

# LOCAL JURISDICTIONS' HAZARD MITIGATION PLAN SUMMARIES USED FOR REGIONAL PLANNING STAKEHOLDER MEETINGS

Appendix 2-5

*Standard Portion: Planning Process*

***Commonwealth of Kentucky Enhanced Hazard Mitigation Plan: 2013 Version***

Kentucky Emergency Management (KYEM)

University of Kentucky, Martin School of Public Policy and Administration

Hazard Mitigation Grants Program (UK-HMGP)

**BLUEGRASS AREA DEVELOPMENT DISTRICT**

**COUNTIES<sup>1</sup>:** Anderson (21,421); Bourbon (19,985); Boyle (28,432); Clark (35,613); Estill (14,672); *Fayette*<sup>2</sup> (295,803); Franklin (49,285); Garrard (16,912); Harrison (18,846); Jessamine (48,586); Lincoln (24,742); Madison (82,916); Mercer (21,331); Nicholas (7,135); Powell (12,613); Scott (47,173); Woodford (24,939).

**CITIES<sup>3</sup>:** Lawrenceburg (10,505); Paris (8,553); Millersburg (792); North Middletown (643); Danville (16,218); Junction City (2,241); Perryville (751); Winchester (18,368); Irvine (2,715); Ravenna (605); Frankfort (25,527); Lancaster (3,442); Cynthiana (6,402); Berry (264); Nicholasville (28,015); Wilmore (3,686); Stanford (3,487); Crab Orchard (841); Hustonville (405); Richmond (31,364); Berea (13,561); Harrodsburg (8,340); Burgin (965); Carlisle (2,010); Stanton (2,733); Clay City (1,077); Georgetown (29,098); Sadieville (303); Stamping Ground (643); Versailles (8,568); Midway (1,641).

**HIGH-RISK HAZARDS:** Flooding, Severe Storms, Droughts/Extreme Heat, Severe Winter Storms; **MEDIUM-RISK HAZARDS:** Dams, Karsts, Tornadoes; **LOW-RISK HAZARD:** Earthquakes, Landslides, and Wildfires

**FLOODING**

*Table 1: Flash-Flooding Events and Damages (7/31/2002 – 7/31/2012):*

|                  | <i>Events</i> | <i>Mean Events Per Year</i> | <i>Event Frequency<sup>4</sup></i> | <i>Property Damage</i> | <i>Crop Damage</i> | <i>Fatalities/ Injuries</i> |
|------------------|---------------|-----------------------------|------------------------------------|------------------------|--------------------|-----------------------------|
| <i>Anderson</i>  | 4             | .4                          | 1 every 30 months                  | \$100,000              | \$0                | 0/0                         |
| <i>Bourbon</i>   | 3             | .3                          | 1 every 40 months                  | \$10,000               | \$0                | 0/0                         |
| <i>Boyle</i>     | 1             | .1                          | 1 every 120 months                 | \$20,000               | \$0                | 0/0                         |
| <i>Clark</i>     | 10            | 1                           | 1 every 12 months                  | \$7,000                | \$0                | 0/0                         |
| <i>Estill</i>    | 21            | 2.1                         | 1 every 6 months                   | \$20,000               | \$0                | 0/0                         |
| <i>Franklin</i>  | 11            | 1.1                         | 1 every 11 months                  | \$3,080,000            | \$0                | 3/1                         |
| <i>Garrard</i>   | 2             | .2                          | 1 every 60 months                  | \$10,000               | \$0                | 0/0                         |
| <i>Harrison</i>  | 6             | .6                          | 1 every 20 months                  | \$3,000                | \$0                | 0/0                         |
| <i>Jessamine</i> | 4             | .4                          | 1 every 30 months                  | \$0                    | \$0                | 1/0                         |
| <i>Lincoln</i>   | 5             | .5                          | 1 every 24 months                  | \$100,000              | \$0                | 0/0                         |
| <i>Madison</i>   | 32            | 3.2                         | 1 every 4 months                   | \$1,059,000            | \$0                | 1/0                         |
| <i>Mercer</i>    | 9             | .9                          | 1 every 13 months                  | \$0                    | \$0                | 0/0                         |
| <i>Nicholas</i>  | 4             | .4                          | 1 every 48 months                  | \$10,000               | \$10,000           | 0/0                         |
| <i>Powell</i>    | 15            | 1.5                         | 1 every 8 months                   | \$105,000              | \$0                | 0/0                         |
| <i>Scott</i>     | 14            | 1.4                         | 1 every 9 months                   | \$0                    | \$0                | 0/0                         |
| <i>Woodford</i>  | 3             | .3                          | 1 every 40 months                  | \$0                    | \$0                | 0/0                         |
| <b>Mean</b>      | <b>9</b>      | <b>.9</b>                   | <b>1 every 30 months</b>           | <b>\$282,750</b>       | <b>\$625</b>       |                             |
| <b>Std. Dev.</b> | <b>8.3</b>    | <b>.83</b>                  | <b>29 months</b>                   | <b>\$789,975</b>       | <b>\$2500</b>      |                             |

Source: NOAA NCDC Storm Events

<sup>1</sup> Source: U.S. Census Bureau, *QuickFacts*. [Accessed on 1/17/13].

<sup>2</sup> Because Lexington-Fayette County has its own mitigation plan it is not included in the data provided for each hazard.

<sup>3</sup> Source: U.S. Census Bureau, *QuickFacts*. [Accessed on 1/17/13].

<sup>4</sup> Event frequencies calculated by hand. Note, however: Because events are not independent (i.e. the same rainstorm can cause multiple flooding events) it is not technically correct to refer to an event frequency. While on average there may be one flood every 30 months, in actuality multiple floods are likely to be grouped together, making the average time period between floods much longer than 30 months.

Table 2: General Flooding Events and Damages (7/31/2002 – 7/31/2012):

|                  | Events     | Mean Events Per Year | Event Frequency          | Property Damage | Crop Damage    | Fatalities/Injuries |
|------------------|------------|----------------------|--------------------------|-----------------|----------------|---------------------|
| Anderson         | 3          | .3                   | 1 every 40 months        | \$0             | \$0            | 0/0                 |
| Bourbon          | 17         | 1.7                  | 1 every 7 months         | \$205,000       | \$0            | 0/0                 |
| Boyle            | 0          | 0                    | N/A                      | \$0             | \$0            | 0/0                 |
| Clark            | 1          | .1                   | 1 every 120 months       | \$0             | \$0            | 0/0                 |
| Estill           | 11         | 1.1                  | 1 every 11 months        | \$30,000        | \$0            | 0/0                 |
| Franklin         | 2          | .2                   | 1 every 60 months        | \$0             | \$0            | 0/0                 |
| Garrard          | 0          | 0                    | N/A                      | \$0             | \$0            | 0/0                 |
| Harrison         | 2          | .2                   | 1 every 60 months        | \$0             | \$0            | 0/0                 |
| Jessamine        | 3          | .3                   | 1 every 40 months        | \$0             | \$0            | 0/0                 |
| Lincoln          | 0          | 0                    | N/A                      | \$0             | \$0            | 0/0                 |
| Madison          | 2          | .2                   | 1 every 60 months        | \$0             | \$0            | 0/0                 |
| Mercer           | 1          | .1                   | 1 every 120 months       | \$0             | \$0            | 0/0                 |
| Nicholas         | 9          | .9                   | 1 every 13 months        | \$0             | \$5,000        | 0/0                 |
| Powell           | 8          | .8                   | 1 every 15 months        | \$0             | \$0            | 0/0                 |
| Scott            | 1          | .1                   | 1 every 120 months       | \$0             | \$0            | 0/0                 |
| Woodford         | 1          | .1                   | 1 every 120 months       | \$0             | \$0            | 0/0                 |
| <b>Mean</b>      | <b>3.8</b> | <b>.38</b>           | <b>1 every 60 months</b> | <b>\$14,688</b> | <b>\$313</b>   |                     |
| <b>Std. Dev.</b> | <b>4.9</b> | <b>.49</b>           | <b>45 months</b>         | <b>\$51,299</b> | <b>\$1,250</b> |                     |

Source: NOAA NCDC Storm Events

### SEVERE STORMS

Table 3: Severe Storm Events and Damages (7/31/2002 – 7/31/2012)

|                  | Events      | Mean Events Per Year | Event Frequency         | Property Damage | Crop Damage   | Fatalities/Injuries |
|------------------|-------------|----------------------|-------------------------|-----------------|---------------|---------------------|
| Anderson         | 50          | 5                    | 1 every 2 months        | 245,000         | 100,000       | 0/0                 |
| Bourbon          | 45          | 4.5                  | 1 every 3 months        | 89,000          | 0             | 1/1                 |
| Boyle            | 33          | 3.3                  | 1 every 4 months        | 5,000           | 0             | 0/0                 |
| Clark            | 38          | 3.8                  | 1 every 3 months        | 375,000         | 30,000        | 0/0                 |
| Estill           | 119         | 11.9                 | 1 every 1 month         | 1,420,500       | 0             | 0/0                 |
| Franklin         | 53          | 5.3                  | 1 every 2 months        | 260,000         | 0             | 0/0                 |
| Garrard          | 35          | 3.5                  | 1 every 3 months        | 555,000         | 0             | 0/0                 |
| Harrison         | 37          | 3.7                  | 1 every 3 months        | 888,000         | 0             | 0/0                 |
| Jessamine        | 40          | 4.0                  | 1 every 3 months        | 253,500         | 0             | 0/0                 |
| Lincoln          | 32          | 3.2                  | 1 every 4 months        | 187,000         | 0             | 0/0                 |
| Madison          | 84          | 8.4                  | 1 every 1 month         | 220,000         | 0             | 0/0                 |
| Mercer           | 43          | 4.3                  | 1 every 3 months        | 335,000         | 0             | 0/0                 |
| Nicholas         | 17          | 1.7                  | 1 every 7 months        | 575,000         | 0             | 0/0                 |
| Powell           | 104         | 10.4                 | 1 every 1 month         | 399,000         | 0             | 0/0                 |
| Scott            | 73          | 7.3                  | 1 every 2 months        | 283,000         | 0             | 0/0                 |
| Woodford         | 42          | 4.2                  | 1 every 3 months        | 20,000          | 0             | 0/0                 |
|                  |             |                      |                         |                 |               |                     |
| <b>Mean</b>      | <b>52.8</b> | <b>5.3</b>           | <b>1 every 2 months</b> | <b>524,469</b>  | <b>8,125</b>  |                     |
| <b>Std. Dev.</b> | <b>27.9</b> | <b>2.8</b>           | <b>1.5 months</b>       | <b>641,957</b>  | <b>25,617</b> |                     |

Source: NOAA NCDC Storm Events

## DROUGHTS/EXTREME HEAT<sup>5</sup>

*Public data is not available for droughts and the data available for extreme heat is not available on a county<sup>6</sup> level.*

Total Extreme Heat Events (1960-2009): **9**

Total Damage Due to Extreme Heat (1960-2009): **\$1.08 million**

## SEVERE WINTER STORMS

*County-level data<sup>7</sup> for severe winter storms is not available. There have, however, been 3 Presidential Disaster Declarations between 2000 and 2010 that would have partially-yet-significantly affected the Bluegrass ADD's jurisdictions:*

- **DR1454** (February 15-26, 2003);
- **DR1578** (December 21-23, 2004);
- **DR1818** (January 26 – February 13, 2009), for which \$40,849,456 was provided by FEMA for public assistance<sup>8</sup> alone

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<sup>5</sup> Source: "2011 Bluegrass Area Development District Hazard Mitigation Plan," pp. 6-33. County level data on drought is not available.

<sup>6</sup> The inability to retrieve even county-level data is due to how such events are measured, i.e., as events affecting large swaths of multiple regions—called "Zones"—that cannot be parceled out in order to isolate only those counties in the BGADD region.

<sup>7</sup> See Footnote 6

<sup>8</sup> Source: "Kentucky Severe Winter Storms and Flooding – FEMA-1818-DR." From: [www.fema.gov/disaster/1818](http://www.fema.gov/disaster/1818) [Accessed 2/8/2013].

## BARREN RIVER AREA DEVELOPMENT DISTRICT

**COUNTIES**<sup>9</sup>: Allen (19,956); Barren (42,173); Butler (12,690); Edmonson (12,161); Hart (18,199); Logan (26,835); Metcalfe (10,099); Monroe (10,963); Simpson (17,327); Warren (113,792).

**CITIES**<sup>10</sup>: Scottsville (4,226); Cave City (2,240); Glasgow (14,028); Park City (537); Morgantown (2,394); Rochester (152); Woodbury (90); Brownsville (836); Bonnieville (255); Horse Cave (2,311); Munfordville (1,615); Adairville (852); Auburn (1,340); Lewisburg (810); Russellville (6,960); Edmonton (1,595); Fountain Run (217); Gamaliel (376); Tompkinsville (2,402); Franklin (8,408); Bowling Green (58,067); Oakland (225); Plum Springs (453); Smiths Grove (714); Woodburn (355).

**SEVERE-RISK HAZARDS**: Tornadoes; **HIGH-RISK HAZARDS**: Droughts, Earthquakes, Extreme Temperatures, Sinkholes/Karst, Winter Weather; **MODERATE-RISK HAZARD**: Flooding, Dams, Landslides, Severe Storms

### TORNADOES<sup>11</sup>

|                    | <i>Events</i> | <i>Property Damage</i> | <i>Crop Damage</i>  | <i>Deaths</i> | <i>Injuries</i> |
|--------------------|---------------|------------------------|---------------------|---------------|-----------------|
| <i>Allen</i>       | 8             | \$1,670,457.96         | -                   | 4             | 11.09           |
| <i>Barren</i>      | 18            | \$22,746,667.00        | \$100,000           | 4             | 102             |
| <i>Butler</i>      | 10            | \$3,239,124.63         | -                   | 2             | 0.42            |
| <i>Edmonson</i>    | 9             | \$175,457.96           | -                   | 0             | 2.09            |
| <i>Hart</i>        | 15            | \$4,466,513.51         | -                   | 1             | 23.03           |
| <i>Logan</i>       | 21            | \$7,009,547.63         | \$416.67            | 2.14          | 29.2            |
| <i>Metcalfe</i>    | 17            | \$7,080,457.96         | -                   | 3             | 9.09            |
| <i>Monroe</i>      | 12            | \$4,152,386.53         | \$200,000           | 0             | 0.09            |
| <i>Simpson</i>     | 18            | \$9,403,061.10         | -                   | 1.14          | 34.23           |
| <i>Warren</i>      | 25            | \$6,899,000.01         | \$50,166.67         | 4             | 74.33           |
| <b>BRADD TOTAL</b> | <b>153</b>    | <b>\$66,842,674.33</b> | <b>\$350,583.34</b> | <b>21.28</b>  | <b>285.57</b>   |

“Every county in the region has been struck at least once over the past half century. As expected, the larger counties in the region have been struck more frequently [Section 4, p. 148].”

