

## 7.0 APPENDIX B: HAZARD AND VULNERABILITY DATA

This appendix is a supplement to Section 2: Hazard Identification and Risk Assessment. A complete list of historical incidents of each hazard is provided here. Additionally, detailed data on the anticipated damage to Knox County from a 100-year flood and earthquake, per HAZUS estimates, is provided.

### 7.1 HAZARD HISTORY DATA

The National Climactic Data Center has maintained records on weather incidents across the United States since 1950. The tables below provide a history of the incidents on record for Knox County from 1950 through present day.

#### 7.1.1 Drought and Extreme Heat

These incidents include all occurrences categorized as drought or extreme heat.

Hazard	Location	Date	Injuries	Deaths	Property Damage	Crop Damage
Drought	Knox County	08/01/1996	0	0	0	0
Drought	Knox County	06/01/1999	0	0	0	0
Drought	Knox County	07/01/1999	0	0	0	0
Drought	Knox County	08/01/1999	0	0	0	0
Drought	Knox County	09/01/1999	0	0	0	5M

#### 7.1.2 Flood

The flood incidents identified in this table include events classified as flood and flash flood.

Hazard	Location	Date	Deaths	Injuries	Property Damage	Crop Damage
Flash Flood	Southern Portion	04/29/1996	0	0	0	0
Flash Flood	Knox County	05/11/1996	0	0	0	0
Flash Flood	Knox County	06/01/1997	0	0	40K	15K
Flash Flood	Knox County	06/01/1997	0	0	25K	15K
Flash Flood	Mount Vernon	07/26/1997	0	0	5K	0
Flash Flood	Knox County	06/27/1998	0	0	50K	0
Flash Flood	Knox County	06/27/1998	0	0	3M	1M
Flash Flood	Knox County	06/27/1998	0	0	3M	500K
Flash Flood	Knox County	06/28/1998	0	0	150K	0
Flash Flood	Knox County	04/08/2000	0	0	0	0
Flash Flood	Knox County	04/19/2002	0	0	0	0

Hazard	Location	Date	Deaths	Injuries	Property Damage	Crop Damage
Flash Flood	Knox County	04/19/2002	0	0	0	0
Flash Flood	Knox County	05/21/2004	0	0	600K	0
Flood	Knox County	06/17/2004	0	0	0	0
Flood	Knox County	01/01/2005	0	0	750K	0
Flash Flood	North Portion	06/10/2005	0	0	250K	0
Flash Flood	Northeast Portion	07/10/2006	0	0	3.5M	0
Flash Flood	Mount Vernon	07/14/2006	0	0	0	0
Flash Flood	Knox County	07/22/2006	0	0	200K	0
Flood	Batemantown	08/21/2007	0	0	25K	0
Flood	Waterford	02/28/2011	0	0	400K	0
Flood	Danville	07/08/2013	0	0	200K	0
Flood	Fredericktown	07/09/2013	0	0	0	0
Flash Flood	Chesterville	06/03/2017	0	0	0	0
Flood	Mount Liberty	11/18/2017	0	0	50K	0
Flood	Mount Vernon	02/15/2018	0	0	25K	0
Flood	Waterford	04/03/2018	0	0	4K	0
Flash Flood	Mount Liberty	07/03/2019	0	0	2K	0

### 7.1.3 Severe Thunderstorm

Thunderstorm incidents include events that produced any combination of hail, lightning and thunderstorm wind; all hazards were not necessarily present in all incidents.

