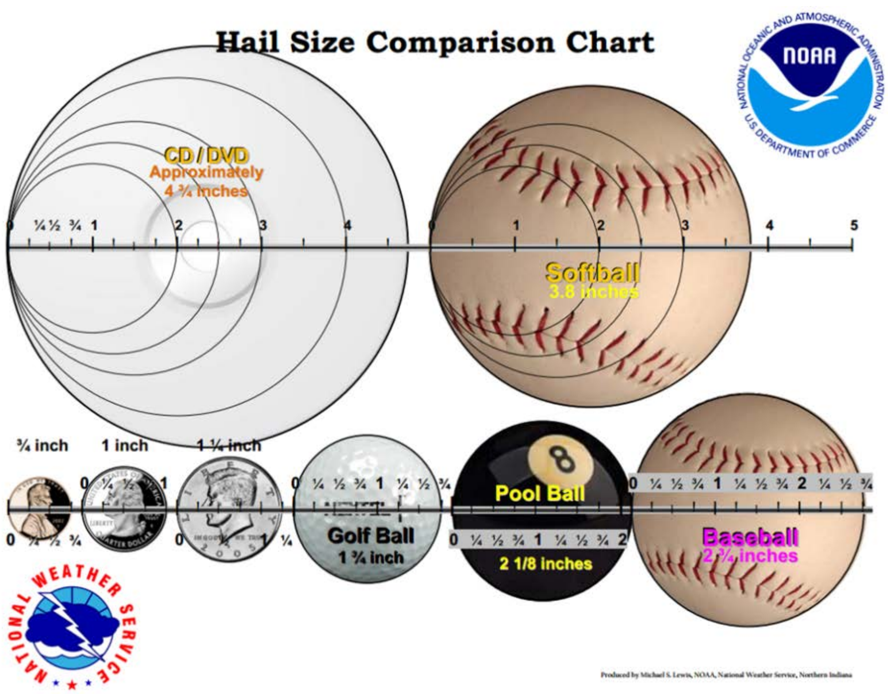
[188] NOAA Storm Prediction Center. "Derecho Facts Page". [Online] 3 July 2015. http://www.spc.noaa.gov/misc/AbtDerechos/derechofacts.htm

when, in fact, they heard a straight-line wind.
The key difference is the direction of the winds. All wind flows *into* a tornado. Debris is often lying at angles due to the curving of the inflow winds. All wind flows *out* from a downburst. Debris is often lying in a straight line parallel to the outward wind flow. The best way to determine if damage was caused by a tornado or a downburst is to fly over the area and look down on the damage path.

According to forecasters at the Storm Prediction Center, severe wind is the most difficult threat to forecast because it comes from a wider range of environments than supercells, tornadoes, or large hail. Damaging winds can be produced by Mesoscale Convective Systems, squall lines, or even just a dying thunderstorm or hurricane, such as the remnants of Hurricane Ike in 2008.

Damaging wind events can develop with little advanced warning. In an extremely dry environment, little or no rain may reach the surface, but the wind may exceed hurricane force and may approach the speeds of a weak to moderate tornado. In a wet environment, the microburst may be embedded in heavy rain, but its onset may be so sudden leaving little to no time for advanced warning.

Hail



Hail is a form of precipitation that occurs when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere, where they freeze into ice. Hail forms only in thunderstorms, in huge cumulonimbus clouds that contain vast amounts of energy in the form of updrafts and downdrafts. Hail formation requires air moving up (thunderstorm updraft) that keeps the pieces of ice from falling. Drops of supercooled water hit the ice and freeze on it, causing it to grow. Hail falls when it becomes heavy enough to overcome the strength of the updraft and is pulled by gravity towards the earth. The stronger the updraft, the larger the hailstone can grow.

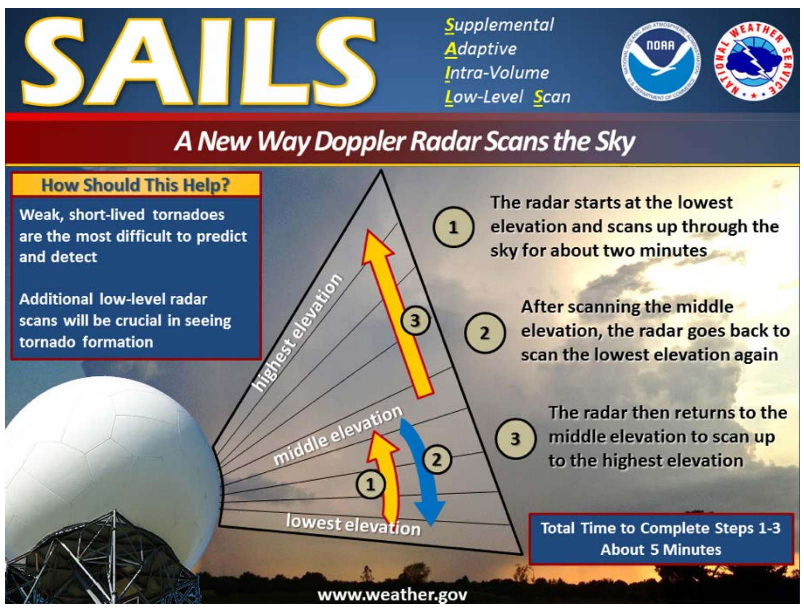
Source: NOAA

There is no clear distinction between storms that do and do not produce hailstones. Nearly all severe thunderstorms probably produce hail aloft, though it may melt before reaching the ground.

Hailstones can have layers like an onion if they travel up and down in an updraft, or they can have few layers if they are "balanced" in an updraft. These layers are caused by the different rates of accumulation and freezing of supercooled water as the hailstone forms. The more supercooled water a hailstone makes contact with, the larger and heavier the stone is likely to become. When the hailstone becomes so heavy that the updraft can no longer support it, it falls from the sky.

Hailstones can begin to melt and then re-freeze together, forming large and very irregularly shaped hail. The largest hailstone recovered in the U.S. fell in Vivian, South Dakota on July 23, 2010 and was approximately the size of a volleyball. It had a diameter of 8 inches, a circumference of 18.62 inches and weighed almost two pounds.[189]

A hail shaft is a column of hail falling from a single thunderstorm cell. The first sign that hail may be arriving is a growing whitening among the shafts of rain. Hail falls in paths known as hail swaths. They can range in size from a few acres to an area 10 miles wide and 100 miles long. Piles of hail in hail swaths have been so deep, a snowplow was required to remove them, and occasionally, hail drifts have been reported.



[189] NOAA. "South Dakota Storm Produces Record Hailstone". [Online]. Accessed on 16 Oct 2016. https://www.weather.gov/media/abr/vivian/073010RecordHailVivianSD.pdf

Forecasting Severe Summer Weather

Thunderstorm forecasting is very similar to the forecasting used to predict tornadoes. Three times daily, a severe weather outlook is issued on a nationwide basis indicating whether conditions are either favorable or unfavorable for thunderstorms to develop in specific regions in the United States.

To forecast thunderstorms, meteorologists use a variety of data. Surface and upper air observations are studied to find areas of low level moisture and instability, and to determine how winds aloft might influence storm development.

Satellite imagery is used to help track the movement of weather systems that might generate thunderstorms. Radar and satellites are used to trace the storms once they do form.

Meteorologists at the Storm Prediction Center in Norman, Oklahoma are tasked with monitoring for signs of severe thunderstorms and tornado development. They issue Severe Thunderstorm Watches for areas where conditions are favorable for the formation of severe storms. Warnings are issued by local National Weather Service Forecast Offices.

Doppler radar is also used to identify damaging wind hazards. Sometimes a thin line appears on the radar display indicating a gust front. Doppler radar velocity data can show areas of diverging winds at the surface and even the strength of those winds. Winds coming together at the upper levels of the storm can also be seen on velocity displays and can indicate the development of a microburst.

Major airports routinely use Terminal Doppler Weather Radars to monitor weather conditions occurring within a few miles of the airport. Of special interest are conditions that might cause microbursts, which can be deadly to aircraft.

The possibility of lightning can be predicted, but it is impossible to forecast individual strikes since lightning is so widespread, frequent and random. Currently, cloud-to-ground and intra-cloud lightning flashes are detected by antennas and mapped in real-time across the entire U.S. by the National Lightning Detection Network.

Advisories, Watches and Warnings

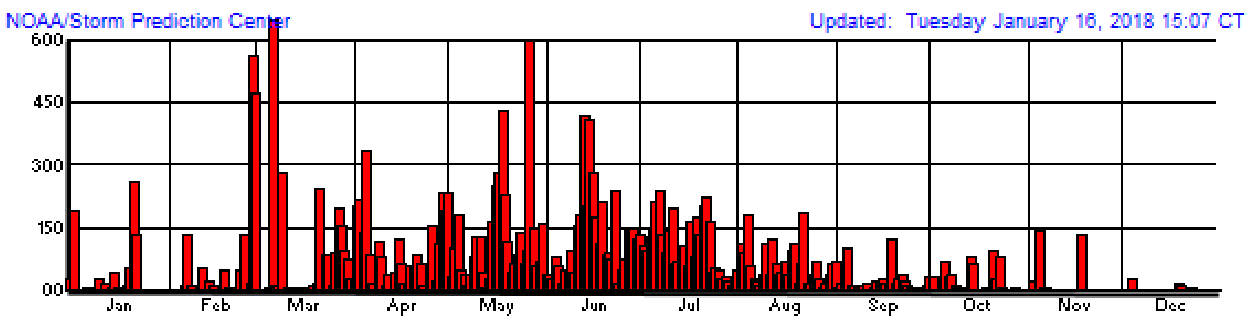
- **Severe Thunderstorm Watch** – Issued by the Storm Prediction Center when conditions are favorable for severe thunderstorm formation.
- **Severe Thunderstorm Warning** – Issued by local NWS Forecast Office when severe weather has been reported by spotters or indicated on radar. Warnings indicate imminent danger to life and property to those in the path of the storm.
- **High Wind Advisory** – Issued by the NWS when high wind speeds may pose a hazard.
- **High Wind Watch** – Issued by the NWS when there is the potential of high wind speeds developing that may pose a hazard or is life threatening.
- **High Wind Warning** – Issued by the NWS when high wind speeds may pose a hazard or is life threatening.

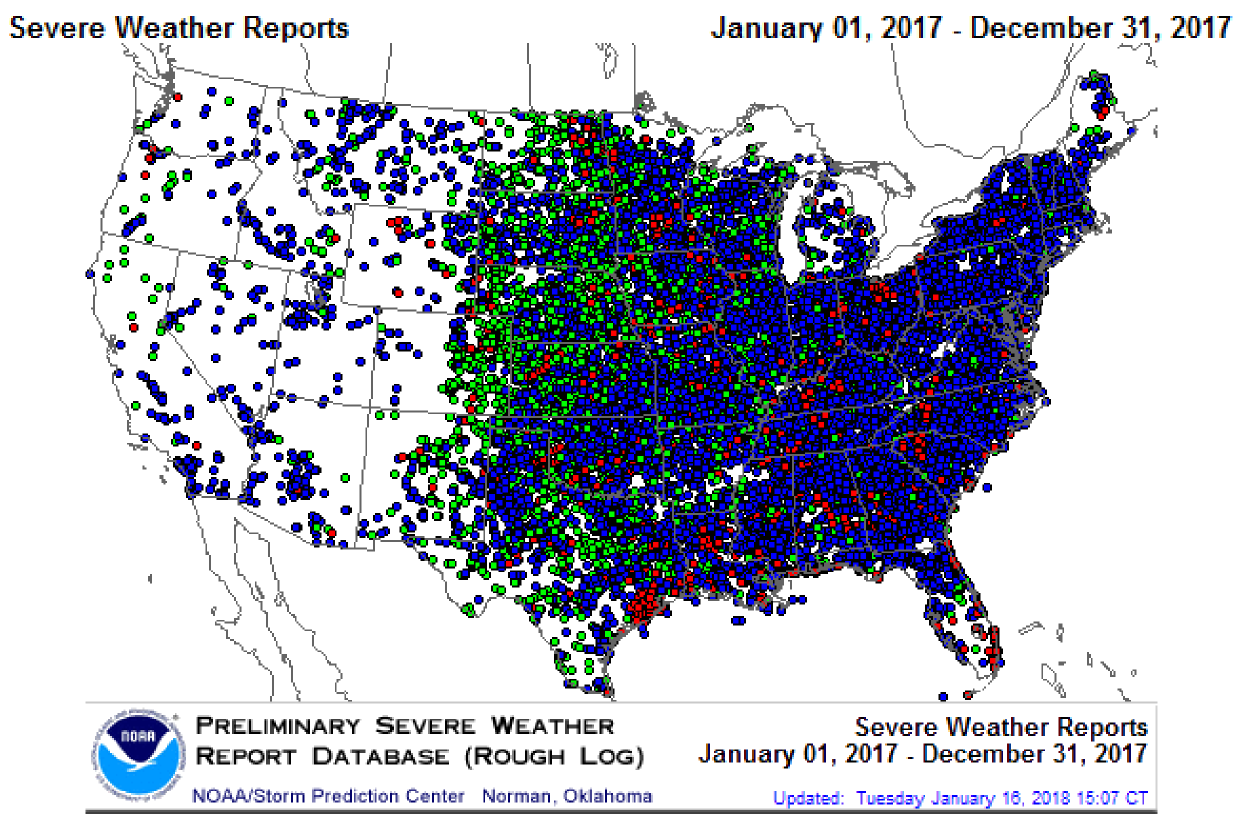
Criteria for wind advisories, warnings and watches vary from state to state.

Weather spotters play a vital role in the warning and information process by observing storms and making reports back to the National Weather Service. Spotters are trained to identify and describe severe local storms. Spotter information, coupled with Doppler radar, satellite, and other data, has enabled the National Weather Service to issue more timely and accurate warnings to save thousands of lives.

NOAA's Annual Severe Weather Report Summary 2015

Below are charts from NOAA's preliminary annual severe weather report summary of 2015. Please note that the data is preliminary and subject to revision. Additional information can be found here:
http://www.spc.noaa.gov/climo/online/monthly/2017_annual_summary.html





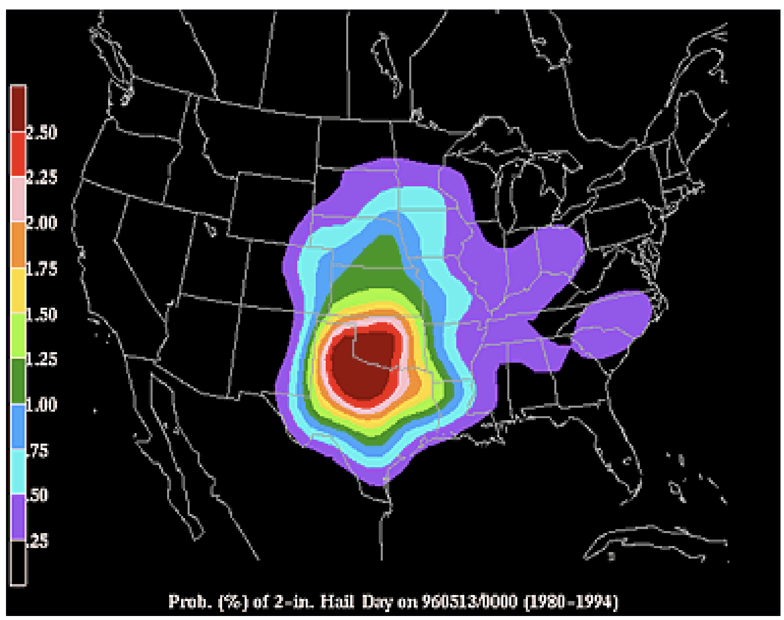
Severe Summer Weather in the United States

Thunderstorms are known to occur in almost every region of the world. There are about 1,800 thunderstorms occurring at any one moment around the world, or 16 million a year.

In the United States, the Florida peninsula and the southeast plains of Colorado have the highest thunderstorm frequency. Relatively small thunderstorms occur about once a year in Alaska and two to three times a year in the Pacific Northwest. Although the greatest severe weather threat in the United States extends from Texas to Minnesota, it is important to note that no place in the United States is completely immune to the threats of severe weather.

Every year, most of the United States experiences about five cloud-to-ground lightning strikes per square mile. Most of the interior of the country east of the Rocky Mountains has about ten discharges per square mile. Maximum flash densities are found along the Gulf Coast and Florida peninsula, where over a year's time 25 strikes per square mile have been measured. Lightning strikes the United States approximately 25 million times annually, and lightning is clearly among the country's most severe weather hazards. An average of 49 people are killed each year in the U.S. by lightning.[190]

Damage from severe thunderstorm winds accounts for half of all severe weather reports in the lower 48 states and is more common than damage from tornadoes. Since most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft, anyone living in thunderstorm-prone areas is at risk for experiencing this phenomenon.



Source: NOAA National Severe Storms Laboratory

Though Florida has the most thunderstorms, Nebraska, Colorado and Wyoming usually have the most hailstorms. The area where these three states meet – "hail alley," averages seven to nine hail days per year. The reason why this area gets so much hail is that the freezing levels (the area of the atmosphere at 32 degrees or less) in the high plains are much closer to the ground than they are at sea level, where hail has plenty of time to melt before reaching the ground.
Hailstorms may occur anywhere in the United States if convective activity and sufficient

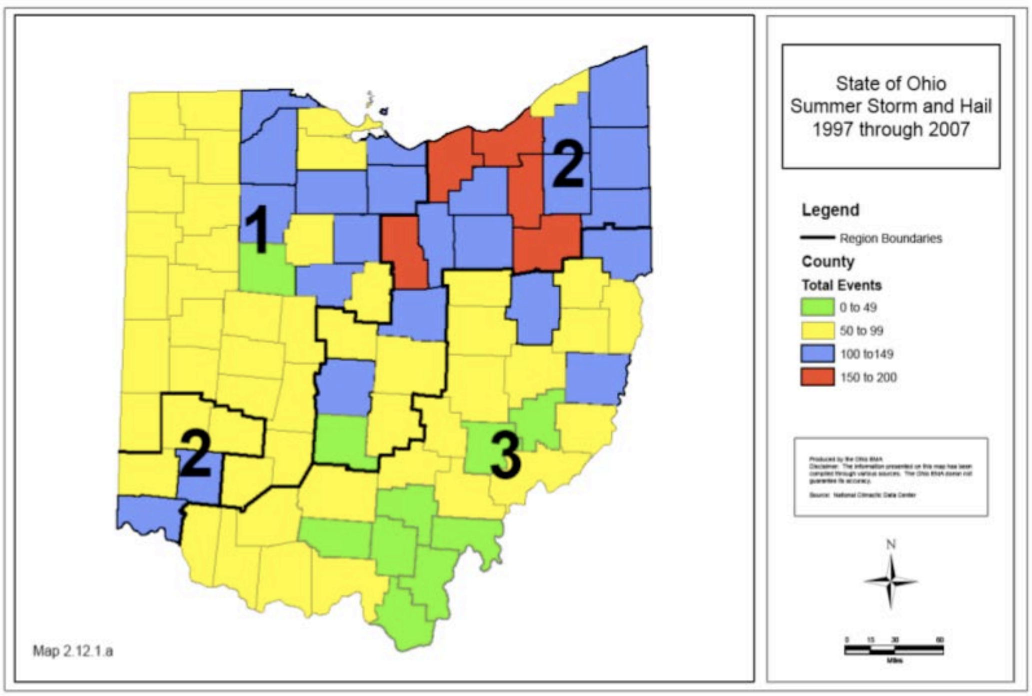
[190] "Lightning Safety," NWS, accessed on 3 July 2015, http://www.lightningsafety.noaa.gov/

moisture are present and if the freezing level aloft is relatively low. According to NOAA records, hail was the main factor in two weather events since 1980 that caused $1 billion or more in damages to young crops, businesses, homes, cars, and trucks. A series of storms over six days in early April 2001 caused $1.9 billion in damages in 13 states from Texas to Pennsylvania. A three-day event in early April 2003 damaged $1.6 billion in property and agriculture in 10 states from Texas to Tennessee.[191]

Severe Summer Weather in Ohio

Severe summer weather events – thunderstorms and lightning, wind and hail events – are common throughout Ohio and reported hundreds of times each year. Over 5000 events were documented since 1950. Based on available data, severe summer storms are the most prevalent natural hazard in Ohio.

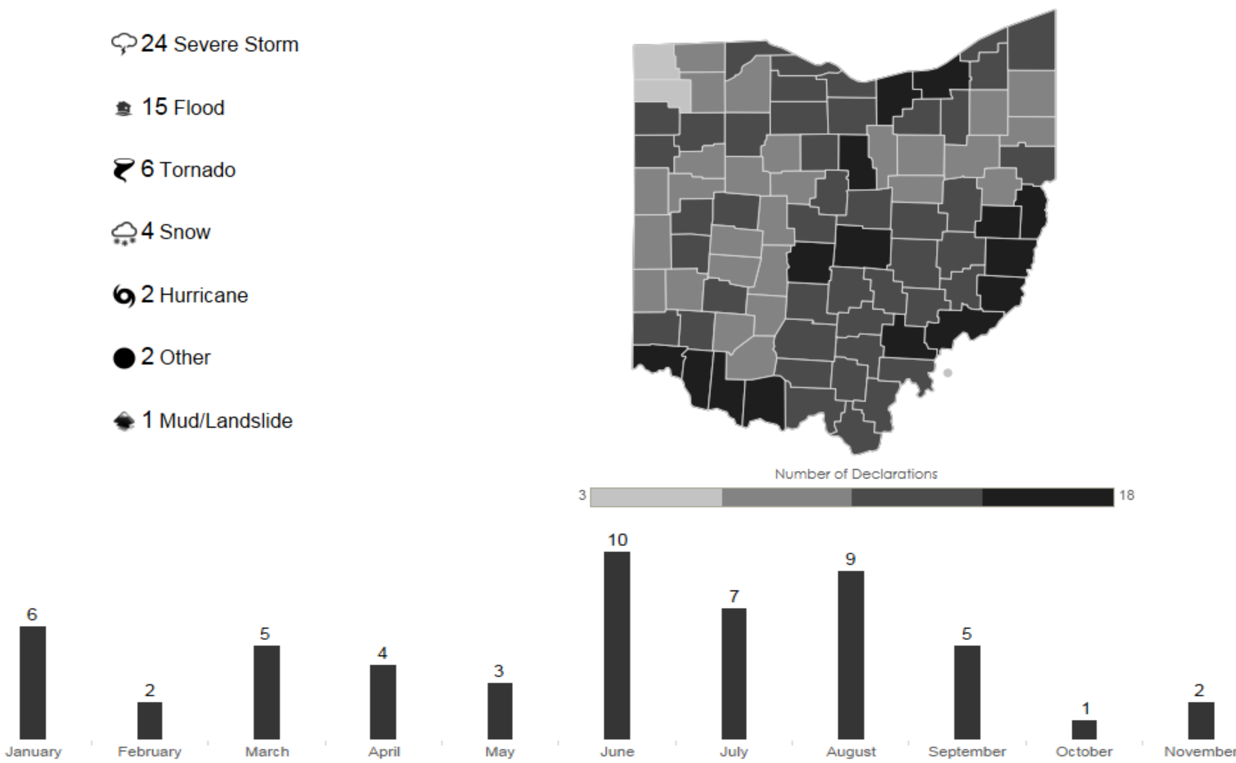
The five counties with the highest number of reported occurrences, 150 to 200 over 10 years, are Richland, Lorain, Cuyahoga, Summit and Stark. The area with the lowest reported occurrences is in south-central Ohio. Over half of the counties in Ohio have reported between 50 and 99 summer storm events over the course of 10 years. Based on the dispersion pattern (see map), proximity to Lake Erie appears to influence the number of summer storms.



Produced by the Ohio EMA. Disclaimer: The information presented on this map has been compiled through various sources. The Ohio EMA does not guarantee its accuracy. Source: National Climactic Data Center

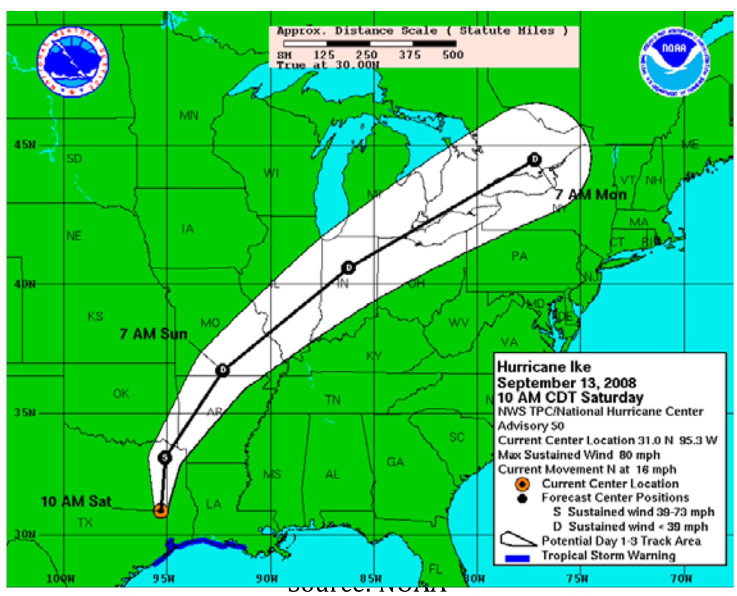
191 "Volleyball from the Sky," NOAA, accessed on 3 July 2015, http://www.noaa.gov/features/02_monitoring/hailstone.html

Since 1953, Ohio has received 54 federal disaster declarations. Of those 54 disasters, 24 have been related to severe storms. 26 of the 54 disaster declarations have occurred in the summer months of June, July and August.[192]



Source: FEMA

On September 14, 2008, Ohio experienced a storm that did enough damage to rival that of the 1974 Xenia tornado. The remnants of Hurricane Ike merged with a frontal boundary across the lower Ohio Valley on Sunday morning. Due to the very low pressure of this system, the pressure gradient to the south and east of the surface low remained very tight as it raced into northwest Ohio through Sunday evening. This led to widespread damaging winds across much of the Ohio Valley, with gusts in excess of 70 mph reported.



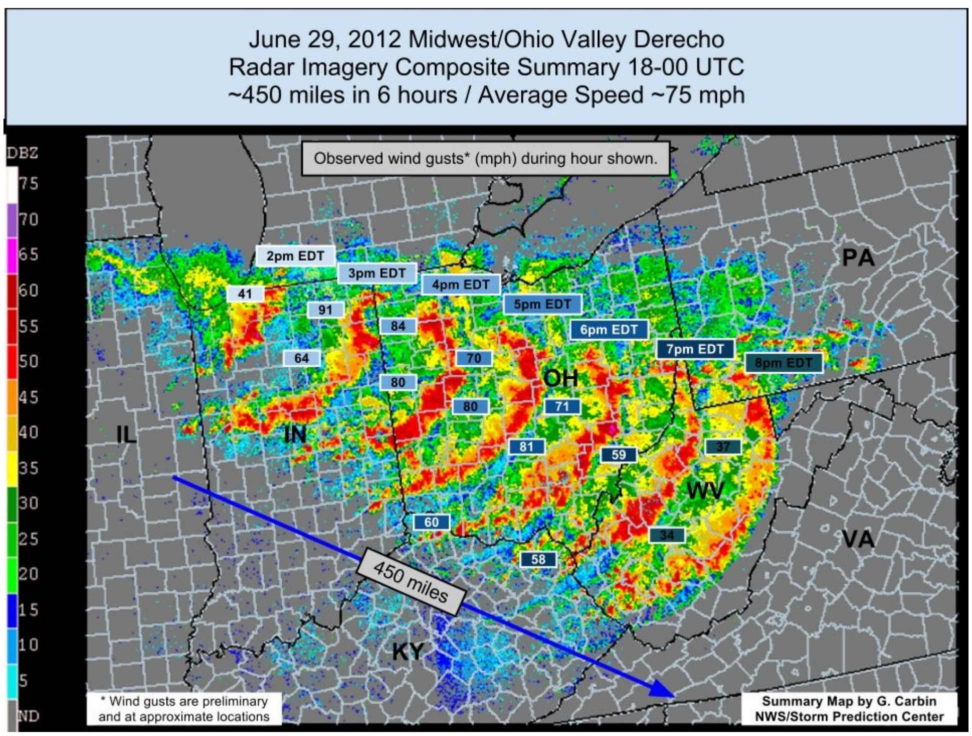
Source: NOAA

[192] "Data Visualization: Disaster Declarations for States and Counties," FEMA, accessed on 4 July 2015, http://www.fema.gov/data-visualization-disaster-declarations-states-and-counties

These severe winds persisted for several hours, which resulted in much more widespread damage than typical severe thunderstorm winds, which usually last a matter of minutes. The highest official measured gust was 79 mph at Dayton International Airport, and the highest unofficial measured wind gust was 84 mph in West Chester, Ohio. Winds of 75 mph were reported at Port Columbus International Airport. The initial damage total was $533,000,000. The heaviest damage occurred roughly along a corridor extending along and just north of the Ohio River through Indiana and Kentucky, and along and just north of the I-71 corridor into Central Ohio. The Cincinnati, Columbus, and Dayton metro areas were all strongly impacted. Damage to trees and structures across this corridor was widespread, and there were numerous injuries. Damage on either side of this corridor was less severe and was mostly limited to large tree branches and a few power lines blown down.

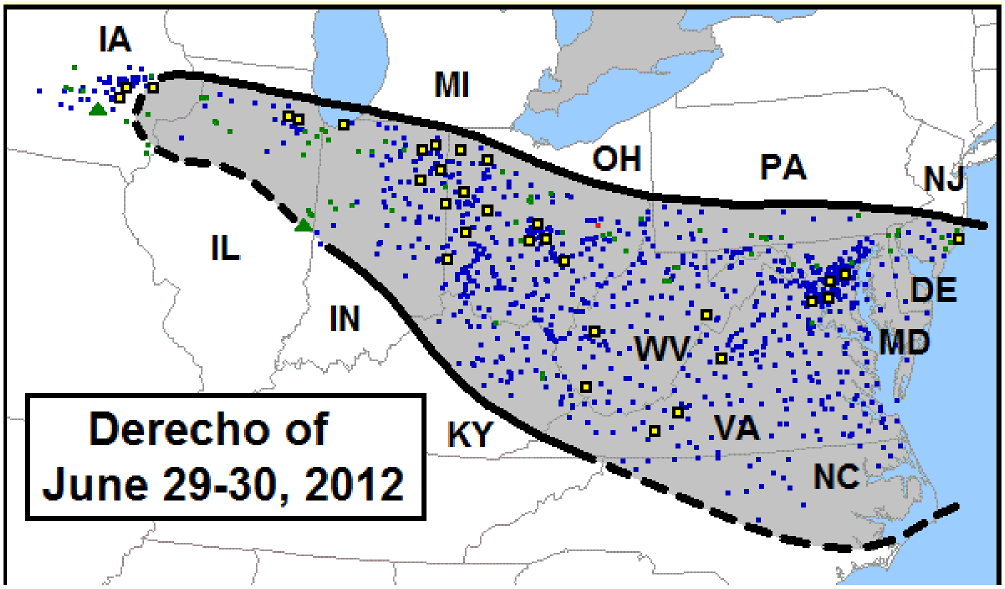
Widespread power outages affecting more than 2.6 million people were reported, and numerous roads and highways were blocked or closed due to debris and fallen power lines. Three fatalities were reported in the Cincinnati area, one in Central Ohio and two in southeast Indiana. It was weeks before all power was restored.

On June 29, 2012, a derecho tore across a number of states including Ohio. It caused widespread, significant wind damage and power outages for over 1 million people in Ohio. Wind gusts of over 80 mph were recorded and the derecho had an average forward speed of 60 mph. Insurance claims totaled over $433 million in Ohio alone. In the days following the derecho, hundreds of thousands were without power, some for up to a week, and temperatures topped 100 degrees as Ohio entered a heat wave.[193]



[193] "June 29, 2012 Derecho Event," NWS Wilmington, Ohio, accessed on 4 July 2015, http://www.erh.noaa.gov/iln/events/20120629/

In the map below, the small blue squares indicate wind damage or wind gusts ≥ 58 mph, larger black squares with yellow centers are wind gusts ≥ 74 mph, green squares are hail ≥ 0.75 inches; large green triangles are hail ≥ 2.0 inches; and small red square are tornadoes.



Source: NOAA Storm Prediction Center

Severe Summer Weather in Franklin County

Like Ohio, Franklin County is no stranger to severe summer weather. From January 1, 1950, to January 1, 2015, the National Climatic Data Center reported the following for Franklin County:[194]

Thunderstorm/Strong/High Wind Events

Number of Events	431
Deaths	2
Injuries	44
Damage	$138.097M

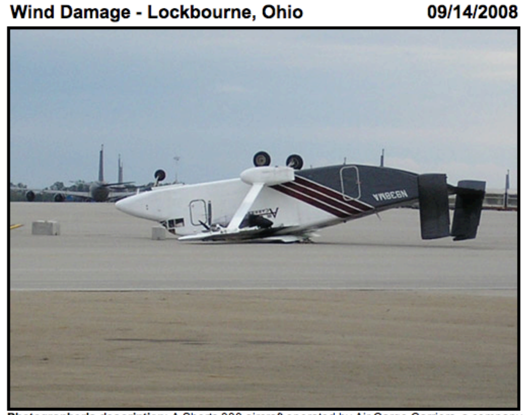
Lightning Events

Number of Events	5
Deaths	3
Injuries	4
Damage	$20K

Hail Events

Number of Events	212

Wind Damage - Lockbourne, Ohio 09/14/2008



Photographer's description: A Shorts 330 aircraft operated by Air Cargo Carriers, a company that does contract work for UPS. It was overturned on the ramp at Rickenbacker Airport (KLCK) on Sunday afternoon. The photo was taken on Monday early evening from near the base of the control tower looking southwest. The aircraft was unattended and not tied down. It weighs approximately 15,000 lbs empty.

Photographer	David Penney - NWS Spotter
Date taken	September 14, 2008
Location	Rickenbacker Airport - Near Lockbourne, OH (Franklin County) map
Event	Wind damage

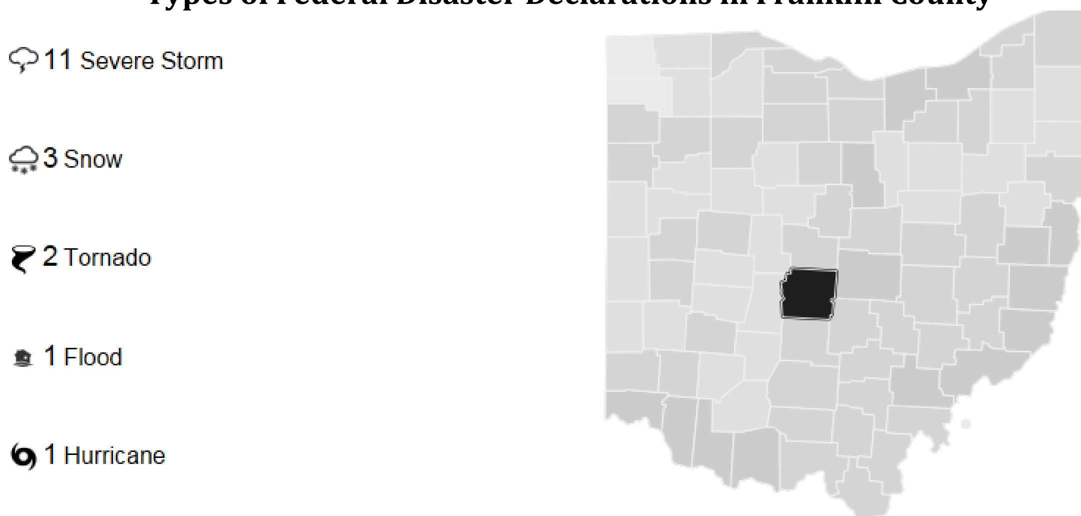
Source: NWS Wilmington, Ohio

194 "Query Results; Franklin County, Ohio," NCDC – NOAA, accessed on 1 February 2018, http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=39%2COHIO

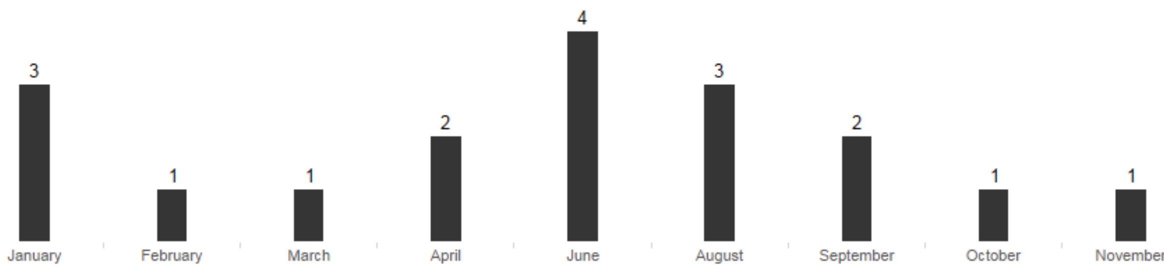
Deaths	0
Injuries	0
Damage	$181.297M

Of the 18 federal disaster declarations since 1953 in Franklin County, 11 were for severe storms.

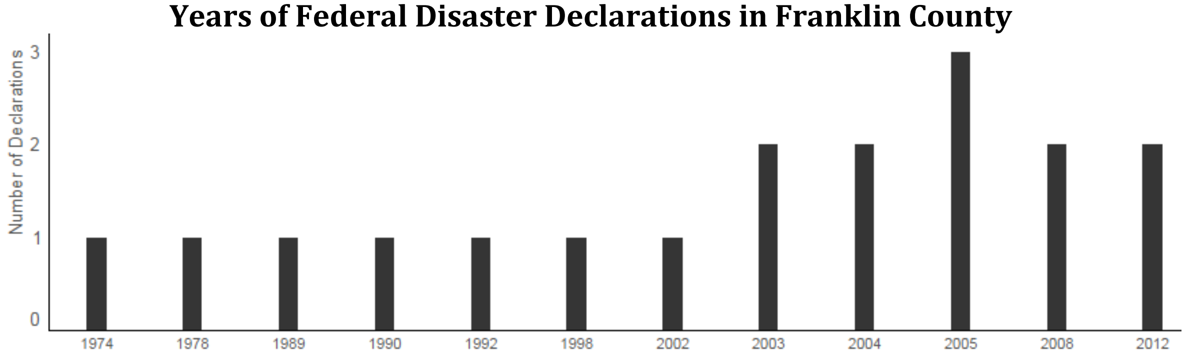
Types of Federal Disaster Declarations in Franklin County



Months of Federal Disaster Declarations in Franklin County



Years of Federal Disaster Declarations in Franklin County



Source: FEMA[195]

[195] "Data Visualization: Disaster Declarations for States and Counties," FEMA, accessed on 4 July 2015, http://www.fema.gov/data-visualization-disaster-declarations-states-and-counties

The remnants of Hurricane Ike were damaging for Franklin County. The National Climatic Data Center reported $128.7 million in damages for the county. Over 300,000 people were without power, some for over a week.

Wind Damage - Columbus, Ohio **09/14/2008**

Photographer's description: Tree of large circumference blown over onto power, cable and phone lines causing 2 utility poles to break on a residential street north of Ohio State University.

Photographer	James Delewese
Date taken	September 15, 2008
Location	Columbus, OH (Franklin County) map
Event	Wind damage

Franklin County Emergency Management and Homeland Security reported storm-related cost reimbursement from FEMA at over $3.7 million. The City of Columbus reported reaching nearly $4.3 million in storm related costs, most of it related to power failures, damaged equipment and buildings, and debris removal. Westerville led the suburbs with $406,188 in storm-related costs, more than half related to power failures.

The derecho of June 29, 2012 also heavily affected Franklin County. Not only did hundreds of thousands of people lose power for several days to a week, but it was also during an intense heat wave. This photo shows damage to the Hamilton Road area of Columbus as a result of the derecho.

The following are some examples of severe summer weather events as reported by the National Climate Data Center. More information is available at the following site.

http://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Hail&eventType=%28Z%29+Heat&eventType=%28Z%29+High+Wind&eventType=%28C%29+Lightning&eventType=%28Z%29+Strong+Wind&eventType=%28C%29+Thunderstorm+Wind&beginDate_mm=07&beginDate_dd=01&beginDate_yyyy=1950&endDate_mm=07&endDate_dd=31&endDate_yyyy=2015&county=FRANKLIN%3A49&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=39%2COHIO

Event Details

Event	Thunderstorm Wind
Magnitude	85 kts.
State	OHIO
County/Area	FRANKLIN
WFO	ILN
NCDC Data Source	PDC
Begin Date	1997-01-05 01:30:00.0 EST
Begin Lat/Lon	40.1/-83.12
End Date	1997-01-05 01:40:00.0 EST
End Location	DUBLIN
End Lat/Lon	40.1/-83.12
Deaths Direct/Indirect	0/0 (fatality details below, when available...)
Injuries Direct/Indirect	1/0
Property Damage	1M
Crop Damage	
Episode Narrative	A three block area of a neighborhood received extensive damage from a downburst. Major structural damage occurred to 8 homes while 37 other homes received minor damage. Numerous trees were downed. One injury occurred when debris was blown through a window into a child's bedroom.

Event Details

Event	Hail
Magnitude	1.75 in.
State	OHIO
County/Area	FRANKLIN
WFO	ILN
Report Source	TRAINED SPOTTER
NCDC Data Source	PDS
Begin Date	2003-04-20 19:10:00.0 EST
Begin Location	2W WESTERVILLE
Begin Lat/Lon	40.11667/-82.95
End Date	2003-04-20 19:20:00.0 EST
End Location	2W WESTERVILLE
End Lat/Lon	40.11667/-82.95
Deaths Direct/Indirect	0/0 (fatality details below, when available...)
Injuries Direct/Indirect	0/0
Property Damage	80M
Crop Damage	
Event Narrative	Hail up to the size of golf balls affected the north side of the Columbus metro area and southern Delaware county. Hail was extensive from Dublin, through Worthington and Powell, to Westerville. Trees and shrubs were stripped of their foliage and cars and homes sustained significant hail damage. The hail covered the ground in some locations up to six inches deep in Worthington in northern Franklin county and near the Polaris Mall in southern Delaware county.

Event Details

Event	Hail
Magnitude	2.00 in.
State	OHIO
County/Area	FRANKLIN
WFO	ILN
Report Source	Emergency Manager
NCDC Data Source	CSV
Begin Date	2006-10-04 18:05:00.0 EST-5
Begin Location	0N GAHANNA
Begin Lat/Lon	40.02/-82.87
End Date	2006-10-04 18:20:00.0 EST-5
End Location	0N BLACKLICK
End Lat/Lon	40/-82.82
Deaths Direct/Indirect	0/0 (fatality details below, when available...)
Injuries Direct/Indirect	0/0
Property Damage	100.00M
Crop Damage	0.00K
Episode Narrative	A line of severe thunderstorms affected central Ohio during the afternoon and evening ahead of a cold front.
Event Narrative	Hail up to hen egg size fell for up to 15 minutes across the eastern Columbus suburbs, causing extensive widespread damage to vehicles, homes and other structures. The hail accumulated up to several inches deep in spots, and remained on the ground well after the thunderstorm had passed.

Climate Change Impacts

In 2011, 11 of the 14 United States weather-related disasters with damages of more than $1 billion affected the Midwest. Several types of extreme weather events have already increased in frequency and/or intensity due to climate change, and further increases are projected.[196]

[196] Extreme Weather," U.S. Global Change Research Program. " accessed on 1 August 2015, http://nca2014.globalchange.gov/report/our-changing-climate/extreme-weather

Vulnerability Assessment – Severe Summer Weather

**Note: all information in this vulnerability assessment can be attributed to the Franklin County 2012 Natural Hazards Mitigation Plan and National Climatic Data Center searches accessed via* *http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=39%2COHIO*

This hazard is considered to be a "Relatively High Probability Event" meaning the anticipated frequency of the hazard within the County is more than twice but no more than 5 times a year. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability

Not all thunderstorms carry risks to property and lives, instead simply bringing needed rain to farmlands and reservoirs. No place in the United States is completely immune to the threats of severe thunderstorms. Thunderstorms can produce several severe weather conditions that are harmful to life and property including flash flooding, lightning, hail, high winds, and tornadoes.

Historically, Franklin County has always experienced thunderstorms and always will. Storm severity cannot be predicted, but improved weather radar and public warnings may lessen the impacts of these storms, allowing residents to be better prepared.

Potential Impact of Severe Summer Weather

The National Weather Service (NWS) estimates that over 100,000 thunderstorms occur each year on the U.S. mainland. Approximately 10 percent are classified as "severe." Thunderstorms can produce deadly and damaging tornadoes, hailstorms, intense microburst winds, lightning, and flash floods. Since 1975, severe thunderstorms were involved in more than 327 federal disaster declarations. Every thunderstorm produces lightning, which kills more people each year than tornadoes.

Severe summer storms can lead to property damage as well as loss of life. Severe summer storms damage structures, including homes and businesses, vehicles, and infrastructure, including utility lines. Neighborhoods can be left without power for several days. This can be life threatening to people who rely on life sustaining equipment powered by electricity in their homes. Severe Summer Storms can disrupt the operation of businesses and schools and recovery from storm damages can be costly.

In Franklin County, high winds occur annually. The most common detrimental effects are interruptions in power supply and communications services due to downed wires and blocked roadways due to downed trees.

As seen in a large portion of Ohio, including Franklin County, Tropical Depression Ike passed through Ohio with devastating force leaving hundreds of thousands without power with thousands of trees blown down.

In a worst case scenario, a severe summer storm could pass over Franklin County causing large power outages leaving hundreds of thousands without power. Large quantities of trees and large limbs will fall down potentially destroying everything onto which they fall including structures, power lines, and vehicles. Downed trees will also have the potential to obstruct emergency routes delaying emergency response times. The wind forces from a worst case scenario event like this will have the potential to knock over dilapidated buildings and cause exterior damage to a vast number of buildings within the County.

Identifying Structures

Exposure of Existing Buildings to Severe Summer Weather
The methodology for identifying structures potentially at risk of damage due to severe summer storms is the same as the methodology used to identify structures potentially at risk of damage due to heavy snow or ice.

All structures and infrastructure within Franklin County could be exposed to the effects of severe summer storms. Depending upon the severity of the storm, any existing structures might be damaged to some extent. However, in Franklin County, there are 169,283 structures that were built before 1960. Thus the percentage of existing buildings considered at particular risk of damage due to severe summer storms is 32.5%.

To predict the structural cost associated with a worst case scenario for a severe summer storm (which could include wind, hail and lighting); it is assumed that all structures older than 50 years will be significantly damaged. This analysis is based on the perception that building codes have become more stringent and that new building will withstand all wind forces expected in Ohio. To estimate the commercial values, the same percentage of structures will be assumed to be built over 50 years ago, which is 32.5%. According to the Franklin County Auditor's Office real estate report as of 2015 which contains information for tax year 2012, the total value of residential and commercial structures is $50.8 billion and $17.6 billion. Therefore, the estimated maximum damage that is expected for worst case scenario wind and hail damage is $16.51 billion and $5.72 billion, respectively.

For this assessment, to identify structures, we identified residents built prior to 1960. Non-Residential (Commercial) and Critical facilities from the current SHARPP data.

Residential – 169,283
Non – Residential – 55,017
Critical Facility - 0
Total 224,300

Exposure of Future Buildings to Severe Summer Weather
Any future structures could be exposed to severe summer storms as this hazard does not occur in specific locations. However, future buildings may be less likely to be damaged by the effects of severe summer storms as they will meet the most current building code requirements for bracing, roof design, and electrical grounding.

Estimating Potential Loss

Methodology
According to the NCDC, estimated property damage in Franklin County attributable to the five hazards associated with summer storms (thunderstorms, lightning, strong and high winds, and hail) accounts for $319.414 million in damage. Damage attributable to thunderstorms from 1950 through 2017 is $9.121 million. Damage attributable to lightning from 1950 through 2017 is $20,000. Damage attributable to strong and high winds from 1950 through 2017 is $128.976 million. Damage attributable to hail from 1950 through 2017 is $181.297 million. This data is used to estimate potential annual dollar losses due to severe summer storms.

Estimated Potential Dollar Losses
Due to severe summer storms combining four hazards that have been historically documented over different periods of time, the potential dollar losses from severe summer storms will be broken down into each specific hazard.

The total loss for thunderstorm winds over 67 years is $9.121 million; therefore, the average annual loss is $9.121 million / 67 = $136,134.

The total loss for lightning over 67 years is $20,000; therefore, the average annual loss is $20,000 / 67 = $298.50.

The total loss for strong and high winds over 67 years is $128.976 million; therefore, the average annual loss is $128.976 million / 67 = $1.925 million.

The total loss for hail over 67 years is $181.297 million; therefore, the average annual loss is $181,297 million / 67 = $2.706 million.

The total average estimated annual cost to all severe summer weather is $319.414 million / 67 = $4,767,373 million annually.

The damage in dollars represented in this vulnerability statement only quantify the damage to structures and does not reflect ancillary costs associated with this hazard.

Transportation Accident – Aircraft - #13

Hazard Summary

An aviation accident is defined as an occurrence associated with the operation of an aircraft which takes place between the times any person boards with the intent to fly and all persons have disembarked, in which a person is fatally or seriously injured, the aircraft sustains damage or structural failure, and/or the aircraft is missing or is completely inaccessible. Franklin County has four operational airports, all located in densely populated areas. According to the National Transportation Safety Board, since 1982 there have been 92 aviation accidents in the Columbus, Ohio area.[197] This hazard was ranked 13 out of 20.

[197] "Aviation Accident Statistics," NTSB, 4 May 2015, http://www.ntsb.gov/investigations/AccidentReports/Pages/aviation.aspx

Hazard Profile

The Convention on International Civil Aviation Annex 13 defines an aviation accident as an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, in which:

a) a person is fatally or seriously injured as a result of:

— being in the aircraft, or

— direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or

— direct exposure to jet blast,

except when the injuries are from natural causes, self-inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew; or

b) the aircraft sustains damage or structural failure which:

— adversely affects the structural strength, performance or flight characteristics of the aircraft, and

— would normally require major repair or replacement of the affected component,

except for engine failure or damage, when the damage is limited to the engine, its cowlings or accessories; or for damage limited to propellers, wing tips, antennas, tires, brakes, fairings, small dents or puncture holes in the aircraft skin; or

c) the aircraft is missing or is completely inaccessible.

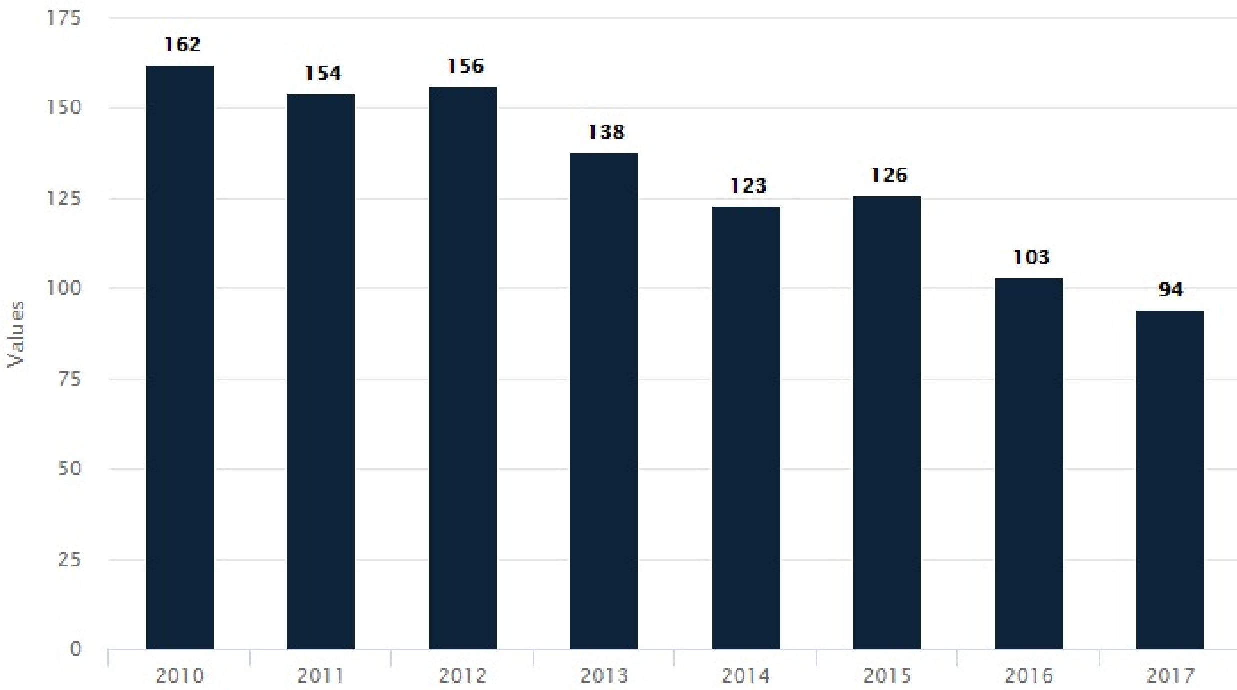
Air crashes are an ever-present danger because of the unforgiving nature of flight. Aircraft are designed to minimize the chance of failure, and pilots are trained with safety as a primary consideration. The relative rarity of incidents, coupled with the often-dramatic outcome, is one reason why aviation accidents make headline news. The odds of a plane crash today are distinctly low compared to those in other transportation modes, but the chance of fatalities in such a disaster is notably higher.

