SECTION 2:
HAZARD IDENTIFICATION & RISK ASSESSMENT

2.1 HIRA OVERVIEW & HAZARD IDENTIFICATION SUMMARY

The State of Ohio is prone to many natural and manmade hazards. Ohio has experienced thousands of hazard events, resulting in millions of dollars in losses and casualties, and 46 Presidential disaster declarations. In 2003 as part of an overall effort to reduce future exposure to damages and meet the planning requirements of the DMA 2000, the State of Ohio began the development of the initial Hazard Identification and Risk Assessment (HIRA). The HIRA has been subsequently reviewed and approved for the 2008 and 2011 plan updates.

This section will cover six separate requirements of the 44 CFR 201.4 (identifying hazards, profiling hazard events, assessing vulnerability by jurisdiction, estimating potential losses by jurisdiction, assessing vulnerability of state facilities, and estimating potential losses of state facilities). The first four of the six requirements are integrated into each hazard for which is detailed. The last two (state facility vulnerability assessment and loss estimation) are discussed in this section, but specifics are integrated into each hazard. The following will provide a more in-depth explanation of these six elements and describe the steps taken to ensure the element was met.

Identifying hazards

The 44 CFR 201.4 (c)(2)(i) requires the risk assessment include an overview of the type of all natural hazards that can affect the state. This section of the plan presents a list of potential hazards that may likely impact the state. Due to the states northern geographical setting on Lake Erie, it is vulnerable to a wide array of hazards that threaten its communities, businesses, governments and environment. To determine the hazards that pose the greatest threat to the state, the OMPAT (in conjunction with FEMA) developed a list of potential hazards by conducting a review of several key resources, which include:

- Review of historical data on events that have occurred in the last 40 years;
- Review of 2003 and 2008 plan data;
- Collaboration with various agencies who are known “experts” on different hazards, including the Ohio Departments of Natural Resources, Transportation and Environmental Protection Agency;
- Review of hazards identified in guidance materials provided by FEMA – Region V; and
- Review of the local mitigation plans. Ohio currently has 101 approved single and multi jurisdictional plans with 2 in progress. One additional Plan was updated and forwarded to FEMA Region V for review and pending approval. The approved plans were used to assess the impacts hazards are having throughout the state.

Risk Assessment

44 CFR 201.4 (c)(2)(i) – The risk assessment shall include an overview of the location of all natural hazards that can affect the State, including information on previous occurrences of hazard events, as well as the probability of future hazard events, using maps where appropriate. The risk assessment relies upon information about past hazard events from published sources such as NOAA, USGS, USACE, Ohio EMA and ODNR, among other agencies.

The risk assessment section for each hazard in this plan includes a description of the location of the hazard, past occurrences, and a discussion of probability of future hazard events.

Vulnerability Analysis by Jurisdiction

44 CFR 201.4 (c)(2)(ii) – The risk assessment shall include an overview and analysis of the state's vulnerability to the hazards described in this paragraph (c)(2), based on estimates provided in local risk assessments. The state shall describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events. The methodology for this section varies by hazard due to available data and will be more thoroughly discussed prior to the results of the section for each hazard.

Improved integration of LHMP data into the state HIRA is an ongoing effort. Since the last State Mitigation Plan revision, Ashland and Adams Counties were the final jurisdictions to complete their first mitigation plans. By April 2010, all counties in the state had a mitigation plan. As local plans start to expire and jurisdictions update their plans, vulnerability information and loss estimation are collected and assembled. As the State Hazard Analysis Resource and Planning Portal (SHARPP) becomes more functional, this information and other data are compiled, analyzed and evaluated. Many of the local plans use HAZUS-MH or similar programs to analyze vulnerability to the jurisdiction and project estimated losses to structures, critical facilities, commercial enterprise and business interruption. These data are incorporated into the analysis tables in this Section of the Plan to provide the most current and accurate risk assessment at the State level. By the second quarter of 2011, SHARPP is projected to electronically track and evaluate hazard metrics and impact to residential, commercial and critical building stock, as well as damage estimates.

Estimating Potential Losses by Jurisdiction

44 CFR 201.4 (c)(2)(iii) – The risk assessment shall include an overview and analysis of potential losses to identified structures, based on estimates provided in local risk assessments. The methodology for this section varies by hazard due to available data and will be more thoroughly discussed prior to the results of the section for each hazard.

Similar to the requirement to utilize vulnerability analysis information from LHMPs, data are similarly incorporated using methods and input as stated in the

Vulnerability Analysis section described above. Each jurisdiction's plan utilizes a formal approach to determine losses that can be expected from different hazard scenarios. For purposes of identification, this section of the plan categorizes loss estimates by hazard and provides an example of how an LHMP performed an in-depth analysis. It should be noted that this analysis of LHMPs is a summary of some good practices. With so many plans being developed, it would be impossible to give a very thorough analysis of each local risk assessment until SHARPP comes on line. Future updates to the SOHMP will continue to spotlight County plan loss estimations that depict risk and vulnerabilities from natural hazards.

Assessing Vulnerability of State Facilities

44 CFR 201.4 (c)(2)(ii) – The risk assessment shall include an overview and analysis of the state's vulnerability to the hazards described in this paragraph (c)(2), based on estimates provided in local risk assessments. State-owned or operated critical facilities located in the identified hazard areas shall be addressed. The general methodology for the development of this section is discussed below, and any specific variation by hazard is addressed within the section for that specific hazard.

The State of Ohio currently maintains a partial listing of state-owned facilities located in the Risk Management Section of the Department of Administrative Services. The listing, as it exists from DAS is not sufficient for a vulnerability assessment or loss estimation. A growing number of the facilities are geocoded and many of the addresses are not sufficient to allow for automated geocoding. Considering the state owns everything from 30-story skyscrapers to small sheds, the decision was made to focus on structures whose values exceed $1 million or more, which has a key purpose in disaster response. Special cases exist at multi-building compound, such as prisons, while other structures were included that had lower values (or limited importance) due to their proximity to a structure meeting the thresholds.

Subsequently, the state determined which of the state-owned structures were considered to be critical facilities during a disaster. Critical facilities are defined as any facility whose services are necessary to the recovery and response operations following a disaster. Then, as disasters occurred, the Mitigation Strategy, prepared in support of the administration of the Hazard Mitigation Grant Program, included activities to geocode and obtain additional information on these identified facilities so vulnerability assessments and loss estimations could be completed.

The initial effort to geocode and collect basic building information focused on Franklin and Delaware counties. These counties encompass the state capital—the City of Columbus. The centers for most state operations are located in these counties. This initial effort was completed via a HMTAP contract with URS Corporation. Subsequent efforts included all counties declared in DR-1507-OH, DR-1556-OH, DR-1580-OH and DR-1720-OH. The Federal Coordinating

Officers for these disasters allowed mitigation DAEs to collect the same information URS collected for the declared counties.

The most recent effort was completed by a DAE activated to specifically complete another leg of the collection effort. After consultation with members of the Ohio EMA, the decision was made to start with the largest urban areas and work to the sparsely populated counties. The target leg of the effort was greater Cleveland. This included all the surrounding counties that encompass the Cleveland Metropolitan Statistical Area.

As resources become available, the next locations to inventory are the greater Cincinnati area, Dayton, and Toledo. Once all urban areas are completed the process will focus on the most populated rural counties and continue until all of Ohio has been geocoded.

For those counties still pending geocoding, the values of the anticipated inventory are provided. Because the State is a dynamic entity which builds, purchases, sells, and razes structures, the result is an ever changing inventory. Due to the uncertainty of the actual count and value of building, only those counties which have been geocoded are used for analysis.

Estimating Potential Losses of State Facilities

44 CFR 201.4 (c)(2)(iii) – The risk assessment shall include an overview and analysis of potential losses to identified structures, based on estimates provided in local risk assessments. The state shall estimate the potential dollar losses to state-owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas. The general methodology for the development of this section is discussed below, and any specific variation by hazard is addressed within the section for that specific hazard.

At this time, assessments have been completed in 20 of the 34 counties for state structures in Region 1 (see Table 2.1.a and Appendix C). The assessment will be completed as resources become available. Currently, there are a total of 118 state-owned structures. The value of geocoded structures in the region is $420,804,675. Out of those 33 are classified as critical facilities. The values of geocoded state-owned structures and critical facilities in Region 1 are $388,716,248 and $32,088,427, respectively. The county with the largest dollar exposure of state-owned structures is Marion at $288,139,569, due to a high security prison. Seneca County has the highest dollar exposure of critical facilities at $3,271,799.

Out of Region 2, assessments have been conducted on 19 of the 25 counties (see Table 2.1.a and Appendix C). The assessment for the remaining counties will be completed as resources become available. Presently, there are a total of 378 state-owned structures. The value of geocoded structures in the region is $2,565,418,691. 324 structures are state-owned structures and 54 are classified as critical facilities. The values state-owned structures and critical facilities in Region 2 are $2,362,890,560 and $202,528,131, respectively. As would be expected, Franklin County, which contains the state capital, represents the

majority of the dollar value with $1,859,092,160 in state-owned structures and $154,972,529 in critical facilities that are exposed.

Twenty-four of the 29 counties within Region 3 have been inventoried for vulnerable state-owned structures and critical facilities (see Table 2.1.a and Appendix C). The inventory for the remaining counties will be completed in phases as resources become available. Presently, there are a total of 172 state-owned structures and critical facilities, the value of which totals $172,695,204. 130 structures are state-owned structures and 42 are classified as critical facilities. The values of state-owned structures and critical facilities in Region 3 are $145,661,665 and $27,033,539, respectively. The county with the largest dollar exposure of state-owned structures is Belmont at $49,135,708 due to a prison. Lawrence County has the highest dollar exposure of critical facilities at $2,115,090.

UPDATE SUMMARY

The 2003 HIRA identified a comprehensive list of hazards, both manmade and natural, but only included a more complete risk assessment and vulnerability analysis for five hazards. Further updates in 2008 and 2011 included risk assessments/vulnerability analyses on all 12 natural hazards, and one technological hazard (dam/levee failure). Developing these data was a collaborative process involving several state and Federal agencies who are deemed to be the “experts” in their particular hazard(s). For the 2011 update, the existing analyzed hazards were reviewed for accuracy and availability of improved data. Based on the review it was determined that the following major updates be made:

- Data updates for the following hazards: Floods, Tornadoes, Winter Storms, Earthquakes, Droughts, Severe Summer Storms, and Invasive Species;
- Hazardous Materials and Terrorism were removed after careful consideration of the sensitivity of the information and the potential for misuse;
- The Dam/Levee Failures section was rewritten to incorporate a state-maintained dam inventory and dam priority list. Also, levee inventories from the State and FEMA were combined and evaluated.

Table 2.1.a

Total State-Owned Structure and Critical Facility Information by Region											
Region 1				Region 2				Region 3			
County	SO St. Value	SO CF Value	Total	County	SO St. Value	SO CF Value	Total	County	SO St. Value	SO CF Value	Total
Allen	$20,294,446	$7,966,963	$28,261,409	Ashland	$10,391,165	$13,976,980	$24,368,145	Adams	$0	$760,627	$760,627
Auglaize	$2,027,076	$1,529,944	$3,557,020	Ashtabula	$40,124,846	$3,463,499	$43,588,345	Athens	$32,505,169	$2,808,250	$35,313,419
Champaign	$0	$1,147,740	$1,147,740	Butler	$0	$5,505,878	$5,505,878	Belmont	$49,135,708	$1,347,740	$50,483,448
Clark	$0	$1,050,078	$1,050,078	Cuyahoga	$50,772,179	$6,213,702	$56,985,881	Brown	$65,208	$970,328	$1,035,536
Clinton	$0	$2,197,818	$2,197,818	Delaware	$23,872,985	$7,394,232	$31,267,217	Carroll	$0	$611,224	$611,224
Crawford	$0	$1,143,222	$1,143,222	Fairfield	$17,986,893	$766,764	$18,753,657	Clermont	$3,431,946	$253,692	$3,685,638
Defiance	$0	$4,340,497	$4,340,497	Franklin	$1,859,092,160	$154,972,529	$2,014,064,689	Columbiana	$1,568,280	$859,423	$2,427,703
Darke	$0	$868,109	$868,109	Geauga	$383,336	$834,720	$1,218,056	Coshocton	$0	$811,244	$811,244
Erie	$96,117,027	$3,489,853	$99,606,880	Greene	$4,660,889	$3,011,201	$7,672,090	Gallia	$17,060,839	$2,091,100	$19,151,939
Fayette	$222,581	$1,051,434	$1,274,015	Hamilton	$44,379,039	$5,348,848	$49,727,887	Guernsey	$7,604,726	$1,347,740	$8,952,466
Fulton	$0	$978,140	$978,140	Knox	$18,357,401	$804,670	$19,162,071	Harrison	$0	$1,057,617	$1,057,617
Hancock	$450,896	$1,819,770	$2,270,666	Lake	$152,384	$2,409,217	$2,561,601	Highland	$0	$597,712	$597,712
Hardin	$0	$1,302,642	$1,302,642	Licking	$22,315,457	$1,996,725	$24,312,182	Hocking	$489,094	$817,921	$1,307,015
Henry	$0	$792,984	$792,984	Lorain	$101,265,777	$1,046,127	$102,311,904	Holmes	$0	$394,405	$394,405
Huron	$0	$586,443	$586,443	Mahoning	$63,773,028	$351,783	$64,124,811	Jackson	$500,000	$1,266,000	$1,766,000
Logan	$0	$627,344	$627,344	Medina	$1,059,595	$169,000	$1,228,595	Jefferson	$500,000	$1,266,000	$1,766,000
Lucas	$111,043,289	$1,893,190	$112,936,479	Montgomery	$70,386,516	$5,887,936	$76,274,452	Lawrence	$0	$2,115,090	$2,115,090
Madison	$257,920,017	$1,581,407	$259,501,424	Pickaway	$214,139,019	$2,292,098	$216,431,117	Meigs	$0	$1,167,669	$1,167,669
Marion	$288,139,569	$648,543	$288,788,112	Portage	$5,133,427	$1,793,566	$6,926,993	Monroe	$0	$1,389,960	$1,389,960
Mercer	$0	$1,512,930	$1,512,930	Richland	$21,422,096	$1,413,370	$22,835,466	Morgan	$496,641	$1,508,239	$2,004,880
Morrow	$0	$1,381,740	$1,381,740	Stark	$38,275,862	$1,006,516	$39,282,378	Muskingum	$1,634,022	$200,000	$1,834,022
Miami	$0	$5,995,119	$5,995,119	Summit	$60,369,325	$3,552,785	$63,922,110	Noble	$57,142,664	$969,943	$58,112,606
Ottawa	$32,968,327	$2,494,800	$35,463,127	Trumbull	$8,858,101	$0	$8,858,101	Perry	$0	$1,385,505	$1,385,505
Paulding	$0	$866,022	$866,022	Warren	$59,409,389	$2,879,191	$62,288,580	Pike	$0	$822,565	$822,565
Preble	$0	$1,887,841	$1,887,841	Wayne	$0	$946,254	$946,254	Ross	$5,781,342	$2,019,777	$7,801,119
Putnam	$0	$1,479,060	$1,479,060	TOTAL	$2,362,890,560	$202,528,131	$2,565,418,691	Scioto	$109,023,716	$1,673,596	$110,697,312
Sandusky	$2,390,700	$635,000	$3,025,700					Tuscarawas	$19,764,050	$1,745,600	$21,509,650