Hazard	Location	Date	Deaths	Injuries	Property Damage	Crop Damage
Hail	Knox County	07/24/1961	0	0	0	0
Hail	Knox County	05/10/1963	0	0	0	0
Hail	Knox County	08/09/1966	0	1	<1K	0
Lightning	Knox County	08/09/1966	0	1	<1K	0
Thunderstorm Wind	Knox County	08/09/1966	0	1	<1K	0
Lightning	Knox County	06/10/1968	0	0	<1K	0
Thunderstorm Wind	Knox County	06/10/1968	0	0	<1K	0
Hail	Knox County	07/22/1968	0	0	<1K	0
Lightning	Knox County	05/13/1970	0	0	6K	0
Thunderstorm Wind	Knox County	05/13/1970	0	0	6K	0
Hail	Knox County	04/14/1974	0	1	3K	0
Thunderstorm Wind	Knox County	04/14/1974	0	1	3K	0
Thunderstorm Wind	Knox County	09/08/1977	0	0	0	0
Thunderstorm Wind	Knox County	07/05/1980	0	0	0	0

Hazard	Location	Date	Deaths	Injuries	Property Damage	Crop Damage
Thunderstorm Wind	Knox County	07/21/1980	0	0	0	0
Thunderstorm Wind	Knox County	06/08/1981	0	0	0	0
Thunderstorm Wind	Knox County	07/18/1982	0	0	0	0
Thunderstorm Wind	Knox County	04/02/1983	0	0	0	0
Thunderstorm Wind	Knox County	05/02/1983	0	0	0	0
Hail	Knox County	07/21/1983	0	0	3K	0
Hail	Knox County	07/07/1985	0	0	0	0
Thunderstorm Wind	Knox County	06/15/1986	0	0	0	0
Thunderstorm Wind	Knox County	05/14/1987	0	0	0	0
Thunderstorm Wind	Knox County	08/05/1988	0	0	0	0
Thunderstorm Wind	Knox County	06/08/1990	0	0	0	0
Thunderstorm Wind	Knox County	06/30/1990	0	0	0	0
Thunderstorm Wind	Knox County	08/28/1990	0	0	0	0
Hail	Knox County	07/07/1991	0	0	0	0
Thunderstorm Wind	Knox County	05/02/1992	0	0	0	0
Hail	Knox County	11/22/1992	0	0	0	0
Thunderstorm Wind	Fredericktown	08/31/1993	0	0	50K	0
Thunderstorm Wind	Fredericktown	09/02/1993	0	0	5K	0
Thunderstorm Wind	Artanna	06/16/1994	0	0	50K	0
Thunderstorm Wind	Knox County	06/16/1994	0	0	5K	0
Thunderstorm Wind	Patton Road	06/16/1994	0	0	5K	0
Thunderstorm Wind	Mount Vernon	06/29/1994	0	0	5K	0
Thunderstorm Wind	Knox County	08/28/1994	0	0	50K	0
Thunderstorm Wind	Danville	09/24/1994	0	0	5K	0
Thunderstorm Wind	Knox County	04/11/1995	0	0	0	0
Hail	Bladensburg	04/18/1995	0	0	0	0
Thunderstorm Wind	Mount Vernon	06/07/1995	0	1	700K	0
Thunderstorm Wind	Gambier	06/07/1995	0	0	3K	0
Thunderstorm Wind	Centerburg	06/14/1995	0	0	0	0
Hail	Knox City	06/21/1995	0	0	3K	0
Thunderstorm Wind	Mount Vernon	06/21/1995	0	0	0	0
Hail	Mount Vernon	06/21/1995	0	0	0	0
Thunderstorm Wind	Knox County	07/13/1995	0	0	20K	10K
Thunderstorm Wind	Fredericktown	07/15/1995	0	0	2K	0
Thunderstorm Wind	Fredericktown	07/16/1995	0	0	2K	0
Thunderstorm Wind	West Half	08/15/1995	0	0	15K	0
Thunderstorm Wind	Danville	08/17/1995	0	0	2K	0
Thunderstorm Wind	Fredericktown	09/13/1995	0	0	2K	0
Thunderstorm Wind	Southern Portion	04/29/1996	0	0	0	0
Hail	Centerburg	06/03/1996	0	0	0	0

