8:4 Risk Assessment

All components of this Risk Assessment were developed using the best available data in the Purchase Region. GIS resources and public input were used to identify which hazards, of those listed below, affect the region. The Purchase Area Development District (PADD) staff compiled this information to identify hazards and the Jackson Purchase Hazard Mitigation Council (JPHMC) reviewed the definitions and discussed their occurrence in and impact on the region. This review identified all hazards to the region and consequently all hazards that affect Marshall County.

For this revision, the Marshall County Mitigation Planning Team (MPT) reviewed and revised the prioritization of hazards from their 2012 Plan using updated climatic/event data, 2016 revised flood zones, local events occurring since the previous plan, 2010 Census data, and 2015 American Community Survey. These provided a higher resolution for the resulting Hazard re-prioritization and revised risk assessments. The resulting prioritization and risk assessments are contained in this county annex.

8:4.1 Identifying Hazards

FEMA recognizes many forms of natural hazards. Major natural hazards that may occur include:

- Geologic hazards
  - Tsunami
  - Volcano
  - Earthquake
  - Land Subsidence/Karst Topography
  - Landslide
- Weather generated hazards
  - Avalanche
  - Hurricane
  - Severe Thunderstorm
  - Hailstorm
  - Windstorm/Microburst
  - Severe Winter storm
  - Tornado
- Wildfire
- Flooding
  - Flashfloods
  - General Flooding
  - Coastal
  - Riverine
- Urban
- Climatological
  - Drought
  - Extreme Heat
- Failure of Man-made structures from the impact of natural forces
  - Dam Failure
  - Levee/flood Wall Failure

Natural Hazards Addressed by the Regional Plan

The regional planning process identified hazards that significantly impact the entire Purchase Region and eliminated from consideration those natural hazards that do not. Natural hazards where a historical record of damage to people and property exists, or the potential for such damage to occur, are addressed in the plan. This determination does not preclude the plan from including more hazards in future updates. The Marshall County MPT agreed that the identification process was sufficiently thorough to serve all the signatory counties of the plan and will not be repeated for the Marshall County 2018 Update. Table 8.1 summarizes why hazards were identified.

Table 8.1 Hazards Identified and Reasons for Identification

Hazard	How Identified	Why Identified
Tornado	* Review of past disaster damage * Review of FEMA hazard maps * Public Input	* Several past occurrences * Hazard maps show all jurisdictions affected
Flood **Flash Flood** **River Erosion**	* Review of past disaster damage (FEMA & National Climatic Data Center) * Local Emergency Management * Public Input * Review of FIRM maps	* Affects the region frequently * Maps show many flood prone areas * Public identified several regions not mapped affected by flooding * Repetitive flooding has led to the deposit of enormous amounts of silt in Kentucky's Mississippi River ports
Thunderstorm Wind **Hail**	* Review of past disaster damage * Public Input * Review of past occurrences from National Climatic Data Center	* Many events in the past * Widespread: affects all jurisdictions * High wind zone
Earthquake	* Review of Ground Motion Maps * Review of the New Madrid and Wabash Seismic Zone Maps * Public Input	* Proximity to New Madrid/Wabash Seismic Zones * Historic accounts of 1812 disaster. * Potential for destructive impact in some jurisdictions
Winter Storm / Ice Storm	* Review of past disaster damage * Review of past occurrences from National Climatic Data Center * Public Input * Local DES/KYTC	* Several past occurrences * Variety of events including snow/ ice * Can affect all jurisdictions
Excessive Heat / Drought	* Review of past disaster damage * Public Input * Review of Palmer Drought Severity Index	* Losses have occurred in past * Large impact of agriculture on the region
Dam Failure	* Review of High Risk Dams in the region * Corps of Engineers Input	*Potential for flooding *Number of High Risk dams in region
Wildfire	* Review of State Mitigation Plan * Public Input	*Potential for loss at Wildland/urban interface, * Increased fuel supply due to ice storm damage

8:4.2 Hazard Profiles

The Marshall County MPT reviewed the previously profiled hazards based on; historical evidence gathered from the Kentucky State Climatology Center, the National Centers for Environmental Information (NCEI), Federal Emergency Management (FEMA) Hazard Mapping website, the Kentucky State Hazard Mitigation Plan and the Kentucky Geological Survey. The PADD staff gathered GIS information and historical data to provide to the MPT. There are some limitations to the best available GIS and historical data pertaining to hazards. The Marshall County MPT identified what hazards affected the county based on past experiences. Information collected throughout the planning process by means of public input was a pertinent resource to the plan. Because the purpose of this plan is to identify hazards that present a threat to the safety of life and property, only moderate and high risk hazards will be fully addressed in this plan.

Summary of Hazard Profiles

Several overall conclusions can be drawn from the information gathered in the Hazard Profiles. Based on historical frequency and past disaster damages, several hazards identified in the regional plan, stand out as more significant threats to Marshall County, while several others appear to be less significant.

According to frequency and damage figures, Flash Flood, Winter Storm, Thunderstorm Wind, and Tornado stand out as the most significant threats to Marshall County. Earthquake is a hazard rated by committee members as one of the biggest potential threats. There is no historical data on actual earthquake damages in Marshall County to analyze the threat, and considerable debate as to the severity of the resultant damage even for the "worst case scenario".

Dam Failure and Wildfire are perceived as possible threats to portions of the county, yet historic frequency and damage data do not suggest that these are among the most significant. There is no historical occurrence of damage or injury due to a dam failure in Marshall County. Dam failure is considered a hazard due to the location of Kentucky Dam and the impounded Kentucky Lake, along Marshall County's eastern border. Portions of the county, and more specifically the city of Calvert City, are downstream from the dam as well as Barkley Dam, along the Tennessee and Ohio Rivers. Wildfires, more specifically brushfires, have likely occurred however no injuries or damages were documented. Hail is also a hazard that threatens the county, having caused some property and crop damage.

In the previous plan, it was the consensus of the MPT that there was another hazard related to the existence of Kentucky Dam and the lake impounded by the dam, the hazard of "River Erosion" or bank erosion. This was thought to be caused by the rapid fluctuation of water levels especially as Kentucky Lake is drawn down to accommodate heavy (or anticipated heavy) rains upstream in the watershed, and the rapid drawn down of the lake to reach winter pool. No hard evidence of such damage has since been recorded. The 2011-2012

MPT decided to remove Stream Erosion from consideration for this revision of their plan.

Table 8.2 is a summary of past Declared Disasters as provided by FEMA for Marshall County. Throughout this annex, this table will be referenced as each hazard is profiled. This table is limited to providing information only related to declared disasters on the county level and does not list each jurisdiction.

Table 8.2 Presidential Disaster Declarations that Affected PADD Counties

DR#	Declaration Date	Disaster Type	Total Declared Counties	Declared Counties	Counties Declared for Public Assistance and Individual Assistance	Counties Declared for Public Assistance Only	County	DH Approved Funding	IFG Approved
381	5/11/1973	Severe Storms, Flooding	5	Ballard, Carlisle, Fulton, Hickman, McCracken	Ballard, Carlisle, Fulton, Hickman, McCracken	0			
461	3/29/1975	Severe Storms, Flooding	17	Ballard, Calloway, Fulton, Graves, Hickman, Marshall, McCracken	Ballard, Calloway, Fulton, Graves, Hickman, Marshall, McCracken	0			
821	2/24/1989	Severe Storms, Flooding	67	Ballard, Carlisle, Graves, Hickman, Marshall, McCracken	Ballard, Carlisle, Graves, Hickman, Marshall, McCracken	0			
1089	1/13/1996	Blizzard	120	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall	0	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall, McCracken			
1163	3/4/1997	Flooding	101	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall, McCracken	Ballard, Carlisle, Fulton, Hickman, Marshall, McCracken	Calloway	McCracken	$137,084.85	$78,709.00
1802	10/9/2008	Severe Wind Storm	36	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall, McCracken	0	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall, McCracken,			
3302	1/28/2009	Severe Wind Storm	114	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall, McCracken	0	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall, McCracken,			

DR#	Declaration Date	Disaster Type	Total Declared Counties	Declared Counties	Counties Declared for Public Assistance and Individual Assistance	Counties Declared for Public Assistance Only	County	DH Approved Funding	IFG Approved
1818	2/5/2009	Severe Winter Storm, Flooding	117	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall, McCracken	0	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall, McCracken,			
1976	5/4/2011	Severe Storms, Tornadoes, Flooding	22	Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, Marshall, McCracken		Calloway			
4057	3/6/2012	Severe Storms, Tornadoes, Straight-line Winds, Flooding	1	Ballard		Ballard			
4216	4/30/2015	Severe Winter Storms, Snowstorms, Flooding, Landslides, Mudslides	3	Ballard, Marshall, McCracken		Ballard, Marshall, McCracken			
4218	5/12/2015	Severe Winter Storms, Snowstorms, Flooding, Landslides, Mudslides	3	Calloway, Fulton, Marshall		Calloway, Fulton, Marshall			
4278	8/26/2016	Severe Storms, Tornadoes, Flooding, Landslides, Mudslides	2	Calloway, Marshall		Calloway, Marshall			

Source:https://www.fema.gov/disasters?field_state_tid_selective=49&field_disaster_type_term_tid=All&field_disaster_declaration_type_value=All&items_per_page=20&=GO

According to State Department of Emergency Management records Marshall County was eligible for Public Assistance as a result of the above declarations.

For this revision, the MPT for Marshall County reviewed and revised the prioritization of Hazards from their 2012 Plan using updated climatic/event data, 2009 revised flood zones, local events occurring since the previous plan, 2010 census data and U.S. Census Bureau 2011-2015 American Community Survey 5 Year Estimates. These provided a higher resolution for the resulting Hazard re-prioritization and revised risk assessments. All following discussions of Hazard Profiles, Risk and Risk Assessment are in the order of these revised priorities.

Table 8.3 Marshall County Hazard Summary Table

PLAN VERSION	2017	2012
HIGH RISK HAZARDS	TORNADO THUNDERSTORM WIND WINTER STORM / ICE STORM FLASH FLOOD	TORNADO SEVERE STORM / WIND /HAIL SEVERE WINTERSTORM
MODERATE RISK HAZARDS	EARTHQUAKE FLOOD HAIL	EARTHQUAKE FLOOD HAILSTORM
LOW RISK HAZARDS	EXCESSIVE HEAT DROUGHT DAM FAILURE WILDFIRE	EXTREME HEAT /DROUGHT DAM FAILURE WILDFIRE

SOURCE: Marshall County MPT 2017
NOTE: Due to the frequency of events Flash Flood was elevated to a high risk as part of the 2017 update. The following discussion has been re-ordered from the 2012 plan to reflect revised priorities.

The following table represents a summary of the events on record in the NCEI Storm Events Database occurring in Marshall County for the period January 1, 1950 through March 31, 2017. Data is available as early as 1950, but depending on reporting for some events, the first event on record may come at a much later time. The detailed, disaggregated listing of these events are included in Appendix 1.

Please see NCEI (formerly the National Climatic Data Center) contact page if you have questions at https://www.ncdc.noaa.gov/customer-support

Table 8.4 Summary of Hazard Previous Occurrences and Impacts for Marshall County January 1, 1950 – March 31, 2017

Event	Events	Death	Injury	Property Damage($)	Crop Damage($)
Tornado	17	6	52	$9.012M	$5.00K
Thunderstorm Wind	131	0	9	$3.618M	$5K
Winter Storm	22	0	0	$19.89K	$0
Flash Flood	25	0	0	$2.785M	$0
Flood	20	0	0	$779K	$0
Hail	74	0	0	$10.050K	$30K
Excessive Heat	7	0	0	$0	$0
Drought	32	0	0	$0	$9.2M
Wildfire	1	0	0	$0	$0
Dam Failure	No History				
1 class A structure = no loss of life anticipated, only damage to dam owner's property					
2 class B structures = loss of life not probable, some economic loss & environmental damage					

Source: https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=21%2CKENTUCKY

For the purpose of the update to the 2018 JPHM Plan, the events will be reviewed from January 1, 2012 through March 31, 2017. The storm events database maintained by the NCEI will be utilized for as the source for the best available data for the Purchase Region.

Tornado

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground. It is most often generated by a thunderstorm when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly and upper level winds, especially the jet stream runs at an angle relative to the prevailing surface winds. These conditions occur with regularity over the Purchase Region in the spring, but as evidenced recently, can occur at any time of the year. Tornadoes are often accompanied by large hail and damage is most often the result of the high wind velocity and wind-blown debris. The most violent tornadoes have rotating winds of 250 miles per hour or more and are capable of causing extreme destruction. They have the power to uproot trees, structures, and turn harmless objects into deadly flying debris.

Most tornadoes aren't very wide and touch down only briefly. However, a highly destructive tornado may carve a path over a mile wide and several miles long. Tornadoes typically cause the most damage to lightly or poorly built structures, such as residential homes. An average of 800-1000 tornadoes are reported nationwide and they are more likely to occur during the spring and early summer months. Tornadoes can occur at any time of the day, but are more likely to form in the late afternoon or early evening.

In 2007 the Enhanced Fujita (EF) Scale was introduced to better reflect wind speed and the amount of damage produced by tornadoes. It replaced the Fujita-Pearson Scale that defined every tornado on record in the United States since 1950. EF rankings are assigned after a tornado event has occurred and the National Weather Service has inspected the damage.

Table 8.5 The Enhanced Fujita Tornado Measurement Scale

Scale	Estimated Wind Speed	Typical Damage
EF0	65-85 mph	Light Damage - Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; signboards damaged.
EF1	86 – 110 mph	Moderate Damage - Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
EF2	111 – 135 mph	Considerable Damage - Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light object missiles generated; cars lifted off ground and thrown.
EF3	136 – 165 mph	Severe Damage - Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
EF4	166 – 200 mph	Devastating Damage - Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
EF5	>200 mph	Incredible Damage - Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yards); trees debarked; incredible phenomena will occur.

Table 8.6 Tornado Events and Impacts in Marshall County
January 1, 2012 – March 31, 2017

Location	Date	Time	Time Zone	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
OAK LEVEL	04/18/2013	19:57	CST-6	EF0	0	0	8.00K	0.00K
CALVERT CITY	10/31/2013	20:03	CST-6	EF0	0	0	35.00K	0.00K
WALNUT GROVE	10/02/2014	23:10	CST-6	EF1	0	0	75.00K	0.00K
HARVY	05/10/2016	14:16	CST-6	EF1	0	0	50.00K	0.00K
ELVA	12/26/2016	15:08	CST-6	EF0	0	0	4.00K	0.00K
TOTALS:					**0**	**0**	**172.00K**	**0.00K**

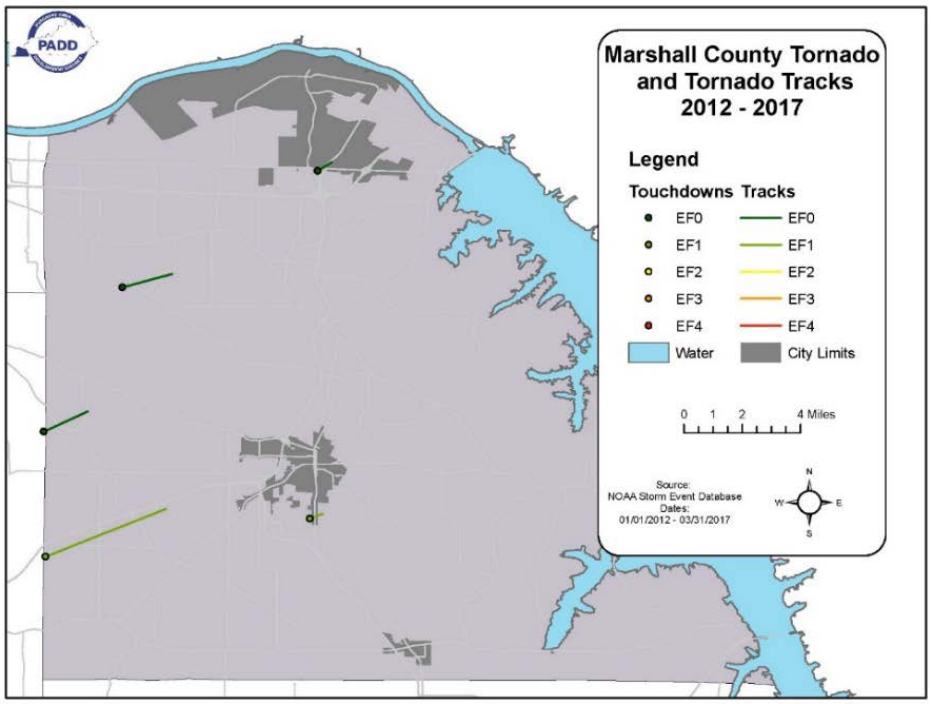
Source: National Oceanic and Atmospheric Administration, National Centers for Environmental Information, Storm Events Database:
https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=21%2CKENTUCKY

The following event descriptions are typical of tornado events experienced in Marshall County.

- On October 2, 2014 a tornado occurred on the south side of Benton. The tornado crossed the old two-lane U.S. Highway 641 with peak winds estimated near 105 mph. A tire business was destroyed when a large portion of a block wall collapsed and much of the roof was blown off. Two outbuildings sustained loss of roofing material and damage to a wall. Two homes had fascia, siding, and shingle damage. Two garages lost some shingles. Windows were cracked at a church. Several trees were snapped. The average path width was 110 yards.

- On May 10, 2016 a tornado entered Marshall County from Graves County less than a mile south of where the Purchase Parkway crosses the county line. The tornado remained along the south side of the Purchase Parkway (future Interstate 69) until it lifted about four miles west-southwest of downtown Benton. The tornado was considerably weaker in the Marshall County portion of its track than in Graves County, where the tornado produced EF-3 damage. In Marshall County, a wooden barn was destroyed, and a single-wide mobile home was rolled over. However, most of the damage consisted of trees uprooted and snapped by winds between 90 and 100 mph.

Figure 8.1
Vulnerability to Tornados through Identification of Tornado Tracks
January 1, 2012 – March 31, 2017



SUMMARY AND CONCLUSIONS OF TORNADO PROFILE

For the period covered by this update (January 1, 2012 through March 31, 2017, there were five occurrences of tornadoes in Marshall County reported by the NCEI. These occurrences resulted in no injuries however property damage totaled $172,000.

Information from Table 8.6 and Figure 8.1 related to Tornadoes can be used to define the frequency of tornado events and the impact of these events. Data on tornado event magnitude is provided in the form of the Enhanced Fujita Scale as shown on the map.

Marshall County experienced five reported events over a 5.25 year period, which indicates 0.95 reported tornado events per year, a near 100% probability that such an event will occur in any given year. The cost of a tornado event can be calculated as:

- $172,000 total damage divided by 5 events = $34,400 damage per event on average
- $34,400 average damager per event times 0.95 events per year = $32,680 damage per year on average.

Of critical concern to the Marshall County MPT, and the main contributing factor in their consideration of risks and vulnerability, is the human cost of Tornado Events. Fatalities, injuries and property damage are always a threat during tornado events even though none were observed during this update period. Information for individual city jurisdictions is not available in this data. However, in future updates of this tornado profile, information regarding each jurisdiction and losses should be included if available.

Thunderstorm Wind

A thunderstorm is formed from a combination of moisture, rapidly rising, warm air, or a force capable of lifting air, such as the meeting of a warm and cold front, a sea breeze, or a mountain. Thunderstorms can produce tornadoes, large hail and heavy rain which can cause flash flooding. The National Weather Service considers a thunderstorm as severe if it develops ¾ inch hail or 58 mph winds. Straight line winds can exceed 100 miles per hour and are responsible for wind damage associated with thunderstorms. One type of straight-line wind, the downburst, can cause damage equivalent to a strong tornado and can be extremely dangerous to aviation.

Thunderstorms affect relatively small area when compared with winter storms, as the average storm is 15 miles in diameter and lasts an average of 30 minutes. All thunderstorms are dangerous and capable of threatening life and property in localized areas. Every thunderstorm produces lightning, which results from the buildup and discharge of electrical energy between positively and negatively charged areas.

Thunderstorms are quite frequent in Marshall County. They have produced damage and injuries, but no recorded fatalities over the update period. Numerous severe thunderstorms have been recorded that produce high winds, lightning, and hail, in the county. Many of these thunderstorms have caused property or crop damage. These storms although relatively short in duration when compared to other weather events are often long lived enough to track across the entire county before dissipating their energy or exiting the region.

Table 8.7 Thunderstorm Wind Events and Impacts in Marshall County January 1, 2012 – March 31, 2017

Location	Date	Time	Time Zone	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
TATUMSVILLE	01/22/2012	22:43	CST-6	65 kts. EG	0	0	25.00K	0.00K
LITTLE CYPRESS	03/02/2012	13:30	CST-6	55 kts. EG	0	0	10.00K	0.00K
BENTON	06/11/2012	15:08	CST-6	61 kts. EG	0	0	35.00K	0.00K
DRAFFENVILLE	06/11/2012	15:10	CST-6	52 kts. EG	0	2	15.00K	0.00K
AURORA	06/11/2012	15:12	CST-6	52 kts. EG	0	0	10.00K	0.00K
HARVY	07/07/2012	18:30	CST-6	52 kts. EG	0	0	2.00K	0.00K
BREWERS	09/06/2012	18:25	CST-6	52 kts. EG	0	0	30.00K	0.00K
BENTON	01/29/2013	23:45	CST-6	61 kts. EG	0	0	5.00K	0.00K
DOGTOWN	01/29/2013	23:53	CST-6	61 kts. EG	0	0	30.00K	0.00K
SHARPE	04/18/2013	20:00	CST-6	52 kts. EG	0	0	4.00K	0.00K
HARVY	12/21/2013	17:32	CST-6	63 kts. MG	0	0	38.00K	0.00K
BREWERS	07/01/2014	17:50	CST-6	52 kts. EG	0	0	10.00K	0.00K
CALVERT CITY	04/03/2015	08:06	CST-6	70 kts. EG	0	0	15.00K	0.00K
GILBERTSVILLE	04/03/2015	08:07	CST-6	65 kts. EG	0	0	18.00K	0.00K
HARDIN	06/26/2015	11:50	CST-6	52 kts. EG	0	0	1.00K	0.00K
PALMA	06/26/2015	12:30	CST-6	52 kts. EG	0	0	5.00K	0.00K
CALVERT CITY	12/23/2015	15:26	CST-6	56 kts. EG	0	0	0.00K	0.00K

Location	Date	Time	Time Zone	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
OAK LEVEL	12/23/2015	15:30	CST-6	52 kts. EG	0	0	4.00K	0.00K
DRAFFENVILLE	04/27/2016	15:45	CST-6	52 kts. EG	0	0	20.00K	0.00K
OAK LEVEL	06/15/2016	12:36	CST-6	70 kts. EG	0	0	80.00K	0.00K
BENTON	06/15/2016	12:59	CST-6	61 kts. EG	0	0	10.00K	0.00K
TATUMSVILLE	06/15/2016	13:00	CST-6	56 kts. EG	0	0	6.00K	0.00K
OAK LEVEL	07/06/2016	13:00	CST-6	61 kts. EG	0	0	45.00K	0.00K
BENTON	07/06/2016	13:05	CST-6	50 kts. MG	0	0	60.00K	0.00K
FAIRDEALING	07/07/2016	12:58	CST-6	74 kts. EG	0	0	40.00K	0.00K
ELVA	12/26/2016	15:06	CST-6	61 kts. EG	0	0	2.00K	0.00K
HARVY	03/01/2017	05:27	CST-6	87 kts. EG	0	0	25.00K	0.00K
CALVERT CITY	03/01/2017	05:30	CST-6	65 kts. MG	0	0	100.00K	0.00K
SHARPE	03/07/2017	04:35	CST-6	65 kts. EG	0	0	5.00K	0.00K
TOTALS					0	2	650.00K	0.00K

Wind Magnitude Definitions:
Measured Gust:'MG', Estimated Gust:'EG', Measured Sustained:'MS', Estimated Sustained:'ES' Source: Source: National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI), Storm Events Database
https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=21%2CKENTUCKY

The following event descriptions are typical of the type of thunderstorm/wind events experienced in Marshall County.

- On March 1, 2017 widespread damaging winds were observed across northern and central Marshall County. A 75 mph wind gust was measured by National Weather Service personnel on a hill at the interchange of I-24 and the Purchase Parkway. The roof was blown off a large metal storage shed at the Marshall County Road Department near Draffenville. Several structures sustained minor damage in Benton while trees and power lines were down, causing power outages. Several large pine trees were toppled at a residence on U.S. Highway 68, destroying a vehicle. In addition wind gusts around 75 mph were estimated by a National Weather Service employee near Palma.

- On June 15, 2016, a microburst containing winds up to 80 mph continued eastward from Graves County to about three miles west of Benton. At least four barns or sheds were damaged or destroyed, with one collapsing to the ground along Highway 1949. Dozens of trees were uprooted or snapped. The microburst width was about one mile.

- There were scattered reports of downed trees in north central and northeast Marshall County on July 6, 2016. A wind gust of 58 mph was measured at the Kentucky mesonet site near Draffenville. Some isolated structural damage was reported in the area, mostly due to fallen trees. Several miles north of Fairdealing, trees were blown down near Kentucky Lake.

SUMMARY AND CONCLUSIONS OF THUNDERSTORM WIND PROFILE

From January 1, 2012 through March 30, 2017, there have been 29 occurrences of Thunderstorm Wind events were reported in Marshall County by the NCEI. These occurrences resulted in two injuries and over $650,000 in reported personal property damage.

The number of Thunderstorm Wind events were combined to look at the frequency of occurrence. Marshall County experienced 29 Reported Events over the 5.25 year update period, which divides out to 5.2 reported events per year, a more than 100% probability that such an event will occur in any given year. For Marshall County the cost of a Thunderstorm Wind Event could be calculated as:

- $650,000 in damages / 29 events = $22,414 per event on average.
- $22,414 average damage per event x 5.2 events per year = $116,553 average damage per year.