Total State-Owned Structure and Critical Facility Information by Region								
Region 1				Region 2		Region 3		
Seneca	$11,557,307	$3,271,799	$14,829,106	Legend		Vinton	$0	$774,725	$774,725
Shelby	$5,436,099	$3,024,399	$8,460,498	White Cell ~ Geocoded		Washington	$5,624,640	$1,742,468	$7,367,108
Union	$60,567,524	$951,936	$61,519,460	Amber Cell ~ Data Only		TOTAL	$145,661,665	$27,033,539	$172,695,204
Van Wert	$20,750	$1,147,740	$1,168,490						
Williams	$0	$3,425,334	$3,425,334						
Wood	$7,606,913	$4,723,866	$12,330,778						
Wyandot	$0	$699,287	$699,287	Additional county inventories will be completed as opportunities arise.					
TOTAL	$388,716,248	$32,088,427	$420,804,675						

HAZARD IDENTIFICATION SUMMARY

The hazards evaluated in the SOHMP to determine whether they could potentially affect the state include:

1) Coastal Erosion
2) Droughts
3) Earthquakes
4) Floods
5) Storm Surges
6) Landslides
7) Land Subsidence
8) Natural Biohazards (Invasive species)
9) Severe Thunderstorms
10) Windstorms
11) Hailstorms
12) Severe Winter/Ice Storms
13) Tornadoes
14) Wildfire
15) Tropical Cyclones
16) Snow Avalanches
17) Extreme Summer Weather
18) Expansive Soils
19) Tsunami
20) Volcano
21) Dam Failure
22) HAZMAT
23) Terrorism
24) Urban Fire
25) Nuclear Accidents

The list was more closely examined, paying special attention to the likelihood of future occurrence and the fact that many of the identified hazards are interrelated (i.e., landslides can be a result of flooding). Following this, the list of hazards was reduced to the hazards that are most likely to affect the state and are most likely to pose more serious threats.

For the purpose of ranking hazards affecting the state, in order of importance for mitigating their effects, a hazard index was assigned (see Table 2.1.b) on a scale of 1-5, with 5 being the highest priority for considering mitigation goals (highest, high, medium, low, and lowest). This index takes into account the anticipated frequency of occurrence (see Table 2.1.c), the specific consequences of impact (see Table 2.1.d) and if there has been a past declaration for that particular hazard. This is not meant to be a scientific process, but will serve as a way to prioritize mitigation goals based on the potential frequency and likely extent of damage from hazards known to affect the state.

It is important to note that HIRAs are developed for different purposes. For the purposes of emergency planning and similar functions, a document called the *2007 Ohio HIRA* has also been produced. The *2007 Ohio HIRA* (Appendix I) prioritizes hazards utilizing criteria developed to facilitate emergency planning. These criteria include frequency, duration, speed of onset, magnitude, impact on business, impact on people, and impact on property. This method assigns a numerical value to vulnerability based on the criteria of impacts on businesses,

people, and property. The *2007 Ohio HIRA* places more emphasis on life safety issues versus the HIRA performed for the SOHMP which places a similarly high priority on property/facility damage. Also, the *2007 Ohio HIRA* evaluates manmade hazards. These data are valuable as they represent another method to "ground truth" the data in the SOHMP HIRA.

Table 2.1.b

Hazard Index Ranking				
Impact → / Frequency of Occurrence ↓	Catastrophic	Critical	Limited	Negligible
Highly Likely	5 *(Highest)*	4 *(High)*	4 *(High)*	3 *(Medium)*
Likely	5 *(Highest)*	4 *(High)*	3 *(Medium)*	2 *(Low)*
Possible	4 *(High)*	3 *(Medium)*	2 *(Low)*	2 *(Low)*
Unlikely	3 *(Medium)*	2 *(Low)*	1 *(Lowest)*	1 *(Lowest)*
Highly Unlikely	2 *(Low)*	1 *(Lowest)*	1 *(Lowest)*	1 *(Lowest)*

Source: FEMA, 1997

Table 2.1.c

Frequency of Occurrence	
Highly Likely	Near 100 Percent probability in the next year.
Likely	Between 10 and 100 percent probability in the next year, or at least one chance in the next 10 years.
Possible	Between 1 and 10 percent probability in the next year, or at least one chance in the next 100 years.
Unlikely	Less than 1 percent probability in the next year, less than one chance in the next 100 years.
Highly Unlikely	Little to no probability in next 100 years.

Source: FEMA, 1997

Table 2.1.d

Consequences of Impact	
Catastrophic	Multiple Deaths, complete shutdown of facilities for 30 days or more, more than 50 percent of property is severely damaged.
Critical	Multiple severe injuries, complete shutdown of critical facilities for at least 2 weeks, more than 25 percent of property is severely damaged.
Limited	Some injuries, complete shutdown of critical facilities for more than one week, more than 10 percent of property severely damaged.
Negligible	Minor injuries, minimal quality-of-life impact, shutdown of critical facilities and services for 24 hours or less, less than 10 percent of property is severely damaged.

Source: FEMA, 1997

Table 2.1.e

Hazard Ranking Assessment				
Hazard	**Past Federal Declarations**	**Frequency**	**Impact**	**Hazard Ranking**
Natural Hazards				
Coastal Erosion	No	Highly Likely	Negligible	3
Droughts	No	Likely	Negligible	2
Earthquakes	No	Possible	Limited	2
Floods	Yes	Highly Likely	Critical	4
Seiche / Coastal Flooding	No	Likely	Limited	3
Landslides	Yes	Highly Likely	Limited	4
Land Subsidence	No	Possible	Negligible	2
Invasive Species	No	Highly Likely	Limited	4
Severe Thunderstorms	Yes	Highly Likely	Critical	4
Windstorms	Yes	Highly Likely	Critical	4
Hailstorms	No	Likely	Negligible	2
Severe Winter/Ice Storms	Yes	Highly Likely	Critical	4
Tornadoes	Yes	Highly Likely	Critical	4
Wildfire	No	Likely	Limited	3
Tropical Cyclones	No	Unlikely	Negligible	1
Snow Avalanches	No	Highly Unlikely	Negligible	1
Extreme Summer Weather	No	Likely	Negligible	2
Expansive Soils	No	Unlikely	Negligible	1
Tsunami	No	Highly Unlikely	Negligible	1
Volcano	No	Highly Unlikely	Negligible	1
Technological Hazards				
Dam Failure	No	Possible	Critical	3
Hazardous Materials Events	No	Likely	Negligible	2
Terrorism	No	Unlikely	Critical	2
Urban Fire	No	Highly Likely	Negligible	3
Nuclear Accidents	No	Unlikely	Critical	2

Once the hazard ranking was complete an assessment was conducted to narrow the field of hazards (see Table 2.1.e). Several hazards were deleted from the list based on the unlikelihood of occurrence and the potential for a negligible impact on the state should they occur. These include tropical cyclones, snow avalanches, extreme summer weather, expansive soils, tsunami events, and volcano events. Other hazards were combined, as many of them are factors in larger hazards. The final hazard list included 15 hazards, which are listed in order of importance below.

- **Flooding** (4) – which includes flash flooding and normal riverine flooding. There have been numerous past federal and state declarations for this disaster.
- **Seiche / Coastal Flooding** (4) – this is a geographically specific hazard for areas bordering Lake Erie. There have been no past declarations for this disaster.
- **Tornadoes** (4) – which include windstorms. There have been several past declarations for tornadoes and high wind events resulting from severe thunderstorms.
- **Landslides** (4) – which include road slips and mudslides. There have been several declarations for this type of disaster many resulting from severe flooding.
- **Winter Storms** (4) – which include snowstorms, ice storms and any other winter precipitation. There have been many declarations for this type of disaster.
- **Severe Summer Storms** (4) – these storms have a higher ranking than dam/levee failure because there are many factors associated with severe thunderstorms. In Ohio the primary disaster factors for severe thunderstorms have been flooding, tornadoes, high wind events, and landslides all of which have been addressed separately. Other aspects of severe thunderstorms (hail and lightning) are not as pressing in the overall mitigation process.
- **Invasive Species** (4) – There have been no federal declarations for invasive species to date.
- **Dam / Levee Failure** (3) – Though dam/levee failure is not at the top of the ranking chart, it is still considered an important hazard since it is related to flooding as either a cause or effect.
- **Coastal Erosion** (3) –Erosion from coastal storms and normal Lake Erie fluctuations.
- **Wildfire** (3) – there have been no federal declarations for wildfires to date.
- **Land Subsidence** (2) – there have been no federal declarations for land subsidence to date.

- **Droughts** (2) – there have been no federal declarations for droughts to date.
- **Earthquakes** (2) – there have been no federal declarations for earthquakes to date.
- **Hazardous Materials (HAZMAT)** (2) – which include nuclear accidents. There have been no federal declarations for HAZMAT events to date.
- **Terrorism** (2) – there have been no federal declarations directly referred to as terrorism in the past. However, in August 2003 there was a declaration related to power outage, which began in Cleveland and spanned across a significant portion of the northern United States and southern Canada. This grid could be considered a major target area in future terrorist activity and should be planned for accordingly.

This plan discusses each of the hazards in more detail with the exception of two technological hazards that were previously mentioned in the 2003 SOHMP – terrorism and hazardous materials. It is felt that these two hazards are better addressed in ongoing Homeland Security and emergency management planning efforts and are represented in the *2007 Ohio HIRA*.

According to the Ohio HIRA, the following are the top ten hazards (ranking score in parenthesis): Riverine Flooding (27.00), Windstorm/tornado (26.25), Flash flood/seiche (23.75), Snow/ice/hail/sleet (23.25), Radiological Incidents (22.25), Disease Human (22.00), Water Control Structure Failure (22.00), Disease – Animal (21.50), building/structure collapse (20.75), and terrorism (20.00). These tend to correspond fairly well with the hazards profiled in the SOHMP HIRA, with the exception of radiological incidents, disease (human and animal), and terrorism (none of which are evaluated in the SOHMP HIRA).

2.2 FLOOD

Floods are natural and beneficial functions of stream and lacustrine systems. Floods occur when streams or lakes overflow their banks and spill onto the adjoining land area, which is called a floodplain. Loss of life and property can result when people build structures and develop in flood hazard areas. Numerous factors can cause or exacerbate flooding in Ohio including: heavy and/or prolonged periods of rainfall, snowmelt, soil saturation, ground freeze, severe wind events, and inadequate drainage systems. Floods damage private and public property and infrastructure in Ohio every year. Flooding is the most frequently occurring natural disaster in Ohio and the United States.

RISK ASSESSMENT

The two major drainage basins in Ohio are the Lake Erie and Ohio River basins. Streams in the northern third of the state flow into Lake Erie and eventually into the Atlantic Ocean. Streams in the southern two-thirds of the state flow into the Ohio River and eventually into the Gulf of Mexico.

There are many types of flooding that occur in Ohio including: riverine, flash flooding, coastal flooding, and shallow flooding. Riverine flooding is generally characterized by slower rising water, which allows for increased warning time but has the potential to last for longer periods of time. Ohio communities experience riverine flooding on both large basins and smaller tributary streams throughout the state. Major sources of riverine flooding in Ohio include the Ohio River, Scioto River, Great Miami River, Muskingum River, Hocking River, Maumee River, Blanchard River, Sandusky River, Cuyahoga River, Grand River, Little Miami River, the Mahoning River and their larger tributaries.