Hazard	Location	Date	Deaths	Injuries	Property Damage	Crop Damage
Thunderstorm Wind	Knox County	06/24/1996	0	0	2K	0
Thunderstorm Wind	Howard	08/15/1996	0	0	2K	0
Hail	Howard	08/15/1996	0	0	0	0
Thunderstorm Wind	Fredericktown	12/01/1996	0	0	0	0
Hail	Mount Vernon	05/14/1997	0	0	0	0
Hail	Howard	07/26/1997	0	0	0	0
Hail	Fredericktown	08/16/1997	0	0	0	0
Hail	Gambier	05/03/1998	0	0	0	0
Hail	Mount Vernon	05/19/1998	0	0	0	0
Hail	Fredericktown	06/27/1998	0	0	0	0
Hail	Mount Vernon	06/27/1998	0	0	0	0
Hail	Fredericktown	06/27/1998	0	0	0	0
Hail	Gambier	06/27/1998	0	0	0	0
Hail	Howard	06/27/1998	0	0	0	0
Lightning	Mount Vernon	07/01/1999	0	0	150K	0
Hail	Mount Vernon	06/12/2000	0	0	0	0
Hail	Mount Vernon	07/28/2000	0	0	0	0
Hail	Martinsburg	04/09/2001	0	0	10K	0
Lightning	Mount Vernon	07/01/2001	0	0	10K	0
Hail	Fredericktown	04/19/2002	0	0	20K	0
Hail	Ankenytown	04/19/2002	0	0	5K	0
Hail	Mount Vernon	04/19/2002	0	0	5K	0
Hail	Bladensburg	05/31/2002	0	0	25K	0
Hail	Millwood	05/31/2002	0	0	5K	0
Thunderstorm Wind	Millwood	04/04/2003	0	0	5K	0
Thunderstorm Wind	Martinsburg	04/20/2003	0	0	50K	0
Hail	Martinsburg	04/20/2003	0	0	3K	0
Hail	Martinsburg	04/20/2003	0	0	5K	0
Thunderstorm Wind	Danville	05/07/2003	0	0	10K	0
Thunderstorm Wind	Danville	07/04/2003	0	0	25K	0
Thunderstorm Wind	Mount Vernon	07/07/2003	0	0	15K	0
Thunderstorm Wind	Mount Vernon	07/08/2003	0	0	50K	0
Thunderstorm Wind	Centerburg	07/21/2003	0	0	0	0
Thunderstorm Wind	Knox County	07/27/2003	0	0	15K	0
Thunderstorm Wind	Knox County	08/26/2003	0	0	300K	0
Thunderstorm Wind	Knox County	08/26/2003	0	0	10K	0
Thunderstorm Wind	Fredericktown	08/27/2003	0	0	8K	0
Thunderstorm Wind	Danville	08/27/2003	0	0	7K	0
Thunderstorm Wind	Mount Vernon	09/27/2003	0	0	2K	0
Thunderstorm Wind	Millwood	11/12/2003	0	0	100K	0