- BRADD has recorded 153 tornadoes between the years 1950 and 2010 [Section 4, p. 148].

### DROUGHTS<sup>12</sup>

“Under normal climatic conditions, the BRADD region receives about 50 inches of precipitation over a year, with eastern counties averaging slightly higher amounts than western counties...October is typically the driest month, but it still averages more than three inches of precipitation [Section 4, p.17].”

- “A monthly time series of the PDSI<sup>13</sup> for Kentucky’s Central Climate Division” [shows that] “[e]ight of the ten counties in the BRADD region are located in this division [susceptible to droughts], making it the single best indicator of drought history. The BRADD region has experienced severe drought conditions on 17 separate occasions over this past century when the PDSI dropped from being positive to a value less than -3. That translates to a drought recurring about every five to eight years [Section 4, p. 17].”

<sup>9</sup> 2010 Population Data in parentheses from U.S. Census Bureau, QuickFacts

<sup>10</sup> 2010 Population Data in parentheses from U.S. Census Bureau, American FactFinder

<sup>11</sup> Data from: National Climatic Data Center (NCDC) and SHELDDUS

<sup>12</sup> The source for information in this section is the Kentucky Climate Center.

<sup>13</sup> PDSI = “Palmer Drought Severity Index”

## **EARTHQUAKES**

The basis for earthquakes being listed as a “High-Risk” hazard has to do with the BRADD Region sitting atop the New Madrid Seismic Zone (NMSZ) coupled with the following statement: “Scientists estimate that the probability of a magnitude 6 to 7 earthquake occurring in this [New Madrid] seismic zone within the next 50 years is higher than 90%. Estimates of losses from a future earthquake in the United States approach \$200 billion [Section 4, p. 26].”

## **EXTREME TEMPERATURES [Section 4, pp. 31-32]:**

Extreme Temperatures being labeled as “High-Risk” has to do with the following considerations:

- All areas of BRADD will be affected by a heat wave or a cold wave.
- *RE: HEAT WAVES:*
  - The natural humidity of the Ohio Valley region leads to any temperatures above 90 degrees to be considered a “heat wave”.
  - Weather in the BRADD region varies greatly.
  - There have been 8 “notable” heat waves to have occurred in BRADD in the past 12 years.
    - Four of these eight have occurred since 2006, with two occurring in 2010<sup>14</sup>.
- *RE: COLD WAVES*<sup>15</sup>:
  - Though cold waves have occurred sparingly<sup>16</sup>, when they do occur, minimum temperatures range from -21 degrees Fahrenheit to -10 degrees for anywhere from 7 to 17 days straight. 2010’s cold wave was anomalous as the minimum temperature recorded was still positive at 9 degrees Fahrenheit.

## **SINKHOLES/KARST**

“Many of Kentucky’s cities are built on karst including: Bowling Green, Munfordville and Russellville. Springs and wells in karst areas supply water to tens of thousands of homes. Much of Kentucky’s prime farmland is underlain by karst. Caves are also important karst features, providing recreation and unique ecosystems. Mammoth Cave is the longest surveyed cave in the world, with more than 350 miles of passages [Section 4, p. 101].”

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<sup>14</sup> The data only exists to 2010.

<sup>15</sup> Data from: National Climactic Data Center (NCDC) and SHELDUS

<sup>16</sup> The last “cold wave” occurred in 2010. Before 2010, the only other years in which “cold waves” were recorded were, in descending order: 1994, 1989, 1977, 1963, 1951, 1948, 1901, and 1899.

**WINTER STORMS<sup>17</sup> (ICE STORM)<sup>18</sup>**

|                    | <i>Events</i> | <i>Property Damage</i> | <i>Crop Damage</i> | <i>Injuries</i> | <i>Deaths</i>     |
|--------------------|---------------|------------------------|--------------------|-----------------|-------------------|
| <i>Allen</i>       | 12            | \$583,520              | \$8,333            | 2.84            | N/A <sup>19</sup> |
| <i>Barren</i>      | 15            | \$844,808              | \$4,167            | 2.9             | N/A               |
| <i>Butler</i>      | 13            | \$733,104              | \$4,167            | 2.84            | N/A               |
| <i>Edmonson</i>    | 14            | \$844,470              | \$4,167            | 2.84            | N/A               |
| <i>Hart</i>        | 14            | \$844,808              | \$4,167            | 2.9             | N/A               |
| <i>Logan</i>       | 14            | \$844,467              | \$4,167            | 2.84            | N/A               |
| <i>Metcalfe</i>    | 13            | \$583,861              | \$4,167            | 2.9             | N/A               |
| <i>Monroe</i>      | 12            | \$1,259,120            | \$4,167            | 2.9             | N/A               |
| <i>Simpson</i>     | 14            | \$583,520              | \$8,333            | 2.84            | N/A               |
| <i>Warren</i>      | 14            | \$594,467              | \$4,167            | 2.84            | N/A               |
| <b>BRADD TOTAL</b> | 135           | \$7,716,147            | \$50,000           | 28.64           | 1.9               |

“The average annual snowfall based on stations from across the region is almost 13 inches. Based on...Bowling Green, only about 15 percent of winters have brought more than 20 inches of snow...The ice storm 50-year recurrence interval for the Barren River Region is a 0.75-inch storm. This means that the region has the probability to expect a storm of at least this magnitude on the average of once over a 50-year period.”

- It is implied that Winter Storm/Ice Storm is a “High-Risk” hazard for BRADD’s most recent plan largely because of the 2009 Ohio Valley Ice Storm.

<sup>17</sup> Data from: The Army Corp of Engineers, National Climactic Data Center (NCDC), and SHELDUS.

<sup>18</sup> BRADD lists only “ice storms” and “snowfall” as “winter storms” for the most recent plan update. There is data for damages resulting from “snowfall” displayed in the plan. However, such damages amount to next to nothing. They are not included here.

<sup>19</sup> “Deaths” are considered N/A here because of how the data was recorded: The BRADD region experienced 1.9 deaths. The data for each individual county divided this 1.9 equally, thus giving each county 0.19 deaths. This is meaningless.

## FLOODS<sup>20</sup>

|                    | <i>Events</i> | <i>Property Damages</i> | <i>Crop Damages</i> | <i>Injuries</i> | <i>Deaths</i> |
|--------------------|---------------|-------------------------|---------------------|-----------------|---------------|
| <i>Allen</i>       | 22            | \$1,106,904.53          | \$41,712.54         | 0.22            | 0             |
| <i>Barren</i>      | 14            | \$1,101,904.53          | \$91,712.54         | 0               | 0.22          |
| <i>Butler</i>      | 67            | \$7,811,157.84          | \$10,6712.54        | 10.48           | 0.20          |
| <i>Edmonson</i>    | 26            | \$11,661,553.63         | \$41,834.49         | 0               | 4.01          |
| <i>Hart</i>        | 24            | \$53,401,061.81         | \$47,262.54         | 0               | 1.01          |
| <i>Logan</i>       | 26            | \$9,158,039.83          | \$41,712.54         | 10.48           | 2.41          |
| <i>Monroe</i>      | 5             | \$1,032,164.17          | \$122,479.69        | 0               | 0.22          |
| <i>Metcalfe</i>    | 10            | \$1,034,099.65          | \$41,834.49         | 0               | 0.22          |
| <i>Simpson</i>     | 17            | \$2,722,976.53          | \$41,837.54         | 0               | 1.22          |
| <i>Warren</i>      | 32            | \$8,147,929.66          | \$146,762.54        | 0               | 3.22          |
| <b>BRADD TOTAL</b> | <b>243</b>    | <b>\$97,177,792.18</b>  | <b>\$723,861.45</b> | <b>21.18</b>    | <b>21.18</b>  |

In BRADD's 2006 Hazard Mitigation Plan, flooding was ranked highly as risk. For this most recent 2010 Plan, BRADD demoted flooding to being a "Moderate-Risk" hazard. Presumably this has to do with the following [Section 4, p.39]:

- The threat of flooding within the BRADD Region as a whole varies significantly.
- Those portions of the BRADD Region that sit atop karst are not highly susceptible to flooding; though it is mentioned that the sinkhole plains can be quite susceptible to flooding.
- Most flooding within the BRADD Region as a whole, then, results from rainfall, i.e. flash floods. Thus, if droughts have been promoted to being a "high-risk" hazard, then flooding due to rainfall must be demoted.

<sup>20</sup> Data from: National Climactic Data Center (NCDC) and SHEL DUS

## BIG SANDY AREA DEVELOPMENT DISTRICT

**COUNTIES**<sup>21</sup>: Floyd (39,451); Johnson (23,358); Magoffin (13,333); Martin (12,929); Pike (65,024).

**CITIES**<sup>22</sup>: Allen (193); Martin (634); Prestonsburg (3,255); Wayland (426); Wheelwright (780); Paintsville (3,459); Salyersville (1,883); Inez (717); Warfield (269); Coal Run Village (1,706); Elkhorn (982); and Pikeville (6,903).

**HIGH-RISK HAZARDS**<sup>23</sup>: Flooding, Severe Storms, Landslides / Sinkholes / Rock Falls / Mine Subsidence; **MEDIUM-RISK HAZARDS**: Dams / Levee Failure, Wildfires; **LOW-RISK HAZARDS**: Drought / Extreme Heat, Earthquakes, Hurricanes

### FLOODING

*Table 1: What Was Recorded in BSADD Plan<sup>24</sup> - Aggregated (1975-2009)*

|          | # of Events/Occurrences | Damages      |
|----------|-------------------------|--------------|
| Floyd    | 46                      | \$73,268,485 |
| Johnson  | 29                      | \$76,080,209 |
| Magoffin | 34                      | \$56,642,080 |
| Martin   | 31                      | \$80,479,050 |
| Pike     | 55                      | \$82,289,818 |

*Table 2: Flash Flood Events and Damages from NOAA Storm Events Database (November 2006 – October 2012)*

|                 | # of Events/Occurrences | Total County Damage Amount |
|-----------------|-------------------------|----------------------------|
| <i>Floyd</i>    | 10                      | \$287,000                  |
| <i>Johnson</i>  | 3                       | \$5,000                    |
| <i>Magoffin</i> | 3                       | \$0                        |
| <i>Martin</i>   | 5                       | \$0                        |
| <i>Pike</i>     | 16                      | \$614,000                  |

*Table 3: General Flood Events and Damages from NOAA Storm Events Database (November 2006 – October 2012)*

|                 | # of Events/Occurrences | Total County Damage Amount |
|-----------------|-------------------------|----------------------------|
| <i>Floyd</i>    | 4                       | \$25,000                   |
| <i>Johnson</i>  | 1                       | \$0                        |
| <i>Magoffin</i> | 1                       | \$0                        |
| <i>Martin</i>   | 4                       | \$0                        |
| <i>Pike</i>     | 4                       | \$1,000                    |

**Context [Paraphrased]:** The future probability of flooding within the Big Sandy region is very high: Big Sandy has Licking River, Tug Fork River, Levisa Fork River, and Russell Fork River; all of these, along with their accompanying streams and tributaries are susceptible to flooding, especially when the Ohio River floods [p. 105].

<sup>21</sup> Populations in parentheses. Source: U.S. Census Bureau QuickFacts

<sup>22</sup> Population in parentheses. Source: U.S. Census Bureau American FactFinder

<sup>23</sup> The choosing of which hazards to profile was based upon wording within the BSADD "2011 Hazard Mitigation Plan": In the Summary of each profiled hazard is a qualitative assessment of likelihood that a hazard event will occur and the amount of potential damage that can be wrought if a hazard occurs. BSADD generally gives greater weight to the latter (the amount of potential damage) than to the likelihood of occurrence.

<sup>24</sup> Damages likely not adjusted for inflation. Original source is unknown. The number of events is likely accurate; though, given the length of the time interval, it is unclear how helpful the information is.

## SEVERE STORMS<sup>25</sup>

Table 4: What Was Recorded in BSADD Plan – Aggregated (1994-2010)

|                 | # of Events/Occurrences | Damages   |
|-----------------|-------------------------|-----------|
| <i>Floyd</i>    | 84                      | \$344,150 |
| <i>Johnson</i>  | 117                     | \$439,000 |
| <i>Magoffin</i> | 74                      | \$221,000 |
| <i>Martin</i>   | 50                      | \$194,180 |
| <i>Pike</i>     | 141                     | \$631,000 |

Table 5: Severe Storm Events and Damages from NOAA Storm Events Database (November 2006 – October 2012)

| <i>Thunder-storms</i> | # of Events | Damages   | <i>Hail</i>     | # of Events | Damages  | <i>High Winds</i> | # of Events | Damages  | <b>Total Events</b> | <b>Total Damages</b> |
|-----------------------|-------------|-----------|-----------------|-------------|----------|-------------------|-------------|----------|---------------------|----------------------|
| <i>Floyd</i>          | 34          | \$482,500 | <i>Floyd</i>    | 11          | \$13,000 | <i>Floyd</i>      | 3           | \$3,000  | <b>48</b>           | <b>\$498,500</b>     |
| <i>Johnson</i>        | 27          | \$559,500 | <i>Johnson</i>  | 10          | \$5,000  | <i>Johnson</i>    | 2           | \$0      | <b>39</b>           | <b>\$564,500</b>     |
| <i>Magoffin</i>       | 21          | \$198,000 | <i>Magoffin</i> | 11          | \$0      | <i>Magoffin</i>   | 3           | \$12,000 | <b>35</b>           | <b>\$210,000</b>     |
| <i>Martin</i>         | 22          | \$254,000 | <i>Martin</i>   | 8           | \$0      | <i>Martin</i>     | 2           | \$0      | <b>32</b>           | <b>\$254,000</b>     |
| <i>Pike</i>           | 46          | \$830,000 | <i>Pike</i>     | 19          | \$7,000  | <i>Pike</i>       | 4           | \$14,000 | <b>69</b>           | <b>\$851,000</b>     |

## LANDSLIDES/SINKHOLES/ROCK FALLS/MINE SUBSIDENCE

“...the future probability of landslide, sinkhole, rock fall, and/or mine subsidence occurrences in the Big Sandy Region is high with a moderate chance of occurrence; although the Risk Assessment Subcommittee along with BSADD staff continues to conclude that the severity and potential impact of these events is severe for the region based on the high percent of slopes greater than the 20%, heavy rain flow patterns, large amount of coal production, continual timber removal operations, and the development for industry, roadway, and housing [p. 242].”