Of critical concern to the Marshall County MPT and the main contributing factor in their consideration of risks and vulnerability, is the human cost of Severe Storm Events.

Winter Storm/Ice Storm

Winter Storms can produce an array of hazardous weather conditions that include heavy snow, freezing rain, sleet, high winds, and extreme cold. Ice Storms occur when freezing rain accumulates on surfaces and the ground. When a quarter-inch or more of ice builds up, severe impacts can result. Winter storms are fueled by strong temperature gradients and an active upper-level cold jet stream. An Ice Storm can develop when warmer air above the freezing mark above the ground moves over subfreezing air near the ground. Snow aloft falls through the warmer air and melts into rain, then the rain droplets fall into the subfreezing air and freeze upon contact creating a glaze of ice. Winter and Ice storms can paralyze a community by shutting down normal everyday operations. Accumulating snow and ice can result in downed trees and power lines and may block transportation routes or make them hazardous. Heavy snow can lead to the collapse of weak roofs or unstable structures. Often, the loss of electricity results in the loss of heat in some homes and buildings. This presents a threat to human life, especially the elderly population.

The level of impact Winter Storms have is greatly determined by a community's ability to manage and control the affect; for example, the rapid mobilization of snow removal equipment. Because winter storms are sporadic in western Kentucky, many communities cannot afford the expensive equipment and maintenance of snow removal. This increases the potential damage a Winter Storm may cause. Depending on the severity of Ice Storms, impacts can persist for days. If more than a half-inch of accumulation occurs and damage is widespread, it can take a while to remove trees and repair power lines. This can result in a loss of electricity and heat for several days. During the planning period for this update there have been seven Winter Storms recorded in Marshall County and zero ice storms. The last Ice Storm on record happened in January 2009.

Table 8.8 Winter Storm Events and Impacts in Marshall County, January 1, 2012 – March 31, 2017

Location	Date	Time	Time Zone	Event Type	Deaths	Injuries	Property Damage	Crop Damage
MARSHALL (ZONE)	12/05/2013	22:00	CST-6	Winter Storm	0	0	0.00K	0.00K
MARSHALL (ZONE)	02/04/2014	12:00	CST-6	Winter Storm	0	0	50.00K	0.00K
MARSHALL (ZONE)	03/02/2014	10:00	CST-6	Winter Storm	0	0	0.00K	0.00K
MARSHALL (ZONE)	02/20/2015	14:00	CST-6	Winter Storm	0	0	0.00K	0.00K
MARSHALL (ZONE)	03/04/2015	14:00	CST-6	Winter Storm	0	0	0.00K	0.00K
MARSHALL (ZONE)	01/21/2016	23:00	CST-6	Winter Storm	0	0	0.00K	0.00K
TOTALS					**0**	**0**	**50.00K**	**0.00K**

Source: National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI), Storm Events Database
https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=21%2CKENTUCKY

The following event descriptions are typical of the type of winter storm/ice storm events experienced in Marshall County.

- On February 4, 2014 one-quarter to one-half inch of ice coated trees and power lines across western Kentucky. The highest accumulations of ice were from the Murray area, northeast across Kentucky Lake, to Madisonville and Calhoun. The freezing rain started as a period of heavy snow and sleet in some areas, mainly from Paducah to Madisonville and points north. Scattered power outages were reported across western Kentucky. In the Pennyrile area east of Kentucky Lake, a utility company reported 2,000 customers without power. Some tree branches were brought down by the ice. Roads started off very slick with numerous accidents, but they became mainly wet as temperatures rose into the lower 30's. In Marshall County, downed power lines blocked the intersection of Highways 641 and 58. A vigorous fast-moving Pacific storm system that originated off the Baja of California raced northeast. A strong warm front moved as far north as the Tennessee Valley. Widespread heavy precipitation north of the warm front resulted in significant icing across western Kentucky, along with some minor accumulations of sleet and snow.

SUMMARY AND CONCLUSIONS OF WINTER STORMS / ICE STORM PROFILE

From January 1, 2012 through March 30, 2017, there have been six occurrences of Winter Storms in Marshall County reported by the NCEI. These occurrences totaled over $50,000 in reported personal property damage for the entire region affected.

The number of Winter Storm and Ice Storm events for the Marshall County and the Cities of Benton, Calvert City and Hardin were considered jointly to look at the frequency of occurrence.
Purchase Region. Ice Storm events, such as the one in 2009, have had a major impact on the region in the past however for this reporting period this specific type of event had no impact. Details regarding this event history are available in Appendix 1.

Marshall County experienced six reported Winter Storm Events over the 5.25 year plan update period, which divides out to 1.1 reported Winter Storm Events per year, or a more than 100% probability that such an event will occur in any given year. Based on recorded events and reported damages for Marshall County the cost of a Winter Storm Event could be calculated as:

- $50,000 divided by 6events = $8,333 average damage per event.
- $8,333 average damage per event x 1.1 average events/year = $9,166 per year.

Ice Storm events, such as the one in 2009, have had a major impact on the region in the past however for this reporting period this specific type of event had no impact. While no Ice Storm events have not been recorded during this update period, such events are considered a significant risk due to the 2009 Ice Storm which produced significant damage to the entire Purchase Region.

Flash Flood / Flood

As can be seen from the table below, Flash Flood is the most common form of flooding in Marshall County. The cause, being too much rain water, delivered in too short of time. However, rather than steep slopes and narrow valleys channeling and concentrating the runoff from heavy rains, the runoff is too great in volume for the county's characteristic low lying, meandering streams, to carry away. This slow drainage is often exacerbated by stream blockages of tree limbs and trunks, which form effective check dams and barrages.

River basin flooding is common among Kentucky's major streams and bodies of water during the winter and early spring months. The major drainage systems in Marshall County are the Ohio River, Tennessee River, and Clarks River. The Ohio and Tennessee Rivers delivered catastrophic flooding to the area in the past, most memorably in 1937, but has since been contained, if not controlled by levees, floodwalls, dams and by the controlled release of waters from Kentucky Dam on the Tennessee River and Barkley Dam on the Cumberland. Even so, a river such as the mighty Ohio will sometimes have its way. The event record below is a description of a typical, major, Purchase Region flood event and its impact on Marshall County.

Between January 1, 2012 and March 31, 2017 there were nine flash floods and zero river basin floods recorded in Marshall County. The flash flood events did not cause any deaths or injuries however there were $2,540,000 million in property damages.

Table 8.9 Flash Flood / Flood Events and Impacts in Marshall County January 1, 2012 – March 31, 2017

Location	Date	Time	Time Zone	Event Type	Deaths	Injuries	Property Damage	Crop Damage
BENTON	03/08/2012	17:00	CST-6	Flash Flood	0	0	2.450M	0.00K
CALVERT CITY	06/01/2013	05:18	CST-6	Flash Flood	0	0	0.00K	0.00K
HARVY	12/23/2015	16:17	CST-6	Flash Flood	0	0	0.00K	0.00K
BENTON	12/28/2015	11:46	CST-6	Flood	0	0	50.00K	0.00K
TATUMSVILLE	03/09/2016	16:06	CST-6	Flood	0	0	0.00K	0.00K
SCALE	07/03/2016	23:30	CST-6	Flash Flood	0	0	0.00K	0.00K
SHARPE	07/07/2016	00:48	CST-6	Flash Flood	0	0	400.00K	0.00K
GILBERTSVILLE	08/01/2016	14:25	CST-6	Flash Flood	0	0	2.000M	0.00K
BENTON	08/06/2016	12:15	CST-6	Flash Flood	0	0	0.00K	0.00K
				TOTALS	0	0	2.450M	0.00K

Source: National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information Storm Events Database:
https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=21%2CKENTUCKY

The following event descriptions are typical of the type of flooding experienced in Marshall County.

- On July 7, 2016 widespread major flash flooding affected Marshall County, especially the northern and central parts of the county. A rainfall amount of 6.87 inches was recorded in four hours and 15 minutes at the Kentucky mesonet site in Draffenville. An off-duty meteorologist in Calvert City measured three inches of rain per hour. Multiple evacuations were conducted throughout the county by various agencies. Many roads across the county were flooded, including numerous main roads. At least 22 roads were washed out across the county. Residents of about 10 homes were stranded because their street was washed out. The damage to county roads alone totaled over $600,000 dollars. A pickup truck crashed headlong into one of the washed out sections. The Purchase Parkway (future Interstate 69) was closed for a few hours due to a couple feet of water over the highway at mile-marker 46. In Calvert City, a vehicle was three-quarters full of water, and an apartment building was flooded. In Benton, 13 people were evacuated from an assisted living facility due to flooding. West of Calvert City, six people were trapped in a flooded apartment. Evacuations were conducted in Gilbertsville, where water was up to the door of a mobile home. Some rooms at a resort motel on U.S. Highway 641 near Gilbertsville were flooded.

- Multiple clusters of thunderstorms in the Benton area resulted in substantial damage on July 3, 2016. One street was washed out and there were numerous homes with flooded garages & basements. Most of the flooding was near creeks that run through town. South of Benton, a bridge was washed out on the northern end of Highway 783 where it crosses a creek. A 24-hour rainfall amount of 7.50 inches was reported just southeast of Benton.

Figure 8.2

Marshall County 100 Year Floodplain
Source: FEMA National Flood Hazard Layers, 2016

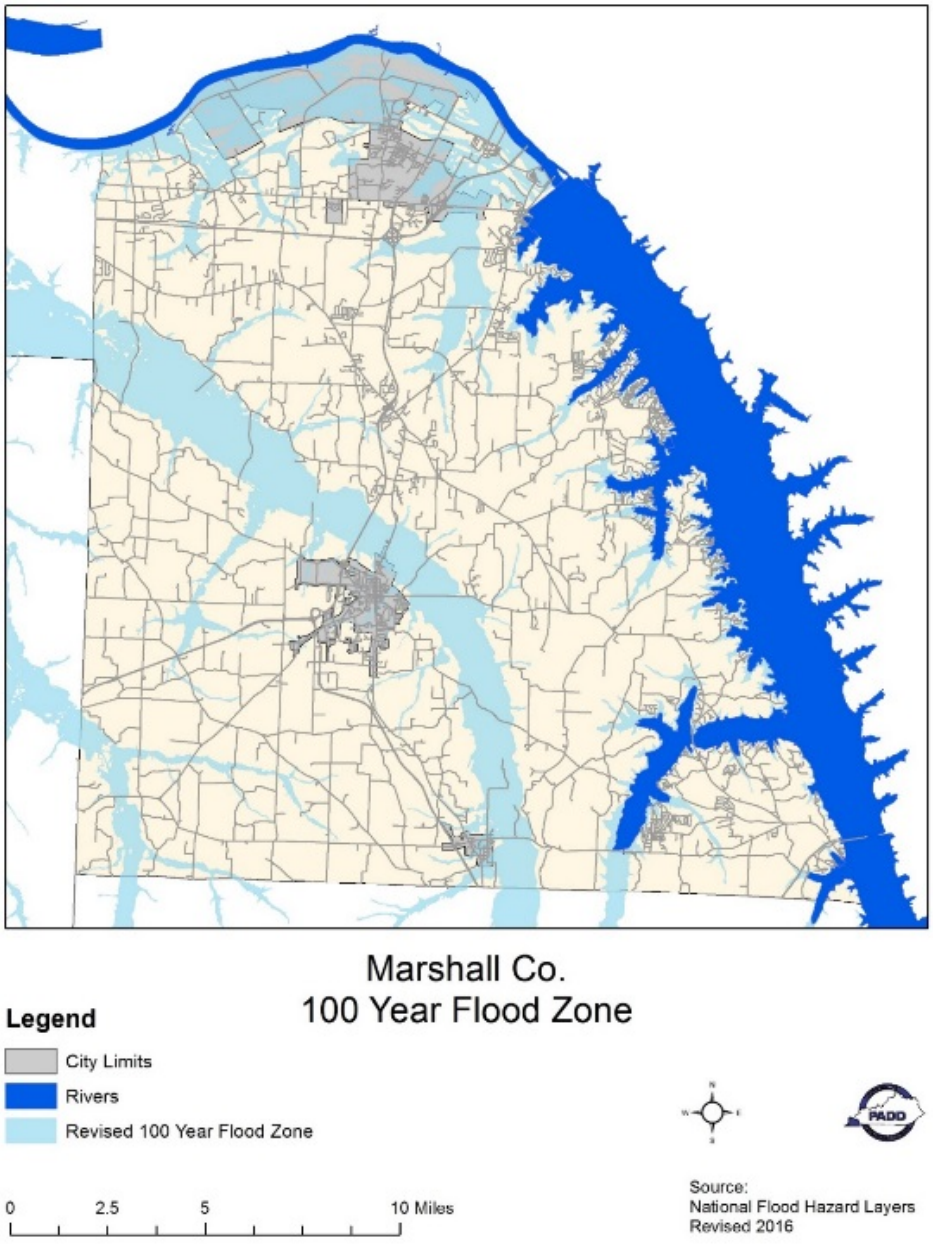


Figure 8.3 City of Benton
Flood Hazard Zone

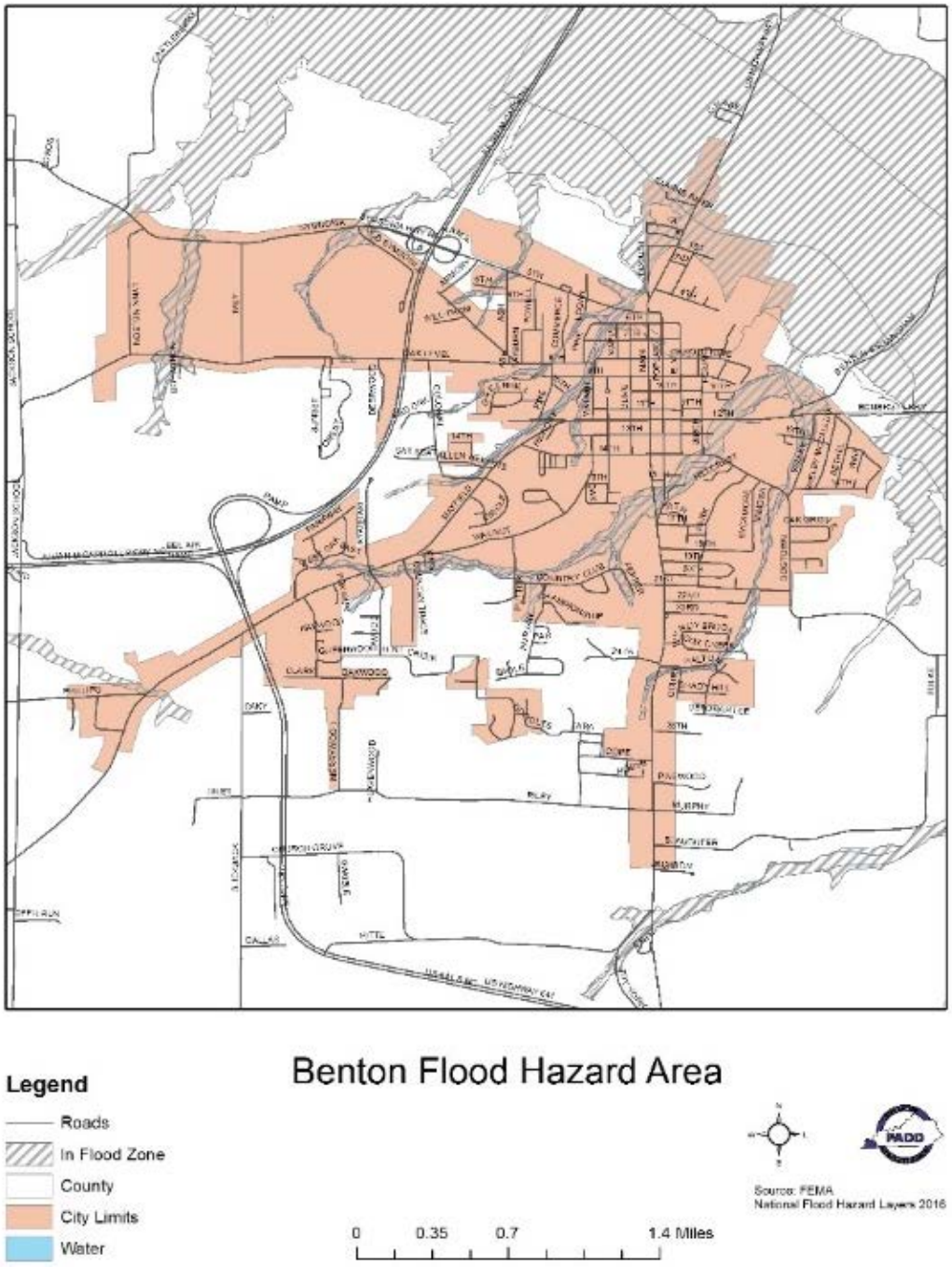


Figure 8.4 City of Calvert City Flood Hazard Zone

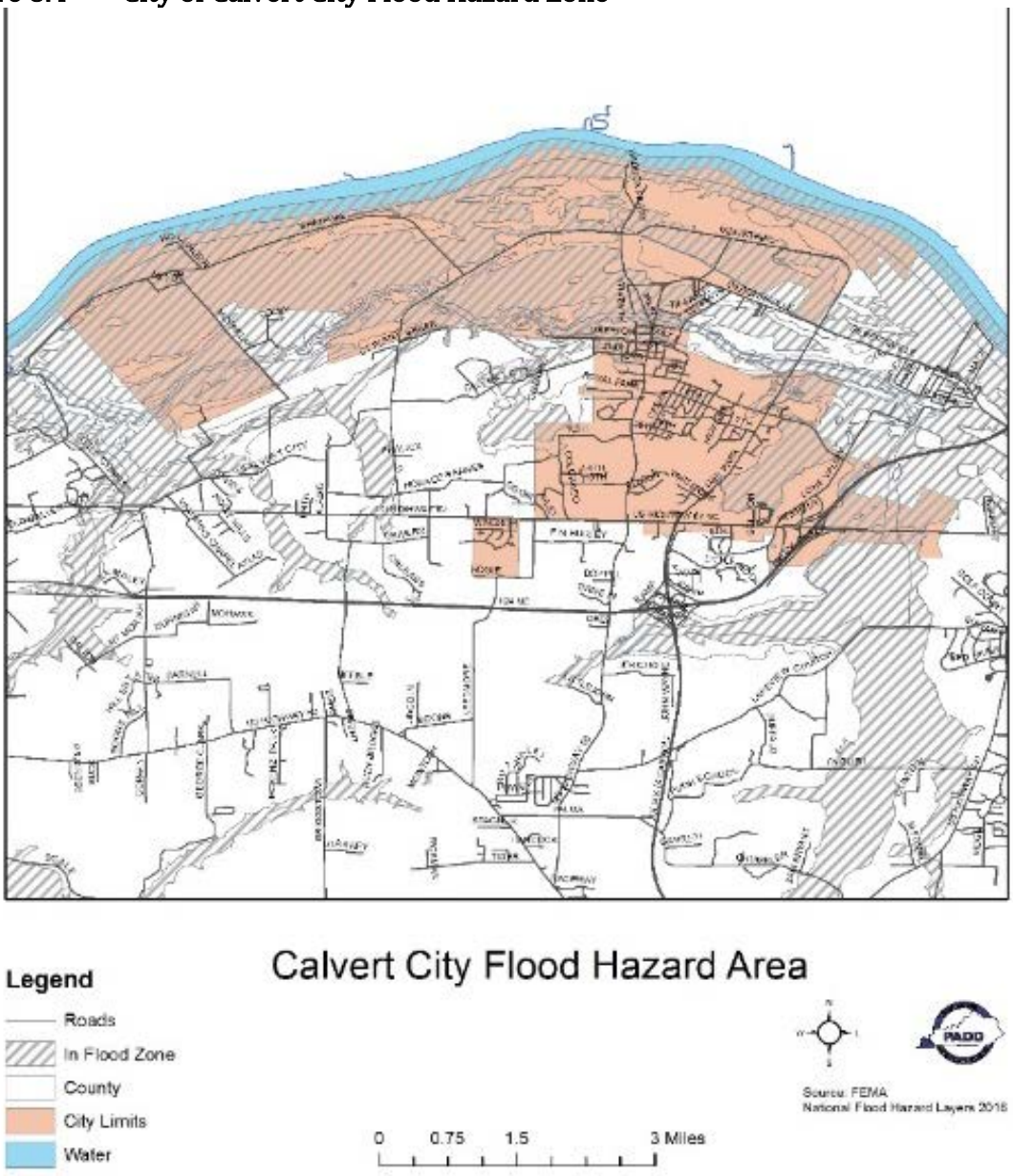
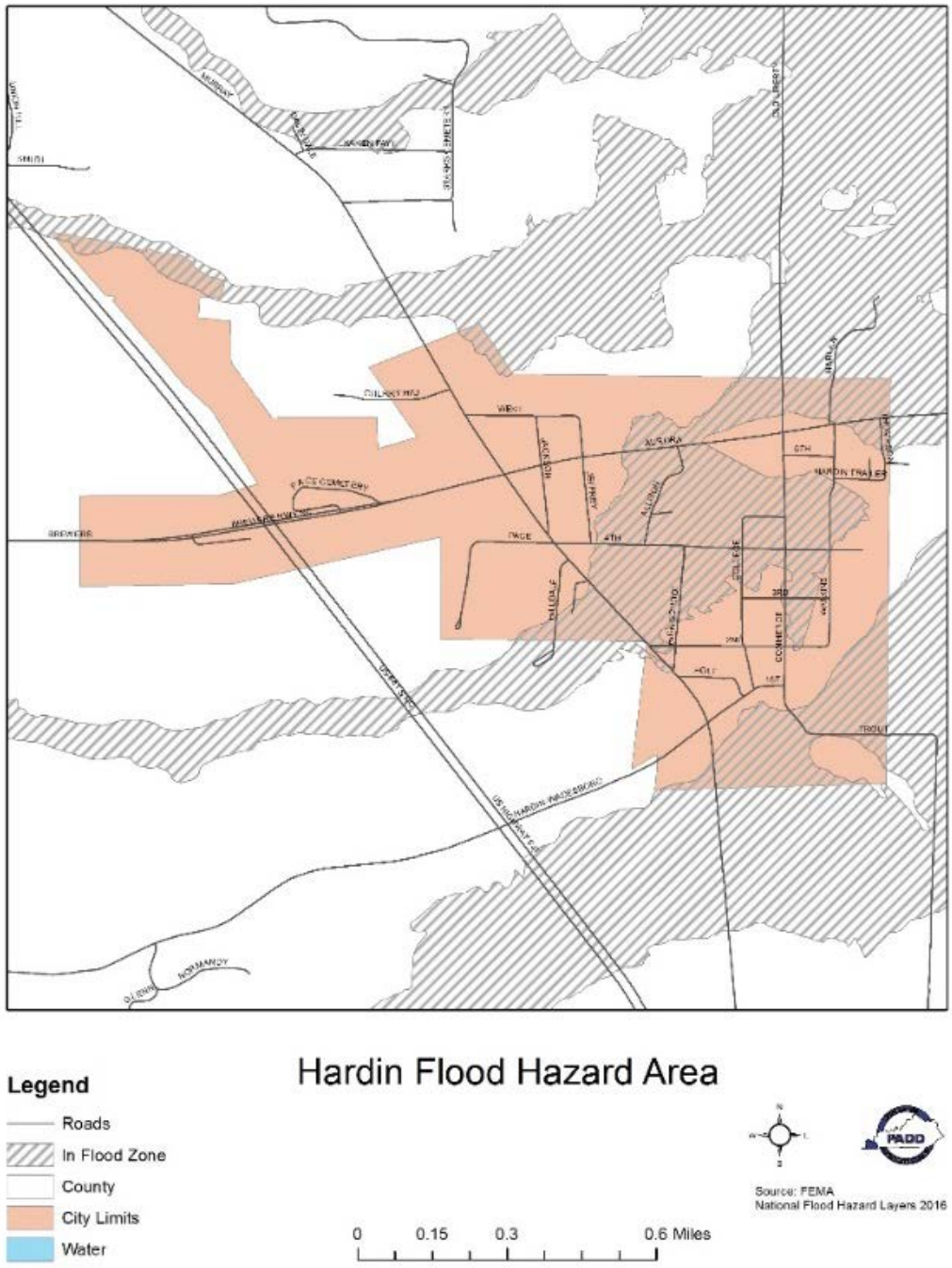


Figure 8.5 City of Hardin
Flood Hazard Areas[1]



[1] Figures 8.3, 8.4, 8.5 source material from the FEMA National Flood Hazard Layers, 2016

Table 8.10 National Flood Insurance Program Participation by Jurisdiction

Jurisdiction	Floodplain Management Ordinance	SFHA in Jurisdictional Limits	Comments	City Class
Ballard County	X	X		
City of Barlow			No mapped SFHA	6
City of Kevil			No mapped SFHA	6
City of La Center		X	SFHA mapped in 2009, NFIP under consideration	5
City of Wickliffe	X	X		5
Calloway County	X	X		
City of Murray	X	X		3
City of Hazel			No mapped SFHA	6
Carlisle County	X	X		
City of Bardwell	X	X		5
City of Arlington	X	X		6
Fulton County	X	X		
City of Fulton	X	X		4
City of Hickman	X	X		4
Graves County	X	X		
City of Mayfield	X	X		3
City of Wingo		X		6
Hickman County		X	Mapped SFHA, non-participant	
City of Clinton	X	X		5
City of Columbus			No mapped SFHA	5
Marshall County	**X**	**X**		
City of Benton	**X**	**X**		**4**
City of Calvert City	**X**	**X**		**4**
City of Hardin	**X**	**X**		**5**
McCracken County	X	X		
City of Paducah	X	X		2

Information from the FEMA Community Status Book as of 6-13-17

SUMMARY AND CONCLUSIONS OF FLOODING PROFILE

Information from the above tables and maps related to flooding can be used to define the frequency of Flood Events and the impact of these events. Data on flood event magnitude was not available.