Flash flooding can occur when a severe storm produces large amounts of rainfall in a short time. Flash flooding is generally characterized by high velocity water that rises and recedes quickly allowing little or no warning time to evacuate. Ohio's Appalachian Region is particularly vulnerable to flash flooding because of the steep terrain and narrow stream valleys. Ohio's urban areas also experience flash flooding that may be attributed to inadequate or poorly maintained storm water infrastructure, increased impervious area, and lost wetland areas. The U.S. Geological Survey (USGS) has concluded that urbanization generally increases the size and frequency of floods and may increase a community's flood risk.

Coastal flooding occurs in the counties that border Lake Erie. Flooding in coastal areas can be caused by stream overflow, wave run-up caused by strong winds, and higher than normal lake levels. Annual fluctuations in Lake Erie water levels are the result of seasonal changes and the amount of water flowing into and out of the lake. In-flow for Lake Erie includes drainage from the upper portion of the Great Lakes basin through the Detroit River, water from streams flowing directly into the lake, contribution from ground water, and from precipitation falling directly into the lake. Out-flow includes discharge into Lake Ontario through the Niagara River, evaporation, and any diversion or other withdrawals. Lake Erie

levels also exhibit a wider range of long-term fluctuations that are the result of prolonged and persistent deviation from average climatic conditions.

Shallow flooding occurs in flat areas with inadequate channels that prevent water from draining easily. There are four types of shallow flooding: sheet flow, ponding, urban drainage and rural drainage. Sheet flow flooding occurs in areas where channels are not defined. Sheet flow flooding moves downhill and covers a large area under a relatively uniform depth.

Ponding occurs in flat areas where runoff collects in depressions and cannot drain out. Ponding can occur where glaciers carved out depressions in the landscape, and where man-made features such as roads have blocked drainage outlets.

Urban drainage systems can include combinations of ditches, storm sewers, detention ponds, house gutters, and yard swales. When a rainfall event exceeds the design capacity of the drainage system, it can result in sewer back up and overflowing ditches. Basements are highly susceptible to flood damage caused by overloaded sewer and drainage systems. Urban drainage flooding can also occur behind levees when rainfall amounts exceed the capacity of pumps or other man-made systems designed to drain the areas protected by the levees.

Rural drainage flooding in northwest Ohio is similar to urban drainage flooding in Ohio's cities and villages. Most of northwest Ohio was covered by a large swamp prior to European settlement that was subsequently drained, and since used mainly for agriculture. The flat topography of this area is drained by an extensive system of ditches, swales, and small meandering streams. Rural flooding occurs when rainfall exceeds the design capacity of the drainage system.

Ohio's river systems offer many benefits that have contributed to the development of the state such as: transportation, waste disposal, energy, commerce, recreation, and water supply. As a result, most major communities include development in flood hazard areas. Wetland areas have been developed, streamside forests have been removed, and streams have been straightened and channelized to allow for faster and increased runoff. After two centuries, these development patterns have drastically changed Ohio's riparian ecosystems, and resulted in escalating flood damages.

Historical responses to flooding can be divided into three major era's according to the Federal Interagency Floodplain Management Task Force. The Frontier Era (Pre-1917) is characterized by limited federal involvement in flood control or relief. During this time, many federal policies and programs encouraged land development with the common goal being "to conquer the wild landscape and to promote productive use of the land". Flood hazards were the problem of the individual property owner, or dealt with cooperatively at the local level.

The Structural Era (1917-1959) is characterized by attempts to modify and control floodwater and get water off the land as quickly as possible. The federal government began assuming the costs to construct dams, levees, reservoirs, and

other large structural flood control projects. Near the end of this era resource managers began to realize that flood control projects were not eliminating flood damage and may be harming the environment.

During the Stewardship Era (1960-present), people began to recognize the important benefits and natural functions provided by floodplain areas such as natural flood and erosion control, water quality maintenance, groundwater recharge, recreation, wildlife habitat, agricultural production and many others. The responsibility of floodplain management began to shift from the federal government back to the local level. The federal government began to focus on providing financial assistance to reduce and recover from the impacts of flooding. Congress created the National Flood Insurance Program (NFIP) in 1968 as a response to mounting flood losses and increasing disaster relief costs. The intent of the program is to reduce future flood damage through community floodplain management ordinances, and provide an insurance alternative to federal disaster relief.

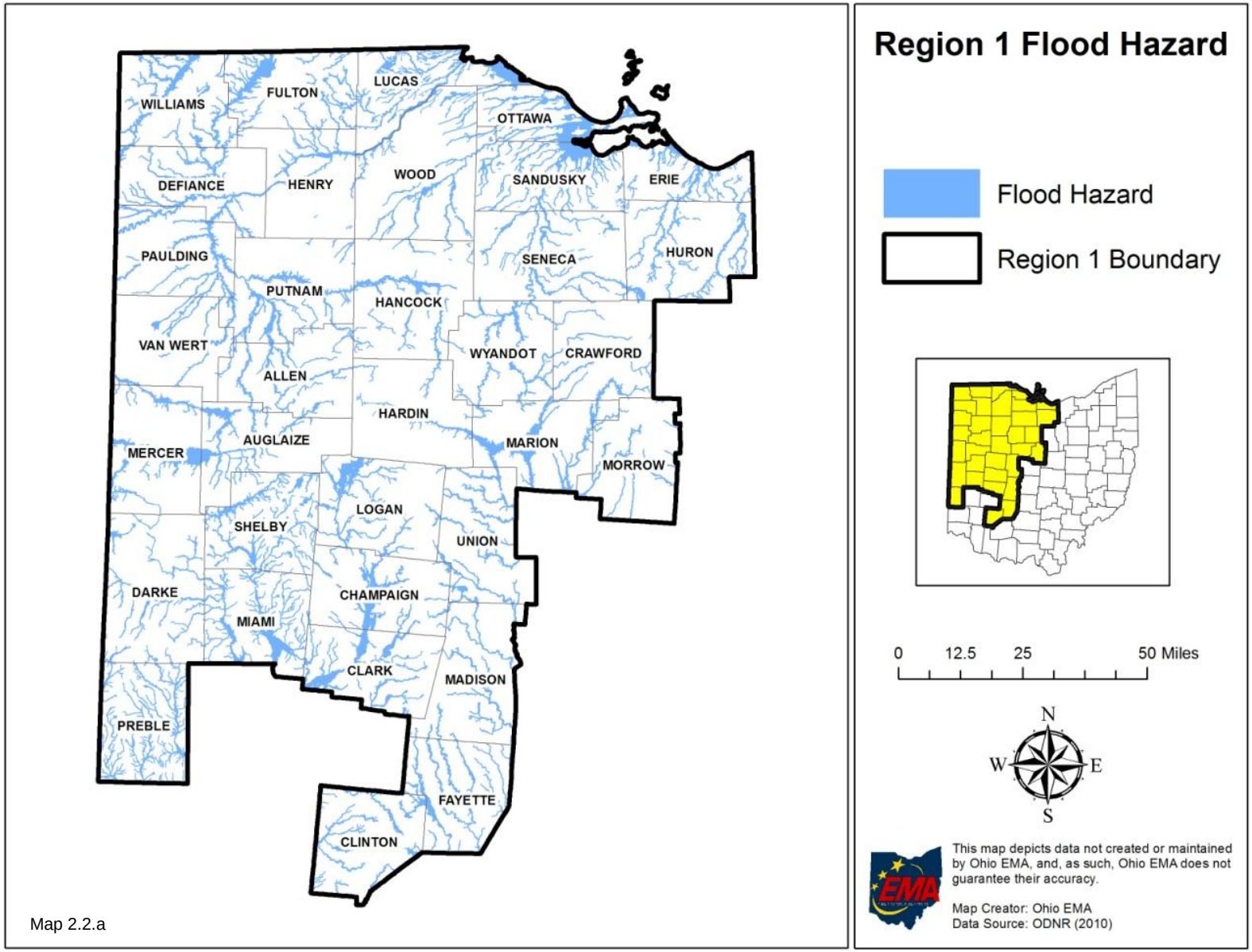
The political jurisdictions in Ohio that are eligible to participate in the NFIP include cities, villages, and unincorporated areas (through the county government). There are 251 cities, 688 villages, and 88 counties in Ohio. There are 743 Ohio communities (which include cities, villages, and 86 counties) that participate in the NFIP. FEMA has identified flood hazard areas in every county in the state. As of December 2010, there are 40,412 flood insurance policies in effect for $6,166,391,500 in coverage statewide. Since 1978, the NFIP has paid 21,967 claims totaling $239,203,259.

Location

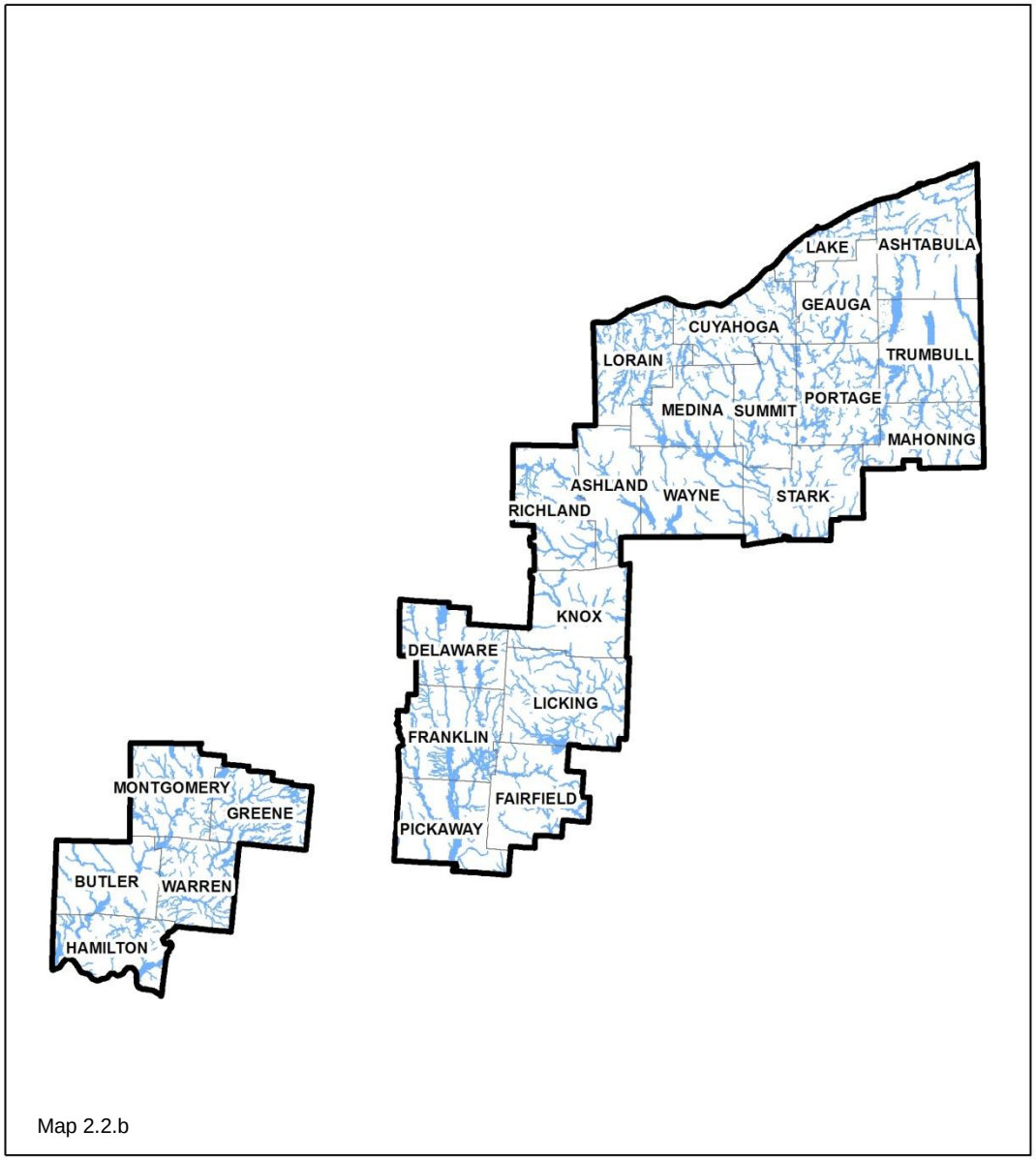
The four sources of information used to determine the location of flooding in Ohio are FEMA flood maps and studies, NOAA data, information provided by the Ohio Department of Natural Resources - Division of Soil and Water Resources, and HAZUS analyses. Flood maps generated by FEMA to support the NFIP are the primary source of information on the location of special flood hazard areas (SFHAs) in the state. There are two main types of flood maps: the Flood Hazard Boundary Map (FHBM) and the Flood Insurance Rate Map (FIRM). The FHBM identifies approximate SFHAs based on the best available data at the time the map was created.

Generally, Flood Insurance Studies (FISs) and FIRMs are issued by FEMA following a detailed engineering analysis of flood hazard areas in participating communities. The FIS and FIRM identify 1%-annual-chance flood elevations and boundaries for selected stream reaches in the community. The FIRM will contain flood elevation information for various flood frequencies and may also delineate floodway boundaries.