“Since the early 1970s, the Kentucky Transportation Cabinet and the Kentucky Transportation Center has received reports of approximately 3,000 landslides. Costs for repair of these landslides exceed \$2 million annually. Thousands of slides are unrelated to transportation, however, and many are unreported. These also pose significant hazards to people and infrastructure. The Kentucky State Emergency Management office has spent \$617,466 on acquisitions of landslide-prone homes from 2005 to 2007 [p. 245].”

**Topography:** “Generally, the topography in the Big Sandy Region can be characterized throughout the area as extremely mountainous with slopes from 10 to 50 percent. The dendritic pattern of the bottom lands, formed over the geologic past through the process of stream cutting, has provided the template for development in the area. The historic growth pattern has been a logical and sequential development of the bottomlands and upland terraces; the "hollows", the hillsides and finally any available land which can be leveled to support development [p. 11].”

<sup>25</sup>“Severe Storms” is a combination of “High Wind,” “Hail Storm,” and “Thunderstorm.”

## BUFFALO TRACE AREA DEVELOPMENT DISTRICT

**COUNTIES**<sup>26</sup>: Bracken (8,488); Fleming (14,348); Lewis (13,870); Mason (17,490); Robertson (2,282).

**CITIES**<sup>27</sup>: Augusta (1,190); Brooksville (642); Germantown<sup>28</sup> (154); Ewing (264); Flemingsburg (2,658); Concord (35); Vanceburg (1,518); Dover (252); Maysville (9,011); Sardis<sup>29</sup> (103); Mount Olivet (299).

**HIGH-RISK HAZARDS**<sup>30</sup>: Flooding, Severe Storms, Severe Winter Storms; **MEDIUM-RISK HAZARDS**: Tornadoes, Landslides

### FLOODING<sup>31</sup>

*July 31, 2002 – July 31, 2012*

|                  | <i>Events</i> | <i>Property Damage</i> | <i>Crop Damage</i> | <i>Injuries/Fatalities</i> |
|------------------|---------------|------------------------|--------------------|----------------------------|
| <i>Bracken</i>   | 3             | \$2,000                | \$0                | 0/0                        |
| <i>Fleming</i>   | 2             | \$49,630               | \$0                | 0/0                        |
| <i>Lewis</i>     | 10            | \$45,000               | \$0                | 0/0                        |
| <i>Mason</i>     | 3             | \$0                    | \$0                | 0/0                        |
| <i>Robertson</i> | 2             | \$33,000               | \$0                | 0/0                        |

*Source: NCDC Storm Events database*

### FLASH FLOODING

*July 31, 2002 – July 31, 2012*

|                  | <i>Events</i> | <i>Property Damage</i> | <i>Crop Damage</i> | <i>Injuries/Fatalities</i> |
|------------------|---------------|------------------------|--------------------|----------------------------|
| <i>Bracken</i>   | 4             | \$8,000                | \$0                | 0/0                        |
| <i>Fleming</i>   | 20            | \$502,000              | \$1,000            | 0/0                        |
| <i>Lewis</i>     | 12            | \$459,000              | \$0                | 0/4                        |
| <i>Mason</i>     | 12            | \$141,000              | \$0                | 0/0                        |
| <i>Robertson</i> | 0             | \$0                    | \$0                | 0/0                        |

*Source: NCDC Storm Events database*

### SEVERE STORMS

*July 31, 2002 – July 31, 2012*

|                  | <i>Events</i> | <i>Property Damage</i> | <i>Crop Damage</i> | <i>Injuries/Fatalities</i> |
|------------------|---------------|------------------------|--------------------|----------------------------|
| <i>Bracken</i>   | 37            | \$1,209,000            | \$0                | 0/0                        |
| <i>Fleming</i>   | 77            | \$353,500              | \$0                | 2/0                        |
| <i>Lewis</i>     | 36            | \$90,000               | \$20,000           | 0/0                        |
| <i>Mason</i>     | 36            | \$230,000              | \$0                | 0/0                        |
| <i>Robertson</i> | 14            | \$166,000              | \$0                | 0/0                        |

*Source: NCDC Storm Events database*

<sup>26</sup> Populations in parentheses. *Source*: U.S. Census Bureau, QuickFacts database

<sup>27</sup> Populations in parentheses. *Source*: U.S. Census Bureau, American FactFinder database

<sup>28</sup> Also is considered as residing partially in Mason County

<sup>29</sup> Also is considered as residing partially in Robertson County

<sup>30</sup> The BTADD plan does not specify high risk hazards. These three were chosen on the basis of the frequency of Presidential Disaster Declarations in BTADD.

<sup>31</sup> *Source*: NCDC Storm Events database. One of the limitations of the NCDC database is that "zone" data can be difficult to find. For example, though one can search for anything containing Bracken County's Zone number (97) an event entered as affecting zones 95>100 would not show up. For the sake of damage totals I have divided the amount of damage by the number of counties affected by the event.

**SEVERE WINTER STORMS**<sup>32</sup>

*July 31, 2002 – July 31, 2012*

|                  | <i>Events</i> | <i>Property Damage</i> | <i>Crop Damage</i> | <i>Injuries/Fatalities</i> |
|------------------|---------------|------------------------|--------------------|----------------------------|
| <i>Bracken</i>   | 10            | \$0                    | \$0                | 0/0                        |
| <i>Fleming</i>   | 56            | \$30,240               | \$0                | 0/0                        |
| <i>Lewis</i>     | 13            | \$0                    | \$0                | 0                          |
| <i>Mason</i>     | 19            | \$0                    | \$0                | 0                          |
| <i>Robertson</i> | 8             | \$0                    | \$0                | 0                          |

*Source: NCDC Storm Events database*

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<sup>32</sup> All winter storm data is “zone” data, which makes each county estimate a very rough approximation.

**CUMBERLAND VALLEY AREA DEVELOPMENT DISTRICT**

**COUNTIES<sup>33</sup>:** Bell (28,691); Clay (21,730); Harlan (29,278); Jackson (13,494); Knox (31,883); Laurel (58,849); Rockcastle (17,056); and Whitley (35,637).

**CITIES<sup>34</sup>:** Middlesboro (10,334); Pineville (1,732); Manchester (1,255); Benham (500); Cumberland (2,237); Evarts (962); Harlan (1,745); Loyall (1,461); Lynch (747); McKee (800);Barbourville (3,165); Corbin<sup>35</sup> (7,304); London (7,993); Brodhead (1,211); Livingston (226); Mt. Vernon (2,477); Williamsburg (5,245).

**VERY HIGH-RISK HAZARDS:** Flooding; **HIGH-RISK HAZARDS:** Severe Storms / Tornadoes, Winter Storms; **MODERATE-RISK HAZARDS:** Landslides; **LOW-RISK HAZARDS:** Earthquakes, Wildfires, Dam Failures / Levee Failure, Drought / Heat Wave

**FLOODING**

1996-2010<sup>36</sup>

|                   | <i>Events</i> | <i>Property Damage</i> | <i>Crop Damage</i> | <i>Fatalities/Injuries</i> |
|-------------------|---------------|------------------------|--------------------|----------------------------|
| <i>Bell</i>       | 48            | \$48,329,000           | \$11,000           | 0/0                        |
| <i>Clay</i>       | 34            | \$36,346,000           | \$21,000           | 0/1                        |
| <i>Harlan</i>     | 26            | \$79,665,000           | \$10,000           | 0/0                        |
| <i>Jackson</i>    | 20            | \$1,486,000            | \$0                | 0/0                        |
| <i>Knox</i>       | 42            | \$46,938,000           | \$11,000           | 1/0                        |
| <i>Laurel</i>     | 42            | \$2,106,000            | \$11,000           | 0/0                        |
| <i>Rockcastle</i> | 31            | \$1,360,000            | \$0                | 0/0                        |
| <i>Whitley</i>    | 92            | \$46,901,000           | \$16,000           | 0/0                        |

*Sources: "Cumberland Valley Area Development District 2012 Regional Mitigation Plan"; NCDC Storm Events database*

**WATERWAYS:**

"The CVADD is served by four major waterways. These are the Cumberland River, Little Laurel River, Rockcastle River, and the Red Bird River. The Cumberland River is the primary watercourse located in the CVADD. Cranks Creek, Martins Fork and the North Fork come together at the City of Harlan in Harlan County to form the Cumberland River. The Cumberland River flows southwest out of Harlan County and travels through four of the eight counties in the District until the Laurel River and Rockcastle River join the Cumberland River, to become Lake Cumberland. The Red Bird River flows alongside the easternmost boundary of Clay and Bell Counties and eventually drains into the Kentucky River [p. 45]."

<sup>33</sup> Populations in parentheses, current to 2010. *Source:* U.S. Census Bureau, QuickFacts database

<sup>34</sup> Populations in parentheses, current to 2010. *Source:* U.S. Census Bureau, American FactFinder database

<sup>35</sup> Corbin partially is situated in Whitley County, as well.

<sup>36</sup> CVADD combines Flood and Flash Flood into one category for their data analysis. In some cases they give 1993-2010 data, but for a few counties they only give 1996-2010, and so I have truncated the 1993-1995 data so that cross-county comparisons are more easily possible.

## SEVERE STORMS

1996-2010<sup>37</sup>

|            | Events | Property Damage | Crop Damage | Fatalities/Injuries |
|------------|--------|-----------------|-------------|---------------------|
| Bell       | 95     | \$483,000       | \$0         | 0/1                 |
| Clay       | 83     | \$421,000       | \$5,000     | 0/0                 |
| Harlan     | 57     | \$287,000       | \$0         | 2/0                 |
| Jackson    | 71     | \$264,000       | \$0         | 0/2                 |
| Knox       | 60     | \$387,000       | \$0         | 0/0                 |
| Laurel     | 113    | \$429,000       | \$0         | 0/2                 |
| Rockcastle | 61     | \$182,000       | \$0         | 0/0                 |
| Whitley    | 81     | \$581,000       | \$0         | 0/0                 |

Sources: "Cumberland Valley Area Development District 2012 Regional Mitigation Plan"; NCDC Storm Events database

## TORNADOES

1972-2012

|            | F0 | F1 | F2 | F3 | F4 | Property Damage | Crop Damage | Fatalities/Injuries |
|------------|----|----|----|----|----|-----------------|-------------|---------------------|
| Bell       | 3  | 2  | 0  | 1  | 0  | \$25,463,000    | \$0         | 1/15                |
| Clay       | 5  | 0  | 1  | 0  | 0  | \$2,775,000     | \$0         | 0/0                 |
| Harlan     | 2  | 0  | 0  | 0  | 0  | \$720,000       | \$0         | 0/0                 |
| Jackson    | 1  | 1  | 0  | 0  | 0  | \$500,000       | \$0         | 0/1                 |
| Knox       | 0  | 2  | 0  | 0  | 0  | \$80,000        | \$0         | 0/0                 |
| Laurel     | 3  | 5  | 5  | 2  | 0  | \$31,995,000    | \$0         | 6/98                |
| Rockcastle | 2  | 3  | 0  | 1  | 0  | \$2,810,000     | \$0         | 1/10                |
| Whitley    | 0  | 2  | 1  | 0  | 0  | \$300,000       | \$0         | 0                   |

Sources: "Cumberland Valley Area Development District 2012 Regional Mitigation Plan"; NCDC Storm Events database

## WINTER STORMS

1993-2010<sup>38</sup>

|            | Events | Property Damage <sup>39</sup> | Crop Damage | Fatalities/Injuries <sup>40</sup> |
|------------|--------|-------------------------------|-------------|-----------------------------------|
| Bell       | 90     | \$13,036,000                  | \$0         | 2/1                               |
| Clay       | 35     | \$10,011,000                  | \$0         | 2/1                               |
| Harlan     | 90     | \$10,141,000                  | \$0         | 2/1                               |
| Jackson    | 46     | \$10,018,000                  | \$0         | 2/1                               |
| Knox       | 35     | \$10,111,000                  | \$0         | 2/1                               |
| Laurel     | 40     | \$10,031,000                  | \$0         | 2/1                               |
| Rockcastle | 44     | \$10,111,000                  | \$0         | 2/1                               |
| Whitley    | 36     | \$10,111,000                  | \$0         | 2/1                               |

Sources: "Cumberland Valley Area Development District 2012 Regional Mitigation Plan"; NCDC Storm Events database

<sup>37</sup> In some cases CVADD gives 1993-2010 data, but for a few counties they only give 1996-2010. So, I have truncated the 1993-1995 data so that cross-county comparisons are more easily possible.

<sup>38</sup> **The 10 million dollars reflected in the totals below derive primarily from one storm: The February 3, 1998 Winter Storm that covered 33 counties and created a total of 10 million dollars in damage, thus costing an average of \$303,000 per county.**

<sup>39</sup> Damages are recorded by "zone"; so, in recording 10 million dollars of damages in Whitley County, the table is showing that storms that included Whitley County caused 10 million dollars of damage. This does not mean that all of the damage occurred in Whitley County.

<sup>40</sup> The fatalities and injuries were all caused by the storm of 2/03/1998; but the National Climatic Data Center (NCDC) does not single out counties from where they occurred. Instead, the fatalities/injuries simply show up for each county regardless whether that county actually had any fatalities/injuries. Further, consider that the NCDC recorded "zone" data for the winter storms. This means the data actually covers 33 counties; it is not certain if any or all of the fatalities/injuries were in CVADD.

## FIVCO AREA DEVELOPMENT DISTRICT

**COUNTIES<sup>41</sup>:** Boyd (49,538); Carter (27,718); Elliott (7,852); Greenup (36,914); and Lawrence (15,858).

**CITIES<sup>42</sup>:** Ashland (21,627); Catlettsburg (2,124); Grayson (4,208); Olive Hill (2,039); Sandy Hook (674); Bellefonte (858); Flatwoods (7,422); Greenup (1,128); Raceland (2,668); Russell (3,408); South Shore (1,440); Worthington (1,609); Wurtland (1,026); Blaine (170); Louisa (2,742).