Plane crashes with large numbers of casualties started with the early passenger flights of the 1920s. The yearly death toll of plane crashes exceeded 100 for the first time in 1928, and 1000 for the first time in 1943. In the past 10 years, less deaths have occurred per year due to aviation accidents. In 2007, 2008, 2011, 2012, 2013, 2015, 2016, and 2017 less than 1,000 people died per year.[198]

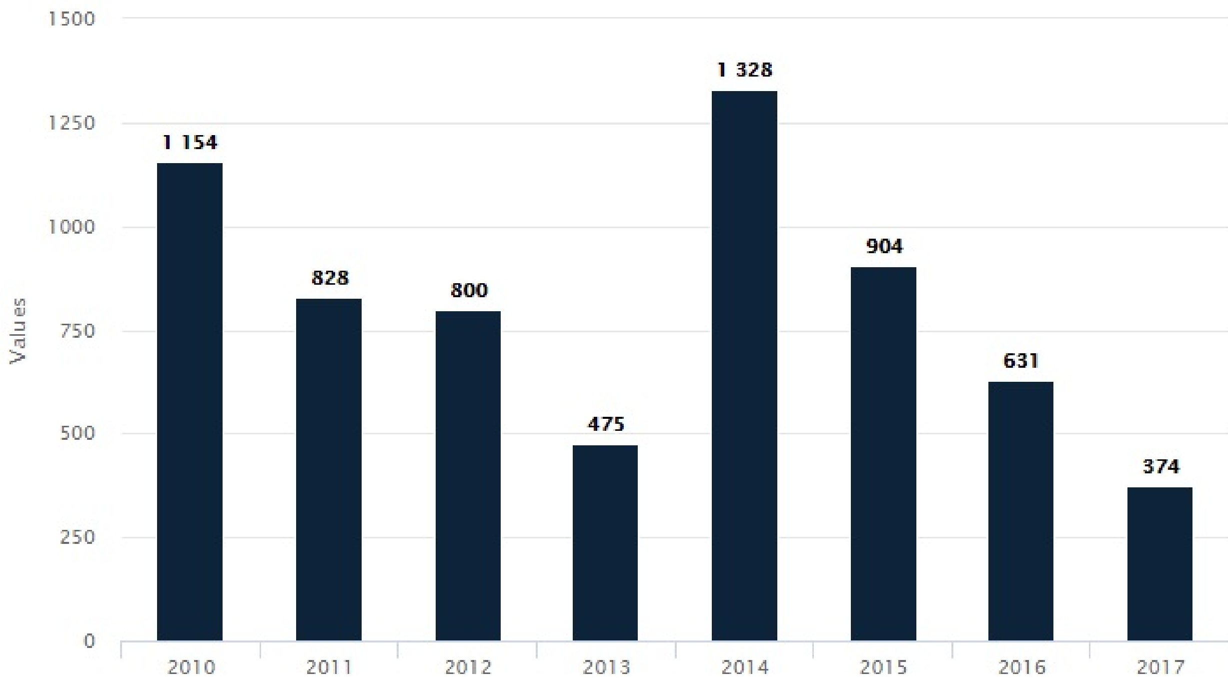
The charts on the next page illustrate the number of fatal accidents and fatalities on civil aircraft with 19 or more passengers.

[198] "Death Rate per Year," Bureau of Aircraft Accidents Archives (B3A), accessed on 28 February 2018, http://www.baaa-acro.com/statistics/death-rate-per-year

Number of Accidents [199]



Number of Fatalities [200]



199 http://www.baaa-acro.com/crash-graph?created[min]=2010-01-01&created[max]=2019-12-31
200 http://www.baaa-acro.com/casualities-graph?created[min]=2010-01-01&created[max]=2019-12-31

2015 – 2016 US Aviation Transportation Fatalities [201]

General Aviation	378	386
Airlines	0	0
Air Taxi	27	19
Commuter	1	8
Foreign/Unregistered*	12	4
Total, Aviation**	**416**	**412**

* Foreign/unregistered includes non-US registered aircraft involved in accidents in the United States
** Total fatalities may not equal the sum of each category because accidents may involve multiple categories.

Causes of Fatal Aircraft Accidents

A study compiled by PlaneCrashInfo.com representing 1,015 fatal accidents involving commercial aircraft world-wide from 1950 through 2010 for which a specific cause was known. Aircraft with 18 or less passengers aboard, military aircraft, private aircraft and helicopters are not included.[202]

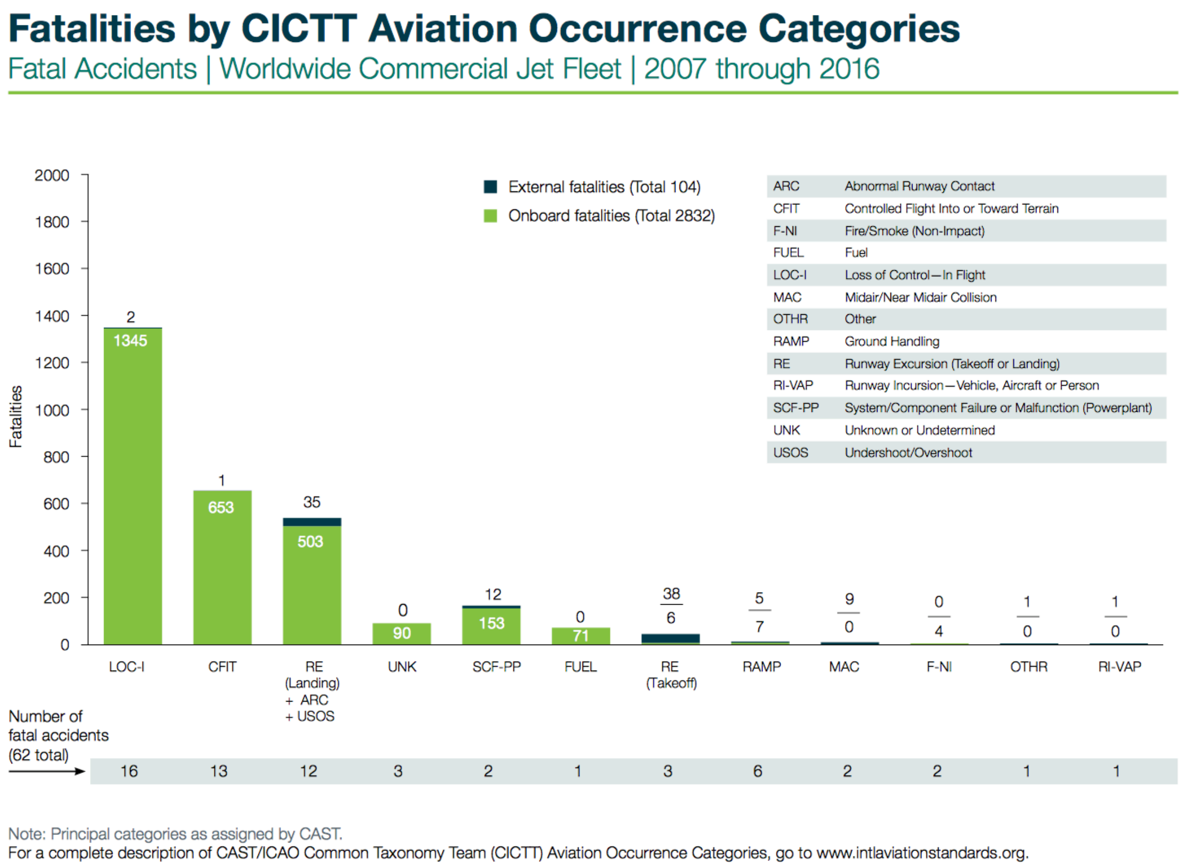
Causes of Fatal Accidents by Decade (Percentage)

Cause	1950s	1960s	1970s	1980s	1990s	2000s	All
Total Pilot Error	58	63	44	57	55	57	53
Pilot Error	43	33	25	29	29	34	32
Pilot Error (weather related)	9	18	14	16	21	18	16
Pilot Error (mechanical related)	7	4	5	2	5	5	5
Other Human Error	2	8	9	5	8	6	6
Weather	15	12	14	14	8	6	12
Mechanical Failure	19	19	20	21	18	22	20
Sabotage	5	4	11	12	10	9	8
Other Cause	0	2	2	1	1	0	1

Source: PlaneCrashInfo.com

Pilot error was the most reported cause, accounting for an average of 53% of all accidents, followed by mechanical failure at 20%. Roughly 12% were reported as weather related.

[201] https://www.ntsb.gov/investigations/data/Documents/TransportationFatalites-2015-2016.pdf
[202] "Statistics," PlaneCrashInfo.com, accessed on 22 June 2015, http://planecrashinfo.com/cause.htm



Source: Statistical Summary of Commercial Jet Airplane Accidents, Boeing

The chart above is from the Boeing 2016 Statistical Summary and illustrates the categories of commercial fatal airline accidents worldwide from 2007 through 2016. The leading category of fatal accidents is loss of control in flight followed by controlled flight into or toward terrain.[203]

The FAA System Safety Handbook states that accidents are the result of multi-contributors: unsafe acts and/or conditions, failures, errors, malfunctions, inappropriate functions, normal functions that are out of sequence, faults and anomalies.

Aviation Safety

Despite the growing demands on the U.S. aviation system, the system continues to maintain its high level of safety. The accident rate for commercial aircraft has remained about the same for the past two decades. However, increased traffic projected over the next ten years could be accompanied by a commensurate increase in the number of aircraft accidents.

[203] "Statistical Summary on Commercial Jet Airplane Accidents-Worldwide Operations 2007-2016," Boeing Commercial Airplanes-Aviation Safety, accessed on 8 April 2018, http://www.boeing.com/resources/boeingdotcom/company/about_bca/pdf/statsum.pdf

Aviation has come a long way in the last 100 years. Heavy passenger aircraft for the civilian market are manufactured by two major companies – Boeing, of the United States, and the European company Airbus. When measured on a passenger-distance calculation, air travel is the safest form of transportation available. The following are the figures quoted by the airline industry. For every billion kilometers traveled, trains have a fatality rate 12 times larger than air travel, while automobiles have a fatality rate 62 times larger. However, when measured by fatalities per person transported, buses are the safest form of transportation.

The National Transportation and Safety Board (NTSB) reported the following statistics:

Accident Summary for Major Segments of US Civil Aviation CY 2015

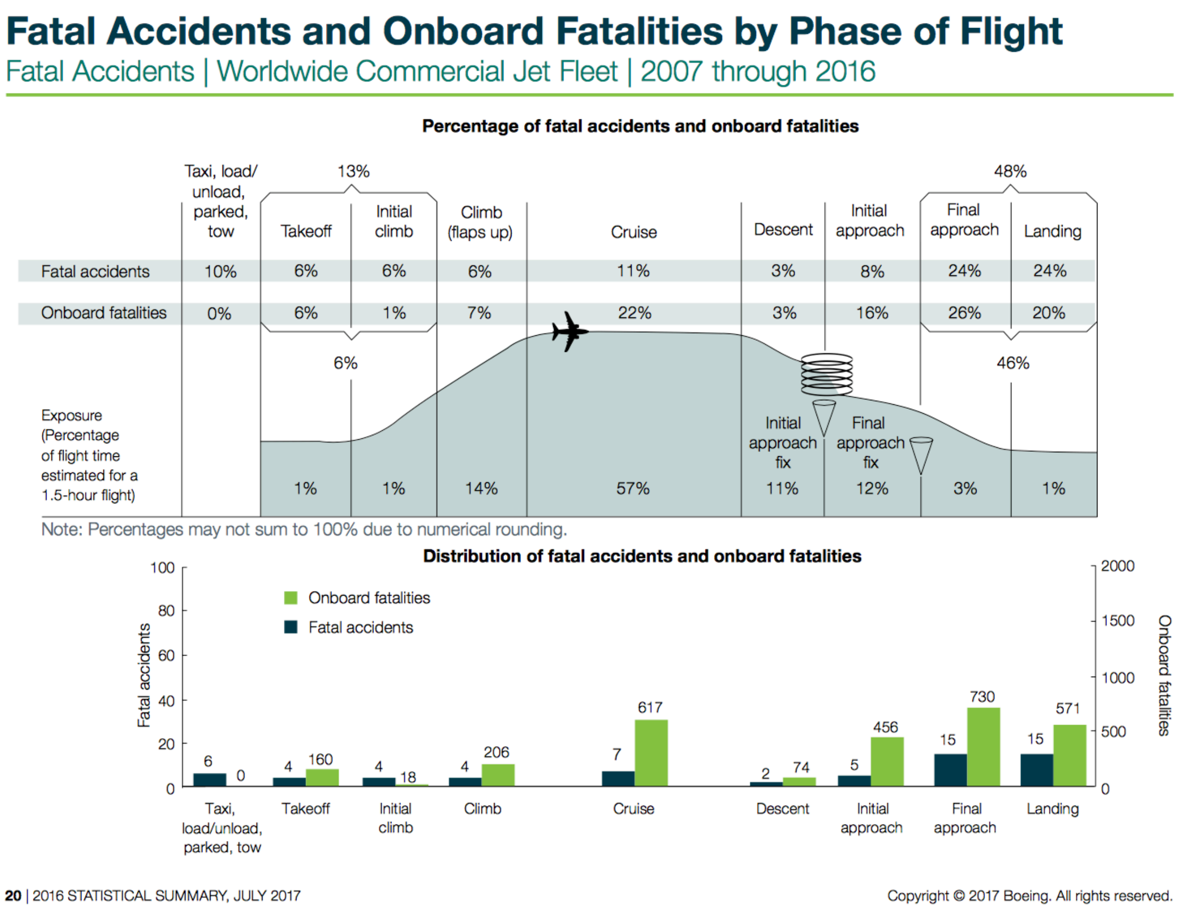
Segment	Accidents	Fatal Accidents	Fatalities
Part 121 Air Carriers	30	0	0
Part 135 Commuter and On-Demand Carriers	43	8	28
General Aviation	1210	230	378
Total US Civil Aviation	**1282**	**238**	**406**

Source: Accident Summary for Major Segments of US Civil Aviation CY 2015[204]

Airline crashes can happen anywhere. It is known that 16% of all major crashes are low-impact crashes on the airport runway, while 79% are high impact crashes within one and one half miles of the airport. The remaining occur during travel.

The chart on the following page illustrates the percentage of fatal accidents and onboard fatalities by phase of flight.

[204] "Accident Summary for Major Segments of US Civil Aviation CY 2015", NTSB, accessed on 8 April 2018, http://www.ntsb.gov/investigations/data/Pages/AviationDataStats.aspx



Source: Statistical Summary of Commercial Jet Airplane Accidents, Boeing[205]

Aircraft Accidents in the United States

In the United States, most civil aviation incidents are investigated by the National Transportation Safety Board (NTSB). The NTSB will also investigate incidents which occur overseas in collaboration with local investigation authorities where the crash has involved a U.S.-registered aircraft, where there has been significant loss of American lives, or when the type of aircraft involved was built by an American manufacturer.

The deadliest aviation-related disaster of any kind, considering fatalities on both the aircraft and on the ground, was the destruction of the World Trade Center in New York City on September 11, 2001. The crashes killed 2,988, most of them in the World Trade Center Towers or emergency personnel responding to the disaster.

More recent aircraft accidents in the United States include that of Delta Airlines Flight 1086, which skidded off the runway at LaGuardia Airport in New York City March 5, 2015 and crashed into a fence, coming inches from Flushing Bay. No fatalities occurred, but more

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205 "Statistical Summary of Commercial Jet Airplane Accidents," Boeing, accessed on 8 April 2018 http://www.boeing.com/resources/boeingdotcom/company/about_bca/pdf/statsum.pdf

than a dozen people were injured. On July 6, 2013, Asiana Airlines Flight 214 crashed on the final approach into San Francisco. Three people died and 187 were injured.

Aircraft Accidents in Ohio

The Ohio Department of Transportation, Aviation Division reports the following aviation facts for Ohio.[206]

Ohio Airports

Type	Number
Public Use Airports	157
Public Use Heliports	14
Public Use Seaplane Landing Areas	2
Privately Owned/Private Use Airports & Heliports	633

Ohio Aircraft/Pilots

FAA Registered Aircraft in Ohio	Approximately 11,000
FAA Registered Pilots in Ohio	Approximately 18,000

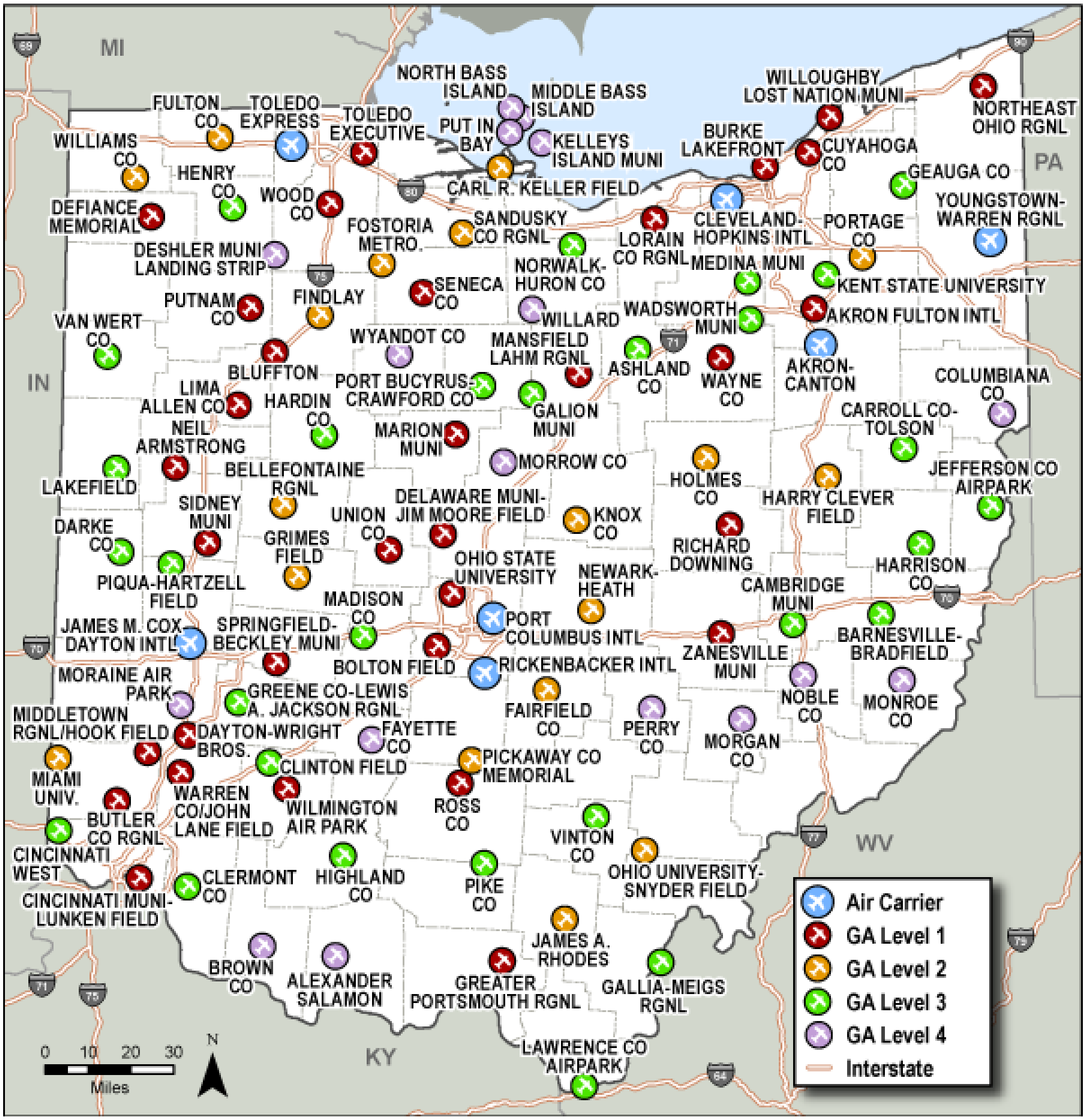
Economic Impact of the Ohio Airport System

Total Employment	123,456 Jobs
Total Payroll	$4.2 Billion
Total Economic Impact/All Airports	$13.3 Billion
Total Economic Impact/General Aviation Airports	$1.8 Billion

Ohio Airports [207]

[206] "Aviation Overview", Ohio Department of Transportation, accessed on 17 Jan 2016, http://www.dot.state.oh.us/Divisions/Operations/Aviation/Pages/Overview.aspx

[207] "Ohio Airports Focus Study Findings", Ohio Department of Transportation, accessed on 17 Jan 2016, https://www.dot.state.oh.us/Divisions/Operations/Aviation/OhioAirportsFocusStudy/Pages/default.aspx



Source: ODOT

In Ohio from 1962-2015 there have been 4,123 aviation accidents with a total of 571 fatalities. Included in these statistics are crashes that occurred on approach to the Greater Cincinnati Airport, which is actually located in Covington, Kentucky.[208]

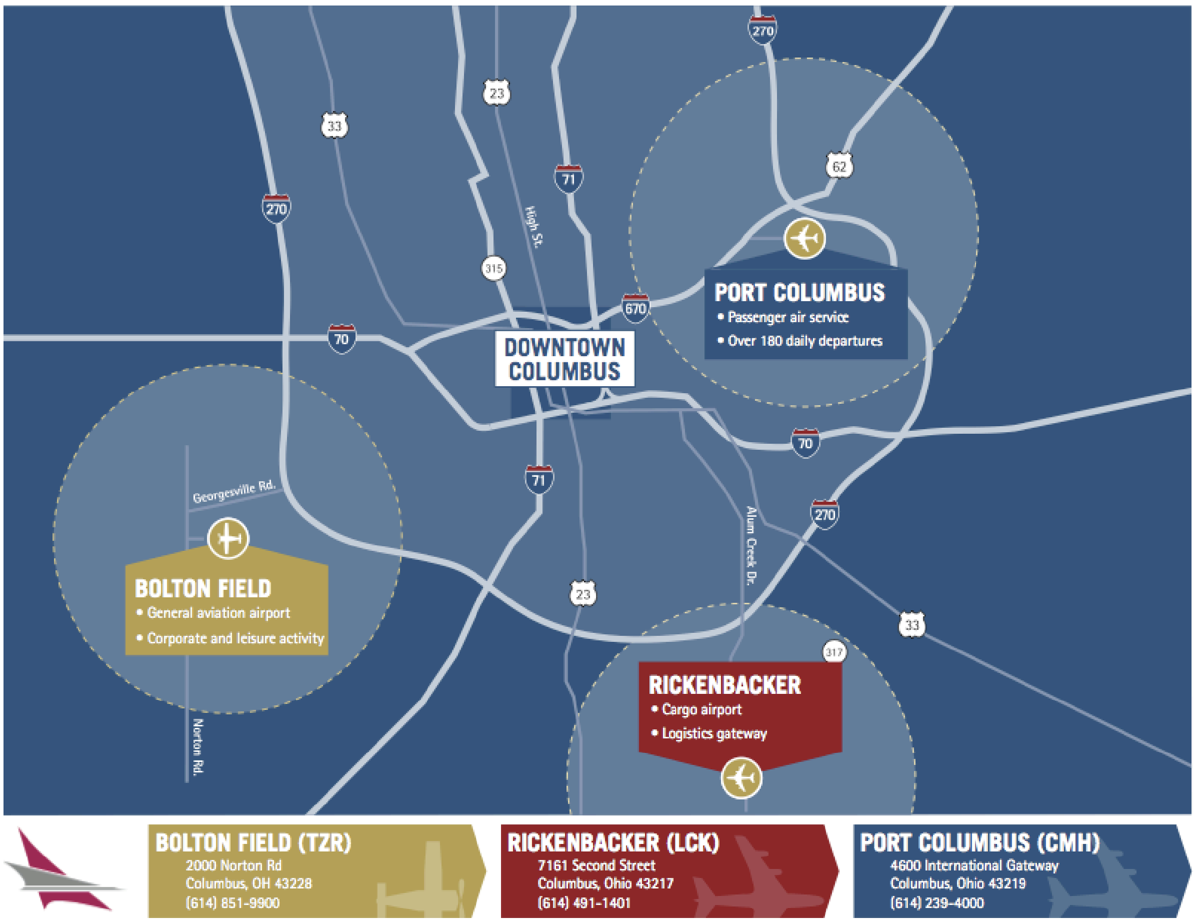
Many aircraft accidents in Ohio involve small planes. The worst plane crash to take place on Ohio soil was near Marseilles, Ohio. A Lake Central Airlines Convair CV-380 crashed on March 5, 1967, when all four blades fell off the right propeller. The No. 2 blade penetrated

[208] "Aviation Accident Statistics," NTSB, 4 May 2015 http://www.ntsb.gov/investigations/AccidentReports/Pages/aviation.aspx

and destroyed the structural integrity of the fuselage. All 38 people on board were killed, 35 passengers and three crew.

Aircraft Accidents in Franklin County

Airports
Areas adjacent to airports present the greatest potential locations for an aircraft incident. Franklin County has four airports in densely populated areas. This increases the impact to Franklin County from an air crash incident. Three of Franklin County's airports are operated by the Columbus Regional Airport Authority: Port Columbus International Airport, Rickenbacker Inland Airport, and Bolton Field. The fourth, Don Scott Field, is operated by The Ohio State University.



Source: Columbus Regional Airport Authority

Port Columbus International Airport

Port Columbus International Airport was opened in 1929 as part of the first Transcontinental Air / Rail Service from New York to the West Coast.[209] Over 6.3 million passengers used Port Columbus in 2014, the highest since 2011.

Rickenbacker Inland Airport
Rickenbacker is an international cargo-dedicated airport, a multimodal logistics hub, a charter passenger terminal, a U.S. Foreign-Trade Zone, and a major component of the economic engine of Central Ohio.[210]

Bolton Field
Bolton Field, constructed in 1970, serves as a reliever to Port Columbus. It has 5,500 feet of runway and parallel taxiway. It serves corporate and business transportation, aircraft re-fueling and maintenance, aircraft charters, flight training, recreational flying, aerial advertising, and traffic reporting. Events and activities such as fly-ins, banner towing and ballooning also take place on airport grounds.[211]

The Ohio State University Airport – Don Scott Field
Don Scott Field is home to 230 aircraft, including single and multi-engine, piston and turbine engine aircraft and rotorcraft.[212]

Source: Wikipedia File Photo

Accidents
According to the National Transportation Safety Board since 1982 there have been 92 aviation accidents in the Columbus, Ohio area. For detailed information on these incidents refer to the following source website (please note it will be necessary for the user to run the query). http://www.ntsb.gov/_layouts/ntsb.aviation/Results.aspx?queryId=00e45cfe-f7ec-4d97-b064-ddff77d62478

Two notable aviation accidents are as follows:

[209] "About Port Columbus," Columbus Regional Airport Authority, accessed on 26 July 2015 http://columbusairports.com/general-aviation/port-columbus/port-columbus
[210] "About Rickenbacker," Columbus Regional Airport Authority, accessed on 26 July 2015 http://columbusairports.com/general-aviation/rickenbacker/
[211] "Bolton Field," Columbus Regional Airport Authority, accessed on 26 July 2015, http://columbusairports.com/general-aviation/bolton-field/bolton-field
[212] "The Ohio State University Airport," Ohio State University, accessed on 27 July 2015, http://www.osuairport.org

- January 7, 1994. A United Express Jetstream J4101 commuter plane stalled while approaching runway 28L during a snowstorm. The plane struck a concrete block building about 1.2 miles east of the runway at Port Columbus. Seven of the 12 people on board died. The plane was destroyed by a post-crash fire. There was damage on the ground to numerous trees, the storage warehouse was destroyed along with heavy mechanical equipment and an automobile, which were inside.
- September 1, 2008. A scheduled cargo flight, an Air Tahoma Convair CV-580, took off from Rickenbacker on a flight to Mansfield, Ohio. The pilot radioed he was returning to the airport, but crashed in a cornfield and caught fire. All three people on board died.

Vulnerability Assessment – Transportation Accidents - Aircraft

This hazard is considered to be a "Very Low Probability Event" meaning the frequency of the hazard is historically once every 125 years or more. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability
Transportation accidents involving aircraft can and do happen anytime and anywhere; however, there is no historical data that these have caused significant structural damage in Franklin County.

Potential Impact of Transportation Accidents Involving Aircraft
For this vulnerability assessment a worst-case scenario of a large commercial aircraft (747) accident in downtown Columbus was analyzed. The site for the accident is at the intersection of High Street and Broad Street.

Identifying Structures
A 747 requires approximately 10,000 feet to land depending on the model of the aircraft. The wing span of this aircraft is 224.7 feet. According to the Franklin County Emergency Management & Homeland Security (FCEM&HS) Geographic Information Systems (GIS) program there are approximately 69 structures in this area from High Street and Broad Street. Zero structures were considered to be critical facilities.

Exposure of Existing Buildings to Damages Due to Transportation Accidents Involving Aircraft
For this worst case scenario consider the following damage based upon proximity to the aircraft:

Feet	Structural Loss	Number of Structures
0-2500	100%	23
2,500-5,000	50%	12
5,000-10,000	25%	6

Exposure of Future Buildings to Damages Due to Transportation Accidents Involving Aircraft
Exposure to future structures is expected to be the same as for existing structures.

Estimating Potential Loss

Methodology
For this assessment Franklin County Emergency Management and Homeland Security provided information from their GIS program. This data was used in the development of the following data.

According to the FCEM&HS GIS report there are 69 structures within this 225 foot by 10,000 foot area from High and Broad Streets with a total replacement value of $155,663,700.

Using the above information:

Feet	Structural Loss	Number of Structures	Value
0-2500 feet	100%	23	$51,887,900
2,500-5,000	50%	12	$25,943,950
5,000-10,000	25%	6	$12,971,975

Estimated Potential Dollar Losses
Using the above methodology the total number of structures impacted would be 41. The total value of the loss would be $90,803,825.

The damage in dollars represented in this vulnerability statement only quantify the damage to structures and does not reflect ancillary costs associated with this hazard.

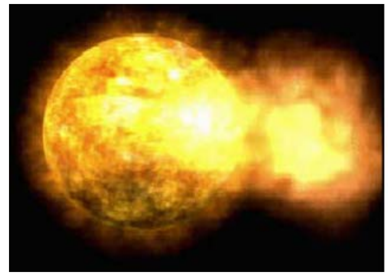
Space Weather - #14

Hazard Summary

Space weather is a consequence of the behavior of the Sun, the nature of Earth's magnetic field and atmosphere, and our location in the solar system. The active elements of space weather are particles, electromagnetic energy, and magnetic field, rather than the more commonly known weather contributors of water, temperature, and air.[213] There are various phenomena that originate from the Sun that can result in space weather storms. Outbursts from huge explosions on the Sun—Solar Flares and Coronal Mass Ejections (CME)—send space weather storms hurling outward through our solar system. The Sun also emits a continuous stream of radiation in the form of charged particles that make up the plasma of the solar wind. Solar storms can impact the technology we rely on every day: Global Positioning Systems (GPS), satellites, and electric power grids. Just as with other types of weather, the National Weather Service forecasts space weather disturbances and serves as the official source for civilian alerts and warnings.[214] This hazard was added for the 2018 risk assessment update and was ranked 14 out of 20.

213 "A Profile of Space Weather", NOAA Space Weather Prediction Center, accessed on 30 March 2016, http://www.swpc.noaa.gov/sites/default/files/images/u33/primer_2010_new.pdf
214 "Space Weather: Storms from the Sun", accessed on 30 March 2016, http://www.swpc.noaa.gov/sites/default/files/images/u33/swx_booklet.pdf

Hazard Profile



Source: NASA

The sun is the main source of space weather and is an average star, similar to millions of others in the Universe. Its basic energy source is nuclear fusion, which uses high temperatures and densities within its center to fuse hydrogen molecules and produce energy.[215] The sun is highly magnetic and turbulent with many features which impact the Earth and create wide-ranging impacts on communications, GPS, and satellites.

Sunspots are dark areas on the surface of the sun which contain strong magnetic fields that are constantly shifting. On average, sunspots are about the size of the Earth. They form when strong magnetic fields emerge through the solar surface and result in surface cooling from about 6000°C to 4200°C. The frequency of sunspots on the Earth's surface increases and decreases through an 11-year cycle ranging from Solar Minimum (lowest number of sunspots) to Solar Maximum (largest number of sunspots). The increase in sunspots also corresponds with an increase in solar activity and the highest space weather impacts on Earth.[216]

Increased solar activity can happen at any time during the solar cycle, but is most likely to come from an area with a high concentration of sunspots.[217] Solar activities which impact space weather here on earth are classified as solar particle events. The two types are sudden bursts of radiation called solar flares, and sudden bursts of plasma and magnetic field structures from the sun's atmosphere called coronal mass ejections (CMEs).

Space Weather Terms

Watches are used for making long-lead predictions of geomagnetic activity.

Warnings are used to raise the public's level of alertness based on an expectation that a space weather event is imminent.

Space Weather Causes

Coronal Mass Ejection (CME)

Large portions of the corona, or outer atmosphere of the Sun, can be explosively blown into space, sending billions of tons of plasma, or superheated gas, in Earth's direction. These CMEs have their own magnetic field and can slam into and interact with Earth's magnetic field, resulting in geomagnetic storms. The fastest of these CMEs can reach Earth in under a day, with the slowest taking 4 or 5 days to reach Earth.[218]

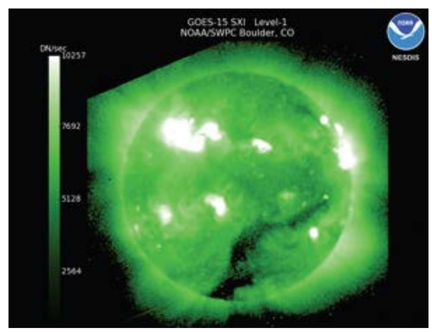
[215] "A Profile of Space Weather", NOAA Space Weather Prediction Center, accessed on 30 March 2016, http://www.swpc.noaa.gov/sites/default/files/images/u33/primer_2010_new.pdf
[216] "A Profile of Space Weather", NOAA Space Weather Prediction Center, accessed on 30 March 2016, http://www.swpc.noaa.gov/sites/default/files/images/u33/primer_2010_new.pdf
[217] "Space Weather", NOAA Space Weather Prediction Center, accessed on 30 March 2016, http://www.swpc.noaa.gov/sites/default/files/images/u33/swx_poster_a.jpg
[218] "Space Weather", NOAA Space Weather Prediction Center, accessed on 30 March 2016, http://www.swpc.noaa.gov/sites/default/files/images/u33/swx_poster_a.jpg

Solar Flares
Reconnection of the magnetic fields on the surface of the Sun drive the biggest explosions in our solar system. These solar flares release immense amounts of energy and result in electromagnetic emissions spanning the spectrum from gamma rays to radio waves. Traveling at the speed of light, these emissions make the 93 million mile trip to Earth in just 8 minutes.[219]

Types of Space Weather

Radio Blackouts
Radio Blackouts are caused by bursts of X-ray and Extreme Ultra Violet radiation emitted from solar flares. Radio blackouts primarily affect High Frequency (HF) (3-30 MHz) communication, although fading and diminished reception may spill over to Very High Frequency (VHF) (30-300 MHz) and higher frequencies. These storms are a consequence of enhanced electron densities caused by solar flare emissions. The emissions ionize the sunlit side of Earth, which increases the amount of energy lost as radio waves pass through this region.

Radio blackouts are among the most common space weather events to affect Earth. Minor events occur, on average, 2000 times each solar cycle. Blackouts are by far the fastest to impact our planet. The X-rays creating radio blackouts arrive at the speed of light–8 minutes from Sun to Earth, making advance warnings difficult. Usually the radio blackouts last for several minutes, but they can last for hours.[220]



Solar Flare
Source: NOAA Space Weather Prediction Center

Solar Radiation Storms
Solar radiation storms occur when large quantities of charged particles, protons and electrons, are accelerated by processes at or near the Sun. When these processes occur, the near-Earth satellite environment is bathed with high energy particles. Earth's magnetic field and atmosphere offer some protection from this radiation, but the amount of protection is a function of altitude, latitude, and magnetic field strength. The polar regions are most affected by energetic particles because the magnetic field lines at the poles extend vertically downwards, allowing the particles to spiral down the field lines and penetrate into the atmosphere, increasing ionization.

Energetic protons reach Earth within 30 minutes to several hours after a solar eruption. Solar radiation storms can last from a few hours to days, depending on the magnitude of

[219] "Space Weather", NOAA Space Weather Prediction Center, accessed on 30 March 2016, http://www.swpc.noaa.gov/sites/default/files/images/u33/swx_poster_a.jpg
[220] "Space Weather: Storms from the Sun", accessed on 30 March 2016, http://www.swpc.noaa.gov/sites/default/files/images/u33/swx_booklet.pdf

the eruption. Solar radiation storms can occur at any time during the solar cycle but tend to be most common around solar maximum.[221]

Geomagnetic Storms

Geomagnetic storms, strong disturbances to Earth's magnetic field, pose problems for many activities, technological systems, and critical infrastructure. The Earth's magnetic field changes in the course of a storm as the near-Earth system attempts to adjust to the jolt of energy from the Sun carried in the solar wind. CMEs and their effects can disturb the geomagnetic field for days at a time.

Aurora Borealis or Northern Lights
Source: U.S. Air Force

The most visible attribute of a geomagnetic storm is the aurora, which becomes brighter and moves closer to the equator. This heightened aurora signals the vigorous electrodynamic processes at play as they respond to the burst of energy.

Geomagnetic storms usually last a few hours to days. The strongest storms may persist for up to a week. A string of CMEs may cause prolonged disturbed periods related to the additional energy being pumped into Earth's magnetic field. The frequency of geomagnetic storms, in general, depends on where we are in the solar cycle–with most storms occurring near solar maximum; however, these storms are also common in the declining phase due to high-speed solar wind streams.[222]

Impacts of Space Weather

Electric Power Transmission

Geomagnetic storms result in electric currents as the area shaped by Earth's magnetic field is compressed and disturbed. The disturbed conditions create additional currents in long conductors on the ground such as overhead transmission lines or long pipelines. In the most extreme cases, these currents can cause voltage instability or damage to power system components, potentially resulting in temporary service disruptions, or even a widespread power outage.[223]

Global Positioning Systems (GPS)

Geomagnetic storms can impact the accuracy and availability of GPS by changing the ionosphere, the electrically charged layer of the atmosphere a GPS signal must pass through from satellite to ground receiver. The ionosphere is the largest source of error in

221 "Space Weather: Storms from the Sun", accessed on 30 March 2016, http://www.swpc.noaa.gov/sites/default/files/images/u33/swx_booklet.pdf
222 "Space Weather: Storms from the Sun", accessed on 30 March 2016, http://www.swpc.noaa.gov/sites/default/files/images/u33/swx_booklet.pdf
223 "Space Weather", NOAA Space Weather Prediction Center, accessed on 30 March 2016, http://www.swpc.noaa.gov/sites/default/files/images/u33/swx_poster_b.jpg

GPS positioning and navigation. These ionospheric disturbances are ever-present but can become severe during geomagnetic storms, resulting in range errors in excess of 100 feet, or even resulting in loss of lock on the GPS signal entirely. These errors can have significant impacts on precision uses of GPS such as navigation, agriculture, oil drilling, surveying, and timing.[224]

HF Radio Communications/Aviation

Space weather impacts radio communication in a number of ways. The changes in ionospheric density and structure modify the transmission path and even block transmission of high frequency radio signals completely. These frequencies are used by amateur (ham) radio operators, industries such as commercial airlines, and government agencies such as the Federal Emergency Management Agency and the Department of Defense.[225]

Satellite Communications

There are thousands of satellites in orbit around Earth with applications in television and radio, communications, meteorology, national defense, and much more. Space weather can affect these satellites in many ways. Solar radiation storms can cause spacecraft orientation problems by interfering with star trackers and by causing errors or damage in electronic devices. Geomagnetic storms can create a hazardous charging environment for satellites resulting in damaging electrostatic discharge, much like touching a door knob and getting that spark on a dry winter day. Geomagnetic storms also cause heating of the atmosphere, essentially causing it to expand, which results in more drag or slowing down of an orbiting satellite. In a worst case, space weather can cause the satellite to fail.[226]

GPS Satellite
Source: Space Weather Center

Historically Significant Geomagnetic Storms

Carrington Event of August-September 1985: strongest geomagnetic storm on record. During this event, currents electrified telegraph lines which in some cases set telegraph papers on fire; and the Northern Lights (electrically charged particles from the sun that enter Earth's atmosphere) were visible as far south as Cuba and Hawaii.

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224 "Space Weather", NOAA Space Weather Prediction Center, accessed on 30 March 2016, http://www.swpc.noaa.gov/sites/default/files/images/u33/swx_poster_b.jpg

225 "HF Radio Communications," NOAA, accessed on 22 September 2015, http://www.swpc.noaa.gov/impacts/hf-radio-communications

226 "Space Weather", NOAA Space Weather Prediction Center, accessed on 30 March 2016, http://www.swpc.noaa.gov/sites/default/files/images/u33/swx_poster_b.jpg

March 13, 1989: a powerful geomagnetic storm caused a major blackout in Canada that left six million people without electricity for nine hours. According to the North American Electric Reliability Corporation (NERC), the flare disrupted electric power transmission from the Hydro Québec generating station and even melted some power transformers in New Jersey.[227]

Space Weather Scales

The NOAA Space Weather Scales report three categories of solar effects. These scales communicate current and future space weather conditions and their possible effects on people and systems. The NOAA space weather scales correlate space weather events with their likely effects on technological systems. As shown in the table below, the scales describe the environmental disturbances for three event types: Geomagnetic Storms (G-scale), Solar Radiation Storms (S-scale), and Radio Blackouts (R-scale). The scales have numbered levels, analogous to hurricanes, tornadoes, and earthquakes that convey severity.

Description of Space Weather Scale	Minor -- Extreme				
Geomagnetic Storms: disturbances in the geomagnetic field caused by gusts in the solar wind that blows by Earth.	G1	G2	G3	G4	G5
Solar Radiation Storms: elevated levels of radiation that occur when the numbers of energetic particles increase.	S1	S2	S3	S4	S5
Radio Blackouts: disturbances of the ionosphere caused by X-ray emissions from the sun.	R1	R2	R3	R4	R5

[227] "Space Weather," Ready.gov, accessed on 5 September 2015, http://www.ready.gov/space-weather

Scale	Description	**Geomagnetic Storm Scales**[228] Effect	Physical measure	Avg. Freq. (1 cycle = 11 years)
G 5	Extreme	**Power systems:** Widespread voltage control problems and protective system problems can occur, some grid systems may experience complete collapse or blackouts. Transformers may experience damage. **Spacecraft operations:** May experience extensive surface charging, problems with orientation, uplink/downlink and tracking satellites. **Other systems:** Pipeline currents can reach hundreds of amps, HF (high frequency) radio propagation may be impossible in many areas for one to two days, satellite navigation may be degraded for days, low-frequency radio navigation can be out for hours, and aurora has been seen as low as Florida and southern Texas (typically 40° geomagnetic lat.).	Kp = 9	4 per cycle (4 days per cycle)
G 4	Severe	**Power systems:** Possible widespread voltage control problems and some protective systems will mistakenly trip out key assets from the grid. **Spacecraft operations:** May experience surface charging and tracking problems, corrections may be needed for orientation problems. **Other systems:** Induced pipeline currents affect preventive measures, HF radio propagation sporadic, satellite navigation degraded for hours, low-frequency radio navigation disrupted, and aurora has been seen as low as Alabama and northern California (typically 45° geomagnetic lat.).	Kp = 8, includin g a 9-	100 per cycle (60 days per cycle)
G 3	Strong	**Power systems:** Voltage corrections may be required, false alarms triggered on some protection devices. **Spacecraft operations:** Surface charging may occur on satellite components, drag may increase on low-Earth-orbit satellites, and corrections may be needed for orientation problems. **Other systems:** Intermittent satellite navigation and low-frequency radio navigation problems may occur, HF radio may be intermittent, and aurora has been seen as low as Illinois and Oregon (typically 50° geomagnetic lat.).	Kp = 7	200 per cycle (130 days per cycle)
G 2	Moderate	**Power systems:** High-latitude power systems may experience voltage alarms, long-duration storms may cause transformer damage. **Spacecraft operations:** Corrective actions to orientation may be required by ground control; possible changes in drag affect orbit predictions. **Other systems:** HF radio propagation can fade at higher latitudes, and aurora has been seen as low as New York and Idaho (typically 55° geomagnetic lat.).	Kp = 6	600 per cycle (360 days per cycle)
G 1	Minor	**Power systems:** Weak power grid fluctuations can occur. **Spacecraft operations:** Minor impact on satellite operations possible. **Other systems:** Migratory animals are affected at this and higher levels; aurora is commonly visible at high latitudes (northern Michigan and Maine).	Kp = 5	1700 per cycle (900 days per cycle)

228 "NOAA Space Weather Scales", SWPC, Accessed 4 April 2016, http://www.swpc.noaa.gov/noaa-scales-explanation

Solar Radiation Storm Scales[229]

Scale	Description	Effect	Physical measure (Flux level of >= 10 MeV particles)	Average Frequency (1 cycle = 11 years)
S 5	**Extreme**	**Biological:** Unavoidable high radiation hazard to astronauts on EVA (extra-vehicular activity); passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. **Satellite operations:** Satellites may be rendered useless, memory impacts can cause loss of control, may cause serious noise in image data, star-trackers may be unable to locate sources; permanent damage to solar panels possible. **Other systems:** Complete blackout of HF (high frequency) communications possible through the polar regions, and position errors make navigation operations extremely difficult.	10^5	Fewer than 1 per cycle
S 4	**Severe**	**Biological:** Unavoidable radiation hazard to astronauts on EVA; passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. **Satellite operations:** May experience memory device problems and noise on imaging systems; star-tracker problems may cause orientation problems, and solar panel efficiency can be degraded. **Other systems:** Blackout of HF radio communications through the polar regions and increased navigation errors over several days are likely.	10^4	3 per cycle
S 3	**Strong**	**Biological:** Radiation hazard avoidance recommended for astronauts on EVA; passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. **Satellite operations:** Single-event upsets, noise in imaging systems, and slight reduction of efficiency in solar panel are likely. **Other systems:** Degraded HF radio propagation through the polar regions and navigation position errors likely.	10^3	10 per cycle
S 2	**Moderate**	**Biological:** Passengers and crew in high-flying aircraft at high latitudes may be exposed to elevated radiation risk. **Satellite operations:** Infrequent single-event upsets possible. **Other systems:** Small effects on HF propagation through the polar regions and navigation at polar cap locations possibly affected.	10^2	25 per cycle
S 1	**Minor**	**Biological:** None. **Satellite operations:** None. **Other systems:** Minor impacts on HF radio in the polar regions.	10	50 per cycle

[229]"NOAA Space Weather Scales", SWPC, Accessed 4 April 2016, http://www.swpc.noaa.gov/noaa-scales-explanation

Radio Blackout Scales[230]

Scale	Description	Effect	Physical measure	Average Frequency (1 cycle = 11 years)
R 5	Extreme	**HF Radio:** Complete HF (high frequency) radio blackout on the entire sunlit side of the Earth lasting for a number of hours. This results in no HF radio contact with mariners and en route aviators in this sector. **Navigation:** Low-frequency navigation signals used by maritime and general aviation systems experience outages on the sunlit side of the Earth for many hours, causing loss in positioning. Increased satellite navigation errors in positioning for several hours on the sunlit side of Earth, which may spread into the night side.	X20 (2×10^{-3})	Less than 1 per cycle
R 4	Severe	**HF Radio:** HF radio communication blackout on most of the sunlit side of Earth for one to two hours. HF radio contact lost during this time. **Navigation:** Outages of low-frequency navigation signals cause increased error in positioning for one to two hours. Minor disruptions of satellite navigation possible on the sunlit side of Earth.	X10 (10^{-3})	8 per cycle (8 days per cycle)
R 3	Strong	**HF Radio:** Wide area blackout of HF radio communication, loss of radio contact for about an hour on sunlit side of Earth. **Navigation:** Low-frequency navigation signals degraded for about an hour.	X1 (10^{-4})	175 per cycle (140 days per cycle)
R 2	Moderate	**HF Radio:** Limited blackout of HF radio communication on sunlit side, loss of radio contact for tens of minutes. **Navigation:** Degradation of low-frequency navigation signals for tens of minutes.	M5 (5×10^{-5})	350 per cycle (300 days per cycle)
R 1	Minor	**HF Radio:** Weak or minor degradation of HF radio communication on sunlit side, occasional loss of radio contact. **Navigation:** Low-frequency navigation signals degraded for brief intervals.	M1 (10^{-5})	2000 per cycle (950 days per cycle)

[230]"NOAA Space Weather Scales", SWPC, Accessed 4 April 2016, http://www.swpc.noaa.gov/noaa-scales-explanation

Space weather prediction services in the United States are provided primarily by NOAA's Space Weather Prediction Center (SWPC) and the U.S. Air Force's (USAF) Weather Agency (AFWA), which work closely together to address the needs of the civilian and military communities. The SWPC draws on a variety of data sources, both space and ground-based, to provide forecasts, watches, warnings, alerts, and summaries as well as operational space weather products to civilian and commercial users.

Space Weather in the United States

The 1989 Quebec storm described above also affected the United States. New York Power lost 150 megawatts the moment the Quebec power grid went down. The New England Power Pool lost 1,410 megawatts at about the same time. Service to 96 electrical utilities in New England was interrupted while other reserves of electrical power were brought online. Across the United States, over 200 power grid problems erupted within minutes of the start of the March 13, 1989 storm. Fortunately none of these caused a blackout.[231]

On July 23, 2012, two CMEs rocketed away from the sun more than four times faster than a typical eruption. The storm tore through Earth's orbit, but instead of striking the Earth, it hit the STEREO-A spacecraft. If this double eruption had occurred just a week earlier, it would have likely struck the Earth and been more devastating than the Carrington Event in 1859.[232] According to a study by the National Academy of Sciences, the total economic impact of such a storm actually hitting Earth could exceed $2 trillion, which is 20 times greater than the costs of a Hurricane Katrina. Multi-ton transformers damaged by such a storm might take years to repair.[233]

Space Weather in Ohio

Geomagnetic storms can affect any and all parts of the earth. Ohio is not immune to geomagnetic storms, although no major impacts have occurred in this state as of publication.

Space Weather in Franklin County

There have been no known Geomagnetic Storms that have caused a measureable impact to Franklin County. However, it is possible that major geomagnetic storms could impact Franklin County. Therefore, planning efforts should begin to take place. This coincides with federal guidance for comprehensive all-hazards emergency planning, which includes Geomagnetic Storms as a potential risk category.

Climate Change Impacts

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231 "The Day the Sun Brought Darkness," NASA, accessed on 5 September 2015, http://www.nasa.gov/topics/earth/features/sun_darkness.html

232 "Carrington-Class CME Narrowly Misses Earth," NASA, accessed on 17 October 2015, http://science.nasa.gov/science-news/science-at-nasa/2014/02may_superstorm/

233 "Near Miss: The Solar Superstorm of July 2012," NASA, accessed on 17 October 2015, http://science.nasa.gov/science-news/science-at-nasa/2014/23jul_superstorm/

All weather on Earth begins with the Sun. Space weather and terrestrial weather are influenced by the small changes the Sun undergoes during its solar cycle. The most important impact the Sun has on Earth is from the brightness or irradiance of the Sun itself. The Sun produces energy in the form of photons of light. At Ultraviolet (UV) wavelengths, the solar irradiance variability is larger over the course of the solar cycle, with changes up to 15%. This has a significant impact on the absorption of energy by ozone and in the stratosphere.

The total wavelength-integrated energy from sunlight is referred to as the Total Solar Irradiance (TSI). This energy is scattered, reflected, and absorbed at various altitudes in the atmosphere, but the resulting change in the temperature of the atmosphere is measurable. It should be noted that the change in climate due to solar variability is likely small, but more research needs to be done.

There are other types of space weather that can impact the atmosphere. Energetic particles penetrate into the atmosphere and change the chemical constituents. These changes in minor species such as Nitrous Oxide (NO) can have long lasting consequences in the upper and middle atmosphere, however it has not been determined if these have a major impact on the global climate of Earth.

The duration of solar minimum may also have an impact on Earth's climate. During solar minimum there is a maximum in the amount of Cosmic rays, high energy particles whose source is outside our Solar system, reaching earth. There is a theory that cosmic rays can create nucleation sites in the atmosphere which seed cloud formation and create cloudier conditions. If this were true, then there would be a significant impact on climate, which would be modulated by the 11-year solar cycle.[234]

It has not been definitively shown that solar storms and magnetic storms are responsible for climate change. The consensus among scientists is that the sun is not responsible for the most recent climate change.[235]

[234] "Space Weather Impacts on Climate," NOAA, accessed on 22 September 2015, http://www.swpc.noaa.gov/impacts/space-weather-impacts-climate
[235] "Climate Connections: Questions from Puerto Rico," USGS, uploaded on 23 November 2011, https://www.youtube.com/watch?v=XHHoT5Tz88Y&feature=plcp&context=C3e71404UDOEgsToPDskJh6h62DmOyqs6xkfJ68xDJ

Vulnerability Assessment – Space Weather

This hazard is considered to be a "Very Low Probability Event" meaning the frequency of the hazard is historically once every 125 years or more. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability

Space Weather can disrupt navigation systems such as the Global Navigation Satellite System (GNSS) and create harmful geomagnetic induced currents (GICs) in the power grid and pipelines.[236] Generally, power outages due to space weather are very rare events, but evidence suggests that significant effects could occur.

No structural damage due to space weather has occurred in Franklin County.

Potential Impact of Space Weather

No damage to structures is anticipated due to space weather.

According to an article in NASA Science News the Earth came very close to having a solar event which could have caused $2 trillion economic impact.[237] This would be a worldwide event that would not be localized and therefore difficult to determine economic impact on just Franklin County.

Identifying Structures

No structures are expected to experience damage due to space weather; therefore, this updated risk assessment does not identify existing or future buildings at risk of loss due to space weather.

Exposure of Existing Buildings to Damages Due to Space Weather

No existing buildings are exposed to damage due to space weather.

Exposure of Future Buildings to Damages Due to Space Weather

No future buildings will be exposed to damage due to space weather.

Estimating Potential Loss

Methodology

This would be a worldwide event and could cause $2 trillion economic impact.

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[236] "Geomagnetic Storms," NOAA Space Weather Prediction Center, accessed on 5 September 2015, http://www.swpc.noaa.gov/phenomena/geomagnetic-storms

[237] "Near Miss: The Solar Superstorm of July 2012," NASA, accessed on 24 Nov 2015, http://science.nasa.gov/science-news/science-at-nasa/2014/23jul_superstorm/

Potential structural dollar loss due to space weather is estimated to be $0.00 because no historical data for structural losses due to space weather.

Estimated Potential Dollar Losses
The estimated potential structural dollar loss annually in Franklin County due to space weather is $0.00.

Potential dollar loss worldwide is $2 trillion.

Extreme Heat - #15

Hazard Summary

An extreme heat event, or heat wave, is a prolonged period of excessively hot weather, which may be accompanied by high humidity. 2012 was the last year in which a heat related death occurred in Ohio[238]. Three people died as a result of extreme heat in Ohio that year. This hazard was ranked 15 of 19.

This is a county-wide hazard that can affect all areas and jurisdictions of the county.

[238] "Weather Fatalities": http://www.nws.noaa.gov/om/hazstats.shtml retrieved 1 March 2018

Hazard Profile

While there is no single agreed upon definition of an extreme heat event, there are multiple federally funded organizations that provided suitable definitions of extreme heat events. The U.S. Environmental Protection Agency defines extreme heat events as "periods of summertime weather that are substantially hotter and/or more humid than typical for a given location at that time of year.[239]" While the National Weather Service defines a heat wave as "A period of abnormally and uncomfortably hot and unusually humid weather. Typically a heat wave lasts two or more days."[240] Extreme heat is relative to the typical weather patterns of a given area. Temperatures considered normal in hotter climates may be considered extreme in areas which are normally cooler.

North American summers are hot; most summers see heat waves in one section or another of the United States. East of the Rockies, they tend to combine both high temperature and high humidity, although some of the worst have been catastrophically dry.