Hazard	Location	Date	Deaths	Injuries	Property Damage	Crop Damage
Hail	Fredericktown	05/07/2004	0	0	2K	0
Thunderstorm Wind	Knox County	05/18/2004	0	0	100K	0
Thunderstorm Wind	Knox County	05/18/2004	0	0	25K	0
Hail	Millwood	05/21/2004	0	0	2K	0
Thunderstorm Wind	Knox County	05/21/2004	0	0	250K	0
Thunderstorm Wind	Gambier	05/30/2004	0	0	5K	0
Thunderstorm Wind	Gambier	06/09/2004	0	0	10K	0
Hail	Howard	06/09/2004	0	0	0	0
Thunderstorm Wind	Fredericktown	06/13/2004	0	0	10K	0
Thunderstorm Wind	Knox County	06/14/2004	0	0	15K	0
Thunderstorm Wind	Centerburg	06/15/2004	0	0	10K	0
Thunderstorm Wind	Mount Vernon	06/15/2004	0	0	4K	0
Thunderstorm Wind	Gambier	08/19/2004	0	0	40K	0
Thunderstorm Wind	Gambier	08/19/2004	0	0	30K	0
Hail	Centerburg	08/28/2004	0	0	50K	0
Thunderstorm Wind	Mount Vernon	08/28/2004	0	0	25K	0
Thunderstorm Wind	Knox County	05/13/2005	0	0	12K	0
Thunderstorm Wind	Fredericktown	06/05/2005	0	0	3K	0
Thunderstorm Wind	Fredericktown	06/10/2005	0	0	10K	0
Thunderstorm Wind	Knox County	06/30/2005	0	0	10K	0
Thunderstorm Wind	Knox County	07/25/2005	0	0	15K	0
Thunderstorm Wind	Mount Vernon	07/26/2005	0	0	15K	0
Thunderstorm Wind	Mount Vernon	07/26/2005	0	0	10K	0
Thunderstorm Wind	Fredericktown	08/20/2005	0	0	2K	0
Hail	Mount Liberty	04/14/2006	0	0	0	0
Thunderstorm Wind	Fredericktown	05/25/2006	0	0	6K	0
Thunderstorm Wind	Mount Vernon	05/25/2006	0	0	2K	0
Thunderstorm Wind	Central Portion	06/22/2006	0	0	175K	0
Hail	Martinsburg	07/02/2006	0	0	0	0
Thunderstorm Wind	Mount Vernon	07/10/2006	0	0	50K	0
Hail	Centerburg	07/18/2006	0	0	0	0
Thunderstorm Wind	Central Portion	08/03/2006	0	0	120K	0
Thunderstorm Wind	Centerburg	04/11/2007	0	0	15K	0
Hail	Millwood	05/01/2007	0	0	0	0
Thunderstorm Wind	Mount Vernon	06/02/2007	0	0	4K	0
Thunderstorm Wind	Martinsburg	06/13/2007	0	0	2K	0
Thunderstorm Wind	Centerburg	06/17/2007	0	0	10K	0
Thunderstorm Wind	Amity	08/09/2007	0	0	50K	0
Thunderstorm Wind	Centerburg	09/25/2007	0	0	5K	0
Thunderstorm Wind	Mount Vernon	09/25/2007	0	0	0	0