**HIGH-RISK HAZARDS<sup>43</sup>:** Flooding, Winter Storms, Wildfire; **OTHER HAZARDS TO CONSIDER:** Landslides, Tornadoes, Earthquakes, Thunderstorm / Severe Wind, Drought, Dam/ Levee Failure

### FLOODING

*TABLE 1: TOTAL FLOOD EVENTS AND CONSEQUENCES (1993-2011)*

|                 | # Events/Occurrences | Total Damage Amount | Deaths/Injuries |
|-----------------|----------------------|---------------------|-----------------|
| <i>Boyd</i>     | 40                   | \$11,775,000        | 3/2             |
| <i>Carter</i>   | 37                   | \$11,388,000        | 4/1             |
| <i>Elliott</i>  | 14                   | \$1,457,000         | 0/0             |
| <i>Greenup</i>  | 28                   | \$13,413,000        | 2/0             |
| <i>Lawrence</i> | 20                   | \$6,765,000         | 0/0             |

Source: FIVCO Area Development District "Multi-Jurisdictional FEMA Mitigation Plan" 2011 Update

*TABLE 2: FLASH FLOOD EVENTS AND CONSEQUENCES (JANUARY 2006 – DECEMBER 2012)*

|                 | # Events/Occurrences | Total Damage Amount | Deaths/Injuries |
|-----------------|----------------------|---------------------|-----------------|
| <i>Boyd</i>     | 6                    | \$1,560,000         | 0/0             |
| <i>Carter</i>   | 4                    | \$5,310,000         | 1/0             |
| <i>Elliott</i>  | 4                    | \$56,000            | 0/0             |
| <i>Greenup</i>  | 4                    | \$900,000           | 0/0             |
| <i>Lawrence</i> | 3                    | \$40,000            | 0/0             |

Source: NOAA National Climatic Data Center (NCDC) Storm Events Database

*TABLE 3: GENERAL FLOOD EVENTS AND CONSEQUENCES (JANUARY 2006 – DECEMBER 2012)*

|                 | # Events/Occurrences | Total Damage Amount | Deaths/Injuries |
|-----------------|----------------------|---------------------|-----------------|
| <i>Boyd</i>     | 5                    | \$546,000           | 0/0             |
| <i>Carter</i>   | 6                    | \$10,106,000        | 0/0             |
| <i>Elliott</i>  | 5                    | \$0                 | 0/0             |
| <i>Greenup</i>  | 8                    | \$3,585,000         | 0/0             |
| <i>Lawrence</i> | 2                    | \$1,000             | 0/0             |

Source: NOAA National Climatic Data Center (NCDC) Storm Events Database

"Located along the Ohio and Big Sandy rivers and bisected by numerous small rivers and streams, flooding is inherent to the region. The topography of the region consists of steep sloping hills separated by narrow drainage. This topography makes flash flooding a major issue as the narrow drainages often struggle to dispense the volume of water that a substantial rainfall generates as it quickly runs off of the steep hillsides. These issues are often exacerbated by deforestation and development that speeds up the pace of runoff and decreases the amount of absorption thus causing both the volume of water and the speed at which it is entering the drainage system to increase. In many cases the drainage system is further hindered by blockages in the stream channel by debris, heavy siltation, or even beaver dams [pp. 17-18]."

<sup>41</sup> Populations in parentheses. Source: U.S. Census Bureau, QuickFacts

<sup>42</sup> Populations in parentheses; populations are five-year estimates from American Community Survey. Source: U.S. Census Bureau, American FactFinder

<sup>43</sup> FIVCO ADD does not actually rank its hazards. Acknowledging subjectivity, the wording of FIVCO's plan, accompanied by data from the NOAA National Climatic Data Center Storm Event Database, and a content analysis of the mitigation actions emphasized and included in the plan imply that the listed hazards would be ranked equally and highly to FIVCO.

## WINTER STORMS

TABLE 4: TOTAL WINTER STORM EVENTS<sup>44</sup> (1993-2012)

|          | # Events/Occurrences | Total Damage Amount | Death/Injury |
|----------|----------------------|---------------------|--------------|
| Boyd     | 23                   | \$3,360,000         | 0/0          |
| Carter   | 24                   | \$3,360,000         | 0/0          |
| Elliot   | 43                   | \$10,135,000        | 2/1          |
| Greenup  | 21                   | \$3,335,000         | 0/0          |
| Lawrence | 24                   | \$3,380,000         | 0/0          |

Source: FIVCO Area Development District “Multi-Jurisdictional FEMA Mitigation Plan” 2011 Update supplemented with NOAA National Climatic Data Center (NCDC) Storm Events Database

“Three major winter storm events in the FIVCO region are the blizzard of 1978, the so-called “Storm of the Century” blizzard of 1993, and the ice storm of 2003. The blizzard of 1993 was responsible for 270 deaths and over \$1 billion of damage throughout the Eastern United States [p. 39].”

Regarding “Winter Storms<sup>45</sup>,” the following dates were of consequence for each of the counties of the FIVCO Area Development District. The damages accrued from these four events that affected all five of FIVCO’s counties amounted to 99.5%<sup>46</sup> of the total damages experienced by FIVCO ADD related to heavy snows, winter storms, winter weather, and ice storms:

- January 6, 1996 [“Winter Storm”]; Total Damages for ADD : \$50,000
- February 3, 1998 [“Heavy Snow”]; Total Damages for ADD: \$13,600,000
- February 16, 2003 [“Ice Storm”]; Total Damages for ADD: \$9,640,000
- January 27, 2009 [“Winter Storm”]; Total Damages for ADD: \$175,000

## WILDFIRES

TABLE 5: WILDFIRE EVENTS AND AMOUNT OF ACREAGE BURNED (2000-2011)

|          | Events | # of Acres Burned |
|----------|--------|-------------------|
| Boyd     | 121    | 1034              |
| Carter   | 457    | 5757              |
| Elliot   | 117    | 2663              |
| Greenup  | 400    | 8391              |
| Lawrence | 333    | 9752              |

Source: FIVCO Area Development District “Multi-Jurisdictional FEMA Mitigation Plan” 2011 Update

“The physical characteristics of the FIVCO region make it at times vulnerable to wildfires. The topography consists of areas of extreme slope which allow fires to spread rapidly and make fighting them difficult. There is adequate fuel in the region, although there are no large uninterrupted tracts of forest land. The region is predominantly rural and tree-covered...The development pattern outside of the urban areas consists of extremely low density spatially distributed houses and small farms. Such development often does not appear in land-use data derived from remote sensing technologies and therefore appears as entirely forested. Because of this development pattern, the urban-wildland interface is very difficult to define...

<sup>44</sup> “Winter Storm” includes the following NOAA National Climatic Data Center classifications: “Winter Storm,” “Winter Weather,” “Snow,” “Heavy Snow,” “Ice Storm”

<sup>45</sup> Keep in mind that “Winter Storms” are high-impact and low-frequency events, generally: So, while it appears that FIVCO has experienced “Winter Storms” with much frequency, it should be considered that very few of these events resulted in any significant damages. The four events listed below this footnote describe 99.5% of the recorded damages for the years 1993-2012.

<sup>46</sup> Total Damages from “Winter Storms” = \$23,570,000. Damages from four listed events: \$23,465,000. 23,465,000/23,570,000 = 0.995.

“During the Summer and Fall seasons, the weather conditions are occasionally dry for lengthy periods of time and make wildfires more likely. In the FIVCO region there were over 500 recorded wildfires from 2000 to 2003 according to Kentucky Division of Forestry data. The largest of these fires burned 2000 acres. **No data is currently available on losses sustained due to wildfire**<sup>47</sup> [p. 60].”

### LANDSLIDES

“Landslides are a common problem throughout the Appalachian region, the FIVCO region included. According to USGS landslide hazard data, most of the FIVCO region is at high risk to landslides [p. 44].”

Further, FIVCO’s “hazard mitigation planning committee” performed a lot of work identifying areas within the FIVCO region most prone to landslides. The amount of work and planning to identify these points and to develop the maps implies that landslides were a priority.

### TORNADOES

*Total Damage Due to Tornadoes (January 2006 – December 2012): \$2,650,000*

For FIVCO, tornadoes are a relative rarity in frequency, at least since 2006. Though low in frequency, the ones that have hit FIVCO in the past six years have had a significant impact. Tornadoes have only impacted two of FIVCO’s five counties: Carter County, where one tornado hit on May 11, 2008 causing \$300,000 worth of damage, and Lawrence County, where two tornadoes hit on March 2, 2012 causing \$2,350,000 worth of damage.

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<sup>47</sup> Emphasis mine.

## GREEN RIVER AREA DEVELOPMENT DISTRICT

**COUNTIES**<sup>48</sup>: Daviess (96,659); Hancock (8,565); Henderson (46,250); McLean (9,531); Ohio (23,842); Union (15,007); and Webster (13,621).

**CITIES**<sup>49</sup>: Owensboro (57,265); Whitesville (552); Hawesville (945); Lewisport (1,670); Corydon (720); Henderson (28,757); Robards (515); Calhoun (763); Island (458); Livermore (1,365); Sacramento (468); Beaver Dam (3,409); Centertown (423); Fordsville (524); Hartford (2,672); McHenry (388); Rockport (266); Morganfield (3,285); Sturgis (1,898); Uniontown (1,002); Waverly (308); Clay (1,181); Dixon (786); Providence (3,193); Sebree (1,603); Slaughters (216); Wheatcroft (160).

**HIGH-RISK HAZARDS:** Earthquakes, Severe Thunderstorms, Tornadoes, Flooding; **MODERATE-RISK HAZARDS:** Excessive Heat / Drought, Land Subsidence, Severe Winter Storms; **LOW-RISK HAZARDS:** Dams / Levee Failures, Landslides

### EARTHQUAKES

*Presidential Disaster Declarations (1971-2010): 0*

*Known Fault Lines:* New Madrid and Wabash Valley faults

"The GRADD region is located near the New Madrid and the Wabash Valley faults. Frequent earthquakes are reported along both faults, though an event of catastrophic impact has not occurred since 1812. Although earthquakes cannot be predicted, acknowledging the region's proximity to major faults and addressing known vulnerabilities are essential to mitigation planning efforts. A severe earthquake event, for example, could cause significant damages to certain masonry structures, especially those atop alluvial soil, which is prevalent in the GRADD region. Older structures in the downtown areas of many GRADD cities could experience high risks during and after earthquake events [p. 59]."

### SEVERE THUNDERSTORMS

*Presidential Disaster Declarations (1971-2010): 9*

|                  | Lightning (46) | Hail (49) | Wind (54) | Yearly Average |
|------------------|----------------|-----------|-----------|----------------|
| <i>Daviess</i>   | 276,974        | 36,000    | 4,442,000 | 89,015         |
| <i>Hancock</i>   | 6,932          | 0         | 90,000    | 1,818          |
| <i>Henderson</i> | 117,974        | 5,000     | 772,000   | 16,963         |
| <i>McLean</i>    | 13,774         | 1,000     | 386,000   | 7,467          |
| <i>Ohio</i>      | 6,983          | 1,000     | 539,000   | 10,153         |
| <i>Union</i>     | 11,974         | 61,000    | 535,000   | 11,412         |
| <i>Webster</i>   | 21,974         | 1,000     | 446,000   | 9,128          |
| <i>GRADD</i>     | 456,585        | 105,000   | 7,210,000 | 145,946        |

<sup>48</sup> 2010 populations in parentheses (from U.S. Census Bureau "QuickFacts")

<sup>49</sup> 2010 populations in parentheses (from U.S. Census Bureau "American FactFinder")

## TORNADOES

*Presidential Disaster Declarations (1971-2010): 7*

“Over the last 60 years, the GRADD region has experienced a high number of tornado events, with almost half of them occurring within the last ten years [p. 244].”

|                  | Events | Damages     | Injuries |
|------------------|--------|-------------|----------|
| <i>Daviess</i>   | 20     | 79,738,000  | 36       |
| <i>Hancock</i>   | 6      | 231,000     | 0        |
| <i>Henderson</i> | 16     | 10,623,000  | 19       |
| <i>McLean</i>    | 5      | 1,803,000   | 2        |
| <i>Ohio</i>      | 7      | 8,028,000   | 0        |
| <i>Union</i>     | 12     | 3,328,000   | 15       |
| <i>Webster</i>   | 14     | 24,440,000  | 37       |
| <i>GRADD</i>     | 80     | 128,191,000 | 109      |

## FLOODING

*Presidential Disaster Declarations (1971-2010): 10*

*Damages (1964-2009): Daviess (\$2,412,342); Hancock (\$1,867,842); Henderson (\$19,948,671); McLean (\$3,252,141); Ohio (\$2,423,146); Union (\$2,394,828); Webster (\$1,920,472)*

*Waterways: 260 miles of navigable waterways*

## GATEWAY AREA DEVELOPMENT DISTRICT

**COUNTIES**<sup>50</sup>: Bath (11,591); Menifee (6,306); Montgomery (26,499); Morgan (13,923); and Rowan (23,333).

**CITIES**<sup>51</sup>: Owingsville (1,530); Salt Lick (303); Sharpsburg (323); Mount Sterling (6,895); Jeffersonville (1,506); Camargo (1,081); Frenchburg (486); West Liberty (3,435); Lakeview Heights (185); and Morehead (6,845).

**HIGH-RISK HAZARDS**: Flood, Karsts/Sinkholes, Severe Winter Storms; **MODERATE-RISK HAZARDS**: Tornadoes, Severe Thunder Storms and Hailstorms, Wildfires, Dam Failure, Drought, Extreme Heat; **LOW RISK HAZARDS**: Earthquakes, Landslides / Land Subsidence

### FLOOD<sup>52</sup>

[169 Events; \$169,642,000 in Damages; 2 Deaths]

#### Flash Flood

- Total Number of Events for Gateway Region (from 1993 – 2011): **131 Events**
  - o Bath (21); Menifee (25); Montgomery (33); Morgan (23); Rowan (29)
- Total Amount of Damages<sup>53</sup> for Gateway Region (from 1993 – 2011): **\$3,849,000**
  - o Bath (\$388,000); Menifee (\$2,058,000); Montgomery (\$267,000); Morgan (\$289,000); Rowan (\$847,000)
- Total Deaths for Gateway Region: **2**
  - o 1 in Bath County; 1 in Montgomery County

#### General Flood

- Total Number of Events for Gateway Region (from 1993 – 2011): **38 Events**
  - o Bath (4); Menifee (6); Montgomery (7); Morgan (10); Rowan (11)
- Total Amount of Damages<sup>54</sup> for Gateway Region (from 1993 – 2011): **\$165,793,000**
  - o Bath (\$38,242,000); Menifee (\$34,305,000); Montgomery (\$34,312,000); Morgan (\$51,929,000); Rowan (\$7,005,000)
    - Averages over the 18-year period: Bath (\$9,560,500 per flood); Menifee (\$5,717,000 per flood); Montgomery (\$4,901,714 per flood); Morgan (\$5,192,900 per flood); Rowan (\$636,818 per flood)
- Total Deaths from General Flooding for Gateway Region: **0**

<sup>50</sup> Populations in parentheses (from U.S. Census Bureau)

<sup>51</sup> Populations in parentheses (from American FactFinder, U.S. Census Bureau)

<sup>52</sup> From 1993 - 2011

<sup>53</sup> Property + Crop Damages

<sup>54</sup> Property + Crop Damages

## KARST

- *Proportion of Counties Subject to Karst*

| <i>County</i>     | <i>Minor Karst Occurrence</i> | <i>Major Karst Occurrence</i> |
|-------------------|-------------------------------|-------------------------------|
| <i>Bath</i>       | 39.89%                        | 1.33%                         |
| <i>Menifee</i>    | ---                           | 22.09%                        |
| <i>Montgomery</i> | 38.96%                        | 1.03%                         |
| <i>Morgan</i>     | ---                           | 2.05%                         |
| <i>Rowan</i>      | 0.71%                         | 7.42%                         |

- *141 Sinkhole Events* throughout Gateway Region: Bath (35); Menifee (14); Montgomery (80); Morgan (3); Rowan (9)

**Flood:** “Both General Flooding and Flash Flooding have occurred in all five counties in the Gateway Region, but they have not occurred in all 15 jurisdictions in the Gateway Region. Owingsville, Salt Lick, Sharpsburg, Frenchburg, Camargo, Jeffersonville, and West Liberty have not reported a general flood. Lakeview Heights has not reported a general flood or a flash flood. As in the original plan, Morgan County has the highest frequency of events and reported damages<sup>55</sup>.” [p. 82-83]

“When reviewing the past disaster figures, the numbers show that Flash Floods occur three times more often than General Flooding (130 to 38). The probability of a future General Flooding event for the Gateway Counties is highest in Montgomery and Rowan Counties (*1 every 17 months*) and lowest in Bath County (*1 every 45 months*). This is a change from the original plan where [the] highest probability was in Montgomery County (*1 every 7 months*) and the lowest was in Bath County (*1 every 24 months*). The probability of a future General Flooding event for the Gateway Jurisdictions is highest in the Morehead and Mt. Sterling jurisdictions (*1 every 12 months*) and lowest in the Bath County jurisdiction (*1 every 45 months*).” [p. 83]

**Karst:** “According to data retrieved from the Kentucky Geological Survey all five of the Gateway Region counties have areas with potential for karst. Nearly 15% of the Gateway Region’s area has minor karst occurrence and an additional 6% of the area has major karst occurrence. There have also been numerous reported sinkholes in the Gateway Region. According to the Kentucky Geological Survey there have been 141 sinkhole events recorded in the region.” [p. 224]

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<sup>55</sup> Highest reported *overall* damages. However, as shown above, Morgan County’s *per-flood* amount of damage is the *lowest* of all five counties (due to the increased frequency of flooding in Morgan County).