Heat kills by pushing the human body beyond its limits. In extreme heat and high humidity, evaporation is slowed and the body must work extra hard to maintain a normal temperature. Most heat illnesses occur because the victim has been overexposed to heat or has over-exercised for his or her age and physical condition. Older adults, young children and those who are sick or overweight are more likely to succumb to extreme heat.

Conditions that can induce heat-related illnesses include stagnant atmospheric conditions and poor air quality. Consequently, people living in urban areas may be at greater risk from the effects of a prolonged heat wave than those living in rural areas. Also, asphalt and concrete store heat longer and gradually release heat at night, which can produce higher nighttime temperatures known as the "urban heat island effect."

In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. During a period in the early part of this century, more people died from extreme heat than from hurricanes, lightning, tornadoes, floods, and earthquakes combined[241]. In the disastrous heat wave of 1980, more than 1,250 people died. These are the direct casualties. It is difficult to calculate those deaths not directly caused by heat, but advanced by heat wave weather. Experts believe the number of deaths related to extreme heat are actually much higher based upon these deaths.

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[239] "Climate Change and Extreme Heat Events", CDC National Center for Environmental Health, Retrieved 19 September, 2015 from http://www.cdc.gov/climateandhealth/pubs/ClimateChangeandExtremeHeatEvents.pdf
[240] "Glossary", National Weather Service, Retrieved 19 September 2015 from http://w1.weather.gov/glossary/index.php?letter=h
[241] "Extreme Heat Prevention Guide", CDC Emergency Preparedness and Response, Retrieved 19 September 2015 from http://emergency.cdc.gov/disasters/extremeheat/heat_guide.asp

2015 Heat Related Fatalities

In 2015, 45 people died as a result of extreme heat, up dramatically from the 2014 total of 20 but down from the 92 fatalities in 2013. This number is well below the 10-year average for heat related fatalities, 113. In 2015, the most dangerous place to be was in a permanent home, likely with little or no air conditioning, where 15 people died. For the third consecutive year, Nevada numbered by far the most heat victims, 25, more than double the state's 2014 total of 12. The next deadliest states were Texas, 5, and Pennsylvania with 4 heat-related deaths. As in the past, extreme heat most strongly affected adults aged 50+, with 33 deaths (73%). Sadly, the next highest age-range was children 0-9, many left in vehicles. Once again, more males, 32 (71%), than females, 13 (29%), were killed by heat.

2015 Heat Related Fatalities by State and Location

State	BF	CA	GF	MH	OT	OU	PH	VE	Total
AR (Arkansas)	0	0	0	0	0	0	1	1	2
AZ (Arizona)	0	0	0	0	0	0	0	2	2
GA (Georgia)	0	0	0	0	0	0	0	1	1
IL (Illinois)	0	0	0	0	0	1	0	0	1
KS (Kansas)	0	0	0	0	0	1	0	0	1
MO (Missouri)	0	0	0	0	1	0	0	0	1
NV (Nevada)	0	0	0	0	4	8	10	3	25
OR (Oregon)	0	0	0	0	1	0	0	0	1
PA (Pennsylvania)	0	0	0	0	2	0	2	0	4
TN (Tennessee)	0	0	0	0	0	0	2	0	2
TX (Texas)	0	0	0	0	3	0	0	2	5
Total	0	0	0	0	11	10	15	9	45
Percent	0.00	0.00	0.00	0.00	24.44	22.22	33.33	20.00	

2015 Heat Related Fatalities by Age and Gender

	Female	Male	Unknown	Total	Percent
0 to 9	1	4	0	5	11.11
10 to 19	0	1	0	1	2.22
20 to 29	0	2	0	2	4.44
30 to 39	0	1	0	1	2.22
40 to 49	0	3	0	3	6.67
50 to 59	2	4	0	6	13.33
60 to 69	3	8	0	11	24.44
70 to 79	3	5	0	8	17.78
80 to 89	4	4	0	8	17.78
90 to --	0	0	0	0	0.00
Unknown	0	0	0	0	0.00
Total	13	32	0	45	
Percent	28.89	71.11	0.00		

Legend

BF -	Ball Field
CA -	Camping
GF -	Golfing
MH -	Mobile/Trailer Home
OT -	Other
OU -	Outside/Open Areas
PH -	Permanent Home
VE -	Vehicle/Towed Trailer

Source: NOAA

Heat Index

In an effort to alert the public and appropriate authorities to the hazards of extreme heat, the National Weather Service developed the heat index (sometimes referred to as the "apparent temperature"). The heat index (HI), given in degrees Fahrenheit, is an accurate measure of how hot it really feels when effects of the relative humidity are added to the actual air temperature.

The National Weather Service will initiate alert procedures when the HI is expected to exceed 105 degrees for at least one day. The procedures are:

- Include HI values in zone and city forecasts.
- Issue Special Weather Statements and/or Public Information Statements presenting a detailed discussion of:
    - The extent of the hazard including HI values.
    - Who is most at risk.
    - Safety rules for reducing the risk.
- Assist state/local health officials in preparing emergency messages, including meteorological information, detailed medical information, advice and names and phone numbers of health officials.
- Release to the media and over NOAA Weather Radio all of the above information.

NOAA's National Weather Service

Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Source: NOAA

To find the HI, look at the Heat Index Chart above. As an example, if the air temperature is 96 degrees F (found at the top of the chart) and the Relative Humidity (RH) is 55% (found on the left side of the chart), the HI, or how hot it really feels, is 112 degrees F. This is at the intersection of the 96 degree column and the 55% humidity row.

Note: Since HI values were devised for shady light wind conditions, exposure to full sunshine can increase HI values by up to 15 degrees. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

NOAA's Extreme Heat Advisory Products

- Heat Advisory: Issued when the Heat Index will be equal to or greater than 100°F, but less than 105°F.
- Excessive Heat Watch: Possibility that Excessive Heat Warning Criteria may be met at longer ranges (12 to 48 hours out). [242]
- Excessive Heat Warning: Heat indices will attain or exceed 105°F.

The Effect of Excessive Heat on the Human Body

Heat disorders generally have to do with a reduction or collapse of the body's ability to shed heat by circulatory changes and sweating, or a chemical (salt) imbalance caused by too much sweating. When heat stress on a body exceeds the level the body can cool, or when the body cannot compensate for fluids and salt lost through perspiration, the temperature of the body's inner core begins to rise and heat-related illness may develop. Ranging in severity, heat disorders share one common feature: the individual has overexposed or over exercised for his age and physical condition in the existing thermal environment. Studies indicate that, other things being equal, the severity of heat disorders tend to increase with age. Acclimation has to do with adjusting sweat-salt concentrations, among other things. The idea is to lose enough water to regulate body temperature with the least possible chemical disturbance.

People living in urban areas must deal with special hazards. The stagnant atmospheric conditions of a heat wave can trap pollutants in urban areas. Severe pollution coupled with dangerously hot weather create a compounded public health problem. High inner-city death rates can also be attributed to low-income areas without access to air-conditioning. The cost of running air conditioners may be too high for some elderly people on fixed incomes as well. Also, in high crimes areas, many people are unable to ventilate with open windows or cool off by spending time outside. People remaining inside their closed homes with no way to cool themselves was a factor in a number of deaths during the Chicago heat wave of 1995.

The term "heat island" refers to urban areas that are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F warmer than its surroundings. In the evening, the difference can be as high as 22°F. Heat islands can affect cities by increasing summertime peak energy demand, air conditioning

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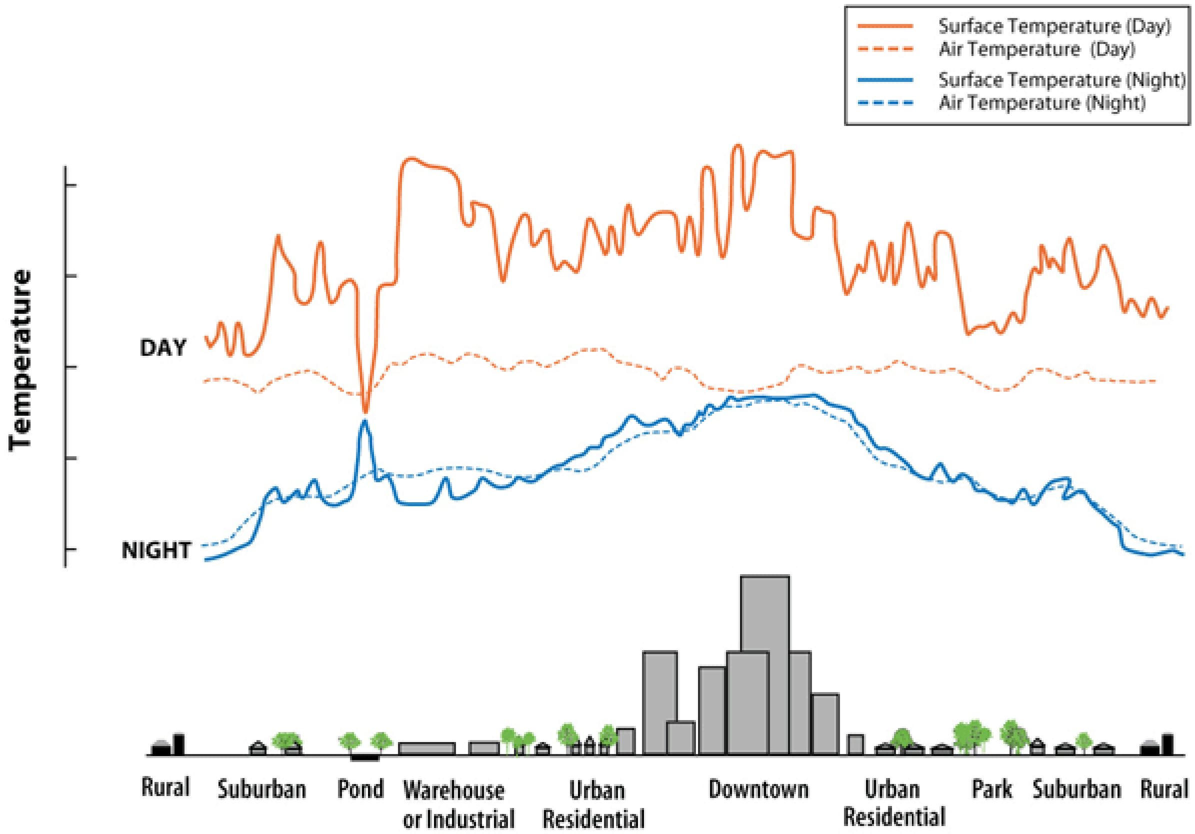
[242] "Heat Safety Resources" National Weather Service, Retrieved 17 September 2015 from http://www.nws.noaa.gov/os/heat/ww.shtml

costs, air pollution and greenhouse gas emissions, heat-related illness and mortality, and water quality.[243]

The following chart shows the impact of the urban heat island on ambient temperatures.



Source: U.S. Environmental Protection Agency

Symptoms of Heat Related Disorders

- Sunburn: Redness and pain on the skin; in severe cases skin swelling, blisters, fever, and headaches.
- Heat Cramps: Painful muscular spasms due to exertion. Often accompanied by heavy sweating. Any activity that results in profuse sweating followed by too little or too much fluid intake can result in these painful muscle spasms. Although heat cramps are the least severe, they are often the first signal that the body is having trouble with the heat.
- Heat Exhaustion: Occurs as two types, water depleted and sodium depleted, although in reality they often overlap. Signs and symptoms include fatigue and malaise, anorexia, nausea, vomiting, anxiety, and confusion. Potentially dangerous

[243] "Heat Island Effect", United States Environmental Protection Agency, accessed on 17 Jan 2016, http://www.epa.gov/heat-islands

clinical manifestations include circulatory collapse and excessive temperature. Core body temperature is usually higher than 100.4^0 F but below the cutoff for heatstroke, which is 104^0 F. Typically occurs when people exercise heavily or work in a hot, humid place where body fluids are lost through heavy sweating. Blood flow to the skin increases, causing blood flow to decrease to the vital organs. This results in a form of mild shock. If not treated, the victim's condition will worsen. Body temperature will keep rising and the victim may suffer heat stroke.

Heat exhaustion from water depletion tends to occur in the elderly, who are more likely to have pre-existing conditions or take medications that predispose them to dehydration. Signs of dehydration include excessive thirst, fatigue, dry oral mucosa, and decreased urinary output. Heat exhaustion from sodium depletion occurs most often in un-acclimated persons who maintain volume status with water but fail to replace sodium lost in sweat. Symptoms such as weakness, fatigue, and headache appear acutely, but the onset tends to occur over a period of several days.

Heatstroke: Heatstroke, sometimes referred to as sunstroke, is the deadliest of heat illnesses. It is a life-threatening condition. It occurs in two forms – classic and exertional – and is defined by a core body temperature above 104^0 F. The victim's temperature control system, which produces sweating to cool the body, stops working. The body temperature can rise so high that brain damage and death may result if the body is not cooled quickly. Treatment must begin immediately to ensure survival. Classic heatstroke occurs during summer months and predominantly affects those of advanced age or with chronic medical conditions. Symptoms of heatstroke are hot dry skin, rapid and strong pulse, and possible unconsciousness.

Exertional heatstroke most often occurs in the summer and primarily affects laborers or athletes. Symptoms are similar to those of classic heatstroke, but with one major difference: many people with exertional heatstroke continue to sweat.
Heatstroke is a medical emergency. Multiple organ systems can be affected. Heat exhaustion, if not promptly treated, can lead to heatstroke, and the two conditions may overlap.

Factors that Increase the Risk of Experiencing a Heat Related Disorder

Meteorological Characteristics

- Increased temperature
- Increased relative humidity
- Dry, hot winds

Demographic Characteristics

- Physical constraints (including underlying medical conditions)
- Mobility constraints
- Cognitive impairments
- Economic constraints
- Social isolation

Behavioral Choices

- Wearing inappropriate clothing
- Failing to stay adequately hydrated
- Consuming alcohol
- Engaging in outdoor activities
- Eating heavy and/or hot foods

Regional Characteristics

- Living in an area with a variable climate
- Living in an urban area
- Living on the upper floors of buildings

Source: Excessive Heat Events Guidebook, USEPA

Other Effects of Heat Waves

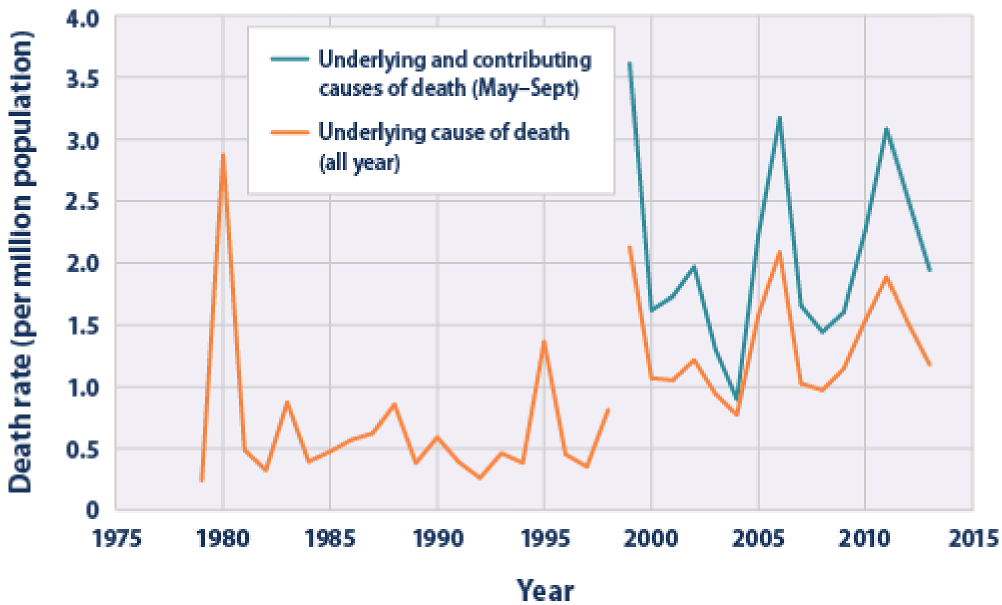
In addition to physical stress, excessive heat causes psychological stress to a degree which affects performance and is associated with increase in violent crime. Heat waves often lead to electricity spikes due to increased air conditioning use, which can create power outages. If a heat wave occurs during a drought, which dries out vegetation, it can contribute to wildfires. And heat waves can cause roads and highways to buckle, water lines to burst, and power transformers to detonate.

Extreme Heat in the United States

Heat waves are a particularly lethal type of weather phenomenon with 9,000 Americans experiencing heat-related deaths from 1979-2013[244]. The chart below depicts the annual rates for deaths classified as "heat-related" by medical professionals in the United States. The orange line shows deaths for which heat was listed as the main or underlying cause

[244] "Climate Change Indicators", US EPA, retrieved 4 November 2015 from http://www3.epa.gov/climatechange/science/indicators/health-society/heat-deaths.html

during any point in a given year. The blue line shows deaths for which heat was listed as either the underlying or contributing cause of death during the months from May to September, based on a broader set of data that became available in 1999. It is important to note that between 1998 and 1999, the World Health Organization revised the international codes used to classify causes of death. As a result, data from earlier than 1999 cannot easily be compared with data from later years.



Source: U.S. EPA

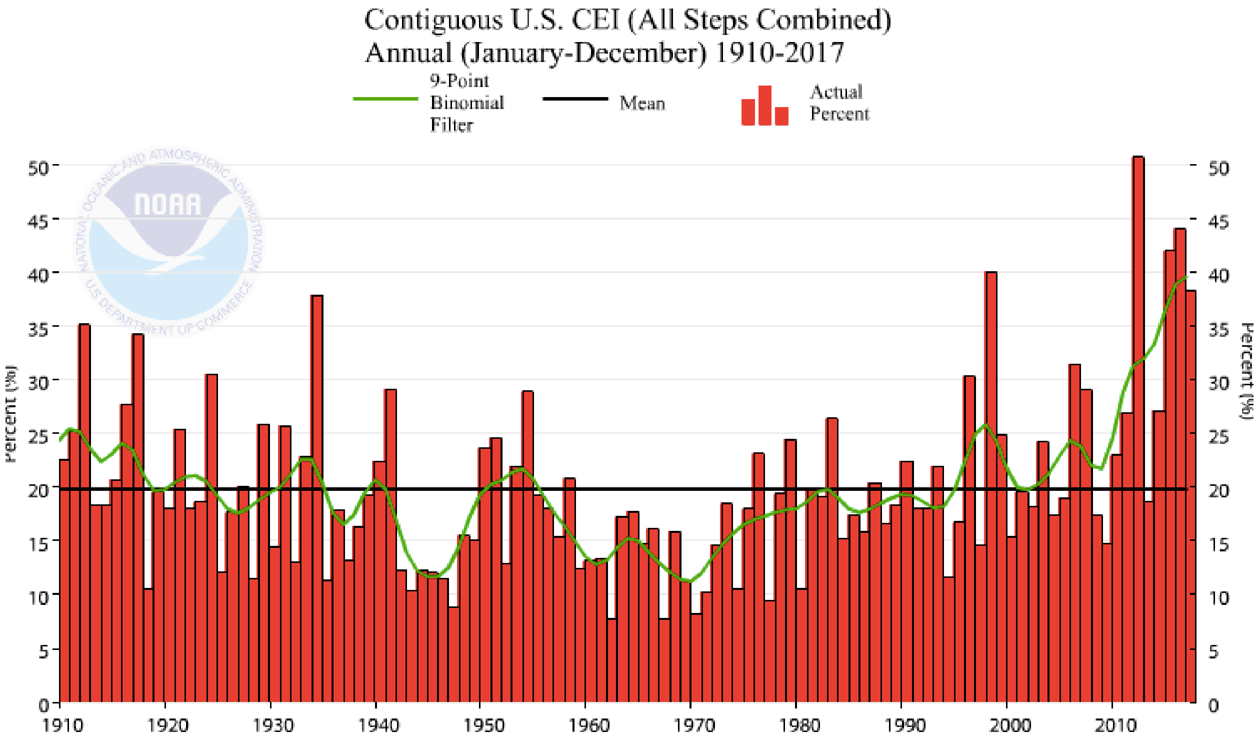
In the United States, lack of a uniform definition for heat-related death results in substantial variation in the criteria used to certify such deaths. The most stringent definition of heat-related death is: a core body temperature of greater than or equal to 105^{0}F taken at the time of death, with no other reasonable explanation of death. Revised criteria used by some medical examiners say that a death also can be classified as heat-related if the person is "found in an enclosed environment with a high ambient temperature without adequate cooling devices and the individual had been known to be alive at the onset of the heat wave."[245]

Alternative mortality estimates come from analyses of daily urban summertime mortality patterns in the United States developed by Dr. Laurence S. Kalkstein, associate director, Center for Climatic Research at the University of Delaware and his colleagues. This method calculates the number of heat-related deaths based on differences in daily deaths on extreme heat days compared to longer-term averages.

[245] Donoghue ER, Graham MA, Jentzen JM, Lifschultz BD, Luke JL, Mirchandani HG. Criteria for the diagnosis of heat-related deaths: National Association of Medical Examiners: position paper. Am J Forensic Med Pathol 1997;18:11– 4.

Whatever method is used, studies show significant regional variation. Extreme heat events have the greatest impact in the Northeast and Midwest and the least impact in the South and Southwest. This is consistent with the hypotheses that populations in the most vulnerable areas are not as acclimatized to elevated temperatures and the structures in less susceptible areas are better designed to accommodate elevated temperatures. There have been heat waves in warmer climates; however, the death rates appear to be lower.

The below graph shows extremes in high temperatures for the contiguous United States for a period from 1910 to 2017. As indicated in the below graph, 2012 was a year of extreme heat.



Source: NOAA

<u>1936 North American Heat Wave</u> The Dust Bowl years of 1930-1936 brought some of the hottest summers on record to the United States, especially across the Plains, Upper Midwest and Great Lakes states. For the Upper Mississippi River valley, the first few weeks of July 1936 brought the hottest temperatures of that period, including several all-time highs. The heat wave took place in the middle of the Great Depression, and it contributed to it, leading to catastrophic human suffering and an enormous economic toll. The death toll exceeded 5,000. Many of the deaths occurred in built up city areas of Chicago, Detroit, St. Louis, Milwaukee, Cleveland, Toronto and other urban areas.

<u>July 1995 Heat Wave</u> The heat wave of 1995 was one of the worst weather-related disasters in Illinois history with approximately 525 deaths over a 5-day period. The hottest weather occurred from July 12 to July 16. The 106^0 F temperature on July 13 set the record

for the warmest July temperature since measurements began at Midway in Chicago. Not only were the daytime temperatures high, the nighttime low temperatures were high (upper 70s and lower 80s) as well. Record humidity levels also accompanied the hot weather.

Many of the victims were the elderly in the heart of the urban area. Many low-income elderly citizens either had no air conditioning or could not afford to operate the system they had. Many citizens were also hesitant to open windows and doors at night for fear of crime.

Record heat related deaths were also reported in Milwaukee, Philadelphia, and St. Louis. This heat wave led to a nationwide call to cities to examine their heat emergency warning and response plans.

July 2006 North American Heat Wave This long-lasting heat wave, 43 days, began in the center of North America in the Plains and the Midwest on July 15, 2006. By July 21, the heat had moved to the West Coast and then returned to the Plains on July 28. The high temperature spread to the East Coast and made its way to the South by August 4, 2006.

The demand for electricity caused a 5-day blackout in Queens, New York, causing the closure of LaGuardia Airport and subway lines. Many roads buckled and water lines ruptured. The hardest hit cities were Oklahoma City, Dallas and Shreveport. Crops dried up and livestock perished in the heat. The heat wave killed over 200 people nationwide. At least half the victims were elderly.

Extreme Heat in Ohio

Summer 1934 The summer of 1934 ranks as the hottest in Ohio since temperature records began in 1883. The average temperature of 75.7 ^{0} F for the months of June, July, and August broke the old record set in 1891 and was five degrees above normal.

July 1934 was the hottest month ever recorded in Ohio. Many heat records were set on July 21, including 106^{0} F in Columbus, 109^{0} F in Cincinnati and 111^{0} F in Wilmington and Hamilton. A weather station four miles northwest of Gallipolis recorded 113^{0} F. Estimates of the death toll in Ohio were 160 dead, just during the week of July 20-26.

July 1995 Heat Wave The state suffered an unusually long period of hot weather with afternoon temperatures generally in the 90s with high humidity. Peak heat and humidity occurred on July 14, with high temperatures near or exceeding 100^{0} F. Dew points were also unusually high, averaging near 80^{0} F which produced a heat index as high as 126^{0}F in Toledo. A number of roads and sidewalks buckled from the heat. Older utility systems suffered a high incidence of breakdown due to prolonged high demand. It was so hot that a heat kink occurred on the railroad tracks in Athens County. A Conrail freight train had 16 cars derail, and a chemical leak prompted a six-hour evacuation in the vicinity. Thirteen fatalities were reported, all in Cuyahoga County, in the Cleveland urban area.

July – August 1999 As reported by the CDC, a heat wave occurred in the midwestern and eastern United States from July 12 through August 1, 1999, and caused or contributed to 18 deaths in Cincinnati and four deaths in Dayton. A CDC survey of 24 U.S. metropolitan areas indicated that Ohio recorded some of the highest rates for heat-related deaths during this heat wave, with Cincinnati reporting 21 per million and Dayton reporting seven per million (CDC, unpublished data, 1999).[246]

The last part of July was very hot and humid across the state with temperatures reaching into the 90s most days and above 100^0 F for a few days. The dew points and overnight lows were in the 70s through much of the period.

July 2006 Ohio also was part of the 2006 nationwide heat wave. Ohio farmers reportedly used fans and cold showers to keep their cattle cool. Even with those efforts, the animals produced about 10 pounds less milk per day because of the heat.

July 2012 Climate stations in Columbus, Cincinnati and Dayton all recorded July 2012 as 5 to 6 degrees above normal. It was the warmest July in Columbus since record keeping began in 1878 and had the most days (22 total) of 90 degrees and above ever recorded. Additionally, on June 29, 2012, a derecho moved across the region causing widespread power outages. Immediately following the derecho, while the power was still out for many, the area experienced an extreme heat event with temperatures topping 100 degrees. From June 30-July 13, 2012, seven people died of heat-related causes in Ohio. During this extreme heat event, the Ohio Emergency Management Agency, the Ohio Department of Health, and the Ohio Department of Aging worked together to identify areas of high concentrations of power outages and older residents. Approximately 200 National Guard personnel conducted home visits to the elderly to look for people experiencing signs of heat exhaustion using wellness toolkits. On July 2, Ohio launched a "Check on Your Neighbor" campaign and on July 3, the Ohio Board of Regents and Ohio Department of Aging enlisted university and college students to conduct a "Knock and Talk" effort to assist the elderly.

Extreme Heat in Franklin County

Franklin County has been affected by heat waves but has not reported as many heat-related deaths as Cincinnati, Dayton, and Cleveland.

Franklin County is vulnerable to extreme heat. Residents should practice personal preventative strategies to avoid heat-related disorders. Throughout the year, local Health Departments and FCEM&HS work with identified vulnerable population groups to

[246] Heat Related Illnesses, Deaths, and Risk Factors --- Cincinnati and Dayton, Ohio, 1999, and United States, 1979—1997: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm4921a3.htm; Retrieved 16 June 2016

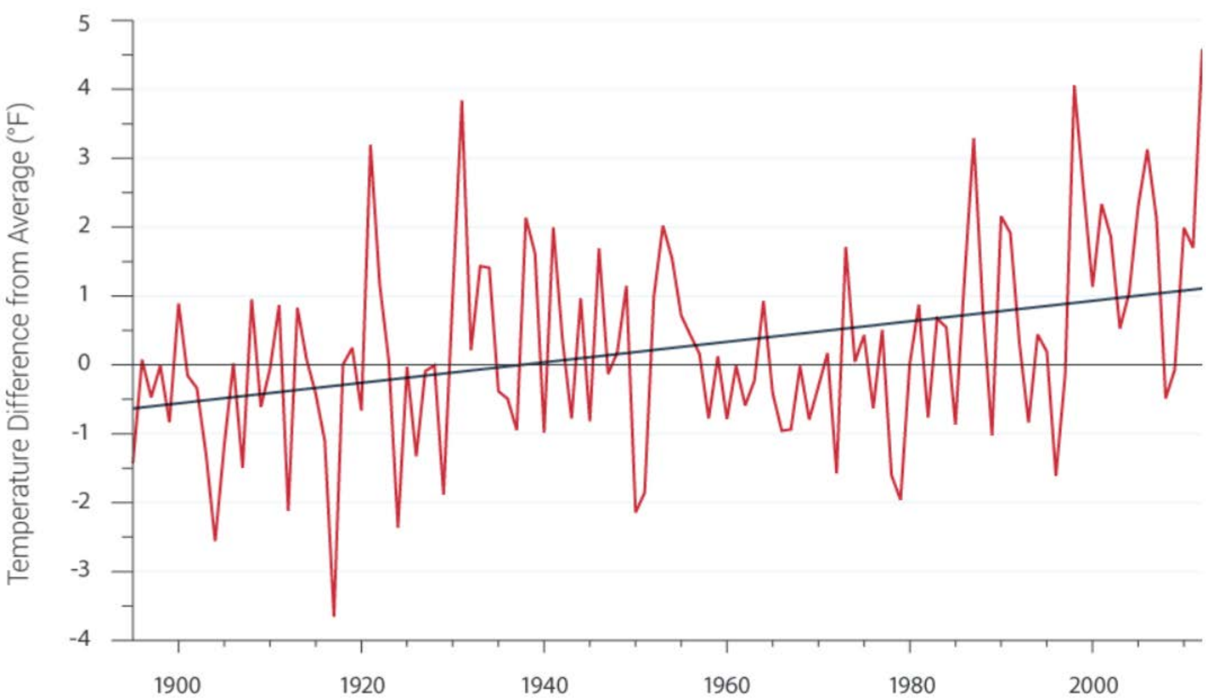
encourage those groups to be prepared for the potential for extreme heat. Local health departments offer heat-related advice and several organizations in Columbus offer summer cooling programs, such as free fans and help with utility costs.

Climate Change Impacts

Heat waves have generally become more frequent across the United States in recent decades, with western regions (including Alaska) setting records for numbers of these events in the 2000s.

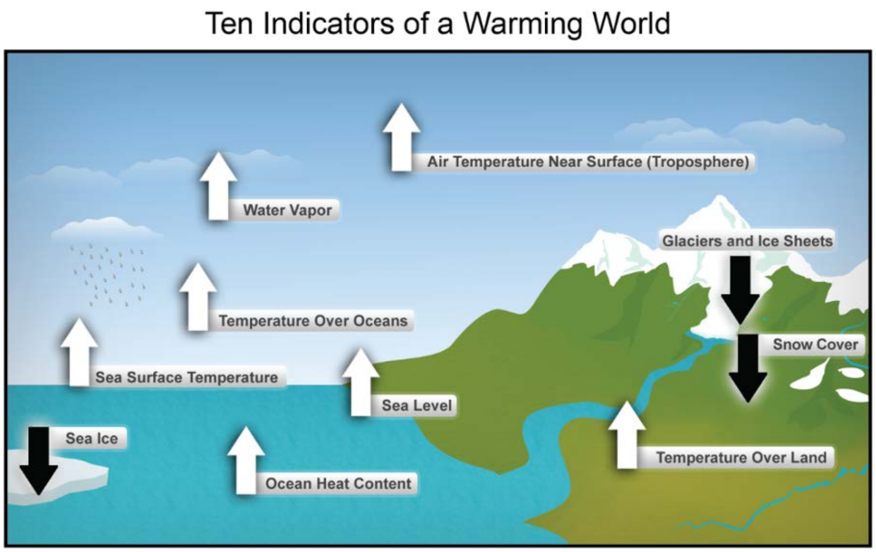
Most of the Midwest's population lives in cities, which are particularly vulnerable to life-threatening heat waves because of aging infrastructure and factors unique to urban areas discussed earlier in this section.

In the below chart, annual average temperatures (red line) across the Midwest show a trend towards increasing temperature. The trend (heavy black line) calculated over the period 1895-2012 is equal to an increase of 1.5°



Source: updated from Kunkel et al. 2013

In some areas, prolonged periods of record high temperatures associated with droughts contribute to dry conditions that are driving wildfires. The meteorological situations that cause heat waves are a natural part of the climate system; therefore, the timing and location of individual events may be largely a natural phenomenon, although even these may be affected by human-induced climate change. There is emerging evidence that most of the increases of heat wave severity in the United States, Europe, and Russia are likely due to human activity. For example, the summer 2011 heat wave and drought in Texas was primarily driven by precipitation deficits, but the human contribution to climate change approximately doubled the probability that the heat was record-breaking. While such an event could be triggered by a naturally occurring event such as a deficit in precipitation, the chances for record-breaking temperature extremes has increased and will continue to increase as the global climate warms. Generally, the changes in climate are increasing the likelihood for these types of severe events.



Source: National Climatic Data Center

The number of extremely hot days is projected to continue to increase over much of the United States, especially by late century. The Centers for Disease Control and Prevention are preparing for increased duration, severity and frequency with regards to extreme heat events.[247] As these events increase, emergency responders, public health, hospital services and coroners will need to consider additional preparedness measures due to increased demand for services. Summer temperatures are projected to continue rising, and a reduction of soil moisture, which exacerbates heat waves, is projected for much of the western and central United States in the summer months. Climate models project that the same summertime temperatures that ranked among the hottest 5% in 1950-1979 will occur at least 70% of the time by 2035-2064 in the U.S. if global emissions of heat-trapping gases continue to grow. By the end of this century, what have previously been once-in-20-year extreme heat days (1-day events) are projected to occur every two or three years over most of the nation. In other words, what now seems like an extremely hot day will become commonplace.

The below charts address extreme heat climate change considerations specific to Columbus, Ohio.[248]

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[247] "Climate Change and Extreme Heat Events", CDC National Center for Environmental Health, Pg. 8, Retrieved 19 September, 2015 from http://www.cdc.gov/climateandhealth/pubs/ClimateChangeandExtremeHeatEvents.pdf

[248] "Climate Changes and Impacts in Columbus, Ohio," GLISA, accessed on 19 Oct 2016, http://bpcrc.osu.edu/sites/bpcrc.osu.edu/files/Columbus_Climate.pdf

Rising Temperatures

Average Temperature

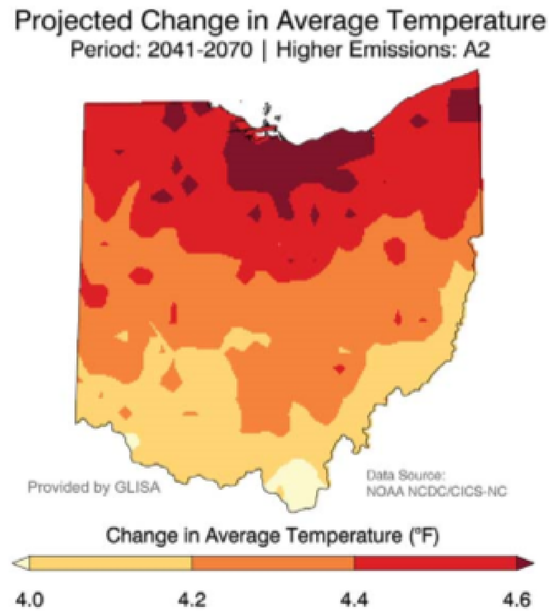
2.3°F
1951-2012

Average temperatures warmed by 2.3°F from 1951 through 2012, faster than the national and global rates. Models project this trend will continue with temperatures rising approximately 3-5°F by mid-century.

Growing Season

26 Days
1951-2012

The length of the freeze-free season (growing season) increased by 25.5 days from 1951 through 2012, and is expected to lengthen by an additional 1-2 months throughout the coming century.

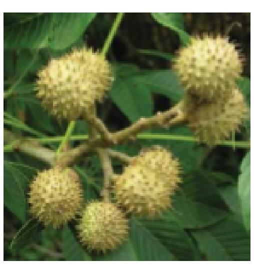


Average temperatures are projected to increase by 3 to 5°F by the middle of the 21st century, depending on the rate of future greenhouse gas emissions. Shown above are mid-century projections for 2041-2070 that assume greenhouse gas emissions will continue to rise as they have in the recent past (the A2 Scenario).

What Rising Temperatures Mean for Columbus:

Dangerously Hot Days: Rising temperatures increase the risk of extremely hot days. By mid-century, Columbus could see an additional 3 to 7 weeks per year of high temperatures exceeding 90°F, and an additional 1 to 2 weeks exceeding 95°F.

Air Quality: Air quality deteriorates with warmer temperatures, increasing the risk of serious public health consequences. A greater incidence of asthma attacks and other respiratory conditions is anticpated.



Agriculture: Through mid-century, some crop types may flourish in a warmer climate. Beyond mid-century, those benefits will likely be negated by heat stress, more frequent droughts, and a greater risk from pests.

Natural Resources: Rising temperatures will alter the habitats of fish and wildlife, forcing plants and animals to migrate or adapt. Those unable to migrate with the pace of climate change will lose their advantage over other species, reducing ecosystem diversity.

Vulnerability Assessment – Extreme Heat

This hazard is considered to be a "Relatively Moderate Probability Event" meaning the anticipated frequency of the hazard within the County is once every 5 to 25 years. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability

Franklin County has been affected by extreme heat events which have caused a variety of issues, including but not limited to health and drought which then affect such activities as farming and recreation. It is evident from national events relating to extreme heat that it does have an economic impact. In Franklin County there is not specific economic loss data to relate to this type of event, so the national event noted in the potential impact will be used.

There has been no structural damage due to extreme heat in Franklin County.

Potential Impact of Extreme Heat

In 1980 the nation saw a devastating heat wave and drought that claimed at least 1700 lives and had an estimated economic cost of $15 - $19 billion in 1980 dollars.[249]
Negative impacts of extreme heat events would be experienced by many through increased health concerns.

No damage to structures is anticipated due to extreme heat.

Identifying Structures

It is unlikely that structures would experience damage due to extreme heat; therefore, this risk assessment does not identify existing or future buildings at risk of loss due to extreme heat.

Exposure of Existing Buildings to Damages Due to Extreme Heat

No existing buildings are exposed to damage due to extreme heat.

Exposure of Future Buildings to Damages Due to Extreme Heat

No future buildings will be exposed to damage due to extreme heat.

Estimating Potential Loss

Methodology

Potential structural dollar loss due to extreme heat is estimated to be $0.00 because there is no historical data on structural losses due to extreme heat.

[249] "Impacts of Temperature Extremes," Colorado State University, accessed on 27 Nov 2015, http://sciencepolicy.colorado.edu/socasp/weather1/adams.html

The economic loss could be extensive as noted in the 1980 event which resulted in $15 - $19 billion in economic loss. These are figures for all heat event areas in the United States for this 1980 event.

Estimated Potential Dollar Losses
The estimated potential dollar loss annually in Franklin County due to structural damage from extreme heat is $0.00.

Potential economic loss for a worst case scenario across the United States could be $15 - $19 billion.

Earthquakes - #16

Hazard Summary

An earthquake is what happens when two blocks of the earth suddenly slip past one another. The surface where they slip is called the fault or fault plane.[250] Franklin County is not located on a fault line, nor have any epicenters been located in Franklin County. Earthquakes occurring in other areas have been felt in Franklin County; however, no damage has been reported. This hazard was ranked 16 out of 20.

This is a county-wide hazard that can affect all areas and jurisdictions of the county.

[250] "The Science of Earthquakes," USGS, accessed on 3 Nov 2015, http://earthquake.usgs.gov/learn/kids/eqscience.php

Hazard Profile

Earthquakes strike without warning, allowing no time for preparation or evacuation. Systems designed to provide warning and estimated arrival times are in development by the United States Geological Survey (USGS) in the US. These Earthquake Early Warning Systems are in use in other countries and are in prototype phase in the US.

The deadliest earthquake in history struck Haiti on January 12, 2010. The official death toll estimate was 316,000 people with more than 1 million people displaced.[251] The worst earthquake in U.S. history was the 1906 San Francisco Earthquake where 3,000 lives were lost. Collapsing buildings claim by far the majority of lives. The destruction is often compounded by mudslides, fires, floods or tsunamis.

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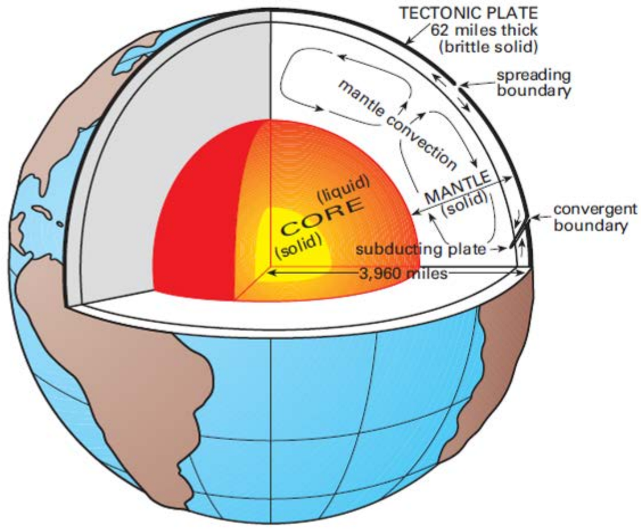

Interior zones of the Earth (figure modified from Washington Division of Geology and Earth Resources, Information Circular No. 85, 1988). The Earth's crust consists of great plates that slowly move across the surface of the Earth in response to convection cells in the mantle. Most earthquakes occur where plates meet, such as at spreading or convergent boundaries.

Earthquakes are the consequence of the slow movement of the earth's crustal plates. At the sites where these plates collide, earthquakes are a regular phenomenon. More than 100,000 earthquakes with magnitudes of 3 or greater occur worldwide each year. It is estimated that there are 500,000 detectable earthquakes in the world each year.[252] 100,000 of those can be felt, and 100 of them cause damage according to the USGS.

Faults are zones of weakness in the upper crust. When sufficient strain builds up to overcome the frictional resistance of the blocks of rock on either side of the fault, the rocks will slide past each other. When the blocks of rock snap, or quickly move past one another, an earthquake happens, releasing energy in the form of seismic waves.

There are two types of seismic waves: body waves and surface waves. Body waves are divided into primary (P) waves and secondary (S) waves. P-waves are the fastest and move with a push-pull motion. S-waves, also called shear waves, move more slowly and displace materials perpendicular to their direction of travel. Surface waves travel more slowly than either P-waves or S-waves and are responsible for most of the destructive effects of earthquakes. The velocity of a wave depends on the density and elastic properties of the materials through which the wave passes.

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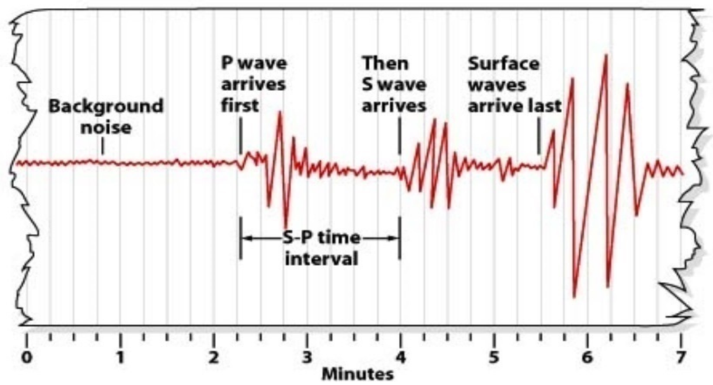
[251] "10 Deadliest Earthquakes in History," CNN, last modified on 27 April 2015, http://www.cnn.com/2015/04/27/world/gallery/ten-deadliest-earthquakes/

[252] "Earthquake Facts," USGS, accessed on 3 Nov 2015, http://earthquake.usgs.gov/learn/facts.php

Measuring Earthquakes



Seismographs are instruments that record seismic waves generated by earthquakes. A seismometer is the component that transforms seismic-wave energy into electrical voltage that can be analyzed in digital form by computer or into analog form that is displayed on paper or file. The squiggly up-and-down series of lines that correspond to seismic wave energy on these records are called seismograms. See graphic to the right for an example of a typical seismogram.

Earthquakes are measured in a number of ways, but two types of scales are most common. The Magnitude Scale and Modified Mercalli Intensity Scale each portray useful information.

A Magnitude Scale, such as the Richter scale, is an instrumental scale that depicts the total energy released during an earthquake. It is calculated by measuring the amplitude of seismic waves on a seismogram. The magnitude of an earthquake is the same at any location where it can be adequately measured. An increase of one whole number on the magnitude scale corresponds to a 10-fold increase in ground motion. The scale is logarithmic; therefore, an increase of two whole numbers on the scale is a 100-fold increase of seismic-wave amplitude. The amount of energy released during an earthquake is about 31 times greater for each whole-number increase in the magnitude scale. The Richter Scale is the most common magnitude scale used.[253]

The Modified Mercalli Intensity Scale portrays the amount of ground shaking at a particular location on the basis of the effects felt by people and the observed damage to buildings and terrain. It is similar to the way the Fujita Scale works in estimating the strength of tornadoes. The Modified Mercalli Scale is defined by Roman Numerals from I to XII. I represents not felt and XII represents total destruction. Intensity is greatest at the epicenter and decreases with distance away from this point.

Magnitude	Typical Maximum Modified Mercalli Intensity
1.0 - 3.0	I
3.0 - 3.9	II - III
4.0 - 4.9	IV - V
5.0 - 5.9	VI - VII
6.0 - 6.9	VII - IX
7.0 and higher	VIII or higher

The chart to the right shows the general relationship between the Modified Mercalli Scale and the Magnitude scales typically used.

253 "Measuring the Size of an Earthquake," HSGS, accessed on 3 Nov 2015, http://earthquake.usgs.gov/learn/topics/measure.php

The following table details intensities that are typically observed at locations near the epicenter of earthquakes of different magnitudes.

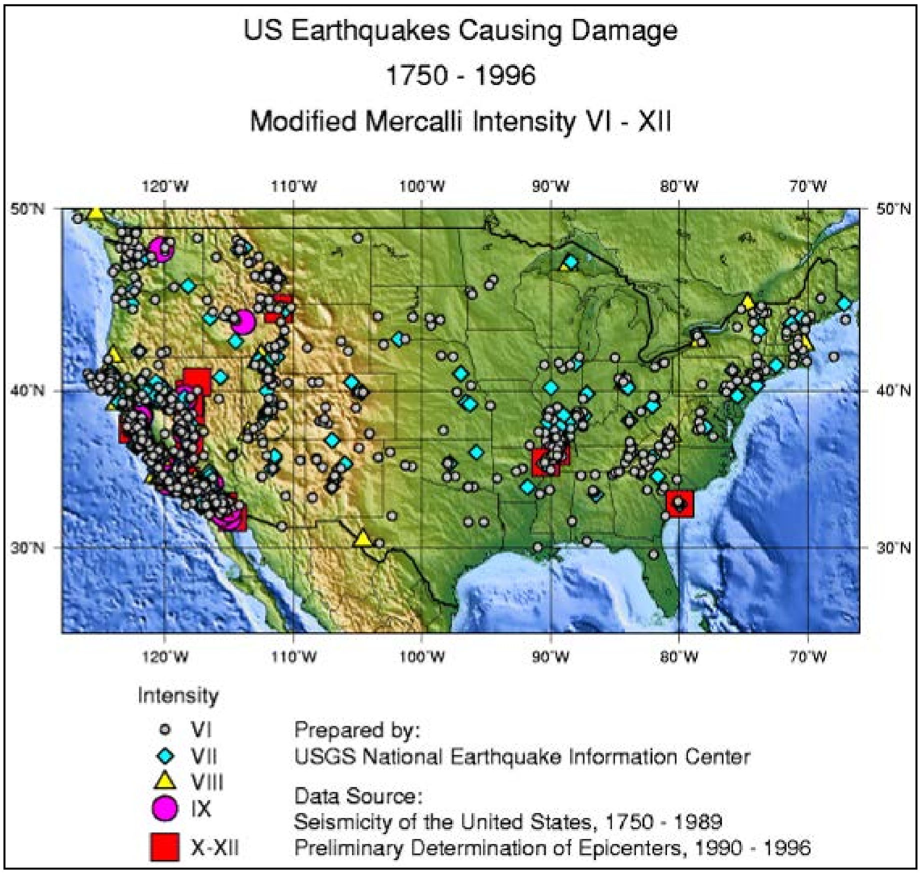
Modified Mercalli Scale[254]

I.	Not felt except by a very few under especially favorable conditions.
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.
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 motor cars rocked noticeably.
V.	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
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.
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.
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.

Earthquakes in the United States

[254] "Magnitude/Intensity Comparison", USGS, accessed on 17 Jan 2016, http://earthquake.usgs.gov/learn/topics/mag_vs_int.php

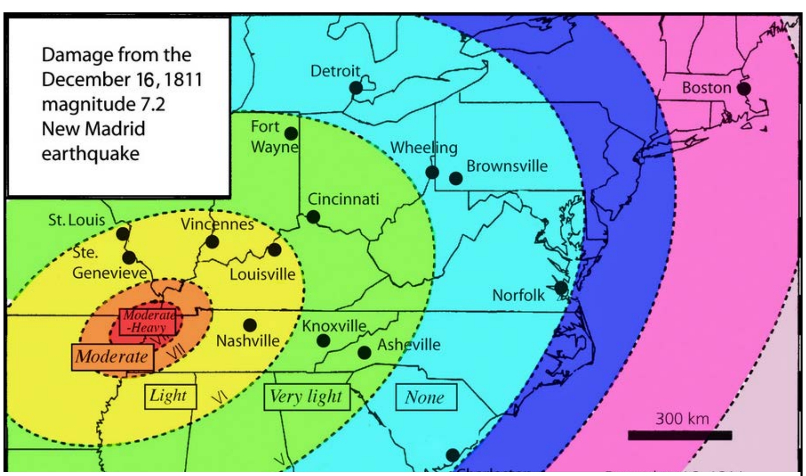
Since its early history, earthquakes have affected the United States. The greatest seismic activity in the United States is along the Pacific Coast in California and Alaska. 42 states have experienced earthquakes, magnitude 3.5 and higher in the last 30 years (1974-2003).



Earthquakes have stuck many areas of the United States, including the Central and East Coast states as well as the more familiar earthquake activity in West Coast states.

The deadliest earthquake in the United States was the April 18, 1906, San Francisco earthquake, taking an estimated 3,000 lives. Aftershocks were felt as far away as Oregon and Nevada. The quake caused major damage to the city and is known as one of the worst natural disasters in U.S. history. The Great Alaska Earthquake of 1964 was the largest earthquake in the United States.

The 1811-1812 series of earthquakes at New Madrid, Missouri were the largest earthquakes in historic times in the continental United States. Half the town of New Madrid was destroyed. Large areas sank into the earth and new lakes were formed. The Mississippi River changed its course, creating numerous geographic exclaves, including Kentucky Bend. Some sections of the Mississippi River appeared to run backward for a short time. Church bells were reported to ring as far as



Source: Purdue

Boston and sidewalks were reported cracked and broken in Washington, DC. The New Madrid Fault System is still a major concern according to USGS. Publications on this fault are available at usgs.gov.

While large earthquakes are expected in the United States, compared to the millions who have been killed by earthquakes in Europe, Asia, and South America, the United States has been comparatively fortunate.

Earthquakes in Ohio

Although not thought of as an earthquake-prone state, at least 200 earthquakes with epicenters in Ohio have been felt since 1776. At least 15 moderately-sized earthquakes have caused minor to moderate damage in Ohio. Most of these earthquakes have been felt only locally and have caused no damage or injuries.

In addition, a number of earthquakes with origins outside Ohio have been felt in the state. Ohio is on the periphery of the New Madrid Seismic Zone. The great New Madrid earthquakes of 1811 and 1812 were felt throughout Ohio, causing chimneys to topple in Cincinnati.

A major earthquake centered near Charleston, South Carolina, in 1886 was strongly felt in Ohio. More recently, a 5.3 magnitude earthquake centered at Sharpsburg, Kentucky in 1980 caused minor to moderate damage in communities near the Ohio River in southwestern Ohio.

Three areas of Ohio appear to be particularly susceptible to seismic activity. The most active area is Shelby County and surrounding counties in western Ohio. At least 40 felt earthquakes have occurred in this area since 1875. Although most of these events have caused little to no damage, some minor to moderate damage has occurred. Two earthquakes in 1937, on March 2 and March 9, caused significant damage in the Shelby County community of Anna, including toppled chimneys, cracked plaster, broken windows, and structural damage to buildings.

Northeastern Ohio has experienced more than 80 felt earthquakes since 1836. Most of these events were small and caused little or no damage. One earthquake on January 31, 1986, strongly shook Ohio and was felt in 10 other states and southern Canada. This event was a 5.0 magnitude earthquake and caused moderate damage in the epicenter area of Lake and Geauga counties.