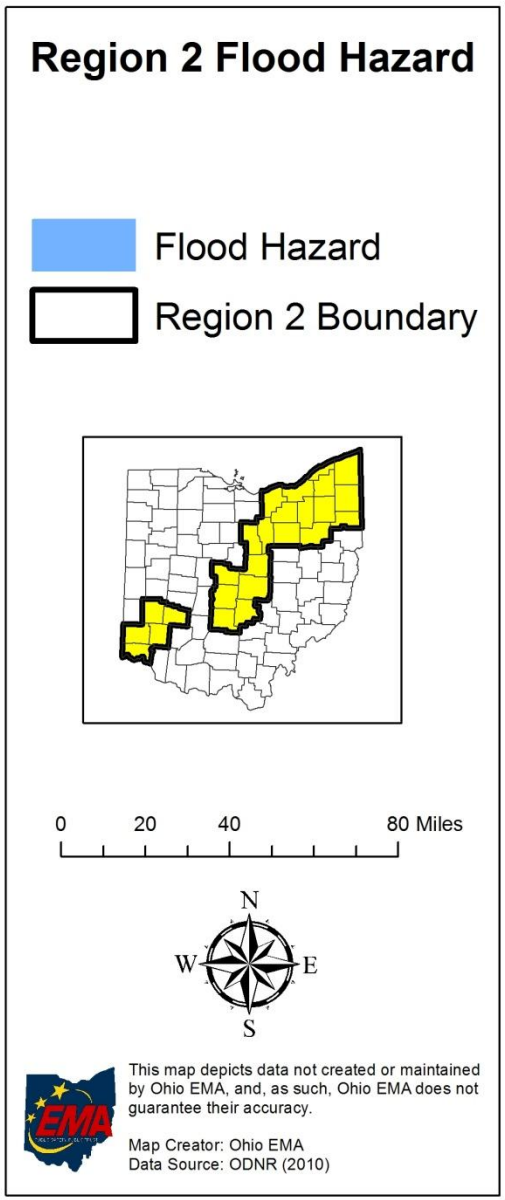
Flooding occurs in every county in Ohio. There are over 60,000 miles of named, unnamed and intermittent streams in Ohio. FEMA has mapped approximately 2,777 square miles of flood hazard area in the state. Maps 2.2.a -2.2.c display FEMA identified SFHAs in the State of Ohio for the designated Regions.

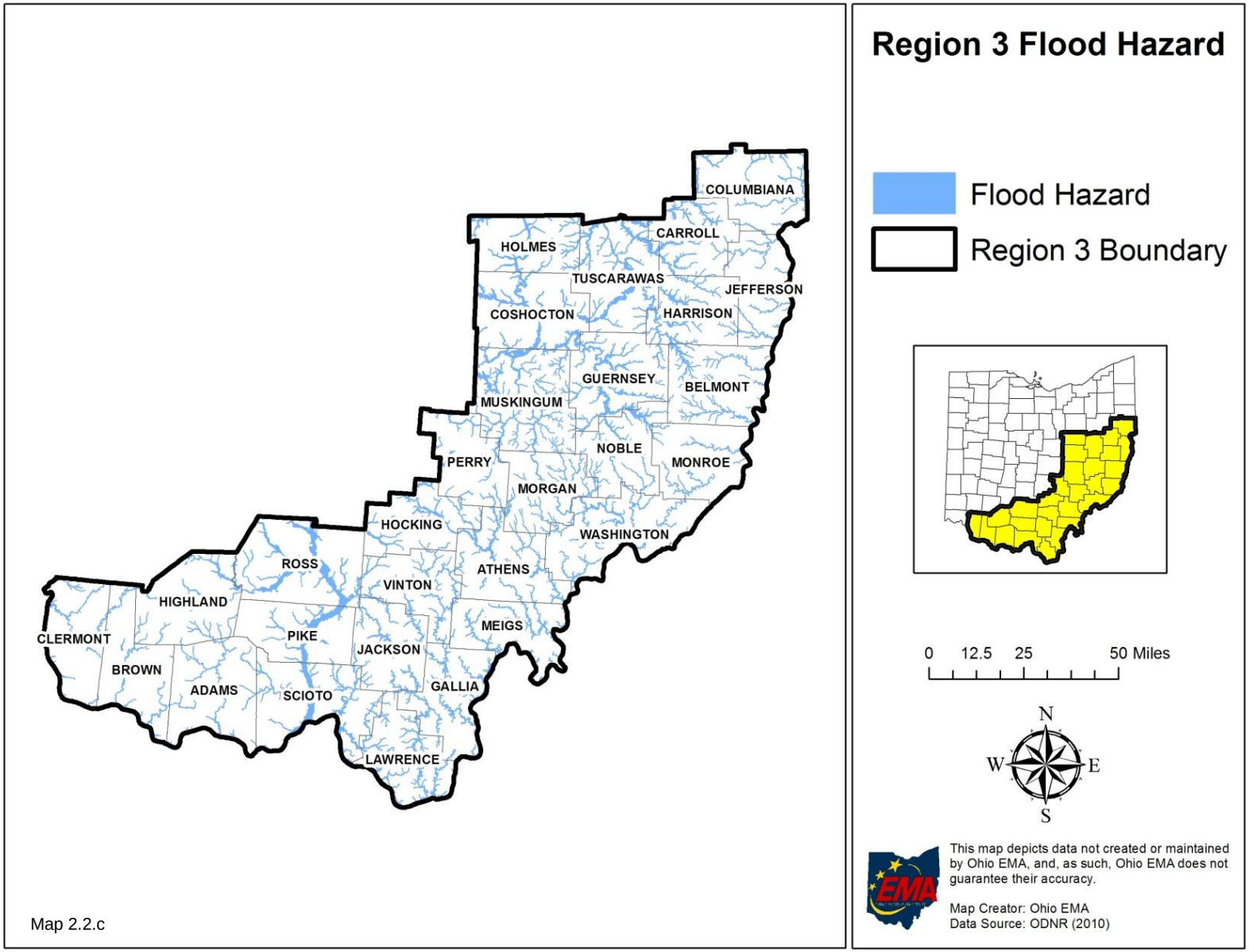

Region 1 Flood Hazard
Flood Hazard
Region 1 Boundary
WILLIAMS
FULTON
LUCAS
OTTAWA
DEFIANCE
HENRY
WOOD
SANDUSKY
ERIE
PAULDING
SENECA
HURON
PUTNAM
HANCOCK
VAN WERT
WYANDOT
CRAWFORD
ALLEN
HARDIN
AUGLAIZE
MARION
MERCER
MORROW
LOGAN
SHELBY
UNION
DARKE
CHAMPAIGN
MIAMI
CLARK
MADISON
PREBLE
FAYETTE
CLINTON
0 12.5 25 50 Miles
N
W
E
S
This map depicts data not created or maintained by Ohio EMA, and, as such, Ohio EMA does not guarantee their accuracy.
Map Creator: Ohio EMA
Data Source: ODNR (2010)

Map 2.2.a


LAKE
ASHTABULA
GEAUGA
CUYAHOGA
TRUMBULL
LORAIN
PORTAGE
MEDINA
SUMMIT
MAHONING
ASHLAND
WAYNE
STARK
RICHLAND
KNOX
DELAWARE
LICKING
FRANKLIN
FAIRFIELD
PICKAWAY
MONTGOMERY
GREENE
BUTLER
WARREN
HAMILTON

Map 2.2.b


Region 2 Flood Hazard
Flood Hazard
Region 2 Boundary
0
20
40
80 Miles
N
W
E
S
This map depicts data not created or maintained by Ohio EMA, and, as such, Ohio EMA does not guarantee their accuracy.
Map Creator: Ohio EMA
Data Source: ODNR (2010)


Region 3 Flood Hazard
Flood Hazard
Region 3 Boundary
COLUMBIANA
CARROLL
HOLMES
TUSCARAWAS
JEFFERSON
COSHOCTON
HARRISON
GUERNSEY
BELMONT
MUSKINGUM
NOBLE
PERRY
MONROE
MORGAN
HOCKING
WASHINGTON
ROSS
ATHENS
VINTON
HIGHLAND
MEIGS
CLERMONT
PIKE
JACKSON
BROWN
ADAMS
SCIOTO
GALLIA
LAWRENCE
0 12.5 25 50 Miles
N
W
E
S
This map depicts data not created or maintained by Ohio EMA, and, as such, Ohio EMA does not guarantee their accuracy.
Map Creator: Ohio EMA
Data Source: ODNR (2010)
Map 2.2.c

The NOAA's National Climate Data Center (NCDC) Storm Events Database contains information on the location of flood events in Ohio. The database can be searched by county and includes a written description of the location of flood events reported in the state. The database also contains latitude and longitude values for some events and contains information on reported deaths, injuries, and estimated property and crop damage. The database can be found on the NCDC website.

The Ohio Department of Natural Resources, Division of Soil and Water Resources is mandated to be a state repository for flood hazard information (Ohio Revised Code Section 1521.13(C)(2)). The Floodplain Management Program maintains copies of flood hazard data generated by various federal, state, local, and private entities.

Past Occurrences

Profiling past occurrences of flooding at the state level involves gathering and compiling data from many different sources. The data sources used to profile the past occurrences of flooding include FEMA, the ODNR, the Ohio EMA, the NOAA, and the book *Thunder in the Heartland* by Thomas W. and Jeanne Applehans-Schmidlin, 1996. Table 2.2.a displays a summary of historic flooding information from 1860 to 1990 based on the chronicle *Thunder in the Heartland: A Chronicle of Outstanding Weather Events in Ohio.* More specific information on these events as well as events post 1990 can be found in the narrative of this section.

Table 2.2.a

Summary of Historic Flood Events 1860-1990[1]			
Date of Event	**Affected Area(s)**	**Water Bodies Affected**	**Event Description**
8/12/1861	Columbiana County, Elkton, Lisbon	Beaver Creek, Elk Run	Every home in Elkton was damaged and four persons drowned when one home was washed off its foundation.
2/17/1867	Toledo, Maumee	Maumee River	Ice jams destroyed one bridge and damaged several others. Flooding in downtown Toledo.
2/11/1881	Toledo, Grand Rapids, Columbus, Findlay	Maumee River, Scioto River, Blanchard River	Four bridges were damaged by ice jams and debris in Toledo. Flooding in downtown Toledo.
2/1883	Statewide	Auglaize, Blanchard, Maumee, Portage, and Sandusky Rivers	A combination of snowmelt, ice jams, frozen ground and heavy rains caused flooding statewide.
2/14/1884	Statewide	Ohio, Hocking, Maumee, and Muskingum Rivers	Second highest stage on the Ohio River in Cincinnati. Thousands were evacuated and 3000 buildings were submerged.
5/12/1886	Xenia	Shawnee Creek	Flash flooding washed away several homes killing 21 people and destroying one bridge.
1/23/1904	Lorain, Toledo, Waverly	Black, Scioto, Mahoning and Maumee Rivers	Ships, bridges, and structures were damaged by ice jams and flooding.
3/14-18/1907	Ohio River Watershed	Southern 2/3 of Ohio	Large scale flooding in the Ohio River Watershed resulted in 32 casualties, hundreds of flooded structures, utility and infrastructure damage.
3/23-27/1913	Statewide	Statewide	Described as "Ohio's Greatest Weather Disaster". Four days of heavy rain on saturated soils resulted in 467 casualties, over 2,200 homes destroyed, over 40,000 damaged, and over $2.5 Billion damage in 2003 dollars.
7/16/1914	Cambridge	Wills Creek Watershed	Over 7.09 inches of rain in 1.5 hours causing flash flooding.
8/16/1920	Toledo	Maumee River	Flash flooding in downtown Toledo damaged homes, businesses and infrastructure.

Summary of Historic Flood Events 1860-1990[1]			
Date of Event	**Affected Area(s)**	**Water Bodies Affected**	**Event Description**
2/26/1929	Cleveland, Dayton, Mt. Vernon, Bridgeport, Springfield	Little Miami, Maumee, Miami, Rocky, Mad, and Kokosing Rivers, Wheeling and Buck Creeks	Two to three inches of rain, melting snow, and ice jams caused widespread flooding.
3/21/1933	Cincinnati and Southern Ohio	Ohio River	Two periods of heavy rain cause widespread minor flooding.
8/7/1935	Coshocton and surrounding counties	Tuscarawas Watershed	Heavy rain on saturated soils saturated soils caused flash flooding.
3/19/1936	Ohio River Communities from Pittsburgh to Steubenville	Upper Ohio River	Snowmelt and heavy rains in Penn. and W. Virginia caused the Ohio River to rise 20 feet in two days.
1/26/1937	All Ohio River Communities	Ohio River	Described as the "Greatest Flood on the Ohio River". Record levels on the Ohio River from Gallipolis to the confluence with the Mississippi.
7/7/1943	Akron and Steubenville	Cuyahoga River, Cross and Wills Creeks	Six to seven inches of rain in several hours caused flash flooding and landslides.
6/16/1946	Wayne and Holmes Counties	Killbuck and Salt Creeks	Heavy rain caused flash flooding resulting in one death, a train wreck destroying 5 bridges and seriously damaging 55 others.
6/8/1947	Adams, Lawrence and Scioto Counties	South Fork of Scioto Brush Creek and other small tributaries to the south emptying into the Ohio River	Flash flooding damaged many homes, bridges, roads, and crops.
3/21/1948	Counties in the Lake Erie Watershed	Lake Erie Watershed	The most severe damage was reported in along the Chagrin River in Cleveland. Twenty buildings were destroyed and 153 were damaged.
6/16/1950	Crooksville, Roseville	Moxahala Creek Watershed	One of the most intense rainfalls ever known in Ohio caused severe flood damages to homes and businesses.