## KIPDA

56

**COUNTIES<sup>57</sup>:** *In Kentucky:* Bullitt (74,319); Henry (15,416); Jefferson<sup>58</sup> (741,096); Oldham (60,316); Shelby (42,074); Spencer (17,061); Trimble (8,809) *In Indiana<sup>59</sup>:* Clark (110,232); Floyd (74,578)

**CITIES<sup>60</sup>:** Fox Chase (447); Hebron Estates (1,807); Hillview (8,172); Hunters Hollow (386); Lebanon Junction (1,813); Mt. Washington (9,117); Pioneer Village (2,030); Shepherdsville (11,222); Campbellsburg (813); Eminence (2,498); New Castle (912); Pleasureville<sup>61</sup> (834); Smithfield (106); Louisville (597,337); Crestwood (4,531); Goshen (909); LaGrange (8,082); Orchard Grass Hills (1,595); Pewee Valley (1,456); River Bluff (403); Shelbyville (14,045); Simpsonville (2,484); Taylorsville (763); Bedford (599); Milton (574).

### HAZARDS – INTRODUCTION

*The KIPDA plan did not prioritize hazards. It profiled with equal intensity and thoroughness all hazards that could possibly affect the KIPDA region using the University of Louisville’s Center for Hazards Research (CHR) methodology. However, the Louisville Metro/Jefferson County hazard mitigation plan did prioritize hazards. Hazards profiled also used CHR methodology. For convenience, Louisville Metro’s prioritization will be considered representative of the KIPDA region as a whole.*

### HAZARDS – PROFILED

- **SEVERE (HIGHEST RISK):** *Dam Failure, Flooding, Severe Storms (excluding Hail), Severe Winter Storms, Tornadoes*
- **HIGH (SECOND-HIGHEST RISK):** *Hail, Karst*
- **MODERATE (TERTIARY RISK):** *Drought, Extreme Heat, Earthquakes, Landslides, Wildfires*

### SEVERE RISK HAZARDS

**Dam Failure<sup>62</sup>:** # Events: 1 (1973-2010<sup>63</sup>); 2% chance of occurring anywhere within KIPDA region.

| <i>County</i>                 | <i>Estimated Losses if Failure</i> |
|-------------------------------|------------------------------------|
| <i>Bullitt</i>                | \$404,034,000                      |
| <i>Henry</i>                  | \$129,636,000                      |
| <i>Jefferson<sup>64</sup></i> | \$2,394,357,764                    |
| <i>Oldham</i>                 | \$812,972,000                      |
| <i>Shelby</i>                 | \$523,324,000                      |
| <i>Spencer</i>                | \$314,650,000                      |
| <i>Trimble</i>                | \$57,968,300                       |

*Source: KIPDA Regional Hazard Mitigation Plan: 2011, p. 118; Louisville Metro Multi-Hazards Mitigation Plan 2011, Sec. 3.0, p. 35*

<sup>56</sup> This “fact sheet” includes both the “KIPDA Regional Hazard Mitigation Plan: 2011” and the “Louisville Metro Multi-Hazards Mitigation Plan” 2011.

<sup>57</sup> Populations in parentheses. *Source:* U.S. Census Bureau, *QuickFacts*

<sup>58</sup> Jefferson County, KY, while included within the KIPDA region, is not included in KIPDA’s hazard mitigation plan for Kentucky. Rather, Jefferson County conducted its own mitigation plan update as Louisville Metropolitan. The plan update was funded as an L-PDM 2008 project.

<sup>59</sup> Clark County, IN and Floyd County, IN are included within the KIPDA region. Obviously, they are not included in KIPDA’s hazard mitigation plan for Kentucky.

<sup>60</sup> Populations in parentheses. *Source:* U.S. Census Bureau, *American FactFinder*

<sup>61</sup> Technically, Pleasureville exists in both Henry and Shelby counties.

<sup>62</sup> There have been no recorded past events of dam failure. The figures presented represent potential losses that could occur.

<sup>63</sup> *Source:* National Performance of Dams Program (NPDP)

<sup>64</sup> Jefferson County loss estimate figures actually represent figures for all of the Louisville Metropolitan Statistical Area. Thus some overlap in loss estimate figures is included.

### Flooding:

- # Events (excluding Louisville Metropolitan): 41 (1960-2010<sup>65</sup>); from 1960, 0.82 flooding events per year
  - Total Losses for KIPDA region (excluding Louisville Metro): \$58,008,000
  - Average Annualized Loss Risk for KIPDA region (excluding Louisville Metro): \$1, 016,000
- # Events for Louisville Metropolitan: 41 (1964-2010<sup>66</sup>); from 1964, 0.89 flooding events per year

| County    | Loss Estimate   | Damages <sup>67</sup> (1964 – 2008) |
|-----------|-----------------|-------------------------------------|
| Bullitt   | \$1,933,860,000 | \$16,769,528.99                     |
| Henry     | \$478,027,000   | \$11,761,374.71                     |
| Jefferson | \$1,631,430,293 | \$208,298,243                       |
| Oldham    | \$2,183,910,000 | \$35,573,824.99                     |
| Shelby    | \$1,423,220,000 | \$11,600,861.20                     |
| Spencer   | \$585,328,000   | \$3,157,079.45                      |

Source: KIPDA Regional Hazard Mitigation Plan: 2011, pp. 162, 182-187, 190; Louisville Metro Multi-Hazards Mitigation Plan 2011, Sec 3.0, p. 70

Further to Consider: Louisville Metropolitan includes an assessment of flooding on its watersheds. The property located within all of Louisville Metropolitan's watersheds has a replacement value of \$1,402,425,634.

### Tornadoes:

- # Events (excluding Louisville Metropolitan): 55 (1960-2010<sup>68</sup>); from 1960, 1.1 tornado events per year
  - Past Damages (1960-2010): \$114,000,839
  - Average Annualized Loss Risk: \$2,280,000

| County    | Average Annual Risk | Damages                    |
|-----------|---------------------|----------------------------|
| Bullitt   | \$2,374,360         | \$146,818,006              |
| Henry     | \$181,005           | \$4,010,034                |
| Jefferson | N/A (See below)     | \$15,000,384 <sup>69</sup> |
| Oldham    | \$118,336           | \$250,991                  |
| Shelby    | \$160,488           | \$1,858,442                |
| Spencer   | \$44,023            | \$1,932,651                |
| Trimble   | \$16,889            | \$1,041,969                |

Source: KIPDA Regional Hazard Mitigation Plan: 2011, pp. 279-284 (except Jefferson); 1989-2008; adjusted for inflation to 2012 dollars

- # Events Louisville Metropolitan: 14 (1960-2010<sup>70</sup>); from 1960, 0.28 tornado events per year [about 1 every 3.5 years]
  - Potential Loss Estimate<sup>71</sup>: \$4,277,203,867

## HIGH-RISK HAZARDS

### Karst/Sinkholes:

- KIPDA excluding Louisville Metropolitan: No past events recorded
  - Karst is present in all of KIPDA's counties.
    - Oldham County is underlain predominately with bedrock, meaning high potential for karst.
    - Eastern Bullitt County is also highly susceptible to karst.

<sup>65</sup> Source: SHELDUS database

<sup>66</sup> No source citation provided in "Louisville Metro Multi-Hazards Mitigation Plan"

<sup>67</sup> Source: SHELDUS database; Adjusted for inflation to 2012 dollars using U.S. Bureau of Labor Statistics CPI Calculator

<sup>68</sup> Source: SHELDUS database; NOAA National Climatic Data Center (NCDC)

<sup>69</sup> Source: "Louisville Metro Multi-Hazards Mitigation Plan" 2011, p. 181. Damages from 1960-2010.

<sup>70</sup> Source: *Ibid.*

<sup>71</sup> Assumes tornadoes would tear down every building in Louisville Metropolitan. Source: "Louisville Metro Multi-Hazards Mitigation Plan" 2011, p. 185

| <i>County</i> | <i>Loss Estimate</i> |
|---------------|----------------------|
| Bullitt       | \$36,712,000         |
| Henry         | \$265,200            |
| Oldham        | \$3,264,800          |
| Shelby        | \$709,200            |
| Spencer       | \$2,665,600          |
| Trimble       | \$1,166,200          |

- Louisville Metropolitan: No past events recorded; 451 sinkholes mapped
  - Loss Estimate: \$21,328,774,738

### **MODERATE-RISK HAZARDS**

#### **Droughts:**

- #Events (excluding Louisville Metropolitan): 0 (1960-2010<sup>72</sup>);
- # Events for Louisville Metropolitan: 29 (1895-2010<sup>73</sup>)
  - Probability Ratio: 0.25 within Louisville Metropolitan [Since 1895, there has been about 1 “drought” event to occur every four years.]

| <i>County</i> | <i>Estimated Losses</i> <sup>74</sup> |
|---------------|---------------------------------------|
| Bullitt       | \$187,321,000                         |
| Henry         | \$246,003,000                         |
| Jefferson     | \$38,017,288,909                      |
| Oldham        | \$1,905,470,000                       |
| Shelby        | \$1,002,540,000                       |
| Spencer       | \$325,696,000                         |
| Trimble       | \$130,012,000                         |

Source: KIPDA Regional Hazard Mitigation Plan: 2011, p. 128; Louisville Metro Multi-Hazards Mitigation Plan 2011, Sec 3.0, p. 44

**Earthquakes:** Profiled intensely; little relevant for KIPDA region or for Louisville Metropolitan

#### **Landslides:**

- # Events (excluding Louisville Metropolitan): 20 (1970-2010<sup>75</sup>); from 1970, 1 landslide event every 2 years
  - Past Damages (1970-2010): \$1,274,566
- # Events Louisville Metropolitan: 7 (1990-2009<sup>76</sup>); from 1990, 0.35 landslide events per year
  - Past Damages (1990-2009): \$98,851

| <i>County</i> | <i>Loss Estimate</i> |
|---------------|----------------------|
| Bullitt       | \$6,144,670          |
| Henry         | \$491,960,000        |
| Jefferson     | \$350,252,067        |
| Oldham        | \$2,718,810,000      |
| Shelby        | \$881,058,000        |
| Spencer       | \$519,910,000        |
| Trimble       | \$281,342,000        |

<sup>72</sup> Source: SHEL DUS database

<sup>73</sup> No source citation provided in “Louisville Metro Multi-Hazards Mitigation Plan”

<sup>74</sup> The loss estimates will be exceedingly high. This is due to the assumption that potentially everything could be damaged during a drought. The entire region is assumed equally susceptible. View these estimate with skepticism.

<sup>75</sup> Source: Kentucky Transportation Cabinet Road Landslide database

<sup>76</sup> Source: *Ibid.*

## KENTUCKY RIVER AREA DEVELOPMENT DISTRICT

**COUNTIES**<sup>77</sup>: Breathitt (13,878); Knott (16,346); Lee (7,887); Leslie (11,310); Letcher (24,519); Owsley (4,755); Perry (28,712); Wolfe (7,355)

**CITIES**<sup>78</sup>: Jackson (2,231); Hindman (777); Pippa Passes (533); *Lee County*: Beattyville (1,307); Hyden (365); Blackey (120); Fleming-Neon (770); Jenkins (2,203); Whitesburg (2,139); Booneville (81); Buckhorn (162); Hazard (4,456); Vicco (334); Campton (441).

**HIGH-RISK HAZARDS**<sup>79</sup>: Flooding, Winter Storms, Tornadoes, Lightening/Sever Thunderstorm/Hail; **LOW RISK HAZARDS**: Drought/Extreme Heat, Landslides, Dam/Levee Failure, Wildfires, Earthquake, Hurricanes, Tsunami, Volcanoes

### FLOODING

#### Why It Was Selected as a [High-Risk] Hazard<sup>80</sup>:

- “All eight Counties have been impacted by flooding of various intensities over the past 100 years.
- The region contains many rivers and streams all prone to flooding.
- The region contains all three major tributaries to the Kentucky River.
- The topography, particularly the steep terrain, is conducive to flash-flooding [p. 19].”