Southeastern Ohio has been the site of at least 10 felt earthquakes, with epicenters in the area, since 1776. These earthquakes caused minor to moderate damage in several Ohio River counties.[255]

[255] "Earthquake Hazards Program," USGS, accessed on 8 Aug 2015, http://earthquake.usgs.gov/regional/states/ohio/history.php

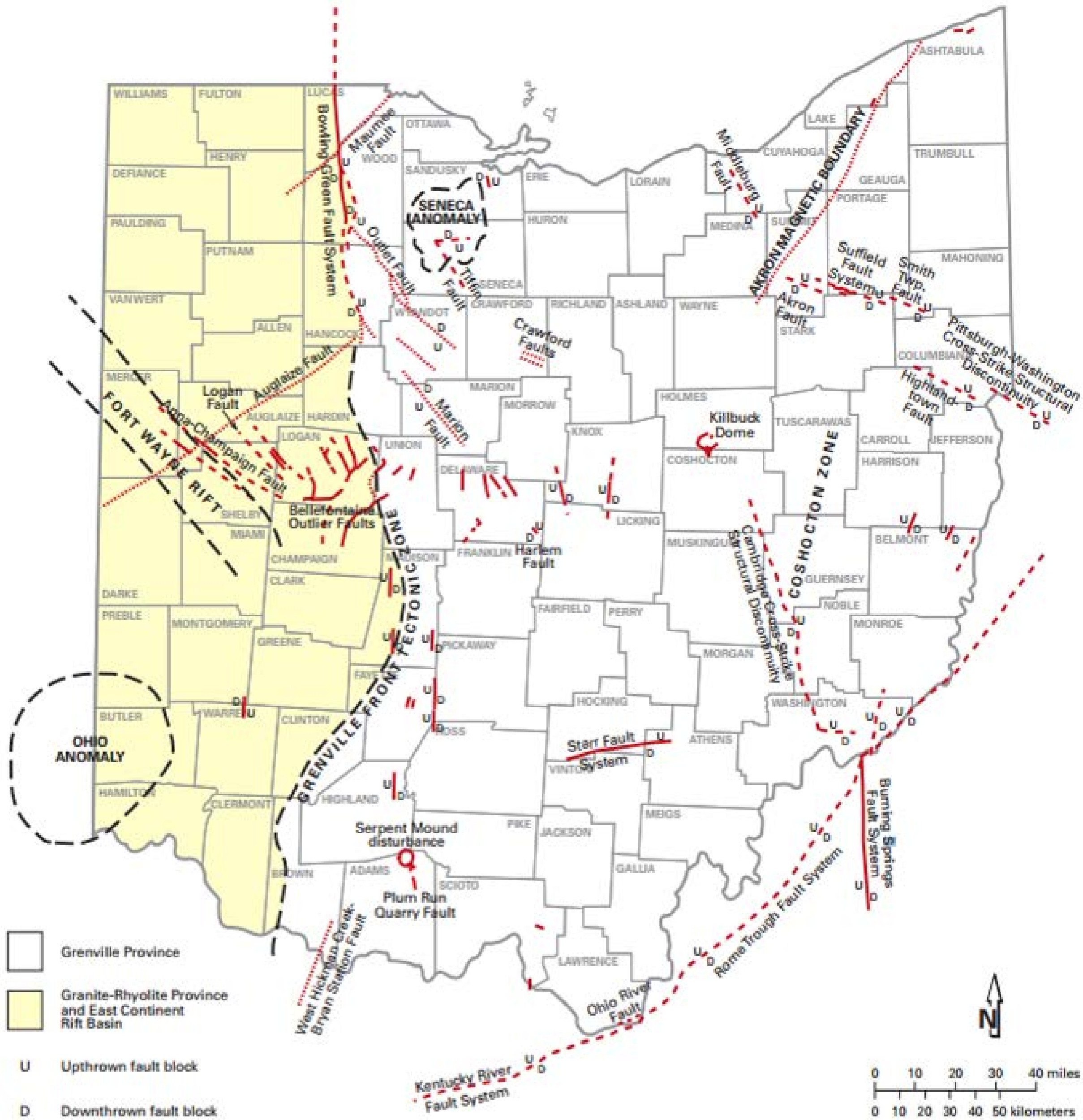
Ohio earthquakes appear to be associated with ancient zones of weakness in the earth's crust. These zones are characterized by deeply buried and poorly known faults. Active faults do not reach the surface in Ohio and therefore are difficult to map.

Earthquakes in the eastern United States are difficult to predict because they have very long recurrent intervals. This is complicated by the fact that seismic waves tend to travel for very long distances in the eastern states. The relatively brittle and flat-lying sedimentary rocks of this region tend to carry seismic waves throughout an area of thousands of square miles for even a moderate-sized earthquake.

One of the more recent earthquakes in Ohio happened in 2011 near Youngstown. The earthquake measured 4.0 on the Richter scale.[256]

[256] "Magnitude 4.0-Youngstown-Warren Urban Area, Ohio", USGS, accessed on 29 August 2015, http://earthquake.usgs.gov/earthquakes/eqinthenews/2011/usc0007f7s/

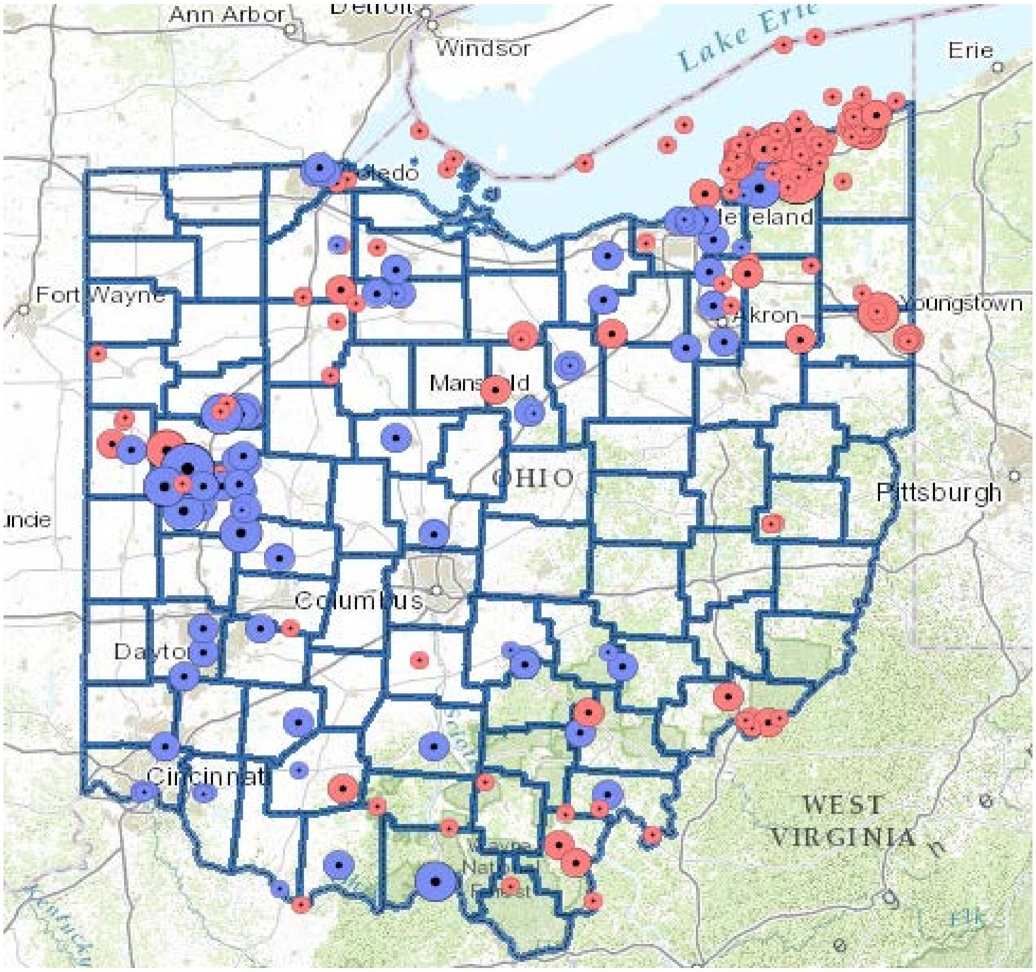
Ohio Faults



Note: This map portrays a number of deep faults and other structures that have been identified by a variety of geological studies. Some faults are well known, whereas others are speculative. Very few of them are visible at the surface. The Fort Wayne (Anna) rift in western Ohio is the site of numerous historic earthquakes.

Source: NSGS

Ohio Earthquakes



Legend

Source*:* ODNR[257]

[257] "Ohio Earthquake Epicenters," ODNR, accessed on 20 September 2015, https://gis.ohiodnr.gov/website/dgs/earthquakes/

Hydraulic Fracking and Earthquakes in Ohio

There has been much discussion on the topic of fracking and its potential link to earthquakes in Ohio. Following is a portion of an article recently published by NBC News on January 5, 2015.

"A hydraulic fracturing, or fracking, well in Ohio triggered scores of small earthquakes in March 2014, including one large enough to be felt in nearby towns, a new study confirms. The biggest quake, a magnitude 3, was one of the largest ever caused by fracking. State officials shut down the well two days after the earthquake hit.

Fracking involves the high-pressure injection of water, sand and chemicals into rock to break it up and release trapped oil and gas. In Ohio, fracking triggered earthquakes on a hidden fault in ancient crystalline rock beneath a natural gas well in the Utica Shale, according to the study, published on January 5, 2015 in the Bulletin of the Seismological Society of America.[258]

No earthquakes were ever recorded in this region of Ohio before fracking started, and the shaking stopped after the well was shut down, said lead study author Robert Skoumal, a graduate student in seismology at Miami University in Ohio. Skoumal and other Miami University researchers identified 77 earthquakes with magnitudes ranging from 1 to 3 that occurred from March 4 to 12.

In this Wednesday, January 4, 2011 file photo, a brine injection well owned by Northstar Disposal Services LLC is seen in Youngstown, Ohio, with the skyline of Youngstown in the distance. A dozen earthquakes in northeastern Ohio were almost certainly induced by injection of gas-drilling wastewater into the earth, state regulators said Friday, March 9, 2012 as they announced a series of tough new rules for drillers. (AP Photo/Amy Sancetta, File)

"The company happened to be unlucky because they were hydraulic fracturing near an unknown fault," Skoumal said. The largest earthquake rattled nerves in eastern Ohio but did not cause any damage.

It is rare for fracking to cause earthquakes that people can feel. This is the fifth reported case tying fracking to felt earthquakes, and the second instance in Ohio. Fracking typically

[258] "Fracking Confirmed as Cause of Rare "Felt" Earthquake in Ohio", Seismological Study of America, 5 January 2015, http://www.seismosoc.org/Society/press_releases/BSSA_105-1_Skoumal_et_al_Press_Release.pdf

causes tiny tremors that are too small to be felt by people, usually smaller than about magnitude 1.

This is a condensed version of a report from Live Science."

Source: NBC News[259]

Earthquakes in Franklin County

There have been no recorded earthquake epicenters in Franklin County. Earthquake movement has been felt in the county from epicenters in other parts of Ohio; however no damage has been reported.

The brief historic record of Ohio earthquakes suggests an approximately magnitude 5 earthquake is the maximum event for the state. Earthquakes would most likely happen in the western seismic zone, or in northeastern Ohio, with a lesser possibility in southeastern Ohio. Such earthquakes would be expected to cause little or no damage in Franklin County.

It has been estimated that even a large earthquake in the New Madrid Seismic Zone would only cause slight damage in Franklin County.

Climate Change Impacts

While there is much discussion on this subject among the scientific community it is not clear if and how these two are related. A growing number of scientists believe climate change can affect the underlying structure of the earth as it relates to rainwater in river deltas putting pressure on the earth's tectonic plates. However, other scientists say this earthquake risk of sea-level rise and changing rainfall is overstated. These scientists claim there is not yet enough data to support such a hypothesis.[260]

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259 "Fracking Triggered Scores of Small Earthquakes in Ohio in 2014: Study," NBC News, last modified 5 January 2015, http://www.nbcnews.com/science/environment/fracking-triggered-scores-small-ohio-earthquakes-2014-study-n280166

260 "More Fatal Earthquakes to Come, Geologists Warn," Newsweek, updated on 28 April 2015, http://www.newsweek.com/nepal-earthquake-could-have-been-manmade-disaster-climate-change-brings-326017.html

Vulnerability Assessment – Earthquake

**Note: all information in this vulnerability assessment can be attributed to the Franklin County 2012 Natural Hazards Mitigation Plan and FEMA's HAZUS data print date May 2014.*

This hazard is considered to be a "Low Probability Event", meaning the anticipated frequency of the hazard within the County is once every 26 to 124 years. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability

All structures and infrastructure in Franklin County are equally at risk of experiencing an earthquake. However, no structural damage is anticipated in a mild earthquake of the magnitude typically experienced in Ohio. In other cases, damages are expected to be limited and examples of anticipated damages are broken dishes and windows and toppled file cabinets.

For this vulnerability assessment we will use the 2014 HAZUS data worst case scenario of a 5.4 magnitude earthquake.

Potential Impact of Earthquakes

Based on the history of earthquakes in Ohio, no structural damage is anticipated in Franklin County. However, for earthquakes, the available history covers a period of just over 200 years, which is a relatively short period of time for an examination of earthquakes. Large earthquakes may only affect a location every several centuries or millennia. A large earthquake affecting Franklin County might cause structural damage in dilapidated structures or structures that do not meet current building codes. Roads and bridges might be damaged and trees and power lines might fall.

Thus the impact of an earthquake might range from negligible to minor damage. Based on over 200 years of experience in Franklin County, there will most likely be no damage or very slight damage. If in the worst case scenario a magnitude 5.4 earthquake, the strongest earthquake in Ohio's history, were to have an epicenter in the center of Franklin County, then moderate damage would be expected.

HAZUS estimates that there are 386,000 buildings in the region which have an aggregate total replacement value of 91,875 million. For a 5.4 magnitude earthquake, HAZUS estimates that about 54,130 buildings will be at least moderately damaged. Of the 54,130 buildings 189 would be considered critical facilities. This is 14.0% of the total number of buildings in the scenario. There are an estimated 10,219 buildings that will be completely destroyed by having over 50% damage to the structure. The following table shows estimated total damage for each occupancy type within Franklin County.

Building Exposure by Occupancy Type for a 5.4 Magnitude Earthquake

Occupancy	Expected Buildings Damaged				
	None	Slight	Moderate	Extensive	Complete
Single Family	186,783	65,916	29,119	6,759	1,481
Other Residential	37,839	14,521	7,350	1,714	341
Commercial	13,772	4,798	3,623	1,181	202
Industrial	3,502	1,141	926	308	45
Agricultural	664	200	169	58	8
Religion	1,147	443	329	114	24
Government	400	149	130	39	10
Education	500	172	143	46	11
Total:	244,607	87,340	41,790	10,219	2,122

Identifying Structures

Exposure of Existing Buildings to Earthquake Damages
In this update, the age of a structure is used to estimate the potential damage an earthquake may have in Franklin County.

All existing buildings have the potential to experience an earthquake. Given no history of damage in Franklin County due to earthquakes, damages are estimated to be limited to the more dilapidated structures and structures with unreinforced masonry. In Franklin County, 169,283 are at least 50 years old. Of these structures, dilapidated structures would be expected to endure the most damage over all.

Exposure of Future Buildings to Earthquake Damages
All future structures will also have the potential to experience an earthquake. However, given that new structures must meet current building codes and given the expected magnitude of earthquakes in Franklin County, structure loss is expected to decrease.

Estimating Potential Loss

Methodology
USGS data was used to identify that there is no evidence that an earthquake has caused any damage in Franklin County since 1776.

According to the above table, 141,471 structures will have some loss ranging from slight to complete.

According to the Franklin County Auditor's Office real estate report as of 2015, which contains information for tax year 2012, the total value of residential and commercial structures is $68.4 billion and the total number of residential and commercial structures is 568,157.[261] $68,400,000,000 / 568,157 = 120,389 average value per structure.

Slight damage	87,340	61%
Moderate damage	41,790	29%
Extensive damage	10,219	7%
Complete damage	2,122	1%

Estimated Potential Dollar Losses
Slight damage 25% dollar loss
87,340 X 120,389 = 10,514,775,260 X .25 = $2,628,693,815

Moderate damage 50% dollar loss
41,790 X 120,389 = 5,031,056,310 X .50 = $2,515,528,155

Extensive and complete are considered 100% structural loss and will be combined 8%
12,341 X 120,389 = $1,485,720,649

Total estimated potential dollar loss: $6,629,942,619

The damage in dollars represented in this vulnerability statement only quantify the damage to structures and does not reflect ancillary costs associated with this hazard.

The damage in dollars represented in this vulnerability statement only quantify the damage to structures and does not reflect ancillary costs associated with this hazard. These numbers are as a result of utilizing an assumption that Franklin County will be impacted by a substantial earthquake. Franklin County has no history or evidence that an earthquake of this magnitude is realistic. While the data derived from software systems (HAZUS) has a place in the process, subject matter expertise and history show a much lower risk and much lower damage in dollars attributed to this hazard.

[261] Franklin County Auditor's Office, accessed on 13 October 2015, https://www.franklincountyauditor.com/real-estate/real-estate-info

Invasive Species - #17

Hazard Summary

Invasive species is defined as an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health.[262] An increasing threat of exotic diseases, such as the dangerous West Nile virus, exists because of increased transportation and encroachment of humans into previously remote ecosystems. Two events that have caused substantial economic and environmental damage in Ohio are the introduction of zebra mussels into waterways and the infestation of the emerald ash borer, responsible for killing ash trees. This hazard was ranked 17 out of 20.

[262] "Definitions," Pacific Northwest Invasive Plant Council, accessed on 3 Nov 2015, http://www.pnw-ipc.org/invasives.shtml

Hazard Profile

There are currently more than 6,500 nonindigenous species of plants, animals and microorganisms established in the United States, posing risks to native species, valued ecosystems, and human and wildlife health.[263] Many invading organisms and diseases cause substantial losses in agriculture, livestock, fisheries, and other resource production systems. Some significantly alter ecosystems, resulting in costly damages due to increases in fire, flooding, and erosion. A few are vectors, or carriers, of human diseases. By some estimates, the current annual environmental, economic, and health-related costs of invasive species may even exceed those of all other natural disasters combined.

The United States Geological Survey defines invasive species as any species that is not native to an ecosystem and whose introduction does (or is likely to) cause harm to the economy, environment, or human health. Invasive species comprise "biological pollution," which (unlike chemical pollution) multiplies on its own, often explosively, with far-reaching consequences. Many invasive species often go unnoticed until they have spread to many locations, making eradication difficult.

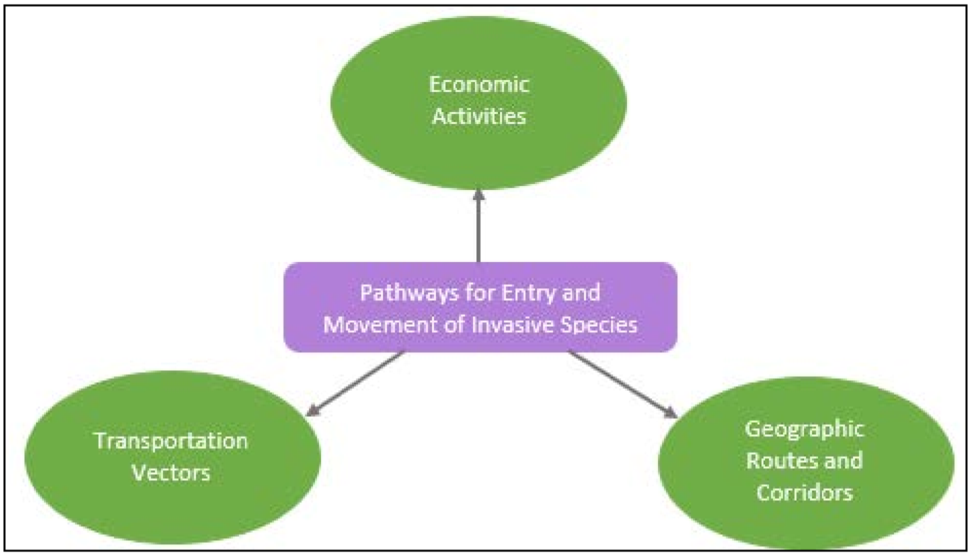
Increased global travel and trade provides pathways for both intentional and unintentional introductions of invasive species. Many species introduced for beneficial purposes are now harmful. An example is kudzu, which was first planted in the U.S. for erosion control. Over 80% of tree and shrub invaders in the U.S. arrived as landscape plants. Accidental introductions often hitchhike across borders where they are not expected. Zebra mussels traveled to the Great Lakes unnoticed in ballast water from Europe. The chestnut blight fungus arrived with imported ornamental trees from Asia and destroyed the American chestnut during the early 20th century. Below are photos (from left to right) of a kudzu-covered field in northern Georgia, a zebra mussel, and chestnut blight.


[263] "CERC Science Program: Invasive Species," USGS, accessed on 3 Nov 2015, http://www.cerc.usgs.gov/SciencePrograms.aspx?ScienceProgramId=3

Sources: USGS[264] Texas Invasives[265] Missouri Botanical Garden[266]

Movement Pathways

The mechanisms by which species reach new habitats are called "pathways." Pathways are the geographic routes that non-native species take, the economic activities that involve them, and the means of transportation that carry them. Pathways operate at all levels, from local to global, and almost all are related to human activity. Commerce in goods and services, recreational and business travel, and changes in land use all facilitate the introduction of new species to new places every day.



Source: Adapted from National Invasive Species Council and Aquatic Nuisance Species Task Force

Geographic routes and corridors – Non-native species can move into new areas when barriers are removed or altered; highways, canals, and trade routes provide such opportunities. Canals connect water bodies, and highways, railways, and tunnels cross mountains and link valleys. Today, modern modes of travel provide access to places previously inaccessible, and political, social, and economic barriers that once isolated large parts of the world are mostly gone. Together, these changes provide extensive routes and corridors not only for the movement of people but also for other species.

The movement of species is greatly facilitated by infrastructure. Artificial waterways have been built to link bodies of water, especially in the Great Lakes region. The end points, direction, and frequency of travel in maritime trade all influence movement of species. Ships tend to ply established routes, so the same species are likely to be introduced many times, increasing the probability of successful establishment in a new habitat. Roadsides

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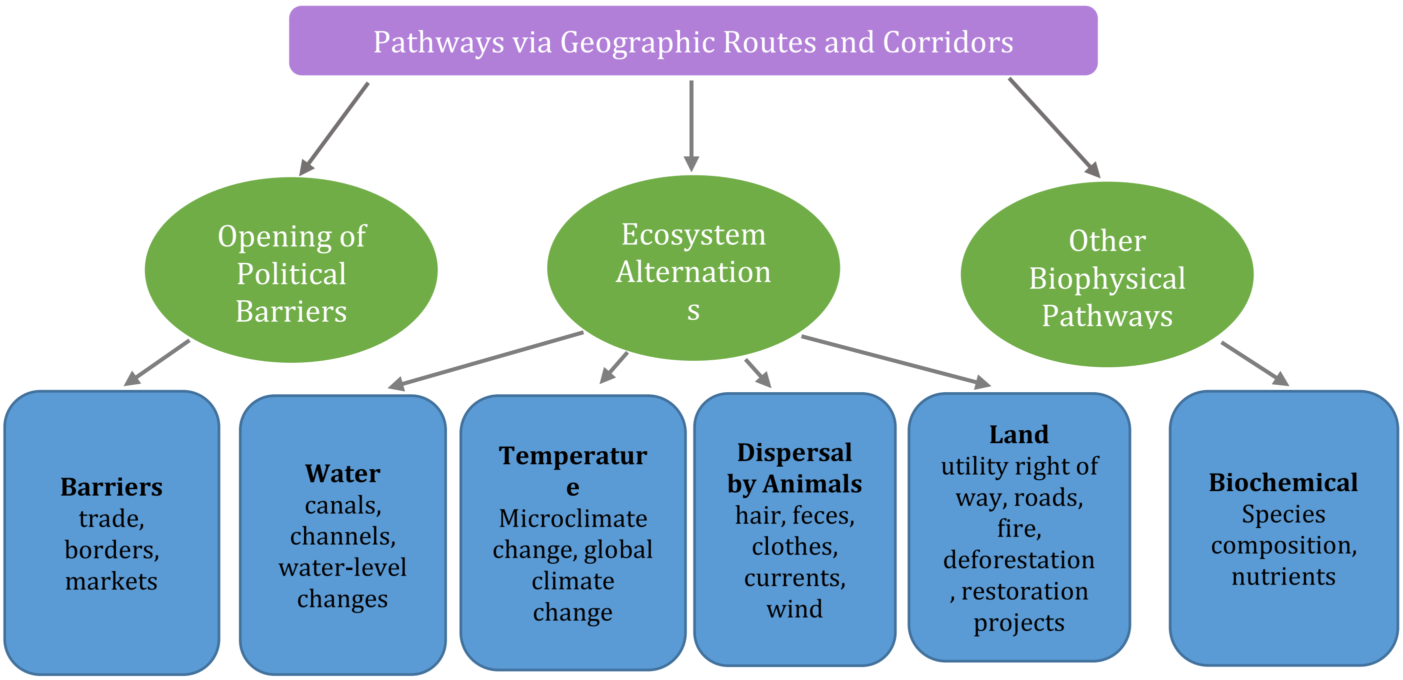
264 "Changing Patterns in the Number of Species in North American Floras," USGS, accessed on 14 June 2016, http://landcover.usgs.gov/luhna/chap4.php#figure4-1

265 "Hello Zebra Mussels, Goodbye Texas Lakes," Texas Invasives, accessed on 16 Oct 2016, http://texasinvasives.org/zebramussels/

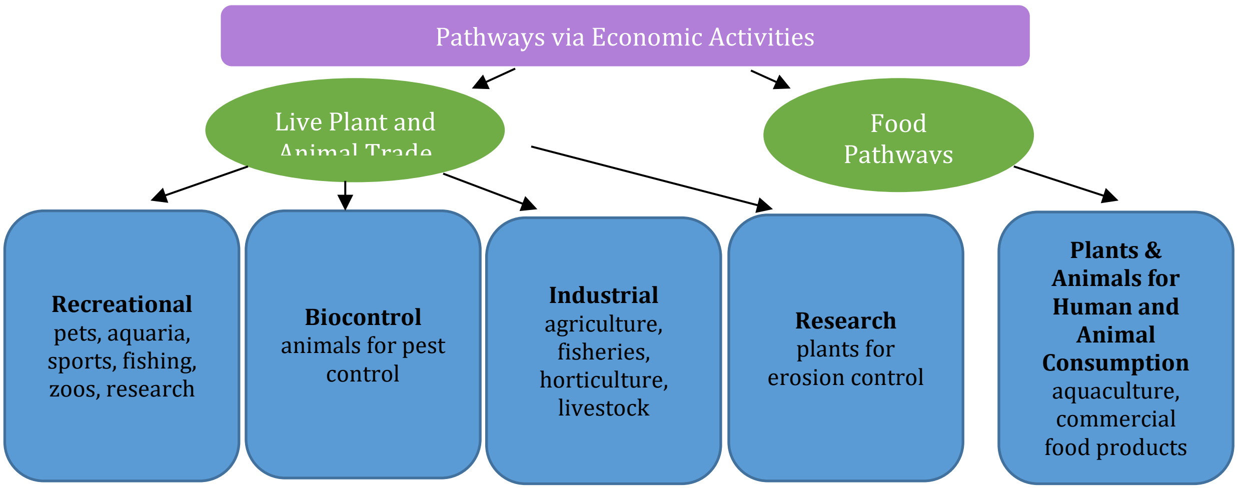
266 "Chestnut Blight," Missouri Botanical Garden, accessed on 16 Oct 2016, http://www.missouribotanicalgarden.org/gardens-gardening/your-garden/help-for-the-home-gardener/advice-tips-resources/pests-and-problems/diseases/cankers/chestnut-blight.aspx

provide a conduit of movement of seeds or parts of plants, either by wind or attached to animals or vehicles. In some cases, the problem is exacerbated by the intentional planting of non-native invasive species along roads for aesthetic, erosion control or other reasons.



Source: Adapted from National Invasive Species Council and Aquatic Nuisance Species Task Force

<u>Activities</u> – Numerous economic activities drive interstate and international trade in live plants and animals. Commercial trade can allow non-native plants, animals, and diseases to escape and spread. Horticulture, the aquarium and pet trades, zoos, botanical gardens, and agriculture are some of the significant pathways of intentional introduction. These intentionally introduced species may cause little or no harm, or they may be labeled invasive if unintended negative consequences result. Unintentional introductions are a side effect of these economic activities. Species hitchhike in transported soil, on vegetation, on animal fur, or with human travelers. Fungal and bacterial diseases are often transported by similar pathways through affected plants/animals or in associated soil and water.



Source: Adapted from National Invasive Species Council and Aquatic Nuisance Species Task Force

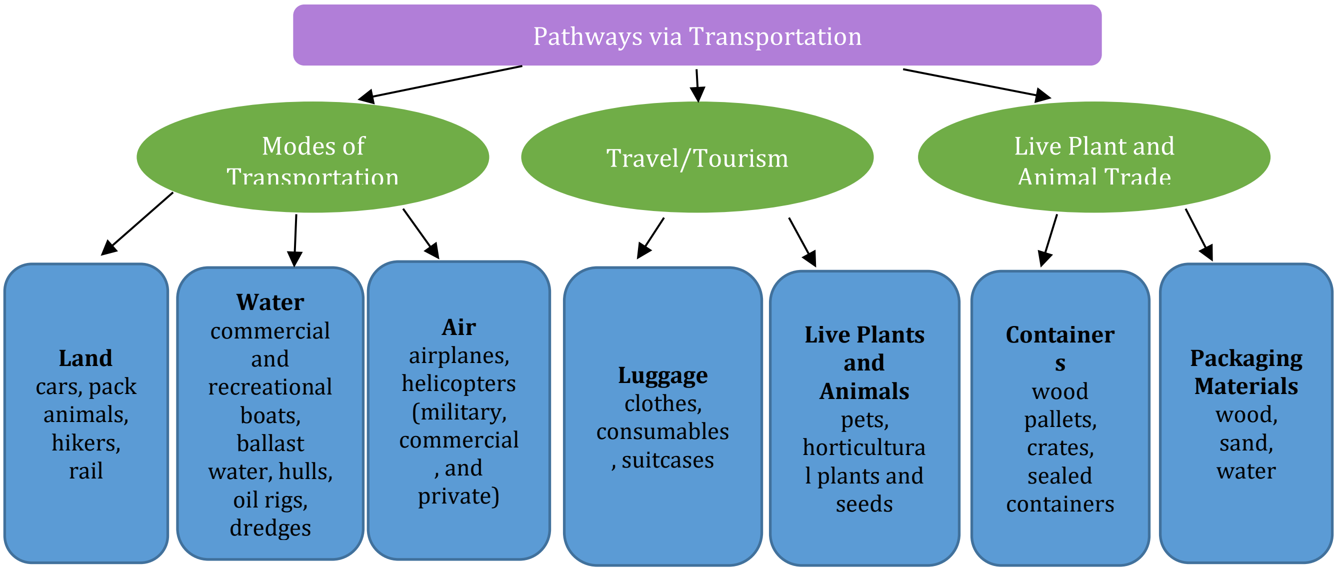
Transportation Vectors – Goods and organisms move from place to place by countless means. Invasive species may hitchhike on transport vessels themselves, in packaging and storage containers, on clothes, and inside the bodies of living things (including humans). Typically, a species arrives by one pathway and spreads by another. Any single species may arrive repeatedly from different parts of the world.

Ballast water from ocean-going vessels has created a global dispersal mechanism for plant and animal non-native aquatic species. An estimated 7,000 species of plants and animals are transported around the world in ships' ballast water each day. They can then travel from one body of water to another via recreational boats. Since 1993, ships entering the Great Lakes have first been required to exchange the fresh or estuarine ballast water that they pick up in other ports for ocean water. Ideally, this water's high salinity kills any potential freshwater invaders. But discoveries of new non-native species continue to increase with the intensity of shipping in the Great Lakes.

Aquatic non-natives can attach to hulls, decks, propellers, or other physical parts of ships and watercraft. Boats can also transport non-native species in live wells, bait buckets, and other places where water is carried.

Wooden cases and pallets, as well as materials such as straw or wood chips that are used to protect the contents of shipping containers, can harbor hitchhikers. Bark beetles, one of the most damaging groups of insects worldwide, are often transported in the packing material within a ship's cargo.

Travelers and tourists move plants, insects, and diseases, sometimes accidentally and sometimes intentionally.



Source: Adapted from National Invasive Species Council and Aquatic Nuisance Species Task Force

Impacts of Invasive Species

Invasive species have destructive effects that can be economic, environmental, or health-related, but are not always easy to measure and not necessarily obvious. Putting a dollar value on the impacts of invasive species is not a straightforward process. While some economic costs, such as those of the labor and pesticides used for control of a species, are direct, other costs – such as losses to fisheries, recreation or crops – are indirect. Still others, such as impacts on native species or damage to ecosystems are very hard to measure. Loss of ecosystem services is a quantifiable value. For example, the honey bee blight has required many farmers to pay for pollination services either through transient hives, or even hand-pollination. Disruptions to the food chains within ecosystems can result in burgeoning populations of insects which then require insecticides to control. Calculation of the monetary value of lost ecosystem services is complex; however it generates a very real and very high number. These invasive species have affected economic sectors including agriculture, fisheries, forestry, energy production, and recreation. Invaders cost at least tens of millions of dollars each year, and damage could reach into the billions.[267]

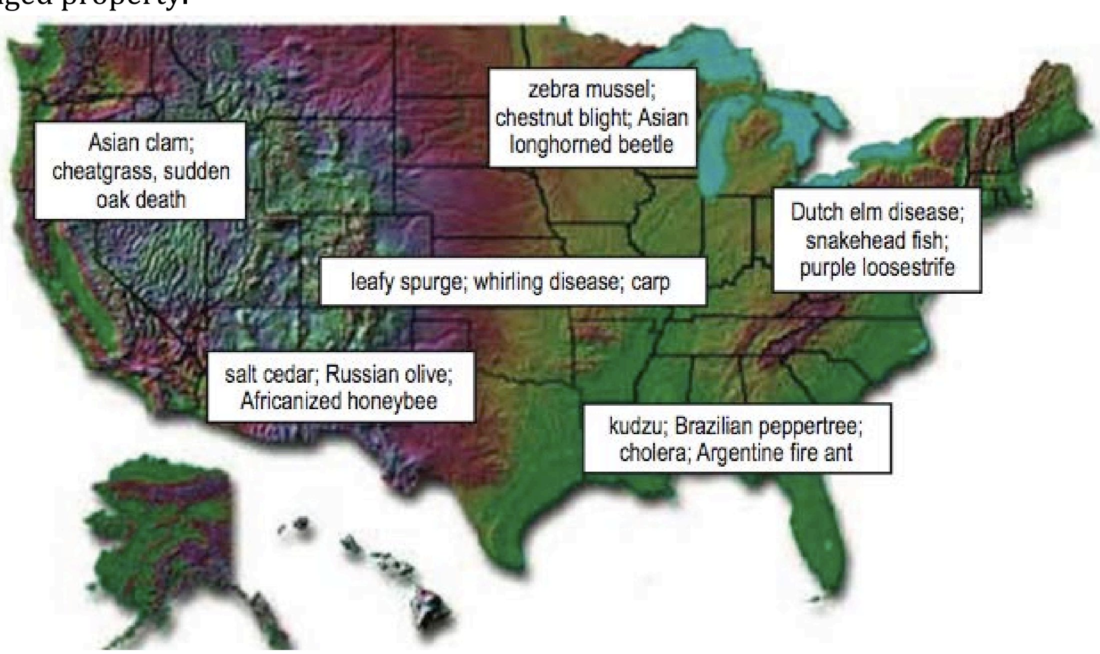
Insect pests kill trees, thereby affecting the forestry industry, animal habitat and food sources, as well as ecosystem services provided by healthy trees. Aquatic plants and animals outcompete or hybridize with native populations, obstruct cooling systems, damage docks, hurt the fishing industry, and reduce recreational opportunities. Invasive plants increase the environment's susceptibility to erosion, wildfires, and flood events, with each having their own effect on the environment. They can also alter the soil chemistry and reduce the water table levels. Economic impacts of invasive plants or diseases on

[267] "The Cost of Invasive Species", U.S. Fish and Wildlife Service, accessed on 19 Oct 2016, https://www.fws.gov/verobeach/pythonpdf/costofinvasivesfactsheet.pdf

agriculture are also significant. For example, citrus greening disease is substantially impacting citrus producing states in the U.S. In response, the citrus industry is advocating for genetically modified organism (GMOs) in order to create disease resistant trees. The development and introduction of these GMOs is not just a monetary cost, it carries with it an uncertain fate and for many people, a large concern for the unknown human health or environmental risks.

An increasing threat of exotic diseases exists because of increased transportation and encroachment of humans into previously remote ecosystems. This can lead to new associations between a disease and a human or animal host. Introduced birds, rodents, and insects can serve as vectors and reservoirs of diseases affecting humans. Throughout recorded history, epidemics of human diseases such as malaria, yellow fever, typhus and bubonic plague have been associated with these vectors. A recent example of an introduced disease is the spread of the West Nile Virus across North America from birds brought to a New York zoo, resulting in deaths of humans, birds, mammals, and reptiles. The full range of impacts of invasive species and their control goes beyond immediate effects and can have long term public health implications.

Diseases, viruses, and pathogens originating from foreign or invasive sources can also decimate populations of ecosystem-critical species, livestock and recreationally-important species. Currently the world is facing a salamander apocalypse due to rapid spread of a fungal disease being spread through the unregulated pet trade. White nose syndrome in bats, whirling disease in trout and avian bird flu represent additional types of animal afflictions which are already present in the United States a pose international threats if not managed property.



Source: National Biological Information Infrastructure

Invasive Species in the United States

Hundreds of species from other countries arrive in the United States unintentionally each year – and introductions are on the rise. The current environmental, economic, and health-related costs of invasive species could exceed $138 billion per year – more than all other natural disasters combined.[268]

In the United States alone, scientists estimate that about 7,000 invasive species of plants, mammals, birds, amphibians, reptiles, fish, arthropods, and mollusks are established. Invasive species adversely affect every ecosystem in the United States, from Alaska to Florida, from urban centers to wilderness.[269]

Plants – Most alien plants now established in the United States were introduced for food, fiber, or ornamental purposes. An estimated 5,000 non-native plant species now exist in U.S. natural ecosystems, compared with a total of about 17,000 native U.S. plants. Most of the alien plants established in the U.S. natural ecosystems have displaced several native plant species. Many introduced plant species established in the wild are having a negative effect on U.S. national, state, and local parks and natural areas.

Mammals – About 20 species of mammals have been introduced into the United States; these include dogs, cats, horses, burros, cattle, sheep, pigs, goats, and deer. Several of these species have escaped or were released into the wild; many have become pests by preying on native animals, grazing on vegetation, or intensifying soil erosion. Many small animals have also been introduced into the United States. These include a number of rodents that have become serious pests on farms, in industries, and in homes.

Birds – About 97 of the 1,000 bird species in the United States are exotic. Of the 97 introduced bird species, only 5% are considered beneficial, while most (56%) are pests. Several species, including chickens and pigeons, were introduced into the United States for agricultural purposes. Pigeons are the most common nuisance bird in the US.

Aquatic Species – Of the 1,555 species of non-native aquatic species identified in the United States and its territories, 145 are found in Ohio's waters. Fish alone account for almost half of these species, and aquatic plants another 22%.

Amphibians and reptiles – About 53 species of amphibians and reptiles have been introduced into the United States. All of these alien species occur in states where it seldom freezes. The negative ecological impacts of a few of these exotic species have been enormous.

[268] "Invasive Plant Species: Inventory, Mapping, and Monitoring – A National Strategy", USGS, accessed on 17 Jan 2016, http://pubs.er.usgs.gov/publication/53892

[269] "Environmental and Economic Costs Associated with Non-Indigenous Species in the United States", Cornell Chronicle, accessed on 17 Jan 2016, http://www.news.cornell.edu/stories/1999/01/environmental-and-economic-costs-associated-non-indigenous-species

Fish – A total of 138 alien fish species have been introduced into the United States. Most of these introduced fish have been established in states with mild climates. Forty-four native species of fish are threatened or endangered by alien invasive fish.

Arthropods – Thousands of arthropod species have been introduced in the country. More than 95% of these introductions were accidental, with many species gaining entrance via plants or through soil and water ballast from ships.

Mollusks – Eighty-eight species of mollusks have been introduced and established in the U.S. aquatic ecosystems. Three of the most serious pests are the zebra mussel, Asian clam, and quagga mussels.

Overall, the number of non-native species in the United States has grown exponentially in recent years, along with the international trade that primarily brings them.

Invasive Species in Ohio and Franklin County

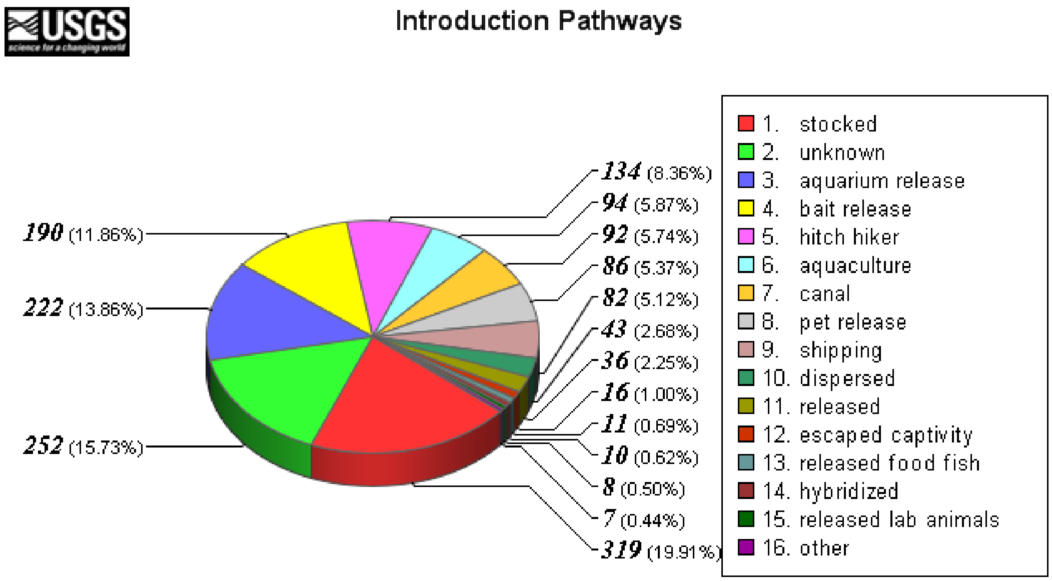
Like infectious diseases, invasive species can travel beyond the borders of any one state or county. Therefore, Franklin County and the State of Ohio will be discussed together in this section.

Ohio is a major player in interstate and global trade. With 1,000 miles of navigable waterways, the 10th largest highway network in the nation, and international seaports, the state is a hub for commerce. Once the nation's leading agricultural state, it is now the second highest in manufacturing output. Sixty percent of all U.S. households lie within 600 miles of Ohio, and more than 50% of the Canadian market is within the same range. While this is good for the state's economy, it also provides the circumstances for entry and establishment of damaging non-native species, which arrive through canals, shipping containers, ships' ballast water, the intentional import of live commercial plants and animals, and many other mechanisms.

Non-native species arrive in Ohio from all parts of the world and by a variety of pathways, which continue to expand and change over time. Organisms arrive by intent – for commercial exchange – or unintentionally, as hitchhikers in the constant movement of goods and people from place to place.

In the below charts, each category represents a combination of species introduced into the U.S. via a pathway. A single species can be introduced by more than one pathway and may therefore be counted more than once. All of the below graphs were created by the United States Geological Survey on August 6, 2015.[270]

[270] "NAS Graphs and Charts: Aquatic Species by State," USGS, accessed on 6 August 2015, http://nas.er.usgs.gov/graphs/State.aspx



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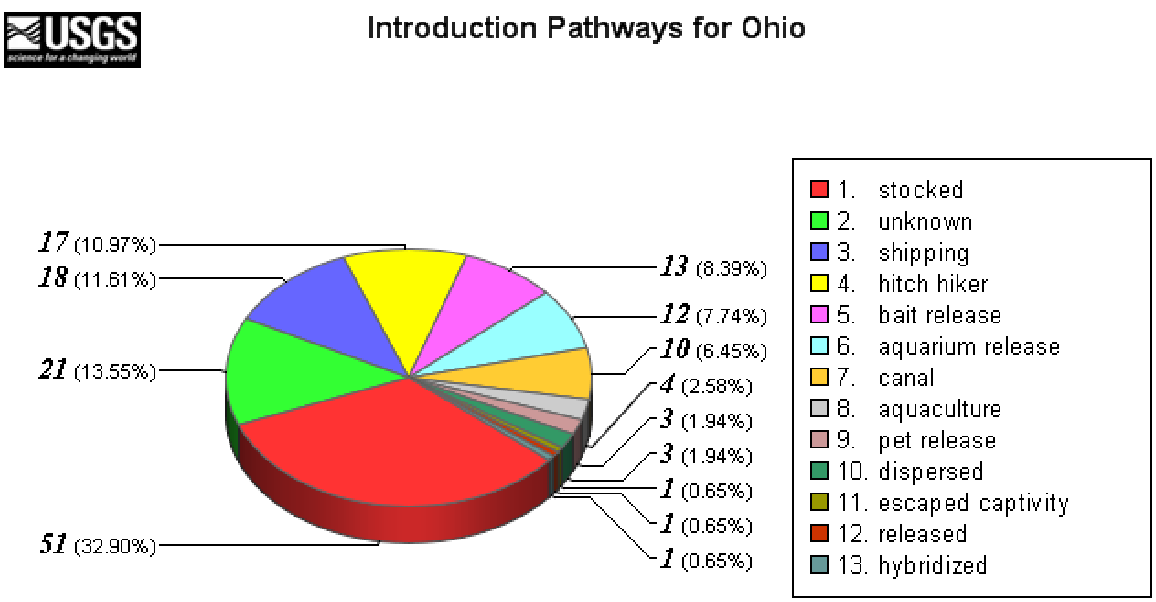
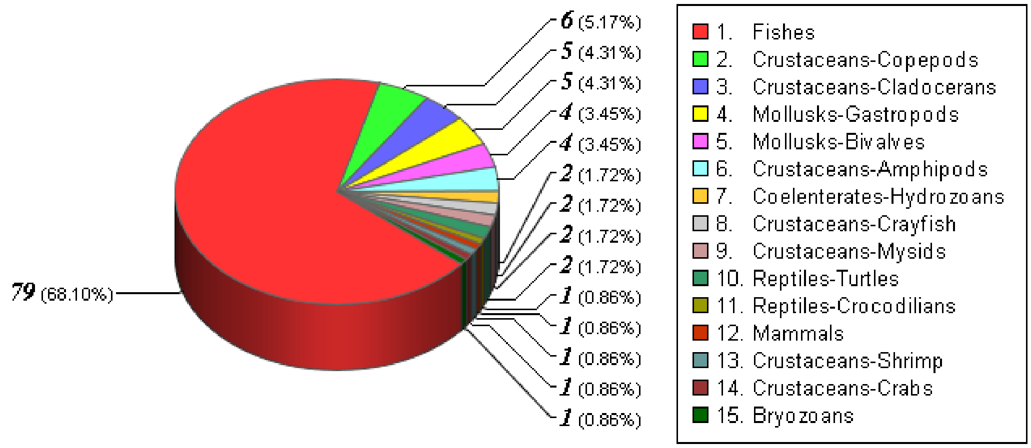


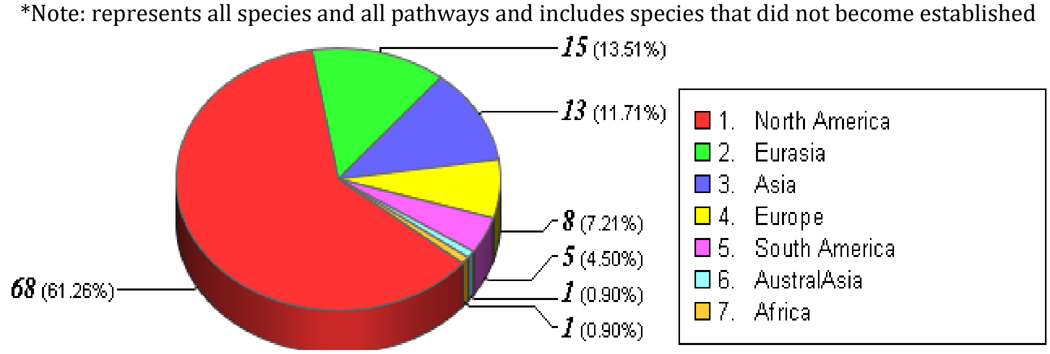
Each category represents a combination of species introduced via a pathway in Ohio.



This graph shows the proportion of species that have been introduced into the United States that belong to various taxonomic groups**.**

Origin of Species Introduced to Ohio

*Note: represents all species and all pathways and includes species that did not become established



Source: USGS, Center for Aquatic Resource Studies, Nonindigenous Aquatic Species Program

Specific Invasive Concerns in Ohio

Plants – Three thousand plant species are known to occur in Ohio. Of these, approximately 25% are non-native. Of the more than 700 non-native plants in Ohio, fewer than 100 are known to be invasive problems in natural areas; however, those that are can cause extensive economic damage and do harm to Ohio's natural resources. Ten that are considered the worst are listed in the following table.

Ohio's Top Ten Invasive Plants[271]

[271] "Ohio's Top Invasive Plants", Ohio Department of Natural Resources, accessed on 17 Jan 2016, http://ohiodnr.gov/invasiveplants

- Japanese Honeysuckle - Lonicera japonica
- Japanese Knotweed - Polygonum cuspidatum
- Autumn-Olive - Elaeagnus umbellata
- Buckthorns - Rhamnus frangula, R. cathartica
- Purple Loosestrife - Lythrum salicaria
- Common Reed or Phragmites - Phragmites australis
- Reed Canary Grass - Phalaris arundinacea
- Garlic Mustard - Alliaria petiolata
- Multiflora Rose - Rosa multiflora
- Bush Honeysuckles - Lonicera maackii, L. tatarica, L. morrowii

Terrestrial Invertebrates, Vertebrates, and Pathogens – A number of invasive terrestrial animals and pathogens cause considerable damage in Ohio. Vertebrates include the Norway rat, English sparrow, European starling, and common rock pigeons. These species are found in Ohio's cities as well as most of the United States.

Invasive insect and plant pathogens (including bacteria, viruses, and fungi) are some of the costliest invaders. Among insects, the Asian longhorned beetle, emerald ash borer, hemlock wooly adelgid and European gypsy moth are considered the worst.
Fungal diseases also cause considerable damage to trees and forests. They include beech bark disease, chestnut blight, Dutch elm disease and sudden oak death. Insects and pathogens affect animals as well, with West Nile Virus probably being the best-known example.

Ohio is also battling invasive feral swine, also called wild boar or hogs which are destructive animals that damage important habitats.

Invasive Insects & Diseases - The Ohio Department of Natural Resources partners with other state and federal agencies including the Ohio Department of Agriculture Plant Industry Division's Plant Pest Control section and the U.S. Department of Agriculture Animal and Plant Health Inspection Service to identify, quarantine, and eradicate invasive insect and diseases.

Aquatic Invasive Species - Aquatic invasive species include plants and animals living in and degrading the quality of our waterways. Species like zebra mussels, bighead and silver carp, and curlyleaf pondweed are changing the dynamics of our underwater habitats.[272]

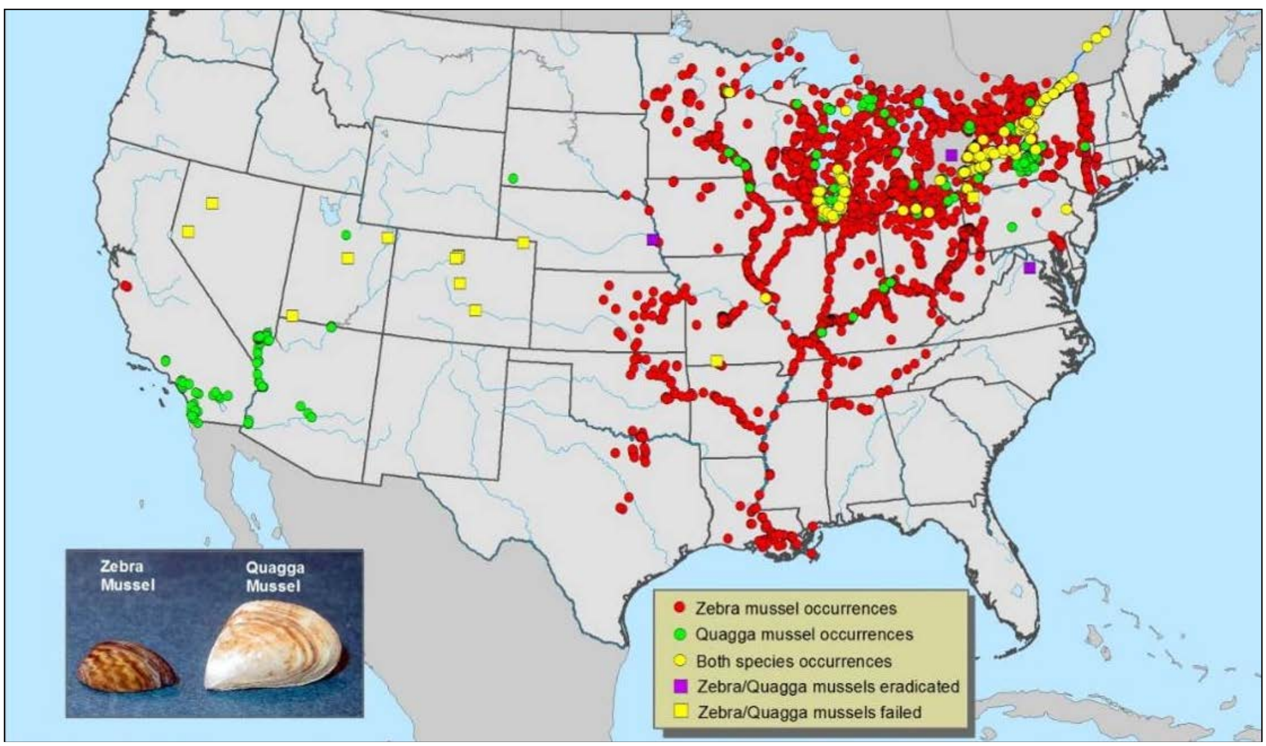
Impact of Invasive Species in Ohio - Of the invasive species in Ohio, two that pose some of the greatest economic and environmental threats are the zebra mussel and the emerald ash borer. Each has already caused a substantial amount of economic and environmental damage in the state and is expected to do more.

[272] "Invasive Species," ODNR, accessed on 3 Nov 2015, http://ohiodnr.gov/invasivespecies

Zebra Mussels – These small invertebrates, who originated in the Black and Caspian Seas, are thought to have arrived in ballast water in the Great Lakes in the 1980s. They are now found throughout the Great Lakes and in inland waters of Ohio and other states, and rank as one of the most costly aquatic invasions in the United States. These mussels outcompete native species, alter water quality, and damage industrial equipment. The zebra mussel slows or blocks flow through the water intakes of municipal water systems, electric generating plants, and factories that draw cooling water from the Great Lakes or their tributaries.

Once in a body of water, zebra mussels reproduce rapidly and are spread further via ships' ballast water-exchanges, recreational boating, and water currents. They will attach to any unprotected surface. Zebra mussels are particularly good travelers and can survive in small amounts of water. Examinations of recreational boats have found larval and adult zebra mussels in all of their onboard water. In boats taken out of the water frequently, adult zebra mussels have been found attached to transportation trailers.