Hazard	Location	Date	Deaths	Injuries	Property Damage	Crop Damage
Thunderstorm Wind	Mount Vernon	01/09/2008	0	0	75K	0
Thunderstorm Wind	Mount Vernon	01/09/2008	0	0	8K	0
Thunderstorm Wind	Danville	05/31/2008	0	0	1K	0
Thunderstorm Wind	Fredericktown	05/31/2008	0	0	0	0
Hail	Mount Vernon	06/22/2008	0	0	0	0
Hail	Amity	06/23/2008	0	0	0	0
Hail	Centerburg	06/23/2008	0	0	0	0
Thunderstorm Wind	Mount Vernon	06/28/2008	0	0	2K	0
Thunderstorm Wind	Danville	07/08/2008	0	0	2K	0
Thunderstorm Wind	Danville	08/01/2008	0	0	1K	0
Hail	Mount Vernon	08/07/2008	0	0	0	100K
Hail	Mount Vernon	08/07/2008	0	0	0	0
Thunderstorm Wind	Gambier	02/11/2009	0	0	3K	0
Thunderstorm Wind	Centerburg	06/25/2009	0	0	3K	0
Thunderstorm Wind	Mount Vernon	08/20/2009	0	0	2K	0
Hail	Loudonville	04/25/2010	0	0	0	0
Hail	Danville	04/25/2010	0	0	0	0
Hail	Mount Vernon	05/07/2010	0	0	5K	0
Hail	Mount Vernon	05/07/2010	0	0	5K	0
Hail	Danville	06/02/2010	0	0	0	0
Thunderstorm Wind	Brandon	06/03/2010	0	0	20K	0
Thunderstorm Wind	Ankenytown	06/04/2010	0	0	10K	0
Thunderstorm Wind	Gambier	06/05/2010	0	0	3K	0
Thunderstorm Wind	Jelloway	06/27/2010	0	0	8K	0
Thunderstorm Wind	Centerburg	08/04/2010	0	0	2K	0
Hail	Fredericktown	09/07/2010	0	0	0	0
Hail	Fredericktown	09/07/2010	0	0	0	0
Hail	Fredericktown	03/23/2011	0	0	2K	0
Hail	Fredericktown	03/23/2011	0	0	5K	0
Hail	Mount Vernon	04/20/2011	0	0	10K	0
Thunderstorm Wind	Knox County	06/10/2011	0	0	20K	0
Thunderstorm Wind	Bladensburg	07/07/2011	0	0	2K	0
Thunderstorm Wind	Fredericktown	07/11/2011	0	0	10K	0
Thunderstorm Wind	Fredericktown	07/11/2011	0	0	10K	0
Thunderstorm Wind	Danville	07/22/2011	0	0	0	0
Thunderstorm Wind	Howard	07/29/2011	0	0	1K	0
Hail	Mount Vernon	03/15/2012	0	0	0	0
Hail	Centerburg	03/30/2012	0	0	0	0
Hail	Centerburg	03/30/2012	0	0	25K	0
Hail	Martinsburg	03/30/2012	0	0	5K	0

Hazard	Location	Date	Deaths	Injuries	Property Damage	Crop Damage
Hail	Martinsburg	03/30/2012	0	0	0	0
Hail	Mount Vernon	05/28/2012	0	0	0	0
Thunderstorm Wind	Waterford	06/29/2012	0	0	1.4M	0
Hail	Mount Vernon	07/04/2012	0	0	0	0
Hail	Mount Vernon	07/04/2012	0	0	0	0
Thunderstorm Wind	Mount Vernon	07/26/2012	0	0	15K	0
Thunderstorm Wind	Mount Vernon	07/26/2012	0	0	10K	0
Hail	Monroe Mills	08/09/2012	0	0	18K	0
Thunderstorm Wind	Fredericktown	04/10/2013	0	0	4K	0
Hail	Fredericktown	05/10/2013	0	0	0	0
Thunderstorm Wind	Gambier	05/10/2013	0	0	10K	0
Thunderstorm Wind	Brandon	06/12/2013	0	0	1K	0
Hail	Mount Vernon	06/12/2013	0	0	0	0
Hail	Mount Vernon	06/12/2013	0	0	0	0
Thunderstorm Wind	Danville	06/12/2013	0	0	15K	0
Thunderstorm Wind	Mount Vernon	06/12/2013	0	0	50K	0
Thunderstorm Wind	Martinsburg	06/13/2013	0	0	15K	0
Thunderstorm Wind	Academia	06/25/2013	0	0	1K	0
Hail	Mount Vernon	07/10/2013	0	0	0	0
Thunderstorm Wind	Mount Vernon	07/10/2013	0	0	75K	0
Thunderstorm Wind	Mount Vernon	07/10/2013	0	0	8K	0
Thunderstorm Wind	Danville	07/23/2013	0	0	4K	0
Thunderstorm Wind	Knox County	10/06/2013	0	0	3K	0
Thunderstorm Wind	Centerburg	11/01/2013	0	0	5K	0
Thunderstorm Wind	Martinsburg	11/17/2013	0	0	12K	0
Thunderstorm Wind	Mount Vernon	12/22/2013	0	0	5K	0
Thunderstorm Wind	Centerburg	04/29/2014	0	0	2K	0
Hail	Howard	05/14/2014	0	0	0	0
Hail	Gambier	05/28/2014	0	0	0	0
Thunderstorm Wind	Howard	05/28/2014	0	0	5K	0
Hail	Danville	05/28/2014	0	0	0	0
Thunderstorm Wind	Martinsburg	05/11/2015	0	0	25K	0
Thunderstorm Wind	Mount Vernon	06/12/2015	0	0	2K	0
Thunderstorm Wind	Monroe Mills	06/18/2015	0	0	4K	0
Thunderstorm Wind	Lock	07/14/2015	0	0	50K	0
Thunderstorm Wind	Academia	06/15/2016	0	0	35K	0
Thunderstorm Wind	Fredericktown	09/10/2016	0	0	15K	0
Thunderstorm Wind	Howard	06/13/2017	0	0	15K	0
Thunderstorm Wind	Mount Vernon	07/07/2017	0	0	8K	0
Thunderstorm Wind	Gambier	07/22/2017	0	0	125K	0