#### Flash Flood (2009-2012)<sup>81</sup>

- **Total Number of Events for KRADD Region (2009-2012)**<sup>82</sup>:
  - *Breathitt (8); Knott (4); Lee (4); Leslie (5); Letcher (10); Owsley (3*<sup>83</sup>*); Perry (10); Wolfe (2)*
- **Total Amount of Damages for KRADD Region (2009-2012)**
  - *Breathitt (\$105,000); Knott (\$71,000); Lee (\$1,015,000); Leslie (\$38,000); Letcher (\$61,000); Owsley (\$6,000); Perry (\$146,000); Wolfe (\$0)*

#### General Flood (2009-2012)

- **Total Number of Events for KRADD Region (2009-2012)**:
  - *Breathitt (3); Knott (2); Lee (3); Leslie (3); Letcher (5); Owsley (2); Perry (4); Wolfe (1)*
- **Total Amount of Damages for KRADD Region (2009-2012)**
  - *Breathitt (\$1,005,000); Knott (\$1,000); Lee (\$100,000); Leslie (\$10,000); Letcher (\$0); Owsley (\$0); Perry (\$8,000); Wolfe (\$0)*

“All eight Counties and fourteen Cities within the Kentucky River Area Development District are susceptible to various types of flooding. Flash-flooding has historically caused the greatest amount of localized flood damage to public roads, bridges, and culverts, as well as private property. Riverine flooding has, from time to time, caused extensive and widespread damage over several days. The flooding problem in southeastern Kentucky is compounded due to the step topography, narrow stream and river valleys, and a lack of adequate usable property for development outside of flood zones and flood-prone areas. A flood event of significant proportion (50 to 100 year event) occurs approximately every 12 to 15 years causing widespread damage over the entire region. Localized flash-flooding and

<sup>77</sup> 2010 Population Data in parentheses from U.S. Census Bureau, “QuickFacts”

<sup>78</sup> 2010 Population Data in parentheses from U.S. Census Bureau, “American FactFinder”

<sup>79</sup> There is, technically, no definition by KRADD of a “high-risk hazard.” Rather, KRADD identifies its seven hazards and lists them in descending order of having most to least impact on the KRADD region. Assuming this descending order of impact, this report simply chose the first three as being KRADD’s “high-risk” hazards.

<sup>80</sup> From “Table 1” of “KRADD Regional Hazard Mitigation Plan” 2011, p. 19

<sup>81</sup> From the “KRADD Regional Hazard Mitigation Plan” 2011, there are no reported flooding events (and, thus, no reported damage amounts) between the years 1974-2008.

<sup>82</sup> For both the “Flash Floods” and “General Floods” subsections, data derived from the NOAA “Storm Events Database.” Events were counted by date. In other words, if the NOAA recorded an event on May 15 and recorded one on May 16, these were counted as two events. This was done because though the dates could be close enough so that NOAA was actually capturing one flood over that took place over a number of days, this usually wasn’t the case. Rather, if dates were close together, floods were occurring in two different areas within the county recording the flood events.

<sup>83</sup> All took place in 2009.

minor region-wide flooding occurs almost every year, with some years having multiple events. Examples include the three declarations of 2003 [p. 91].”

## **WINTER STORMS**

### **Why It Was Selected as a [High-Risk] Hazard<sup>84</sup>:**

- “Past storms have resulted in multiple deaths.
- Takes extensive local resources to address cleanup and restoration of services.
- Has impacted all eight counties [p. 19].”

**Total Number of Events (1994-2012): 29 Property Damage (1994-2012):** Over \$10 million  
**Probability<sup>85</sup>:** At least one per year, estimates range from 3.1 per year (if isolating the data to the most recent 10 years) to 1.65 per year (including the last 20 years of data) [paraphrased from p. 101].

“According to NOAA data 29 winter storms have affected the Kentucky River ADD region since 1959. These storms have caused \$10 million+ worth of property damage injuring 2 and causing 2 deaths in the eight counties of the KY River ADD [p. 99].”

## **TORNADOES**

### **Why It Was Selected as a [High-Risk] Hazard<sup>86</sup>:**

- “Past occurrences have resulted in multiple deaths.
- All eight counties are susceptible.
- Localized damage has been...extensive [p. 19].”

**Total Number of Events for KRADD Region (October 2006 – October 2012): 4**

- *Leslie County: 1; Wolfe County: 3*

**Total Amount of Damages for KRADD Region (October 2006 – October 2012): \$130,000**

- *Leslie County: \$25,000; Wolfe County: \$105,000*

“The region overall faces about four tornados every ten years. All jurisdictions are susceptible to tornado damage. Tornados are not limited to any specific geographical boundary. However, the counties and jurisdictions to the north and west including Lee & the City of Beattyville, Owsley & the City of Booneville, Breathitt & the City of Jackson, Wolfe & the City of Campton, and Leslie & the City of Hyden seem to be somewhat more susceptible to the stronger tornados and historically have sustained more damage than the other counties and cities. An exception is Letcher County in the east, which has had 2 historical events. This may be due to the topography of those jurisdictions. Certain sections of each have more rolling, open land with wider river valleys and lower maximum elevations [p. 108].”

## **GEOGRAPHY OF REGION:**

“The topography ranges from extremely rugged mountains, with narrow river and stream valleys in the eastern and southern five counties, to a combination of rugged mountains and rolling farmland in the northern and western counties. Much of the region is covered in hardwood forests and the Daniel Boone National forest covers much of Leslie County, parts of Owsley, Lee and Wolfe Counties. Most of the mountains are ‘fold’ mountains except for the Pine Mountain range, a ‘fault’ range, following the eastern and southern borders of Letcher and Leslie Counties [p. 1].”

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<sup>84</sup> From “Table 1” of “KRADD Regional Hazard Mitigation Plan” 2011, p. 19

<sup>85</sup> The number here is a bit misleading: The KRADD Region experienced large, highly damaging events in 1998 and 2003.

<sup>86</sup> From “Table 1” of “KRADD Regional Hazard Mitigation Plan” 2011, p. 19

## LAKE CUMBERLAND AREA DEVELOPMENT DISTRICT

**COUNTIES**<sup>87</sup>: Adair (18,656), Casey (15,955), Clinton (10,272) Cumberland (6856), Green (11,258) McCreary (18,306), Pulaski (63,063), Russell (17,565), Taylor (24,512), Wayne (20,813).

**CITIES**<sup>88</sup>: Columbia (4452), Liberty (2168); Albany (2033); Burkesville (1521); Greensburg (2163); Burnside (611); Eubank (319); Ferguson (924); Science Hill (639); Somerset (11,196); Jamestown (1794); Russell Springs (2441); Campbellsville (9108); Monticello (6188)

**HIGH -RISK HAZARDS**: Tornado, Dams and Levees, Thunderstorm/ Lighting/Windstorm; **MEDIUM -RISK HAZARDS**: Earthquake, Drought, Extreme Summer Weather, Severe Winter Storm/Ice Storm Flood, Landslide, Hailstorm, Wildfire, Hazardous Materials; **LOW-RISK HAZARD**: Expansive Soil, and Land Subsidence

### TORNADOES

The following list of Tornado event occurred in the LCADD region's cities and counties. The data was obtained from the National Climate Data Center Storm Events database. The years 1950 through 2010 was queried and reduced the following events.

| County:    | Events | Damages         | Fatalities/Injuries |
|------------|--------|-----------------|---------------------|
| Adair      | 10     | \$9,075,000.00  | 6/65                |
| Casey      | 5      | \$2,750,000.00  | 0/0                 |
| Clinton    | 10     | \$404,000.00    | 9/65                |
| Cumberland | 5      | \$451,000.00    | 0/35                |
| Green      | 6      | \$2,840,000.00  | 0/3                 |
| McCreary   | 9      | \$610,000.00    | 2/25                |
| Pulaski    | 21     | \$7,115,000.00  | 6/46                |
| Russell    | 6      | \$3,800,000.00  | 2/72                |
| Taylor     | 7      | \$380,000.00    | 0/54                |
| Wayne      | 8      | \$28,585,000.00 | 4/57                |

### DAMS AND LEVEES

Based on an analysis of the dams currently in place the LCADD region had the following breakdown of dams with hazard classifications based on the potential for loss of life and damage to property. **High Hazard**: dam failures would probably result in loss of life and major damages to property. **Significant Hazard**: dam failure could possibly cause some loss of life and property damage. **Low Hazard**: dam failure would be unlikely to cause loss of life or property damage. The table below shows the number and hazards lever, based on the National Inventory of Dams Downstream Hazards Classification, for each county in LCADD Region.

| County:    | Number of Dams | High Hazard | Significant Hazard | Low Hazard |
|------------|----------------|-------------|--------------------|------------|
| Adair      | 3              | 1           | 0                  | 2          |
| Casey      | 3              | 2           | 0                  | 1          |
| Clinton    | 2              | 0           | 2                  | 0          |
| Cumberland | 0              | 0           | 0                  | 0          |
| Green      | 0              | 0           | 0                  | 0          |
| McCreary   | 9              | 0           | 3                  | 6          |
| Pulaski    | 9              | 0           | 0                  | 9          |

<sup>87</sup> Source: U.S. Census Bureau, QuickFacts. [Accessed on 6/14/13].

<sup>88</sup> Source: Populations in parentheses (from American FactFinder, U.S. Census Bureau) [Accessed on 6/14/13].

| <i>County:</i> | <i>Number of Dams</i> | <i>High Hazard</i> | <i>Significant Hazard</i> | <i>Low Hazard</i> |
|----------------|-----------------------|--------------------|---------------------------|-------------------|
| <i>Russell</i> | 4                     | 1                  | 0                         | 3                 |
| <i>Taylor</i>  | 8                     | 1                  | 1                         | 6                 |
| <i>Wayne</i>   | 0                     | 0                  | 0                         | 0                 |

### **THUNDERSTORM/LIGHTNING/WINDSTORM**

Limited detailed data on specific locations within the individual cities or counties in the LCADD Region was available on Thunderstorms, Lightning, and Windstorm losses. The researched data did show that the entire region is affected by this hazard. However data was not available in for each city/county area due to no loss amounts between 1955 and 2010. Loss data that was cumulative for all areas of the state was not included [page 473].

| <i>County:</i>    | <i>Events</i> |
|-------------------|---------------|
| <i>Adair</i>      | 84            |
| <i>Casey</i>      | 67            |
| <i>Clinton</i>    | 54            |
| <i>Cumberland</i> | 44            |
| <i>Green</i>      | 71            |
| <i>McCreary</i>   | 70            |
| <i>Pulaski</i>    | 203           |
| <i>Russell</i>    | 73            |
| <i>Taylor</i>     | 123           |
| <i>Wayne</i>      | 87            |

**LINCOLN TRAIL AREA DEVELOPMENT DISTRICT**

**COUNTIES:** Breckinridge (20,059); Grayson (25,746); Hardin (105,543); LaRue (14,193); Marion (19,820); Meade (28,602); Nelson (43,437); Washington (11,717).

**CITIES:** Cloverport (1,152); Hardinsburg (2,343); Irvington (1,181); Caneyville (608); Clarkson (875); Leitchfield (6,699); Elizabethtown (28,531); Radcliff (21,688); Sonora (513); Upton (683); Vine Grove (4,520); West Point (797); Hodgenville (3,206); Bradfordsville (294); Lebanon (5,539); Loretto (713); Raywick (134); Brandenburg (2,643); Ekron (135); Muldraugh (947); Bardstown (11,700); Bloomfield (838); Fairfield (113); New Haven (855); Mackville (222); Springfield (2,519); Willisburg (282).

**HIGH-RISK HAZARDS:** Flooding, Severe Storms, Winter Storms; **MODERATE-RISK HAZARDS:** Tornado and Snow and Ice

**Floods:** 1967-2008, Gap in data from 1990-1995

|                     | <i>Events</i> | <i>Total Cost</i>    | <i>Deaths</i> | <i>Injuries</i> |
|---------------------|---------------|----------------------|---------------|-----------------|
| <i>Breckinridge</i> | 45            | \$7,640,550          | 2.09          | 0.11            |
| <i>Grayson</i>      | 41            | \$8,191,065          | 0.04          | 0.11            |
| <i>Hardin</i>       | 53            | \$46,041,197         | 2.17          | 0.11            |
| <i>LaRue</i>        | 32            | \$7,926,297          | 0.17          | 0.11            |
| <i>Marion</i>       | 37            | \$9,540,477          | 0.31          | 2.54            |
| <i>Meade</i>        | 37            | \$7,714,271          | 1.14          | 0.11            |
| <i>Nelson</i>       | 71            | \$33,269,834         | 0.17          | 0.11            |
| <i>Washington</i>   | 35            | \$8,560,877          | 0.17          | 0.11            |
| <b>LTADD Total</b>  | <b>351</b>    | <b>\$128,884,568</b> | <b>6.26</b>   | <b>3.31</b>     |

**Summary:** "Every County in the Lincoln Trail Region has been seriously affected by past flooding. Nearly every two to three years serious flooding occurs along one or more of the major streams, and it is not unusual for this to occur several years in succession or to have multiple occurrences within the course of a year... Nelson County experienced 29 flooding events in the last 10 year period with an average cost per event exceeding \$200,000."

**Major Historic Event:** March 1997

"92 counties in Kentucky and 14 counties in southern Indiana were declared disaster areas. Tens of thousands of people were evacuated from their homes, with total damage across the region around \$400,000,000. In the small city of West Point in Hardin County, it was estimated that 85% of the city was under water leaving residents devastated and property destroyed."

**Tornadoes:** 49 years

|                      | <i>Events</i> | <i>Total Cost</i>   | <i>Deaths</i> | <i>Injuries</i> |
|----------------------|---------------|---------------------|---------------|-----------------|
| <i>Breckinridge</i>  | 10            | \$4,955,260         | 1.09          | 20              |
| <i>Grayson</i>       | 10            | \$56,433,213        | 3.00          | 22.09           |
| <i>Hardin</i>        | 20            | \$15,908,723        | 2             | 73.09           |
| <i>LaRue*</i>        | 8             | \$4,390,111         | 0             | 19.12           |
| <i>Marion</i>        | 10            | \$710,833           | 0             | 2.15            |
| <i>Meade</i>         | 9             | \$6,090,324         | 31            | 267             |
| <i>Nelson</i>        | 13            | \$2,033,978         | 1             | 28.5            |
| <i>Washington</i>    | 11            | \$1,840,007         | 0             | 5.15            |
| <b>LTADD** Total</b> | <b>91</b>     | <b>\$92,362,449</b> | <b>38.09</b>  | <b>436.84</b>   |

\*LaRue includes 57 years of data,

\*\*LTADD includes 50 years of data

**Summary:** “Tornados do not adhere to geographic boundaries and have affected each of our eight counties in the Lincoln Trail Region, several reaching a magnitude of F3 or higher.”

**Major Historic Event:** April 3, 1974

“In what is labeled the worst tornado outbreak in U.S. history, 148 twisters touched down in 13 states, killing 330 people and injuring 5,484. Between the hours of 3:40pm and midnight 26 of those tornados touched down in Kentucky and affected 39 of our 120 counties, killing 77 people and injuring 1,377. Closer to home, within the Lincoln Trail Region a total of 36 of our residents were killed and 353 were injured. The tornado causing the most destruction hit Meade County and had an intensity rating of F5 on the Fujita scale and a path 550 yards wide.”