The number of Flood Events for Marshall County and the Cities of Benton, Calvert City and Hardin were rolled together for this review. On average the frequency of occurrence indicates a more than 100% probability that such an event will occur in any given year. The cost of a Flood Events could be calculated as:

- 9 events / 5.25 year plan update period = 1.7 an average of events per year
- $2,450,000 property damage / 9 events = $272,222 average damage per event.

$272,222 average damage per event x 1.7 events per year = $462,777 average damage per year.

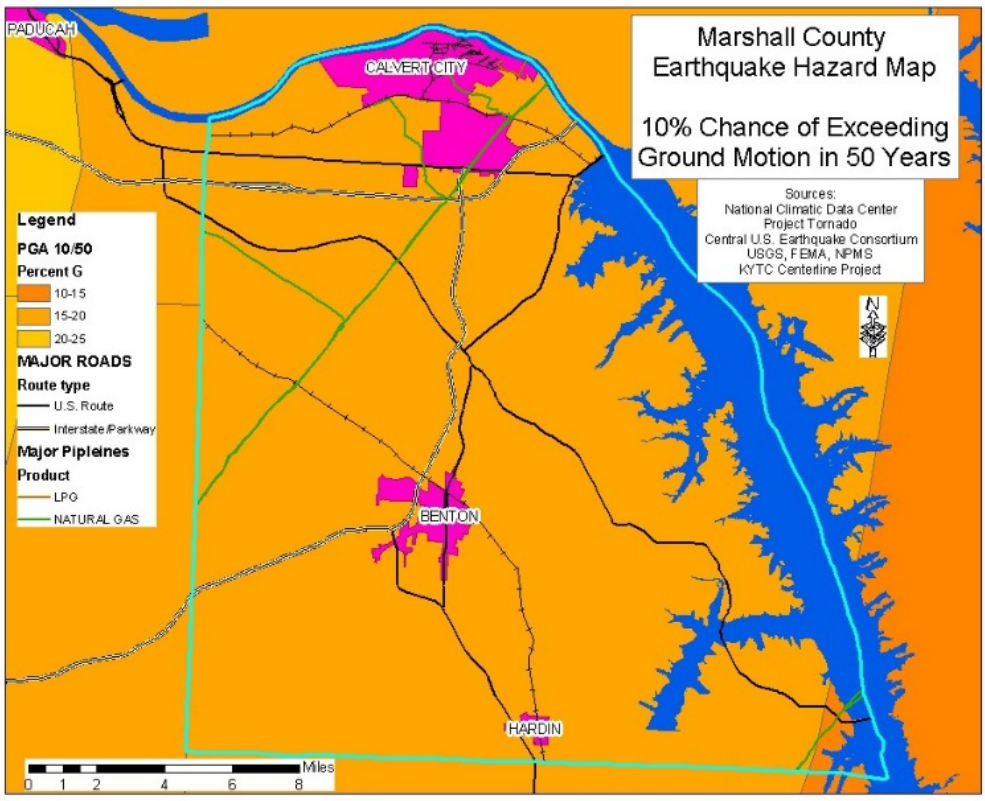
Earthquake

An earthquake is a geologic event that involves movement or shaking of the earth's crust. Earthquakes are usually caused by the release of stresses accumulated as a result of the rupture of rocks along borders of the earth's ten tectonic plates. Earthquakes can affect hundreds of thousands of square miles, causing damage to property, resulting in loss of life and injury, and disrupting the social and economic functioning of the affected area.

An assessment to the earthquake threat to the entire Purchase Region is provided in the regional plan. All of Marshall County lies in an area that has a 10 per cent probability of an earthquake in the new Madrid Seismic Zone producing ground motions that exceed 15 % to 20% of "G" during the next 50 years (See Figure 8.6). That would equate to a VI on the Modified Mercalli Scale, or a 5.4 on the Richter. (Trees sway, suspended objects swing & objects fall off shelves). The remainder of the county would experience ground motions 10-15% of G under the same conditions.

That does not mean it will happen in fifty years, as one could look at the data and just as correctly assume that there is a 90% probability that the region will not experience this level of ground motion during a given 50 year period. It should be noted that 20% of G is an acceleration of 73 inches/second/second.

Figure 8.6 Earthquake Ground Motion Map



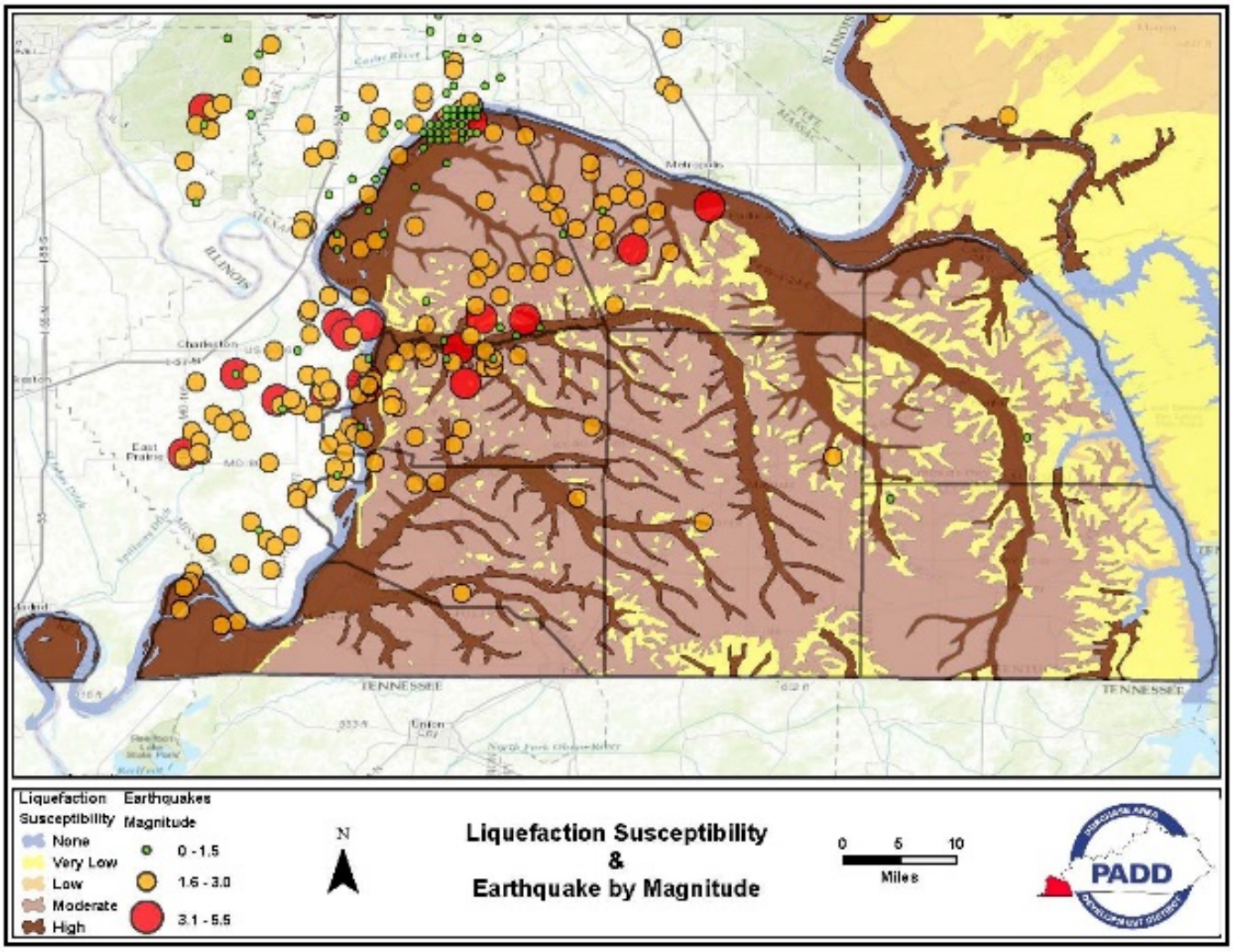
At issue for all the Purchase Region and virtually all of Marshall County would be the effect of a large magnitude quake on the soils underlying the region. The ground shaking estimate accounts for both the likely ranges of recurrence intervals and locations. Due to the

relatively low rate of seismicity, ground cover, deep soil, etc., most faults within the region aren't even mapped. Even the precise location of faults within the New Madrid Seismic Zone are subject to debate. No one knows what causes New Madrid earthquakes. However, there are ideas that are being researched. Although there is great uncertainty regarding the cause of earthquakes, scientists generally do agree on what happens when they do occur – that is, the likely levels of ground shaking associated with the waves earthquakes emit. These levels are reflected in the National Seismic Hazard Maps, which represent the products of a long consensus building process. These maps also account for the uncertainties in our understanding.

Most property damage and earthquake-related deaths are caused by the failure and collapse of structures due to ground shaking. The level of damage depends on the amplitude and duration of the shaking, which are directly related to the earthquake size, distance from the fault, site and regional geology. Earthquakes may also cause liquefaction. Liquefaction occurs when the ground soil loses the ability to resist shear and flows, much like quick sand. When liquefaction occurs, anything relying on the substrata for support can shift, tilt, rupture, or collapse.

Figure 8.7 shows the underlying soil structure for Marshall County. It indicates that virtually the entire county is underlain by beds of sediment, not bedrock. This increases the potential for ground shaking and liquefaction.

Figure 8.7 Generalized Liquefaction Susceptibility & Earthquake Magnitude of the Purchase Region



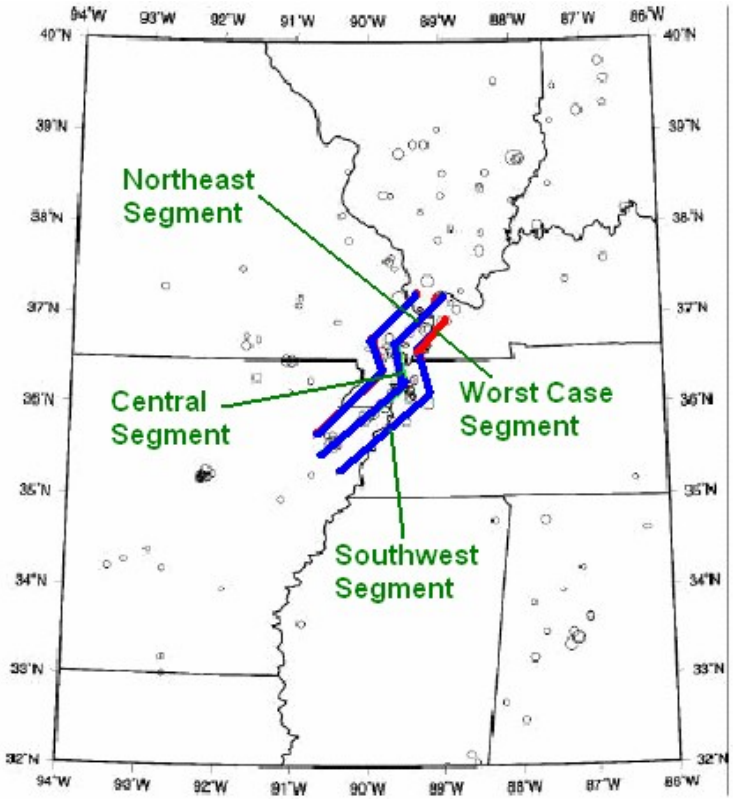
Source: USGS Map was derived from the USGS Earthquake Catalog, Available at: https://earthquake.usgs.gov/earthquakes/search/

Included as an Appendix 2 to the regional plan and the Marshall County Annex are excerpts from Mid-America Earthquake Center Report 08-02 "Impact of Earthquakes on the Central USA". This report is the result of a FEMA funded Project completed under the management of the U.S. Army Corps of Engineers.

> The NMSZ scenario for the State of Kentucky consists of a magnitude 7.7 (Mw7.7) earthquake along the northeast extension of the presumed eastern fault line in the New Madrid fault system. The ground motions used to represent this seismic event were developed by the U.S. Geological Survey (USGS) for the middle fault in the proposed New Madrid Seismic Zone (NMSZ). Each fault line is presumed to consist of three fault segments; northeastern, central, and southwestern. This scenario, the worst case event for Kentucky, employs an event in the northeast segment of the eastern fault. The location of this scenario event is illustrated in Figure 8.8. For more information on the ground motion used in this scenario please reference Appendix 2.
>
> This earthquake impact assessment includes all 120 counties in the State of Kentucky. Kentucky is approximately 40,400 square miles and is bordered by Indiana and Ohio to the north, Tennessee to the south, West Virginia and Virginia to the east and Illinois and Missouri to the west. For the purposes of this analysis, 25 critical counties have been identified in the western portion of the state where shaking is anticipated to be most intense. These 25 counties are the focus of much of the damage assessment included within this document". Purchase counties included as critical counties are Ballard, Calloway, Carlisle, Fulton, Graves, Hickman, McCracken, and Marshall.
>
> Within the State of Kentucky, nearly 29,000 buildings experience complete damage, which are included in the nearly 53,000 at least moderately damaged buildings. While this is roughly 2% of all Kentucky buildings, many of these collapsed structures are concentrated in the western counties. As with previous state scenarios, residential buildings experience the greatest amount of damage. Nearly 98% of all building collapses occur to residential structures. In addition, about 94% of all at least moderate damage occurs in the 25 critical counties for Kentucky.

More detailed data from the scenario's results are included in Appendix 2.

Figure 8.8
Scenario Fault Location for the State of Kentucky



SUMMARY AND CONCLUSIONS OF EARTHQUAKE HAZARD PROFILE

Low magnitude earthquakes occur constantly in the New Madrid Seismic Zone. Depending on the depth and magnitude, some of the stronger tremblers, 3 and above, are felt throughout the entire region. Damages amount to the rare instance of a picture being knocked off a wall or items shaken from shelves.

The potential for an earthquake of catastrophic proportions is not open to debate. Historic and geologic evidence are proof. However, the probability of such an event in any given time frame is open to interpretation and the effects are still a matter of discussion. The excerpts from Report 08-02 include the results generated by the team at the Mid-America Earthquake Center, of a HAZUS simulation for a New Madrid magnitude 7.7. The results clearly support at least the Moderate Risk ranking of this hazard, and provide detailed potential damage and casualty estimates.

Hail

Hail is one of four types of precipitation that falls from the sky. It's also the most dangerous, damaging type, occurring during severe storms. If hail measuring larger than ¾ inches in diameter falls during a thunderstorm, it is classified as severe weather. Sometimes damaging winds accompany this type of storm as well. According to the National Oceanic and Atmospheric Administration, hail causes over one billion dollars of damage in the United States each year.

Generally, hail must be 1 ¼ inches in diameter (Half-Dollar size) before it causes damage to heavy composite shingles or wood shake shingles. Lightweight composite shingles may show damage after being struck by 1-inch diameter (Quarter size) hail. Only deteriorated composite shingles will show hail damage due to hail less than 1 inch in diameter, and the hail generally must be more than ¾ inch in diameter (Dime size).

TORRO Hailstorm Intensity Scale

The Torro Hailstorm Intensity Scale was introduced by Jonathan Webb of Oxford, England, in 1986 as a means of categorizing hailstorms. The scale extends from H0 to H10 (See Table 8.11) with its increments of intensity or damage potential related to hail size, texture, numbers, fall speed, speed of storm translation, and strength of the accompanying wind.

An indication of equivalent hail kinetic energy ranges (in joules per square meter) has now been added to the first six increments on the scale, and this may be derived from radar reflectivity or from hail pads. The International Hailstorm Intensity Scale recognizes that hail size alone is insufficient to accurately categorize the intensity and damage potential of a hailstorm, especially towards the lower end of the scale. For example, without additional information, an event in which hail of up to walnut size is reported (hail size code 3: hail diameter of 21-30 mm) would be graded as a hailstorm with a minimum intensity of H2-3. Additional information, such as the ground wind speed or the nature of the damage the hail caused, would help to clarify the intensity of the event. For example, a fall of walnut-sized hail with little or no wind may scar fruit and sever the stems of crops but would not break vertical glass and so would be ranked H2-3. However, if accompanied by strong winds, the same hail may smash many windows in a house and dent the bodywork of a car, and so be graded an intensity as high as H5.

However, evidence indicates that maximum hailstone size is the most important parameter relating to structural damage, especially towards the more severe end of the scale. It must be noted that hailstone shapes are also an important feature, especially as the "effective" diameter of non-spheroidal specimens should ideally be an average of the co-ordinates. Spiked or jagged hail can also increase some aspects of damage.

Table 8.11

H	Intensity Category	Typical Hail Diameter (mm)*	Probable Kinetic Energy, J-m²	Typical Damage Impacts
H0	Hard Hail	5	0-20	No damage
H1	Potentially Damaging	5-15	>20	Slight general damage to plants, crops
H2	Significant	10-20	>100	Significant damage to fruit, crops, vegetation
H3	Severe	20-30	>300	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	25-40	>500	Widespread glass damage, vehicle bodywork damage
H5	Destructive	30-50	>800	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	40-60		Bodywork of grounded aircraft dented, brick walls pitted
H7	Destructive	50-75		Severe roof damage, risk of serious injuries
H8	Destructive	60-90		(Severest recorded in the British Isles) Severe damage to aircraft bodywork
H9	Super Hailstorms	75-100		Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
H10	Super Hailstorms	>100		Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

Size codes are presented in TABLE 8.12 The Size Code is the maximum reported size code accepted as consistent with other reports and evidence.

Table 8.12

Size code	Maximum Diameter mm	Description
0	5-9	Pea
1	10-15	Mothball
2	16-20	Marble, grape
3	21-30	Walnut
4	31-40	Pigeon's egg > squash ball
5	41-50	Golf ball > Pullet's egg
6	51-60	Hen's egg
7	61-75	Tennis ball > cricket ball
8	76-90	Large orange > Soft ball
9	91-100	Grapefruit
10	>100	Melon

From January 1, 2012 through March 31, 2017, there have been 12 occurrences of Hail events in Marshall County reported by the NCEI. There were no injuries or property damages associated with these events for the plan update period.

Table 8.13 Hail Events and Impacts in Marshall County January 1, 2012 – March 31, 2017

Location	Date	Time	Time Zone	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
BENTON	01/22/2012	23:00	CST-6	0.88 in.	0	0	0.00K	0.00K
BENTON	02/29/2012	07:28	CST-6	1.00 in.	0	0	0.00K	0.00K
AURORA	02/29/2012	09:24	CST-6	1.00 in.	0	0	0.00K	0.00K
DRAFFENVILLE	04/05/2012	15:40	CST-6	0.75 in.	0	0	0.00K	0.00K
GILBERTSVILLE ARPT	07/06/2013	17:55	CST-6	0.88 in.	0	0	0.00K	0.00K
CALVERT CITY	04/25/2015	18:21	CST-6	0.75 in.	0	0	0.00K	0.00K
AURORA	06/08/2015	11:50	CST-6	1.00 in.	0	0	0.00K	0.00K
CALVERT CITY	06/08/2015	12:20	CST-6	1.25 in.	0	0	0.00K	0.00K
ELVA	12/23/2015	15:28	CST-6	1.00 in.	0	0	0.00K	0.00K
BENTON	05/10/2016	14:25	CST-6	1.00 in.	0	0	0.00K	0.00K
AURORA	03/27/2017	12:58	CST-6	1.00 in.	0	0	0.00K	0.00K
BENTON	03/27/2017	15:15	CST-6	0.75 in.	0	0	0.00K	0.00K
TOTALS					**0**	**0**	**0.00K**	**0.00K**

Source: National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI), Storm Events Database
https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=21%2CKENTUCKY

SUMMARY AND CONCLUSIONS FOR HAIL PROFILE

There were 12 hail events during the 5.25 year update planning period. On average this means that approximately 2.3 hail events occur in Marshall County on any given year. This translates into a 100% chance of a hail event occurring in Marshall County. While no Hail damage was recorded during this update period, small events are not uncommon. The primary hazard associated with such events is typically property damage in the form of vehicle and crop damage. As there were no hail damages reported for the update period, the annualized cost could not be calculated. A history of such events which did generate damage is located in Appendix 1.

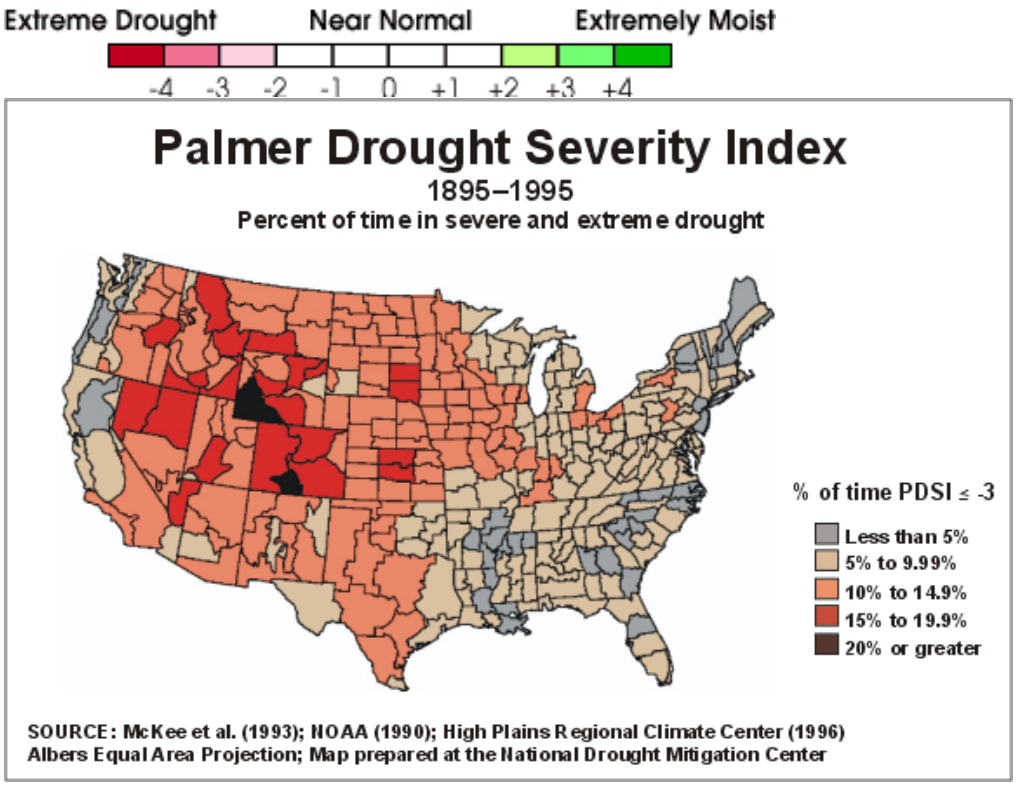
Excessive Heat / Drought

Excessive Heat is defined as temperatures that hover 10 degrees or more above the average high temperatures for the region and last for several weeks. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when a "dome" of high atmospheric pressure traps hazy, damp air near the ground. Excessively dry and hot conditions can provoke dust storms and low visibility.

Droughts occur when a long period passes without substantial rainfall. Drought conditions can cause significant crop damage, but there is little property damage from excessive heat. Due to the historical occurrences of drought and excessive heat in the Purchase Region, these hazards present a threat not only to the agriculture of the region, but to the aged, and chronically ill population.

The Palmer Drought Severity Index (PDSI) is used to show the relative dryness or wetness in an area and indicates prolonged and abnormal moisture deficiency or excess. The PDSI is used for evaluating the scope, severity and frequency of prolonged periods of abnormally wet or dry weather. The PDSI scale follows below.

Figure 8.9 Palmer Drought Severity Index



During the planning period for this update there have been a combined total of 14 events recorded in Marshall County. Of those 14 events, three have been Excessive Heat and 11 Drought. There were no injuries / fatalities or damages (property or crop) recorded during these events.

Table 8.14 Excessive Heat / Drought Events and Impacts in Marshall County January 1, 2012 – March 31, 2017

Location	Date	Time	Time Zone	Event Type	Deaths	Injuries	Property Damage	Crop Damage
MARSHALL (ZONE)	05/12/2012	00:00	CST-6	Drought	0	0	0.00K	0.00K
MARSHALL (ZONE)	06/01/2012	00:00	CST-6	Drought	0	0	0.00K	0.00K
MARSHALL (ZONE)	07/01/2012	00:00	CST-6	Drought	0	0	0.00K	0.00K
MARSHALL (ZONE)	07/01/2012	10:00	CST-6	Excessive Heat	0	0	0.00K	0.00K
MARSHALL (ZONE)	07/18/2012	10:00	CST-6	Excessive Heat	0	0	0.00K	0.00K
MARSHALL (ZONE)	08/01/2012	00:00	CST-6	Drought	0	0	0.00K	0.00K
MARSHALL (ZONE)	09/01/2012	00:00	CST-6	Drought	0	0	0.00K	0.00K
MARSHALL (ZONE)	10/01/2012	00:00	CST-6	Drought	0	0	0.00K	0.00K
MARSHALL (ZONE)	11/01/2012	00:00	CST-6	Drought	0	0	0.00K	0.00K
MARSHALL (ZONE)	12/01/2012	00:00	CST-6	Drought	0	0	0.00K	0.00K
MARSHALL (ZONE)	01/01/2013	00:00	CST-6	Drought	0	0	0.00K	0.00K
MARSHALL (ZONE)	01/10/2015	00:00	CST-6	Drought	0	0	0.00K	0.00K
MARSHALL (ZONE)	07/27/2015	12:00	CST-6	Excessive Heat	0	0	0.00K	0.00K
MARSHALL (ZONE)	11/01/2016	00:00	CST-6	Drought	0	0	0.00K	0.00K
TOTALS					**0**	**0**	**0.00K**	**0.00K**

Source: National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI), Storm Events Database https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=21%2CKENTUCKY

SUMMARY AND CONCLUSIONS OF EXCESSIVE HEAT / DROUGHT PROFILE

Combined there have been 14 heat related events in the county during the 5.25 year planning period. This divides out to 2.7 events per year, a better than 100% probability that either a drought or excessive heat event (or both) could occur in any given year. Common sense would dictate that the conditions that generated a heat type event in one county could have generated a heat type event in another. One in every 10 events could prove deadly and almost four heat injuries result from every event. From a County perspective the cost of an Excessive Heat Event is difficult to assess as there are no monetary damages available. Of critical concern to the Marshall County MPT was the potential for human casualties in the form of heat stroke and heat exhaustion causing injury and even deaths.