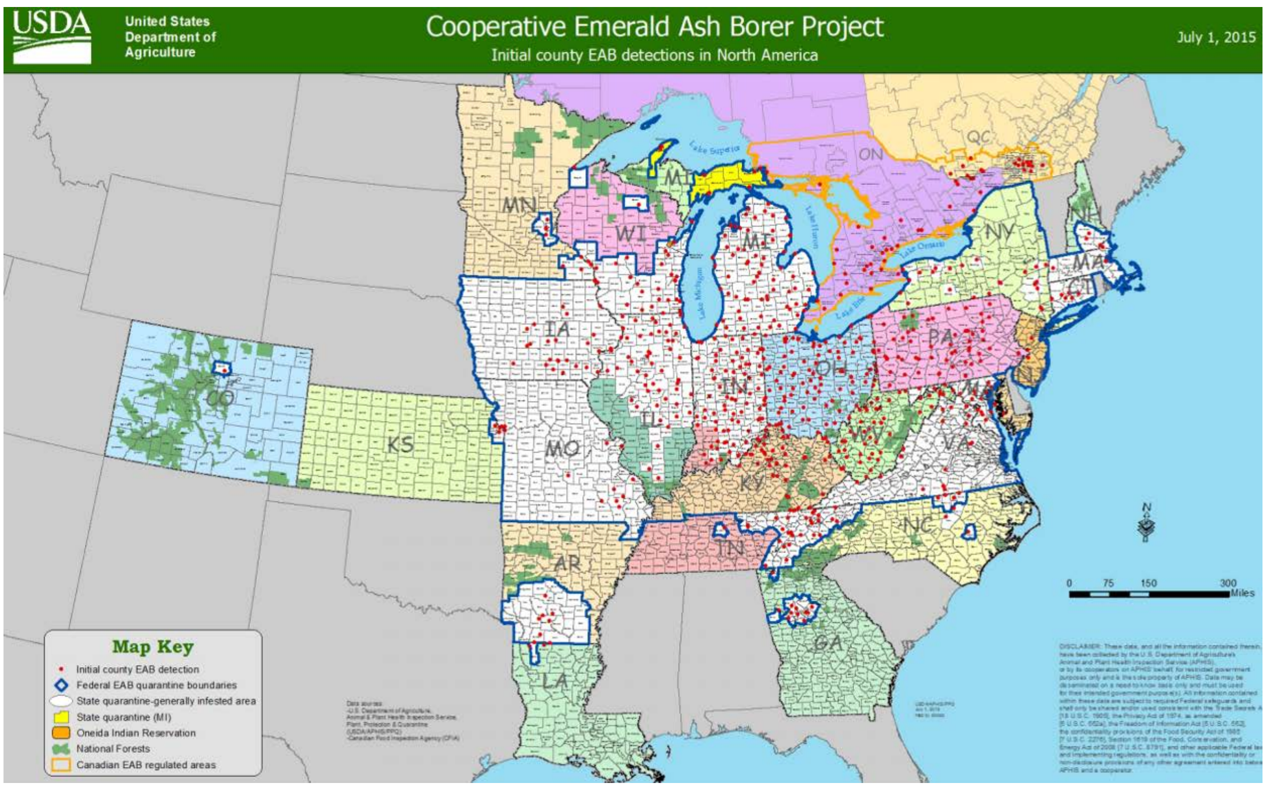
Rapidly multiplying zebra mussels have caused over $3 billion in damage to the Great Lakes region. One Michigan town lost water for three days after a mussel colony clogged its water-intake pipe. Great Lakes officials estimate that $5 billion will be spent in ten years on zebra mussel control.



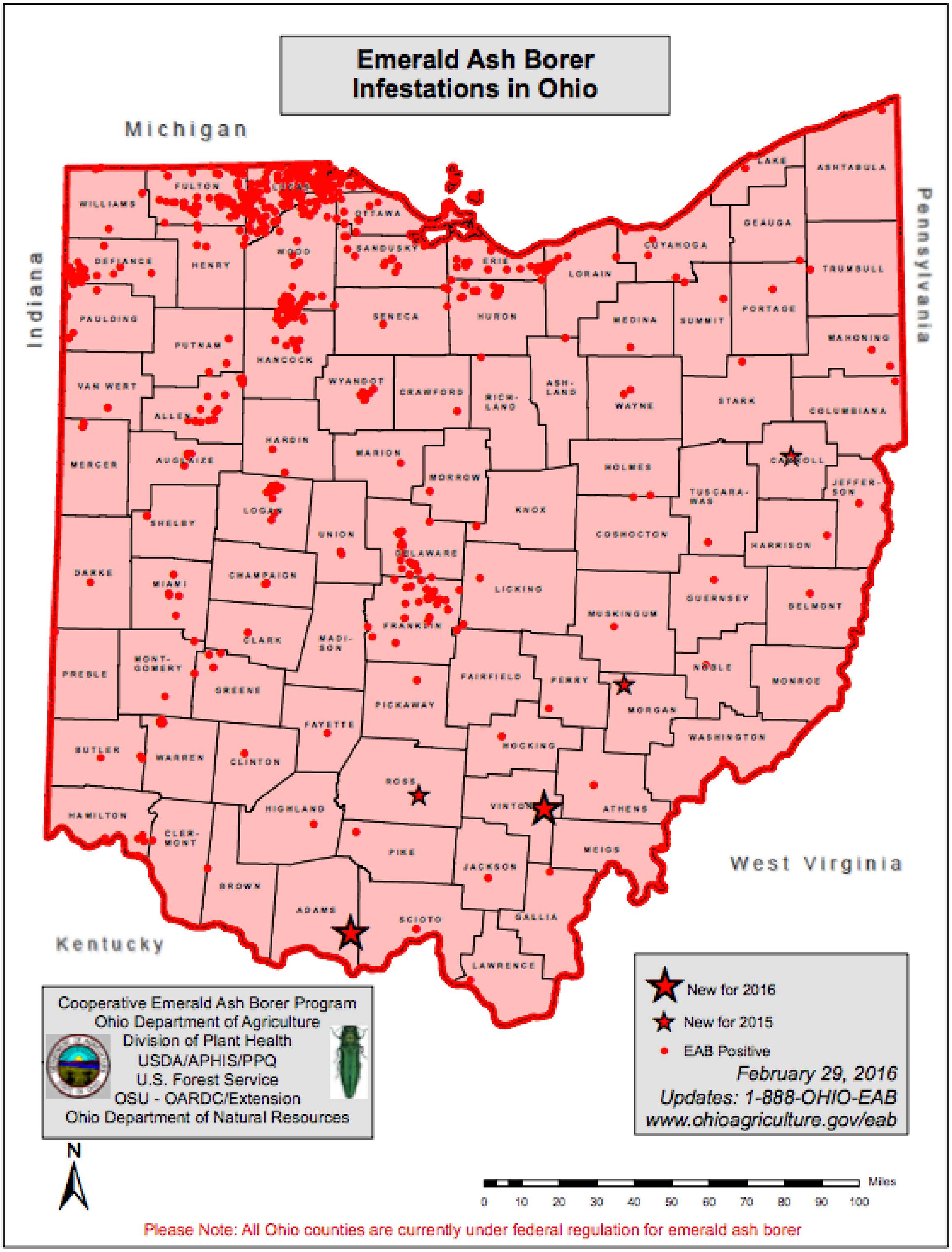
Source: USGS

Emerald Ash Borer – The emerald ash borer arrived from Asia in wooden packing material carried in cargo ships and airplanes. First identified in Michigan in 2002 and confirmed in Ohio in 2003, it continues to expand into neighboring states. Ash trees can grow to more than 100 feet tall, and most are dead within five years of infestation.

The emerald ash borer entered Ohio from Michigan in infested nursery stock and is now spreading primarily through the pathways of firewood and other ash products. The movement of ash trees, ash tree materials, and hardwood firewood out of the state is prohibited without certification from the U.S. Department of Agricultural (USDA). There is also an intrastate quarantine. The Ohio Department of Agriculture prohibits movement of these materials out of the counties on its quarantine list.



Ohio Counties under Quarantine for Emerald Ash Borer



Source: Ohio Department of Agriculture, Division of Industry

Because ash is one of the most commonly planted shade trees, the cost of removing and disposing of dead and dying ash trees has severely strained the budgets of municipalities and property owners. Statewide, removing the estimated one to four million ash trees currently growing in Ohio's parks, along streets, and on private property is expected to cost between $700 million and $2.9 billion. The cost to replace each ash tree with another small shade tree is estimated at an additional $300 million to $1.3 billion.
Since 2011, the City of Columbus has removed more than 17,000 ash trees at a cost of $4.5 million in tree removal, according to Columbus Recreation and Parks. Columbus also retired most of its tree-removal equipment due to excessive use, requiring the purchase of two new chippers at a cost of about $110,000.

The ash trees have become such a problem that AEP started a dedicated ash-tree program in 2013 and now has dedicated ash-tree crews. AEP will take out ash trees at no expense, not just for cities, townships and villages, but also for private landowners, which could cost over $5,000 for a large tree.[273] AEP only removes ash trees that threaten their power lines. Landowners are responsible for all other trees.

Invasive Plant Impacts in Ohio
The Ohio Department of Natural Resources Division of Natural Areas and Preserves has compiled a list of more than 60 plants that are currently impacting nature preserves, wildlife areas, parks and forests throughout the state. Some of the top invasive non-native plants include: bush honeysuckles (Amur, Morrow and Tatarian), buckthorn (glossy and common), garlic mustard, purple loosestrife, common reed grass, reed canary grass, autumn and Russian olive, multiflora rose, Japanese honeysuckle, narrow-leaved cattail, Canada thistle, and tree-of-heaven.

Managing invasive plants is a challenging issue, because the same characteristics that allow them to flourish also make them difficult to control. Traditional management tools such as hand pulling the most aggressive plants are labor-intensive and unsuccessful at eradicating the invasive plants in the long-term. Herbicides have become an effective tool in curbing invasive plant infestation while protecting native plant species. Effective techniques are only just emerging to meet an ecological challenge that will only increase as more invasive plants gain a foothold in our natural areas.[274] Eradication of these species is unlikely, resulting in the need for continuous efforts to monitor for new growth, control the spread and remove where possible. Labor and chemicals to treat are very costly and unless continually managed, populations will reestablish.

Climate Change Impacts

[273] "And another ash tree falls," The Columbus Dispatch, last modified on 8 April 2015, http://www.dispatch.com/content/stories/local/2015/04/08/and-another-ash-tree-falls.html
[274] "Climate Change Impacts in the United States," U.S. Global Change Research Program, accessed on 7 August 2015, http://www.globalchange.gov/browse/reports/global-climate-change-impacts-united-states

In general, climate change will tend to amplify existing climate-related risks to people, ecosystems, and infrastructure in the Midwest. Direct effects of increased heat stress, flooding, drought, and late spring freezes on natural and managed ecosystems may be multiplied by changes in pests and disease prevalence, increased competition from non-native or opportunistic native species, ecosystem disturbances, land-use change, landscape fragmentation, atmospheric pollutants, and economic shocks such as crop failures or reduced yields due to extreme weather events. Much of the region's fisheries, recreation, tourism, and commerce depend on the Great Lakes and expansive northern forests, which already face pollution and invasive species pressure that will be exacerbated by climate change.

The combined effects of climate change, land-use change, and increasing numbers of invasive species are the primary threats to natural ecosystems in the Midwest. Species most vulnerable to climate change include those that occur in isolated habitats; live near their physiological tolerance limits; have specific habitat requirements, low reproductive rates, or limited dispersal capability; are dependent on interactions with specific other species; and/or have low genetic variability.

The Great Lakes, have recently recorded higher water temperatures and less ice cover as a result of regional climate changes. Summer surface water temperatures in Lake Huron increased 5.2° F and 2.7° F in Lake Ontario between 1968 and 2002, with smaller increases in Lake Erie. Due to the reduction in ice cover, the temperature of surface waters in Lake Superior during the summer increased 4.5° F, twice the rate of increase in air temperature. These lake surface temperatures are projected to rise by as much as 7° F by 2050 and 12.1° F by 2100. Higher temperatures, increases in precipitation, and lengthened growing seasons favor production of blue-green and toxic algae that can harm fish, water quality, habitats, and aesthetics, and could heighten the impact of invasive species already present.

Warming is likely to increase the ranges of several invasive plant species in the United States, increase the probability of establishment of invasive plant species in boreal forests in Alaska, and expand the range of the hemlock wooly adelgid, an insect that has killed many eastern hemlocks in recent years. Invasive species costs to the U.S. economy are estimated at $120 billion per year, including substantial impacts on ecosystem services. For example, the yellow star-thistle, a wildland pest which is predicted to thrive with increased atmospheric CO_2, currently costs California ranchers and farmers $17 million in forage and control efforts and $75 million in water losses. Desert plants are damaged or killed by fires fueled by non-native grasses, leading to a large-scale transformation of desert shrubland into grassland in the Western United States. Bark beetles have infested extensive areas of the western United States and Canada, killing forest across areas greater than any other outbreak in the last 125 years. Climate change has been a major causal factor, with higher temperatures allowing more beetles to survive winter, complete two life cycles in a season rather than one, and to move to higher elevations and latitudes. Bark beetle outbreaks in the Greater Yellowstone Ecosystem are occurring in habitats where outbreaks either did not previously occur or were limited in scale.

Vulnerability Assessment – Invasive Species

**Note: all information in this vulnerability assessment can be attributed to the Franklin County 2012 Natural Hazards Mitigation Plan.*

This hazard is considered to be a "Relatively High Probability Event" meaning the anticipated frequency of the hazard within the County is more than twice but no more than 5 times a year. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability

Various invasive species have posed problems for Franklin County in recent years. Submerged structures and infrastructure in bodies of water are at risk of being affected by zebra mussels. Due to a rapid multiplication, a town off Lake Michigan lost water for three days when a colony of zebra mussels clogged their water-intake pipe. Zebra mussels are easily transported on vessel hulls and multiply fairly rapidly.

The emerald ash borer is a beetle that chews the inner bark and phloem of the ash trees. The feeding of the beetle creates holes that cut off the flow of nutrients and water to the rest of the tree. Any ash tree within the state of Ohio has the potential to be affected by the emerald ash borer. It is not a question of if the emerald ash borer will affect an ash tree; rather, the concern is when the insect will compromise the tree. The population is increasing and it is only a matter of time until all ash trees in the state have been affected.

Potential Impact of Invasive Species

The replacement of all the ash trees within Ohio parks, along streets and on private property is expected to cost as much as $4.2 billion.

Although zebra mussels have impacted Ohio's waters, Franklin County has experienced minimal impacts of this species. Boaters and facilities that utilize water from the affected water bodies have been able to adapt to the introduction of this species.

Identifying Structures

Exposure of Existing Buildings to Invasive Species Damages

Structures identified as potentially at risk of damage due to invasive species are those found in bodies of water, such as water intake pipes. Therefore, if zebra mussels are known to be in the same waterways as an intake pipe, regular maintenance can prevent damage to the facility utilizing the pipe. There is no current data shown for effects of invasive species on buildings.

Even though invasive species are an ever-changing list, at the current time no invasive species are shown to cause damage to any type of existing structures.

Exposure of Future Buildings to Invasive Species Damages
Future buildings should have the same vulnerability to invasive species as existing buildings. Currently, there are no buildings that are affected by any invasive species; therefore, no damage is expected by invasive species.

Estimating Potential Loss

Methodology
Past Risk Assessments estimate that the cost to Ohioans can be $1 billion to $4.2 billion to replace ash trees. The price will ultimately be dependent on the timeframe and the amounts that municipalities will be able to afford for the replacement of these trees. To obtain an estimated cost for Franklin County, these amounts will be divided up over 10 years and all 88 counties in Ohio.

Estimated Potential Dollar Losses
Because the invasive species hazard is relatively new, there is little to no historical data to use for estimating the cost accrued by this hazard.

Estimated potential dollar losses for Franklin County due to the emerald ash borer can be between $1.1 million and $4.7 million per year. Because Franklin County is home of the state capital and a large number of parks, even this large amount may be a low estimate for potential dollars lost.

Zebra mussels have impacted Ohio’s waters, but Franklin County has seen minimal dollars lost due to the introduction to this species.

Structural losses due to invasive species is expected to be $0.00.

Air and Water Pollution/Contamination - #18

Hazard Summary

Pollution refers to the contamination of water, land or the air by substances that can adversely impact the environment and human health. Franklin County is subject to point and nonpoint water pollution of streams, as well as mobile (i.e., transportation) and stationary (i.e., businesses and factories) sources of air pollution, which can result in reduced air quality. This hazard was ranked 18 out of 20.

Hazard Profile

Pollution refers to the contamination of water, land or the air by substances that can adversely impact the environment and human health. Usually these substances are waste materials. Sometimes it is not the type of material but its concentration that determines if it is a pollutant. For example, nutrients such as nitrogen and phosphorus are essential elements for plant growth. If they are overabundant in a body of water, however, such conditions could compromise the aquatic ecosystem and negatively affect water potability and pose a tactile threat to birds, animals and humans.

Air and Water Pollution and Contamination in the United States

Air Pollution/Contamination

Air pollution is caused when the atmosphere is filled with too much gas, particulate matter, and droplets of liquid. In cities, vehicle exhaust fumes, along with the pollutants given off by construction work and industry are two significant pollution sources. In rural areas, dust given off by tractors, vehicles being driven on gravel or dirt tracks, smoke given off by crop and wood burning, and work in rock quarries are some of the primary causes of air pollution.

Facts about Air Pollution
American Lung Association

- Nearly 138.5 million people—almost 44 percent of the nation—live where pollution levels are too often dangerous to breathe.
- Scientific evidence increasingly shows that air pollution plays a major role as a trigger for asthma episodes. Specifically, fine particles, sulfur dioxide and ozone have been linked to increases in patients' use of asthma medication, emergency department visits and hospital admissions.
- Power plant particle pollution is estimated to cause more than 603,000 asthma episodes per year, 366,000 of which could be avoided by cleaning up the power plants.
- Estimates of the annual human health costs of outdoor air pollution range from $14 billion to $55 billion annually.
- Each year, pollution claims 70,000 lives in the U.S.
- Globally, an estimated 200,000 to 570,000 people die each year from ambient air pollution.

Every industrial process exhibits its own pattern of air pollution. Petroleum refineries are responsible for extensive hydrocarbon and particulate pollution. Iron and steel mills, metal smelters, pulp and paper mills, chemical plants, and cement and asphalt plants all discharge vast amounts of various particulates. Uninsulated high-voltage power lines ionize the adjacent air, forming ozone and other hazardous pollutants. Airborne pollutants from other sources include insecticides, herbicides, radioactive fallout and dust from fertilizers, mining operations, and livestock feedlots.

The Clean Air Act requires the Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards for six common air pollutants. These commonly found air pollutants (also known as "criteria pollutants") are found all over the United States. They are as follows:[275]

[275] "What are the Six Common Air Pollutants?' USEPA, 5 July 2015, https://www.epa.gov/criteria-air-pollutants

- Ozone – can be found at ground level or miles above the planet. Its effects can be negative or positive depending on its location in the atmosphere. Ozone occurs in two layers of the atmosphere. The stratosphere or "good" ozone layer extends from approximately 6 to 30 miles above the earth and provides protection from the sun's harmful ultraviolet (UV) rays.[276] Low level ozone in the lower atmosphere, or ground level, is negative because it is harmful to breathe and it damages crops, trees and other vegetation. It is a main ingredient of urban smog and, which can cause health problems including respiratory system irritation and reduced lung function[277], and is believed to contribute to the effects of global warming, along with other greenhouse gases. Low level ozone is mostly produced by car exhausts and industrial emissions. It can also be formed when other pollutants in the air, such as Volatile Organ Compounds (VOCs), react to the presence of sunlight.
- Particulate matter – Is a mixture of small, solid particles and liquid droplets suspended in the air. Particulate matter can be produced by power plants, car exhausts, forest fires, and some industries. These particles are measured in micrometers and generally classified by size: PM 10 and PM 2.5. PM 2.5 are particularly dangerous to health because these fine particles can pass through the throat and nose, where they can settle deep into the lungs and cause breathing problems.
- Carbon Monoxide – is an odorless gas formed from incomplete burning of fossil fuels. Seventy-five percent of all such emissions in the U.S. come from motor vehicles.
- Nitrogen Oxides – are highly reactive gases. They can be odorless and colorless. Nitrogen oxides such as nitrogen dioxide, nitric acid, nitrous oxide, and other nitrates create smog at lower levels and acid rain at higher levels. The reddish-brown smog seen hanging over large metropolitan areas is attributable to nitrogen dioxide. Many health problems are related to these compounds. Current scientific evidence links short-term exposure to nitrogen oxides, ranging from 30 minutes to 24 hours, with adverse respiratory effects including airway inflammation in healthy people and increased respiratory symptoms in people with asthma.[278]
- Sulfur Dioxide – is formed by the burning of fuel containing sulfur. A major contributor is the burning of coal and oil. People who can suffer from this pollution are the elderly, children, asthma sufferers, and those with heart or lung problems. It is important to note that the elderly, children, and those with chronic health conditions suffer disproportionately from all types of air pollution, not just the presence of sulfur dioxide. The very old and very young often may have physical systems that are not strong enough or not yet fully developed. Those with chronic

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276 "Good Up High, Bad Nearby," U.S. EPA, accessed on 19 September 2015, http://www.airnow.gov/index.cfm?action=gooduphigh.index

277 "Smog-Who Does it Hurt?" U.S. EPA, July 1999, http://www3.epa.gov/airnow/health/smog.pdf

278 "Health", U.S. EPA, accessed on 19 September 2015, http://www3.epa.gov/airquality/nitrogenoxides/health.html

health conditions have systems that have been damaged or compromised so they are more susceptible to the physical effects of pollution.

- Lead – can be found in some household products, including children's toys. It can also be found in the atmosphere due to the emissions of motor vehicles and some industrial plants. Lead can be introduced into the atmosphere by the burning of waste. When taken into the body, lead accumulates in bones. It can cause nervous system, kidney, immune system, reproductive, and cardiovascular system problems.

For each of these pollutants, the EPA tracks two kinds of air pollution trends: air concentrations based on actual measurements of pollutant concentrations in the ambient air at selected monitoring sites throughout the country, and emissions based on engineering estimates of the total tons of pollutants released into the air each year.

Water Pollution/Contamination

Pollution affecting water quality may come from point or nonpoint sources, or a combination of both. The EPA defines point source pollution as "any single identifiable source of pollution from which pollutants are discharged such as a pipe, ditch, ship or factory smokestack." Factories and sewage treatment plants are two common types of point sources. Unregulated discharges from point sources can result in water pollution and impaired or unsafe drinking water supplies, and can restrict activities like fishing and swimming. Fish and other aquatic life can show negative affects with short and long term exposure to pollutants, resulting in loss of species diversity, diminished health, and buildup of toxins. Fish consumption advisories and accumulated concentrations of toxins in animals which feed upon affected fish are a result of long term exposure to pollutants in the water or sediment.

An example of harmful point pollution was the release of Hexavalent Chromium in the ground by Pacific Gas and Electric at their plant in Hinkley, California, in 1993. Hexavalent Chromium was found in well water in the town, and the company covered up knowledge of the pollution. Community members suffered medical conditions ranging from nosebleeds to cancer. The situation was exposed by a legal assistant investigating on her own and documented in the movie "Erin Brockovich."

Nonpoint source pollution comes from many different sources. Nonpoint pollution is transported by rainfall or snowmelt moving over and through the ground.[279] As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and underground sources of drinking water.[280]

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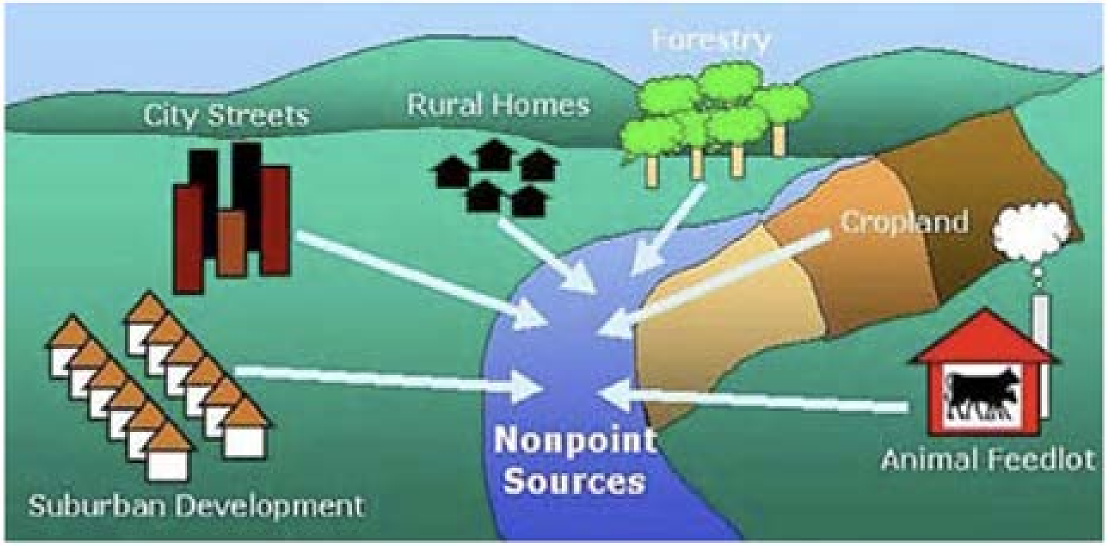
[279] "Nonpoint Source Pollution: Water Primer," OSU, accessed on 19 Oct 2016, https://www.researchgate.net/publication/255625956_A_Basic_Primer_on_Nonpoint_Source_Pollution_and_Impervious_Surface

[280] "What is Nonpoint Source Pollution," USEPA, accessed on 5 July 2015, http://www.epa.gov/polluted-runoff-nonpoint-source-pollution/what-nonpoint-source

Sources of Nonpoint Pollution



Source: NOAA

According to the USDA and other state and federal agencies, most nonpoint pollutants fall into six major categories.

Nonpoint Source Pollutants and Major Sources

Sediment	Nutrients (Fertilizers, Grease, Organic Matter)	Acids and Salts	Heavy Metals (Lead, Mercury, Zinc)	Toxic Chemicals (Pesticides, Organic, Inorganic Compounds)	Pathogens (Bacteria, Viruses)
• Construction Sites • Mining Operations • Croplands • Logging Operations • Streambank Erosion • Shoreline Erosion • Grazed Woodland	• Croplands • Nurseries • Orchards • Livestock Operations • Gardens, Lawns, Forests • Petroleum Storage Areas • Landfills	• Irrigated Lands • Mining Operations • Urban Runoff, Roads, Parking Lots • Landfills	• Mining Operations • Vehicle Emissions • Urban Runoff, Roads, Parking Lots • Landfills	• Croplands, • Nurseries, Orchards • Building Sites • Gardens, Lawns • Landfills	• Domestic Sewage • Livestock Waste • Landfills

Source: OSU Extension Fact Sheet: Nonpoint Source Pollution: Water Primer

Concentration of some pollutants from runoff may be lower than the concentration from a point source. The total amount of a pollutant delivered from nonpoint sources may be higher – and is more difficult to control – because the pollutants come from many places. It also varies over time in terms of the flow and the types of pollutants it contains. The cumulative impacts of non-point pollution continue to be a threat to aquatic environments and water quality. As evident by the Gulf Coast hypoxia issue and persistent Lake Erie algal blooms, nutrients and sediment concentrations originating from upstream land uses can have significant detrimental and costly impacts to important natural resources.

Clean Air and Water Laws
Pollution and contamination prevention is much easier than cleaning up after the fact. This has led to a series of federal and state laws and regulations, but not until hard lessons had been learned.

Clean Air Laws
In the town of Donora, Pennsylvania, population 14,000, October 26 to 31, 1948, 20 people died and 7,000 became ill in one of the worst pollution incidents in history. The town was accustomed to air pollution and smog from the zinc and iron works that dominated the town. On a heavily foggy night, sulfur dioxide fumes from the zinc works mixed with fog to produce a sulfuric acid mist that settled over the town. The nation was outraged. The incident led to the passage of the Air Pollution Control Act of 1955. This was the first federal attempt to control air pollution. Since then, clean air legislation has been revised and strengthened. The Clean Air Act of 1990 set limits on the discharge of air pollutants from industrial facilities and motor vehicles and addressed acid rain and ozone depletion.

The EPA has established national air quality standards to protect public health. The Air Quality Index (AQI) is an index for reporting daily air quality. It reports how clean or polluted the air is and what associated health effects might be of concern. Ground-level ozone and airborne particles are the two pollutants that pose the greatest threat to human health in this country.[281] The purpose of the AQI is to help the public understand what local air quality means to public health. To make it easier to understand, the AQI is divided into six categories, as indicated in the chart below.

[281] "Air Quality Index (AQI) – A Guide to Air Quality and Your Health," AIRnow, accessed on 5 July 2015, http://www3.epa.gov/airnow/aqi_brochure_02_14.pdf

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
When the AQI is in this range:	*..air quality conditions are:*	*...as symbolized by this color:*
0-50	Good	Green
51-100	Moderate	Yellow
101-150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Each category corresponds to a different level of health concern. The six levels of health concern and what they mean are:

- "Good" AQI is 0 - 50. Air quality is considered satisfactory, and air pollution poses little or no risk.
- "Moderate" AQI is 51 - 100. Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people. For example, people who are unusually sensitive to ozone may experience respiratory symptoms.
- "Unhealthy for Sensitive Groups" AQI is 101 - 150. Although general public is not likely to be affected at this AQI range, people with lung disease, older adults and children are at a greater risk from exposure to ozone, whereas persons with heart and lung disease, older adults and children are at greater risk from the presence of particles in the air. .
- "Unhealthy" AQI is 151 - 200. Everyone may begin to experience some adverse health effects, and members of the sensitive groups may experience more serious effects. .
- "Very Unhealthy" AQI is 201 - 300. This would trigger a health alert signifying that everyone may experience more serious health effects.
- "Hazardous" AQI greater than 300. This would trigger a health warnings of emergency conditions. The entire population is more likely to be affected.[282]

Clean Water Laws

[282] "Air Quality Index (AQI) Basics", AirNow, accessed on 18 Jan 2016, http://www.airnow.gov/index.cfm?action=aqibasics.aqi

Like clean air laws, the passage of clean water laws was spurred by an event. The Cuyahoga River in Cleveland, Ohio, had a history of catching on fire since 1936. On June 22, 1969, an oil slick and debris in the river caught fire. The fire lasted just thirty minutes but received national attention with an article in TIME magazine.[283] The event led to the passage of the Clean Water Act in 1972. The U.S. EPA set standards to regulate the discharge of industrial and municipal waste.[284]

Air and water pollution are under federal and state regulatory agencies; thus, they are not an emergency management issue except under extreme and acute circumstances.

Air and Water Pollution and Contamination in Ohio

Air Pollution/Contamination
The Ohio EPA's Division of Air Pollution Control operates and maintains an automated air quality data acquisition and reporting system. Real time air quality data can be accessed here: http://wwwapp.epa.ohio.gov/gis/mapportal/

Water Pollution/Contamination
The Ohio EPA and ODNR have identified 13,000 stream miles in Ohio that have been affected by nonpoint source pollution. Franklin County contains portions of several streams and their tributaries that have been classified as being affected by nonpoint pollution. Nutrients and sedimentation generated by agricultural activities are problematic in Ohio waterways. Failing septic systems, sedimentation and siltation from erosion, and lawn chemicals can persist as land is developed. Storm water runoff generated as precipitation falls on impervious surfaces like roadways and parking lots can also transport oils, salt, sediments and chemicals to local waterways.

The Ohio EPA, ODNR, and USGS have several programs to monitor and regulate Ohio source waters. These laws have significantly reduced the amount of pollution released into the environment. Grossly contaminated water and air are much less common today than they were 50 years ago. However, there is still concern about the possible risks of continuous low-level exposure to pollutants, and particularly to nonpoint source pollutants. (Given the well-publicized issues surrounding our nutrient-impaired waterbodies in Ohio (L. Erie, Grand Lake, Buckeye Lake) and the toxins which are generated through certain resultant algal populations, these situations should be of high concern for their immediate impacts to drinking water supplies and recreational uses.

Air and Water Pollution and Contamination in Franklin County

[283] "Cuyahoga River Fire," Ohio Historical Society, accessed on 5 July 2015, http://www.ohiohistorycentral.org/w/Cuyahoga_River_Fire?rec=1642
[284] "Forty Years Later, Cuyahoga River No Longer Burns," USGS, accessed on 5 July 2015, http://oh.water.usgs.gov/

The American Lung Association's 2016 "State of the Air" report found the Columbus metropolitan area ranked 44th most polluted in the nation for year-round particle pollution. Not only are these improved levels, but these are the area's best levels ever recorded, meeting national air quality standards.

"The 2016 'State of the Air' report demonstrates that the protections of the Clean Air Act are having positive impacts on year-round particle pollution levels in the Columbus metropolitan area," said Shelly Kiser, Director of Advocacy for the American Lung Association in Ohio. "Through both federal measures and state renewable energy and energy efficiency standards, we can continue to see cleaner air and healthier residents of Central Ohio.

Ozone Pollution in Franklin County

The metro area continued to reduce ozone pollution in 2012-2014, and ranked tied for 37th most polluted city for ozone in the nation.

Franklin County reduced its weighted average to 12.3 days (an F) of unhealthy levels of ozone from 16.9 in 2011-2013. This is the area's best level ever. Even though the levels are much too high, they are a vast improvement from the worst period, with 49.3 days in 1997-1999.

"Ozone is harmful to public health and especially children, older adults and those with asthma and other lung diseases," said Kiser. "When older adults or children with asthma breathe ozone-polluted air, too often they end up in the doctor's office, the hospital or the emergency room."

Nationwide, ozone pollution has decreased because the nation has cleaned up major sources of the emissions that create ozone, especially coal-fired power plants and vehicles. However, according to research, climate change causes warmer temperatures, which makes ozone harder to clean up.

Particle Pollution in Franklin County

The 2016 report found zero days with unhealthy levels of year-round particle pollution (soot) levels in the area in 2012-2014, ranking it as one of the nation's cleanest cities. The metro area had its best levels ever for year-round particle pollution in 2012-2014, slightly improving its levels from 2011-2013.

"Particle pollution is made of soot or tiny particles that come from coal-fired power plants, diesel emissions, wildfires and wood-burning devices. These particles are so small that they can lodge deep in the lungs and trigger asthma attacks, heart attacks and strokes, and can even be lethal," said Kiser. "Year-round particle pollution levels have dropped thanks to the cleanup of coal-fired power plants and the retirement of old, dirty diesel engines."

On the county level, Franklin County improved its level of year-round particle pollution to its best annual level yet. This year's levels continue the steady decrease in annual particle pollution levels from a high in 2000-2002.

Included in this metro area are Delaware, Fairfield, Fayette, Franklin, Guernsey, Hocking, Knox, Licking, Logan, Madison, Marion, Morrow, Muskingum, Perry, Pickaway, Ross and Union Counties.

Increased heat, changes in weather patterns, drought and wildfires are all related to climate change, which has contributed to the extraordinarily high numbers of days with unhealthy particle pollution in some cities.[285]

Franklin County At-Risk Groups, 2017 [286]

Total Population	Under 18	65 and over	Pediatric Asthma	Adult Asthma	COPD	Lung Cancer	Cardiovascular Disease	Diabetes	Poverty
1,251,722	295,725	138,531	21,290	96,685	67,131	861	72,955	88,119	208,972

Water Pollution/Contamination

During the past 20 years, urban growth and lifestyle changes have placed increasing demands on outdated water and sewage systems. Throughout Franklin County there are neighborhoods experiencing the effects of the demands that are being placed upon obsolete sewage systems. The most critical concerns deal with health issues resulting from contaminated ground and surface water.

Franklin County's Water Quality Partnership (WQP) program was initiated to address these serious public health issues by forming partnerships with local townships and villages.

The Franklin County Department of Sanitary Engineering is responsible for providing a safe and dependable supply of drinking water to 40,000 residents in Franklin County.[287] The City of Columbus Division of Water has a Water Quality Assurance Lab (WQAL) which provides the ability to perform independent monitoring, research new treatment methods, provide water analyses of the watershed and distribution system, and respond to the

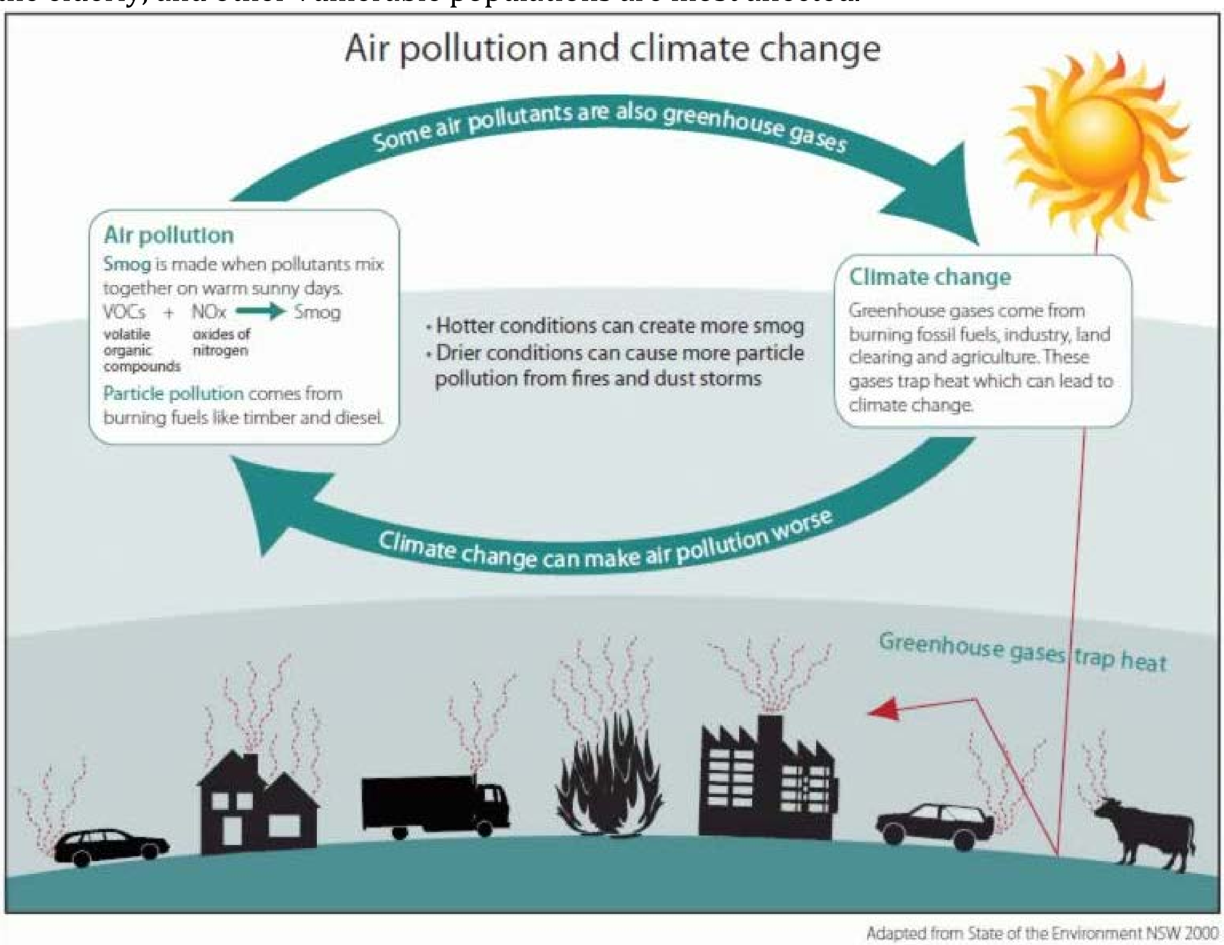
[285] http://www.lung.org/local-content/_content-items/about-us/media/press-releases/oh-columbus-area-reports-best.html
[286] http://www.lung.org/assets/documents/healthy-air/state-of-the-air/state-of-the-air-2017.pdf (Page 132)
[287] "Welcome," Franklin County Department of Sanitary Engineering, accessed on 21 September 2015, http://cleanwater.franklincountyohio.gov/about/about-us.cfm

customer's water quality concerns. The water delivered to City of Columbus residents meets all of the requirements of the Safe Drinking Water Act (SDWA).[288]

Climate Change Impacts

Related to water, climate change is expected to cause stronger storms leading to flashier flows, more runoff, and greater chances of sewer overflows that can contaminate water supplies.[289]

Climate change creates the ideal conditions for both particle and ozone pollution including spikes in soot and continual high-smog days. Warmer weather increases the risk of ozone pollution and makes cleaning it up even more challenging. Rising temperatures also increase droughts, wildfires and other sources of particle pollution. Children with asthma, the elderly, and other vulnerable populations are most affected.



Source: County Sustainability Group[290]

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[288] "Water Protection", City of Columbus Division of Water, accessed on 21 September 2015, https://columbus.gov/DrinkingWater/

[289] "Climate Changes and Impacts in Columbus, Ohio," GLISA, accessed on 18 Jan 2016, http://bpcrc.osu.edu/sites/bpcrc.osu.edu/files/Columbus_Climate.pdf

[290] County Sustainability Group, http://www.countysustainability.ca/indexAir.html

Vulnerability Assessment – Air and Water Pollution

This hazard is considered to be a "Relatively Moderate Probability Event" meaning the anticipated frequency of the hazard within the County is once every 5 to 25 years. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability

No damage to structures is anticipated due to air and water pollution.

Franklin County has the potential to experience contamination of water, land, or the air by substances that adversely impact the environment and human health. An incident could occur in which sewage contaminates drinking water supplies.

Potential Impact of Air and Water Pollution

No damage to structures is anticipated due to air and water pollution.

Negative impacts of air and water pollution would be experienced by many through increased health concerns. An incident could occur in which sewage contaminates drinking water supplies. To understand the potential impact of this type of event we look at two events.

1. April 8, 2015 in Louisville Kentucky an estimated 90 million gallons of raw sewage was released into the Ohio River causing an estimated $10 million in damages.[291]

2. In September of 2010 approximately 130,000 gallons of raw sewage was released into the Great Miami River causing an estimated $20,000 in damages.[292]

These two events highlight the potential for such an incident to occur in Franklin County. For this worst case scenario assessment we will use the figure of $10 million as the potential impact.

Identifying Structures

No structures would experience damage due to air and water pollution; therefore, this updated risk assessment does not identify existing or future buildings at risk of loss due to air and water pollution.

Exposure of Existing Buildings to Damages Due to Air and Water Pollution

No existing buildings are exposed to damage due to air and water pollution.

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[291] "Lack of Backup Power Caused Sewage Plant Spill," Courier Journal, last updated on 29 May 2015, http://www.courier-journal.com/story/tech/science/environment/2015/05/29/lack-backup-power-caused-morris-forman-waste-water-treatment-plant-flood-sewage-spill/28154537/

[292] "Sewage Spill Did Little River Damage, But Will Cost $20K to Fix," Dayton Daily News, 10 Sept 2010, http://www.daytondailynews.com/news/news/local/sewage-spill-did-little-river-damage-but-will-cost/nNGwN/

Exposure of Future Buildings to Damages Due to Air and Water Pollution

No future buildings will be exposed to damage due to air and water pollution.

Estimating Potential Loss

Methodology

Potential structural dollar loss due to air and water pollution is estimated to be $0.00 because no historical data is available for structural losses due to air and water pollution.

Using the above scenarios, it is reasonable to expect an impact of $10 million to Franklin County should such an incident happen locally.

Estimated Potential Dollar Losses

The estimated potential dollar loss annually in Franklin County due to structural damage due to air and water pollution is $0.00.

Potential impact is $10 million.

Drought - #19

Hazard Summary

Drought is defined as a prolonged period of abnormally dry weather, where the lack of sufficient precipitation causes a serious hydrologic imbalance with economic and/or social consequences.[293] Franklin County is primarily impacted by drought relating to shortages in the water supply as well as a decrease in overall water quality. Drought also greatly impacts land throughout the county that is utilized as cropland or pasture. This hazard was ranked 19 of 20.

This is a county-wide hazard that can affect all areas and jurisdictions of the county.

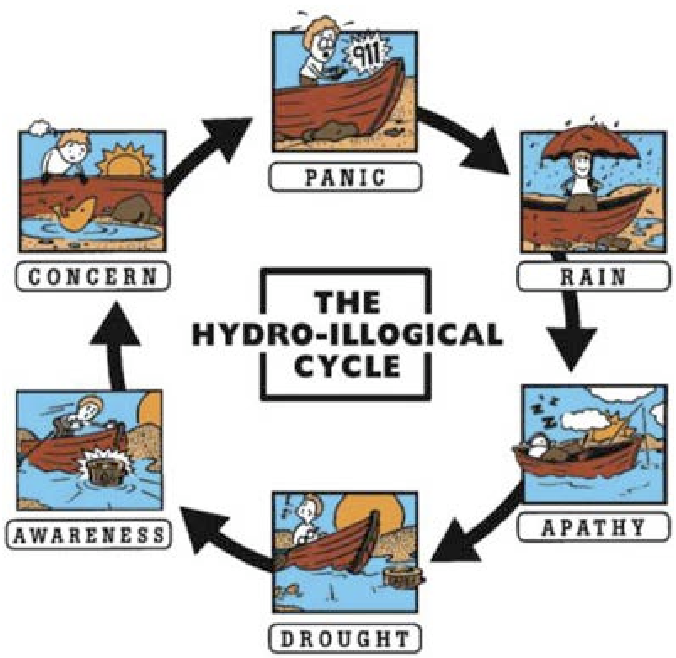
[293] "State of Ohio Emergency Operations Plan Drought Incident Annex," Ohio EMA, accessed on 14 June 2016, http://ema.ohio.gov/Documents/Ohio_EOP/2016_Update_DROUGHT_INCIDENT_ANNEX.pdf

Hazard Profile

There are several definitions of drought; however, the Glossary of Meteorology defines drought as a period of abnormally dry weather sufficiently long enough to cause serious hydrological imbalance of the affected area.[294] Drought is considered relative to the long-term average balance between precipitation and evapotranspiration (i.e., evaporation + transpiration) in a particular area, a condition often perceived as "normal." It is also related to timing and climatic factors such as high temperature, high wind, and low relative humidity.

The impact of drought on society results from the interplay between a natural event (less precipitation than expected resulting from natural climatic variability) and the demand people place on water supply. Humans often exacerbate the impact of drought.

Unlike other natural hazards, drought does not have a clearly defined beginning and end. As a result, our reaction to drought traditionally has not been timely. The below illustration was commissioned by The National Drought Mitigation Center to show how drought, as a slow-moving natural disaster, tends to emerge under the radar and intensify until people can no longer ignore it. When drought ends, people are often glad to forget about it and to resume business as usual.[295]



Source: The National Drought Mitigation Center

[294] "Drought," American Meteorological Society, Glossary of Meteorology, last modified on 25 April 2012, http://glossary.ametsoc.org/wiki/Drought

[295] "The Hydroillogical Cycle," National Drought Mitigation Center, University of Nebraska, accessed on 6 July 2015, http://drought.unl.edu/Planning/HydroillogicalCycle.aspx

Four Perspectives on Drought

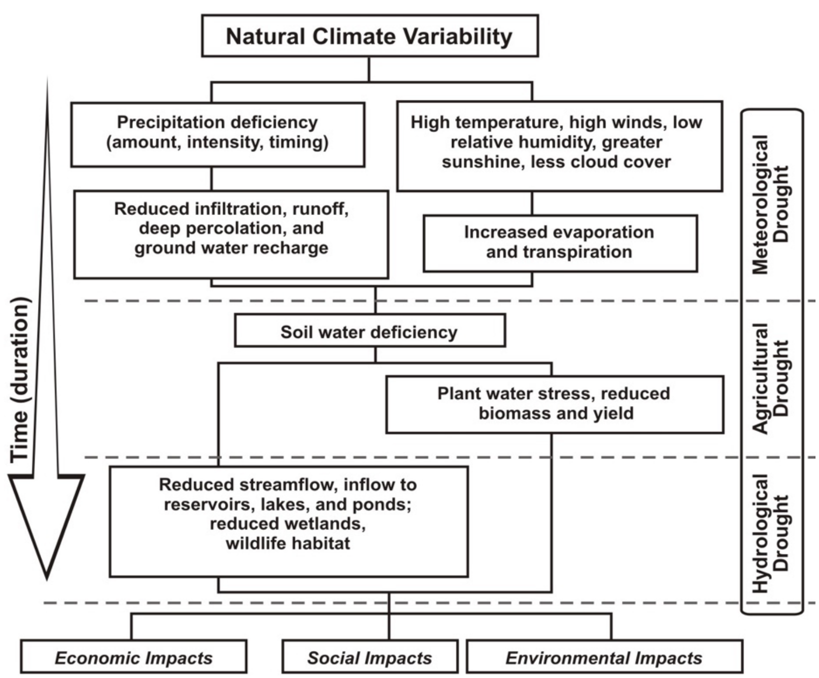
Meteorological Drought

Meteorological drought is defined usually on the basis of the degree of dryness (in comparison to some "normal" or average amount) and the duration of the dry period.[296] Meteorological droughts are region specific, based on the number of days with precipitation less than that region's specific threshold, on seasonal rainfall pattern, or on periods without rainfall. Actual precipitation departures from average amounts may be related on monthly, seasonal, or annual time scales.

Hydrological Drought

Hydrological drought is associated with the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply (i.e., stream flow, reservoir, lake levels, and ground water). The frequency and severity of hydrological drought is often defined on a watershed or river-basin scale.[272]

Changes in land use, land degradation, and construction of dams all affect the hydrological characteristics of the basin. Changes in land use upstream may alter hydrologic characteristics such as infiltration and runoff rates, resulting in more variable stream flow and higher incidence of hydrologic drought downstream. Land-use change is one of the ways human actions alter the frequency of water shortage even when no change in the frequency of meteorological drought has been observed.



Source: The National Drought Mitigation Center

[296] "Types of Drought," National Drought Mitigation Center, University of Nebraska, accessed on 6 July 2015, http://drought.unl.edu/DroughtBasics/TypesofDrought.aspx

Agricultural Drought
Agricultural drought links various characteristics of meteorological or hydrological drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil and water deficits, reduced ground water or reservoir levels, and so forth. Plant water demand depends on prevailing weather conditions, biological characteristics of a specific plant, a plant's stage of growth, weather conditions, and biological properties of the soil.

Socioeconomic Drought
Socioeconomic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply. The supply of many economic goods, such as water, forage, food grains, fish, and hydroelectric power, depends on weather. Because of the natural variability of climate, water supply is ample in some years but unable to meet human and environmental needs in other years.

Sequence of Drought Impacts
The sequence of impacts associated with meteorological, agricultural, and hydrological drought further emphasizes their differences. When drought begins, the agricultural sector is usually the first to be affected because of its heavy dependence on stored soil water. Soil water can be rapidly depleted during extended dry periods. If precipitation deficiencies continue, then people dependent on other sources of water will begin to feel the effects of the shortage. Those who rely on surface water (i.e., reservoirs and lakes) and subsurface water (i.e., ground water) are usually the last to be affected.

Monitoring Drought
There are several indices that measure how much precipitation for a given period of time has deviated from historically established norms. The two most widely used are the Palmer Drought Severity Index and the Standardized Precipitation Index.

Palmer Drought Severity Index
W.C. Palmer developed the first comprehensive drought index in the United States, in 1965. The object of the Palmer Drought Severity Index (PDSI) is to provide measurements of moisture conditions that are standardized so the comparisons using the index can be made between locations and between months. The PDSI is a meteorological drought index and responds to weather conditions that have been abnormally dry or abnormally wet.

The Palmer Index has been widely used for a variety of applications across the United States. It is most effective measuring impacts sensitive to soil moisture conditions, such as agriculture. It has also been useful as a drought monitoring tool and has been used to trigger actions associated with drought contingency plans. Three positive characteristics of the PDSI are:

1. Provides measurement of the abnormality of recent weather for a region.
2. Provides an opportunity to place current conditions in historical perspective.
3. Provides spatial and temporal representations of historical droughts.

The Palmer Index has typically been calculated on a monthly basis, and a long-term archive of the monthly PDSI values is maintained at the National Climatic Data Center.[297]

Palmer Classifications	
4.0 or more	extremely wet
3.0 to 3.99	very wet
2.0 to 2.99	moderately wet
1.0 to 1.99	slightly wet
0.5 to 0.99	incipient wet spell
0.49 to -0.49	near normal
-0.5 to -0.99	incipient dry spell
-1.0 to -1.99	mild drought
-2.0 to -2.99	moderate drought
-3.0 to -3.99	severe drought
-4.0 or less	extreme drought

Source: National Drought Mitigation Center

Standardized Precipitation Index

The Standardized Precipitation Index (SPI) is based on the probability of precipitation for any time scale. It can be computed for different time scales, can provide early warning of drought, can help assess drought severity, and is less complex than Palmer. The SPI reflects the impact of drought on the availability of the different water resources.[298]

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, while negative values indicate less than median precipitation.

[297] "Comparison of Major Drought Indices: Palmer Drought Severity Index," National Drought Mitigation Center, University of Nebraska, accessed on 4 August 2015, http://drought.unl.edu/Planning/Monitoring/ComparisonofIndicesIntro/PDSI.aspx

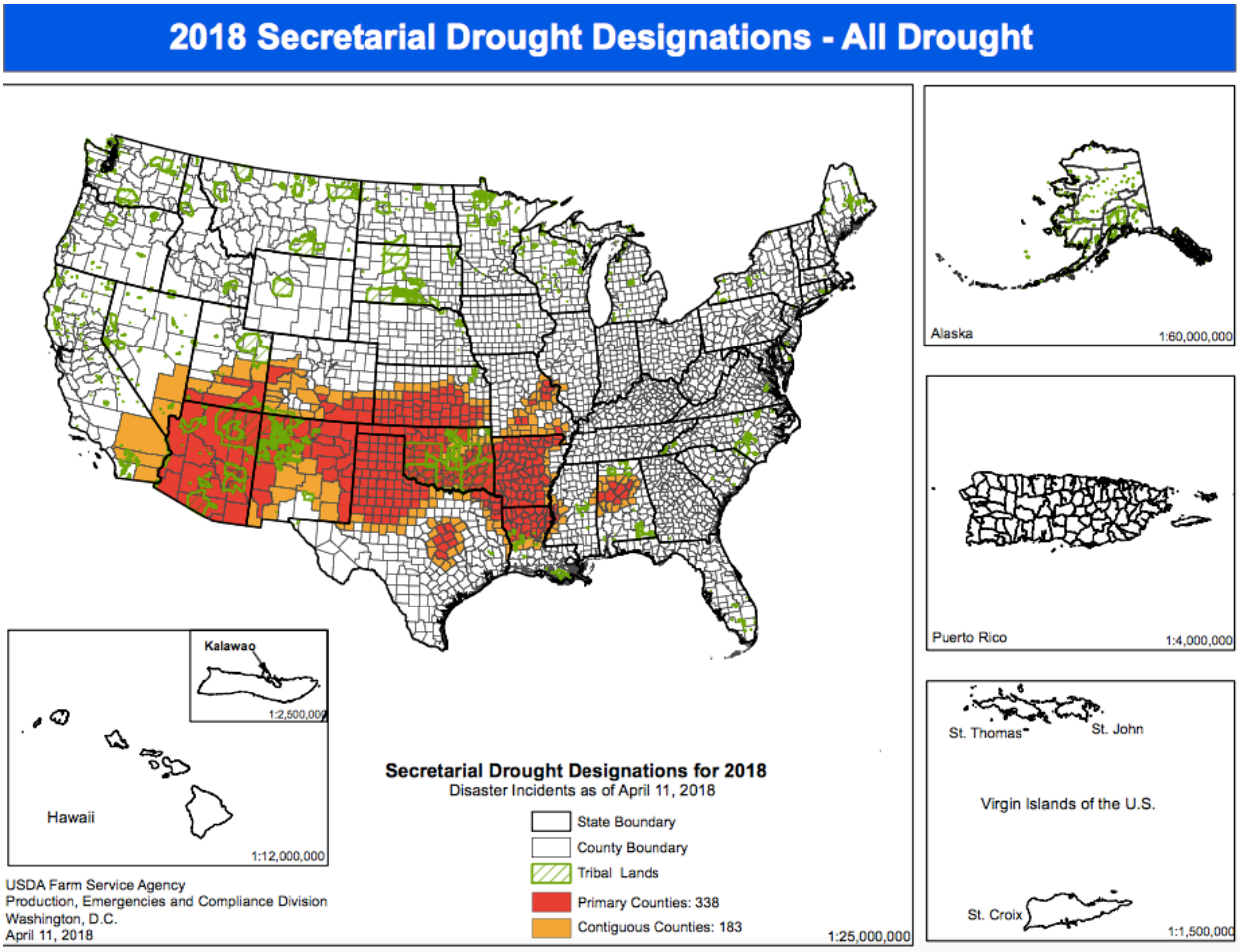
[298] "Standardized Precipitation Index", National Drought Mitigation Center, accessed on 18 Jan 2016, http://drought.unl.edu/portals/0/docs/spi-program-alternative-method.pdf

A drought event occurs any time the SPI is continuously negative and reaches an intensity where the SPI becomes -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 for each month the event continues.