**Severe Thunderstorms:** 49 years

|                        | <i>Events</i> | <i>Total Cost</i>   | <i>Deaths</i> | <i>Injuries</i> |
|------------------------|---------------|---------------------|---------------|-----------------|
| <i>Breckinridge</i>    | 173           | \$1,157,803         | 0.25          | 2.21            |
| <i>Grayson*</i>        | 177           | \$1,190,288         | 0.25          | 6.62            |
| <i>Hardin**</i>        | 252           | \$64,567,949        | 4.45          | 133.17          |
| <i>LaRue</i>           | 168           | \$1,359,787         | 1.32          | 11.6            |
| <i>Marion</i>          | 165           | \$1,246,735         | 0.24          | 1.63            |
| <i>Meade***</i>        | 181           | \$1,544,733         | 3.45          | 46.26           |
| <i>Nelson</i>          | 203           | \$1,351,130         | 0.3           | 12.58           |
| <i>Washington</i>      | 160           | \$1,453,572         | 0.22          | 3.58            |
| <b>LTADD**** Total</b> | <b>1479</b>   | <b>\$73,871,999</b> | <b>10.48</b>  | <b>217.65</b>   |

\*51 years

\*\*53 years

\*\*\*50 years

\*\*\*\*53 years of data for counties with 53 years of data available

Summary: “Severe Thunderstorms do not adhere to geographic boundaries and have affected each of our eight counties in the Lincoln Trail Region, several containing winds reaching 50 knots or more.”

Major Historic Event: N/A – Though there have been many severe thunderstorms in LTADD there is not one singled out as being significantly more catastrophic than the others.

**Severe Winter Storm:** 49 years

|                     | <i>Events</i> | <i>Total Cost</i>   | <i>Deaths</i> | <i>Injuries</i> |
|---------------------|---------------|---------------------|---------------|-----------------|
| <i>Breckinridge</i> | 30            | \$1,411,082         | 0.31          | 1.83            |
| <i>Grayson</i>      | 31            | \$1,981,398         | 0.29          | 3.41            |
| <i>Hardin</i>       | 33            | \$2,692,155         | 0.29          | 3.47            |
| <i>LaRue</i>        | 30            | \$1,050,662         | 0.29          | 3.36            |
| <i>Marion</i>       | 28            | \$2,681,555         | 0.29          | 3.36            |
| <i>Meade</i>        | 29            | \$1,420,840         | 0.29          | 1.81            |
| <i>Nelson</i>       | 155           | \$2,307,155         | 1.29          | 3.47            |
| <i>Washington</i>   | 36            | \$2,697,743         | 0.37          | 3.48            |
| <b>LTADD Total</b>  | <b>249</b>    | <b>\$16,242,589</b> | <b>3.42</b>   | <b>24.19</b>    |

3.3.1.d Severe Winter Storms

**Summary:** “Due to its mild, temperate climate, the Lincoln Trail Region has experienced few severe winter storms. However, ice, snow and freezing rain do occur. Even though precipitation may not be heavy it can create difficult and dangerous conditions. Rarely does snow accumulate to depths greater than three (3) or four (4) inches.”

**Major Historic Events:** January 28, 2009

“All eight counties in the Lincoln Trail area were among the 103 across the state to be declared disaster areas as a result of the worst winter storm event to hit the state in decades. On January 28, 2009 icy rain began to fall and left a very beautiful but dangerous scene behind. Residents woke to the sounds of limbs snapping and the chill of homes without electricity, water, and phone service. Roads were blocked everywhere, no area was left unaffected. More than 1700 poles were destroyed and reset by Warren RECC in less than 21 days. Residents in several more remote areas across the district were still without power three weeks after the ice storm.

**Narrative Summary of Risks:**

“As expected **Thunderstorms** carry a high-risk level in regards to frequency, the region experiences an average of 29 “severe thunderstorms” each year. This chance of occurrence far exceeds the probability of any other type of weather event. Luckily on the economic side, seven of the eight counties carry a low or even negligible cost per year as a result of thunderstorms. Hardin County however, experienced several thunderstorms that caused in excess of \$100,000, which places them at a high-risk economically.

For each of the eight counties, **Floods** carry a high-risk level for economic impact (exceeds \$100,000 per year) and frequency chance (exceeds 61% per year).

The average **Hail** storm across the region carries an economic impact of \$284,639 and has a more than a 61% chance per year of occurring. Weather events of this magnitude are considered a high-risk hazard.

Based on the cumulative information, the chance of a **Winter storm** occurring in any given year is in the high range (exceeds 61% per year) while economic loss varies across the region from negligible (less than \$24,999 per year) to moderate (\$50,000 - \$99,000 per year)

**Tornados** predominately carry a low-risk level in regards to frequency chance (11%-30%per year), however, the region overall carries a high-risk level for economic impact (exceeds \$100,000 per year).”

**NORTHERN KENTUCKY AREA DEVELOPMENT DISTRICT**

**COUNTIES<sup>89</sup>:** Boone (118,811); Campbell (90,336); Carroll (10,811); Gallatin (8,589); Grant (24,662); Kenton (159,721); Owen (10,838); Pendleton (14,876)

**CITIES<sup>90</sup>:** Florence (29,951); Union (5,379); Walton<sup>91</sup> (3,635); Alexandria (8,477); Bellevue (5,955); California (90); Cold Spring (5,912); Crestview (475); Dayton (5,338); Fort Thomas (15,733); Highland Heights (6,923); Melbourne (401); Mentor (193); Newport (15,273); Silver Grove (1,171); Southgate (3,803); Wilder (3,035); Woodlawn (229); Carrollton (3,938); Ghent (323); Prestonville (161); Sanders (238); Worthville (185); Glencoe (360); Sparta (231); Warsaw (1,615); Corinth (232); Crittenden (3,815); Dry Ridge (2,191); Williamstown (3,925); Bromley (763); Covington (40,640); Crescent Springs (3,801); Crestview Hills (3,148); Edgewood (8,575); Elsmere (8,451); Erlanger (18,082); Fairview (143); Fort Mitchell (8,207); Fort Wright (5,723); Independence (24,757); Kenton Vale (110); Lakeside Park (2,668); Ludlow (4,407); Park Hills (2,970); Ryland Heights (1,022); Taylor Mill (6,604); Villa Hills (7,489); Gratz (78); Monterey (138); Owenton (1,327); Falmouth (2,169)

**HIGH-RISK HAZARDS:** Flooding, Winter Storms; **MODERATE-RISK HAZARDS:** Tornadoes, Severe Storms (Thunder/Lightning/Hail Storms). Landslides, Dam Failure, Earthquakes, Drought, Heat Wave

**FLOODING**

Table 1: Damages Due to Flash-Flooding and General Flooding (1995-2012)

|                  | <i>Flash Flooding</i> | <i>General Flooding</i> |
|------------------|-----------------------|-------------------------|
| <i>Boone</i>     | \$2,106,000           | \$259,000               |
| <i>Campbell</i>  | \$85,000              | \$275,000               |
| <i>Carroll</i>   | \$1,573,000           | \$256,000               |
| <i>Gallatin</i>  | \$133,000             | \$235,000               |
| <i>Grant</i>     | \$1,074,000           | \$46,000                |
| <i>Kenton</i>    | \$2,190,000           | \$302,000               |
| <i>Owen</i>      | \$2,156,000           | \$61,000                |
| <i>Pendleton</i> | \$10,067,000          | \$35,355,000            |

Source: NKADD “Regional Hazard Mitigation Plan” 2012 Update, pp. 95-101

Table 2: Event Counts and Damages Due to Flash-Flooding and General Flooding (2006 – December 31, 2012)

|                  | <i>Flash Flooding</i> |                | <i>General Flooding</i> |                |
|------------------|-----------------------|----------------|-------------------------|----------------|
|                  | <i># of Events</i>    | <i>Damages</i> | <i># Events</i>         | <i>Damages</i> |
| <i>Boone</i>     | 6                     | \$76,000       | 3                       | \$4,000        |
| <i>Campbell</i>  | 7                     | \$22,000       | 6                       | \$27,000       |
| <i>Carroll</i>   | 3                     | \$14,000       | 3                       | \$6,000        |
| <i>Gallatin</i>  | 5                     | \$16,000       | 5                       | \$9,000        |
| <i>Grant</i>     | 4                     | \$15,000       | 1                       | \$3,000        |
| <i>Kenton</i>    | 6                     | \$32,000       | 3                       | \$10,000       |
| <i>Owen</i>      | 5                     | \$30,000       | 2                       | \$5,000        |
| <i>Pendleton</i> | 5                     | \$32,000       | 7                       | \$22,000       |

Source: NOAA National Climatic Data Center Storm Events Database

- Total Flash Flooding Damages for NKADD (1995-2012)<sup>92</sup>: \$19.4 million
- Total General Flooding Damages for NKADD (1995-2012)<sup>93</sup>: \$36.8 million
  - Total Damages from Flooding for NKADD (1995-2012): \$56.2 million

<sup>89</sup> Populations in Parentheses. Source: U.S. Census Bureau, QuickFacts  
<sup>90</sup> Populations in Parentheses. Source: U.S. Census Bureau, American FactFinder  
<sup>91</sup> Partially in Kenton County  
<sup>92</sup> Source: NKADD “Regional Hazard Mitigation Plan” 2012 Update, pp. 95-101  
<sup>93</sup> Ibid.

## WINTER STORMS<sup>94</sup>

Total Number of “Winter Storm” Events (1995-2012<sup>95</sup>): 32

Total Damages from “Winter Storm” Events (1995-2012<sup>96</sup>): \$23.4 million<sup>97</sup>

Deaths from “Winter Storm” Events (1995-2012<sup>98</sup>): Three (3)<sup>99</sup>

Table 3: No Damages for Span of Time Covered Under 2012 Update: “Winter Storm” Events, Damages By Type and By County (2006-2012)

|                  | <i>Winter Storm</i> |                | <i>Winter Weather</i> |                | <i>Ice Storm<sup>100</sup></i> |                | <i>Heavy Snow</i> |                |
|------------------|---------------------|----------------|-----------------------|----------------|--------------------------------|----------------|-------------------|----------------|
|                  | <i>Events</i>       | <i>Damages</i> | <i>Events</i>         | <i>Damages</i> | <i>Events</i>                  | <i>Damages</i> | <i>Events</i>     | <i>Damages</i> |
| <i>Boone</i>     | 5                   | \$0            | 10                    | \$0            | 2                              | \$0            | 5                 | \$0            |
| <i>Campbell</i>  | 4                   | \$0            | 3                     | \$0            | 2                              | \$0            | 5                 | \$0            |
| <i>Carroll</i>   | 3                   | \$0            | 3                     | \$0            | 1                              | \$0            | 4                 | \$0            |
| <i>Gallatin</i>  | 3                   | \$0            | 9                     | \$0            | 1                              | \$0            | 6                 | \$0            |
| <i>Grant</i>     | 4                   | \$0            | 3                     | \$0            | 1                              | \$0            | 5                 | \$0            |
| <i>Kenton</i>    | 5                   | \$0            | 4                     | \$0            | 2                              | \$0            | 6                 | \$0            |
| <i>Owen</i>      | 4                   | \$0            | 2                     | \$0            | 1                              | \$0            | 5                 | \$0            |
| <i>Pendleton</i> | 3                   | \$0            | 5                     | \$0            | 1                              | \$0            | 4                 | \$0            |

Source: NOAA National Climatic Data Center (NCDC) Storm Events Database

The point of displaying that between the years 2006 through 2012 NKADD recorded no damage to property or crops due to “Winter Storm” events is to show that direct property damage is not the only indicator of damage that can be wrought due to a natural hazard. Presumably, NKADD included “Winter Storm” events as a highly ranked hazard not because of what winter storms, winter weather, heavy snow, and, most particularly, two ice storms did to property. Rather, these winter storm events likely caused a lot of indirect damage such as the decrease in the ability of NKADD’s populations to be productive, the increase in traffic accidents, the shortening of school days or school weeks, etc.

## TORNADOES

Table 4: Deaths/Injuries, Property Damages Due to Tornadoes (1950-2012)

| F                | <i>Deaths</i> | <i>Injuries</i> | <i>Property Damage</i> |
|------------------|---------------|-----------------|------------------------|
| <i>Boone</i>     | 0             | 41              | \$6,131,000            |
| <i>Campbell</i>  | 0             | 13              | \$500,000              |
| <i>Carroll</i>   | 1             | 15              | \$5,078,000            |
| <i>Gallatin</i>  | 0             | 7               | \$10,000               |
| <i>Grant</i>     | 1             | 0               | \$285,000              |
| <i>Kenton</i>    | 0             | 2               | \$3,065,000            |
| <i>Owen</i>      | 0             | 0               | \$28,000               |
| <i>Pendleton</i> | 4             | 354             | \$25,445,000           |

Source: NKADD “Regional Hazard Mitigation Plan” 2012 Update, pp. 147-148

Total Number of Events for NKADD (1950-2012)<sup>101</sup>: 46

Total Damages from Tornadoes for NKADD (1950-2012)<sup>102</sup>: \$40.5 million

<sup>94</sup> “Winter Storms” include: “Heavy Snow,” “Ice Storms,” “Winter Weather,” “Winter Storms”

<sup>95</sup> Source: NKADD “Regional Hazard Mitigation Plan” 2012 Update, pp. 107-108

<sup>96</sup> *Ibid.*

<sup>97</sup> Damages were not broken down by county

<sup>98</sup> Source: NKADD “Regional Hazard Mitigation Plan” 2012 Update, pp. 107-108

<sup>99</sup> All three deaths occurred in Carroll County.

<sup>100</sup> The Ice Storm events refer to either or both of two events: February 13, 2007 or January 27, 2009. If a county only reported one “Ice Storm,” then it was referring to the January 27, 2009 Ice Storm.