Summary of Historic Flood Events 1860-1990[1]			
Date of Event	**Affected Area(s)**	**Water Bodies Affected**	**Event Description**
1/21/1959	Statewide	Statewide	Rainfall in January 1959 ranging from 3-6 inches on snow-covered, frozen ground caused the most severe statewide flooding since 1913. Streams reached flood stage from January 21-24 killing 16 people, forcing 49,000 people from their homes, and causing extensive damage to homes, businesses and infrastructure.
6/5/1963	Guernsey County	Wills Creek Watershed	Official records indicate 7.95 inches of rainfall in 16-hours in Cambridge. One railroad bridge was destroyed, all major highways were inundated, and water supplies were polluted.
3/10/1964	Southern and Central Ohio	All Streams in Southern and Central Ohio	Two periods of heavy rain cause widespread flooding resulting in eight deaths, thousands evacuated, 84 homes destroyed, and 8,200 damaged.
7/21/1964	Akron	Ohio Canal and Little Cuyahoga River	Official records indicate 3.05 inches of rain in 75 minutes, but rain distribution was variable. The resulting flooding caused a sewer line to collapse a large section of road killing 3 people.
4/27/1966	Communities Along Lake Erie's Western Basin	Lake Erie's Western Basin	Several hours of winds up to 55 mph from the northeast pushed the western end of Lake Erie to flood stage. Fifteen hundred were evacuated, hundreds of homes were damaged, and utility services were interrupted.
7/12/1966	Erie, Ottawa, and Huron Counties	Sandusky and Huron River Watersheds	Rainfall totals ranging from 9-12 inches of rainfall over and approximately one-day period. Total damages exceed $27 million in 2003 dollars, including damages to 12,000 homes and businesses in Sandusky.
5/23-27/1968	Central and Southern Ohio	Hocking, Scioto, Little Miami	Two periods of heavy rain within 5 days on already saturated soils caused flooding on many streams. Four deaths have been attributed to this event.

Summary of Historic Flood Events 1860-1990[1]			
Date of Event	**Affected Area(s)**	**Water Bodies Affected**	**Event Description**
7/4/1969	Northern Ohio	Lake Erie Watershed	Severe thunderstorms moved from Lake Erie into Ohio's coastal communities on July 4, 1969. Flooding combined with strong wind and tornadoes caused 41 deaths and injured 559 people. Loss estimates for this event totaled $65 million dollars in 1969, or over $328 billion in 2003 dollars.
11/14/1972	Coastal communities from Toledo to Cedar Point	Lake Erie	Northeast wind setup caused Lake Erie to rise 3 feet at Toledo and fall 4 feet at Buffalo resulting in coastal flooding. Total damages were estimated at $22 million in 1972 dollars.
4/9/1973	Coastal communities from Toledo to Port Clinton	Lake Erie	Northeast winds caused 8 to 10 foot waves and flooding.
9/14/1979	Southeastern half of the state		The remains of Hurricane Frederic brought six inches of rain in a band from Cincinnati to Youngstown causing widespread flooding.
3/12/1982	Communities in the Maumee River Watershed	Maumee River Watershed	Two inches of rainfall on snow covered, frozen ground caused flooding. Loss estimates totaled $11 million in 1982 dollars with Defiance County being the hardest hit.
6/14/1990	Shadyside in Belmont County	Pipe Creek and Wegee Creek	Twenty-six people died in a flash flood near Shadyside. Approximately 80 homes were destroyed and 250 were damaged. An estimated that 3-4 inches of rain fell in a little over an hour.
12/31/1990	Widespread	Widespread	The wettest year on record ended with extensive flooding on New Year's Eve causing $50 million (1990 dollars) in damages.

1 - Information summarized from the book: *Thunder in the Heartland A Chronicle of Outstanding Weather Events in Ohio*, Schmidlin, Thomas W., and Jeanne A., Kent State University Press, 1996.

Historically, significant floods in Ohio occurred in 1913, 1937, 1959 and 1969. Heavy rain on saturated soils caused flooding throughout Ohio during March 23-27, 1913 killing 467 people, destroying 2,200 homes, and flooding 40,637 residences. Losses totaled $113 million in 1913 dollars ($2.5 billion in 2010 dollars), including: $78 million to buildings and personal property, $12 million to roads and bridges, $12 million to railroad property, which includes lost profit, $6 million to the agricultural industry, and $4 million dollars to machinery. This flood set record water levels on many Ohio streams. The Miami River Watershed experienced the highest casualties and damages during this event.

The flood of record for the Ohio River occurred the last two weeks in January 1937. Normal January precipitation in Ohio is 2-3 inches. The statewide average rainfall in January 1937 was 9.57 inches, with some stations recording over 14 inches. Ohio River levels on January 26-27 were the highest ever recorded from Gallipolis, Ohio to the confluence with the Mississippi River. Every Ohio community along the river was flooded resulting in 10 casualties, 16 injuries, thousands of damaged structures, and over 54,000 evacuations statewide.

Rainfall in January 1959 ranging from 3-6 inches on snow-covered, frozen ground caused the most severe statewide flooding since 1913. Streams reached flood stage from January 21-24 killing 16 people, forcing 49,000 people from their homes, and causing extensive damage to homes, businesses and infrastructure. Loss estimates for this event totaled $100 million in 1959, or over $752 million in 2010 dollars. Some of the factors that reduced casualties and damages from the 1913 flood include: less intense rainfall amounts, the construction of flood-control reservoirs built after 1913, and improved emergency management procedures and capabilities.

Severe thunderstorms moved from Lake Erie into Ohio's coastal communities on July 4, 1969. This line of storms became nearly stationary for more than eight hours aligned from Toledo southeast to Wooster. Official records indicate over 10 inches of precipitation lasting over a 2-day period. Flooding combined with strong winds and tornadoes caused 41 deaths and injured 559 people. Loss estimates for this event totaled $65 million dollars in 1969, or over $388 million in 2010 dollars. This flood caused extensive damage to homes, businesses, infrastructure, utilities, boats and automobiles.

Twenty-six people died in a flash flood near Shadyside, Ohio on June 14, 1990. The National Weather Service estimated that 3-4 inches of rain fell in a little over an hour near Pipe Creek and Wegee Creek. Total rainfall is estimated at 5.5 inches in three hours. The saturated soils and narrow, steep-sided valleys caused the water to drain quickly into the creeks. Flash flooding began at 9:30PM and was over in 30 minutes. During that time a wall of water six feet high (reported to be 20 feet in some areas) rushed through the valley at seven to ten miles-per-hour. Approximately 80 homes were destroyed and 250 were damaged.

Storms that produced heavy rains during March 1-2, 1997, resulted in severe flooding in southern Ohio. The largest accumulations of rainfall were recorded in southern Adams and Brown Counties and ranged from 10-12 inches over the two-day period. Generally, rainfall amounts of four or more inches fell on most of the counties along or near the southern border of Ohio. Widespread damages to private and public property occurred throughout the area. Preliminary loss estimates totaled nearly $180 million in 1997, or over $245 million in 2010 dollars. Approximately 20,000 people were evacuated and 6,500 residences and 833 businesses were affected. Five deaths were attributed to flooding; all of the fatalities were the result of attempts to drive through flooded roads.

Storms during June 26-30, 1998, resulted in flooding and widespread damage throughout much of central, east-central and southeastern Ohio. More than 10 inches of rain fell during a four-day period in parts of southeast Ohio. Twelve storm or flood-related fatalities were reported and infrastructure and utilities were heavily impacted. Loss estimates totaled nearly $178 million in 1998, or over $239 million in 2010 dollars.

Between the 2005 and 2008 plan updates, three flood events resulted in Presidential disaster declarations. These three events are described below.

DR-1651-OH declared July 2, 2006

Severe thunderstorms and tornado touchdowns caused two deaths and widespread damage in northern Ohio from June 21-23, 2006. The primary causes of damage in this event were flash flooding, which overwhelmed urban stormwater infrastructure, and riverine flooding. Huron County and the City of Brecksville were especially impacted. The communities of Toledo, Norwalk, Valley View and Independence also experienced significant flooding.

The USGS estimated flood recurrence intervals for gaged streams based on flood stage for this event. The flooding on the Vermilion River was estimated to be a 50-year event. The flooding on the Cuyahoga River and Tinkers Creek were estimated to be 25 to 50-year events.

DR-1656-OH declared August 1, 2006

Two separate weather systems produced storms resulting in more than 11 inches of rain in parts of Lake County, Ohio on July 27-28, 2006. As a result of the storms and ensuing flooding, the counties of Lake, Geauga and Ashtabula were declared Federal disaster areas. The flooding caused one fatality and 600 evacuations in Lake County. Over all of Lake County, 100 homes and businesses were destroyed and an additional 731 homes and businesses were damaged. Flooding destroyed five bridges in Lake County and closed 13 roads. The City of Painesville experienced heavy damages.

The USGS stream flow-gaging station at the Grand River near Painesville, Ohio had record peak stream flow and peak stage. The recurrence interval for this event was estimated to be 500 years (Ebner, A.D.; Sherwood, J.M.; Astifan, Brian; and Lombardy, Kirk, 2007, Flood of July 27-31, 2006, on the Grand River near Painesville, Ohio: U.S. Geological Survey Open-File Report 2007-1164).

DR-1720-OH declared August 26, 2007

Heavy rainfall inundated multiple communities across northern Ohio during a two-day period. The rain developed along a nearly stationary frontal boundary that was oriented from west to east across north central Ohio. Moisture from the Gulf of Mexico, as well as the remnants of Tropical Depression Erin, was drawn northward resulting in tropical downpours. The heaviest rains redeveloped each night, starting Sunday night August 19, 2007 into Monday morning and then again on Monday night into the early morning hours of Tuesday, August 21, 2007. Stream gage reports from four locations in the affected area indicated that 24-hour rainfall totals ending at 8AM on August 21, 2007 exceeded the 1,000 year/24-hour rainfall frequency. Peak flood stage of the Blanchard River in the City of Findlay was 0.04 less than the flood of record in 1913 (National Weather Service Forecast Office in Cleveland, Ohio).

Communities in the Blanchard, Sandusky and Mohican River watersheds were heavily impacted. There were approximately 2,500 flooded structures in the City of Findlay. The communities of Ottawa, Bucyrus, Shelby, Lima, Carey, and Bluffton also had many flooded structures. Recovery efforts are still progressing in these areas.

NOAA Data Summary

Table 2.2.b lists the number of reported floods in Ohio since the year 2000, and associated loss totals according to the NOAA's NCDC Storm Events Database. The information in this database comes from NWS, who receives their data from a variety of sources including: county, state, and federal emergency management officials, local law enforcement officials, weather spotters, NWS damage surveys, newspaper clipping service, the insurance industry and the public. An effort is made to use the best available information, but because of time and resource constraints, information from these sources may be unverified by the NWS.

Table 2.2.b

Ohio Flood Data Summary from the National Climatic Data Center					
Year	**Number of Reported Flood Events [2]**	**Deaths**	**Injuries**	**Estimated Property Damage ($) [3]**	**Crop Damage ($)**
2000	44	3	2	10.60 Million	None Reported
2001	37	3	1	14.60 Million	None Reported
2002	38	1	None Reported	2.56 Million	None Reported
2003	63	4	None Reported	353.64 Million	2.95 Million
2004	40	2	None Reported	148.82 Million	.97 Million
2005	39	3	None Reported	65.08 Million	None Reported
2006	33	4	1	561.16 Million	38.36 Million
2007	115	None Reported	None Reported	251.195 Million	16.502 Million
2008	105	1	None Reported	5.308 Million	.045 Million
2009	38	1	None Reported	4.523 Million	.053 Million
2010 [1]	71	5	4	13.295 Million	0.001 Million
Total:	**623**	**27**	**8**	**1.43 Billion**	**58.881 Million**

1 - The data for 2010 is from 1/1/2010 to 8/31/2010.

2 - The number of reported flood events was calculated by adding one record for each date in the data set.

3 - Property damage values prior to 2010 were converted to 2010 dollars.

Source: NOAA, NCDC, Storm Events Database

Probability of Future Events

The probability of occurrence of flooding is the likelihood that a specific event will happen. The likelihood of a flood event happening is usually expressed in terms of frequency. The NFIP provides maps and studies that use the 1% annual chance floodplain area (area inundated during a 100-year flood) as the national standard for regulating floodplain development. It is critical to establish the probability of occurrence for flooding so that the state and local communities can make informed decisions about the sustainability of future development, and determine the feasibility of proposed mitigation projects.

The primary sources of data for determining the probability of occurrence of flooding are the FEMA FISs and FIRMs. Nearly every community that participates in the NFIP has a map that identifies at least some area of flood hazard in the community that has a 1%-annual chance of being equaled or exceeded in any given year. This area is referred to as the 1%-annual-chance floodplain, or the 100-year floodplain, and is graphically represented on a FIRM or FHBM.

Communities that do not have FISs, usually have an FHBM or FIRM that shows the approximate area that would be inundated by the 1%-annual-chance flood. A FHBM was intended for interim use in most communities, until a FIS could be completed. FHBMs are still being used in some Ohio communities where a detailed FIS could not be justified.