Drought in the United States

The cost of losses due to drought in the United States averages $6-8 billion every year. The 1988 drought across a large portion of the U.S. caused losses totaling $40 billion and combined direct and indirect deaths due to heat stress were estimated at over 5,000.[299] Droughts occur all across the country. The major droughts of the 20th century, the 1930s Dust Bowl and the 1950s droughts, had the most severe impact on the central United States. Florida, Oklahoma and Texas suffered from the 1998 drought. The West Coast experienced a six-year drought in the late 1980s and early 1990s, causing California to take aggressive water conservation measures. Even the typically humid northeastern U.S. experienced a 5-year drought in the 1960s that drained reservoirs in New York City down to 25% of capacity. In fact, almost annually, some region of the country experiences drought. More recently, drought conditions have struck the United States since 2012, severely affecting California and western portions of the country.

[299] "Billion-Dollar Weather and Climate Disasters," NOAA National Centers for Environmental Information, accessed on 8 July 2015, https://www.ncdc.noaa.gov/billions/events



Source: USDA Farm Service Agency[300]

The Dust Bowl

The Dust Bowl drought severely affected much of the United States during the 1930s. In some regions of the High Plains, it lasted for eight years. The "dust bowl" effect was caused by sustained drought conditions compounded by years of land management practices that left topsoil susceptible to the forces of wind.

The agricultural and economic damage devastated residents of the Great Plains who were trying to recover from the Great Depression. Lessons were learned, and because of this drought, farmers adopted new cultivation methods to help control soil erosion in dry-land ecosystems. Subsequent droughts in this region have had less impact due to these cultivation practices.

The 1950s Drought

While much of the country celebrated a resurgence of well-being during the post-war era, many residents of the Great Plains and southwestern United States were suffering. During

300 "2015 Secretarial Drought Designations-All Drought," USDA Farm Service Agency, accessed on 29 July 2015, http://www.usda.gov/documents/usda-drought-fast-track-designations-072915.pdf

the 1950s, these areas withstood a five-year drought. In three of those years, the drought reached coast to coast. The drought reached a peak in 1956 and subsided in most areas with the spring rains of 1957.

This drought created severe social and economic repercussions, devastating the region's agriculture. Crop yields dropped by as much as 50%, and excessive temperatures and low rainfall scorched grasslands used for grazing. By the time the drought subsided in 1957, many counties across the region were declared Federal drought disaster areas.

The 1987-1989 Drought

The three-year drought of the late 1980s covered 36% of the United States at its peak and was the costliest drought in U.S. history at $39 billion in damages.

The drought began along the west coast and extended into the northwestern U.S., with greatest impact in the northern Great Plains. By 1988, the drought had intensified and spread across much of the eastern half of the United States. This drought affected much of the nation's primary corn and soybean growing areas, where total precipitation for April through July of 1988 was even lower than during the Dust Bowl. The drought also encompassed the upper Mississippi River Basin, where low river levels caused major problems for barge navigation. The summer of 1988 is well known for extensive forest fires, including the catastrophic Yellowstone fire.

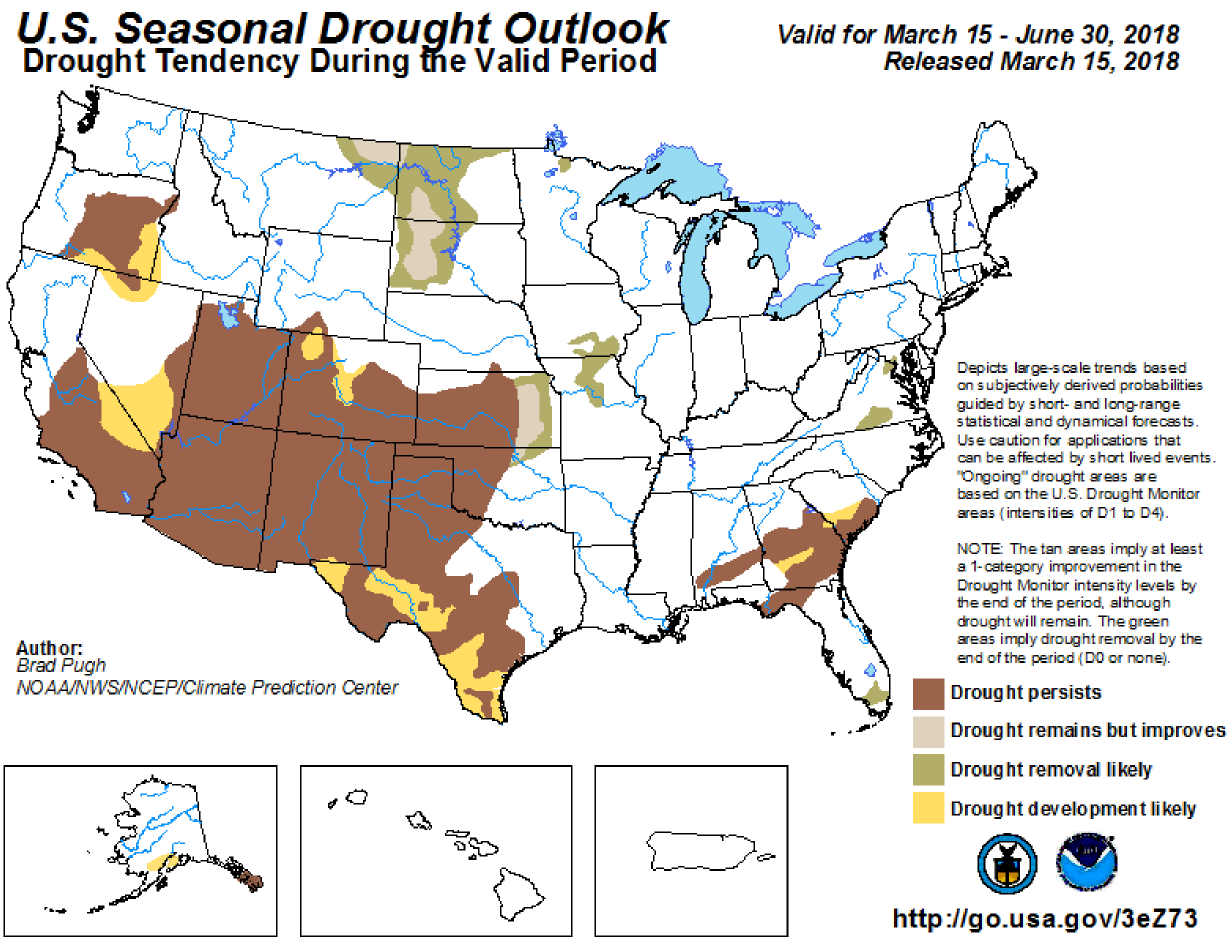
2012 U.S. Drought/Heatwave

The 2012 drought is the most extensive drought in the U.S. since the 1930s. Moderate to extreme drought conditions affected more than half of the country for the majority of 2012 including California, Nevada, Idaho, Montana, Wyoming, Utah, Colorado, Arizona, New Mexico, Texas, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Arkansas, Missouri, Illinois, Indiana, and Georgia. Costly drought impacts occurred across the central agriculture states resulting in widespread harvest failure for corn, sorghum and soybean crops, among others. The associated summer heatwave also caused 123 direct deaths, but an estimate of the excess mortality due to heat stress is still unknown.

2011-2015 California Drought

California is in the 4th year of a record breaking drought. In January 2015, the Governor declared a drought State of Emergency and imposed strict water conservation measures across the state. Californians have been urged to let their lawns die and not waste water on landscaping or swimming pools.[301]

[301] "California Drought Crisis," CBS News, accessed on 8 July 2015, http://www.cbsnews.com/pictures/californias-drought/



Source: NOAA[302]

Drought in Ohio

The State of Ohio monitors precipitation, groundwater levels, stream flows, snowpack, and water quality and utilizes the Palmer Drought Severity Index and other indices to ascertain drought potential.

Ohio receives an annual average of 37.98 inches of precipitation, which recharges ground water and reservoirs. Extended droughts severely diminish the amount of water in streams, reservoirs and aquifers. The population of Ohio is dependent on public ground water systems or private wells and surface water for their water supply.

The most significant impacts which confront the State are in the areas of agriculture, forestry, fish and wildlife, recreation and tourism, public and private water supplies, water

302 "US Seasonal Drought Outlook", National Weather Service, accessed on 8 April 2018 http://www.cpc.ncep.noaa.gov/products/expert_assessment/sdo_summary.php

quality, and economic impacts. Drought severity depends upon the degree of moisture deficiency, drought duration, and size of the affected area.

The Ohio Environmental Protection Agency lists the following operating difficulties connected with long-term dry weather in Ohio:

1. A general increase in system demand as water use for irrigation becomes widespread and privately-owned wells fail.
2. A decrease in the ground water levels resulting in reduced well production or complete failure.
3. Diminished surface water supplies resulting from reduced stream flows and limited replenishment of raw water shortage reservoirs.
4. Increased contaminant levels in surface water as the ratio of contaminants to water volume rises.[303]

Climatological Divisions of Ohio

Source: Ohio Environmental Protection Agency

Correlations between Ohio monthly precipitation and mean air temperature suggest that drought is linked to unusually high summer temperatures. The link between high summer air temperatures and low precipitation is enhanced by strong evapotranspiration and drying of the surface soil layer.

Ohio was the geographic center of the 1991-1992 drought. The central and three northeastern Ohio climatic divisions were the driest places in the country aside from three climatic divisions in Oregon and Washington. National droughts in the past have been focused in virtually every other part of the country aside from the Ohio River Valley region.

[303] "Potential Emergency Situations to Consider When Developing Response and Recovery Actions," Ohio EMA, accessed on 3 Nov 2015, http://epa.ohio.gov/portals/28/documents/security/V2%20C%20-%20Potential%20Emergency%20Situations.pdf

Climatic data indicates that periods of persistent subnormal precipitation in Ohio occurred in 1893-1896, 1952-1954, 1963-1964, and 2012. Overall, however, the worst drought in Ohio was that of 1930-1931, when precipitation reached its lowest amount on record from April 1930 to March 1931. Most recently, Ohio experienced its worst drought in decades in 2012 when below normal precipitation combined with above normal temperatures.[304] In addition, Northeast Ohio experienced several months of "abnormal dryness" in 2017 according to the U.S. Drought Monitor.[305]

Drought in Franklin County

Central Ohio normally receives about 39.31 inches of annual precipitation.[306] Recorded annual extremes for Columbus are 21.6 inches during 1930 and 54.96 inches during 2011.[307] The longest period of record having only a trace of or no precipitation is 48 consecutive days, from September 13 through October 30, 1963. The driest year was 1930 when only 26.59 inches of precipitation was recorded, closely followed by 1934 and 1963.

There have been two occurrences of drought in Franklin County since 1963, both occurring in 1999. The drought spanned two months. However, the months of July and August were each classified as one occurrence each. Dry conditions that began in the spring and early summer continued into July. Excessive heat contributed to substantial crop loss across much of the Buckeye state. Rainfall was widely scattered and did little to help farmers. Crop damage amounts were not available at the time of this writing. Drought conditions continued across the Ohio Valley through August with most areas receiving well below normal rainfall for the month. In some areas around 50% of crops were considered total losses. Most counties in southwest Ohio were declared Federal Disaster Areas by the US Department of Agriculture. At the time of this writing, no monetary estimates were available concerning the crop loss.

As most of Franklin County is urbanized, the maximum impact of severe prolonged drought would be shortages in the water supply. Water quality could suffer and progressive restrictions on water use could be mandated as conditions require. These restrictions could include watering of lawns, parks, and golf courses; swimming pool use; washing of motor vehicles; and ornamental purposes such as fountains and reflecting pools.

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304 "Ohio drought to persist through October," Dayton Daily News, last modified on 20 July 2012, http://www.daytondailynews.com/news/news/ohio-drought-to-persist-through-october/nPym9/

305 http://media.cleveland.com/weather/blog_impact/photo/20170815_midwest_trd.jpg

306 "Columbus, Ohio Average Rainfall", Weather DB, accessed on 4 August 2015 http://rainfall.weatherdb.com/l/189/Columbus-Ohio

307 "The Fashion for 2011: Raincoats and Waders", Columbus Dispatch, last modified on 2 Jan 2012, http://www.dispatch.com/content/stories/local/2012/01/02/the-fashion-for-2011-raincoats-and-waders.html

Franklin County Land Use

2012 CENSUS OF AGRICULTURE
COUNTY PROFILE

Franklin County
Ohio

	2012	2007	% change
Number of Farms	388	429	- 10
Land in Farms	62,017 acres	59,601 acres	+ 4
Average Size of Farm	160 acres	139 acres	+ 15

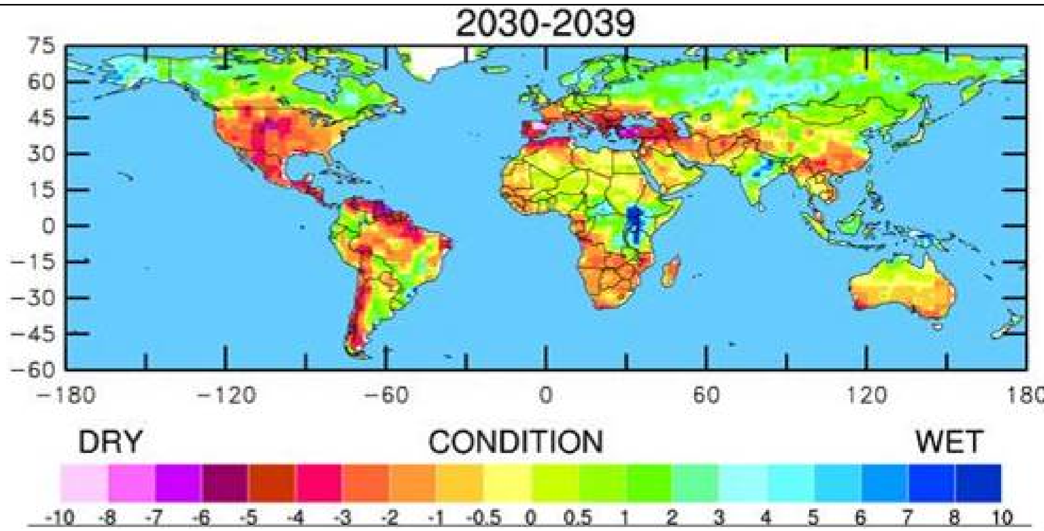
About 24.19% of the county is used for cropland and 1.48% is used for pasture. These areas would be impacted by prolonged drought. These areas represent about one fourth of the county.

The most severe impact in the county would most likely be a water shortage. Fortunately, however, the building of judiciously located dams and storage reservoirs has created a water supply system that by some estimates could be developed to supply 2,500,000 people. The three systems, Griggs, O'Shaughnessy, and Hoover, currently supply 85% of the 130 million gallons of water used in the county daily. The four Ranney Collector Wells in southern Franklin County supply the other 15%, 20 million gallons daily. As surface reservoirs are the last to be affected by drought, it would take a long and severe drought to seriously impact the county.

Climate Change Impacts

There have been changes in some types of extreme weather events over the last several decades. There have been regional trends in floods and droughts with droughts in the Southwest and heat waves everywhere projected to become more intense, and cold waves less intense everywhere.

Droughts will likely continue to worsen due to climate change. Climate models tend to agree that droughts will get more intense and frequent in the Mediterranean, central North America, Mexico, northeast Brazil and southern Africa, though there are still uncertainties as to exact regions. Below is one effort by the National Center for Atmospheric Research to model the potential drought conditions in 2030 to 2039. The below map illustrates the Palmer Drought Severity Index (PDSI) under a moderate emissions scenario. It is important to note that a reading of -4 or below is considered extreme drought. In the United States the projected PDSI in the below scenario ranges as high as -6 to -7 in the Great Plains. For context, the PDSI briefly spiked to -6 in that area during the Dust Bowl, but it rarely exceeded -3 for the rest of the 1930s. In other words, there's a possibility of persisting drought conditions more severe than the Dust Bowl within the next two decades.[308]



Source: National Center for Atmospheric Research

[308] "What We Know About Climate Change and Drought," Washington Post, accessed on 24 July 2012, http://www.washingtonpost.com/blogs/wonkblog/wp/2012/07/24/what-we-know-about-climate-change-and-drought/

Vulnerability Assessment – Drought

**Note: all information in this vulnerability assessment can be attributed to the Franklin County 2012 Natural Hazards Mitigation Plan.*

This hazard is considered to be a "Low Probability Event", meaning the anticipated frequency of the hazard within the County is once every 26 to 124 years. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability

No structural damage due to drought is anticipated in Franklin County.

A drought in Franklin County can have a significant detrimental effect on the domestic water supply, especially for well-water, agriculture, and water-dependent recreational activities. Economic effects in Franklin County would include crop loss.

Potential Impact of Drought

No structural damage due to drought is anticipated in Franklin County.

Negative impacts of drought would be experienced by agricultural interests and some communities would need to reduce water usage in times of severe drought. Communities reliant on reservoirs built to endure times of drought may better tolerate the impacts of drought.

As noted above droughts can and do have a tremendous economic impact on every community even if they are not directly in a drought zone. Much of this impact is seen in the increased cost of farm produced items. As noted above drought has an economic impact of $6-8 billion each year in the United States.

Identifying Structures

No structures would experience damage due to drought; therefore, this updated risk assessment does not identify existing or future buildings at risk of loss due to drought.

Exposure of Existing Buildings to Damages Due to Drought

No existing buildings are exposed to damage due to drought.

Exposure of Future Buildings to Damages Due to Drought

No future buildings will be exposed to damage due to drought.

Estimating Potential Loss

Methodology

Potential structural dollar loss due to drought is estimated to be $0.00 because no historical data is available for losses due to drought.

Due to the many variables and the fact that Franklin County has not had a direct economic loss from a drought a dollar figure has not been entered.
As stated above the economic impact to the United States is $6-8 billion per year.

Estimated Potential Dollar Losses
The estimated potential dollar loss annually in Franklin County due to structural damage due to drought is $0.00.

A direct dollar loss due to drought for Franklin County was not determined.

Karst/Sinkhole- #20

Hazard Summary

According to the Ohio Division of Geological Survey, Regions that contain sinkholes and other features such as caves, springs, disappearing streams, and enlarged fractures, are known as karst terrains. Sinkholes form as bedrock dissolves and surface materials erode or collapse into the resulting voids.[309] Sinkholes can also occur due to poorly backfilled construction or breaks in underground sewer or water pipes.

This hazard was ranked 20 of 20.

Hazard Profile

According to the Ohio Division of Geological Survey, "Karst is a landform that develops on or in limestone, dolomite, or gypsum by dissolution and that is characterized by the presence of characteristic features such as sinkholes, underground (or internal) drainage through solution-enlarged fractures (joints), and caves. While karst landforms and features are commonly striking in appearance and host to some of Ohio's rarest fauna, they also can be a significant geologic hazard. Sudden collapse of an underground cavern or opening of a sinkhole can cause surface subsidence that can severely damage or destroy any overlying structure such as a building, bridge, or highway. Improperly backfilled sinkholes are prone to both gradual and sudden subsidence, and similarly threaten overlying structures. Sewage, animal wastes, and agricultural, industrial, and ice-control chemicals entering sinkholes as surface drainage are conducted directly and quickly into the ground-water system, thereby posing a severe threat to potable water supplies"[310]. Karst terrain is not intrinsically hazardous but can become so if the land near development begin to dissolve.

A sinkhole is a hole that forms in the Earth's surface as a result of the chemical weathering of carbonate rocks like limestone, as well as salt beds or rocks that can be severely weathered as water runs through them and erosion. The process happens through the gradual dissolving process and removal of water. As the rock is removed, caves and open spaces develop under the surface. Once the open spaces become too large to support the weight of the land above them, the surface soil collapses, and a sinkhole is created. The formation of sinkholes often occurs following extreme rainfall, especially after a prolonged

[309] Ohio DNR. GeoFacts No. 31, August 2015. Accessed on 5 March 2018 http://geosurvey.ohiodnr.gov/portals/geosurvey/PDFs/GeoFacts/geof31.pdf

[310] Ohio Geology. No 2, Mapping Ohio's Karst Terrain. Accessed on 5 March 2018 http://geosurvey.ohiodnr.gov/portals/geosurvey/PDFs/newsletter/1999No.2.pdf

dry period. Sinkholes can be found all over the world. Depending on location, sinkholes are sometimes also called sinks, shake holes, swallow holes, swallets, dolines, or cenotes.

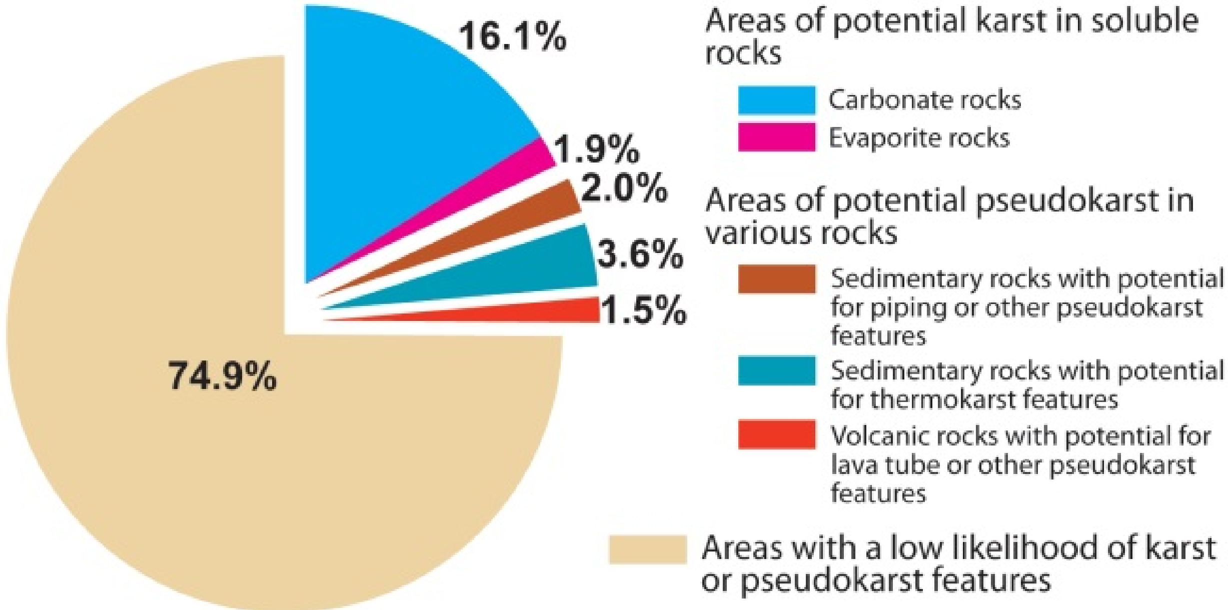
Sinkholes can range from small (a few feet in diameter and a few feet deep) to much larger. Some sinkholes have measured as large as 15-foot wide, and 30 to 40-foot deep.

Karst/Sinkholes in the United States

Approximately 20 percent of the conterminous United States is underlain by karst-modified bedrock. The greatest concentration of karst terrain and karst features in the nation, however, is located in Florida, where 100 percent of the state is underlain by karst forming carbonate bedrock.[311]

The figure below includes all 50 states in its breakdown.[312]

[311] Ohio Geology. No 2, Mapping Ohio's Karst Terrain. 1999. Accessed on 5 March 2018 http://geosurvey.ohiodnr.gov/portals/geosurvey/PDFs/newsletter/1999No.2.pdf
[312] USGS. Karst in the United States: A Digital map Compilation and Database. 2014. Accessed 5 March 2018. https://pubs.usgs.gov/of/2014/1156/pdf/of2014-1156.pdf

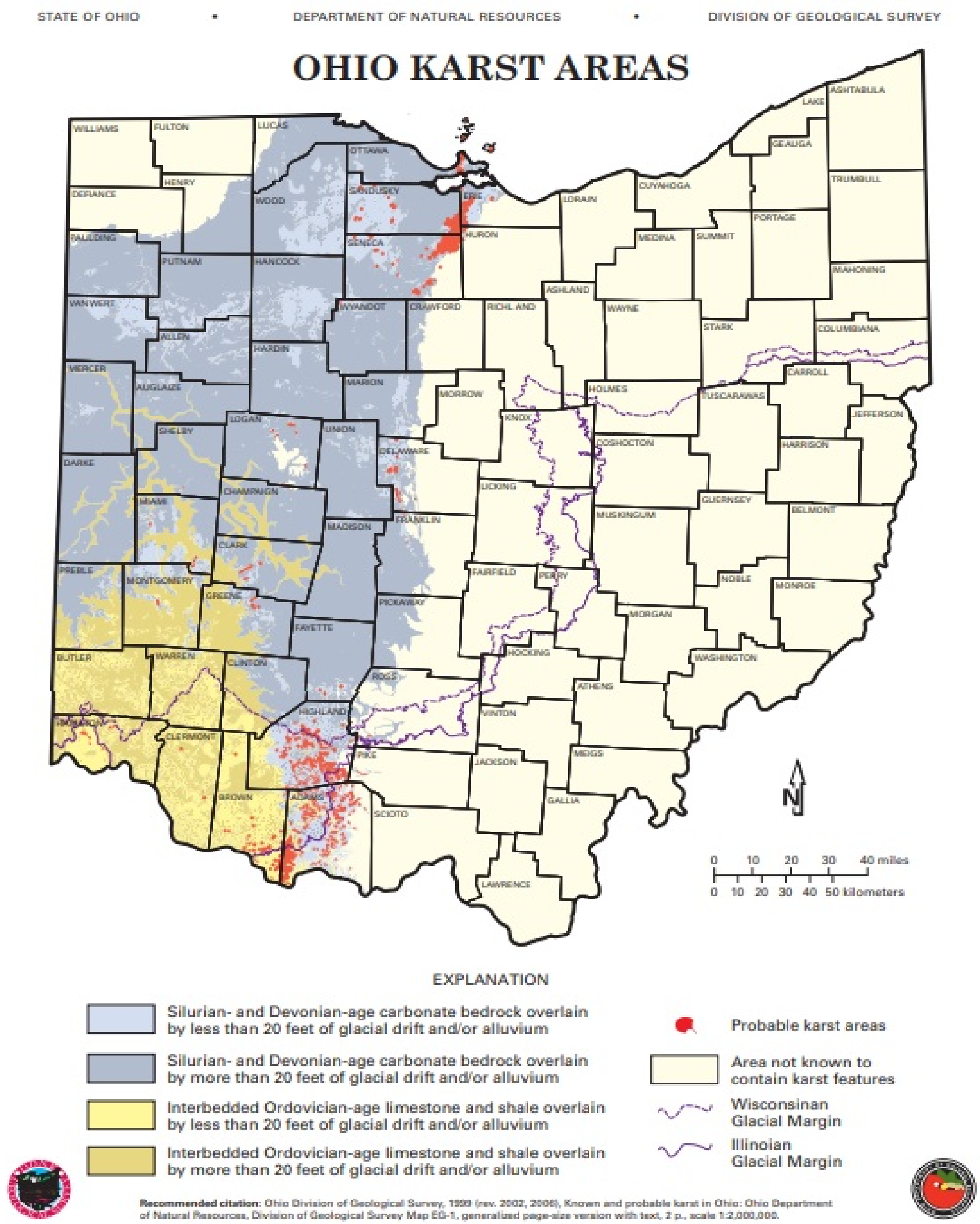


Karst/Sinkholes in Ohio

According to the Ohio DNR, "nearly one-third of Ohio is directly underlain by...bedrock that has the potential to have developed some karst features during its existence." "Even so, less than 2 percent of the Ohio landscape includes karst terrain. The percentage is low because most near-surface carbonite bedrock in Ohio is covered with a thick mantle of glacial deposits which greatly impede or preclude active karst-forming processes. In addition, the abrasive work of Ice Age glaciers is believed to have destroyed much of the karst terrain that had developed in Ohio prior to glaciation.[313]

In general, the western half of Ohio is dominated by thick limestones and dolostones, while the eastern half is primarily shale, sandstone, and some thin carbonates. Therefore, karst is found primarily in the western half of the state where the rocks are susceptible to dissolution. Through 2015, the number of karst features—including verified, suspect, and unverified—mapped in Ohio is about 5,700. This number will change as false positives are identified and removed and as unknown sinkholes are located, especially in southern Ohio. Of the 5,700 total suspect or known karst points, 1,800 points have been field verified as karst, along with more than 100 springs.[314]

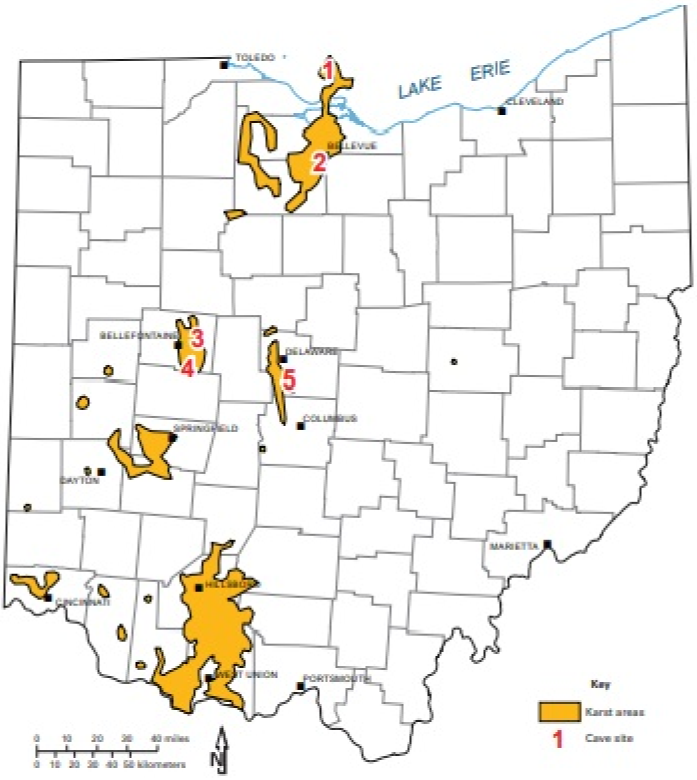
313 Ohio Geology. No 2, Mapping Ohio's Karst Terrain. 1999. Accessed on 5 March 2018 http://geosurvey.ohiodnr.gov/portals/geosurvey/PDFs/newsletter/1999No.2.pdf
314 Ohio DNR. GeoFacts No. 31, August 2015. Accessed on 5 March 2018 http://geosurvey.ohiodnr.gov/portals/geosurvey/PDFs/GeoFacts/geof31.pdf



Source: Ohio DNR[315]

Karst/Sinkholes in Franklin County

[315] Ohio DNR. Ohio Karst Areas. 2007. https://geosurvey.ohiodnr.gov/portals/geosurvey/PDFs/karst/karstmap.pdf



Map of Ohio showing known karst areas.[316] *The densest areas are represented by the orange areas shown running north to south through central Ohio: Highland County and south into Adams and Brown Counties; Erie, Huron, Sandusky, and Seneca Counties; and Delaware and Franklin Counties. Publically accessible caves: (1) Crystal Cave and Perry's Cave, (2) Seneca Caverns, (3) Zane Shawnee Caverns, (4) Ohio Caverns, and (5) Olentangy Indian Caverns.*

Although karst terrain and the risk for sinkholes is more prevalent in the Southern and Western sections of Ohio, the Western half of Franklin County does contain probable karst areas as indicated by the map above.

The following examples were garnered from searching news reports.

On July 9, 1986, two 100-year-old brick sewer lines gave way underneath W. Broad Street causing a 40 by 30ft hole to appear in the road, swallowing one vehicle. The driver was uninjured, but damages and repairs took more than $100,000 to fix.[317]

Climate Change Impacts

Natural sinkholes occur more frequently during times of more volatile rainfall. Studies have shown a good chronological correlation of sinkhole inventories with drought periods.

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[316] Ohio DNR. GeoFacts No. 31, August 2015. Accessed on 5 March 2018 http://geosurvey.ohiodnr.gov/portals/geosurvey/PDFs/GeoFacts/geof31.pdf

[317] The Columbus Dispatch. *The Big Hole Seen 'round the World.* 9 July, 2011. Accessed on 5 March, 2018. http://www.dispatch.com/content/stories/local/2011/07/09/the-big-hole-seen-round-the-world.html

Therefore, it is possible that that this hazard will intensify in the future due to climate change.

Vulnerability Assessment – Karst/Sinkhole

This hazard is considered to be a "Low Probability Event", meaning the anticipated frequency of the hazard within the County is once every 26 to 124 years. This was determined by a committee of subject matter experts scoring the likelihood of this hazard occurring.

Overview of Vulnerability

Sinkholes can cause an immediate and unforeseen hazard. These holes can occur suddenly and cause damage to everything nearby. Sinkholes have been known to damage infrastructure, vehicles, and houses. Sinkholes can also create direct connections between surface water and the water table, potentially facilitating the pollution of the water table. Surface contaminants, such as excess field fertilizer, drain into sinkholes and are often re-expressed at the land surface from springs. It is common to see springs with algae and watercress blooms fed by high concentrations of fertilizer in the water. Houses with a water well in a karst area also have a high risk of surficial contamination from anything that enters a sinkhole, including E. coli (dead deer are commonly disposed of in sinkholes), fertilizer, pesticide, and other waste.[318]

Identifying Structures and Potential Impact of Karst Terrain/Sinkholes

Exposure of Existing Buildings to Sinkholes

Any essential facility can be damaged if a sinkhole opens near or beneath the facility.

Exposure of Future Buildings to Sinkholes

Karst features may pose a threat to current or future infrastructure, including roads, railways, pipelines, foundations, and other structures.

Estimating Potential Loss

Methodology

Potential structural dollar loss due to sinkhole is estimated to be $0.00 because no historical data is available for losses due to sinkhole.

[318] Ohio DNR. GeoFacts No. 31, August 2015. Accessed on 5 March 2018 http://geosurvey.ohiodnr.gov/portals/geosurvey/PDFs/GeoFacts/geof31.pdf

Estimated Potential Dollar Losses

Due to the many variables and the fact that Franklin County has not had a direct economic loss from sinkholes, a figure has not been entered.

Estimated Potential Dollar Losses

The estimated potential dollar loss annually in Franklin County due to structural damage due to sinkholes is $0.00.

A direct dollar loss due to sinkholes for Franklin County was not determined.

Hazards Not Profiled

Summary

The following risks were excluded from analysis due to no identified risk, minimal impact to the community, or limited ability to mitigate the hazard.

Hazard	Explanation for Omission
Landslide	The landslide risk is relatively minor in Franklin County due to the terrain.
Land/Wildfire	This hazard has not created problems in the past and most within the region are typically isolated and of short duration in nature.

Appendix A

Contents

The U.S. Department of Homeland Security Risk Steering Committee DHS Risk Lexicon (September 2010) is a separate PDF document. This document is available from the U.S. Department of Homeland Security (DHS) website at http://www.dhs.gov/xlibrary/assets/dhs-risk-lexicon-2010.pdf

APPENDIX B. MEETING & WORKSHOP DOCUMENTATION

Steering/Core Group Committee Meetings

FRANKLIN COUNTY
Emergency Management and Homeland Security
OHIO

Hazard Mitigation Plan Update 2018

Franklin County, Ohio

Agenda

Thursday, October 5, from 9:30-10:30 a.m.
5300 Strawberry Farms Blvd, Columbus, OH 43230

Introductions

Overview of Mitigation: Why Mitigate?

Mitigation Planning Process

Mitigation Plan Elements

Project Schedule

Franklin County Knowledge Management System

- *SIGN-IN SHEET:* Hazard Mitigation Plan Update -

Hazard Mitigation Plan Update
Franklin County, Ohio

Hazard Mitigation Planning Committee
Date: 10/5/2017

Name	Organization	Phone	E-mail
Tom Hirschy	Dublin	614-410-4808	thirschy@dublin.oh.us
DAVID REUTTER	FRANKLIN SWCD	614 486 9613	DREUTTER@FRANKLINSWCD.ORG
Daiko Abe	ISC	208-390-2021	daiko.abe@i-s-consulting.com
Matt Brown	FCEDP	614-525-5647	mybrown@franklincountyohio.gov
PAT MILLENBAUGH	GAHANNA	614 342-4212	PAT.MILLENBAUGH@GAHANNA.GOV
JAMIE STOUT	FCEMHS	614-794-0213	jlstout@franklincountyohio.gov
via phone Alice Kaltenmark	CPO		
Leah Kahn	ISC	831-818-3324	leah.kahn@i-s-consulting.com

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Hazard Mitigation Plan Update 2018
Franklin County, Ohio

Agenda

Thursday, March 1, from 10:00-11:30 a.m.
5300 Strawberry Farms Blvd, Columbus, OH 43230

Introductions

Risk Summary/Risk Assessment Process

Hazard Summary Worksheet

Goals and Objectives

Jurisdiction/Municipal Outreach & Workshops

Franklin County Knowledge Management System

- *SIGN-IN SHEET:* Hazard Mitigation Plan Update -

Hazard Mitigation Plan Update
Franklin County, Ohio

Hazard Mitigation Planning Committee: Risks and Hazards
Date: 3/1/2018

Name	Organization	Phone	E-mail
Tom Hirschy	Dublin Police	614-410-4808	thirschy@dublin.oh.us
Casey Thomas	City of Whitehall	614-237-8612	Casey.thomas@whitehall-oh.us
PAT MILLENBAUGH	GAHANNA P.D.	614 342 4212	PAT.MILLENBAUGH@GAHANNA.GOV
Nathaniel Vogt	MORPC	614-233-4183	nvogt@morpc.org
DARRYL KOERBER	FCEM&HS	614-724-0910	dlkoerbe@franklincountyohio.gov
Jeff Young	FCEM&HS	614-205-8509	JJYOUNG@franklincountyohio.gov
Brian Miller	City of Westerville	614-901-6606	Brian.Miller@Westerville.org
Dako Abe	ISC	208-390-2021	dako.abe@i-s-consulting.com
Andrew Jarvi	FCEMHS	614-724-0805	aljarvi@franklincountyohio.gov
Matt Brown	Franklin County		

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Hazard Mitigation Plan Update 2018
Franklin County, Ohio

Agenda

Thursday, July 19, from 10:00-11:30 a.m.
5300 Strawberry Farms Blvd, Columbus, OH 43230

Introductions
Mitigation Plan Review and Discussion: Key Changes and Updates
Mitigation Actions/Strategies Review and Discussion
Plan Maintenance & Implementation Discussion
Plan Submittal and Approval Process
Plan Adoption and Next Steps
Franklin County Knowledge Management System

- *SIGN-IN SHEET:* Hazard Mitigation Plan Update -

Hazard Mitigation Plan Update
Franklin County, Ohio

Hazard Mitigation Planning Committee: Final Review Meeting
Date: 7/19/2018

Name	Organization	Phone	E-mail
Andrew Jarvi	FCEMHS	614-724-0805	aljarvi@franklincount
Daiko Abe	ISC	202-390-2021	
Ken Cooper	FCED	614-525-3030	kcooper@franklincountyo
Tom Hirsch	Dublin	614-410-4808	thirsch@dublin.oh.
Ethan Johnson	FCEMHS	740-313-2947	ethan.johnson@rockets
Pat Millenbaugh	Gahanna P.D.	614-342-4212	PAT.MILLENBAUGH
Darrel Koerber	Frank HS	614-724-0910	dkoerber@franklincoun
Nathaniel Vogt	MORPC	614-233-4183	nvogt@morpc.org
Brian Miller	Westerville Division of Fire	614-901-6606	Brian.Miller@Westerville.o
Jeff Young	FCEM & HS	614-205-8509	JJYOUNG@Franklin
Matt Brown	FCEDP	614-525-5697	mybrown@franklincoun

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Workshops

Franklin County Emergency Management and Homeland Security

Hazard Mitigation Plan Update 2018
Franklin County, Ohio

Workshop Agenda

Introductions

Mitigation Overview

Questionnaire Findings

Risk Summary/Risk Assessment Findings

Jurisdiction Hazard Summary Worksheet

Review Ongoing Mitigation Actions/Projects

Identify New Mitigation Actions

Franklin County Knowledge Management System

1

- *SIGN-IN SHEET:* Hazard Mitigation Plan Update -

Hazard Mitigation Plan Update Workshops

Franklin County, Ohio

Date: 4/18/2018

Time: 0900-1130

Mitigation Workshops – City of Columbus

Name	Title	Organization	Phone	E-mail
Christopher Lohr	Planning Manager	Development - Planning	614-645-7244	CRLOHR@COLUMBUS.GOV
Tony Celebrezze	Asst Dir	Bld & Zoning	614 645-6769	Ajcelebrezze@columbus.GOV
Ann Aubry	Deputy Director	Public Utilities	614.645.3122	amaubry@columbus.gov
Andrew Jarvi	Planning Manager	Franklin EM+HS	614.205.4170	aljarvi@franklincountyohio.gov
Sean Farrell	Intern	Franklin EM+HS	401-486-6461	farrell.204@osu.edu
Daiko Abe	Consultant	ISC	208-390-2021	daiko.abe@i-s-consulting
Sabeen Shamsi	Consultant	ISC	630-201-0116	sabeen.shamsi@i-s-consulting.com

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Hazard Mitigation Plan Update
Franklin County, Ohio

Hazard Mitigation Planning Committee Date: 10/5/2017			
Name	**Organization**	**Phone**	**E-mail**
Tom Hirschy	Dublin	614-410-4808	thirschy@dublin.oh.us
DAVID REUTTER	FRANKLIN SWCD	614 486 9613	DREUTTER@FRANKLINSWCD.ORG
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JAMIE STOUT	FCEM+HS	614-794-0213	jlstout@franklincountyohio.gov
via phone Alice Kaltenmark	CPO		
Leah Kahn	ISC	831-818-3324	leah.kahn@i-s-consulting.com

- *SIGN-IN SHEET:* Hazard Mitigation Plan Update -

Hazard Mitigation Plan Update Workshops

Franklin County, Ohio

Date: 4/18/2018

Time: 1300-1530

Mitigation Workshops				
Name	**Title**	**Organization/Jurisdiction**	**Phone**	**E-mail**
John Petrozzi	Chief of Police	Perry Twp	(614) 889-9028	Jpetrozzi@perrytwp.org
Ian Warren	Road Superintendent	Perry Twp	(614) 889-8781	iwarren@perrytwp.org
Jason Nicodemus	Administrator	Truro Twp.	614-866-1317	JNICODEMUS@TRUROTWP.ORG
Pete Kowal	P. Manager	CPH / CEPAC	645-6275	PJKowal@Columbus.gov
Kyle McKee	IT Proj Mgr	City of Dublin	614-410-4451	kmckee@dublin.oh.us
Brandon Brown	Data/GIS mgr	City of Dublin	410 4453	bbrown " "
Ben Collins	Twp Administrator	Plain Twp	614-855-2015	bcollins@plaintownship.org
Jamie Fisher	Twp Administrator	Norwich Twp	614-876-3329	jamie_fisher@norwichtownship.org
Trish Lackey	Event Admin	City of Dublin	614-410-4506	T.Lackey@Dublin.oh.us
Sabeen Shamsi	Consultant	ISC	630-201-0116	sabeen.shamsi@i-s-consulting.com
Daiko Abe	Consultant	ISC	208-390-2021	daiko.abe@i-s-consulting.com
Andrew Jarvi	Planning Manager	Franklin EM + HS	614-205-4170	aljarvi@franklincountyohio.gov
Sean Farrell	Intern	Franklin EM + HS	401-486-6461	farrell.204@osu.edu

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Hazard Mitigation Plan Update Workshops

Franklin County, Ohio

Date: 4/26/2018

Time: 0900-1130

Mitigation Workshops

Name	Title	Organization	Phone	E-mail
Sabeen Shamsi	Consultant	ISC	630-201-0116	sabeen.shamsi@i-s-consulting.com
Daiko Abe	Consultant	ISC	208-390-2021	daiko.abe@i-s-consulting.com
Andrew Jarvi	Planning Manager	Franklin EM + HS	614-205-4170	aljarvi@franklincountyohio.gov
Tim Elmer	OPS ADMIN		614 496-0200	telmer@dublin.oh.us
Kelly Rigano	OPS Supervisor	City of Dublin	614-410-4588	krigano@dublin.oh.us
Chris Nicol	OPS Admin	City of Dublin	614-410-4722	cnicol@dublin.oh.us
Michael Bliss	Fleet	City of Dublin	614 410 4267	mbliss@dublin.oh.us
Nick Plouck	Management Assistant / Office of City Manager	City of Dublin	614.410.4456	nplouck@dublin.oh.us
Kevin Weaver	Director of Public Service	Westerville	614 901 6746	kevin.weaver@westerville.org

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Hazard Mitigation Plan Update Workshops

Franklin County, Ohio

Date: 4/26/2018

Time: 0900-1130

Mitigation Workshops				
Name	**Title**	**Organization**	**Phone**	**E-mail**
TODD TAGESON	Crew Supervisor	City of Dublin	6143730689	Ttageson@dublin.oh.us
Donald Murphy	Drainage Tech	FRANKLIN County Engineer	614-206-6681	Dmurphy@franklincountyengineer.org
Rob Wagner	Crew Supervisor	City of Dublin	614-496-5750	rwagner@dublin.oh.us
Thomas Nutini	Public Ser. Manager	City of Upper Arlington	614 583-5381	tnutini@UAOH.NET
Kyle Kridler	Economic Develop	City of Dublin	614 410 4429	KKridler@dublin.oh.us
Chris Monacelli	Electric Utility Manager	City of Westerville	614-901-6713	Chris.Monacelli@westerville.org
Matt Peoples	Dir Public Service	Canal Winchester	614-834-5111	mpeoples@canalwinchesterohio.gov
Richard Lorenz	Water Utility	City Westerville	614 901 6772	Richard.Lorenz@westerville.org
Scott McAfee	PFO	City of New Albany	614-855-3913	smcafee@newalbanyohio.org
Brian Miller	Fire Chief	City of Westerville	614-901-6606	brian.miller@westerville.org

- *SIGN-IN SHEET:* Hazard Mitigation Plan Update -

Hazard Mitigation Plan Update Workshops

Franklin County, Ohio

Date: 4/26/2018

Time: 1300-1530

Mitigation Workshops				
Name	**Title**	**Organization**	**Phone**	**E-mail**
Jerry Strait	Chief of Police	Worthington PD	614-885-4462	jStrait@ci.worthington.oh.us
John Bailot	Fire Chief	City of Worthington Div of Fire	614-885-7640	jbailot@ci.worthington.oh.us
Ron Whittington	Risk Manager	City of Dublin	614-410-4411	rwhittington@dublin.oh.us
Stephen Moore	Building Official	Groveport	614 830 8025	Smoore@Groveport.org
Mike Anderson	Development Director	Jefferson Twp	614-304-0135	Manderson@JeffersonTownship.org
Joe Gerhart	Supt.	Jefferson Twp	614-861-2440	jgerhart@jeffersontownship.org
Kurt Blevins	Captain	City of Groveport	(614) 563-9383	KBlevins@Groveport.org
Jeff Green	Asst. Admin	" "	614-836-5301	jgreen@groveport.org
Jim Mast	Safety Director	Reynoldsburg	6147741671	JMast@Reyno...
Walter Wagner	Foreman	City of Groveport	614-836-5307	WWagner@groveport.org
Jessica Rice	Admin Coordin	Franklin Township	614-279-9411	jrice@franklin-township.com
Todd Broecker	Captain	Franklin Twp Fire	614-279-9411	tbroecker@franklin-township.com
Jessica Frank	Program manager	Columbus Public Health	614-645-6066	jmfrank@columbus.gov
Steve Farst	City Eng'r	Grove City	614-836-5301	sfarst@groveport.org
Eric Richter	Administrator	Washington Twp.	614-652-3921	ERichter@WTWP.com
Tim Stitt	Sr Bldg Insp	City of Dublin	614-206-6845	tstitt@dublin.oh.us

- *SIGN-IN SHEET:* Hazard Mitigation Plan Update -

Hazard Mitigation Plan Update Workshops

Franklin County, Ohio

Date: 4/26/2018

Time: 1300-1530

Mitigation Workshops				
Name	**Title**	**Organization**	**Phone**	**E-mail**
Sabeen Shamsi	Consultant	ISC	630-201-0116	sabeen.shamsi@i-s-consultingco
Daiko Abe	Consultant	ISC	208-390-2021	daiko.abe@i-s-consultingco
Andrew Jarvi	Planning Manager	Franklin EM + HS	614-205-4170	ajarvi@franklincountyohio.gov
JIM RAYBURN	Planning	Dublin	614-410-4653	jrayburn@dublin.oh.us

Photos from Workshops

4/18/2018 Morning Workshop

4/18/2018 Afternoon Workshop

4/18/2018 Afternoon Workshop

4/26/2018 Morning Workshop

4/26/2018 Morning Workshop

Mitigation Ideas

A Resource for Reducing Risk to Natural Hazards

January 2013

FEMA

Franklin County Emergency Management and Homeland Security

Mitigation Action/Project Examples

***Instructions**: Please adapt the following examples to the mitigation needs of your jurisdiction and/or organization. These are only **examples** and does not represent an all-inclusive list of potential actions.*

Mitigation planning is best accomplished from a multi-hazard perspective. Reducing the level of risk involving one natural or technological hazard may increase the risk of damage from another hazard. Consequently, it is important to consider that some mitigation alternatives may not be viable given a particular set of hazard conditions. For example, elevating a home on stilts to allow for water flow in a floodplain can be a good thing, but it becomes a problem if the home is in an earthquake zone and the ground starts shaking.

ALL HAZARDS

MOUs and Agreements

Local governments should establish mutual aid agreements for utility and communications systems, including 9-1-1. Mutual aid or interagency agreements have value for preventing or responding to other hazard or emergency situations, as fire and police departments often do.

- Establish Mutual-Aid Memorandum of Understandings (MOUs) and agreements with key organizations [List the Organization]

Planning and Preparedness

- Continue to improve the Franklin County Natural Hazard Mitigation Plan through annual reviews and incorporation of incident lessons learned
- Perform Continuity of Operations planning to identify critical functions, essential personnel, vital resources, and critical infrastructure within the county/community that is necessary to maintain public safety and services
- Once a community is familiar with the location of its hazardous areas; it may adopt a land use plan, or modify an existing land use plan to:
    - Encourage greater development restrictions on the property.
    - Guide developments away from hazardous areas
    - Reduce density in the hazardous area
- **Site Emergency Plans or Emergency Action Plans**: Communities can encourage development and testing of internal emergency plans and procedures, including COOP planning, by businesses and other organizations. Communities should develop and test

site emergency plans for schools, factories, office buildings, correctional facilities, recreation areas, and other similar facilities.

- **Real estate disclosure**: Real estate disclosure laws are important because they force a seller to advise a potential buyer about pre-existing conditions. This allows buyers to make more informed decisions about the potential risks involved in owning property, such as whether a property is in a floodplain or if it had been previously damaged from flood water or any other type of hazard condition.
- **Family Disaster Plans and Supply Kits**: Communities can encourage residents to prepare themselves by stocking up with necessary items and planning for how family members should respond if any of a number of possible emergency or disaster events strike.

Warning, Public Information and Education

- Enhance awareness and preparedness of residents through CERT and facilitate community training requests for emergency preparedness education
- Continue to enhance emergency preparedness information available to citizens and visitors through the county/community website and community outreach opportunities
- Make available "new resident" packets to inform residents of potential hazards and threats, and to inform them of warning and outreach tools that are available in the county/community.
- Develop a multi-faceted public awareness campaign to increase citizen enrollment in the Franklin County Emergency Notification System.
- Continue to enhance the communication network related to the delay or closure of county/municipal facilities and roadways.
- Install electronic warning signage and permanent road closure barriers on key highways [List Highway or Road]
- Increase use of weather radio announcements to enhance the redundancy of public information delivery in severe weather situations throughout the county/municipality.
- Develop season-specific fliers to address hazards and ways each resident (or part-time residents) can mitigate their own risks and mail to residents with their water/utility bill.
- Update [insert community] Website with Emergency Information
- Communities can encourage the use of National Oceanic and Atmospheric Administration (NOAA) weather radios among their residents. NOAA Weather Radio continuously broadcasts National Weather Service forecasts, warnings and other crucial weather information. NOAA Weather Radio also provides direct warnings to the public for natural, man-made, or technological hazards, and it is the primary trigger for activating our country's Emergency Alert System (EAS) on commercial radio, television, and cable systems.

NATURAL HAZARDS

Drought

- Support state and local tax credits for the installation of water-conserving plumbing and other devices as retrofits.

- Develop water conservation plans, preferably on a watershed basis, that includes emergency conservation measures or directives and the triggers for implementation of each measure or directive.