Information from the above table can be used to define the frequency of Drought Events and the impact of these events throughout the region. Drought is mainly a threat to the agricultural segment of the county economy, but it is also has a significant impact on water and wastewater systems, especially those with cast iron piping, as soil shrinkage causes pipes to snap was brought to the Regional MPT's attention during the 2012 plan update cycle.

Based on records for the update period, there have been no deaths or injuries attributed to excessive heat in Marshall County. Similarly there has been no drought impact recorded for this period. The complete history of excessive heat and drought events for Marshall County can be reviewed in Appendix 1. As there are no reported damages or injuries for the planning update period, the annualized cost of a heat related event could not be calculated.

Dam Failure

There are around 80,000 dams in the United States. The Kentucky Division of Water regulate 81dams in the Purchase Region. Dams are classified based on the evaluation of damage possible downstream. The FEMA guide to dam classifications is as follows.

Table 8.15 FEMA Classification of Dams

Classification	Description
Class A (Low)	No loss of human life is expected and damage will only occur to the dam owner's property.
Class B (Moderate/Significant)	Loss of human life is not probable, but economic loss, environmental damage, and/or disruption of lifeline facilities can be expected.
Class C (High)	Loss on one or more human life is expected.

Source: FEMA 333; Federal Guidelines for Dam Safety

Table 8.16 lists the existing dams in the area by classification. Seven of the eight counties have dams that have been classified by the state, and three have Class C structures. There is no historical occurrence of damage or injury due to a dam failure in Marshall County. However, dam failure is considered a hazard to persons and property for the nine dams rated by the state as Class C high risk.

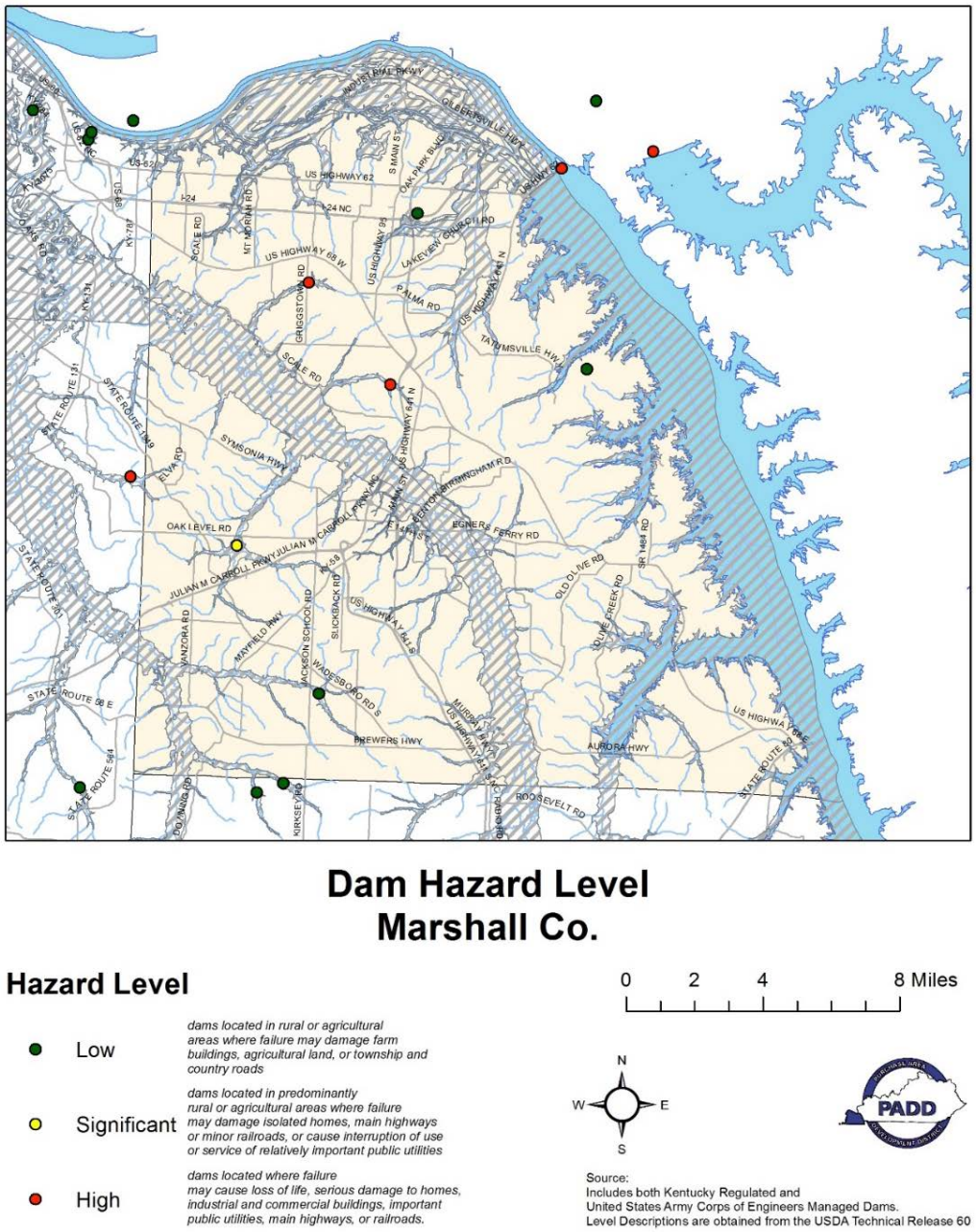
Table 8.16 Existing Dams in the Purchase Region by Classification

County	Class A (low)	Class B (moderate)	Class C (high)
Ballard	3	1	0
Calloway	7	1	0
Carlisle	22	0	1
Graves	23	2	6
Hickman	5	1	0
Marshall	**3**	**1**	**2**
McCracken	**3**	**0**	**0**
Total	**66**	**6**	**9**

Source: Division of Water and Kentucky State Hazard Mitigation plan

Figure 8.10 shows the approximate location of the State rated dams in Marshall County. Not included in this plan update are two large dams, Kentucky Dam and Barkley Dam, which impound the Tennessee and Cumberland Rivers. Both structures are operated by the Tennessee Valley Authority (TVA). For security reasons information regarding these structures is not available however the probability of an earthquake affecting either dam is low based on regular maintenance and monthly inspection of all components of this flood control system.

Figure 8.10 Location of the dams in Marshall County, symbolized by hazard class.



Additional seismic analysis was recently conducted on Kentucky Dam in 2017 and the lone recommendation from the stability analysis and multiple inspections was construction of a 400-foot long sand and stone berm adjacent to the earthen embankment that runs southwest from the concrete portion of the dam toward Kentucky Dam Village. A TVA spokesman described this project as "this berm will take a safe dam and make it safer." This $800,000 project is scheduled for construction in the spring of 2018.

For planning purposes the Marshall MPT can only speculate that the area inundated by failure of one or the other or both of these structures would be at least equal to the 100 year flood zone. The result of the failure of either, or both at a time when the Ohio River was already at flood stage or higher, needs to be explored in future revisions of this plan.

SUMMARY AND CONCLUSIONS FOR DAM FAILURE HAZARD PROFILE

The main question regarding Dam Failure in Marshall County is the concern for a possible catastrophic failure of Kentucky Dam on the Tennessee River, and/or Barkley Dam on the Cumberland. Both would flood downstream areas of the Tennessee and Ohio Rivers that border Marshall County. Inundation maps or projections for the effects for this scenario were not made available to the Marshall MPT and are not included in this plan. For planning purposes it is assumed that the inundation would be at least equivalent to a one hundred year flood and those figures will be used in the vulnerability.

Wildfire

A wildfire is an uncontrollable burning of grasslands, brush or woodlands. The potential for wildfire depends on surface fuel characteristics, weather conditions, recent climate conditions, and topography and fire behavior. There are three different types of wildfire classes:

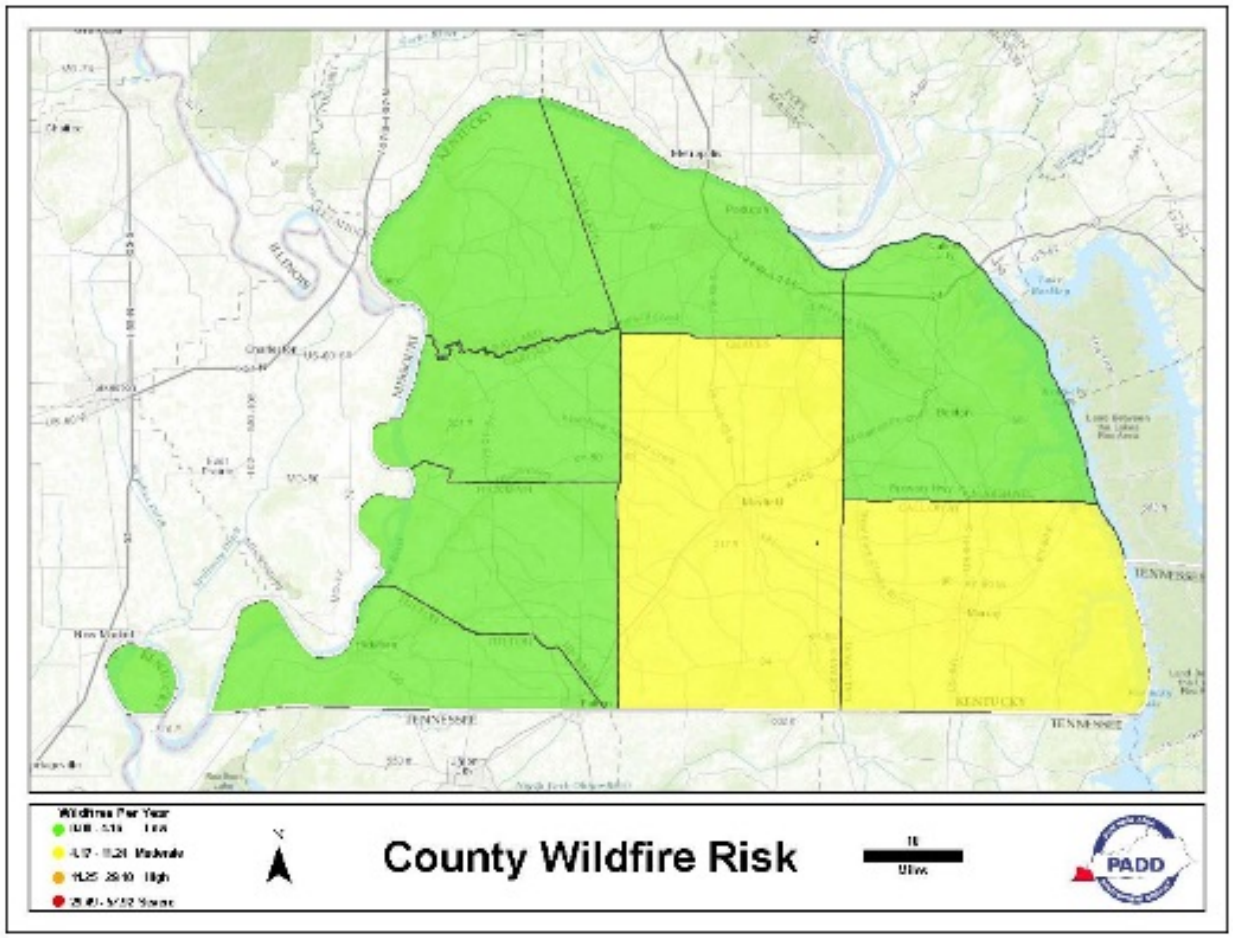
- *Surface fires* are the most common type. These fires burn along the forest floor moving slowly and will damage and kill trees.
- *Ground fires* are usually started by lightening. These fires burn on or below the forest floor.
- *Crown fires* are spread quickly by wind. These fires will move quickly by jumping along tree tops.
    - *Spotting* can be produced by crown fires as well as wind and topography conditions. Large burning embers are thrown ahead of the main fire. Once spotting begins, the fire will be very difficult to control.

Kentucky has two defined wildfire seasons: in the spring, February 15 – April 30 and in the fall, October 1 – December 15. These two seasons are separated by periods of higher moisture and colder, less conducive fire weather. When leaves begin to fall from deciduous hardwood trees a thick litter layer forms in wooded areas creating a fuel source for rapidly expanding wildfires. Also during the fall season, or periods of drought, tall grasses can become very flammable. It is possible for wildfires to occur outside the defined fire seasons during prolonged periods of drought.

Specific outdoor burning laws have been established to lessen the wildfire occurrence during these fire seasons. Kentucky Revised Statute 149.400 prohibits outdoor burning during the defined fire seasons between 6 am and 6 pm unless at a distance of at least 150 feet from woodlands or brushland. In Kentucky, wildfire risks are compounded by the state's extremely high arson rate. Sixty-two percent of Kentucky's wildfires are deliberately set by arsonists.

The biggest threat of wildfires in Kentucky exists in the eastern part of the state. In western Kentucky, specifically the Purchase Region, wildfires are less common. The 2013 State Hazard Mitigation Plan utilized a county risk assessment model to calculate county-level risk. This model was created using the *Average Annual Loss* data for each county. The average annual loss is calculated by multiplying each county's annual rate of occurrence by the average losses (See the 2013 State Hazard Mitigation Plan for more information.) This data was then joined to a county map for display purposes. The Purchase counties are seen in the map below. Based on this model the Purchase counties are at a moderate to low risk of wildfire occurrences. Marshall County is considered to be in the low risk category.

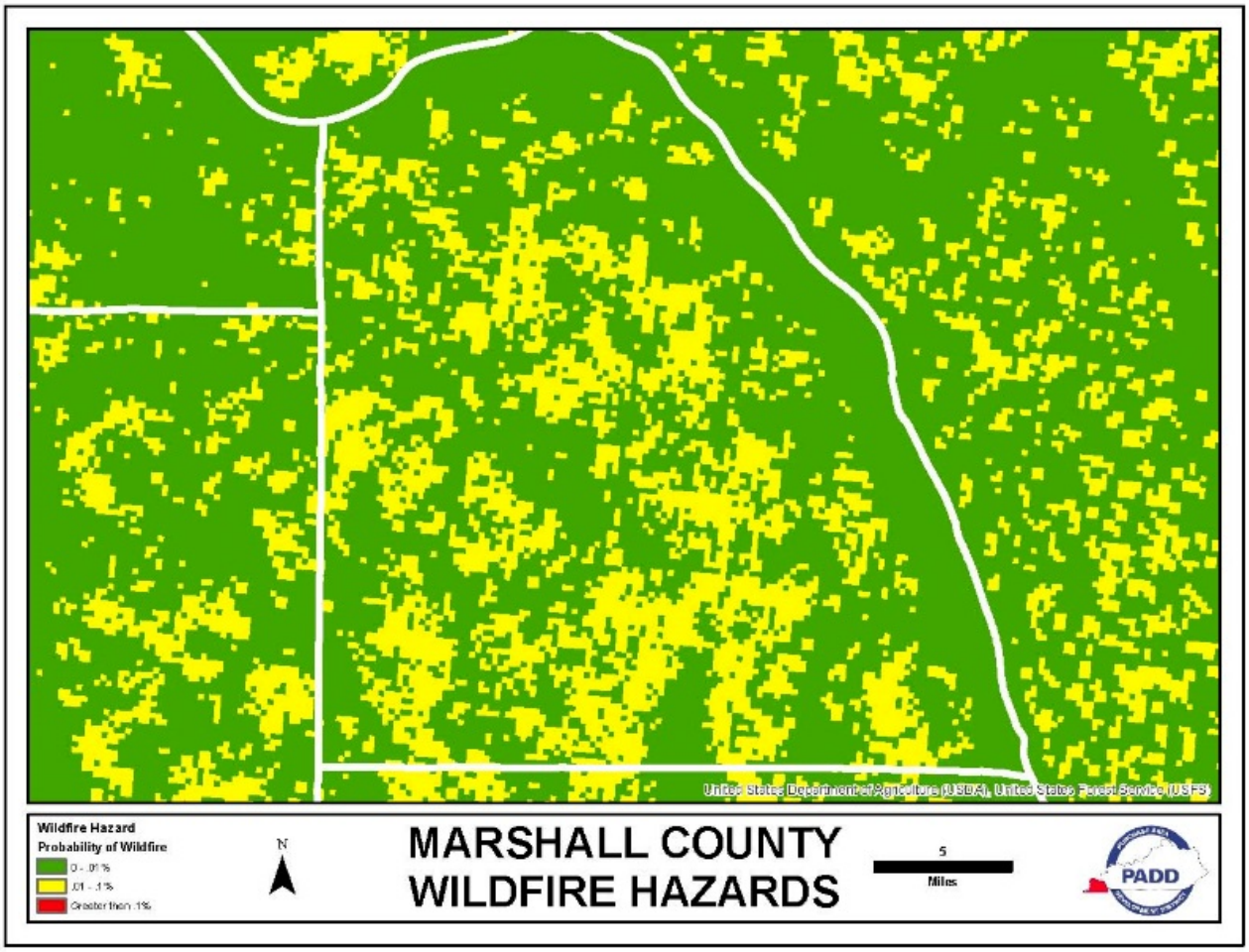
Figure 8.11 County Wildfire Risk in the Purchase Region



The Regional MPT during the 2012 Plan update cycle believed, as a result of the 2009 Ice Storm, a significant percentage of the forest cover in the Purchase Region has been damaged. Some estimates suggest 30% or more of the existing forest could be killed off. This damage will result in considerable "dead and down" fuel, especially if drought and or wind events combine to exacerbate the problem. During the 2017 review, the general feeling is that this risk is greatly diminished at this time. It is likely that there were some number of small field fires during this period however that expense was not documented.

Information obtained from the Kentucky Division of Forestry, displayed in the below map, indicates that a majority of the county has a less than one percent probability of wildfire occurring.

Figure 8.12 Marshall County Wildfire Probability



SUMMARY AND CONCLUSIONS OF WILDFIRE PROFILE

Sometimes a correlation can be drawn between Drought and Wildfire however reported data for Marshall County does not support this assumption. From January 1, 2012 through March 31, 2017, there have been zero occurrences of Wildfire Events reported in Marshall County by the NCEI and likewise zero events for the entire Purchase Region. In a search of the NCEI Storm Events Database there are only three reported events for the entire region. These occurred between February 1996 and January 2006. The only NCEI recorded events in Marshall County occurred on February 20, 2004 and November 12, 2005. The complete history of wildfire events in the Purchase Region can be reviewed in Appendix 1.

With no historic data for damages to support wildfire as a hazard in Marshall County, does not mean that there have not been instances of brush fires that had or will have the potential to grow out of control, especially during periods of drought events. It is therefore included as a Hazard in the risk assessment, albeit a low risk, but a risk that needs to be continually assessed and planned for and perhaps anticipated.

The general feeling is that the ice storm of 2009 generated massive amounts of fuel, in the form of fallen limbs, and that this risk is greatly diminished at this time. It is likely that there were some number of small field fires during this period however that expense was not documented. According to information found in the 2013 State Hazard Mitigation Plan, using the county risk assessment model, Marshall County has a 2.44 annual rate of occurrence for wildfires with an average loss of $1,153.00 per event.

8:4.3 Assessing Vulnerability: Identifying Assets Overall Summary Vulnerability

The vulnerability of structures to Severe Weather and Earthquake Hazards in Marshall County is equal to the total structure value of the county. These hazards are not limited to a particular geographic region. All critical facilities in the county were determined to be vulnerable to Severe Weather and Earthquake Hazards.

Marshall County's vulnerability to flooding was determined by GIS analysis. A GPS derived data base of Critical Facilities, and the Kentucky Infrastructure Authority database for Water and Waste Water facilities were brought into the GIS. FEMA revised Flood Hazard Areas were added as an overlay and where the data intersected those structures/facilities were deemed vulnerable to a 100 year flood. The vulnerability of residential structures was determined by a similar method, laying the Flood Hazard Areas over high resolution aerial imagery to determine which structures were in the flood plain.

The value of Critical Facilities and structures exposed to the other identified hazards, which are limited in area extent, varied by hazard type.

Impact & Frequency

The impact and frequency of each hazard is identified in each hazard profile in the previous section through maps frequency tables and graphs. Impact is addressed further in the charts and narrative discussions found in the following asset identification and vulnerability sections of this plan.

Identification of Assets

This section of the plan identifies what can be affected in each jurisdiction by the different hazard events that affect the Purchase Region. The information to complete this section was collected from a variety of sources using the best available data for identifying the number of buildings, infrastructure and critical facilities and costs associated with them. Some local structure point data was developed to identify the types and numbers of structures in the Flood Hazard area. Values for structures were provided by the American Community Survey 2011-2015 Five Year Estimate, Marshall County, City of Benton, Calvert City and City of Hardin insurance data, and the Kentucky Revenue Cabinet. The information was collected, mapped and summarized by the PADD staff and reviewed and analyzed by the JPHMC for inclusion in the plan. Marshall County MPT members reviewed the following information to determine the vulnerability in each community. Tables were created by the PADD staff to estimate the numbers of existing buildings located in mapped Flood Hazard areas. For the other identified hazards, tornados, severe thunderstorms, earthquakes, and severe winter storms Team members were not able to identify specific hazard areas for those hazards which were determined to potentially affect anything within Marshall County. These hazards and their occurrence is not limited to any particular area based on past historical events and documentation as provided in the hazard profiles for the hazards.

Critical Facilities and Infrastructure

For the purpose of this plan, the JPHMC adopted the definitions of the FEMA HAZUS Loss Estimation Model according to FEMA publication 386-1, version 4.0, pages 3-9 that state the following definitions of critical facilities and infrastructure. HAZUS separates critical facilities into five categories based on their loss potential.

For the purpose of this plan, all of the following elements are considered critical facilities except Hazardous Materials Facilities. It was determined by the regional council that Hazardous Materials Facilities would not be addressed as critical facilities. Rationale: Hazardous Materials facilities are addressed in existing Emergency Operations Plans at the Facility and jurisdictional level, which are deemed by the committee as being both sufficient and beyond the expertise of the committee.

FEMA Critical Facilities Definitions

- Transportation Facilities include airways – airports, heliports; highways – bridges, tunnels, roadbeds, overpasses, transfer centers; railways – track segments, tunnels, bridges, rail yards, depots; waterways – canals, locks, seaports, ferries, harbors, docks, and piers.

- Lifeline Utility Systems such as potable water, wastewater, oil, natural gas, electric power and communication systems.

- Essential Facilities are essential to the health and welfare of the whole population and are especially important following hazard events. Consider not only their structural integrity and content value, but also the effects on the interruption of their functions because the vulnerability is based on the service they provide rather than simply their physical aspects. Essential Facilities include hospitals and other medical facilities, police and fire stations, emergency operations systems, evacuation shelters, schools, and health and human services to the PADD.

- High Potential Loss Facilities are facilities that would have a high loss associated with them, both physical and economical, such as nuclear power plants, dams, and military installations.
- Hazardous Materials Facilities include facilities housing industrial/hazardous materials, such as corrosives, explosives, flammable materials, radioactive materials, and toxins. (Note: Not considered in this Plan)

Critical Facilities Estimated Replacement Value Methodology

Due to a software compatibility problem between FEMA's HAZUS Program, ESRI's Arc and MS Windows, PADD staff was unable to generate complete critical facilities values for the region. FEMA and KYEM have acknowledged this issue and have committed to resolving this problem however this process will not be complete before the region plan expires.
As a result, staff has supplemented updated HAZUS information when available with local data to establish the estimated value of critical facilities. As a last result, data generated during the 2012 update cycle has been utilized to complete tables. For purposes of the update to the 2018 JPHM Plan, this combination of data sources constitutes the best data available.

PADD staff used a combination of GIS data sources and local GIS data layers to build a map of the critical facilities and infrastructure for each jurisdiction found in the hazard area. Estimates were done on a county basis.

Types and Numbers of Buildings for Severe Weather and Earthquake Hazards

Severe Weather Hazards and Earthquakes have been determined to potentially affect anything within each jurisdiction depending on the path of the hazard event. These hazards and their occurrences are not limited to any particular area based on past historical events and documentation is provided in the hazard profiles. They constitute three of the top five priority risks identified by the Marshall County MPT.

Table 8.17 identifies the total number of structures vulnerable to these hazards. This table represents residential structures only and was derived from *U.S* Census Bureau 2011-2015 American Community Survey 5 Year Estimates data. Due to data limitations, the numbers of other types of structures was not available at the time of this plan. Future updates of the plan will include numbers of other types of structures as data becomes available.