Approximately 84% of Ohio communities that participate in the NFIP have a portion of their flood hazard areas identified in an FIS. The purpose of a FIS is to investigate the existence and severity of flood hazards in a certain geographic area. The information in a FIS is used to establish actuarial flood insurance rates and assist the community in its efforts to regulate flood hazard areas. A FIS contains data on: historical flood events, the area and flood sources studied, and the engineering methods employed to generate the flood hazard data. A FIS will have flood elevation profiles for the 100-year recurrence probability flood, and usually the 10-, 50-, and/or 500-year floods. A FIS may also contain tables summarizing floodway data and other flood hazard information. A FIS does not usually contain data for every flood hazard area in a community. The remaining areas may have approximate flood hazard data, or none at all.

There are several other possible data sources for determining the area affected by a particular probability flood event. The Ohio Department of Natural Resources, Division of Soil and Water Resources, is the state repository for flood hazard information and has copies of flood hazard information generated by various federal, state, local and private entities. The Floodplain Management Program maintains current copies of all FEMA FISs and flood maps in the state.

LHMP Data

As stated at the beginning of Section 2, integration of LHMP data into the state HIRA is an ongoing effort. As local plans start to expire and jurisdictions update their plans, vulnerability information and loss estimation are collected and assembled. Highlighted below is some of the more notable jurisdictional plan information that has been assembled and integrated into the state HIRA.

Hamilton County. The Natural Hazards Mitigation Plan of October 2006 examined flash flooding, river flooding and urban flooding (categorized in their plan as Non-Flood Zone flooding). Flash flooding resulted in three deaths and a total of $32.8 million in property damage. In addition, river flooding assessment is conducted for each of the major watersheds that affect the county: the Great Miami River, the Little Miami River, the Ohio River and the Mill Creek watershed plus its tributaries. Each of the watersheds are mapped and analyzed to include properties, repetitive loss areas and critical facilities. These analyses projected 2,089 residential structures at risk at a value of $240 million and 2,122 commercial/industrial structures valued at $178 million.

Belmont County. The Belmont County Natural Hazards Mitigation Plan of May 2007 provides an analysis of riverine and flash flooding. Although it is considered to be a small, rural county, projections show potential losses totaling an estimated $33,839,860. Flooding continues to be a frequent and damaging hazard as a result of the Ohio River, several streams and creeks. There have been seven Presidential declarations due to flooding since 1980, three of which occurred in the month of June. However riverine flooding occurs in the winter as well. In January 1996, floodwaters from the conveyance of two rivers in Pittsburgh caused the Ohio River to crest over 4 feet above flood stage. This caused 61 residences to be destroyed, 136 with major damage, 107 with minor

damage and 14 residences to be affected. Belmont County also has 34 repetitive loss properties: 25 are residential while nine are classified as non-residential. Flash flooding occurs more often than riverine flooding with 37 events recorded between 1950 to 2003 and destroying 440 homes. The most significant event was in June 1990, recorded as the most devastating flash flood to strike Ohio in recent years, resulting in 26 fatalities.

Brown County. The Brown County Natural Hazard Mitigation Plan of May 2007 used HAZUS-MH to project damage in its most flood prone areas. These are identified as the Villages of Ripley, Higginsport and Aberdeen, which experienced flooding in 1997 when the Ohio River exceeded its banks. HAZUS-MH loss estimates currently project $332,383,000 in damages, $141,000,000 in commercial or industrial building loss and $227,090,000 in business interruption. It should also be noted that a significant business sector in the county is focused on the production, auction and wholesale of tobacco leaves, and it is the only one of its kind in the state.

VULNERABILITY ANALYSIS

Flooding vulnerability is the likelihood of something to be damaged in a flood. A vulnerability analysis is a measurement of a community's flood risk. Vulnerability can be measured using many different methods. The method selected is highly dependent on the type and format of available data. If site-specific information on flood elevation, lowest floor elevation, structure type, and replacement value exist, a detailed vulnerability analysis can be performed using flood damage curves. The State of Ohio, and most communities in the state lack all or a component of the data required for a detailed analysis and must use more simplified methods. Several different data sources are utilized in this discussion to help develop a clearer picture of Ohio's flood vulnerability including: local natural hazard mitigation plans, presidential disaster declaration data, the statewide Structure Inventory, NFIP repetitive loss data, and HAZUS-MH analyses.

ODNR Structure Inventory

The ODNR, Division of Soil and Water Resources, Floodplain Management Program developed a statewide coverage of the federally identified 1%-annual-chance floodplains. This coverage was combined with Digital Ortho Quarter Quadrangles to identify the structures located within the flood hazard area. Every structure in or near the 100-year floodplain is identified by a checkmark centered on the rooftop and has been assigned a unique structure ID number. The number assigned to each structure has been entered into a database. The database contains attribute fields for each structure including: structure use (residential, commercial etc.), lowest floor elevation, and Base Flood Elevation. The initial baseline of flood-prone structures and the accompanying database provide a tool that communities can use to develop comprehensive flood vulnerability analyses.

The Structure Inventory was created for each county in Ohio, and packaged on a compact disc (CD). Each county's CD contains maps of their county's digitized FEMA SFHA overlaid onto Digital Ortho Quarter Quadrangles. Each county's map sets are clipped into 8.5 x 11 sheets that can be printed or viewed using free software provided on the CD.

According to the Structure Inventory, there are 139,644 structures in FEMA identified SFHA in the State of Ohio. Once a county's structure inventory database is populated, it can be used to complete a risk assessment by: classifying flood-prone structures by address, use category, repetitive loss status, construction date, foundation type, construction type and several other categories. A populated structure inventory database can also distinguish between structures that have reduced risk because they are built in compliance with local flood damage prevention regulations, and those that are not. This will allow communities to track how and where they are reducing future flood risks. This tool can also be used to identify structures that may be good candidates for future mitigation projects.

The structure inventory can be used by counties to conduct a vulnerability analysis. This vulnerability analysis should include an accurate estimate of the value of flood-prone assets. The most accurate assessment of structure values in the State of Ohio is maintained at the individual county auditor's offices. Each county auditor's office maintains the current tax assessed value of structures in their county. However, most counties do not have these data available in a GIS format. Some counties do not have any computerized tax records, which makes this information difficult to access and compile. If a county auditor can provide the value of structures in the SFHA, it can be used with the structure inventory to provide improved vulnerability analyses.

Communities that are beginning the mitigation planning process, or updating their plan, will be encouraged to use the Structure Inventory to collect data about flood-prone structures in their community. Copies of the Structure Inventory were delivered to all county emergency management agency directors and every local floodplain administrator in the state prior to November 2004. It should be noted that most communities throughout the state did not incorporate these data into their mitigation actions as most communities did not possess GIS resources and capability. In addition, there has been much developmental change in flood hazard areas throughout the state, and these changes would not be present in those 2004 data. As more communities develop GIS capabilities and more flood hazard data are developed, updated structure inventories can be collected and maintained for future vulnerability analyses.

For the purposes of this State Plan Update, the structure inventory provides the most accurate quantification of potential structures as risk from flooding, especially when coupled with the HAZUS-MH results.

Presidential Disaster Declaration Data

Flood vulnerability can also be expressed as historic expenditures on disaster recovery for flood events. Total expenditures for programs triggered by a Presidential Disaster Declarations are tracked and summarized by Ohio EMA (Appendix A).

NFIP Repetitive Loss Properties

The NFIP has identified a subset of structures covered by flood insurance policies that are referred to as "repetitive loss" and "severe repetitive loss."(see Appendix B). For this analysis, a repetitive loss structure is any property covered under an NFIP flood insurance policy with two or more losses in any 10-year rolling period. The NFIP has identified 1,804 structures in Ohio that meet this definition with a combined building and content loss of $85,637,119.

Severe repetitive loss structures are defined as residential structures that are covered under an NFIP flood insurance policy and a) that have at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amounts of such claims payments exceed $20,000; or b) for which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building. For both (a) and (b) above, at least two of the referenced claims must have occurred within any ten-year period, and must be greater than 10 days apart.

NFIP repetitive loss data can be used to identify some of the structures vulnerable to flooding throughout the state. In Ohio, it is estimated that approximately 75% of the structures in the SFHA are not covered by flood insurance for any number of reasons. Some reasons include: ignorance about flood insurance as a mitigation option; the structure is not required to be covered by flood insurance because there is no current mortgage; lack of resources to purchase coverage.

Recent legislation is focused on reducing the number of repetitive loss structures by offering mitigation options to the owners. FEMA mitigation grant programs have also prioritized the mitigation of repetitive loss structures including Severe Repetitive Loss, Repetitive Flood Claims, HMGP, FMA, and the PDM-C. The repetitive loss data should be used to identify areas that are repetitively flooded in a community. Given the current prioritization of repetitive loss structures, these structures should be considered when developing mitigation projects that utilize FEMA funding.

HAZARDS U.S.-MULTI-HAZARD (HAZUS-MH)

Ohio EMA and ODNR cooperated with the US Army Corps of Engineers (USACE) to undertake a HAZUS analysis project under the USACE's Planning Assistance to States program (50/50 cost share program). In this project, the ODNR-FPM and USACE combined to complete Level 1 flood analysis for 49 counties. The Corps analyzed Adams, Ashland, Athens, Coshocton, Delaware,

Fairfield, Fayette, Franklin, Gallia, Guernsey, Harrison, Highland, Hocking, Holmes, Jackson, Knox, Lawrence, Licking, Madison, Marion, Medina, Meigs, Monroe, Morgan, Morrow, Muskingum, Noble, Perry, Pickaway, Pike, Richland, Ross, Scioto, Stark, Tuscarawas, Union, Vinton, Washington and Wayne Counties. The ODNR analyzed Belmont, Carroll, Columbiana, Jefferson, Mahoning, Portage, Summit and Trumbull. The remainder of the state was analyzed using HAZUS-MH MR-4, with both versions 1 and 2, which was conducted from 2009 to 2010. The goal was to complete 100 year and 25 year flood interval HAZUS analysis based on a 4 square mile drainage area. Results of HAZUS runs were shared with counties and jurisdictions when possible to assist in updating local mitigation plans.

LOSS ESTIMATION

ODNR Structure Inventory

Each county (and communities within) is now able to identify the baseline number of structures at risk in identified flood hazard areas of their community. The attribute database will support the measurement of structures with reduced risk through NFIP compliance or mitigation actions (e.g. acquisitions, retrofits, and elevations).

Presidential Disaster Declaration Data

Since 1964 there has been $468,777,580 in Public Assistance funds, $426,432,427 in Individual Assistance funds, $67,875,623 in Hazard Mitigation Grant Program funds, $9,348,252 in State Controlling Board funds, $5,274,171 in State Disaster Relief Program funds, $20,151,111 in Natural Resources Conservation funds, $350,000 in Community Development Block Grant funds, and $34,931,731 in State funds used as to match federal funds spent as a result of disaster declarations related to floods within Ohio. The dollar totals listed above are not in current dollars and exclude insured and unreported losses.

NFIP Repetitive Loss Data

Appendix B list the repetitive loss properties by county and region, indicate the status of flood insurance, estimate the structure and content value, and demonstrate the number of flood losses per structure.

Region 1 has the high number of repetitive loss structures in the state as identified by the NFIP (642). The amount paid out for repair of their structures through August 31, 2010 is $27,173,127. Within Region 1 the most significant concentration of repetitive loss structures is located in the City of Findlay (Hancock County), which is along the Blanchard River. In total, Findlay has 169 repetitive loss structures identified with 485 losses, which have paid a total of $11,422,133 for repairs.

Region 2 is identified as having the lowest number of repetitive loss structures in the State. All of the counties within the region have identified repetitive loss structures. As a whole Region 2 has 537 repetitive loss structures identified, with

$30,427,891 in paid claims being paid for structure repairs and contents replacements. There are two areas of significant loss identified with in the region. The City of Cincinnati (Hamilton County) is located in the southwestern portion of the state on the Ohio River. It has 46 repetitive loss structures with 136 claims for $4,378,774, in repairs paid and contents replaced. The second area includes the City of Eastlake (Lake County), situated in the northeastern portion of the state on Lake Erie. Eastlake has 33 identified repetitive loss structures with 90 claims for a total of $826,020.

Region 3 has the second highest number of repetitive loss structures within the state. In total there are 624 repetitive loss structures with 1,531 reported claims totaling $28,036,102 in repairs and contents paid. The City of Marietta (Washington County) has 116 repetitive loss structures with 281 reported claims representing $7,537,839 in repairs and contents replacements. The second highest RFC count in this region resides in the unincorporated area of Washington County; 53 structures with 125 losses totaling $2,307,150 in repairs and contents replacements. Collectively the counties, which border the Ohio River, represent the largest exposure in this region.

HAZUS-MH

The results of the HAZUS-MH runs have been broken down by region and are reported by county for total building exposure, number of structures impacted by percentage damaged, number of critical facilities impacted, total business interruption losses and the total building loss (See Tables 2.2.c, 2.2.d, 2.2.e, 2.2.f, 2.2.g and 2.2.h). Tables ending in c, d and e contain the results based on a 100 year event while f, g and h contain the 25-year results. It is important to remember all the information reported by HAZUS-MH is an estimate and cannot be interpreted as precise losses.