Extreme Heat/Cold

- Ensure that local plans are in place to manage extreme heat/cold events, especially should power outages accompany the extreme temperature event.
- Ensure that local communities have adequate shelter facilities with properly trained coordinators and/or managers that can address the needs of at-risk populations such as the elderly, the homeless, the disabled and families.
- Ensure that local communities have an adequate monitoring system for housebound at-risk populations.
- Bury water/sewer lines deeper under the streets to prevent frozen main lines
- Install SCADA monitoring on City Water and Sewer Systems

Winter Storms/Heavy Snow

- Ensure local plans include preparation for and management of the response to winter storm events and especially long-term disruption of power supplies and transportation infrastructure.
- To the extent practical, utilities should be designed and built to resist damage and loss of service during winter storm events, such as placing line underground where appropriate.
- Improve the traffic control on rural roads that are subject to snow drifting and white-out driving conditions.
- **Family and Traveler Emergency Preparedness**: A local or state government can produce and distribute family and traveler emergency preparedness information relating to severe winter weather hazards.
- **Driver Safety**: Safety strategies for severe weather events can be included in driver education classes and materials.
- **Animal Protection**: Farmers and other animal custodians should plan for addressing livestock or other animal needs.
- **Snow Fences**: Using snow fences or “living snow fences” (rows of trees or other vegetation) can limit blowing and drifting of snow over critical roadway segments.

Tornado, Straight-line Winds, Hail, Lightning and Severe Thunderstorms

- Identify hazard notification systems that are device-neutral or do not require a personal device to receive warnings.
- Obtain increased funding (or continued funding) for stand-alone safe rooms, safe rooms linked to schools and communities facilities, and community shelters to prevent the future loss of life.
- Require manufactured homes to use tie-downs with anchors [If applicable]
- Establish severe weather protective areas within county/municipal parks and open space.

- Develop a sign retrofitting or new sign program to decrease their vulnerability to wind hazards.
- **Surge Protectors and Lightning Protection**: Surge protection can be installed on critical electronic equipment. Lightning protection devices and methods, such as lightning rods and grounding, can be installed on a community's communications infrastructure and other critical facilities.
- **Construction Standards and Techniques**: To strengthen public and private structures against severe wind damage, communities can require or encourage wind engineering measures and construction techniques that may include structural bracing, straps and clips, anchor bolts, laminated or impact-resistant glass, reinforced pedestrian and garage doors, window shutters, waterproof adhesive sealing strips, or interlocking roof shingles. Also, architectural design can make roofs less susceptible to uplift.
- **Temporary Debris Disposal**: Temporary debris disposal sites can be protected by fencing and/or located away from populated areas.
- **Tree Management**: Tree pruning near power lines can reduce the potential for trees falling on and breaking power lines.

Flooding and Dam Failure

Ninety percent of federal disaster declarations are for flood events. Response and recovery costs can be extremely high, so where risks are apparent it makes sense to take actions that prevent damage from occurring. If flood damage cannot be fully prevented, there may be mitigation techniques that lessen the damage. Flooding addressed in this section can be from high ground water, overland flooding from rivers or streams, or from a dam failure.

- Support the update of out-of-date flood insurance maps.
- Support federal action to develop and disseminate maps that show flood hazards under future conditions such as increased impervious area upstream and potential effects of climate change. To the extent practicable, maps should predict the extent of flooding at least 50 years into the future.
- Consider additional stream gauges, especially in communities with repetitive flood events or repetitive (flood) loss structures.
- Relocate, elevate, and/or floodproof flood-prone property – especially those properties identified as historically or culturally significant to the community.
- Maintain dry-access roads by elevating them above the base flood elevation [if applicable]
- Roads are needed to get people and goods from place to place. In addition to planning for traffic control during floods, there are various construction and placement factors to consider when building roads. To maintain dry access, roads should be elevated above the base flood elevation. However, if a road creates a barrier it can cause water to pond. Where ponding is problematic, drainage and flow may be addressed by making changes to culvert size and placement. In situations where flood waters tend to wash roads out, construction, reconstruction, or repair can include not only attention to drainage but also stabilization or armoring of vulnerable shoulders or embankments.
- Develop an integrated strategic flood warning plan that addresses the repair, repositioning, or upgrade of existing flood warning systems.
- Conduct channel stabilization, improvement, and restoration in [insert] to allow greater drainage and water flow capacity.

- Provide a public education program to inform residents about mitigation measures and means for them to protect themselves and their property during a flood.
- Land with structures may be purchased by and titled in the name of a local governing body that can remove structures and enforce permanent restrictions on development.
- **Zoning Ordinance Adoption or Amendments**: Examples of zoning methods that affect flood hazard mitigation include: 1) adopting ordinances that limit development in the floodplain; 2) limiting the density of developments in the floodplain; and 3) requiring that floodplains be kept as open space.
- **Subdivision Ordinances or Amendments**: Subdivision design standards can require elevation data collection during the platting process. Lots may be required to have buildable space above the base flood elevation.
- **Building Code Adoption or Amendments**: Requirements for building design standards and enforcement include the following possibilities: 1) that a residential structure be elevated; and 2) that a non-residential structure be elevated or floodproofed.
- **Conservation Easements**: Conservation easements may be used to protect environmentally significant portions of parcels from development. They do not restrict all use of the land. Rather, they direct development to areas of land that are not environmentally significant.
- **Purchase of Easement/Development Rights**: Compensating an owner for partial rights, such as easement or development rights, can prevent a property from being developed contrary to a community's plan to maintain open space. This may apply to undeveloped land generally or to farmland in particular.
- **Stormwater Management Ordinances or Amendments**: Stormwater ordinances may regulate development in upland areas in order to reduce stormwater run-off. Examples of erosion control techniques that may be employed within a watershed area include proper bank stabilization with sloping or grading techniques, planting vegetation on slopes, terracing hillsides, or installing riprap boulders or geotextile fabric.
- **Storm Drainage Systems**: Flood mitigation can involve installing, re-routing, or increasing the capacity of a storm drainage system that may involve detention and retention ponds, drainage easements, or creeks and streams. It can include separation of storm and sanitary sewerage systems as well as higher engineering standards for drain and sewer capacity.
- **Drainage System Maintenance**: At most times, a drainage system will do its job and move water to intended areas. However, if a system is not maintained, erosion, material dumping, or deterioration of man-made reinforcement materials may reduce the carrying capacity of a stream. Therefore, regular maintenance, such as sediment and debris clearance, is needed so that the stream may carry out its design function. Also important is detection and prevention/discouragement of discharges into storm-water/sewer systems from home footing drains, downspouts or sump pumps.
- **Multi-Jurisdiction Cooperation Within Watershed**: Forming a regional watershed council helps bring together resources for comprehensive analysis, planning, decision-making, and cooperation.
- **Post-Disaster Recovery Ordinance**: A post-disaster recovery ordinance regulates repair activity, generally depending on property location. It prepares a community to respond to a disaster event in an orderly fashion by requiring citizens to: 1) obtain permits for repairs, 2) refrain from making repairs, or 3) make repairs using standard methods.
- **Hazardous and Buoyant Material Protection**: Containers of hazardous materials such as petroleum or chemicals should not be located in a flood hazard area. If such a location

is necessary, hazardous material containers need to be anchored, because the contents can contaminate water and multiply the damaging effects of flooding by causing fires or explosions, or by otherwise making structures unusable. Also, buoyant materials should be anchored, because if they float downstream, they may cause additional damage to buildings or bridges or may plug a stream resulting in higher flood heights.

- **Manufactured Homes**: Manufactured or mobile homes should be elevated above the base flood elevation and anchored, or more preferably, kept out of the floodplain.
- **Back-up Generators**: A community may consider back-up generators for pumping and lift stations in sanitary sewer systems, along with other measures (e.g., alarms, meters, remote controls, and switchgear upgrades).
- **Basement Backflow Prevention**: Depending on its infrastructure capabilities, a community may encourage the use of check valves, sump pumps, and backflow prevention devices in homes and buildings.

Earthquakes

- Local mapping of fault zones and liquefaction areas as a part of larger all-hazards mapping efforts.
- Local retrofit programs that use best engineering standards for structures located in seismic zones.
- Recognize the potential of earthquake-induced landslides in land-use and development plans.
- Require that local plans and codes in seismically-active areas include identification of fault zones, fault setbacks and seismic construction standards that are specific to the seismic risks faced (e.g. liquefaction vs. bedrock movement.)
- Seek grant funding and tax incentives to encourage the appropriate buy-out or retrofit of unprotected structures in seismically-active areas.
- Improve the structural integrity of essential facilities [Identify the facility]
- **School Survey Procedures**: Schools are critical facilities not only because of the special population they accommodate, but also because they are often identified as shelter sites for a community. Due to this sheltering role, it is essential that these buildings function after a seismic event. A community can develop a survey procedure and guidance document to inventory structural and non-structural hazards in and near school buildings. Survey results can be used to determine mitigation priorities that can be incorporated into capital improvement plans.
- **Buildings as Structural Hazards**: Homeowners and businesses can take simple measures to strengthen their buildings before the next earthquake. Bracing walls and bolting sill plates to the foundation are examples. Non-reinforced masonry buildings and non-ductile concrete facilities are particularly vulnerable to ground shaking. These buildings should be strengthened and retrofitted against future seismic events.
- **Non-Structural Hazards**: Many injuries in earthquakes are caused by nonstructural hazards, such as attachments to buildings. These include lighting fixtures, windows (glass), pictures, tall bookcases, computers, ornamental decorations on the outside of the buildings (like parapets), gas lines, etc. Activities that can reduce the risk of injury and damage include: anchoring tall bookcases and file cabinets, installing latches on drawers and cabinet doors, restraining desktop computers and appliances, using flexible connections on gas and water lines, mounting framed pictures and mirrors securely, and anchoring and bracing propane tanks and gas cylinders.

- **Bridge Strengthening**: State and local highway departments should review construction plans for all bridges to determine their susceptibility to collapse. Problem bridges should be retrofitted.

Landslide/Avalanches

- Local mapping of landslide prone areas.
- Develop building codes for landslide prone areas, including for public and private infrastructure and building foundations.
- Support policies that protect steep slopes, preferably through natural means such as tree planting and conservation.
- **Grading Ordinances**: Grading ordinances require developers and landowners to obtain permits prior to filling or regrading. Such ordinances may also provide specific design standards.
- **Hillside Development Ordinances**: Hillside development ordinances are special purpose ordinances that set specific standards for construction on hillsides.
- **Restraining Structures**: Restraining structures may be designed and used to hold soil in place.
- **Vegetation Placement and Management Plans**: Various types of vegetation increase soil stability through root length and strength and by absorbing precipitation. Management plans are aimed at ensuring long-term maintenance of vegetation appropriate for an area.

Wildfires

- Continue to develop and require standards for homes and other structures in the wildland-urban interface—that emphasizes fire-safe construction.
- Recognize the importance and value of vegetation management ("defensible space") in the wildland-urban interface in rural and urbanizing areas and encourage the development of incentives for creating and maintaining defensible spaces around at-risk structures, such as using the Firewise Communities program.
- Require that planning include multiple and adequate ingress and egress routes to vulnerable areas.
- Increase the number of Fire Wise Communities in the County/Community.
- Conduct forest mitigation procedures to reduce the amount of fuel loading especially in areas that have a high residential population.
- Improve rural roads to ensure that emergency vehicles can provide a quick response to keep Wildland Fires small.
- Roads and driveways should be kept accessible to emergency vehicles and fire equipment. Driveways should be relatively straight and flat, with at least some open spaces to turn. Bridges should be strong enough to support emergency vehicles, with clearance wide and high enough for two-way traffic and emergency vehicle access. Addresses should be visible from the road, and keys to gates around property should be provided to the local fire department.
- **Spotters**: Early detection of wildfires, while fires are smaller, can help make firefighting more successful. Detection can be accomplished by fire spotters who work from either towers or planes.

- Establish a large-scale evacuation plan of the wildland urban interface (WUI) including a mass sheltering plan for such an incident.
- Provide for public education forums to teach residents how to build “eye-pleasing” defensible space into their property.
- Conduct an analysis identifying areas in the county/community that may benefit from the installation of cisterns or hydrants to provide water delivery during firefighting operations.

Power Failure

Public utilities are critical infrastructure for any community. The potential for failure needs to be reviewed, and inadequacies need to be addressed.

- **Obtain Generators for Critical Infrastructure**: A community may consider burying electric and telephone lines, where possible, to resist damage from severe winds, lightning, ice, and other hazards.
- **System Redundancies**: One place where redundancies are recommended is in utility and communications systems, especially lifeline systems, e.g., essential public utilities. The intention is that if one system fails, the other shadow system can take over.
- **Lightning Protection**: Electrical and communications systems should be protected from lightning strikes.
- **Tree Trimming**: Tree trimming and maintenance is important for preventing limb breakage and for safeguarding nearby utility lines. A model measure would be to establish a community forestry program with a main goal of creating and maintaining a disaster-resistant landscape in public right-of-ways.
- **Digging Hotlines**: Most, if not all, states have a utility damage prevention hotline that people can call before digging.
- **Vulnerable Populations**: Communities can develop programs/networks for contacting and assisting elderly or homebound persons during periods of infrastructure failure.

APPENDIX C. PUBLIC PARTICIPATION DOCUMENTATION & FEEDBACK

Public Forums

October 23, 2017 Public Meeting

FRANKLIN COUNTY

Emergency Management
and Homeland Security

OHIO

Hazard Mitigation Plan Update 2018

Franklin County, Ohio

Hazard Mitigation Plan

Public Meeting Agenda

Monday, October 23, from 6 pm - 8 pm

Farmington Hills Fire Station 5, 21455 W. 11 Mile Road, Farmington Hills, MI 48336

Introductions

Overview of Mitigation: Why Mitigate?

Mitigation Planning Process

Mitigation Plan Elements

Project Schedule

Franklin County Knowledge Management System

April 26, 2018 Public Meeting

NEWS RELEASE

PUBLIC MEETING TO DISCUSS POTENTIAL DISASTERS THAT COULD IMPACT THE COUNTY

April 4, 2018, Columbus, Ohio – Franklin County Emergency Management and Homeland Security will be hosting a public information and planning session to gather input from Franklin County residents regarding potential emergencies and disasters that could impact the County. Residents will also have an opportunity to review hazard mitigation projects that have been identified by their communities to minimize the impacts of these hazards. This session is part of the County's Natural Hazard Mitigation Plan, which is undergoing a mandatory 5-year update. The public meeting will be held on the following day and location:

- Thursday, April 26, 2018 at 6:00 p.m. to 8:00 p.m. at the Franklin County Emergency Management and Homeland Security building (5300 Strawberry Farms Blvd., Columbus, Ohio 43230)

"Franklin County is committed to ensuring the safety and well-being of its residents and the reduction of disaster-related damages from natural hazards," Jeff Young, Franklin County Emergency Management & Homeland Security Director said. "The public's participation will assist our emergency planners identify which hazards are of most concern to our residents and businesses. The public meeting will also help us identify and prioritize the services, disaster-related projects, and capabilities the community may need during an emergency."

The meeting will provide the public an opportunity to review the potential hazards that could occur within the County and will request input for the various mitigation measures intended to eliminate or reduce the negative impact of those hazards.

The U.S. Federal government requires local and state governments to have a FEMA-Approved Multi-Hazard Mitigation Plan as established by the Disaster Mitigation Act of 2000 in order to qualify for Pre-Disaster Mitigation (PDM) and Hazard Mitigation Grant Program (HMGP) project grant dollars. These programs are critical sources of Federal funding, especially for a community that wants to proactively initiate mitigation projects using PDM dollars, or for a community that needs HMGP funding following a presidentially declared disaster.

For more information about this plan and meeting, please contact Franklin County Emergency Management and Homeland Security at aljarvi@franklincountyohio.gov or call (614) 724-0805.

- NEXT PAGE -

About Franklin County Emergency Management and Homeland Security

Franklin County Emergency Management and Homeland Security is dedicated to supporting Franklin County cities, villages, and townships through a coordination of effort for logistical support during emergency operations by enhancing all-hazard preparedness along with comprehensive homeland security initiatives and first responder training. Franklin County Emergency Management and Homeland Security develops and coordinates programs for natural, technological, national security, and nuclear/chemical/biological emergencies/disasters affecting Franklin County. For more information, go to http://www.fcemhs.com.

For media inquiries only, please contact XXXX.

- ### -

Franklin County EMHS | 5300 Strawberry Farms Blvd | Columbus, OH 43230 | Phone (614) 794-0213 | fcemhs.com

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www-LegalNotices::	Legals-CD - Legals 3V Public Notice-Legals-21200 Public Notices	ARE YOU READY FOR THE NEXT DISASTER? YOU ARE INVITED TO ATTEND A PUBLIC MEETING TO INFORM RESIDENTS ABOUT POTENTIAL DISASTERS THAT COULD IMPACT YOUR COMMUNITY	4/20/2018

WYSIWYG Content Follows:

ARE YOU READY FOR THE NEXT DISASTER?
YOU ARE INVITED TO ATTEND A PUBLIC MEETING TO INFORM RESIDENTS ABOUT POTENTIAL DISASTERS THAT COULD IMPACT YOUR COMMUNITY

Franklin County Emergency Management and Homeland Security will be hosting a public information and planning session to gather input from Franklin County residents regarding potential emergencies and disasters that could impact the County. This session is part of the County's Natural Hazard Mitigation Plan, which is undergoing a mandatory 5-year update. The public meeting will be held on the following day and location:

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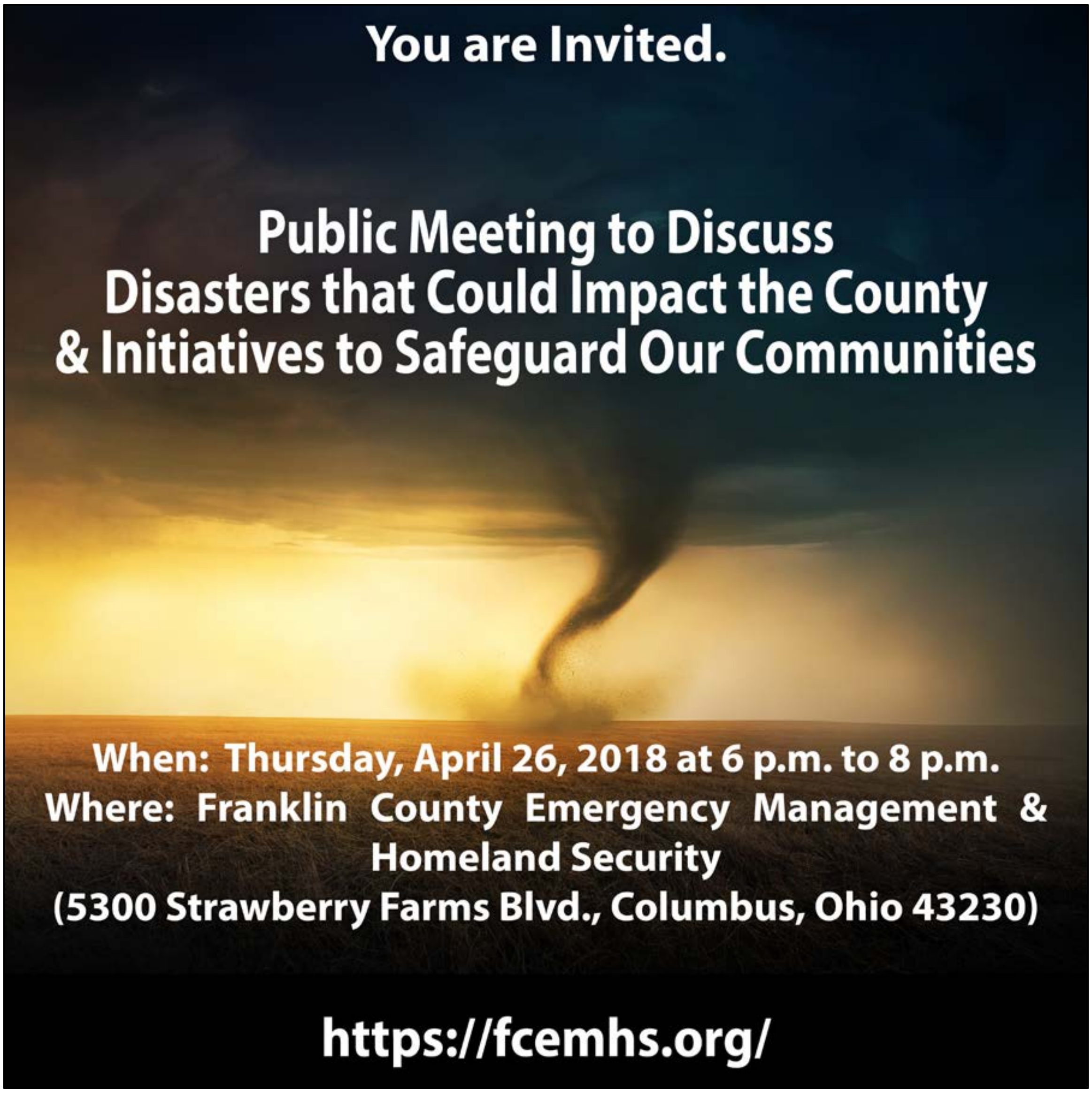
The meeting will provide the public an opportunity to review the potential hazards that could occur within the County and will request input for the various mitigation measures intended to eliminate or reduce the negative impact of those hazards.

4/20


You are Invited.
Public Meeting to Discuss
Disasters that Could Impact the County
& Initiatives to Safeguard Our Communities
When: Thursday, April 26, 2018 at 6 p.m. to 8 p.m.
Where: Franklin County Emergency Management & Homeland Security
(5300 Strawberry Farms Blvd., Columbus, Ohio 43230)
https://fcemhs.org/

Franklin County Emergency Management and Homeland Security

Natural Hazard Mitigation Plan Update 2018

Franklin County, Ohio

Mitigation Meeting

Public Meeting

Thursday, April 26, 2018 at 6:00 p.m. to 8:00 p.m.
Franklin County Emergency Management and Homeland Security building
(5300 Strawberry Farms Blvd., Columbus, Ohio 43230)

Introductions

What is Mitigation?

Questionnaire Findings

Risk Summary

Hazard Summary Worksheet/Hazard Concerns

Identify New Mitigation Opportunities


PREPARING FOR DISASTER


WHY MITIGATE?
NEW AT 11
PREPARING FOR NATURAL DISASTERS
FRANKLIN COUNTY EMA MEETS

- *SIGN-IN SHEET:* Hazard Mitigation Plan Update -

Hazard Mitigation Plan Update: Public Meeting

Franklin County, Ohio

Date: 4/26/2018

Time: 1800 - 2000

Hazard Mitigation Plan: Public Meeting

Name	Address or Jurisdiction	Phone	E-mail
Sabeen Shamsi	ISC Consultant	630-801-0116	sabeen.shamsi@i-s-consulting.com
Daiko Abe	ISC Consultant	208-390-2021	daiko.abe@i-s-consulting.com
Andrew Jarvi	Franklin County	614-205-4170	aljarvi@franklincountyohio.gov
Li Cheng	Franklin County	614 932-2288	li_rose_cheng@yahoo.com
Jeremy Hamilton	7440 Pinsue Dr. Columbus/OH	(614) 704-8700	JHAMILTON@Servproofnecolumbus.com
Kristie Speaks	3135 Westmills Dr CBus	614-325-4356	Kristie_mae@Yahoo.com
Kim [illegible]	591 E Beaumont Rd	614-261-8248	FRITZGRP@AOL.COM
Kim Evans	5017 Big Run South Rd GC	614 570 7095	Onebiglandmark@gmail.com

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- *SIGN-IN SHEET:* Hazard Mitigation Plan Update -

Hazard Mitigation Plan Update: Public Meeting

Franklin County, Ohio

Date: 4/26/2018

Time: 1800 - 2000

Hazard Mitigation Plan: Public Meeting

Name	Address or Jurisdiction	Phone	E-mail
OLIVIA CALDEIRA	510 E. N. BROADWAY	575-8055	caldeira.cde@gmail.com
Ben Bloom	5145 Autumn Fern DRIVE	614-529-1993	histsports@aol.com
Ed Warner	9384 Mahogany Ln Orient 43146	614 563 1028	EJWARNERIII@AOL.com

1

Public Feedback from Public Forum on 4/26/2018

Jurisdiction-Specific Hazard Concerns

Franklin County, OH Hazards

Name: FOR OFFICIAL USE ONLY ; E-mail: FOR OFFICIAL USE ONLY ;

Jurisdiction/Organization/Agency: Pleasent Twp/Grove City / CERT

Natural Hazards	
Hazards	Please describe any specific and/or unique **concerns/risks** that this hazard poses to your jurisdiction and/or organization. For example, are there properties that are at risk of **repetitive damages** from this hazard? Are certain population groups in your jurisdictions more vulnerable to this hazard? Are there specific neighborhoods or areas in your community that are more at risk from one of these hazards?
Dam/Levee Failure	no Dams or levees in my area
Drought	~~Very~~ Many Dirt farms that will loose crops. Close to neighborhoods with lakes possible mosquito/Disease etc
Earthquake	Buildings in OH aren't Built to withstand earthquakes
Extreme Cold	
Extreme Heat	Crop Distruction
Flood (Riverine)	no rivers Streams
Flood (Urban/Flash Flooding)	mostly Fields Neff Road Between Betty and Grove City Rd Floods Frequently But its a small country Rd

Jurisdiction-Specific Hazard Concerns

Landslide	None flat
Severe Summer Weather (Thunderstorm, Lightning, Wind, Hail)	
Severe Winter Weather/Heavy Snowfall/Ice Storm	Overhed power lines
Sinkhole	
Tornado	
Wildfire	Crops in the fall will catch more quickly

Name: FOR OFFICIAL

Organi: USE ONLY

E-mail:

Phone:

New Mitigation Action (Please Describe):

increase CERT funding to increase community Resilience and preparedness

Year Initiated	2018 (New Mitigation Action)
Applicable Jurisdiction	
Lead Agency/Organization	
Supporting Agencies/Organizations	
Potential Funding Source	
Estimated Cost	
Benefits (loss avoided)	
Projected Completion Date	
PRIORITY (High, Medium, Low)	

Please indicate if the mitigation goals and objectives below are applicable to the new mitigation action/project). Check All That Apply.

X	Place an "X" by the applicable goals
	Goal 1: Manage Development
	Goal 2: Maintain Public & Private Infrastructure
	Goal 3: Manage Debris Along Streams & Waterways
	Goal 4: Minimize Damage to Public & Private Property
	Goal 5: Minimize Loss of Life from Severe Weather Hazards
	Goal 6: Reduce the Number of Repetitively Damaged Existing Structures

Handout: New Mitigation Actions (Franklin County)

FOR OFFICIAL USE ONLY

Name:

Organiza

E-mail:

Phone:

New Mitigation Action (Please Describe): More information ~~[illegible]~~ that could be in multiple formats and easy to read for people with disabilities. DODD has a section on Health + Wellness, but it would be great if eaz-e-read guides were readily available + distributed to all organizations that support people with disabilities.

Year Initiated	**2018 (New Mitigation Action)**
Applicable Jurisdiction	
Lead Agency/Organization	
Supporting Agencies/Organizations	
Potential Funding Source	
Estimated Cost	
Benefits (loss avoided)	
Projected Completion Date	
PRIORITY (High, Medium, Low)	

Please indicate if the mitigation goals and objectives below are applicable to the new mitigation action/project). Check All That Apply.

X	Place an "X" by the applicable goals
	Goal 1: Manage Development
X	**Goal 2: Maintain Public & Private Infrastructure**
	Goal 3: Manage Debris Along Streams & Waterways
	Goal 4: Minimize Damage to Public & Private Property
X	**Goal 5: Minimize Loss of Life from Severe Weather Hazards**
	Goal 6: Reduce the Number of Repetitively Damaged Existing Structures

Is there a way to also make this information more readily available to more vulnerable people in economically-depressed areas? Many people with disabilities in more middle-class families + neighborhoods have natural supports, but those who rely completely on outside agency support are at increased risk of being isolated and not able to get help.

This mitigation action:
Instructions: Circle the best option

Multiple formats of hazard response, safety plans, etc. for people w/ disabilities	Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)
Technical Feasibility: This mitigation action/project is technically feasible and offers a long-term solution to the problem being mitigated.	1	2	3	4	5
Cost Effectiveness: This mitigation action/project is cost effective and that funding can be easily allocated to implement this action/project	1	2	3	4	5
Ability to Accomplish/Implement and Sustain: This mitigation action/project is more likely to be implemented and sustained. This action/project is not in conflict with any existing or potential legal issues and does not pose a negative impact on the environment.	1	2	3	4	5
Protection of Critical Resources and Assets: This mitigation action/project is likely to protect critical infrastructure, key resources, and building stock.	1	2	? 3	4	5
Community and Political Acceptance/Support: This mitigation action/project is more likely to gain community and social acceptance. This action is more likely to garner political support.	1	2	3	4	5

Place an "X" by the hazard(s) this action/project will mitigate:

Mitigated Hazard	
X	Place an "X" by the applicable hazard
X	Dam/Levee Failure
X	Drought
X	Earthquake
X	Extreme Cold
X	Extreme Heat
X	Flood (Riverine)
X	Flood (Urban/Flash Flooding)
X	Landslide
X	Severe Thunderstorm
X	Severe Winter Weather/Heavy Snowfall/Ice Storm
X	Sinkhole
X	Tornado
X	Wildfire

Jurisdiction-Specific Hazard Concerns

Franklin County, OH Hazards

FOR OFFICIAL USE ONLY

Name:

Jur

Natural Hazards	
Hazards	Please describe any specific and/or unique **concerns/risks** that this hazard poses to your jurisdiction and/or organization. For example, are there properties that are at risk of **repetitive damages** from this hazard? Are certain population groups in your jurisdictions more vulnerable to this hazard? Are there specific neighborhoods or areas in your community that are more at risk from one of these hazards?
Dam/Levee Failure	
Drought	
Earthquake	
Extreme Cold	Many people with intellectual and developmental disabilities (IDD) do not understand how dangerous extreme temperatures can be, ~~[illegible]~~ may not feel certain things (can have nerve issues) and/or may not be able to communicate their needs. Things we
Extreme Heat	often take for granted are not always considered, so extra / less clothing, water, finding shelter, etc. all need to be very clearly available + accessible.
Flood (Riverine)	
Flood (Urban/Flash Flooding)	

learn how to communicate better ~~for~~ with people with IDD.

Jurisdiction-Specific Hazard Concerns

Landslide	
Severe Summer Weather (Thunderstorm, Lightning, Wind, Hail)	
Severe Winter Weather/Heavy Snowfall/Ice Storm	mobility issues are compounded when there's snow + ice. it can be difficult to use a wheelchair on sidewalks, going uphill, and using assistive equipment when there's ice, precipitation, extreme cold, etc.
Sinkhole	
Tornado	
Wildfire	

My biggest concerns as a disability non-profit ~~is~~ are language + accessibility of information. Making these hazards + subsequent disaster plans as part of Individualized Service Plans for people w/ IDD. Oftentimes they are covered briefly, but people w/ IDD need very clear + specific steps for the different hazards. Many people are not able to live independently + rely on support professionals + agency + providers. My concern is that these hazards can disrupt the professionals from going to work + so there would need to be contingency plans very clearly laid out for the different hazards. It would be really beneficial to survey multiple groups of people with many different types of disabilities. Also, more training for EMS, LEOs, + disaster support organizations so they →

Jurisdiction-Specific Hazard Concerns

Franklin County, OH Hazards

Name:_ **FOR OFFICIAL USE ONLY**

Juri

Natural Hazards	
Hazards	Please describe any specific and/or unique **concerns/risks** that this hazard poses to your jurisdiction and/or organization. For example, are there properties that are at risk of **repetitive damages** from this hazard? Are certain population groups in your jurisdictions more vulnerable to this hazard? Are there specific neighborhoods or areas in your community that are more at risk from one of these hazards?
Dam/Levee Failure	
Drought	
Earthquake	
Extreme Cold	
Extreme Heat	
Flood (Riverine)	
Flood (Urban/Flash Flooding)	WE HAVE A. PROBLEM WITH BLOCKED STORM SEWER DRAINS IN THE FALL & WINTER, OFTEN CAUSING SEVERAL FEET OF WATER BEYOND STREE LEVEL HAgue@ Westmills

Page **1** of **2**

Jurisdiction-Specific Hazard Concerns

Landslide	
Severe Summer Weather (Thunderstorm, Lightning, Wind, Hail)	I FEEL LIKE THERE IS A LACK OF WARNING FOR NON-TORNADO, NON-THUNDERSTORM WIND EVENTS. IE USE SIRENS FOR DERECHO TYPE EVENTS
Severe Winter Weather/Heavy Snowfall/Ice Storm	
Sinkhole	
Tornado	
Wildfire	

Name:
Organi:
E-mail:
Phone:

FOR OFFICIAL USE ONLY

New Mitigation Action (Please Describe):

Call ServPro before the damages worsen. We will perform mitigation to minimize the cost of the repair and recovery. Please call or email with any questions

Year Initiated	**2018 (New Mitigation Action)**
Applicable Jurisdiction	
Lead Agency/Organization	
Supporting Agencies/Organizations	
Potential Funding Source	
Estimated Cost	
Benefits (loss avoided)	
Projected Completion Date	
PRIORITY (High, Medium, Low)	

Please indicate if the mitigation goals and objectives below are applicable to the new mitigation action/project). Check All That Apply.

X	Place an "X" by the applicable goals
	Goal 1: Manage Development
	Goal 2: Maintain Public & Private Infrastructure
	Goal 3: Manage Debris Along Streams & Waterways
X	**Goal 4: Minimize Damage to Public & Private Property**
	Goal 5: Minimize Loss of Life from Severe Weather Hazards
	Goal 6: Reduce the Number of Repetitively Damaged Existing Structures

- Very interested in how we can become a preferred vendor for losses.
- Our services are ~~[illegible]~~ much cheaper than reconstruction
- we would like to be contacted so that we can give a full presentation of our services.

Thank You

Name:
Organiza
E-mail:
Phone:

FOR OFFICIAL USE ONLY

New Mitigation Action (Please Describe): (Not started, But Needed)
7788 Scioto Crossing Blvd, Dublin, OH 43016
power transformer is less than 3 feet to home,
needs to be moved away.

Year Initiated	**2018 (New Mitigation Action)** Not Started
Applicable Jurisdiction	Dublin, OH 43016
Lead Agency/Organization	
Supporting Agencies/Organizations	
Potential Funding Source	
Estimated Cost	$8,000
Benefits (loss avoided)	
Projected Completion Date	
PRIORITY (High, Medium, Low)	

Please indicate if the mitigation goals and objectives below are applicable to the new mitigation action/project). Check All That Apply.

X	Place an "X" by the applicable goals
	Goal 1: Manage Development
	Goal 2: Maintain Public & Private Infrastructure
	Goal 3: Manage Debris Along Streams & Waterways
	Goal 4: Minimize Damage to Public & Private Property
	Goal 5: Minimize Loss of Life from Severe Weather Hazards
	Goal 6: Reduce the Number of Repetitively Damaged Existing Structures

This mitigation action:

Instructions: Circle the best option

	Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)
<u>Technical Feasibility</u>: This mitigation action/project is technically feasible and offers a long-term solution to the problem being mitigated.	1	2	3	4	5
<u>Cost Effectiveness</u>: This mitigation action/project is cost effective and that funding can be easily allocated to implement this action/project	1	2	3	4	5
<u>Ability to Accomplish/Implement and Sustain</u>: This mitigation action/project is more likely to be implemented and sustained. This action/project is not in conflict with any existing or potential legal issues and does not pose a negative impact on the environment.	1	2	3	4	5
<u>Protection of Critical Resources and Assets</u>: This mitigation action/project is likely to protect critical infrastructure, key resources, and building stock.	1	2	3	4	5
<u>Community and Political Acceptance/Support</u>: This mitigation action/project is more likely to gain community and social acceptance. This action is more likely to garner political support.	1	2	3	4	5

Place an "X" by the hazard(s) this action/project will mitigate:

	Mitigated Hazard
X	Place an "X" by the applicable hazard
	Dam/Levee Failure
	Drought
	Earthquake
	Extreme Cold
	Extreme Heat
	Flood (Riverine)
	Flood (Urban/Flash Flooding)
	Landslide
	Severe Thunderstorm
	Severe Winter Weather/Heavy Snowfall/Ice Storm
	Sinkhole
	Tornado
	Wildfire

EMF

Name:
Organizat
E-mail:
Phone:

FOR OFFICIAL USE ONLY

New Mitigation Action (Please Describe):

Scioto Crossing III community in Dublin roadways need to ~~bea~~ looked at, flood every time there is a heavy rain.

Year Initiated	**2018 (New Mitigation Action)**
Applicable Jurisdiction	
Lead Agency/Organization	
Supporting Agencies/Organizations	
Potential Funding Source	
Estimated Cost	
Benefits (loss avoided)	
Projected Completion Date	
PRIORITY (High, Medium, Low)	

Please indicate if the mitigation goals and objectives below are applicable to the new mitigation action/project). Check All That Apply.

X	Place an "X" by the applicable goals
	Goal 1: Manage Development
	Goal 2: Maintain Public & Private Infrastructure
	Goal 3: Manage Debris Along Streams & Waterways
	Goal 4: Minimize Damage to Public & Private Property
	Goal 5: Minimize Loss of Life from Severe Weather Hazards
	Goal 6: Reduce the Number of Repetitively Damaged Existing Structures

This mitigation action:
Instructions: Circle the best option

	Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)
Technical Feasibility: This mitigation action/project is technically feasible and offers a long-term solution to the problem being mitigated.	1	2	3	4	5
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Protection of Critical Resources and Assets: This mitigation action/project is likely to protect critical infrastructure, key resources, and building stock.	1	2	3	4	5
Community and Political Acceptance/Support: This mitigation action/project is more likely to gain community and social acceptance. This action is more likely to garner political support.	1	2	3	4	5

Place an "X" by the hazard(s) this action/project will mitigate:

	Mitigated Hazard
X	Place an "X" by the applicable hazard
	Dam/Levee Failure
	Drought
	Earthquake
	Extreme Cold
	Extreme Heat
	Flood (Riverine)
X	Flood (Urban/Flash Flooding)
	Landslide
	Severe Thunderstorm
	Severe Winter Weather/Heavy Snowfall/Ice Storm
	Sinkhole
	Tornado
	Wildfire

Jurisdiction-Specific Hazard Concerns

Franklin County, OH Hazards

FOR OFFICIAL USE ONLY

Name:_

Juris

Natural Hazards	
Hazards	Please describe any specific and/or unique **concerns/risks** that this hazard poses to your jurisdiction and/or organization. For example, are there properties that are at risk of **repetitive damages** from this hazard? Are certain population groups in your jurisdictions more vulnerable to this hazard? Are there specific neighborhoods or areas in your community that are more at risk from one of these hazards?
Dam/Levee Failure 防洪堤	
Drought	
Earthquake	
Extreme Cold	
Extreme Heat	
Flood (Riverine)	
Flood (Urban/Flash Flooding)	Scioto Crossing Blvd, street Flooding in the community everytime there is heavy rain. Not enough storm drain or improperly design

Page **1** of **2**

Jurisdiction-Specific Hazard Concerns

Franklin County, OH Hazards

Name:______________________; E-mail: ________________________;

Jurisdiction/Organization/Agency: ________________________

Natural Hazards	
Hazards	Please describe any specific and/or unique **concerns/risks** that this hazard poses to your jurisdiction and/or organization. For example, are there properties that are at risk of **repetitive damages** from this hazard? Are certain population groups in your jurisdictions more vulnerable to this hazard? Are there specific neighborhoods or areas in your community that are more at risk from one of these hazards?
Dam/Levee Failure	Griggs, down stream from Hoover. I believe that the public has little to no info on this hazard and that local govt is not thinking about this too much. Little to no time to react for public.
Drought	
Earthquake	
Extreme Cold	warming centers. data base of special needs and high risk individuals
Extreme Heat	cooling centers. database of special needs and high risk individuals
Flood (Riverine)	
Flood (Urban/Flash Flooding)	

Jurisdiction-Specific Hazard Concerns

Landslide	
Severe Summer Weather (Thunderstorm, Lightning, Wind, Hail)	main risk is destruction of infrastructure; specifically electrical
Severe Winter Weather/Heavy Snowfall/Ice Storm	main risk is destruction of infrastructure; specifically electrical.
Sinkhole	
Tornado	destruction of infrastructure, need for specialty rescue and operations teams and heavy equipment.
Wildfire	

Additional Public Outreach Efforts

NEWS RELEASE

Residents invited to take emergency preparedness survey

October 10, 2017, Columbus, Ohio – Franklin County residents and businesses can help Franklin County Emergency Management & Homeland Security (FCEM&HS) update the Franklin County Hazard Mitigation Plan. Hazard mitigation is the process of reducing the impact of a hazard, such as improving drainage in an area prone to flooding. The plan outlines the hazard mitigation actions the County intends to take over the next five years.

Residents and businesses are invited to participate by completing the online survey below. The survey takes only 10 minutes and all responses will be kept confidential. The survey gives residents an opportunity to voice their concerns, let FCEM&HS know what hazards they are most concerned about, and identify services the community may need during an emergency. Feedback from the survey will enable FCEM&HS to better serve residents and businesses before, during and after an emergency or disaster.

To fill out the survey, go to http://franklin.hmp.sgizmo.com/s3. The survey will remain open until November 30, 2017. For a hard copy version of the survey, please contact Franklin County Emergency Management and Homeland Security at 614-794-0213. Businesses that are interested in having their employees confidentially participate in the survey in order to utilize the data to update their business emergency preparedness plans may contact Franklin County Emergency Management and Homeland Security to make those arrangements.

For more information, please contact Jamie Stout, FCEM&HS Planning & Recovery Manager at jlstout@franklincountyohio.gov or call 614-794-0213.

Franklin County adheres to federal requirements to update its emergency preparedness plans in an effort to keep residents, businesses, and organizations well prepared and vigilant. The purpose of emergency preparedness planning is to identify policies and actions that can be implemented over the long term to reduce risk and future losses.

About Franklin County Emergency Management and Homeland Security

Franklin County Emergency Management and Homeland Security is dedicated to supporting Franklin County cities, villages, and townships through a coordination of effort for logistical support during emergency operations by enhancing all-hazard preparedness along with comprehensive homeland security initiatives and first responder training. Franklin County Emergency Management and Homeland Security develops and coordinates programs for natural, technological, national security, and nuclear/chemical/biological emergencies/disasters affecting Franklin County. For more information, go to http://www.fcemhs.com.

###

Franklin County EMHS | 5300 Strawberry Farms Blvd | Columbus, OH 43230 | Phone (614) 794-0213 | fcemhs.com

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Franklin County Emergency Management and Homeland Security

October 25, 2017 ·

Have you taken our online Emergency Preparedness survey yet? Help Franklin County be better prepared for disasters!
prepare.community/franklincounty

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October 19, 2017
Franklin County residents and businesses can help Franklin County Emergency Management & Homeland Security (FCEM&HS) update the the Franklin County Hazard Mitigation Plan. Hazard mitigation is the process of reducing the impact of a hazard, such as improving drainage in an area prone to flooding. The plan outlines the hazard mitigation actions the County intends to take over the next five years.
Residents and businesses are invited to participate by completing the online su... See More
2017 Franklin County Hazard Mitigation Questionnaire
2017 Franklin County Hazard Mitigation Questionnaire.
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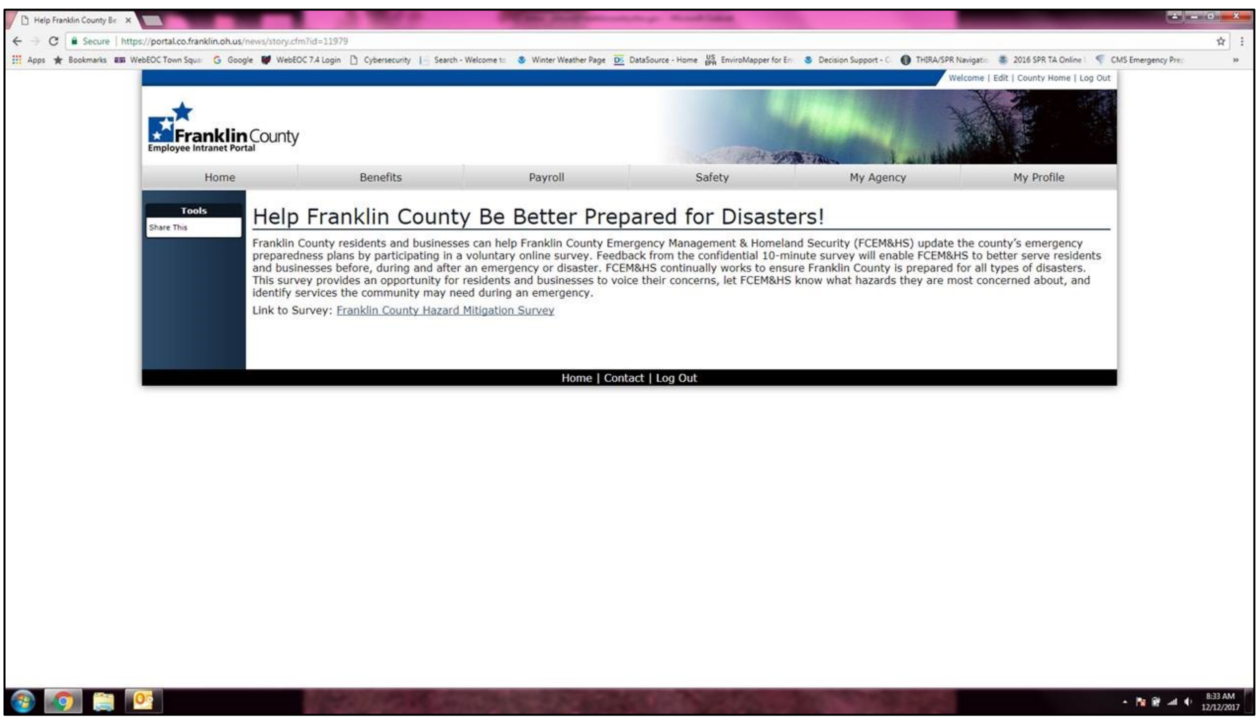

Franklin County
Employee Intranet Portal
Home
Benefits
Payroll
Safety
My Agency
My Profile
Tools
Share This
Help Franklin County Be Better Prepared for Disasters!
Franklin County residents and businesses can help Franklin County Emergency Management & Homeland Security (FCEM&HS) update the county's emergency preparedness plans by participating in a voluntary online survey. Feedback from the confidential 10-minute survey will enable FCEM&HS to better serve residents and businesses before, during and after an emergency or disaster. FCEM&HS continually works to ensure Franklin County is prepared for all types of disasters. This survey provides an opportunity for residents and businesses to voice their concerns, let FCEM&HS know what hazards they are most concerned about, and identify services the community may need during an emergency.
Link to Survey: Franklin County Hazard Mitigation Survey
Home | Contact | Log Out

Dublin Ohio @DublinOhio · 18h

Help our friends at @FCEMHS make the community safer and more prepared by taking this 5-minute survey! #SaferTogether franklin.prepare.sgizmo.com/s3

> **Franklin County Emergency Management** @FCEMHS
> Franklin County Emergency Preparedness Survey
> nextdoor.com/city/post/7156... via @nextdoor

City of Dublin, Ohio - Government
13 hrs ·

Help our friends at Franklin County Emergency Management and Homeland Security make the community safer and better prepared by taking this 5-minute survey! The questionnaire is open until November 30, 2017. #SaferTogether

> **2017 Franklin County Hazard Mitigation Questionnaire**
> 2017 Franklin County Hazard Mitigation Questionnaire.
> FRANKLIN.PREPARE.SGIZMO.COM

Public Review of Plan

NEWS RELEASE

PUBLIC INVITED TO REVIEW AND COMMENT ON COUNTY'S NATURAL HAZARD MITIGATION PLAN

Columbus, Ohio – Franklin County residents and businesses are invited to review and comment on the County's Natural Hazard Mitigation Plan. The plan can be accessed at https://fcemhs.org/Planning/Natural-Hazards-Mitigation.

Comments and questions about the plan can be sent to Franklin County Emergency Management & Homeland Security by e-mail at aljarvi@franklincountyohio.gov or phone (614) 724-0805.

Franklin County adheres to federal requirements to update its natural hazard mitigation plan every five years in an effort to keep residents, businesses, and organizations well prepared and vigilant. The purpose of mitigation planning is to identify policies and actions that can be implemented over the long term to reduce risk and future losses. This planning effort represents the dedicated participation of the County and all municipalities within Franklin County.

The U.S. Federal government requires local and state governments to have a FEMA-Approved Multi-Hazard Mitigation Plan as established by the Disaster Mitigation Act of 2000 in order to qualify for Pre-Disaster Mitigation (PDM) and Hazard Mitigation Grant Program (HMGP) project grant dollars. These programs are critical sources of Federal funding, especially for a community that wants to proactively initiate mitigation projects using PDM dollars, or for a community that needs HMGP funding following a presidentially declared disaster.

For more information about this plan, please contact Franklin County Emergency Management and Homeland Security at aljarvi@franklincountyohio.gov or call (614) 724-0805.

About Franklin County Emergency Management and Homeland Security

Franklin County Emergency Management and Homeland Security is dedicated to supporting Franklin County cities, villages, and townships through a coordination of effort for logistical support during emergency operations by enhancing all-hazard preparedness along with comprehensive homeland security initiatives and first responder training. Franklin County Emergency Management and Homeland Security develops and coordinates programs for natural, technological, national security, and nuclear/chemical/biological emergencies/disasters affecting Franklin County. For more information, go to http://www.fcemhs.com.

For media inquiries only, please contact XXXX.

- ### -

Franklin County EMHS | 5300 Strawberry Farms Blvd | Columbus, OH 43230 | Phone (614) 794-0213 | fcemhs.com

APPENDIX D. COMMUNITY PREPAREDNESS SURVEY

Franklin County Hazard Mitigation Questionnaire **2017**

To Whom It May Concern:

Franklin County is conducting a study to better understand the preparedness needs and risk perceptions of its residents as part of the County's Hazard Mitigation Plan update process. To do so, a questionnaire has been distributed throughout the county, and you have been selected to participate. Your feedback is greatly needed and appreciated! The questionnaire should only take about 10 minutes to complete. All responses will be kept confidential, and your participation is strictly voluntary. Your input will enable the County to better serve you.

DEADLINE
Please complete the survey by November 15, 2017. Thank you for your participation.

If you have any questions, please contact:
Jamie Stout
Franklin County Emergency Management & Homeland Security
5300 Strawberry Farms Blvd. Columbus, OH 43230
Phone: 614-794-0213
E-mail: jlstout@franklincountyohio.gov

DEFINITIONS
Hazard Mitigation: The purpose of hazard mitigation planning is to identify policies and actions that can be implemented over the long term to reduce risk and future losses. Mitigation forms the foundation for a community's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction, and repeated damage.

1 **Do you live and/or work in Franklin County? Please select the best answer that applies to your current situation.**

( ) Yes, I live in Franklin County
( ) Yes, I live and work in Franklin County
( ) Yes, I live in Franklin County, but work in another county
( ) Yes, I work in Franklin County, but live in another county
( ) No, I do not live or work in Franklin County
( ) Not Applicable
( ) Do Not Know
( ) Other: ____________________

2 **Approximately how many years have you <u>lived</u> in Franklin County?**

( ) 0-2 years
( ) 3-5 years
( ) 6-10 years
( ) 11-20 years
( ) 21 or more years
( ) Not Applicable
( ) Do Not Know

3 **Approximately how many years have you <u>worked</u> in Franklin County?**

( ) 0-2 years
( ) 3-5 years
( ) 6-10 years
( ) 11-20 years
( ) 21 or more years
( ) Not Applicable
( ) Do Not Know

4 **Please indicate which community in Franklin County you live in.**

( ) Bexley City
( ) Blendon Township
( ) Brice Village
( ) Brown Township
( ) Canal Winchester City
( ) Clinton Township
( ) Columbus City
( ) Dublin City
( ) Franklin Township
( ) Gahanna City
( ) Grandview Heights City
( ) Grove City
( ) Groveport City
( ) Hamilton Township
( ) Harrisburg Village
( ) Hilliard City
( ) Jackson Township
( ) Jefferson Township
( ) Lockbourne Village
( ) Madison Township
( ) Marble Cliff Village
( ) Mifflin Township
( ) Minerva Park Village
( ) New Albany City
( ) Norwich Township
( ) Obetz Village
( ) Perry Township
( ) Plain Township
( ) Pleasant Township
( ) Prairie Township
( ) Reynoldsburg City
( ) Riverlea Village
( ) Sharon Township
( ) Truro Township
( ) Upper Arlington City
( ) Urbancrest Village
( ) Valleyview Village
( ) Washington Township
( ) Westerville City
( ) Whitehall City
( ) Worthington City

5 **Please indicate which community in Franklin County you work in.**

( ) Bexley City
( ) Blendon Township
( ) Brice Village
( ) Brown Township
( ) Canal Winchester City
( ) Clinton Township
( ) Columbus City
( ) Dublin City
( ) Franklin Township
( ) Gahanna City
( ) Grandview Heights City
( ) Grove City
( ) Groveport City
( ) Hamilton Township
( ) Harrisburg Village
( ) Hilliard City
( ) Jackson Township
( ) Jefferson Township
( ) Lockbourne Village
( ) Madison Township
( ) Marble Cliff Village
( ) Mifflin Township
( ) Minerva Park Village
( ) New Albany City
( ) Norwich Township
( ) Obetz Village
( ) Perry Township
( ) Plain Township
( ) Pleasant Township
( ) Prairie Township
( ) Reynoldsburg City
( ) Riverlea Village
( ) Sharon Township
( ) Truro Township
( ) Upper Arlington City
( ) Urbancrest Village
( ) Valleyview Village
( ) Washington Township
( ) Westerville City
( ) Whitehall City
( ) Worthington City

6 **Please indicate what type of device(s) you use to access the internet. Select ALL that apply.**

[ ] Computer/laptop at home
[ ] Computer/laptop at work/office

[ ] iPad/tablet

[ ] Cell phone

[ ] Public computer (i.e. library)

[ ] I do not have access to the Internet

[ ] Do Not Know

[ ] Other:

7 **Please indicate those activities you have done to prepare for emergencies and disasters. Please select ALL that apply.**

I have…

[ ] an emergency preparedness plan

[ ] flood Insurance

[ ] 72 hour kit/Disaster supply kit

[ ] visited local government web site(s) for emergency preparedness information

[ ] an evacuation plan

[ ] a weather radio

[ ] signed up for ALERT Franklin County

[ ] Other (please specify):

8 **Please indicate where you go to obtain emergency and disaster related information? Please select ALL that apply.**

[ ] Your local government web sites (city, village, township)

[ ] County government web site

[ ] State government web sites

[ ] Federal government web sites (example: www.fema.gov)

[ ] Web search (example: bing.com, google.com)

[ ] Social media (example: facebook, twitter, google+, etc.)

[ ] Voluntary organizations (example: American Red Cross, Salvation Army, etc.)