Table 8.17 Thunderstorm Wind, Tornado, Earthquake Hazard Vulnerable Assets

County	Number of Residential Structures		
	Structures in County	Structures in Hazard Area	% in Hazard Area
Ballard*	3,889	3,889	100%
Calloway	18,065	18,065	100%
Carlisle	2,426	2,426	100%
Fulton	3,360	3,360	100%
Graves	16,753	16,753	100%
Hickman	2,335	2,335	100%
Marshall	**15,898**	**15,898**	**100%**
McCracken	31,342	31,342	100%
Total	**94,240**	**94,240**	**100%**

Sources: U.S Census Bureau 2011-2015 American Community Survey 5 Year Estimates

Critical Facilities and Infrastructure at Risk to Severe Weather and Earthquake Hazards
Using the HAZUS MH definition for critical facilities and infrastructure, the PADD staff identified types and numbers of critical facilities and infrastructure that are vulnerable to Tornados, Thunderstorm Wind, Winter Storm, and Earthquake in Marshall County. Data for each city is included in the county tables.

Table 8.18 Marshall County Critical Facilities & Infrastructure Thunderstorm Wind, Tornado, Earthquake Vulnerability

Type of Facility	# of Existing Buildings	Current Replacement Value	# in Hazard Area
County EOC	1	$4,300,000	1
Communication-Radio	5	$700,000	5
Fire Stations	15	$11,025,000	15
Public Safety Buildings	3	$5,400,000	3
Railways			
Government Buildings	6	$14,530,600	6
Auxiliary Buildings	3	$48,000	3
Hospitals	1	$379,143,000	1
Electric Power Plants	1	107,800,000	1
Sewage Plants	4	$180,000,000	4
Package Treatment Plants	19	$110,000	19
Water Plants	3	$48,000,000	3
Pump Stations	5	$125,000	5
Lift Stations	16	$110,000	16
Flood Control Pump Station	15	$9,885,647	15
Wells	9	$75,000	9
Storage Tanks	14	$5,200,000	14
Schools	12	$180,000,000	12
Airport	1		1
Natural Gas Facilities	1	$1,100,000	1
Dams	6		6
Bridges	88	$52,800,000	88
TOTAL	**227**	**$1,000,352,247**	**227**

Sources: When available local data was used and all other values were determined using HAZUS MH. The numbers of water treatment facilities are derived from Kentucky Infrastructure Authority, Water Resource Information System data and the costs were calculated based on standard planning costs.

Critical Facilities and Infrastructure at Risk to Flooding

The PADD GIS staff produced tables which provide an accurate estimate the number of residential structures and Critical Facilities that are vulnerable to flooding. Imagery coverage flown in 2010 was overlaid with the FEMA Flood Hazard Area Maps revised in 2009. GPS structure points, overlain with the Flood Hazard Areas were the primary source of at risk data, and for all counties the PADD's data and Water Information System data base were used to determine at risk Critical Facilities.

Table 8.19 summarizes the numbers of structures in the Flood Hazard area for each county. The highlighted areas indicate the data for Marshall County. These figures by default are also applicable to the vulnerability of structures to Dam Failure.

Table 8.19 Marshall County Flood Hazard Vulnerable Assets

County	Estimated Number of Residential Structures In Flood Hazard Areas		
	Number of Structures in County	Percentage of Structures in Flood Hazard Area	Number of Structures in Flood Hazard Area
Ballard	3,889	3.7%	147
Calloway	18,237	0.5%	101
Carlisle	2,426	3.2%	80
Fulton	3,360	7.8%	268
Graves	16,753	2.2%	361
Hickman	2,335	8.3%	147
Marshall	**15,898**	**2.8%**	**444**
McCracken	31,342	2.5%	768
Total	**94,240**	**2.5%**	**2,316**

Sources: U.S Census Bureau 2011-2015 American Community Survey 5 Year Estimates
PADD GIS Database

Figures 8.13 and 8.14 indicate the location of critical facilities in each jurisdiction relative to the Flood Hazard areas. These maps were presented to the regional council and for public comment for review during the identification of vulnerable assets for each jurisdiction.

Figure 8.13 Marshall County Flood Zones and Structures

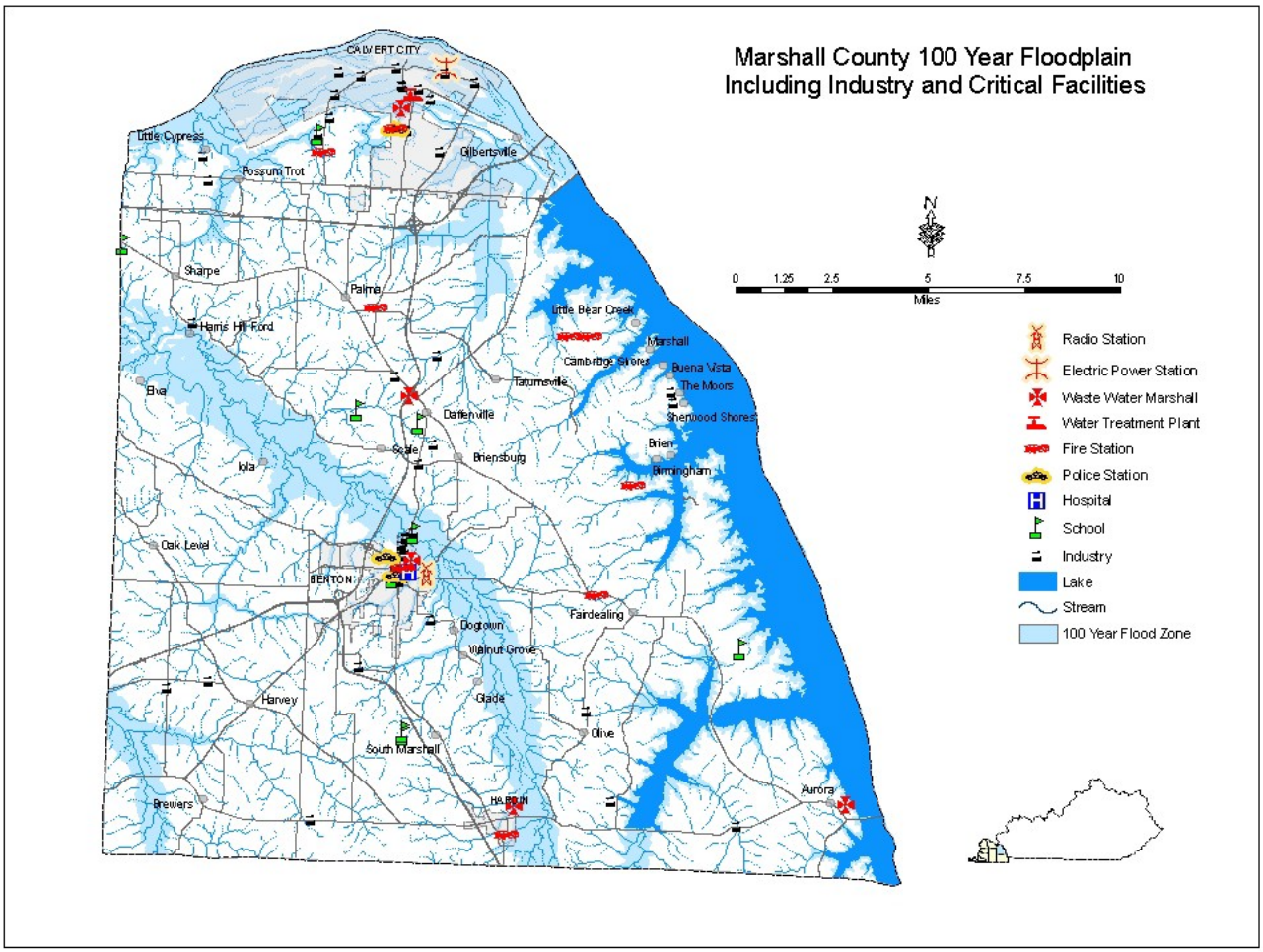
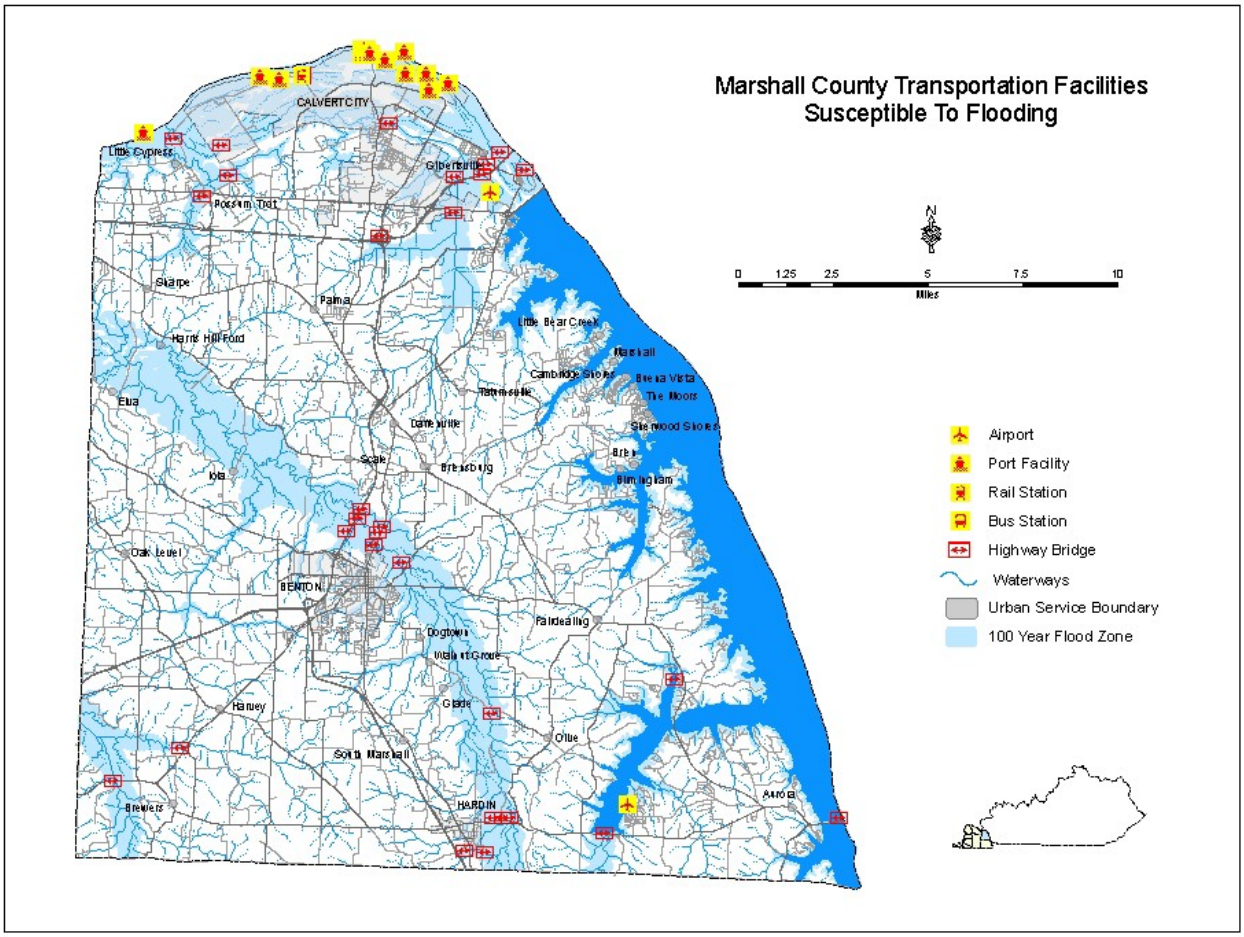


Figure 8.14 Marshall County Flood Zone Including Industry and Critical Facilities



Figures 8.15 and 8.16 indicate the location of critical facilities in each jurisdiction relative to the Flood Hazard areas. These maps were presented to the JPHMC and for public comment for review during the identification of vulnerable assets for each jurisdiction.

Figure 8.15 City of Benton 100 Year Flood Zone Structure Map

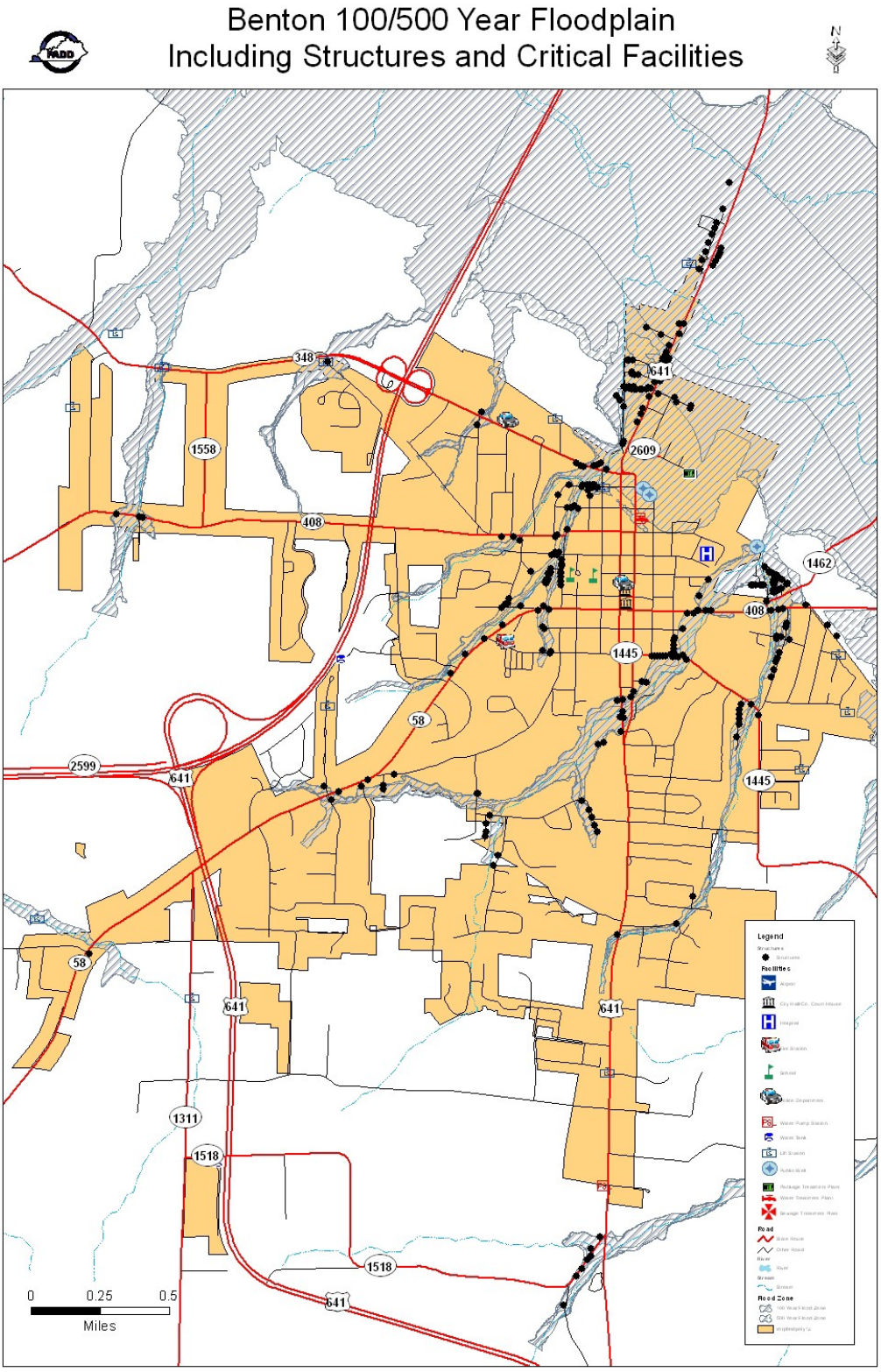


Figure 8.16 City of Calvert City 100 Year Flood Zone Structure Map

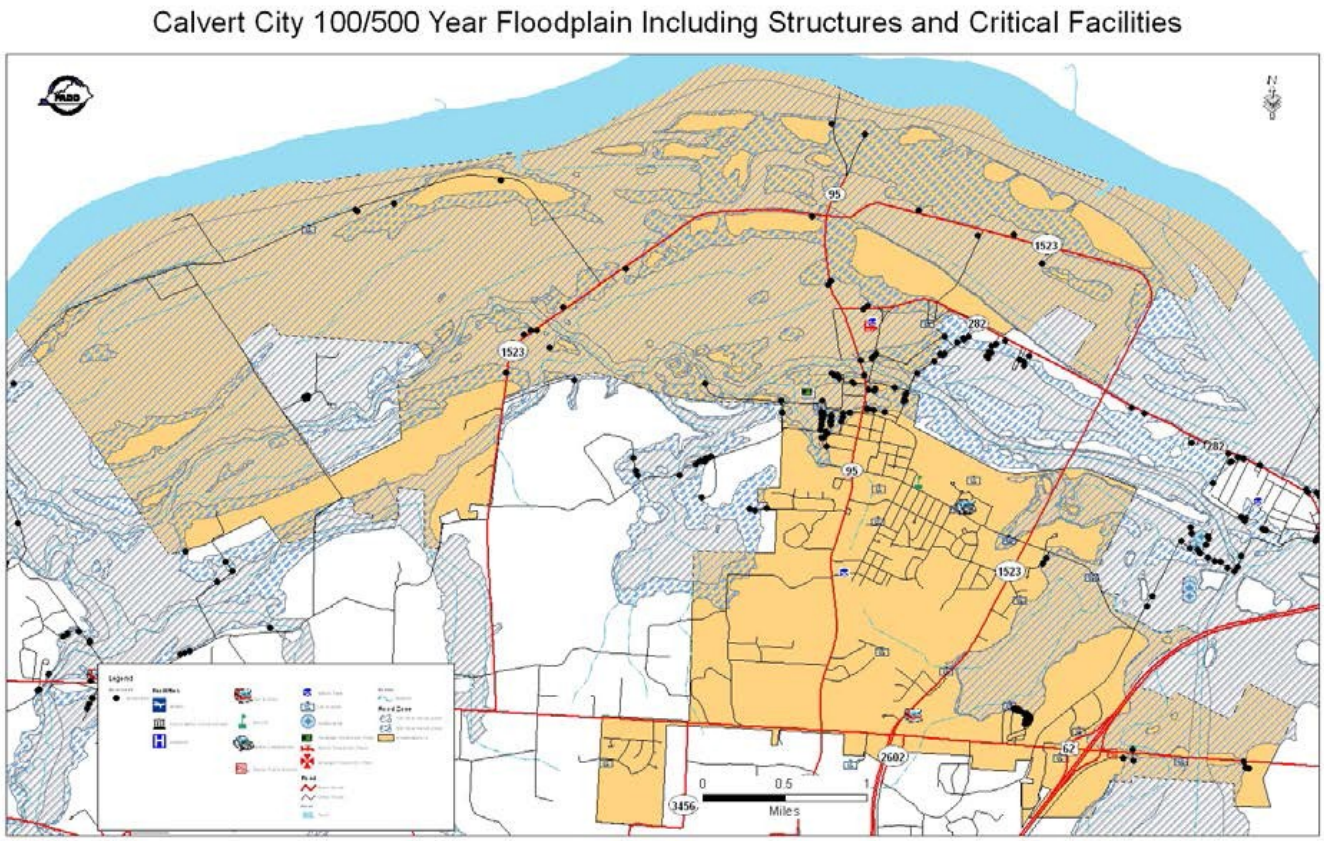


Table 8.18 summarizes the types and number of critical facilities and infrastructure in the identified flood hazard areas. These charts were created using the mapped information above. Ownership issues provided some limitation in distinguishing what critical facilities belonged to a particular jurisdiction; therefore, asset vulnerability was determined on a county level.

Table 8.20 Marshall County Critical Facilities and Infrastructure Flood Vulnerability

Type of Facility	# of Existing Buildings	Current Replacement Value	# in Hazard Area
County EOC	1	$4,300,000	0
Communication-Radio	5	$700,000	0
Fire Stations	15	$11,025,000	0
Public Safety Buildings	3	$5,400,000	0
Railways			
Government Buildings	6	$14,530,600	0
Auxiliary Buildings	3	$48,000	0
Hospitals	1	$379,143,000	0
Electric Power Plants	1	107,800,000	0
Sewage Plants	4	$180,000,000	0
Package Treatment Plants	19	$110,000	7
Water Plants	3	$48,000,000	0
Pump Stations	5	$125,000	0
Lift Stations	16	$110,000	14
Flood Control Pump Station	15	$9,885,647	15
Wells	9	$75,000	0
Storage Tanks	14	$5,200,000	0
Schools	12	$180,000,000	0
Airport			
Natural Gas Facilities	1	$1,100,000	0
Dams	6		6
Bridges	88	$52,800,000	41
TOTAL	**227**	**$1,000,352,247**	**83**

Sources: When available local data was used and all other values were determined using HAZUS MH. The numbers of water treatment facilities are derived from Kentucky Infrastructure Authority, Water Resource Information System data and the costs were calculated based on standard planning costs.

Marshall County, including the Cities of Benton, Calvert City, and Hardin are members of the NFIP. Each has a Flood Plain Management Ordinance in accordance with the appropriate State Revised Statutes. As a consequence, development is not likely to occur in flood regions identified on the FIRMS and by the flood data used in this plan.

Some industrial expansion that takes place will be in existing industrial parks. Much of the industry in Marshall County is dependent upon the National Waterway Transportation System. Industrial expansion will occur in the 100 year floodplain, but in accordance with all State and Local ordinances. These facilities are largely engineered out of the flood zones of the Ohio and Tennessee Rivers.

Wildfire Hazard: Types and numbers of buildings

Wildfire was rated by the Marshall County MPT as a Low Risk Hazard. Portions of the county are heavily forested. These areas are being encroached upon by urban growth, creating a danger area known as the Wildland/Urban Interface.

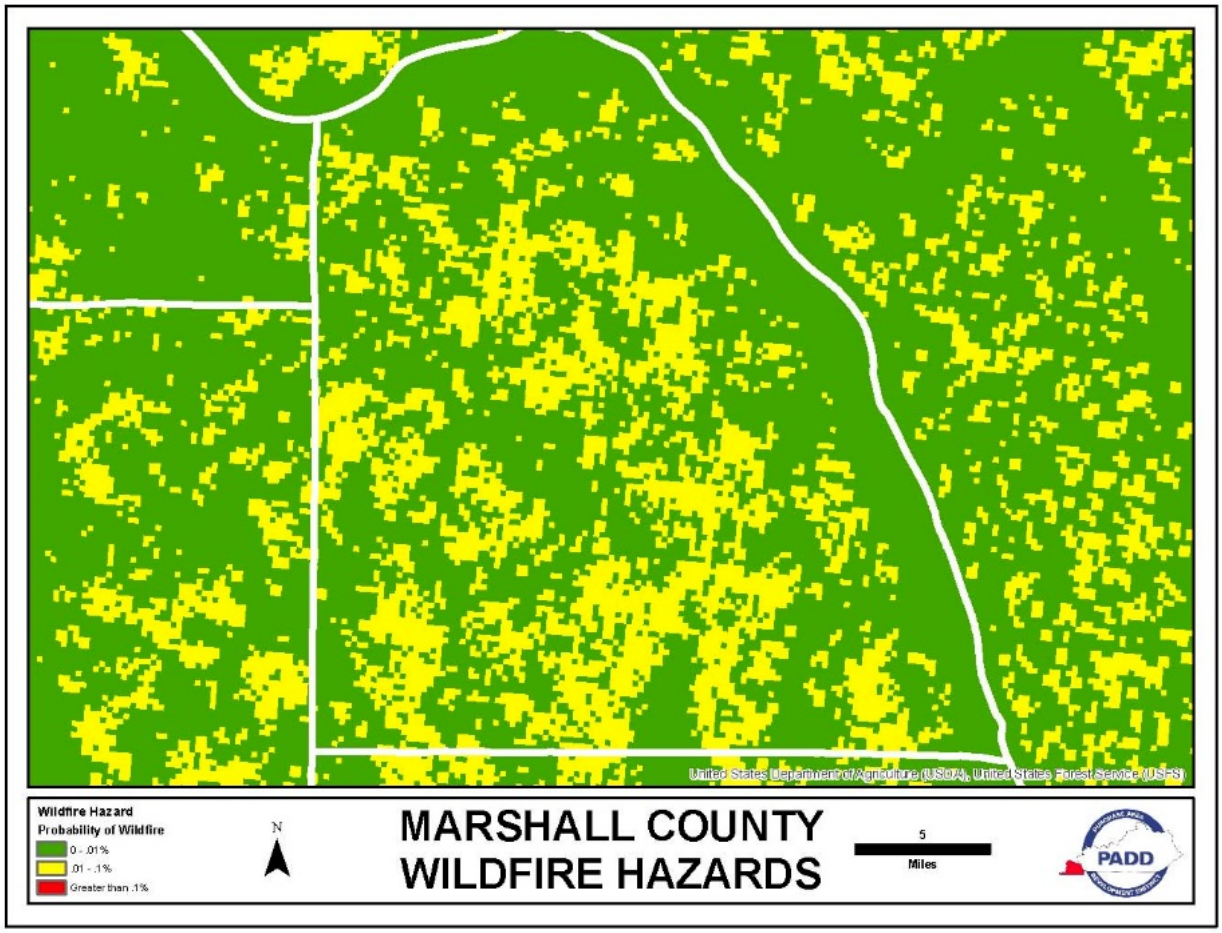
This table represents residential structures only and was U.S. Census Bureau 2011-2015 American Community Survey 5 Year Estimate data. Due to data limitations, the numbers of other types of structures was not available at the time of this plan. Future updates of the plan will include numbers of other types of structures as data becomes available.

Table 8.21 Marshall County Wildland/Urban Interface Wildfire Risk:

County	Number of Residential Structures		
	Structures in County	Structures in Hazard Area	% in Hazard Area
Ballard	3,889	72	1.9
Calloway	18,237	153	0.8
Carlisle	2,426	5	0.2
Fulton	3,360	6	0.2
Graves	16,753	156	0.9
Hickman	2,335	5	0.2
Marshall	**15,898**	**168**	**1.1**
McCracken	31,342	148	0.5
Total	**94,240**	**713**	**0.8%**

Sources: U.S. Census Bureau 2011-2015 American Community Survey 5 Year Estimate, PADD GIS Database

Figure 8.17 Marshall County Wildfire Hazards



Source: United States Department of Agriculture, United States Forestry Service

Table 8.22 represents residential structures only and was derived from U.S. Census Bureau 2011-2015 American Community Survey 5 Year Estimate data. Due to data limitations, the numbers of other types of structures was not available at the time of this plan.