Hazard	Location	Date	Deaths	Injuries	Property Damage	Crop Damage
Thunderstorm Wind	Pipesville	07/22/2017	0	1	75K	0
Thunderstorm Wind	Danville	07/22/2017	0	0	2K	0
Thunderstorm Wind	Fredericktown	08/19/2017	0	0	15K	0
Hail	Monroe Mills	08/19/2017	0	0	0	0
Thunderstorm Wind	Martinsburg	04/14/2019	0	0	5K	0
Thunderstorm Wind	Howard	04/14/2019	0	0	5K	0
Hail	Palmyra	06/02/2019	0	0	0	0
Thunderstorm Wind	Fredericktown	07/02/2019	0	0	0	0
Thunderstorm Wind	Danville	07/02/2019	0	0	10K	0
Thunderstorm Wind	Hunt	07/02/2019	0	0	0	0
Thunderstorm Wind	Martinsburg	07/02/2019	0	0	0	0
Thunderstorm Wind	Centerburg	08/18/2019	0	0	0	0
Thunderstorm Wind	Mount Vernon	08/18/2019	0	0	0	0
Thunderstorm Wind	South Mount Vernon	08/20/2019	0	0	0	0

#### 7.1.4 Tornado/Windstorm

Confirmed tornadoes and high wind events are listed below.

Hazard	Location	Date	Fujita Scale	Deaths	Injuries	Property Damage	Crop Damage
Tornado	Knox County	06/11/1957	F2	0	0	25K	0
Tornado	Knox County	04/02/1970	F2	0	1	250K	0
Tornado	Knox County	09/03/1970	F0	0	0	2.5K	0
Tornado	Knox County	06/08/1981	F2	0	2	250K	0
Tornado	Knox County	06/21/1981	F0	0	0	2.5K	0
Tornado	Knox County	03/31/1982	F2	0	4	250K	0
Tornado	Knox County	04/03/1982	F2	0	9	250K	0
Tornado	Knox County	07/09/1990	F0	0	0	25K	0
Tornado	Danville	06/27/1998	F0	0	0	10K	0
Tornado	Mount Vernon	09/20/2000	F1	0	0	150K	35K
Tornado	Mount Vernon	08/03/2006	F0	0	1	325K	0
High Wind	Knox County	12/01/2006		0	0	20K	0
High Wind	Knox County	12/23/2007		0	0	15K	0
High Wind	Knox County	01/30/2008		0	0	25K	0
High Wind	Knox County	09/14/2008		0	0	4M	750K
High Wind	Knox County	02/11/2009		0	0	400K	0
High Wind	Knox County	12/09/2009		0	0	150K	0
High Wind	Knox County	04/28/2011		0	0	40K	0
High Wind	Knox County	02/24/2012		0	0	25K	0



Hazard	Location	Date	Fujita Scale	Deaths	Injuries	Property Damage	Crop Damage
High Wind	Knox County	11/24/2018		0	0	200K	0
High Wind	Knox County	02/24/2019		0	0	50K	0

**7.1.6 Winter Storm**

Winter storm events include incidents classified as blizzard, extreme cold/wind chill, ice storm, or winter storm.