<sup>101</sup> Source: NKADD “Regional Hazard Mitigation Plan” 2012 Update, pp. 147-148

<sup>102</sup> *Ibid.*

## **SEVERE STORMS**<sup>103</sup>

Table 5: Total Property Damage Wrought by “Severe Storms” by County (1995-2011)

| <i>County</i>    | <i>Property Damage</i>         |             |
|------------------|--------------------------------|-------------|
|                  | <i>Thunder/Lightning Storm</i> | <i>Hail</i> |
| <i>Boone</i>     | \$689,000                      | \$71,000    |
| <i>Campbell</i>  | \$299,000                      | \$10,000    |
| <i>Carroll</i>   | \$159,000                      | \$4,000     |
| <i>Gallatin</i>  | \$516,000                      | \$5,000     |
| <i>Grant</i>     | \$255,000                      | \$7,000     |
| <i>Kenton</i>    | \$267,000                      | \$23,000    |
| <i>Owen</i>      | \$352,000                      | \$15,000    |
| <i>Pendleton</i> | \$508,000                      | \$14,000    |
| <i>Totals</i>    | \$3,045,000                    | \$149,000   |

Source: NKADD “Regional Hazard Mitigation Plan” 2012 Update, pp. 162-165

Total Thunderstorm/Lightning Storm Count (1995-2011): 350; Total Hailstorm Count (1995-2011):143

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<sup>103</sup> All data from NKADD “Regional Hazard Mitigation Plan 2012 Update, pp. 162-165. “Severe Storms” = Thunder/Lightning/Hail Storms

**PURCHASE AREA DEVELOPMENT DISTRICT**

**COUNTIES**<sup>104</sup>: Ballard (8,249); Calloway (37,191); Carlisle (5,104); Fulton (6,813); Graves (37,121); Hickman (4,902); Marshall (31,448); McCracken (65,565)

**CITIES**<sup>105</sup>: Paducah (25,024); Murray (17,741); Mayfield (10,024); Barlow (675); Kevil (376); LaCenter (1,009); Wickliffe (688); Hazel (410); Arlington (324); Bardwell (723); Fulton (2,455); Hickman (2,395); Wingo (632); Clinton (1,388); Columbus (170); Benton (4,349); Calvert City (2,556); Hardin (615).

**HIGH-RISK HAZARDS**<sup>106</sup>: Flooding, Earthquakes, Winter Storms, Tornadoes, Severe Storms/Wind;  
**MODERATE-RISK HAZARDS**: Hail Storm, Windstorm; **LOW-RISK HAZARDS**: Drought/Heat, Dam Failure, Landslide, Erosion/Deposition

**FLOODING**

“From January 1, 1995 through September 30, 2011, there have been **379 occurrences of flooding** in Purchase counties reported by the National Climatic Data Center. These occurrences **totaled over \$55,994,000 in reported personal property damage killing one person and injuring twenty-two** [p. 52].”

| FLOODING BY COUNTY     |               |                     |                     |                  |
|------------------------|---------------|---------------------|---------------------|------------------|
| <i>County</i>          | <i>Number</i> | <i>Dead/Injured</i> | <i>Property</i>     | <i>Crop</i>      |
| <i>Ballard</i>         | 60            | 0/2                 | \$2,548,000         | \$20,000         |
| <i>Calloway</i>        | 38            | 0/7                 | \$734,000           | N/A              |
| <i>Carlisle</i>        | 38            | 0/0                 | \$1,764,000         | \$15,000         |
| <i>Fulton</i>          | 44            | 0/0                 | \$3,534,000         | \$45,000         |
| <i>Graves</i>          | 38            | 0/2                 | \$3,786,000         | N/A              |
| <i>Hickman</i>         | 43            | 4/2                 | \$696,000           | \$15,000         |
| <i>Marshall</i>        | 36            | 0/2                 | \$1,131,000         | N/A              |
| <i>McCracken</i>       | 82            | 1/7                 | \$36,840,000        | \$30,000         |
| <b>Purchase Region</b> | <b>379</b>    | <b>1/22</b>         | <b>\$50,994,000</b> | <b>\$125,000</b> |

**EARTHQUAKES**

“Low magnitude earthquakes occur constantly in the New Madrid Seismic Zone. Depending on the depth and magnitude, some of the stronger tremors—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 [pp. 60-61].”

<sup>104</sup> 2010 Populations in parentheses (from QuickFacts, U.S. Census Bureau)

<sup>105</sup> 2010 Populations in parentheses (from Jackson Purchase Region Natural Hazard Mitigation Plan)

<sup>106</sup> Each county possessed its own separate identification and ranking of hazards, as well. These refer to the top 5 hazards for the Jackson Purchase region as a whole. Think of it as the listing of the most frequently cited “high-risk” hazards across all of Jackson Purchase’s counties.

## WINTER STORMS<sup>107</sup>

The National Climatic Data Center (NCDC) “Storm Events” database limits “Winter Storm” and “Ice Storm” data to the years 2006 through 2012. This means that the NCDC Storm Events database includes Kentucky’s 2008 Winter Storm and January 26-28, 2009’s Ice Storm.

Only Ballard County, Marshall County, and McCracken County showed any property damage amounts for the 2008 Winter Storm. Each of these three counties reported \$500,000 in property damage from the 2008 Winter Storm.

Property damage amounts recorded regarding the 2009 Ice Storm amounted to \$10.2 million each for Ballard, Carlisle, Fulton, and Hickman Counties. McCracken County reported the most property damage from the 2009 Ice Storm: \$27.2 million. Graves County reported \$22.2 million in property damage; Marshall County recorded \$19.2 million; and Calloway County reported \$17.02 million.

There were reported 0 (direct) deaths in each county deriving either from the 2008 Winter Storm or from the 2009 Ice Storm. Further, there were no crop damages reported.

See Footnote #9 below to reference the Jackson Purchase Region Hazard Mitigation Plan in its analysis of winter/ice storm events.

## TORNADOES

From January 1, 1950 through September 30, 2011 there have been **72 occurrences of tornadoes** in Purchase counties reported by the National Climatic Data Center. These occurrences resulted in **seven deaths, injured 100 people and totaled over \$17,614,000 in reported personal property damage** [p. 48].”

| TORNADOES BY COUNTY         |               |                     |                          |                           |
|-----------------------------|---------------|---------------------|--------------------------|---------------------------|
| <i>County</i>               | <i>Number</i> | <i>Dead/Injured</i> | <i>Property</i>          | <i>Crop<sup>108</sup></i> |
| <i>Ballard</i>              | 11            | 0/10                | \$1,160,000              | N/A                       |
| <i>Calloway</i>             | 29            | 1/35                | \$5,362,000              | \$80,000                  |
| <i>Carlisle</i>             | 1             | 0/0                 | \$250,000 <sup>109</sup> | N/A                       |
| <i>Fulton<sup>110</sup></i> | 6             | 0/2                 | \$118,000                | N/A                       |
| <i>Graves</i>               | 15            | 0/1                 | \$466,000                | N/A                       |
| <i>Hickman</i>              | 6             | 0/0                 | \$385,000                | N/A                       |
| <i>Marshall</i>             | 12            | 6/52                | \$8,840,000              | N/A                       |
| <i>McCracken</i>            | 13            | 0/6                 | \$730,000                | N/A                       |
| <b>Purchase Region</b>      | <b>72</b>     | <b>7/100</b>        | <b>\$17,614,000</b>      | <b>N/A</b>                |

## SEVERE STORMS/WIND/HAIL

“From January 1, 1950 through September 30, 2011, there have been **564 occurrences of severe storms** in Purchase counties reported by the National Climatic Data Center. These occurrences **totaled over \$12,242,000 in reported personal property damage and injured 19 people** [p. 54].”

<sup>107</sup> From the Jackson Purchase Region Hazard Mitigation Plan: “From January 1, 1993 through September 30, 2011, there have been 383 occurrences of Winter Storms in Purchase counties reported by the National Climat[ic] Data Center. These occurrences totaled over \$12,642,000 in reported personal property damage [p. 64]. The region as a whole experienced 383 reported Winter Storm Events over a 28 year period, which divides out to 13 Reported Winter Storm Events per year [p. 64].”

This number (\$12,642,000) differs significantly from what was reported to NCDC’s “Storm Events” Database.

<sup>108</sup> With the exception of Calloway County, there were no recorded crop losses related to tornadoes.

<sup>109</sup> This is only an estimate. See: Jackson Purchase Region Natural Hazard Mitigation Plan, Carlisle County Annex.

<sup>110</sup> The red font refers to the fact that tornadoes were **not ranked as a “high-risk”** hazard for Fulton County. Rather, Fulton County ranked Severe Storms/Wind/Hail, Flooding, and River Erosion/Deposition as its high-risk hazards. River Erosion/Deposition resulted in \$1,900,000 in expenditure for dredging.

| SEVERE STORMS/WIND/HAIL BY COUNTY |                                      |               |                     |                          |                 |
|-----------------------------------|--------------------------------------|---------------|---------------------|--------------------------|-----------------|
| <i>County</i>                     | <i>Storm/wind/hail</i><br><i>111</i> | <i>Number</i> | <i>Dead/Injured</i> | <i>Property</i>          | <i>Crop</i>     |
| <i>Ballard</i>                    | Storm/Wind                           | 82            | 0/7                 | \$965,000                | N/A             |
| <i>Calloway</i>                   | Storm/Wind                           | 81            | 0/0                 | \$4,249,000              | N/A             |
| <i>Carlisle</i>                   | Storm/Wind/Hail                      | 53            | 0/0                 | \$981,000                | \$20,000        |
| <i>Fulton</i>                     | Storm/Wind/Hail                      | 43            | 0/2                 | \$513,000 <sup>112</sup> | \$10,000        |
| <i>Graves</i>                     | Storm Only                           | 73            | 0/6                 | \$927,000                | N/A             |
| <i>Hickman</i>                    | Storm Only                           | 45            | 0/0                 | \$316,000                | N/A             |
| <i>Marshall</i>                   | Storm/Wind                           | 76            | 0/5                 | \$2,494,000              | \$5,000         |
| <i>McCracken</i>                  | Storm Only                           | 111           | 0/4                 | \$1,860,000              | \$2,000         |
| <b>Purchase Region</b>            | ----                                 | <b>564</b>    | <b>0/19</b>         | <b>\$12,242,000</b>      | <b>\$37,000</b> |

<sup>111</sup> Each county listed either severe storms, wind storms, and/or hail storms as a high-risk hazard. However, not every county listed all three as being a high-risk hazard. Some counties differentiated between the three. For example, hail storms might be listed as a moderate-risk hazard while severe storms and wind storms were listed as high-risk. Thus, this column refers to which of the three "storms" each county considered "high-risk." Death/Injury, Property Value, and Crop Value numbers all correspond with each county's distinction.

<sup>112</sup> The Fulton County Annex had the property damage number subdivided into \$459,000 and \$54,000. It is unclear to what the subdivisions refer. Subsequently, total property damage amounts to \$459,000 + \$54,000 = \$513,000.

## PENNYRILE AREA DEVELOPMENT DISTRICT<sup>113</sup>

**COUNTIES<sup>114</sup>:** Caldwell (12,973); Christian (73,591); Crittenden (9,336); Hopkins (46,909); Livingston (9,531); Lyon (8,317); Muhlenberg (31,272); Todd (12,460); Trigg (14,305).

**CITIES<sup>115</sup>:** Fredonia (401); Princeton (6,323); Cofton (NA); Hopkinsville (31,419); Lafayette (165); Oak Grove (7489); Pembroke (869); Marion (3,039); Dawson Springs (2,764); Earlington (1,413); Hanson (742); Madisonville (19,587); Mortons (863); Nebo (236); Nortonville (1,203); St. Charles (277); White Plains (884); Carrsville (50); Grand Rivers (382); Salem (752); Smithland (301); Eddyville (2,553); Kuttawa (649); Bremen (195); Central City (5,940); Drakesboro (512); Greenville (4,283); Powderly (739); South Carrollton (184); Elkton (2,062); Guthrie (1,419); Trenton (384); Cadiz (2,551).

**HIGH-RISK HAZARDS:** Flooding, Tornadoes, Severe Thunderstorms; **MODERATE- RISK HAZARDS:** Earthquake, Sever Winter Storm; **LOW-RISK HAZARDS:** Extreme Heat/ Drought. Dam Failure

### FLOODING<sup>116</sup>

- Total Number of Events (past 50 years)<sup>117</sup>: **239 Events**
  - o *Caldwell (14), Christian (34), Crittenden (38), Hopkins (25), Livingston (28), Lyon (9), Muhlenberg (57), Todd (17) and Trigg (17).*
- Total Amount of Damages<sup>118</sup> (past 50 years): **\$5.45 billion**
  - o *Caldwell (\$539,000), Christian (\$45,370,000), Crittenden (\$26,554,000), Hopkins (\$1,414,000), Livingston (\$26,580,000), Lyon (\$347,000), Muhlenberg (\$557,000), Todd (\$5,339,000), and Trigg (\$5,155,000).*
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- “From January 1, 1950 through February 28, 2010, there have been over 145 occurrences of flooding in Pennyriple counties reported to the National Climate Data Center. These occurrences totaled over \$687,933,000 in reported personal property damage, three injuries, and one death. There have been 9 federally declared disasters involving flooding in the Pennyriple region receiving over \$2,290,879.70 in disaster relief funding [p. 33].”

### TORNADOES

- Total Number of Events (past 50 years): **88 Events**
  - o *Caldwell (8), Christian (17), Crittenden (12), Hopkins (10), Livingston (6), Lyon (4), Muhlenberg (10), Todd (10), and Trigg (11)*
- Total Amount of Damages (past 50 years): **\$130.7 million**
  - o *Caldwell (\$853,000), Christian (\$43,945,000), Crittenden (\$5,773,000), Hopkins (\$35,860,000), Livingston (\$415,000), Lyon (\$640,000), Muhlenberg (\$29,585,000), Todd (\$7,995,000), and Trigg (\$5,593,000)*
- “The counties in the Pennyriple Area Development District have experienced 58 tornadoes during the past 60 years resulting in over \$33,297,000 in property damages. Although the damage from tornadoes is limited to the path in which the storm occurs, everything within a particular county is at risk for damage [p. 34].”
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<sup>113</sup> Refers to “Pennyriple Regional Hazard Mitigation Plan [October 2010]”

<sup>114</sup> 2011 Populations in parentheses (from U.S. Census Bureau)

<sup>115</sup> 2011 Populations in parentheses (from American FactFinder, U.S. Census Bureau)

<sup>116</sup> There was no distinction made between flash flooding and general flooding in the Pennyriple Regional Hazard Mitigation Plan [October 2010].

<sup>117</sup> The data is presented as being for the past 50 years, even though the data set actually only goes back 20 years

<sup>118</sup> Pennyriple Regional Hazard Mitigation Plan [October 2010], p. 93

## SEVERE THUNDERSTORMS

- Total Number of Events (past 50 years): **958 Events**
  - o *Caldwell (70), Christian (208), Crittenden (67), Hopkins (130), Livingston (92), Lyon (52), Muhlenberg (112), Todd (115) and Trigg (112).*
- Total Amount of Damages (past 50 years): **\$8.7 million**
  - o *Caldwell (\$346,000), Christian (\$2,716,000), Crittenden (\$662,000), Hopkins (\$780,000), Livingston (\$581,000), Lyon (\$433,000), Muhlenberg (\$699,000), Todd (\$1,991,000), and Trigg (\$496,000).*
- “Thunderstorms are quite frequent in the Pennyriple region. They normally produce damage but few, if any, fatalities. Numerous severe thunderstorms have been recorded that produce high winds, lightning, and hail, in the Pennyriple region. Many of these thunderstorms have caused property or crop damage [p. 35].”