Table 8.22 Marshall County Wildland/Urban Interface Wildfire Risk

County	Structures in County	Structures in Hazard Area	% in Hazard Area
Ballard	3,889	72	1.9
Calloway	18,237	153	0.8
Carlisle	2,426	5	0.2
Fulton	3,360	6	0.2
Graves	16,753	156	0.9
Hickman	2,335	5	0.2
Marshall	**15,898**	**168**	**1.1**
McCracken	31,342	148	0.5
Region	**94,240**	**713**	**0.8%**

Sources: U.S. Census Bureau 2011-2015 American Community Survey 5 Year Estimate, PADD GIS Database

Critical Facilities and Infrastructure at Risk in the Wildland/Urban Interface

Using the HAZUS MH definition for critical facilities and infrastructure, the PADD staff identified types and numbers of critical facilities and infrastructure that are in or adjacent to the Wildland/Urban interface, and consequently at risk to wildfires.

Table 8.23 Marshall County Critical Facilities and Infrastructure Wildfire Vulnerability

Type of Facility	# of Existing Buildings	Current Replacement Value	# in Hazard Area
County EOC	1	$4,300,000	0
Communication-Radio	5	$700,000	0
Fire Stations	15	$11,025,000	5
Public Safety Buildings	3	$5,400,000	0
Railways			
Government Buildings	6	$14,530,600	0
Auxiliary Buildings	3	$48,000	0
Hospitals	1	$379,143,000	0
Electric Power Plants	1	107,800,000	0
Sewage Plants	4	$180,000,000	3
Package Treatment Plants	19	$110,000	2
Water Plants	3	$48,000,000	2
Pump Stations	5	$125,000	5
Lift Stations	16	$110,000	8
Flood Control Pump Station	15	$9,885,647	15
Wells	9	$75,000	5
Storage Tanks	14	$5,200,000	3
Schools	12	$180,000,000	5
Airport	1		1
Natural Gas Facilities	1	$1,100,000	0
Dams	6		1
Bridges	88	$52,800,000	46
TOTAL	**227**	**$1,000,352,247**	**227**

Sources: When available local data was used and all other values were determined using HAZUS MH. The numbers of water treatment facilities are derived from Kentucky Infrastructure Authority, Water Resource Information System data and the costs were calculated based on standard planning costs.

Future Development: Types and Numbers of Future Buildings, Critical Facilities, and Infrastructure

Marshall County is expected to grow slowly over the next ten years with little increase in the number of residential structures, or critical facilities and infrastructure. The Flood Plain Management ordnance restricts building of residential structures in mapped flood prone areas. There are no significant changes in land use anticipated for Marshall County. Should land use changes occur, they will be included in future updates of the plan where applicable.

Table 8.24 Population Projections for the Purchase Region of Kentucky

County	Census 2000	Census 2010	Census 2015	Census Projection				
				2020	2025	2030	2035	2040
Kentucky	4,041,769	4,339,367	4,425,092	4,533,464	4,634,415	4,726,382	4,808,682	4,886,381
Ballard	8,286	8,249	8,212	8,164	8,097	8,005	7,906	7,780
Calloway	34,177	37,191	38,343	39,328	40,487	41,687	42,604	43,503
Carlisle	5,351	4,874	5,036	4,737	4,604	4,450	4,298	4,139
Fulton	7,752	6,238	6,528	5,726	5,252	4,789	4,349	3,939
Graves	37,028	37,421	37,433	37,883	38,243	38,483	38,657	38,788
Hickman	5,262	4,612	4,767	4,349	4,077	3,803	3,563	3,306
Marshall	**30,125**	**31,101**	**32,301**	**31,149**	**31,060**	**30,830**	**30,347**	**29,980**
McCracken	65,514	65,018	66,188	65,317	65,487	65,376	64,918	64,273
Purchase	**193,495**	**195,819**	**195,313**	**196,653**	**197,307**	**197,423**	**196,732**	**195,708**

Source: U.S. Census Bureau, http://www.ksdc.louisville.edu/data-downloads/projections/ 2017

New Residential Structures – Tornado, Earthquake, Severe Thunderstorm, Severe Winter Storm

The PADD staff calculated the estimated future residential structure growth by multiplying the existing number of residential structures by the expected growth rate for each county. Results of these calculations are represented in Table 8.25.

These numbers would represent the approximate number of future residential structures vulnerable to Tornado, Earthquakes, Thunderstorm Wind, and Winter Storms.

Table 8.25 Estimated Future Structure Growth for the Purchase Region

County	Estimated Housing Units (2015)	Estimated % Household Growth Rate (2025)	Estimated Future Growth	Median Structure Value	Estimated Value of Future Growth
Ballard	3883	0.79%	31	$101,800	$3,155,800
Calloway	18,537	7.20%	1335	$119,900	$160,066,500
Carlisle	2437	-8.53%	-159	$77,200	*
Fulton	3,359	-18.81%	-531	$61,000	*
Graves	16,741	2.79%	467	$92,900	$43,384,300
Hickman	2,338	-8.68%	-203	$68,400	*
McCracken	31,544	2.04%	643	$111,600	$71,758,800
Marshall	**15,982**	**1.45%**	**232**	**$124,400**	**$28,860,800**
Purchase	**94,821**	**2.01%**	**1906**		

* Projected Negative Growth Rate

Source: EHHGR - Kentucky State Data Center (Vintage 2016)

EHU - US Census Bureau, Population Division (June 2017)

MSU - American Community Survey 5- Year Estimates (2011-2015)

The PADD staff and Marshall County MPT members discussed potential increase in numbers of vulnerable critical facilities, industry and infrastructure; however, there was no consensus for making a reliable calculation. In future updates, involvement from the local planning process may assist in estimating the increase of critical facilities and infrastructure based on projected population growth.

8:4.4 Assessing Vulnerability: Estimating Potential Losses

Winter Storm, Thunderstorm Wind, Tornado, Earthquake

The total valuation of adjusted property as provided by the Kentucky Department of Revenue was used to estimate the potential dollar loss for all vulnerable structures for the following hazards: Winter Storm, Thunderstorm Wind, Tornado, and Earthquake.

Table 8.24 summarizes the total value of adjusted property as provided by the Kentucky Department of Revenue, and the population for each county as provided by 2011-2015 American Community Survey 5 Year Estimate. These values were used to determine potential dollar losses and the number of people at risk in a county and all its jurisdictions, for those hazards that have no defined area: Winter Storm, Thunderstorm Wind, Tornado, and Earthquake. The figures for Marshall County are highlighted.

During the estimation of potential dollar losses, MPT members reviewed the HAZUS data as in the plan in addition to the aforementioned values. Council members completed dollar estimates where no data was available. Future updates of this plan may include new GIS information for loss estimation where available.

Table 8.26 Total Value of Adjusted Property for the Purchase Region

County	County Square Miles	Population 2011-2015 ACS	Total Property Value 2016($)
Ballard	273.70	8,256	545,949,576
Calloway	412.50	38,106	2,355,178,011
Carlisle	199.10	4,984	234,857,047
Fulton	230.70	6,422	277,810,192
Graves	558.00	37,502	1,886,576,304
Hickman	253.20	4,720	265,028,387
Marshall	**340.00**	**31,181**	**2,457,186,169**
McCracken	268.30	65,408	5,111,587,459
Region	**2,433.5**	**196,579**	**13,134,173,145**

Source: Kentucky State Hazard Mitigation Plan. 2011-2015 American Community Survey 5 Year Estimate, Kentucky Revenue Cabinet, Year Estimate, Kentucky Revenue Cabinet, https://revenue.ky.gov/Property/Pages/default.aspx

Table 8.27 Severe Weather/Earthquake Hazard Vulnerable Asset

County	Structures in County	Structures in Hazard Area	% in Hazard Area
Ballard	3,889	3,889	100%
Calloway	18,237	18,237	100%
Carlisle	2,426	2,426	100%
Fulton	3,360	3,360	100%
Graves	**16,753**	**16,753**	**100%**
Hickman	2,335	2,335	100%
Marshall	15,898	15,898	100%
McCracken	31,342	31,342	100%
Region	**94,240**	**94,240**	**100%**

Source: U.S. Census Bureau 2011- 2015 American Community Survey 5-Year Estimates

PADD staff and the Marshall County MPT determined that all 15,898 residential structures in the county are vulnerable to the "area" threats of weather and earthquake. According to the 2011-2015 American Community Survey 5-Year Estimates, the median house value for Marshall County is $111,600. An estimate of the maximum residential risk for Marshall County is $1,774,216,800.

Critical Facilities and Infrastructure for Severe Weather and Earthquakes

It was the determination of the PADD staff that the best way to estimate the potential dollar loss associated with critical facilities and infrastructure was to use the insurance replacement values for those structures when available. The following table summarizes the potential dollar loss of vulnerable critical facilities in Marshall County to the non-geospecific hazards of Severe Weather and Earthquakes. Additional information on potential earthquake losses, especially for in-ground infrastructure can be found in the Appendix 2.

Table 8.28 Marshall County Critical Facilities and Infrastructure Thunderstorm Wind, Tornado, Earthquake Vulnerability

Type of Facility	# of Existing Buildings	Current Replacement Value	# in Hazard Area	Replacement Cost
County EOC	1	$4,300,000	1	$4,300,000
Communication-Radio	5	$700,000	5	$700,000
Fire Stations	15	$11,025,000	15	$11,025,000
Public Safety Buildings	3	$5,400,000	3	$5,400,000
Railways				
Government Buildings	6	$14,530,600	6	$14,530,600
Auxiliary Buildings	3	$144,000	3	$144,000
Hospitals	1	$379,143,000	1	$379,143,000
Electric Power Plants	1	$107,800,000	1	107,800,000
Sewage Plants	4	$180,000,000	4	$180,000,000
Package Treatment Plants	19	$2,090,000	19	$2,090,000
Water Plants	3	$48,000,000	3	$48,000,000
Pump Stations	5	$625,000	5	$625,000
Lift Stations	16	$1,760,000	16	$1,760,000
Flood Control Pump Station	15	$9,885,647	15	$9,885,647
Wells	9	$675,000	9	$675,000
Storage Tanks	14	$5,200,000	14	$5,200,000
Schools	12	$180,000,000	12	$180,000,000
Airport	1		1	
Natural Gas Facilities	1	$1,100,000	1	$1,100,000
Dams	6		6	
Bridges	88	$52,800,000	88	$52,800,000
TOTAL	**227**	**$1,005,178,247**	**227**	**$1,005,178,247**

Sources: When available local data was used and all other values were determined using HAZUS MH. The numbers of water treatment facilities are derived from Kentucky Infrastructure Authority, Water Resource Information System data and the costs were calculated based on standard planning costs.

Flood

Residential Structures: After the vulnerability maps were created for the flood hazard areas, the cost associated with replacing those structures was evaluated. It was the determination of the PADD staff that the best way to estimate the potential dollar loss associated with the flood hazard areas was to use the median structure value as identified by the 2011- 2015 American Community Survey 5-Year Estimates for residential structures. Table 8.29 summarizes the median residential structure value used to determine the value of structures located in flood hazard areas. The data for Marshall County is highlighted.

Table 8.29 2011 – 2015 Selected Housing Characteristics

Subject	Ballard	Calloway	Carlisle	Fulton	Graves	Hickman	Marshall	McCracken	Purchase Region
Total Housing Units	3,889	18,237	2426	3360	**16,753**	2335	15,898	31,342	94,240
Occupied Housing Units	3288	14,834	2059	2568	**14,390**	1973	12,062	27,514	79,228
Vacant Housing Units	601	3403	367	792	**2363**	362	3296	3828	15,012
Mobile Homes	657	2306	500	205	**2220**	360	2966	2988	12,202
Owner-occupied	2678	9355	2059	2568	**14,390**	1470	9813	18,511	60,844
Renter-occupied	610	5479	367	792	**2363**	503	2789	9003	21,906
Household Size – Owner	2.42	2.49	2.34	2.51	**2.63**	2.26	2.50	2.46	2.45
Household Size– Renter	2.73	2.09	2.58	2.07	**2.37**	2.39	2.18	2.06	2.31
Median House Value -	$101,800	$119,900	$77,200	$61,000	**$92,900**	$68,400	$111,600	$124,400	$94,650

Source: U.S. Census Bureau 2011- 2015 American Community Survey 5-Year Estimates

According to the 2011-2015 ACS 5-Year Estimates the median house value for Marshall County is $111,600. An estimate of the potential residential flood damage for Marshall County is $49,550,400.

Table 8.29 lists the average number of people per household for Marshall County according to 2011-2015 ACS 5-Year Estimates. This value was used to determine the number of people in a flood hazard area. Using imagery and GPS structure points PADD staff estimated that 444 residential structures are located in areas with a map flood hazard.

Table 8.30 Flood Hazard Vulnerable Residential Structures by County

County	Number of Residential Structures			Total Property Value		Number of People		
	Structures in County*	Structures in Hazard Area**	% in Hazard Area**	Total Value in County***	Value in Hazard Area**	Residents*	Residents in Hazard Area**	% in Hazard Area**
Ballard	3,889	147	3.7%	$545,949,576	$18,016,336	8,256	305	3.7%
Calloway	18,237	101	0.5%	$2,355,178,011	$9,420,712	38,106	229	0.6%
Carlisle	2,426	80	3.2%	$234,857,047	$751,543	4,984	199	4%
Fulton	3,360	268	7.8%	$277,810,192	$21,669,195	6,422	450	7%
Graves	16,753	361	2.2%	$1,886,576,304	$41,504,679	37,502	1,013	2.7
Hickman	2,335	147	8.3%	$265,028,387	$16,696,788	4,720	189	4.0%
Marshall	**15,898**	**444**	**2.8%**	**$2,457,186,169**	**$68,801,213**	**31,181**	**1,871**	**8.0%**
McCracken	31,342	768	2.5%	$5,111,587,459	$127,789,686	65,408	2,158	3.3%
Total	**94,240**	**2,818**	**2.9%**	**$13,134,173,145**	**$304,650,152**	**196,579**	**6,733**	**3.2%**

*Sources: * U.S Census Bureau 2011-2015 American Community Survey 5 Year Estimates,*
*** PADD GIS Database, HAZUS & PVA information,*
****Kentucky Revenue Cabinet and PVA data*.

Critical Facilities and Infrastructure

It was the determination of the PADD staff that the best way to estimate the potential dollar loss associated with critical facilities and infrastructure was to use the insurance replacement values for those structures when available, or values from the HAZUS data tables. Table 8.31 summarizes the potential dollar loss of vulnerable critical facilities and infrastructure in flood hazard areas for Marshall County.

Table 8.31 Marshall County Critical Facilities & Infrastructure Flood Vulnerability

Type of Facility	# of Existing Buildings	Current Replacement Value	# in Hazard Area	Replacement Cost
County EOC	1	$4,300,000	0	
Communication-Radio	5	$700,000	0	
Fire Stations	15	$11,025,000	0	
Public Safety Buildings	3	$5,400,000	0	
Railways				
Government Buildings	6	$14,530,600	0	
Auxiliary Buildings	3	$144,000	0	
Hospitals	1	$379,143,000	0	
Electric Power Plants	1	$107,800,000	0	
Sewage Plants	4	$180,000,000	0	
Package Treatment Plants	19	$2,090,000	7	$770,000
Water Plants	3	$48,000,000	0	
Pump Stations	5	$625,000	0	
Lift Stations	16	$1,760,000	14	$1,540,000
Flood Control Pump Station	15	$9,885,647	15	$9,885,647
Wells	9	$675,000	0	
Storage Tanks	14	$5,200,000	0	
Schools	12	$180,000,000	0	
Airport				
Natural Gas Facilities	1	$1,100,000	0	
Dams	6		6	
Bridges	88	$52,800,000	41	$24,600,000
TOTAL	**227**	**$1,005,178,247**	**83**	**$36,795,647**

Sources: When available local data was used and all other values were determined using HAZUS MH. The numbers of water treatment facilities are derived from Kentucky Infrastructure Authority, Water Resource Information System data and the costs were calculated based on standard planning costs.

Wildfire Hazard for Residential Structures

Using wildfire vulnerability data obtained from the United States Department of Agriculture, United States Forestry Service, PADD staff estimated that 1.1% by area of residential structures are in the wildfire threat area. According to the American Community Survey 2011-2015 Five Year Estimate the median house value for Marshall is $111,600.

Table 8.32 Marshall County Wildland/Urban Interface Wildfire Risk

County	Structures in County	Structures in Hazard Area	% in Hazard Area
Ballard	3,889	72	1.9
Calloway	18,237	153	0.8
Carlisle	2,426	5	0.2
Fulton	3,360	6	0.2
Graves	16,753	156	0.9
Hickman	2,335	5	0.2
Marshall	**15,898**	**168**	**1.1**
McCracken	31,342	148	0.5
Region	**94,240**	**713**	**0.8%**

Sources: U.S. Census Bureau 2011-2015 American Community Survey 5 Year Estimate, Purchase Area Development District GIS Database

Using wildfire vulnerability data obtained from the United States Department of Agriculture, United States Forestry Service PADD Staff estimated that 1.1% by area or 168 residential structures are in the wildfire threat area. According to the 2011-2015 ACS 5-Year Estimates the median house value for Marshall County is $111,600. An estimate of the potential residential Wildfire damage for Marshall County is $18,748,800.

Critical Facilities and Infrastructure at Risk in the Wildland/Urban Interface

Using the HAZUS MH definition for critical facilities and infrastructure, the PADD staff identified types and numbers of critical facilities and infrastructure that are in or adjacent to the Wildland-Urban interface, and consequently at risk to wildfires.

Table 8.33 Marshall County Critical Facilities & Infrastructure Wildfire Vulnerability

Type of Facility	# of Existing Buildings	Current Replacement Value	# in Hazard Area	Replacement Cost
County EOC	1	$4,300,000	0	
Communication-Radio	5	$700,000	0	
Fire Stations	15	$11,025,000	5	$3,675,000
Public Safety Buildings	3	$5,400,000	0	
Railways				
Government Buildings	6	$14,530,600	0	
Auxiliary Buildings	3	$144,000	0	
Hospitals	1	$379,143,000	0	
Electric Power Plants	1	107,800,000	0	
Sewage Plants	4	$180,000,000	3	$135,000,000
Package Treatment Plants	19	$2,090,000	2	$220,000
Water Plants	3	$48,000,000	2	$32,000,000
Pump Stations	5	$625,000	5	$625,000
Lift Stations	16	$1,760,000	8	$880,000
Flood Control Pump Station	15	$9,885,647	15	$9,885,647
Wells	9	$675,000	5	$375,000
Storage Tanks	14	$5,200,000	3	$1,114,285
Schools	12	$180,000,000	5	$75,000,000
Airport	1		1	
Natural Gas Facilities	1	$1,100,000	0	
Dams	6		1	
Bridges	88	$52,800,000	46	$27,600,000
TOTAL	**227**	**$1,005,178,247**	**227**	**$286,374,932**

Sources: When available local data was used and all other values were determined using HAZUS MH. The numbers of water treatment facilities are derived from Kentucky Infrastructure Authority, Water Resource Information System data and the costs were calculated based on standard planning costs.

8:4.5 Assessing Vulnerability: Analyzing Development Trends

The Purchase Region grew 1.2% in population between 2000 and 2010 compared to a growth of 7.4% for the state of Kentucky. Marshall County is projected to exhibit low to moderate growth between 2010 and 2020.

Most residential construction occurs in developments. The county can expect an increase in residential development over the next ten years to replace existing housing stock. Essential facilities and services may increase due to demand rather than population pressure.

Table 8.34 identifies growth trends in the PADD as report by the Kentucky State Data Center using Census information.

Table 8.34 Population Projections for the Purchase Region

County	Census 2000	Census 2010	Census 2015	Census Projections				
				2020	2025	2030	2035	2040
Kentucky	4,041,769	4,339,367	4,425,092	4,533,464	4,634,415	4,726,382	5,808,682	4,886,381
Ballard	8,286	8,249	8,212	8,164	8,097	8,005	7,906	7,780
Calloway	34,177	37,191	38,343	39,328	40,487	41,687	42,604	43,503
Carlisle	5,351	4,874	5,036	4,737	4,604	4,450	4,298	4,139
Fulton	7,752	6,238	6,528	5,726	5,252	4,789	4,349	3,939
Graves	37,028	37,421	37,433	37,883	38,243	38,483	38,657	38,788
Hickman	5,262	4,612	4,767	4,349	4,077	3,803	3,563	3,306
Marshall	**30,125**	**31,101**	**32,301**	**31,149**	**31,060**	**30,830**	**33,886**	**29,980**
McCracken	65,514	65,018	66,188	65,317	65,487	65,376	64,918	64,273
Purchase	**193,495**	**195,819**	**195,313**	**196,653**	**197,307**	**197,423**	**196,732**	**195,708**

Source: U.S. Census Bureau, http://www.ksdc.louisville.edu/data-downloads/projections/ 2017

Land Use

Farmland is the principal land use in Marshall County. Land use for commercial purposes is primarily concentrated in the downtown areas of incorporated cities. Industrial development takes place primarily in industrial parks and near the developing Calvert City – Marshall County Riverport.

Marshall County also makes use of land for recreation and greenspace. Marshall County has both city and county parks for recreational purposes. Marshall County is also home to Kentucky Dam Village State Park and Ken-Lake State Park.

Economic and Social Growth Trends

The economy in the PADD is experiencing trends similar to those of the state averages, both in growth and decline. There have been new businesses and industries to open in the region, but in turn there have been layoffs and closures within the market. The fastest growing sectors of the local economy in the Purchase Region were services and manufacturing. Table 8.35 represents the expansion and location of plants in the Marshall County from 2010 to present. This information was retrieved from the Kentucky Cabinet for Economic Development website www.thinkkentucky.com

Table 8.35 Summary of Recent Locations and Expansions, 2014-Present

		Reported	
	Companies	Jobs	Investment
Manufacturing Location	2	198	$24,297,395
Manufacturing Expansion	8	22-26	$359,659,944
Service & Technology Location	0	0	$0
Service & Technology Expansion	0	0	$0

Note: Totals include announced locations and expansions.
Source: Kentucky Cabinet for Economic Development (8/8/2017)

Table 8.36 Employment by Major Industry by Place of Work, 2015

	Marshall County		Labor Market Area	
	Employment	Percent	Employment	Percent
Total All Industries	11,181	100.0	109,154	100.0
Total Private Industries	9,471	84.7	89,611	82.1
Natural Resources and Mining	N/A	N/A	113	0.1
Construction	1,739	15.6	5,744	5.3
Manufacturing	2,476	22.1	13,912	12.7
Trade, Transportation and Utilities	1,510	13.5	22,647	20.7
Information	97	0.9	1,438	1.3
Financial Activities	425	3.8	3,887	3.6
Professional and Business Services	627	5.6	7,518	6.9
Education and Health Services	N/A	N/A	11,720	10.7
Leisure and Hospitality	1,275	11.4	10,234	9.4
Other Services and Unclassified	299	2.7	2,293	2.1

Source: U.S. Department of Labor, Bureau of Labor Statistics

Table 8.37 Top 20 by Employment (Manufacturing, Service, and Technology Firms Only)

Firm	Product(s)/Service(s)	Emp.	Year Established
Benton			
3A Composites USA Inc	Composite aluminum & plastic foam panels & sheets	90	1978
Champion Home Builders Inc	Manufacture mobile homes	150	2016
FLW LLC	Headquarters, publications company, media center, warehouse, tournament operations	64	1979
United Systems & Software Inc	Provides software & professional IT managed services	33	1981
Calvert City			
Air Products & Chemicals Inc	Acetylenes	71	1957
Arkema Inc.	Forane refrigerants and blowing agents, Kynar PVDF polymer resin, VF2 monomer, hydrochloric acid, and electrolyte for the lithium battery industry.	256	1949
Ashland Inc	Acetylene specialty chemicals	502	1956
Calvert City Terminal LLC	Coal terminal - drying/cleaning of coal, transferring coal from rail cars to barges, coal mixing	46	2003
Carbide Industries LLC	Acetylene gas, iron and steel slag conditioners, calcium hydroxide	30	1953
CC Metals & Alloys LLC	Ferro alloys (metal) production & warehouse distribution	125	1949
Clean Earth Calvert City Inc	handling and transportation of environmental waste	50	2002
Estron Chemicals Inc	Additive and resin polymers for powder coating, UV/EB coating, liquid coating, and cosmetics.	69	1978
Jamesbuilt Specialty Barge Construction	Specialty tank and deck barges	45	2008
Paducah River Painting Inc	Barge remanufacturing, painting facility	58	2000
Sekisui Specialty Chemicals America LLC	Polyvinyl alcohol, acetic acid	73	1959
The Lubrizol Corporation	Carbopol polymers	79	1953
Trimac Transportation Inc	Trucking, except local	51	N/A
Wacker Chemical Corporation	Polymer powders for the construction industry. Polymer dispersions for adhesives, non-woven fabrics, paint, paper, building products and carpet.	144	1965
Westlake Vinyl Inc (PVC)	Manufacture PVC resin	70	1991
Westlake Vinyls Inc	Commodity chemicals	340	1990

Source: Kentucky Cabinet for Economic Development (8/31/2017).