Table 2.2.c

Estimate of Potential Losses from Flooding in the 100-Year Event Region 1											
County	**Population**	**Building Exposure Value (thousands)**	**1-10% Damage Count**	**11-20 % Damage Count**	**21-30% Damage Count**	**31-40% Damage Count**	**41-50% Damage Count**	**Substantial Damage Count**	**Essential Facilities Count**	**Estimated Business Interrupt**	**Estimated Building Loss**
Allen	108,437	$8,276,610	4	32	73	128	111	74	8	$111,400,000	$208,570,000
Auglaize	46,699	$3,493,414	0	6	21	34	58	36	4	$84,550,000	$83,330,000
Champaign	39,713	$2,778,965	0	15	17	27	8	3	0	$50,420,000	$49,940,000
Clark	139,671	$10,893,369	0	47	79	112	82	134	0	$237,480,000	$237,520,000
Clinton	43,058	$2,981,570	1	3	7	12	28	21	1	$52,300,000	$51,950,000
Crawford	43,403	$3,556,521	0	8	15	23	35	9	1	$60,150,000	$59,650,000
Darke	51,814	$3,766,740	0	6	9	23	47	54	0	$86,820,000	$86,290,000
Defiance	38,432	$3,261,057	0	8	29	21	30	9	1	$66,280,000	$65,660,000
Erie*	76,603	$7,149,357	27	531	567	699	702	426	5	$8,710,000	$788,310,000
Fayette	28,117	$720,173	0	4	26	49	52	13	2	$400,000	$65,680,000
Fulton	42,402	$3,729,167	0	1	6	11	14	11	0	$36,230,000	$35,940,000
Hancock	74,538	$6,017,435	7	34	43	57	51	52	2	$201,350,000	$197,630,000
Hardin	31,818	$729,078	0	7	14	24	17	14	0	$540,000	$36,690,000
Henry	28,648	$2,157,169	0	2	9	12	14	3	0	$46,680,000	$45,730,000
Huron	59,849	$4,320,061	0	3	16	30	47	32	0	$78,710,000	$78,350,000
Logan	46,582	$3,496,616	1	10	11	17	9	10	0	$38,150,000	$38,150,000
Lucas*	463,493	$39,329,470	13	209	321	357	756	493	15	$1,691,200,000	$1,676,530,000
Madison	42,539	$993,168	0	4	17	31	46	42	0	$300,000	$53,840,000
Marion	65,655	$949,651	1	5	29	66	88	40	6	$870,000	$86,980,000
Mercer	40,666	$2,933,239	0	5	7	6	6	3	0	$37,630,000	$37,300,000
Miami	101,256	$8,311,276	22	81	109	187	154	96	5	$305,560,000	$301,400,000
Morrow	34,642	$604,955	0	2	6	12	15	7	0	$230,000	$42,840,000
Ottawa*	40,945	$4,495,965	29	1,049	1,471	773	547	1,310	14	$6,450,000	$716,570,000
Paulding	18,994	$1,432,929	0	0	13	27	53	98	1	$69,940,000	$69,370,000
Preble	41,422	$2,966,577	0	5	27	28	40	32	0	$102,820,000	$102,430,000
Putnam	34,377	$2,490,483	1	15	23	43	61	45	2	$127,840,000	$126,780,000
Sandusky	60,071	$4,969,968	0	14	36	48	25	10	3	$79,180,000	$78,540,000
Seneca	56,152	$1,708,396	0	11	44	74	102	88	0	$1,020,000	$152,990,000
Shelby	48,990	$3,801,918	0	1	9	23	60	51	0	$75,080,000	$71,590,000
Union	48,903	$1,013,990	0	1	18	40	64	50	1	$480,000	$68,580,000
Van Wert	28,496	$2,055,854	0	6	33	57	45	19	0	$105,720,000	$104,500,000
Williams	37,816	$3,190,059	0	6	23	52	50	34	0	$92,420,000	$93,070,000
Wood	125,380	$10,501,105	5	47	60	79	150	47	4	$237,830,000	$234,870,000
Wyandot	22,394	$711,737	0	5	17	17	23	8	0	$360,000	$41,800,000
TOTAL	**2,211,975**	**$159,788,042**	**111**	**2,183**	**3,205**	**3,199**	**3,590**	**3,374**	**75**	**$4,095,100,000**	**$6,189,370,000**

*Values will need to be reassessed with the next plan update as HAZUS seemed to have difficulty with the flat terrain and coarse topographic data. The next update will incorporate more refined topographic data to better depict the limited relief.

Table 2.2.d

Estimate of Potential Losses from Flooding in the 100-Year Event Region 2											
County	**Population**	**Building Exposure Value (thousands)**	**1-10% Damage Count**	**11-20 % Damage Count**	**21-30% Damage Count**	**31-40% Damage Count**	**41-50% Damage Count**	**Substantial Damage Count**	**Essential Facilities Count**	**Estimated Business Interrupt**	**Estimated Building Loss**
Ashland	5,044	$983,692	1	5	9	17	22	31	1	$1,220,000	$81,790,000
Ashtabula	100,767	$7,704,317	0	38	93	47	130	112	0	$154,740,000	$153,730,000
Butler	363,184	$26,013,775	12	376	532	710	838	772	0	$1,378,000	$1,348,000
Cuyahoga*	1,275,709	$126,156,607	5	151	369	284	394	213	4	$8,690,000	$1,062,260,000
Delaware	168,708	$2,648,854	0	9	24	44	89	131	4	$2,820,000	$168,200,000
Fairfield	143,712	$2,408,997	0	55	147	216	285	97	0	$2,720,000	$271,740,000
Franklin	1,150,122	$12,346,646	13	350	607	850	700	618	13	$21,160,000	$1,679,900,000
Geauga	99,060	$7,865,765	0	7	7	16	14	0	1	$54,290,000	$53,970,000
Greene	159,823	$11,674,521	5	39	50	81	47	33	1	$156,780,000	$153,590,000
Hamilton	855,062	$72,577,343	8	106	154	278	578	1,213	12	$2,820,970,000	$2,800,570,000
Knox	59,637	$1,551,108	9	36	34	51	33	18	4	$1,370,000	$236,500,000
Lake	236,775	$19,802,188	0	314	348	364	394	264	0	$386,860,000	$383,860,000
Licking	158,488	$3,341,506	5	68	108	157	198	185	4	$3,120,000	$331,060,000
Lorain	305,707	$25,063,726	2	94	125	214	279	259	0	$533,600,000	$527,680,000
Mahoning	236,735	$3,047,225	2	23	30	46	28	9	0	$910,000	$129,110,000
Medina	174,035	$12,805,401	0	6	21	42	28	6	0	$83,940,000	$83,300,000
Montgomery	532,562	$45,503,377	128	402	517	762	907	696	34	$1,487,350,000	$1,461,580,000
Pickaway	54,734	$3,263,028	1	9	20	34	46	21	0	$79,600,000	$78,430,000
Portage	157,530	$2,513,342	1	9	28	66	54	57	1	$990,000	$139,080,000
Richland	124,490	$1,712,439	0	11	17	29	35	12	3	$1,110,000	$157,290,000
Stark	379,466	$5,239,841	18	108	119	184	155	92	0	$6,030,000	$463,210,000
Summit	542,405	$6,441,938	4	119	151	180	147	66	5	$4,620,000	$487,190,000
Trumbull	210,157	$17,584,336	3	63	119	159	209	310	3	$408,710,000	$404,430,000
Warren	210,712	$12,832,986	3	43	180	316	543	618	9	$475,650,000	$472,470,000
Wayne	114,222	$1,981,029	1	18	17	36	24	16	2	$1,030,000	$131,120,000
TOTAL	**7,818,846**	**$433,063,987**	**221**	**2,459**	**3,826**	**5,183**	**6,177**	**5,849**	**101**	**$6,699,658,000**	**$11,913,408,000**

*Values will need to be reassessed with the next plan update as HAZUS seemed to have difficulty with the flat terrain and coarse topographic data. The next update will incorporate more refined topographic data to better depict the limited relief.

Table 2.2.e

Estimate of Potential Losses from Flooding in the 100-Year Event Region 3											
County	**Population**	**Building Exposure Value (thousands)**	**1-10% Damage Count**	**11-20 % Damage Count**	**21-30% Damage Count**	**31-40% Damage Count**	**41-50% Damage Count**	**Substantial Damage Count**	**Essential Facilities Count**	**Estimated Business Interrupt**	**Estimated Building Loss**
Adams	28,043	$682,584	0	0	0	7	36	559	2	$1,240,000	$155,190,000
Athens	63,026	$1,765,399	0	28	51	88	156	316	11	$6,060,000	$511,860,000
Belmont	68,066	$1,138,503	0	0	1	6	46	332	3	$960,000	$154,830,000
Brown	44,033	$2,514,600	0	0	3	7	72	955	8	$317,550,000	$781,420,000
Carroll	28,539	$730,209	2	18	46	64	52	49	3	$650,000	$66,270,000
Clermont	196,364	$12,865,575	0	8	24	52	104	88	0	$313,130	$310,700
Columbiana	107,722	$2,177,124	0	2	14	27	85	1,795	7	$3,860,000	$634,560,000
Coshocton	35,767	$857,993	0	10	24	53	67	213	3	$1,510,000	$192,490,000
Gallia	30,694	$1,220,816	1	24	45	91	203	719	5	$5,160,000	$461,650,000
Guernsey	40,054	$1,107,630	1	13	16	50	47	84	3	$2,810,000	$152,520,000
Harrison	15,268	$306,687	0	0	1	6	11	5	1	$210,000	$22,990,000
Highland	42,178	$742,915	0	2	2	5	8	1	0	$410,000	$40,590,000
Hocking	28,912	$946,995	0	7	30	41	45	51	6	$1,290,000	$103,020,000
Holmes	41,854	$712,710	0	1	6	12	26	15	2	$360,000	$40,950,000
Jackson	33,440	$611,569	1	7	7	12	11	3	0	$400,000	$39,520,000
Jefferson	67,691	$1,932,238	0	5	26	78	353	1,992	25	$7,380,000	$817,470,000
Lawrence	62,744	$2,930,308	1	58	236	522	1,355	4,306	21	$12,060,000	$1,528,600,000
Meigs	22,838	$896,860	0	14	50	83	221	549	10	$2,510,000	$271,900,000
Monroe	14,058	$1,887,497	0	8	116	88	552	1,562	14	$6,750,000	$875,790,000
Morgan	14,288	$575,845	0	1	2	10	48	894	2	$1,440,000	$201,710,000
Muskingum	84,884	$1,770,099	1	8	49	107	206	368	3	$2,670,000	$286,340,000
Noble	14,311	$317,128	0	2	2	3	6	6	1	$840,000	$27,600,000
Perry	35,359	$695,152	0	8	16	32	27	26	6	$590,000	$58,400,000
Pike	27,722	$890,437	0	5	11	28	52	172	1	$2,360,000	$144,500,000
Ross	75,972	$1,655,760	4	11	39	87	146	224	7	$4,400,000	$178,740,000
Scioto	76,334	$2,448,603	0	62	136	242	532	1,689	15	$13,330,000	$1,090,740,000
Tuscarawas	91,137	$2,142,377	5	67	81	142	187	311	2	$4,760,000	$362,750,000
Vinton	13,228	$269,073	0	0	1	2	2	4	0	$70,000	$14,700,000
Washington	61,048	$2,604,032	0	2	22	71	420	2,839	15	$11,950,000	$1,230,710,000
TOTAL	**1,465,574**	**$49,396,718**	**16**	**371**	**1,057**	**2,016**	**5,076**	**20,127**	**176**	**$413,893,130**	**$10,448,120,700**