Hazard	Location	Date	Deaths	Injuries	Property Damage	Crop Damage
Extreme Cold/Wind Chill	Knox County	02/02/1996	0	0	20K	0
Extreme Cold/Wind Chill	Knox County	01/10/1997	0	0	5K	0
Winter Storm	Knox County	01/02/1999	0	2	15K	0
Winter Storm	Knox County	01/08/1999	0	0	2K	0
Winter Storm	Knox County	01/13/1999	0	0	2K	0
Winter Storm	Knox County	12/13/2000	0	0	125K	0
Winter Storm	Knox County	03/24/2002	0	0	75K	0
Winter Storm	Knox County	03/26/2002	0	0	300K	0
Winter Storm	Knox County	01/25/2004	0	0	350K	0
Winter Storm	Knox County	02/05/2004	0	0	125K	0
Winter Storm	Knox County	12/22/2004	0	0	5.4M	0
Ice Storm	Knox County	01/05/2005	0	0	6.8M	0
Winter Storm	Knox County	02/13/2007	0	0	30K	0
Ice Storm	Knox County	02/25/2007	0	0	20K	0
Ice Storm	Knox County	03/15/2007	0	0	50K	0
Winter Storm	Knox County	03/04/2008	0	0	400K	0
Winter Storm	Knox County	03/07/2008	0	0	750M	0
Winter Storm	Knox County	12/19/2008	0	0	20K	0
Extreme Cold/Wind Chill	Knox County	01/15/2009	0	0	0	0
Winter Storm	Knox County	01/27/2009	0	0	150K	0
Winter Storm	Knox County	02/05/2010	0	0	200K	0
Winter Storm	Knox County	02/15/2010	0	0	300K	0
Winter Storm	Knox County	02/01/2011	0	0	250K	0
Extreme Cold/Wind Chill	Knox County	03/27/2012	0	0	0	0
Winter Storm	Knox County	12/26/2012	0	0	75K	0
Extreme Cold/Wind Chill	Knox County	01/06/2014	0	0	0	0
Extreme Cold/Wind Chill	Knox County	01/28/2014	0	0	0	0
Winter Storm	Knox County	01/19/2019	0	0	75K	0
Extreme Cold/Wind Chill	Knox County	01/30/2019	0	0	0	0

## 7.2 HAZUS LOSS ESTIMATES

HAZUS is a nationally accepted methodology that utilizes U.S. Census and local geographic information systems (GIS) data to estimate losses for earthquakes, hurricanes, and floods. Because floods and earthquakes are identified as risks in Knox County, HAZUS was used to generate and evaluate the county's vulnerability to these incidents. Estimates from HAZUS were generated using 2010 U.S. Census Bureau data. This data shows Knox County's population as 60,921 and building count as 25,000. Current 2019 figures will be slightly different than the data used in this report.

### 7.2.1 Flood

Knox County's vulnerability to flood was evaluated utilizing a HAZUS scenario for a 100-year flood event. Table 7-1 identifies buildings by occupancy type for all of Knox County and those exposed to risk in this scenario.

**Table 7-1: Building Exposure by Occupancy**

Occupancy	Knox County		100-Year Flood Scenario	
	Exposure (\$1000)	Percent of Total	Exposure (\$1000)	Percent of Total
Residential	\$5,186,928	74.2%	\$1,511,027	68.9%
Commercial	\$896,832	12.8%	\$292,028	13.3%
Industrial	\$302,965	4.3%	\$67,780	3.1%
Agricultural	\$79,193	1.1%	\$28,187	1.3%
Religion	\$153,055	2.2%	\$42,105	1.9%
Government	\$27,240	0.5%	\$8,498	0.4%
Education	\$337,938	4.8%	\$243,471	11.1%
<b>Total</b>	<b>\$6,994,151</b>	<b>100%</b>	<b>\$2,193,096</b>	<b>100%</b>

### *Essential Facility Inventory*

Essential facilities are healthcare facilities like hospitals and clinics, fire and EMS stations, police stations, and operations and dispatch centers. Schools are included in essential facilities. Knox County's essential facilities are identified in Table 7-2. Note that these inventory numbers are based on 2010 US Census data and may vary slightly from the county's current inventory.