While manufacturing and service sectors are important to the region's economy, agriculture proves to be a vital part of the economy as a whole. The changes, both hazard related and non-hazard related, that affect farming greatly impact the Purchase Region. Hazards such as hail, flooding, tornadoes, and high wind damage crops and thus have an effect on the economy of the region. As previously stated, farming is the most prevalent land use in Marshall County. Table 8.38 is a summary of the farmland located in the Purchase Region and the land use for those acres. This data was retrieved from the United States Department of Agriculture.

Table 8.38 Total Farmland Located in Purchase Region

County	Number of Farms	Land in Farms(acres)	Avg. Farm Size(acres)
Ballard	408	107,186	263
Calloway	821	176,076	214
Carlisle	325	98,620	303
Fulton	178	83,382	468
Graves	1,442	291,813	202
Hickman	298	141,131	474
Marshall	**719**	**94,879**	**132**
McCracken	447	67,192	150
Total	**4,638**	**1,060,279**	**276**

Source: U.S. Department of Agriculture, National Agricultural Statistics Service
2012 Census of Agriculture http://www.nass.usda.gov:8080/census/Pull_Data_Census

Social growth trends also play a key role in the economy of the Purchase Region. Median income and housing characteristics of the region are valuable tools in analyzing these growth trends. The following tables describe the median income and housing characteristics retrieved from the Kentucky State Data Center Census 2010 information.

The Purchase Region is expected to have little or no growth over the next 10 years however, Marshall County is projected to grow slightly during this time frame. Development is not likely to occur in flood regions identified in each jurisdiction, because the threat of flooding is known and occurs on an annual basis. Marshall County and the Cities of Benton, Calvert City and Hardin are members of the NFIP and have implemented a Flood Plain Ordinance in accordance with the applicable sections of Kentucky Revised Statues.

Table 8.39 2010 Census and ACS 2011-2015 Median Household Income

	Median Household Income		
Area	**2010 Census***	**ACS 2011-2015****	**Percent Change**
Kentucky	**$42,302**	$43,740	**3.3%**
Ballard	**$39,995**	$42,240	**8.3**
Calloway	**$34,947**	$37,034	**8.6**
Carlisle	**$35,853**	$38,829	**7.7**
Fulton	$27,524	$28,359	2.9
Graves	$34,550	$39,530	12.6
Hickman	$37,045	$41,218	10.1
Marshall	**$41,891**	**$45,212**	**7.3**
McCracken	$40,976	$44,067	7.0

*Source: *2010 data http://www.thinkkentucky.com/edis/cmnty/QuickFacts.aspx?cw=096, Kentucky State Data Center;*
***U.S. Census Bureau, 2011-2015 American Community Survey 5 Year Estimate*

Table 8.40 2010 Census: Selected Housing Characteristics for the Purchase Region

Subject	Ballard	Calloway	Carlisle	Fulton	Graves	Hickman	Marshall	McCracken
Total Housing Units*	3,889	18,237	2,426	3,360	16,753	2,335	**15,898**	31,342
Occupied Housing Units*	3,288	14,834	2,059	2,568	14,390	1,973	**12,602**	27,514
Vacant Housing Units*	601	3,403	367	792	2,363	362	**3,296**	3,828
Seasonal Use Units**	547	5,654	353	144	1442	290	**1,426**	1,678
Mobile Homes*	657	2,306	500	205	2,220	360	**2,966**	2,988
Owner- occupied*	2,678	9,355	2,059	2,568	14,390	1,470	**9,813**	18,511
Renter- occupied*	610	5,479	367	792	2,363	503	**2,789**	9,003
Household Size – Owner*	2.42	2.49	2.34	2.51	2.63	2.26	**2.50**	2.46
Household Size – Renter*	2.73	2.09	2.58	2.07	2.37	2.39	**2.18**	2.06
Median House Value – Owner Occupied*	$101,800	$119,900	$77,200	$61,000	$92,900	$68,400	**$111,600**	$124,400

*Source * U.S. Census Bureau, 2011-2015 American Community Survey 5 Year Estimate*
***2010 Census Updates; http://ksdc.louisville.edu/1census.htm*

8:5 Mitigation Strategy

8:5.1 Capability Assessment

Mitigation strategies were developed in response to the hazard profiles and vulnerability of the assets in each jurisdiction. These strategies provide each jurisdiction with a blueprint for reducing potential losses identified in the risk assessment. These strategies are based on existing authorities, policies, programs, resources, and the ability to expand on and improve the existing tools.

The capability assessment has been divided into three sections:

(A) Existing Authorities, Policies, Programs, and Resources
(B) Existing Governmental Structure
(C) Existing Professional Staff Departments

The purpose of the capability assessment is to identify potential hazard mitigation opportunities available to each jurisdiction through daily operations as a local unit of government. This assessment will highlight the positive measures already in place in the jurisdiction as well as identify weaknesses that could increase vulnerability in a jurisdiction. The capability assessment serves as the foundation for an effective hazard mitigation strategy by establishing goals and objectives for jurisdictions.

(A) Existing Authorities, Policies, Programs, and Resources

The PADD, along with MPT members, evaluated existing authorities, policies, programs, and resources in each jurisdiction. The following chart is a summary of each jurisdiction and the current status of these authorities. Local committee members evaluated this information to determine what goals, objectives, and actions would be necessary to effectively mitigate the vulnerability of a jurisdiction and what resources they currently have that can be used to implement the mitigation strategies identified in this plan.

Table 8.41 Existing Authorities, Policies, Programs, and Resources in the Purchase Region

Jurisdiction	Floodplain Management Ordinance	CRS & FMA Plans	Zoning Regulations	Subdivision Regulations	Land Development Plans	Fire Prevention Code	Comprehensive Plan	Capital Improvement Plan	Stormwater Management Plan	CERT Team	NWS StormReady Program	Local Economic Development	Regional Economic Development	City Class
Ballard County	X							X		X		X	X	
City of Barlow								X				X	X	6
City of Kevil								X				X	X	6
City of La Center					X		X	X				X	X	5
City of Wickliffe	X							X				X	X	5
Calloway County	X		X	X						X	X	X	X	
City of Murray	X		X	X	X		X		X		U	X	X	3
City of Hazel												X	X	6
Carlisle County	X									X	X	X	X	
City of Bardwell	X											X	X	5
City of Arlington	X											X	X	6
Fulton County	X									X	X	X	X	
City of Fulton	X		X	X	X		X	X				X	X	4
City of Hickman	X		X		X		X					X	X	4
Graves County	X									X		X	X	
City of Mayfield	X		X	X	X		X		X			X	X	3
City Wingo												X	X	6
Hickman County										X	X	X	X	
City of Clinton	X											X	X	5
City of Columbus													X	5
Marshall County	**X**				**X**	**X**				**X**	**X**	**X**	**X**	
City of Benton	**X**		**X**				**X**					**X**	**X**	**4**
City of Calvert City	**X**		**X**	**X**	**X**		**X**	**X**	**X**			**X**	**X**	**4**
City of Hardin	**X**											**X**	**X**	**5**
McCracken County	X		X	X	X	X	X			X	X	X	X	
City of Paducah	X		X	X	X		X	X	X			X	X	2

All jurisdictions are members of the PADD. Services are provided by the district in GIS/GPS, Economic Development, Community Development, Aging Services, Workforce Development, and Fiscal Management. Marshall County is exceptional in that it has its own GIS Consortium which provides GIS and GPS Professional Service to the county and member jurisdictions.

The existing authorities, policies, and programs are further explained in relation to the existing governmental structure and powers of the local jurisdiction. It is the responsibility of each local jurisdiction to develop, enact, and enforce the above referenced authorities and programs.

(B) Existing Governmental Structure

Tables 8.42 (county government) and 8.43(city government) summarize the governmental structure for each jurisdiction in the PADD. Each jurisdiction is responsible for the implementation of mitigation strategies in their community. These governmental structures were reviewed by the JPHMC to determine the capability of implementing and enforcing existing and future authorities, policies, programs, and resources.

Table 8.42 County Government Structure in the Purchase Region

County	Type of Government
Ballard County	Judge/Executive and 5 magistrates
Calloway County	Judge/Executive and 4 magistrates
Carlisle County	Judge/Executive and 3 magistrates
Fulton County	Judge/Executive and 4 magistrates
Graves County	Judge/Executive and 3 commissioners
Hickman County	Judge/Executive and 3 magistrates
Marshall County	**Judge/Executive and 3 commissioners**
McCracken County	Judge/Executive and 3 commissioners

Table 8.43 Governmental Structure and Class of Incorporated Cities

City	Class	County	Type of Government
City of Barlow	6	Ballard	Mayor and 4 commissioners
City of Kevil	6	Ballard	Mayor and 6 council members
City of La Center	5	Ballard	Mayor and 4 commissioners
City of Wickliffe	5	Ballard	Mayor and 6 council members
City of Murray	3	Calloway	Mayor and 12 council members
City Hazel	6	Calloway	Mayor and 6 council members
City of Bardwell	5	Carlisle	Mayor and 6 council members
City of Arlington	6	Carlisle	Mayor and 4 commissioners
City of Hickman	4	Fulton	Mayor and 4 commissioners
City of Fulton	4	Fulton	Mayor and 4 commissioners
City of Mayfield	3	Graves	Mayor and 10 council members
City of Wingo	6	Graves	Mayor and 4 commissioners
City of Clinton	5	Hickman	Mayor and 6 council members
City of Columbus	5	Hickman	Mayor and 6 council members
City of Benton	**4**	**Marshall**	**Mayor and 6 council members**
City of Calvert City	**4**	**Marshall**	**Mayor and 6 council members**
City of Hardin	**5**	**Marshall**	**Mayor and 6 council members**
City of Paducah	2	McCracken	Mayor and 4 commissioners

Legal Authority of Local Jurisdictions

There are many tools available to local governments in Kentucky that may help them implement mitigation programs, policies and actions. Any hazard mitigation program can utilize any or all of the five types of government powers granted by the State of Kentucky: Regulation; Acquisition; Taxation; Spending, and Education.

Regulation

- Police Power: Local governments have been granted broad regulatory powers in their jurisdictions. Kentucky Revised Statutes grant the general police power to local governments, allowing them to enact and enforce ordinances and laws that define, prohibit, regulate or abate acts, omissions, or conditions detrimental to the health, safety and welfare of the citizens of their jurisdiction. The general police power also has the ability to define and abate nuisance ordinances, including those related to public health.

- Jurisdictions can include hazard mitigation requirements in their ordinances as protection of public health, safety and welfare. They may also use this power to enforce nuisance ordinances identifying nuisances that threaten the general health and safety of the public.

- Building Codes and Inspection: The construction and rehabilitation of homes, business and other structures according to standards that will make the structures more resistant to the impact of natural hazards is a big part of mitigation activity in a jurisdiction. These standards can be enforced in a jurisdiction through building codes. Through the adoption and enforcement of building codes in each jurisdiction, it can be assured that mitigation strategies are in place for the planning area.

- Land Use: Local governments can control the use of land in the jurisdiction through regulatory powers granted to them by the State of Kentucky. Jurisdictions can control certain aspects of development under these powers. The amount and type of growth in a jurisdiction can greatly affect the vulnerability of the community in the event of a natural hazard. Land use powers include the power to enact and enforce zoning ordinances, floodplain ordinances, and subdivision controls, as well as the power to engage in planning.

    - Acquisition**:** The State of Kentucky Revised Statutes allows for jurisdictions to acquire property for public purpose. Acquisition can be a useful tool for mitigation goals in that property in hazard prone areas may be acquired so that future development is prohibited in a hazardous area.

    - Taxation**:** Local governments have been given the power to levy taxes and special assignments by the State of Kentucky. Taxation extends beyond the collection of revenue and can provide the means by which the community develops in the future.

    - Spending**:** Local governments have also been given the power to make expenditures on behalf of the public in their interest. Hazard mitigation principles should be incorporated in the spending decisions made by the local government in a jurisdiction.

- Education**:** Although most residents in a jurisdiction have some knowledge of the natural hazards that potentially threaten their community, most of them have had little formal education about what they as individuals can do to reduce their vulnerability to a natural hazard event. Education involving mitigation strategies and potential vulnerability will be essential for all jurisdictions in the planning area

(C) Existing Professional Staff Departments

Members of Marshall County MPT reviewed their existing capabilities based on their current professional staff departments. During the public input meetings, participants determined that the implementation of Mitigation Strategies and Projects would depend on the capability of that department in each jurisdiction.

Table 8.44 Capabilities Assessment: Existing Professional Staff Departments

Jurisdiction	Board of Education	Building Inspectors	Court Clerk	Emergency Management	County/City Treasurer	Mayor /County Judge/Executive	Health Department	Road Department	Sheriff Department	City Police Department	PVA (Tax Assessment)	Social Services	Utilities Department
Ballard County	X		X	X	X	X	X	X	X		X	X	X
Wickliffe				X	X	X							X
Barlow				X	X	X				X			X
Kevil				X	X	X							X
LaCenter				X	X	X				X			X
Calloway County	X		X	X	X	X	X	X	X		X	X	X
Murray	X	X		X	X	X		X		X			X
Hazel				X	X	X							X
Carlisle County	X	X	X	X	X	X	X	X	X		X	X	X
Bardwell		X		X	X	X				X			X
Arlington		X		X									X
Fulton County	X		X	X	X	X	X	X	X		X	X	X
Hickman				X	X	X		X		X			X
Fulton	X			X	X	X		X		X			X
Graves County	X		X	X	X	X	X	X	X		X	X	X
Mayfield	X	X		X	X	X		X		X			X
Wingo				X	X	X				X			X
Hickman County	X		X	X	X	X	X	X	X		X	X	X
Clinton				X	X	X				X			X
Columbus				X	X	X							X
Marshall County	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**	**X**
Benton		**X**		**X**	**X**	**X**		**X**		**X**			**X**
Calvert City		**X**		**X**	**X**	**X**		**X**		**X**			**X**
Hardin				**X**	**X**	**X**							**X**
McCracken County	X	X	X	X	X	X	X	X	X		X	X	X
Paducah	X	X		X	X	X		X		X			X

The following definitions summarize the duties and responsibilities of the professional staff departments listed in Table 8.44.

The **Board of Education** maintains the operations of the county school system. This board is elected at large by the people of the community. County funds usually maintain the buildings and provide for other capital projects. State funds usually pay for salaries and the purchase of textbooks and supplies.

The **Building Inspectors** are responsible for enforcing the State Building Code, the NFIP, the Community Rating System, and other applicable local codes. These items are enforced through an inspection and permitting program.

The **PVA, Court Clerk,** and **Sheriff** are elected every four years by the citizens in the county. The PVA is responsible for the valuation of property for tax purposes. The Court Clerk is the custodian of the court system in each county. This office is financed through the State of Kentucky. The Sheriff operates on a budget approved annually by the magistrates (fiscal court) of each county and is responsible for the enforcement of state and local laws.

The **City Police Departments** are responsible for enforcing local and state laws in their designated jurisdiction.

The **Road Departments** are responsible for the care and maintenance of the public roadways in their designated jurisdiction.

The **Utility Departments** are responsible for providing water, gas, electric and sewer services to the public.

The **Emergency Management Service** is responsible for the mitigation, preparedness, response and recovery operations for both natural and man-made disasters. The formation of an emergency management office in each county is mandated under the Kentucky Revised Statutes.

The **County/City Treasurers** are responsible for the management of the budget and fiscal programs for their jurisdiction. This also includes the administration of state and federal grants.

The **Mayor or County Judge/Executive** is responsible for overseeing the daily operations of County or City government in their respective jurisdictions. They are also responsible for the enforcement of County/City policies and regulations.
The **Health Departments** and **Social Services** have separate boards appointed by commissioners. Employment in these departments is approved by the commissioners with state personnel policies applying. These agencies protect and promote public health and provide social services for medical care and governmental social programs for displaced families.

The **Emergency Management, Road Department, Building Inspectors, and Utilities Department** have been identified as the specific departments that will be responsible for carrying out mitigation activities. Each of these departments has been involved in the hazard mitigation planning process by participating in the JPHMC meetings.

It has been determined by the committee that each of these departments have limited available staff that are responsible for multiple duties within their departments. All jurisdictions have limited funding resources available to hire additional staff. Each staff member is adequately trained to accomplish their current work load. Increase in work activities, including hazard mitigation activities, will increase the need for additional staff to effectively perform tasks.

The PADD, as a regional planning agency, has become a primary resource for technical assistance for all jurisdictions in the region. The PADD staff are trained in planning, GIS/GPS, financial management and project development.

SUMMARY: Capability Assessment

The available staff and financial resources of the departments in each jurisdiction determine the ability for expansion and improvement of existing authorities, policies, programs, and resources to reduce potential losses.

Each county in the PADD has equal ability to enforce and implement mitigation strategies. The capability of cities in the Purchase Region varies so communities often work cooperatively with county government to perform projects that improve the quality of life for residents, including mitigation projects and activities.

Because counties have more resources available to implement mitigation activities, it has been suggested that the goals and objectives be prioritized at a county level. City jurisdictions will have the opportunity at any given time to implement mitigation activities if their capabilities expand and the opportunity exists.

The jurisdictions that have participated in the mitigation planning process are identified in this plan. In addition to local participation, the PADD staff has provided professional assistance in GIS and plan development to help enhance the ability of the local jurisdictions to implement mitigation activities.

Based on the above information, the Local Hazard Mitigation Goals, Objectives and Actions were compiled at a county level, taking city jurisdiction public input into consideration.

8:5.2 Hazard Mitigation Goals

The PADD staff, along with Marshall County MPT analyzed the loss estimates in the risk assessment to establish goals and objectives for loss reduction. The goals were established on a regional basis with the input from local city participants. The goals and objectives will serve as a guide to develop specific actions to reduce potential losses caused by hazard events. These goals and objectives were determined to concur with existing community goals and the goals set forth by the Kentucky State Hazard Mitigation Plan.

Mitigation Goals – The mitigation goals were set to be general, long-term guidelines for hazard mitigation in the jurisdictions.

Mitigation Objectives – The mitigation objectives define the strategies and process of implementation to achieve the identified goals. The objectives are specific, measurable, and have a defined completion.

Goal 1: Improve the survivability of critical facilities and infrastructure in order to preserve their capabilities to provide essential services during a hazard event, by reducing the vulnerability of these facilities.

Purpose of Goal in Relation to the Risk Analysis: Events such as the 2015 and 2016 flooding underscored the vulnerability of critical facilities and infrastructure during natural hazards. Loss of these capabilities directly affect public health and public safety in part or all of Marshall County. During a natural hazard event, roadways can be damaged and utility services knocked out. These types of damages hinder emergency first responders from being able to effectively get help to those in need.

The following objectives have been developed as a result of this goal:

1.1: Enhance the rapid restoration of transportation systems.
1.2: Enhance the rapid restoration of utility systems.
1.3: Where possible, move the critical facilities out of flood prone areas.
1.4: Enhance the resistance of/harden critical facility structures to the effects of natural hazards.
1.5: Enhance the capability to maintain essential public health and public safety services by providing back-up sources of power and redundant communications to critical facilities.

Goal 2: Reduce the potential damaging effects of natural hazards through development policies without limiting the goals for growth of the community.

Purpose of Goal in Relation to the Risk Analysis: It has been determined that potential losses associated with development in the Marshall County may be greatly reduced by enforcing or developing county and city policies that regulate development in hazard prone areas. Policies that regulate and guide the development of future infrastructure, residential, and industrial projects will reduce the vulnerability of these facilities.

The following objectives have been developed as a result of this goal:

2.1 Enforce existing policies and authorities.
2.2 Develop new policies such as ordinances and building codes that require new structures to meet standards that will resist natural hazards.
2.3 Develop land use planning policies that restrict development in hazard prone areas such as flood zones.
2.4 Develop subdivision requirements to protect utilities, such as buried power and phone lines.

Goal 3: Protect public health and safety by increasing public awareness of natural hazards that affect Marshall County and by fostering a sense of responsibility within the public for mitigating risks associated with those natural hazards.

Purpose of Goal in Relation to the Risk Analysis: It has been determined that the general public in Marshal County needs to be aware of the high risk areas, and potential harm associated with the natural hazards that affect their area. While policies can be developed to reduce the development in hazard prone areas, public education will ensure that those policies are utilized to their fullest to reduce the number of existing and future structures in those areas. Through public education, individuals may realize the seriousness of potential hazards and act upon this realization by taking steps to secure their property and protect their families against the risks of natural hazards.

The following objectives have been developed as a result of this goal:

3.1 Educate the public on potential natural hazards that affect their Marshall County.
3.2 Increase public understanding and support of the hazard mitigation process.
3.3 Educate the public on how they can take personal responsibility for their own health, safety and property protection.
3.4 Develop and maintain emergency evacuation routes. Educate the public to the location and use of evacuation routes.
3.5 Storm Ready: Maintain Marshall County's status as a Storm Ready Community.
3.7 Pursue Firewise Community status for Marshall County.

Goal 4: Efficiently make use of public and private funds to increase the capabilities of local jurisdictions to reduce potential losses associated with flood hazard events.

Purpose of Goal in Relation to the Risk Area: It has been determined that potential losses can be reduced in Marshall County by their ability to effectively communicate, plan, and implement mitigation projects. Efficiently using public or private money to improve communication, planning, and implementation capabilities for the general public as well as key critical facilities can reduce the impact a hazard has on Marshall County.

The following objectives have been developed as a result of this goal:

4.1 Promote inter-agency and inter-local cooperation for the use of mitigation funds and activities.

4.2 Take advantage of State Hazard Mitigation grants associated with Disaster Declarations, Pre-Hazard Mitigation Grant announcements, and other grants to fund Mitigation Projects.

4.3 Leverage State and local funding, local match sources and in-kind match resources to get the maximum utility from available Mitigation Funds.

Goal 5: Protect Marshall County's most vulnerable populations, buildings and critical facilities and infrastructure through the implementation of cost-effective and technically feasible mitigation projects.

Purpose of Goal in Relation to the Risk Area: During the review of the risk analysis, council members determined several structures and critical facilities and infrastructure that will need to have specific mitigation actions taken in order to be effective in reducing the vulnerability. Some identified structures and critical facilities and infrastructure need to be removed from the flood hazard area completely or built to appropriate standards to reduce the potential losses.

The following objectives have been developed as a result of this goal:

5.1 Increase the availability of adequate shelters and community shelters for protection from the direct and indirect effects of severe weather events.

5.2 Continue to improve early warning of impending severe weather events.

5.3 Reduce the number critical facilities and infrastructure in identified flood hazard areas.

5.4 Utilize available mitigation measures to reduce the number of vulnerable structures in the flood hazard areas.

5.5 Utilize available mitigation measures such as structure elevation to reduce the vulnerability of structures in the flood hazard areas.

5.6 Identify and remove stream blockages of tree limbs and trunks, form effective check dams and barrages, and result in the pooling of water during flood events.

Goal 6: Protect dwellings, structures and their occupants along the Wildland/Urban interface from the potential of Wildfire.

Purpose of Goal in Relation to the Risk Area: While there is not historic data to support damaging wildfires in Marshall County, small field fires and brush fires do occur, especially during periods of drought events. These events, historically, have been very small threats and generally not consider a risk. While considered a low risk, it should be continually planned for and perhaps anticipated.

The following objectives have been developed as a result of this goal:

6.1. Ensure the protection of first responders.
6.2. Enhance the response capability for response to brush fires to mitigate their growth into wildfires.
6.3. Facilitate communities/neighborhoods participation in the State's "Firewise" program.
6.4. Reduce the quantity of available wildfire fuels in proximity to critical facilities and to any/all structures in Marshall County
6.5 Incorporate fire buffer planning into the design considerations for any new critical facility.

Goal 7: Support and participate in regional Hazard Mitigation Planning

Purpose of Goal in Relation to the Risk Area: Marshall County and representatives of various groups and organizations represented the county and participated in the JPHMC and the development of the regional portion of the plan. Because a regional authority does not exist, the realization of the goals and objectives of the JPHMC Multi-jurisdictional Plan depends on the support and cooperation of Marshall County. This is especially true in that; the regional goals and objectives affect all jurisdictions in the Purchase Region, damage to or destruction of the regional critical facilities identified in the plan affect all jurisdictions in the region, the strategies and mitigation projects that will evolve from these goals require the participation of all the jurisdictions in the region and the results will benefit all the participants. In the same vein, Marshall County will require the cooperation and assistance of other jurisdictions, both neighboring and region wide, and the assistance of regional organizations such as the PADD, the Kentucky State Police, KYTC District One, Purchase District Health Department to help plan, fund and implement Hazard Mitigation projects.

The following objectives have been developed as a result of this goal:

7.1. Request agencies such as the Kentucky Geological Survey and the University of Kentucky to conduct/expand further studies into seismicity, soils and ground shaking potential within the region.
7.2. Develop a regional high resolution, spatially accurate imagery data base from which to extract precise point locations and structure footprints for buildings and other critical facilities.
7.3. Adopt an All-Hazard Week public awareness campaign to include earthquake, flood, tornados and severe storms.

Goal 8: Obtain the best data and analysis available to assess the downstream hazard posed existing dams in the event of their failure.

Purpose of Goal in Relation to the Risk Area: Potential losses can be reduced in a jurisdiction by their ability to effectively plan and implement mitigation projects. In order to do so, an accurate assessment of the threat posed by Dam Failure must be made to determine the geographic extent of the hazard and the potential impact of the Hazard in terms of threat to the populace and property.

The following objectives have been developed as a result of this goal:

8.1 Acquire inundation maps for both Kentucky and Barkley Dams.
8.2 Identify and map vulnerable structures, critical facilities, and risk prone areas.
8.3 Update County EOP as required
8.4 Support and participate in ongoing studies simulations and preparedness exercises relating to dam failure.
8.5 Monitor other existing dams in cooperation with the Kentucky Division of Water.