Table 2.2.f

Estimate of Potential Losses from Flooding in the 25-Year Event Region 1											
County	Population	Building Exposure Value (thousands)	1-10% Damage Count	11-20 % Damage Count	21-30% Damage Count	31-40% Damage Count	41-50% Damage Count	Substantial Damage Count	Essential Facilities Count	Estimated Business Interrupt	Estimated Building Loss
Allen	108,437	$8,276,610	6	30	66	96	94	61	8	$182,460,000	$180,140,000
Auglaize	46,699	$3,493,414	0	4	15	24	36	17	2	$52,160,000	$51,410,000
Champaign	39,713	$2,778,965	0	10	11	16	3	1	0	$40,050,000	$12,160,000
Clark	139,671	$10,893,369	0	35	56	89	49	115	0	$159,630,000	$158,040,000
Clinton	43,058	$2,981,570	2	2	5	9	22	17	1	$43,340,000	$43,040,000
Crawford	43,403	$3,556,521	0	7	12	15	37	46	0	$61,450,000	$60,960,000
Darke	51,814	$3,766,740	0	3	8	23	45	39	0	$73,000,000	$2,540,000
Defiance	38,432	$3,261,057	0	11	30	16	15	6	1	$54,630,000	$54,090,000
Erie*	76,603	$7,149,397	14	349	986	161	649	400	3	$7,080,000	$671,720,000
Fayette	28,117	$720,173	0	6	24	44	33	6	2	$350,000	$55,560,000
Fulton	42,402	$3,729,167	0	1	6	12	9	7	0	$31,400,000	$31,140,000
Hancock	74,538	$6,017,435	7	26	40	48	45	36	2	$171,970,000	$168,530,000
Hardin	31,818	$729,078	0	5	8	15	11	6	0	$454,000	$29,719,000
Henry	28,648	$2,157,169	0	1	11	8	11	2	0	$39,890,000	$39,090,000
Huron	59,849	$4,320,061	0	3	14	26	45	29	0	$68,980,000	$68,650,000
Logan	46,582	$3,496,616	1	10	9	6	9	5	0	$30,760,000	$30,280,000
Lucas*	463,493	$39,329,470	15	152	319	384	682	372	7	$1,217,510,000	$1,209,200,000
Madison	42,539	$993,168	0	4	17	29	35	25	0	$250,000	$44,830,000
Marion	65,655	$949,651	0	8	24	69	49	35	6	$770,000	$73,150,000
Mercer	40,666	$2,933,239	0	2	4	4	4	1	0	$32,760,000	$32,480,000
Miami	101,256	$8,311,276	6	45	57	92	87	71	2	$225,490,000	$222,240,000
Morrow	34,642	$604,955	0	2	4	9	11	2	0	$210,000	$35,210,000
Ottawa*	40,945	$4,495,969	17	838	931	526	435	899	1	$5,002,000	$520,390,000
Paulding	18,994	$1,432,929	0	0	12	226	42	80	1	$58,270,000	$57,860,000
Preble	41,422	$2,966,577	0	9	17	25	28	22	0	$88,540,000	$88,230,000
Putnam	34,377	$2,490,483	1	8	14	33	44	43	2	$102,650,000	$101,770,000
Sandusky	60,071	$4,969,968	1	16	24	24	21	12	0	$80,410,000	$79,780,000
Seneca	56,152	$1,708,396	0	7	26	47	67	40	0	$857,000	$123,924,000
Shelby	48,990	$3,801,918	0	0	9	27	52	38	0	$65,690,000	$65,250,000
Union	48,903	$1,013,990	0	2	19	40	50	32	1	$390,000	$56,720,000
Van Wert	28,496	$2,055,854	0	3	27	39	33	10	0	$89,270,000	$88,200,000
Williams	37,816	$3,190,059	0	6	18	32	42	15	0	$70,530,000	$69,580,000
Wood	125,380	$10,501,105	2	31	39	57	105	27	2	$200,950,000	$193,080,000
Wyandot	22,394	$711,737	0	3	10	11	15	4	0	$303,000	$33,858,000
TOTAL	**2,211,975**	**$159,788,086**	**72**	**1,639**	**2,872**	**2,282**	**2,915**	**2,521**	**41**	**$3,257,456,000**	**$4,752,821,000**

*Values will need to be reassessed with the next plan update as HAZUS seemed to have difficulty with the flat terrain and coarse topographic data. The next update will incorporate more refined topographic data to better depict the limited relief.

Table 2.2.g

Estimate of Potential Losses from Flooding in the 25-Year Event Region 2											
County	**Population**	**Building Exposure Value (thousands)**	**1-10% Damage Count**	**11-20 % Damage Count**	**21-30% Damage Count**	**31-40% Damage Count**	**41-50% Damage Count**	**Substantial Damage Count**	**Essential Facilities Count**	**Estimated Business Interrupt**	**Estimated Building Loss**
Ashland	5,044	$983,692	0	4	8	14	22	23	1	$1,060,000	$68,630,000
Ashtabula	100,767	$7,704,317	0	36	89	38	112	85	0	$130,370,000	$128,560,000
Butler	363,184	$26,013,775	8	181	448	710	796	523	0	$916,250,000	$825,620,000
Cuyahoga	1,275,709	$126,156,607	7	127	307	229	362	167	5	$2,550,000	$933,100,000
Delaware	168,708	$2,648,854	1	9	22	35	88	108	2	$2,500,000	$142,790,000
Fairfield	143,712	$2,408,997	0	70	120	188	129	39	0	$2,410,000	$212,350,000
Franklin	1,150,122	$12,346,646	17	309	515	714	574	483	11	$18,180,000	$1,398,090,000
Geauga	99,060	$7,865,765	0	5	4	8	3	0	1	$43,530,000	$43,240,000
Greene	159,823	$11,674,521	4	33	41	56	33	25	1	$134,400,000	$131,530,000
Hamilton	855,062	$72,577,343	11	101	117	231	365	603	7	$1,801,500,000	$1,788,860,000
Knox	59,637	$1,551,108	9	43	32	53	22	10	4	$1,270,000	$210,650,000
Lake	236,775	$19,802,188	0	238	480	118	344	219	0	$327,480,000	$325,000,000
Licking	158,488	$3,341,506	6	53	91	122	155	126	4	$2,670,000	$270,130,000
Lorain	305,707	$25,063,726	1	82	188	116	226	211	1	$483,740,000	$478,080,000
Mahoning	236,735	$3,047,225	2	23	24	29	24	9	1	$1,290,000	$146,360,000
Medina	174,035	$12,805,401	0	1	10	23	11	1	0	$59,190,000	$58,760,000
Montgomery	532,562	$45,503,377	102	340	418	615	643	449	27	$1,220,730,000	$1,200,690,000
Pickaway	54,734	$3,263,028	3	6	18	32	28	18	0	$69,670,000	$68,600,000
Portage	157,530	$2,513,342	1	12	37	65	48	59	1	$940,000	$130,740,000
Richland	124,490	$1,712,439	0	10	15	33	18	6	3	$930,000	$128,920,000
Stark	379,466	$5,239,841	20	83	111	156	120	63	11	$5,310,000	$385,790,000
Summit	542,405	$6,441,938	6	94	103	112	74	33	5	$4,140,000	$404,480,000
Trumbull	210,157	$17,584,336	2	46	79	95	150	183	2	$82,120,000	$279,300,000
Warren	210,712	$12,832,986	2	49	164	294	407	484	9	$416,910,000	$413,980,000
Wayne	114,222	$1,981,029	1	12	10	23	16	7	1	$866,000	$106,208,000
TOTAL	**7,818,846**	**$433,063,987**	**203**	**1,967**	**3,451**	**4,109**	**4,770**	**3,934**	**97**	**$5,730,006,000**	**$10,280,458,000**

Table 2.2.h.

Estimate of Potential Losses from Flooding in the 25-Year Event Region 3											
County	**Population**	**Building Exposure Value (thousands)**	**1-10% Damage Count**	**11-20 % Damage Count**	**21-30% Damage Count**	**31-40% Damage Count**	**41-50% Damage Count**	**Substantial Damage Count**	**Essential Facilities Count**	**Estimated Business Interrupt**	**Estimated Building Loss**
Adams	28,043	$682,584	0	0	3	6	43	501	2	$1,220,000	$147,910,000
Athens	63,026	$1,765,399	1	22	42	86	138	272	6	$5,000,000	$446,570,000
Belmont	68,066	$1,138,503	0	0	1	4	42	288	4	$950,000	$142,180,000
Brown	44,033	$2,514,600	0	0	7	20	82	840	6	$289,840,000	$287,700,000
Carroll	28,539	$730,209	0	19	36	53	32	40	1	$640,000	$58,150,000
Clermont	196,364	$12,865,575	0	8	15	41	104	69	0	$231,030	$229,670
Columbiana	107,722	$2,177,124	0	1	14	32	96	1,606	6	$3,730,000	$590,960,000
Coshocton	35,767	$857,993	0	8	23	40	60	179	3	$1,290,000	$164,210,000
Gallia	30,694	$1,220,816	1	12	38	56	161	618	5	$4,190,000	$388,090,000
Guernsey	40,054	$1,107,630	0	18	15	30	35	53	4	$2,130,000	$142,590,000
Harrison	15,268	$306,687	0	0	1	4	7	3	1	$190,000	$19,910,000
Highland	42,178	$742,915	0	2	2	3	8	1	0	$370,000	$34,810,000
Hocking	28,912	$946,995	0	5	18	33	33	34	6	$1,140,000	$84,380,000
Holmes	41,854	$712,710	0	1	6	10	18	13	3	$330,000	$34,030,000
Jackson	33,440	$611,569	3	7	4	11	2	2	0	$400,000	$32,890,000
Jefferson	67,691	$1,932,238	0	4	28	104	368	1,699	19	$5,850,000	$694,310,000
Lawrence	62,744	$2,930,308	1	71	263	585	1,211	3,640	20	$10,850,000	$1,349,080,000
Meigs	22,838	$896,860	1	28	58	94	131	390	10	$2,200,000	$219,130,000
Monroe	14,058	$1,887,497	0	12	100	64	415	1,029	12	$4,560,000	$630,250,000
Morgan	14,288	$575,845	0	0	2	10	63	763	2	$1,130,000	$169,800,000
Muskingum	84,884	$1,770,099	1	11	49	104	161	276	2	$2,260,000	$237,860,000
Noble	14,311	$317,128	0	2	2	2	5	3	1	$760,000	$23,430,000
Perry	35,359	$695,152	0	9	15	23	20	17	4	$520,000	$49,610,000
Pike	27,722	$890,437	0	5	11	24	41	128	0	$2,070,000	$117,090,000
Ross	75,972	$1,655,760	2	7	37	62	139	144	7	$3,520,000	$134,270,000
Scioto	76,334	$2,448,603	0	18	52	114	386	1,327	10	$7,260,000	$635,040,000
Tuscarawas	91,137	$2,142,377	5	55	67	132	140	266	1	$4,460,000	$317,550,000
Vinton	13,228	$269,073	0	0	0	1	1	2	0	$60,000	$12,430,000
Washington	61,048	$2,604,032	0	11	49	141	516	2,266	15	$10,700,000	$1,064,680,000
TOTAL	**1,465,574**	**$49,396,718**	**15**	**336**	**958**	**1,889**	**4,458**	**16,469**	**150**	**$367,851,030**	**$8,229,139,670**

Region 1 collectively has approximately $159,788,042,000 in total building exposure to flooding for the 1%-annual-chance event. A total of 3,374 structures are estimated to be substantially damaged, meaning damages that total 50 percent or more of the structures' pre-flood market values. There are an estimated 75 critical facilities impacted, which include police, fire, hospitals and schools. The overall estimated building loss is expected to approach $6,189,370,000 with an additional $4,095,100,000 in business interruption. Changing to a 4%-annual-chance event (25-year flood), a total of 2,521 structures are estimated to be substantially damaged. There are an estimated 41 critical facilities impacted. Finally, the overall estimated building loss is projected to approach $4,752,821,000, with an additional $3,257,456,000 in business interruption.

Region 2 collectively has $433,063,987,000 in total building exposure to flooding for the 100-year event. A total of 5,849 structures are estimated to be substantially damaged, meaning damages that total 50 percent or more of the structures' pre-flood market values. There are an estimated 101 critical facilities impacted, which include police, fire, hospitals and schools. The overall estimated building loss should approach $11,913,408,000, with an additional $6,699,658,000 in business interruption. Changing to a 25-year event, a total of 3,934 structures are estimated to be substantially damaged. There are an estimated 97 critical facilities impacted. Finally, the overall estimated building loss is $10,280,458,000 with an additional $5,730,006,000 in business interruption. According to the HAZUS-MH runs, there appear to be more critical facilities impacted during a 25-year event than a 100-year event. We have no explanation for this occurrence.

Region 3 collectively has $49,396,718,000 in total building exposure to flooding for the100-year event. A total of 20,127 structures are estimated to be substantially damaged, meaning damages that total 50 percent or more of the structures' pre-flood market values. There are an estimated 176 critical facilities impacted, which include police, fire, hospitals and schools. The overall estimated building loss is expected to approach $10,448,120,700 with an additional $413,893,130 in business interruption. Changing to a 25-year event, a total of 16,469 structures are estimated to be substantially damaged. There are an estimated 150 critical facilities impacted. Finally, the overall estimated building loss should approach $8,229,139,670 with an additional $367,851,030 in business interruption.

STATE OWNED / CRITICAL FACILITIES VULNERABILITY ANALYSIS & LOSS ESTIMATION

The estimate for losses to state owned facilities was developed using the existing, state-owned structure inventory spatial files and the ODNR county floodplain shapefiles. Table 2.1.a presents the total exposure of state owned facilities collected to date for Ohio.

Region 1 has two structures valued at $2,751,961 in the 100-year floodplain. Based on a 25-percent loss estimate, the total loss would be $687,990. Both

structures are part of the Seneca county MRDD campus located near Tiffin. This region contains the largest number of counties yet to be inventoried. Once the more populous Lake Erie coastal counties are included, these loss estimates may increase.

Region 2 has four structures valued at $7,180,500 in the 100-year floodplain. Three structures are in the Delaware State Park, and the remaining structure is a medical corrections center in Columbus. Losses to these structures at an estimated 25 percent would be $1,795,125. There are two anomalies in the analysis of Region 2. First, there are seven Halls on the OSU campus, associated with OSU Hospitals, which are in the floodplain. The values of the buildings were not provided to URS during their inventory. Structural damage to the buildings would be minimal; however, if flooded, the cost of emergency operations and repairing flooded underground connecting tunnels would cause an economic loss. The OSU Medical Hospitals comprise one of four major hospital campuses in the area. There is no indication that the remaining medical facilities would be overwhelmed during a flood event.

The second anomaly is a collection of buildings in Columbus, which is located in an area that was removed from the FEMA-identified floodplain by the construction of a floodwall. The ODNR floodplain map does not reflect this change, but the structures are no longer considered flood prone.

Region 3 has six state-owned facilities in the floodplain, but they only involve a four-county area. The first is a rest area on Interstate 77 in Guernsey County. Second is a correctional dormitory in Tuscarawas County. Third, Washington County is home to the county Office of Jobs and Family Services (in the heavily exposed City to Marietta) and a portion of an ODOT compound. Finally, Columbiana County has two pottery museums deemed flood prone. Combined the risk exposure is $5,066,888 with an anticipated loss (at 25%) of $1,266,722.