[ ] Religious Organization

[ ] Local English-speaking television

[ ] Local English-speaking radio

[ ] Local Spanish-speaking radio

[ ] National News (Radio and Television)

[ ] Print Media - English (example: newspapers)

[ ] Brochures and Newsletters

[ ] Word of Mouth (example: friends, family, co-workers)

[ ] Do Not Know

[ ] Not Applicable

[ ] Other (please specify):

9 **Would you agree or disagree with the following statements?**

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Do Not Know
I feel prepared for a disaster.	( )	( )	( )	( )	( )	( )
I am familiar with Franklin County Emergency Management & Homeland Security's website and can easily obtain information about emergencies and disasters.	( )	( )	( )	( )	( )	( )
During times of emergency, information is provided in a language or format I can understand.	( )	( )	( )	( )	( )	( )
I can easily obtain emergency information in times of crisis.	( )	( )	( )	( )	( )	( )

10 **Please indicate how Franklin County Emergency Management & Homeland Security can better assist you in preparing for emergencies and disasters (example: provide preparedness materials in my language).**

____

11 **If a disaster (i.e. Tornado) impacted Franklin County, knocking out electricity and running water, would your household be able to manage on its own for at least three (3) days?**

( ) Yes
( ) No
( ) Maybe
( ) Do Not Know

12 **Do you believe that your household and/or place of business might ever be threatened by the following hazards? Please rate what hazards present the greatest risk.**

Low Risk = Low impact on threat to life and property damage

Medium Risk = Medium impact on threat to life and property damage
High Risk = High impact on threat to life and property damage

	Low Risk	Medium Risk	High Risk	Not Applicable
Tornadoes	( )	( )	( )	( )
Cyber Threat	( )	( )	( )	( )
Infectious Diseases (H1N1, Ebola…)	( )	( )	( )	( )
Flooding	( )	( )	( )	( )
Lone Wolf Terrorist Incident	( )	( )	( )	( )
Dam Failure	( )	( )	( )	( )
Utility/Energy Interruption or Failure	( )	( )	( )	( )
CBRNE Terrorist Incident (Chemical, Biological, Radiological, Nuclear, Explosive)	( )	( )	( )	( )
Severe Winter Weather	( )	( )	( )	( )
Hazardous Material Incidents	( )	( )	( )	( )
Civil Disturbance	( )	( )	( )	( )
Severe Summer Weather	( )	( )	( )	( )
Aircraft Accident-	( )	( )	( )	( )
Space Weather (Solar Flare)	( )	( )	( )	( )
Extreme Heat	( )	( )	( )	( )
Earthquakes	( )	( )	( )	( )
Invasive Species (Emerald Ash Borer, zebra muscles…)	( )	( )	( )	( )
Air and Water Pollution/Contamination	( )	( )	( )	( )
Drought	( )	( )	( )	( )

13 **Please select the answer that best describes your experience.**

( ) I have <u>never</u> experienced property damage or loss from a disaster(s) within Franklin County

( ) I have experienced minor property damage and loss from a disaster(s) within Franklin County

( ) I have experienced major property damage and loss from a disaster(s) within Franklin County

( ) I have experienced catastrophic property damage and loss from a disaster(s) within Franklin County

14 **If you have experienced any damage(s) or injury(ies) from a disaster that occurred in Franklin County, please list the hazard(s) that caused the damages/losses and/or injuries (Example: flooding, wind, winter storm)**

____

15 **If you have experienced any damage(s) or injury(ies) from a disaster that occurred in Franklin County, please indicate where this occurred (Example: my home, on a roadway or intersection, at work, etc.)**

____

16 **If you have experienced any damage(s) or injury(ies) from a disaster, please describe the damages and/or injuries. (Example: basement flooded, roof was damaged, vehicle was damaged, broken bones, lacerations, etc.)**

____

17 **Based on YOUR PERCEPTION of your jurisdiction's hazards, to what degree of emphasis would you expect your jurisdiction to mitigate the following hazards? Mitigation means to take an action that will eliminate or reduce the impacts of a hazard before it occurs. For example, elevating a home onto stilts to remove the threat of flooding, or installing safe rooms to provide a safe place during tornadoes.**

- **No Mitigation Needed = No mitigation on this hazard is expected or needed**
- **Low Priority = This hazard should be mitigated, but is not a high priority compared to other hazards**
- **Medium Priority = It is important to mitigate this hazard**
- **High Priority = It is a high priority to emphasize mitigation for this hazard**

	No Mitigation Needed	Low Priority	Medium Priority	High Priority
Tornadoes	( )	( )	( )	( )
Cyber Threat	( )	( )	( )	( )
Infectious Diseases (H1N1, Ebola…)	( )	( )	( )	( )
Flooding	( )	( )	( )	( )
Lone Wolf Terrorist Incident	( )	( )	( )	( )
Dam Failure	( )	( )	( )	( )
Utility/Energy Interruption or Failure	( )	( )	( )	( )
	No Mitigation Needed	Low Priority	Medium Priority	High Priority

CBRNE Terrorist Incident (Chemical, Biological, Radiological, Nuclear, Explosive)	( )	( )	( )	( )
Severe Winter Weather	( )	( )	( )	( )
Hazardous Material Incidents	( )	( )	( )	( )
Civil Disturbance	( )	( )	( )	( )
Severe Summer Weather	( )	( )	( )	( )
Aircraft Accident-	( )	( )	( )	( )
Space Weather (Solar Flare)	( )	( )	( )	( )
Extreme Heat	( )	( )	( )	( )
Earthquakes	( )	( )	( )	( )
Invasive Species (Emerald Ash Borer, zebra muscles…)	( )	( )	( )	( )
Air and Water Pollution/Contamination	( )	( )	( )	( )
Drought	( )	( )	( )	( )

18 **If an evacuation was ordered for your area, please indicate how likely you would be to do the following.**

	Very Likely	Somewhat Likely	Not Very Likely	Not Likely at All	Do Not Know	Not Applicable
Immediately evacuate as instructed.	( )	( )	( )	( )	( )	( )
I would first consult with family and friends outside my household before making a decision to evacuate.	( )	( )	( )	( )	( )	( )
Wait and see how bad the situation is going to be before deciding to evacuate.	( )	( )	( )	( )	( )	( )
Refuse to evacuate no matter what.	( )	( )	( )	( )	( )	( )

19 **What might prevent you from leaving your place of residence if there was an evacuation order? Please select ALL that apply.**

[ ] Pet

[ ] Livestock

[ ] Job

[ ] Need to care for another person

[ ] Spouse/Significant Other won't leave

[ ] Need to stay and protect property

[ ] Lack of money

[ ] No place to go

[ ] No transportation

[ ] Traffic

[ ] Lack of gas/fuel for vehicle

[ ] Disability/Health Issues

[ ] No obstacles would prevent me from evacuating

[ ] I would refuse to evacuate no matter what

[ ] Other (please specify): ____________________

20 **If you were to evacuate, where would you <u>most likely stay</u>? Please select the best answer.**

( ) Shelter/evacuation center

( ) Church or place of worship

( ) Workplace

( ) Home of a friend or relative

( ) Hotel/motel

( ) Do not know

( ) Other (please specify): ____________________

21 **In an evacuation, would you or anyone in your household require special assistance?**

( ) Yes

( ) Maybe

( ) No

( ) Do not know

( ) Not applicable

( ) Other: ____________________

22 **If yes, would that assistance be provided by someone within your household, by an outside agency, or by a friend or relative outside your household?**

( ) Within household

( ) Friend/Relative (outside household)

( ) Outside Agency

( ) Do not know

( ) Not applicable

( ) Other: ____________________

23 **If applicable, please indicate what kind of outside assistance your household may need during an evacuation (i.e. Transportation, Medical, etc.)**

____

24 **What type of structure do you live in?**

( ) Detached single family home

( ) Duplex, triplex, quadruple home

( ) Multi-family building – 2 stories or more (apartment/condo)

( ) Mobile home
( ) Manufactured home
( ) Recreational vehicle (RV)
( ) Some other type of structure
( ) Do Not Know
( ) Not Applicable
( ) Other (please specify): ____________

25 **How many persons, including yourself, are currently living in your household?**

	1	2	3	4	5	6	7	8	9	10 or more
Under age 5										
Ages 6 - 10										
Ages 11 - 19										
Ages 20 - 44										
Ages 45 - 64										
Ages 65-79										
Ages 80+										

26 **Which of the following best describes your race/ethnicity? Please select ALL that apply.**

[ ] American Indian or Alaska Native
[ ] Hawaiian or Other Pacific Islander
[ ] Asian or Asian American
[ ] Black or African American
[ ] Hispanic or Latino
[ ] Non-Hispanic White
[ ] Other (please specify): ____________

27 **Please indicate the language(s) spoken in your household. Please select ALL that apply.**

[ ] English
[ ] Spanish
[ ] Somali
[ ] Russian
[ ] Other Indo-European language
[ ] Asian and Pacific Island language
[ ] Other (please specify): ____________

28 **Please indicate your sex.**

( ) Female
( ) Male
( ) Not Applicable

Thank You!

This concludes the survey. Thank you for your time!

NEED MORE INFORMATION?
To assist you further in obtaining important information about emergency and disaster preparedness, please visit http://fcemhs.com/

Sign Up for ALERT Franklin County
In the event of an emergency, it is critically important for you to be prepared and for you to be informed. Franklin County is taking a proactive approach to enabling its citizens to be more aware of emergency situations that may impact individuals and businesses in Franklin County, by implementing the ALERT Franklin County Emergency Alert System. This is an emergency notification system enabling and empowering interested parties to be aware of extreme incidents in Franklin County.

- http://alertfranklincounty.com/
- Or contact Franklin County Emergency Management and Homeland Security at 614-794-0213

Join Franklin County's Community Emergency Response Team
The Community Emergency Response Team (CERT) Program educates people about disaster preparedness for hazards that may impact their area and trains them in basic disaster response skills such as fire safety, light search and rescue, team organization, and disaster medical operations using the training learned in the classroom and during exercises. CERT members can assist others in their neighborhood or workplace following an event when professional responders are not immediately available to help.

- For more information on the CERT program, visit: http://fcemhs.org/CitizenPreparedness/FranklinCountyCERT.aspx

APPENDIX E. COMMUNITY PREPAREDNESS & MITIGATION FINAL REPORT

Franklin County

Hazard Mitigation Questionnaire

Response Report

April 2018

Franklin County Emergency Management
& Homeland Security Agency

Introduction and Methodology

Surveys were distributed through a variety of methods beginning on October 2018 including e-mail blasts, press releases, and the Nextdoor app. Community organizations were critical in connecting county and city residents with the survey, and the Franklin County Office of Emergency Management and Homeland Security utilized their broad-based distribution lists of community stakeholders and partners to disseminate the survey to residents.

Online survey results were compiled together upon the close of the survey at the end of February.

In total, 2,098 respondents participated in the survey. To ensure all data could be accurately correlated, only the 1,593 completed surveys were used in this report (please reference the first row in the table below). Approximately, 505 respondents submitted incomplete surveys.

Note: Completed surveys included those responses where the respondent started and reached the end of the survey. In some situations, the respondent chose not to answer one or more questions which is why some discrepancies exist in the total number of responses per question.

Open-ended responses were not edited in order to preserve the respondent's true intentions and/or experience.

Survey Status	Total	Percent
Completed	1,593	75.9
Partial	505	24.1
Disqualified	0	0
Total	2,098	

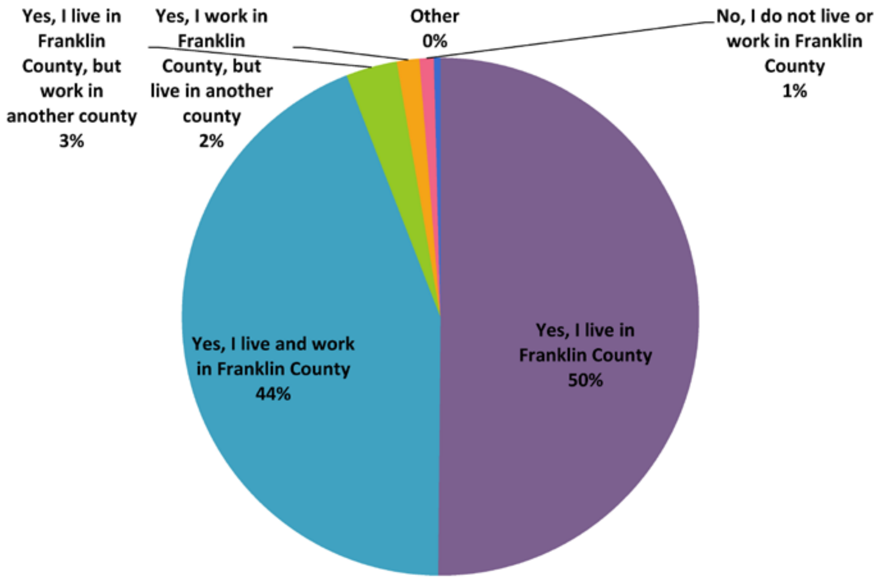
Questionnaire

The survey instrument utilized a combination of descriptive and exploratory questions to gain an understanding of general preparedness intentions and behavior, as well as personal and demographic factors influencing decision making (e.g., information sources, risk perception, age, and socioeconomic status).

The survey was a combination of multiple choice, Likert-scale rating (degree of agreement/disagreement style questions), and open-ended questions. It totaled 28 questions, and respondents took an average of 12 minutes to complete the questionnaire (both online and hardcopy).

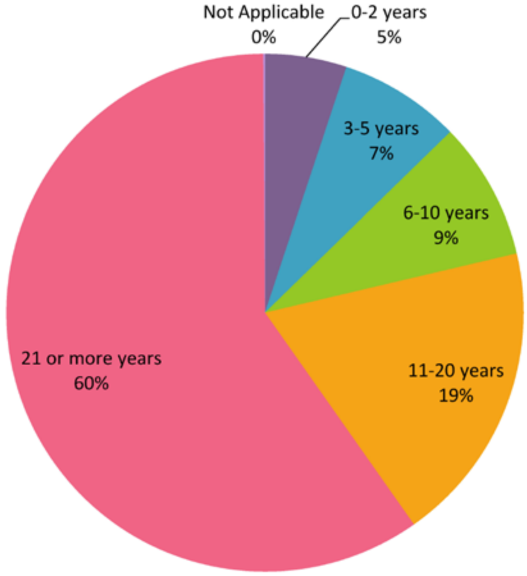
Survey Results

Do you live and/or work in Franklin County? Please select the best answer that applies to your current situation.



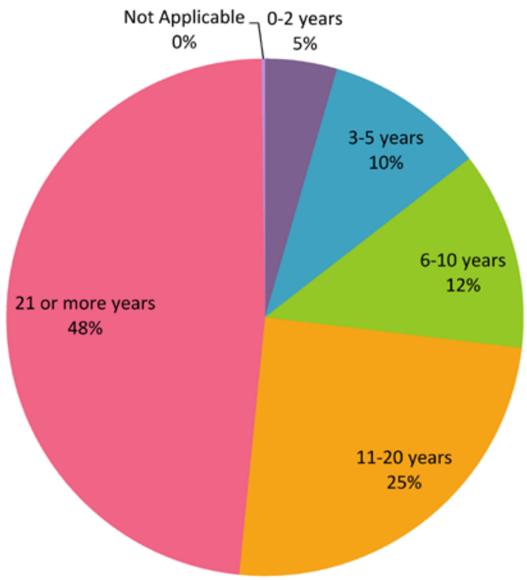
	Percent	Count
Yes, I live in Franklin County	50.1%	1,010
Yes, I live and work in Franklin County	43.9%	886
Yes, I live in Franklin County, but work in another county	3.2%	64
Yes, I work in Franklin County, but live in another county	1.4%	28
No, I do not live or work in Franklin County	0.9%	19
Other	0.4%	9

Approximately how many years have you lived in Franklin County?



	Percent	Count
0-2 years	5.1%	98
3-5 years	7.6%	147
6-10 years	8.6%	166
11-20 years	18.9%	364
21 or more years	59.6%	1,146
Not Applicable	0.1%	2
	Total	1,923

Approximately how many years have you worked in Franklin County?

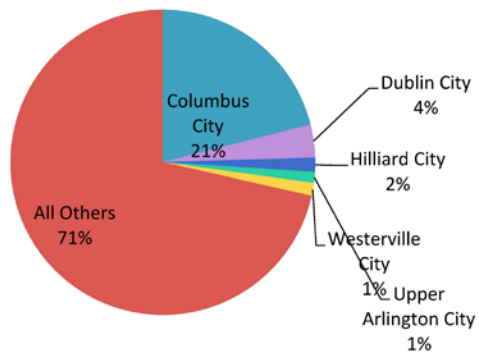


	Percent	Count
0-2 years	4.5%	40
3-5 years	10.0%	90
6-10 years	12.4%	111
11-20 years	24.7%	222
21 or more years	48.2%	433
Not Applicable	0.2%	2
	Total	898

Please indicate which community in Franklin County you live in:

	Percent	Count
Bexley City	0.8%	13
Blendon Township	0.9%	16
Brice Village	0.1%	2
Brown Township	0.3%	5
Canal Winchester City	1.3%	23
Clinton Township	1.5%	26
Columbus City	35.5%	611
Dublin City	12.1%	209
Franklin Township	1.7%	29
Gahanna City	2.9%	50
Grandview Heights City	0.6%	11
Grove City	5.6%	97
Groveport City	0.8%	14
Hamilton Township	0.7%	12
Harrisburg Village	0.1%	1
Hilliard City	7.3%	125
Jackson Township	0.3%	5
Jefferson Township	2.2%	38
Lockbourne Village	0.2%	3
Madison Township	2.4%	42
Marble Cliff Village	0.2%	3
Mifflin Township	0.1%	2
Minerva Park Village	0.1%	2
New Albany City	1.5%	26
Norwich Township	0.5%	9
Obetz Village	0.1%	2
Perry Township	1.0%	17
Plain Township	0.3%	5
Pleasant Township	0.5%	8
Prairie Township	3.3%	56
Reynoldsburg City	2.0%	34
Riverlea Village	0.1%	2
Sharon Township	0.6%	10
Truro Township	0.2%	4
Upper Arlington City	3.7%	64
Valleyview Village	0.1%	1
Washington Township	0.1%	2
Westerville City	5.8%	99
Whitehall City	0.4%	7
Worthington City	2.1%	36
	Total	1,721

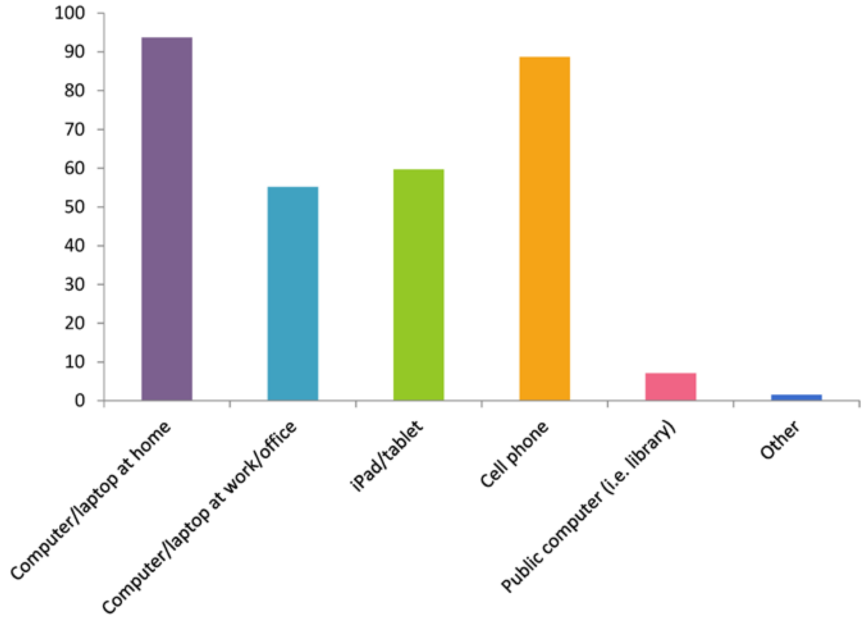
Please indicate which community in Franklin County you work in.



	Percent	Count
Bexley City	0.7%	6
Blendon Township	0.1%	1
Canal Winchester City	0.7%	6
Clinton Township	0.7%	6
Columbus City	57.4%	506
Dublin City	9.5%	84
Franklin Township	1.0%	9
Gahanna City	2.5%	22
Grandview Heights City	1.5%	13
Grove City	2.3%	20
Groveport City	0.6%	5
Hamilton Township	0.3%	3
Hilliard City	4.1%	36
Jackson Township	0.1%	1
Jefferson Township	0.7%	6
Lockbourne Village	0.3%	3
Madison Township	0.5%	4
Marble Cliff Village	0.2%	2
Mifflin Township	0.2%	2
Minerva Park Village	0.3%	3
New Albany City	1.7%	15
Obetz Village	0.2%	2
Plain Township	0.2%	2
Prairie Township	1.2%	11
Reynoldsburg City	1.2%	11
Sharon Township	0.2%	2
Truro Township	0.2%	2
Upper Arlington City	3.1%	27
Washington Township	0.1%	1
Westerville City	3.7%	33
Whitehall City	1.9%	17
Worthington City	2.3%	20
	Total	881

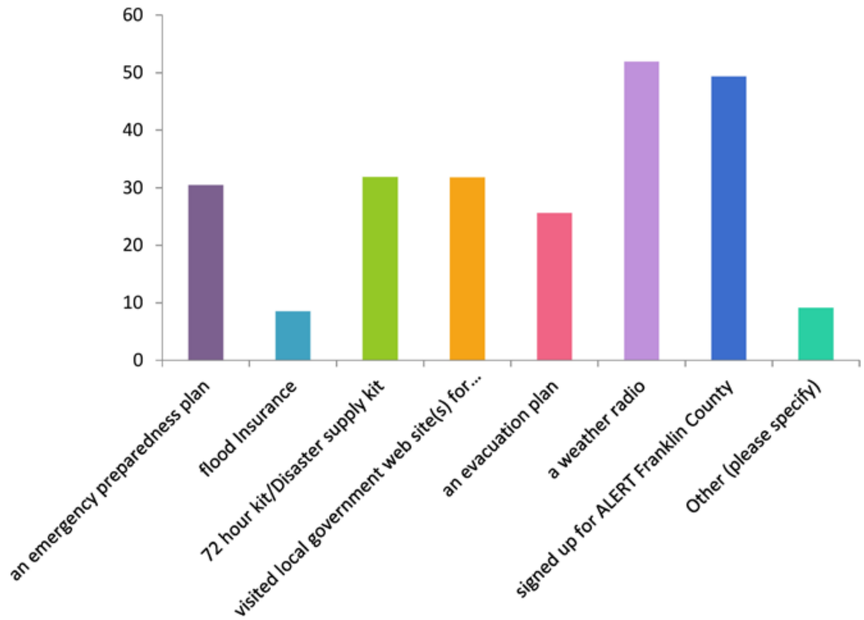
Preparedness

Please indicate what type of device(s) you use to access the internet. Select ALL that apply.



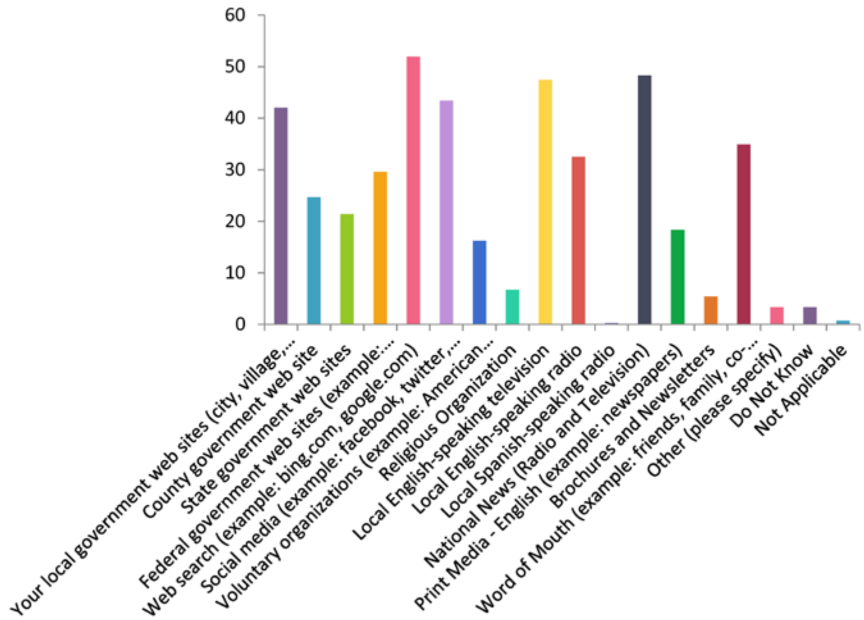
	Percent	Count
Computer/laptop at home	93.7%	1,701
Computer/laptop at work/office	55.2%	1,002
iPad/tablet	59.7%	1,084
Cell phone	88.7%	1,609
Public computer (i.e. library)	7.1%	128
Other	1.5%	27

Please indicate those activities you have done to prepare for emergencies and disasters. Please select ALL that apply. I have…



	Percent	Count
an emergency preparedness plan	30.5%	455
flood Insurance	8.5%	126
72 hour kit/Disaster supply kit	31.9%	476
visited local government web site(s) for emergency preparedness information	31.8%	474
an evacuation plan	25.6%	382
a weather radio	51.9%	774
signed up for ALERT Franklin County	49.3%	734
Other (please specify)	9.1%	136

Please indicate where you go to obtain emergency and disaster preparedness related information? Please select ALL that apply.



	Percent	Count
Your local government web sites (city, village, township)	42.0%	757
County government web site	24.7%	445
State government web sites	21.4%	386
Federal government web sites (example: www.fema.gov)	29.6%	533
Web search (example: bing.com, google.com)	51.9%	934
Social media (example: facebook, twitter, google+, etc.)	43.4%	781
Voluntary organizations (example: American Red Cross, Salvation Army, etc.)	16.2%	291
Religious Organization	6.7%	121
Local English-speaking television	47.4%	854
Local English-speaking radio	32.5%	585
Local Spanish-speaking radio	0.2%	4
National News (Radio and Television)	48.3%	869
Print Media - English (example: newspapers)	18.3%	329

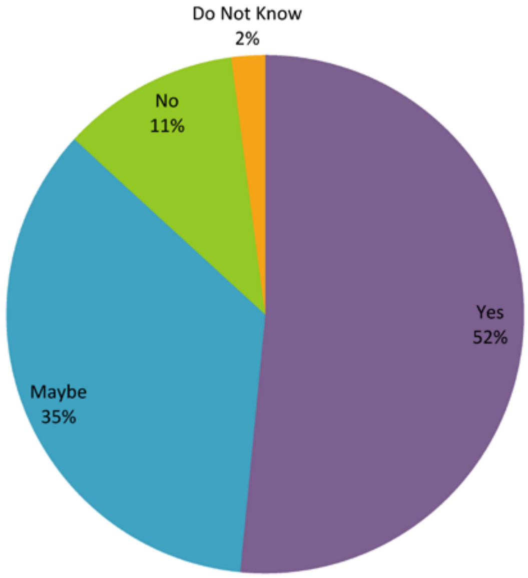
Brochures and Newsletters	5.4%	98
Word of Mouth (example: friends, family, co-workers)	34.9%	629
Other (please specify)	3.3%	59
Do Not Know	3.3%	60
Not Applicable	0.7%	12

Would you agree or disagree with the following statements?

	Strongly Agree		Agree		Neither Agree nor Disagree		Disagree		Strongly Disagree		Do Not Know		Responses
	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count
I feel prepared for a disaster.	94	5%	459	25%	493	27%	525	29%	215	12%	21	1%	1,807
I am familiar with Franklin County Emergency Management & Homeland Security's website and can easily obtain information about emergencies and disasters.	121	7%	355	20%	280	16%	599	34%	356	20%	71	4%	1,782
During times of emergency, information is provided in a	807	45%	702	39%	141	8%	20	1%	15	1%	115	6%	1,800

language or format I can understand.													
I can easily obtain emergency information in times of crisis.	287	16%	753	42%	447	25%	104	6%	30	2%	178	10%	1,799

If a disaster (i.e. snow storm) impacted Franklin County, knocking out electricity and running water, would your household be able to manage on its own for at least three (3) days?



	Percent	Count
Yes	51.6%	928
Maybe	35.3%	635
No	11.1%	199
Do Not Know	2.1%	37
	Total	1,799

Hazards

Do you believe that your **household** might ever be threatened by the following hazards? Please rate what hazards present the greatest risk. Low Risk = Low impact on threat to life and property damage; Medium Risk = Medium impact on threat to life and property damage; High Risk = High impact on threat to life and property damage

	Low Risk		Medium Risk		High Risk		Not Applicable		Responses
	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count
Tornadoes	351	23%	885	57%	322	21%	3	0%	1,561
Cyber Threat	323	21%	697	44%	547	35%	10	1%	1,577
Infectious Diseases (H1N1, Ebola…)	765	48%	647	41%	160	10%	13	1%	1,585
Flooding	1,031	65%	449	28%	80	5%	24	2%	1,584
Lone Wolf Terrorist Incident	877	55%	523	33%	162	10%	20	1%	1,582
Dam Failure	1,207	77%	175	11%	37	2%	157	10%	1,576
Utility/Energy Interruption or Failure	142	9%	726	46%	706	45%	5	0%	1,579
CBRNE Terrorist Incident (Chemical, Biological, Radiological, Nuclear, Explosive)	790	50%	577	37%	193	12%	16	1%	1,576
Severe Winter Weather	132	8%	803	51%	639	40%	6	0%	1,580
Hazardous Material Incidents	770	49%	643	41%	150	10%	17	1%	1,580

	Low Risk		Medium Risk		High Risk		Not Applicable		Responses
	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count
Civil Disturbance	843	53%	582	37%	145	9%	9	1%	1,579
Severe Summer Weather	379	24%	785	50%	413	26%	4	0%	1,581
Aircraft Accident	974	62%	462	29%	129	8%	13	1%	1,578
Space Weather (Solar Flare)	1,160	74%	304	19%	70	5%	36	2%	1,570
Extreme Heat	693	44%	663	42%	222	14%	3	0%	1,581
Earthquakes	1,292	82%	219	14%	28	2%	35	2%	1,574
Invasive Species (Emerald Ash Borer, zebra muscles…)	664	42%	551	35%	314	20%	45	3%	1,574
Air and Water Pollution/Contamination	426	27%	806	51%	337	21%	7	0%	1,576
Drought	715	45%	702	45%	142	9%	15	1%	1,574

Do you believe that your **place of business** might ever be threatened by the following hazards? Please rate what hazards present the greatest risk. Low Risk = Low impact on threat to life and property damage; Medium Risk = Medium impact on threat to life and property damage; High Risk = High impact on threat to life and property damage

	Low Risk		Medium Risk		High Risk		Not Applicable		Responses
	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count
Tornadoes	5	36%	7	50%	2	14%	0	0%	14
Cyber Threat	0	0%	2	17%	10	83%	0	0%	12
Infectious Diseases (H1N1, Ebola…)	4	31%	8	62%	1	8%	0	0%	13
Flooding	10	77%	2	15%	1	8%	0	0%	13
Lone Wolf Terrorist Incident	1	7%	5	36%	8	57%	0	0%	14
Dam Failure	11	79%	3	21%	0	0%	0	0%	14
Utility/Energy Interruption or Failure	2	14%	5	36%	7	50%	0	0%	14
CBRNE Terrorist Incident (Chemical, Biological, Radiological, Nuclear, Explosive)	3	21%	6	43%	5	36%	0	0%	14
Severe Winter Weather	1	7%	5	36%	8	57%	0	0%	14
Hazardous Material Incidents	5	36%	7	50%	2	14%	0	0%	14
Civil Disturbance	5	36%	5	36%	4	29%	0	0%	14

	Low Risk		Medium Risk		High Risk		Not Applicable		Responses
	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count
Severe Summer Weather	5	36%	7	50%	2	14%	0	0%	14
Aircraft Accident	8	57%	3	21%	3	21%	0	0%	14
Space Weather (Solar Flare)	8	57%	3	21%	2	14%	1	7%	14
Extreme Heat	6	43%	6	43%	2	14%	0	0%	14
Earthquakes	9	64%	5	36%	0	0%	0	0%	14
Invasive Species (Emerald Ash Borer, zebra muscles…)	10	71%	3	21%	1	7%	0	0%	14
Air and Water Pollution/Contamination	5	36%	3	21%	6	43%	0	0%	14
Drought	8	57%	6	43%	0	0%	0	0%	14

Please select the answer that best describes your experience.

	Percent	Count
I have never experienced property damage or loss from a disaster(s) within Franklin County	35.2%	567
I have experienced minor property damage and loss from a disaster(s) within Franklin County	58.1%	937
I have experienced major property damage and loss from a disaster(s) within Franklin County	6.3%	102
I have experienced catastrophic property damage and loss from a disaster(s) within Franklin County	0.4%	6
	Total	1,612

Based on YOUR PERCEPTION of your jurisdiction's hazards, to what degree of emphasis would you expect your jurisdiction to mitigate the following hazards? Mitigation definition: The purpose of mitigation planning is to identify policies and actions that can be implemented over the long term to reduce risk and future losses. Mitigation forms the foundation for a community's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction, and repeated damage.

- No Mitigation Needed = No mitigation on this hazard is expected or needed
- Low Priority = This hazard should be mitigated, but is not a high priority compared to other hazards
- Medium Priority = It is important to mitigate this hazard
- High Priority = It is a high priority to emphasize mitigation for this hazard

	No Mitigation Needed		Low Priority		Medium Priority		High Priority		Responses
	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count
Tornadoes	382	24%	384	24%	499	32%	312	20%	1,577
Cyber Threat	157	10%	360	23%	552	35%	517	33%	1,586
Infectious Diseases (H1N1, Ebola…)	124	8%	442	28%	572	36%	450	28%	1,588
Flooding	240	15%	558	35%	545	35%	238	15%	1,581
Lone Wolf Terrorist Incident	217	14%	545	35%	448	28%	366	23%	1,576
Dam Failure	509	32%	519	33%	320	20%	227	14%	1,575
Utility/Energy Interruption or Failure	49	3%	234	15%	566	36%	731	46%	1,580
CBRNE Terrorist Incident (Chemical,	152	10%	517	33%	432	27%	481	30%	1,582

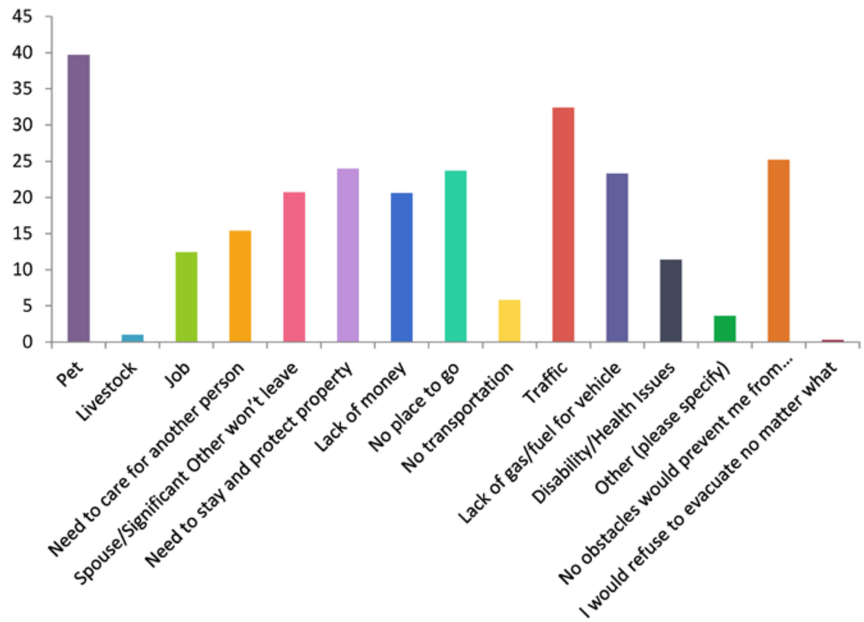
	No Mitigation Needed		Low Priority		Medium Priority		High Priority		Responses
	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count
Biological, Radiological, Nuclear and Explosive)									
Severe Winter Weather	119	8%	347	22%	654	42%	455	29%	1,575
Hazardous Material Incidents	150	10%	532	34%	543	35%	346	22%	1,571
Civil Disturbance	209	13%	603	38%	497	32%	266	17%	1,575
Severe Summer Weather	234	15%	566	36%	544	35%	228	15%	1,572
Aircraft Accident	411	26%	656	42%	314	20%	183	12%	1,564
Space Weather (Solar Flare)	590	38%	690	44%	200	13%	84	5%	1,564
Extreme Heat	301	19%	640	41%	461	29%	169	11%	1,571
Earthquakes	569	36%	731	47%	163	10%	99	6%	1,562
Invasive Species (Emerald Ash Borer, zebra muscles…)	231	15%	631	40%	530	34%	176	11%	1,568
Air and Water Pollution/Contamination	93	6%	344	22%	542	35%	589	38%	1,568
Drought	319	21%	707	45%	399	26%	132	9%	1,557
Tornadoes	382	24%	384	24%	499	32%	312	20%	1,577

	No Mitigation Needed		Low Priority		Medium Priority		High Priority		Responses
	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count
Cyber Threat	157	10%	360	23%	552	35%	517	33%	1,586
Infectious Diseases (H1N1, Ebola…)	124	8%	442	28%	572	36%	450	28%	1,588
Flooding	240	15%	558	35%	545	35%	238	15%	1,581
Lone Wolf Terrorist Incident	217	14%	545	35%	448	28%	366	23%	1,576

If an evacuation was ordered for your area, please indicate how likely you would be to do the following.

	Very Likely		Somewhat Likely		Not Very Likely		Not Likely at All		Do Not Know		Not Applicable		Responses
	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count	Row %	Count
Immediately evacuate as instructed.	782	50%	581	37%	125	8%	36	2%	48	3%	2	0%	1,574
I would first consult with family and friends outside my household before making a decision to evacuate.	565	36%	544	35%	244	16%	164	11%	17	1%	18	1%	1,552
Wait and see how bad the situation is going to be before deciding to evacuate.	208	13%	571	37%	435	28%	296	19%	29	2%	11	1%	1,550
Refuse to evacuate no matter what.	10	1%	53	3%	256	17%	1,119	73%	71	5%	34	2%	1,543

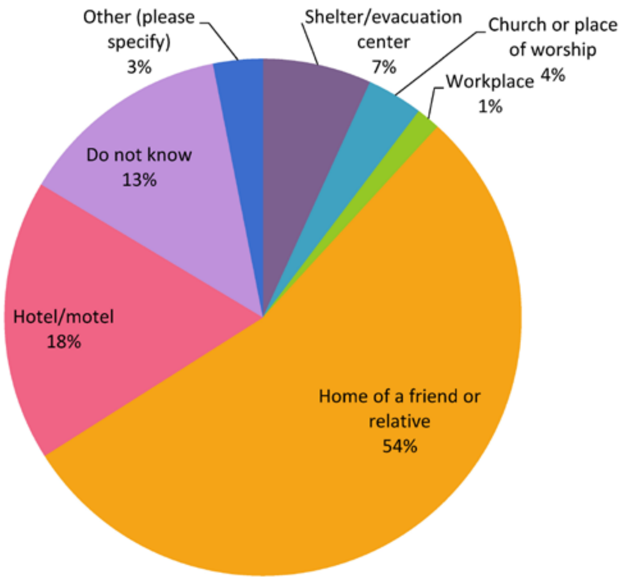
What might prevent you from leaving your place of residence if there was an evacuation order? Please select ALL that apply.



	Percent	Count
Pet	39.7%	628
Livestock	1.0%	16
Job	12.4%	196
Need to care for another person	15.4%	244
Spouse/Significant Other won't leave	20.7%	327
Need to stay and protect property	24.0%	379
Lack of money	20.6%	325
No place to go	23.7%	374
No transportation	5.8%	91
Traffic	32.4%	512
Lack of gas/fuel for vehicle	23.3%	368
Disability/Health Issues	11.4%	180
Other (please specify)	3.6%	57

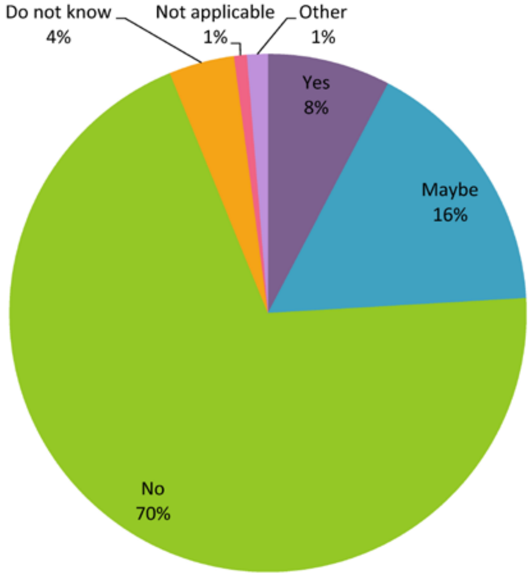
No obstacles would prevent me from evacuating	25.2%	399
I would refuse to evacuate no matter what	0.3%	4

If you were to evacuate, where would you most likely stay? Please select the best answer.



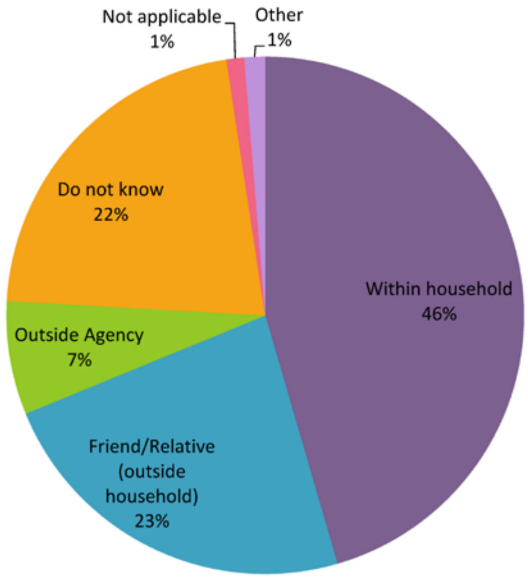
	Percent	Count
Shelter/evacuation center	6.8%	108
Church or place of worship	3.5%	55
Workplace	1.5%	24
Home of a friend or relative	54.2%	863
Hotel/motel	17.6%	280
Do not know	13.3%	212
Other (please specify)	3.1%	50
	Total	1,592

In an evacuation, would you or anyone in your household require special assistance?



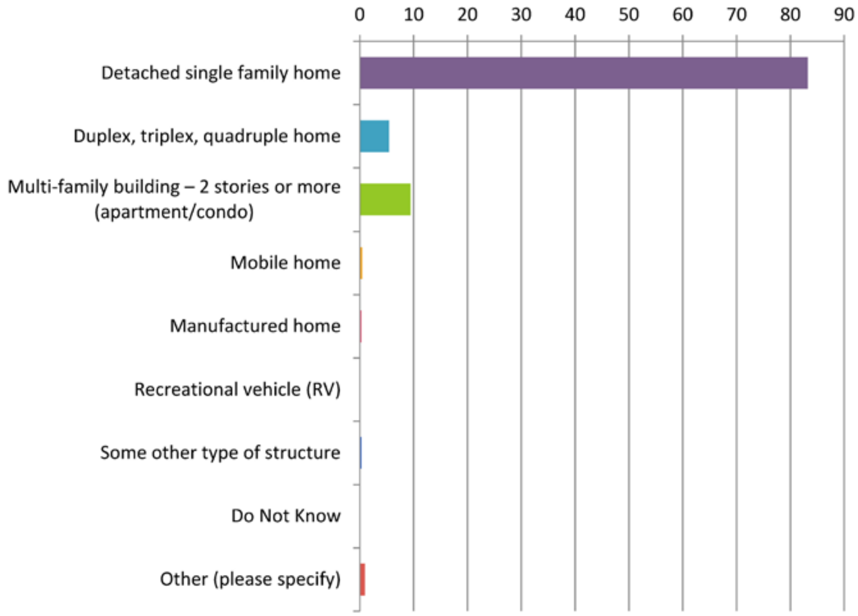
	Percent	Count
Yes	7.7%	122
Maybe	16.4%	260
No	69.8%	1,108
Do not know	4.1%	65
Not applicable	0.8%	12
Other	1.3%	21
	Total	1,588

If yes, would that assistance be provided by someone within your household, by an outside agency, or by a friend or relative outside your household?



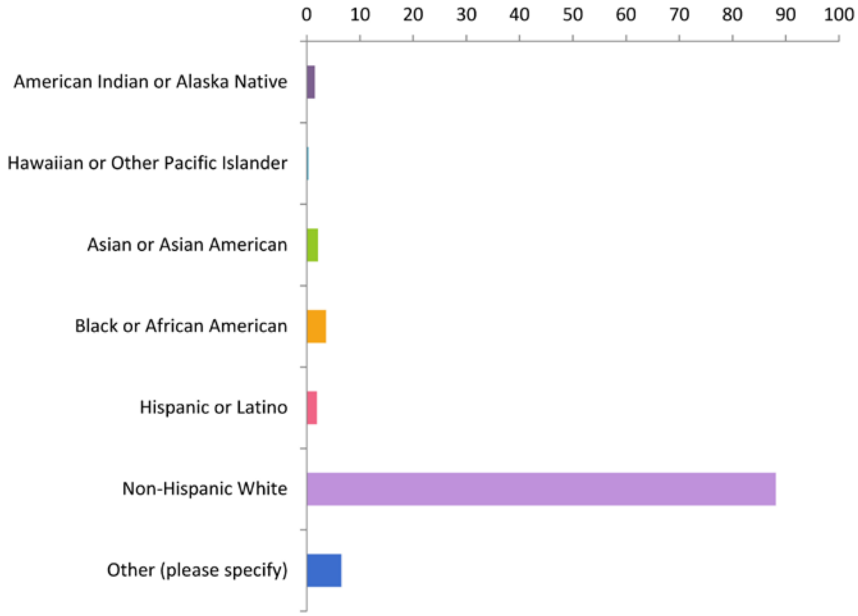
	Percent	Count
Within household	45.5%	172
Friend/Relative (outside household)	23.3%	88
Outside Agency	7.1%	27
Do not know	21.7%	82
Not applicable	1.1%	4
Other	1.3%	5
	Total	378

What type of structure do you live in?



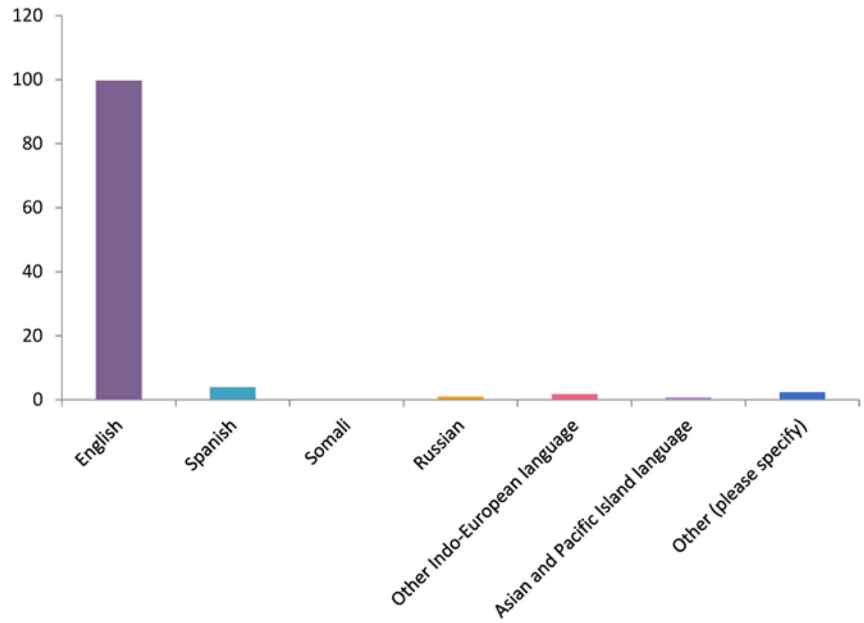
	Percent	Count
Detached single family home	83.2%	1,305
Duplex, triplex, quadruple home	5.4%	84
Multi-family building – 2 stories or more (apartment/condo)	9.4%	148
Mobile home	0.4%	7
Manufactured home	0.3%	5
Recreational vehicle (RV)	0.1%	1
Some other type of structure	0.3%	4
Do Not Know	0.1%	1
Other (please specify)	0.9%	14
	Total	1,569

Which of the following best describes your race/ethnicity? Please select ALL that apply.



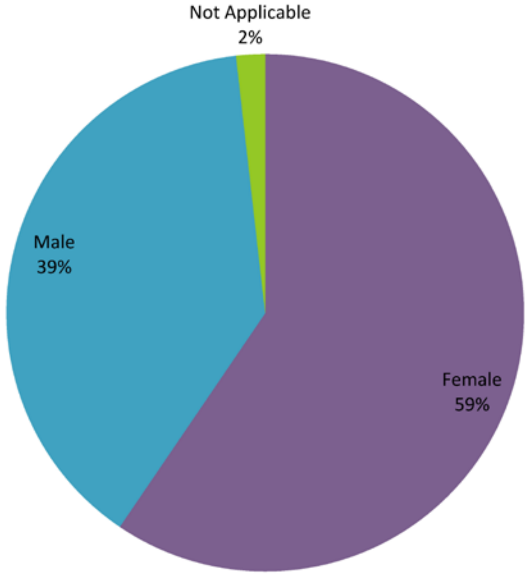
	Percent	Count
American Indian or Alaska Native	1.5%	23
Hawaiian or Other Pacific Islander	0.3%	4
Asian or Asian American	2.1%	33
Black or African American	3.6%	55
Hispanic or Latino	1.9%	30
Non-Hispanic White	88.1%	1,363
Other (please specify)	6.5%	100

Please indicate the language(s) spoken in your household. Please select ALL that apply.



	Percent	Count
English	99.7%	1,567
Spanish	3.9%	62
Somali	0.1%	1
Russian	1.0%	15
Other Indo-European language	1.8%	28
Asian and Pacific Island language	0.8%	12
Other (please specify)	2.4%	37

Please indicate your sex.



	Percent	Count
Female	59.5%	931
Male	38.7%	605
Not Applicable	1.8%	28
	Total	1,564

APPENDIX G. SAMPLE RESOLUTION

Sample Resolution for Franklin County Jurisdictions

The following is a sample resolution in support of the Franklin County Natural Hazards Mitigation Plan. A resolution adopting the plan must be passed by Franklin County and in each participating city and village in Franklin County. Townships may adopt, however they are covered under the Franklin County Commissioner's adoption.

Copies of local adoption resolutions follow in this appendix.

(Sample Resolution)

RESOLUTION ADOPTING THE FRANKLIN COUNTY NATURAL HAZARDS MITIGATION PLAN

WHEREAS, Franklin County has a history of experiencing damage from flooding, tornadoes, severe summer weather, severe winter weather, and other hazards resulting in property loss, loss of life, economic hardship, and threats to public health and safety;

WHEREAS, the *Franklin County Natural Hazards Mitigation Plan* has been updated after more than a year of research and work done by Franklin County Emergency Management and Homeland Security and representatives of various local governmental agencies and stakeholder organizations; and

WHEREAS, the plan recommends mitigation actions submitted by each local jurisdictions designed to mitigate the impacts of natural hazards on the people and property in Franklin County; and

WHEREAS, adoption of this natural hazards mitigation plan is a show of support for continued natural hazards mitigation and a condition of eligibility to receive federal mitigation funds available through the Federal Emergency Management Agency;

NOW THEREFORE BE IT RESOLVED THAT ____(city, village, township)__________does hereby adopt the *Franklin County Natural Hazards Mitigation Plan.*

Adopted at a meeting of the _____________________________, on this day____________.

Said Resolution was adopted upon the following vote:

____

____

APPENDIX H. PARTICIPATING JURISDICTION PLAN ADOPTION

[Insert Upon FEMA Approval]

Resolution No. 0801-18 November 27, 2018

Resolution authorizing the adoption of The Franklin County Natural Hazards Mitigation Plan (Franklin County Emergency Management & Homeland Security)

WHEREAS, Franklin County has a history of experiencing damage from flooding, tornadoes, severe summer weather, severe winter weather, and other hazards resulting in property loss, loss of life, economic hardship, and threats to public health and safety; and,

WHEREAS, the Franklin County Natural Hazards Mitigation Plan has been updated after more than a year of research and work done by Franklin County Emergency Management and Homeland Security and representatives of various local governmental agencies and stakeholder organizations; and,

WHEREAS, the plan recommends many mitigation actions submitted by local jurisdictions designed to mitigate the impacts of the natural hazards on the people and property of Franklin County; and,

WHEREAS, adoption of this natural hazards mitigation plan is a show of support for continued natural hazards mitigation and a condition of eligibility to receive federal mitigation funds through the Federal Emergency Management Agency; and,

BE IT RESOLVED BY THE BOARD OF COMMISSIONERS, FRANKLIN COUNTY, OHIO; does hereby adopt the Franklin County Natural Hazards Mitigation Plan.

Prepared by: Becky Brady

SIGNATURE SHEET FOLLOWS

Summary

The Franklin County Natural Hazards Mitigation Plan

1. The Franklin County Natural Hazards Mitigation Plan serves as the official plan for Franklin County and all included jurisdictions. Mitigation planning efforts for Franklin County began in 2005 with the creation of the first Federal Emergency Management Agency approved plan for Franklin County. That plan was formally adopted in 2007. The 2012 version was the first official update to that plan. The 2018 plan represents the most recent vision of the mitigation plan for Franklin County.
2. The hazard mitigation planning process consisted of gathering and analyzing data available from various sources including the Risk Assessment for Franklin County. The data show that the hazards most likely to result in costly damages are flooding, tornadoes and high winds, and heavy snow and ice.
3. The plan recommends a number of public education efforts, continued support for flood mitigation buy-outs, and the examination and the potential modification of planning guidance and other development regulations to ensure the risk of damage to new structures is minimized. Many of these recommendations are highlighted in the Mitigation Action section of the plan.
4. By adopting this plan, Franklin County government, as well as the cities, villages and townships within commit to working with citizens and business owners to make Franklin County safer. Adoption of the plan is a condition of eligibility to receive federal mitigation funds available through FEMA.

Jeffrey J. Young
Director, FCEM&HS

SIGNATURE SHEET

Resolution No. 801-18 November 27, 2018

RESOLUTION AUTHORIZING THE ADOPTION OF THE FRANKLIN COUNTY NATURAL HAZARDS MITIGATION PLAN

(EMA - Emergency Management Agency)

Upon the motion of Commissioner Marilyn Brown, seconded by Commissioner Kevin L. Boyce:

Voting:

Kevin L. Boyce, President	**Aye**
Marilyn Brown	**Aye**
John O'Grady	**Absent**

Board of County Commissioners
Franklin County, Ohio

CERTIFICATE OF CLERK

IT IS HEREBY CERTIFIED that the foregoing is a true and correct transcript of a resolution acted upon by the Board of County Commissioners, Franklin County, Ohio on the date noted above.

Antwana Booker, Clerk
Board of County Commissioners
Franklin County, Ohio