8:5.3 Identification and Analysis of Mitigation Measures

The intention of this section is to identify, evaluate, and analyze a range of mitigation actions that will help reduce the potential effects of hazard events identified in the risk assessment in section of the plan. These actions were derived based on the analysis of the risk assessment and support the goals and objectives identified in this plan.

The following list describes potential loss reduction mitigation actions and techniques identified for mitigation of hazard events. These actions and objectives were determined to have the greatest influence on hazard loss reduction in Marshall County. Hazard specific mitigation actions are listed in order of priority in accordance with the High Risk Hazards for the county as identified and prioritized by the Marshall County MPT.

- Prevention activities are designed to keep current problems from getting worse and to eliminate the possibility of future problems. Prevention activities reduce a jurisdiction's vulnerability to hazard events. This type of activity is especially effective in hazard prone areas where development has not occurred. Prevention activities include the following:
  - Planning and Zoning
  - Floodplain regulations
  - Stormwater management
  - Building codes
  - Capital improvement programs
  - Open space preservation
  - Dam inspection and monitoring

- Property protection activities are designed to adapt existing structures to withstand natural hazards or to remove structures away from hazard prone areas. Property protection activities include the following:
  - Acquisition
  - Relocation
  - Foundation elevation
  - Insurance – flood and homeowner's
  - Retrofitting (includes activities such as wind-proofing, flood-proofing, and seismic design standards)

- Structural projects lessen the impact of a natural hazard by changing the natural progression of the hazard. These types of projects are usually designed by engineers. Structural projects include the following:
  - Storm sewers
  - Floodwalls
  - Highway Projects
  - Retention Basins
  - Reservoirs
  - Dams
  - Levees
  - Dredging
  - Minor flood control projects
  - Culvert resizing
  - Retaining walls
  - Safe rooms

- Emergency services minimize the impact that a natural hazard has on the residents of a jurisdiction. Usually, actions are taken by emergency response services immediately before, during, or in response to a hazard event. Emergency service activities include the following:
  - Warning systems: sirens / automated calling system
  - Evacuation planning and management
  - Sandbagging for flood protection
  - Emergency response services
  - Protection of critical facilities
  - Emergency generators

- Public information and awareness activities are used to educate the residents of a jurisdiction about the potential hazards that affect their area, hazard prone areas, and mitigation strategies they can take part in to protect themselves and their property. Public information and awareness activities include the following:
  - Public speaking events
  - Outreach projects
  - Availability of hazard maps
  - School programs
  - Library materials
  - Hazard Awareness Weeks
  - Real estate disclosure
  - Storm Ready Community Program
  - Firewise Community Program
  - CERT Teams and CERT Training
  - Citizens Corps Organizations

- Natural resource protection activities include those that minimize hazard losses and preserve or restore the functions of natural systems. Natural resource protection actions include the following:
  - Sediment and erosion control
  - Stream corridor restoration
  - Watershed management
  - Forest and vegetation management
  - Wetlands preservation and management

The goals and objectives for hazard mitigation in Marshall County were developed on a multi-jurisdictional basis. The mitigation activities defined for each goal and objective were largely based on the capability of the county to complete the activities given their geographical location and financial capability. Specific projects included in this plan or evolved out of participation in this planning process.

Table 8.45 Marshall County Hazard Summary Table

HIGH RISK HAZARDS	TORNADO THUNDERSTORM WIND FLASH FLOOD / FLOOD WINTER STORM / ICE STORM EARTHQUAKE
MODERATE RISK HAZARDS	EXCESSIVE HEAT/DROUGHT HAIL
LOW RISK HAZARDS	WILDFIRE DAM FAILURE

SOURCE: Marshall County MPT 2017

Tornado Mitigation Activities: Promote public education to individuals, businesses, and schools for hazard events that may include the following:

- Develop a plan of action for a tornado event – include home, work, school, and outdoor situations
- Have tornado drills on a regular basis
- Encourage all households to maintain a disaster supply kit:
  - A three day supply of water (1 gallon per person per day)
  - Non-perishable food items
  - One change of clothing and shoes per person
  - One blanket or sleeping bag per person
  - A first-aid kit, including all prescription medicines
  - A battery-powered NOAA weather radio with warning alarm and extra batteries
  - A flashlight and extra batteries
  - Special items for infants, elderly or disabled individuals
- Listen to the latest forecasts, especially when planning outdoor activities.
- Publicize multi-media access to tornado watches and warnings.
- Inspect designated tornado shelters for compliance with building codes to ensure their ability to withstand high winds.
- Install warning systems that are not completely dependent upon electricity.

- Pursue programs to provide or subsidize the provision of weather radios to low income populations.
- Evaluate the need for tornado safe rooms, particularly for mobile home parks.
- Analyze the shelter requirements for temporary residents/visitors to the County's Elder Care facilities.
- Evaluate the need for tornado safe rooms, particularly for mobile home parks.
- Initiate mobile home anchoring program
- Build tornado safe rooms where deemed necessary.
- Ensure all critical facilities have a backup source of power – generators
- Train, equip and maintain Storm Spotter cadre
- Build Community Shelters in critical locations

Thunderstorm Wind / Hail Mitigation Activities: Promote public education to individuals, businesses, and schools for hazard events that may include the following.

- Listen to the latest forecasts, especially when planning outdoor activities
- Keep a NOAA weather radio with extra batteries nearby to listen for weather updates.
- Listen especially for severe thunderstorm watches and warnings.
- Practice lightning safety.
  - Outdoor activities should not take place when lightning is present.
  - Fully enclosed vehicles and large permanent buildings provide safe havens from lightning.
- Pursue programs to provide or subsidize the provision of weather radios to low income populations.
- Promote trimming of tree limbs and debris, particularly in areas close to critical facilities and infrastructure such as power lines.
- Ensure all critical facilities have a backup source of power - generators

Flash Flood / Flood Mitigation Activities: Promote public education to individuals, businesses, and schools for hazard events that may include the following.

- Enforce City and County Floodplain Ordnances.
- Participation in the NFIP.
- Promote the purchase flood insurance.
- Construct/Maintain a levee or flood wall.
- Elevate the lowest floor level of existing structures above the floodplain
- Elevate flood prone roads
- When feasible, relocate structures out of the floodplain
- Acquire and demolish structures in the floodplain
- Provide openings in foundation walls to allow water to flow in and out
- Install backflow valves to drains, toilets, and other sewer connections
- Maintain ditches and storm water drainage systems
- Ensure all critical facilities have a backup source of power – generators
- Sedimentation control (dredging)

- Wetland restoration.
- Stream re-alignment (see City of Marshall project below)
- Increase culvert cross section
- Dredge existing channels to maintain current depths and flows
- Identification and removal of stream blockages of tree limbs and trunks forming effective check dams and barrages, and resulting in the pooling of water during flood events.
- Continue to monitor and evaluate the vulnerability of repetitive loss properties to determine if Mitigation action is warranted. Take mitigation action elevation, acquisition or other as required.

Winter Storm Mitigation Activities: Promote public education to individuals, businesses, and schools for hazard events that may include the following.

- Make sure critical facilities have a backup source of heat
- Provide public education as to the safe use of back up heat sources
- Promote trimming of tree limbs and debris, particularly in areas close to critical facilities and infrastructure such as power lines.
- Evaluate subdivision regulations for inclusion of underground utilities for new development
- Promote public education to individuals and families, business, and schools for winter Storm Events and include the following:
  - Insulate the walls and attic of structures
  - Caulk and weather-strip doors and windows
  - Allow water to slowly drip from faucets to prevent pipes from freezing
  - Check the antifreeze and battery in vehicles
  - Stay off snow or ice covered roads if possible
  - Keep a supply of non-perishable food and water
- Ensure all critical facilities have a backup source of power - generators

Earthquake Mitigation Activities: Promote public education to individuals, businesses, and schools for hazard events that may include the following.

- Support, encourage, and lobby for the continuing study of the threat of ground shaking from the Wabash and New Madrid Seismic Zones.
- Evaluate public critical facilities and infrastructure to determine their resistance to ground movement.
- Replacement of brittle water and waste water infrastructure specifically cast iron pipe, asbestos cement pipe, and vitreous clay pipe.
- Ensure that all homes and other structures are secured to their foundations.
- Enforce existing seismic building standards (current building code)
- Promote public education to individuals and families, business, and schools for hazard events that may include the following:

- Identify “safe places” in structures that are vulnerable during an earthquake. A safe place might include space under a sturdy table or desk against an interior wall. Stay away from windows.
- Practice the “drop and cover” technique in each identified safe place. Drop under your identified safe place, duck your head between your knees, and cover the back of your neck with your hands. Practice makes this process an automatic response in the event of an earthquake.
- Develop an action plan for an earthquake event – include home, work, school, and outdoor situations.
  - Secure heavy furniture to walls. Brace or anchor high or top-heavy objects.
  - Purchase earthquake insurance if available.
  - Install strong latches on all cabinet doors. This will prevent them from spilling their contents in the event of an earthquake.
  - Secure items on shelves or bookcases that might fall and cause injury during an earthquake. Move large or heavy items to lower or bottom shelves.
  - Store breakable or glass items in cabinets with latches.
  - Brace overhead light fixtures.
  - Secure water heater to wall studs.
  - Install flexible pipe fittings. These fittings are less likely to break.
- Participate in any/all earthquake planning and exercises at the State and National level.

Excessive Heat/Drought Mitigation Activities: Promote public education to individuals and families, business, and schools for hazard events that may include the following.

- Programs focused on at risk populations, Senior Citizens, very young children
- Air conditioner/fan loan or subsidized purchase program
- Identification of cooling shelters.
- Replacement of brittle water and waste water infrastructure specifically cast iron pipe

Wildfire Mitigation Activities: Promote public education to individuals, businesses, and schools for hazard events that may include the following.

- Each community to strive to be a "Firewise" Community.
- Promote public education to individuals and families, business, and schools for Wildfire Threat include the following:
  - Proper storage of flammables o Class Shingles or tin on roofs o Masonry construction
  - Remove plants with resins, waxes, or oils from landscaping
  - Remove dead branches
  - Reduce the amount of fuel around homes
- Aggressively reduce available fuels in the vicinity of critical facilities
- Amnesty programs for hazardous materials/storage vessels
- Tire amnesty programs
- Removal of potential fuels from the vicinity of Critical Facilities.
- Pursue the acquisition of equipment and training to rapidly respond to brush fires to mitigate their becoming wildfires.

Dam Failure Mitigation Activities: Promote public education to individuals, businesses, and schools for hazard events that may include the following.

- Continue to participate in the State Department of Water monitoring Program for the 31 DOW identified dams in Marshall County.
- Assess the structures at risk to inundation

8:5.4 Implementation of Mitigation Measures

The purpose of this section is to provide a road map on how the mitigation actions identified in section 8:5.3 will be prioritized, implemented and administered in Marshall County.

All jurisdictions will adopt the JPHM Plan upon approval in 2018. Each county in the PADD has equal ability to enforce and implement mitigation strategies. The smaller cities in the Purchase Region, depend greatly upon the county government, and the PADD for support and combine resources to perform projects that improve the quality of life for residents, including mitigation projects and activities.

Given the (small) size of most of the Purchase region's cities, the planning process from which the following mitigation actions derived and were prioritized occurred at the county level. However, each city was represented at county-level meetings. Further, within each county-level planning meeting, individual city mitigation actions were discussed and prioritized. In practice, a city would derive one or two structural or property protection projects that it intended to pursue during the next five years and, first, discussed these projects' feasibility to implement in terms of local financing. Predictably, local financing was a significant constraint for both the county and its cities.

Preventative, natural resource protection, emergency service measures, and public information mitigation actions certainly were discussed at each planning meeting. However, the actions are not highly specific actions, by nature. Building code enforcement and enhancement, floodplain mapping and data, floodplain regulation, storm-water management, and planning activities, as examples, do not typically appear distinctive amidst a county and its cities. It is generally universally important, uncontroversial, and prescient to enforce codes, map and regulate floodplains, manage storm-water activity, and plan and zone. Similar that emergency service activities and public information activities are uncontroversial and generally sought (and not mutually exclusively) by both counties and its cities. So while such activities were discussed individually for counties and for cities, their inclusion within the following mitigation action list will appear similar within each jurisdiction's list. In other words: Marshall County and its incorporated cities, Benton, Calvert City and Hardin all agreed that preventative activities, emergency service measures, and public information activities primarily should be implemented using local and federal-cum-state financing (e.g., EMPG) and are a high priority for pursuance during the next five years.

The jurisdictions that have participated in the mitigation planning process are listed in this plan. In addition to local participation, the PADD staff has provided professional assistance in GIS and plan development to help enhance the ability of the local jurisdictions to implement mitigation activities.

Funding: Outside of local financing and state financing options, the jurisdictions of the PADD will attempt to utilize the following funding sources in implementing goals, objectives and actions when possible: the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation

Assistance Program (FMA), the Pre-Disaster Mitigation Program (PDM), Hazard Mitigation Technical Assistance Programs (HMTAP), the National Earthquake Technical Assistance Program, the Wind and Water Technical Assistance Program, and federal-state matching programs. It should be noted that the above list represents known funding sources at the time of this writing. It is not exhaustive.

Project Prioritization: Marshall County will maintain the list of set goals, objectives, and actions that have been identified in this plan. These items were prioritized based on a set of criteria located in the FEMA Multi-Hazard Mitigation Planning Guidance that includes social, technical, administrative, political, legal, economic, and environmental factors (STAPLE+E) within the county jurisdictions.

As mentioned above, this mitigation strategy will divide mitigation actions into Community-Rating System (CRS) categories *preventative activities*, *property protection activities*, *natural resource protection activities*, *emergency services measures*, *structural projects*, and *public information activities*.

Mitigation actions falling under *preventative activities*, *emergency services measures*, and *public information activities* generally (i.e., unless otherwise specified) are process-driven by nature and driven by uncontroversial and laudable goals. It is thus muddying and complicated to subject such measures to a formal, qualitative, and subjective prioritization mechanism like STAPLE+E. How does a community distinguish "technical assistance" or "hazard response operations" or "enforcement of building codes" as of equally or of higher priority than the construction of a community safe room? Consequently, such process-oriented actions are treated as default "High" in priority and are considered pursued by Marshall County and its incorporated cities of Benton, Calvert City and Hardin, e.g., Marshall County will "enforce building codes" while its cities may not.

The categories *structural projects*, *property protection activities*, and *natural resource protection activities* primarily will include actions that involve construction activity toward new and existing building structures. It is these intended projects and project categories that were prioritized using STAPLE+E.

Each structural/construction action for each community was given a High, Medium, or Low priority using the STAPLE+E framework. Because STAPLE+E relies upon qualitative and subjective assessment, Table 8.43 defines how each component of the STAPLE+E framework was interpreted. Generally, the mitigation actions with the highest priority were the most cost-effective and most compatible with the jurisdiction's social and cultural values. The below list of structural/construction actions includes a column specifying which components of the STAPLE+E framework as defined below were relevant in the designation of the projects' priority status. "E1" in the project lists refers to the "Economic" consideration. "E2" refers to the "Environmental" consideration.

The PADD staff reviewed each jurisdiction's priorities annually to ensure that they were properly prioritized. The designated council representative from each jurisdiction will be responsible for maintaining this list.

The STAPLE+E criteria guidelines for action prioritization that were given to the council members in order to analyze their actions were as follows:

Table 8.46 STAPLE+E Criteria Explanation

S - Social	Mitigation actions are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the community's social and cultural values.
T – Technical	Mitigation actions are technically most effective if they provide long-term reduction of losses and have minimal secondary adverse impacts.
A – Administrative	Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.
P – Political	Mitigation actions can truly be successful if all stakeholders have been offered and opportunity to participate in the planning process and if there is public support for the action.
L – Legal	It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.
E – Economic	Budget constraints can significantly deter the implementation of mitigation actions. It is important to evaluate whether an action is cost-effective, as determined by a cost-benefit review, and possible to fund.
E - Environmental	Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with Federal, State, and local environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

Tables 8.47-8.50 represent non-process actions requiring construction or acquisition related to the goals and objectives set forth in this plan, prioritized by each jurisdiction. The table identifies the hazard the action addresses, the action, the action priority, the entity responsible for the action, the potential sources of funding for the action, and to which Community Rating System (CRS) action category each project belongs.

Table 8.51 represents process actions that, thusly, are of High priority to Marshall County *and* to its incorporated jurisdictions equally: For example, it is expected that "adopting and enforcing building codes" applies with equally "High" priority to Marshall County and to its incorporated cities Benton, Calvert city and Hardin.

Construction/Non-Process Projects to Be Pursued by Each Jurisdiction:

Table 8.47: Marshall County, Unincorporated

Hazard	Action	Priority	STAPLE + E	Responsible Entity	Potential Funding Source	Completion Timeframe
All Identified Hazards	Develop additional public storm shelter(s), in particular one to serve Miller Park	High	S, T, A, P, L, E1, E2	Marshall County Fiscal Court	FEMA/City/ County	Immediate
Flooding	Develop a debris removal plan for streams and ditches	High	S, T, A, P, L, E1, E2	Fiscal Court Public Works	NRCS, local funds	On Going
Flooding	Acquisition of Flood Prone Properties	High	S, T, A, P, L, E1, E2	Marshall County Fiscal Court	FEMA/City/ County	On Going
All Identified Hazards	To the maximum extent possible, provide generators to critical facilities, especially the North Marshall WD treatment plant	High	S, T, A, P, L, E1, E2	Fiscal Court	FEMA/State/ Local match	Immediate
All Identified Hazards	Continue to upgrade emergency services communication equipment as needs change	High	S, T, A, P, L, E1, E2	Emergency Management	FEMA / Homeland Security	On Going
Tornado, Severe Storms Ice Storms	Construct Community shelters/safe rooms in proximity to Campground/RV Parks	High	S, T, A, P, L, E1, E2	Marshall County Fiscal Court	FEMA	Immediate
Wildfire	Acquire equipment and develop procedures for immediate suppression of brush fires	Medium	S, T, A, P, L, E2	County/VFD	CDBG	Long Term
Flooding	Move or develop critical facilities and other structures out of flood hazard areas flood prone areas	Medium	S, T, P, L, E1	Facility Owner	FEMA/Owner	On Going
Flooding	Educate the public of flood prone areas by providing maps and information	Medium	S, T, A, P, L	Emergency Management	911 funds	On Going
Flooding, Earthquake	Educate residents on the availability and importance of flood and earthquake insurance	Medium	S, T, A, P, L	Emergency Management	Fiscal Court	On Going
All Identified Hazards	Adopt and enforce building codes that will help implement mitigation strategies	Medium	S, T, P, L	City /County	City/County	On Going
Flooding	Participate in Wetlands Restoration projects along the Clarks River drainage area	Medium	S, T, A, P, L	County KYFWR 4 Rivers Basin Team	Multiple Sources	Long Term

Table 8.48: Benton, City of

Hazard	Action	Priority	STAPLE+E	Responsible Entities	Potential Funding Sources	CRS Action Category	Completion Timeframe
Flooding	Study cause of flooding/flash flooding along Town Creek and the Fairway Subdivision and identify measures to alleviate flooding	High	S, T, A, P, L, E1, E2	City	Local, State, Federal Grant Programs	Structural	Immediate
Tornadoes	Purchase and Install Emergency Warning Sirens for portions of Benton that don't have adequate coverage	High	S, T, A, P, E1	City; Fiscal Court	Local, FEMA HMA	Emergency Services Measures	Immediate
Tornadoes	Construct Community Safe Room for the Benton City Park	High	S, T, A, P, L, E1	City	FEMA HMA, Local	Structural; Emergency Services Measures	Immediate
All Identified Hazards	Purchase Generators for Critical Facilities	High	S, T, A, P, E1	City	Local, FEMA HMA	Emergency Services Measures	On Going
Tornadoes; Severe Storms; Ice Storms	Trim Trees and Debris from Overhead Powerlines	Medium	S, P, L, E1	Utilities Providers	Private, Local	Preventative Activities	On Going
All Identified Hazards	Upgrade Emergency Services Communication Equipment (for Critical Facilities)	Medium	S, T, P, E1	Marshall County Emergency Management Agency	FEMA/DHS, Other Federal Grants, Local	Emergency Services Measures	On Going

Table 8.49: Calvert City, City of

Hazard	Action	Priority	STAPLE+E	Responsible Entities	Potential Funding Sources	CRS Action Category	Completion Timeframe
Tornadoes	Purchase and Install Emergency Warning Sirens for the areas in Calvert City that don't have adequate coverage	High	S, T, A, P, E1	City	Local, FEMA HMA	Emergency Services Measures	Immediate
Tornadoes	Construct Community Safe Room for the City Park	High	S, T, A, P, L, E1	City	FEMA HMA, Local	Structural; Emergency Services Measures	Immediate
Flooding	Study flooding in and around the Calvert City Apartments to identify solutions	High	S,T, A, P, L, E1, E2	City	FEMA HMA, Local	Structural	Immediate
All Identified Hazards	Purchase Generators for Critical Facilities	High	S, T, A, P, E1	City	Local, FEMA HMA	Emergency Services Measures	On Going
Tornadoes; Severe Storms; Ice Storms	Trim Trees and Debris from Overhead Powerlines	Medium	S, P, L, E1	Utilities Providers	Private, Local	Preventative Activities	On Going
All Identified Hazards	Upgrade Emergency Services Communication Equipment (for Critical Facilities)	Medium	S, T, P, E1	Marshall County Emergency Management Agency	FEMA/DHS, Other Federal Grants, Local	Emergency Services Measures	On Going

Table 8.50: Hardin, City of

Hazard	Action	Priority	STAPLE+E	Responsible Entities	Potential Funding Sources	CRS Action Category	Completion Timeframe
Flooding	Evaluate the potential for flooding adjacent to Martins and Wades Creeks	High	S, T, A, P, L, E1, E2	City	Local, State, Federal Grant Programs	Structural	Immediate
Tornadoes	Purchase and Install Emergency Warning Sirens for the City of Hardin r	High	S, T, A, P, E1	City	Local, FEMA HMA	Emergency Services Measures	Immediate
Tornadoes	Construct Community Safe Room	High	S, T, A, P, L, E1	City	FEMA HMA, Local	Structural; Emergency Services Measures	Immediate
All Identified Hazards	Purchase Generators for Critical Facilities	High	S, T, A, P, E1	City	Local, FEMA HMA	Emergency Services Measures	On Going
Tornadoes; Severe Storms; Ice Storms	Trim Trees and Debris from Overhead Powerlines	Medium	S, P, L, E1	Utilities Providers	Private, Local	Preventative Activities	On Going
All Identified Hazards	Upgrade Emergency Services Communication Equipment (for Critical Facilities)	Medium	S, T, P, E1	Marshall County Emergency Management Agency	FEMA/DHS, Other Federal Grants, Local	Emergency Services Measures	On Going

Table 8.51: Process Mitigation Actions That Apply to Marshall County and Each of Its Incorporated Cities (Benton, Calvert City and Hardin) with Equally (i.e., "High") Priority

Hazard	Action	Priority	Responsible Entities	Potential Funding Sources	CRS Action Category	Completion Timeframe
Flooding	Enforce NFIP Flood Ordinances	High	County and City Executives; Floodplain Managers	Fiscal Court; City Councils	Preventative Activities	On Going
Flooding	Monitor, Evaluate, Collect Damages Data to determine additional and on existing Repetitive-Loss Properties	High	County EMAs; City-Appointed Designees; Floodplain Managers	Fiscal Court; City Councils	Preventative Activities; Property Protection	On Going
All Identified Hazards	Promote the Usage of NOAA Weather Radios	High	County and City EMA and EM agents	Fiscal Court; City Councils	Preventative Activities; Public Information	On Going
Flooding	Provide Updated Floodplain Mapping and other information regarding flood-prone areas to Public	High	County and City EMA and EM agents; Floodplain Managers	Fiscal Court; KYEM; KDOW	Public Information; Preventative Activities	On Going
Earthquakes; Flooding	Public Outreach regarding Importance of and Availability of Earthquake and Flood Insurance	High	County; City; County EMA and EM agents; Floodplain Managers; Insurance	Fiscal Court; City Councils; KYEM; KDOW; UK-KGS	Public Information; Preventative Activities	On Going
All Identified Hazards	Adopt and Enforce Building Codes	High	County; City; Building Inspection agents	Fiscal Court; City Councils; KYEM; FEMA (through HMGP Initiative)	Preventative Activities	Long Term
All Identified Hazards	Public Outreach for the Development of Evacuation Plans and Procedures relevant to All Identified Hazards	High	County; City	Fiscal Court; City Councils; KYEM	Public Information; Emergency Services Measures; Preventative Activities	On Going
Dam Failure	Continue current cooperation with USACE regarding future impacts from Kentucky Dam	High	County (with City Councils' support)	Fiscal Court; City Councils; USACE; KYEM; KDOW; Coast Guard	Preventative Activities; Emergency Services Measures; Natural Resource Protection ; Public Information	Immediate

Hazard	Action	Priority	Responsible Entities	Potential Funding Sources	CRS Action Category	Completion Timeframe
All Identified Hazards	Develop and Implement a Protection Program for Critical Information Systems	High	County; City	Fiscal Court; City Councils	Emergency Services Measures; Preventative Activities	On Going
All Identified Hazards	Develop evacuation plans and procedures for hazards that affect the area	High	County; City	Emergency Management	Fiscal Court	On Going
All Identified Hazards	Encourage homeowners to have a backup power source or alternate heat source	High	County; City	Emergency Management	Homeowner	On Going
All hazards	Develop and implement a protection program for critical information systems such as the AC water lines	High	County; City	Fiscal Court	Fiscal Court	On Going
Flooding	Participate in Wetlands Restoration projects along the Clarks River and Tennessee River drainage basins	High	County; City; Ad-hoc Regional Entities	Fiscal Court; City Councils; Federal Grants	Natural Resource Protection	Long Term