**Table 7-2: Essential Facility Inventory**

Facility Type	Number
Hospital	1 (75 beds)
Schools	24
Fire Stations	6
Police Stations	5

### *Estimated Building Damage*

Per HAZUS estimates, 208 buildings will sustain at least moderate damage. This accounts for 83% of the total buildings identified for the scenario. Four buildings are estimated to be completely destroyed. Tables 7-3 and 7-4 identify the anticipated building damage based on occupancy type and building type.

**Table 7-3: Expected Building Damage by Occupancy**

Occupancy	Percent Damaged					
	1-10%	11-20%	21-30%	31-40%	41- 50 %	> 50%
Agriculture	0	0	0	0	0	0
Commercial	2	7	0	0	0	0
Education	6	0	0	0	0	0
Government	0	0	0	0	0	0
Industrial	0	0	0	0	0	0
Religious	0	0	0	0	0	0
Residential	124	154	38	7	1	1
<b>Total</b>	<b>132</b>	<b>161</b>	<b>38</b>	<b>7</b>	<b>1</b>	<b>1</b>

**Table 7-4: Expected Building Damage by Building Type**

Building Type	Percent Damaged					
	1-10%	11-20%	21-30%	31-40%	41- 50 %	> 50%
Concrete	1	0	0	0	0	0
Manufactured Housing	0	0	1	0	0	0
Masonry	9	27	3	0	0	0
Steel	1	2	0	0	0	0
Wood	119	129	34	7	1	1
<b>Total</b>	<b>130</b>	<b>158</b>	<b>38</b>	<b>7</b>	<b>1</b>	<b>1</b>

Based on this scenario, HAZUS predict that a limited number of critical facilities will sustain moderate or significant damage. Per estimates, one school would sustain moderate damage and loss of use. All other schools as well as hospital beds, emergency services, and institutional services normally present in the county would continue to be functional in a 100-year flood scenario.

**Table 7-5: Expected Damage to Essential Facilities**

Classification	Total	Moderate Damage	Substantial Damage	Loss of Use
Fire Stations	6	0	0	0
Hospitals	1	0	0	0
Police Stations	5	0	0	0
Schools	24	1	0	1

### *Debris Generation*

The amount of debris generated by a flood can be substantial. HAZUS classifies debris into different types based on the handling equipment required: finishes, structure, and foundation. In the given scenario, a total of 5,410 tons of debris is anticipated. Finishes would comprise 23% of that amount. When converting these totals to truckloads, debris removal would require 217 truckloads, assuming 25 tons per truck.

### *Shelter Requirements*

When flooding forces people from their homes, some will seek refuge at a public shelter. In this incident, it is anticipated that 1,061 households (approximately 3,184 people) would be displaced. Of those households, approximately 42 people are anticipated to seek temporary shelter in a public shelter.

### *Building Related Losses*

The total economic loss for the identified 100-year flood event is estimated to be \$333.61M.

Building-related losses are addressed in two loss categories: direct building loss and business interruption loss. Building losses include structural damage and damage to contents. Business interruption losses include the costs associated with not being able to conduct normal business, displaced workers, and lost opportunities. Table 7-6 provides a summary of the anticipated losses.

**Table 7-6: Building-Related Economic Loss Estimates**

<b>Area</b>	<b>Residential</b>	<b>Commercial</b>	<b>Industrial</b>	<b>Others</b>	<b>Total</b>
<b><i>Building Loss</i></b>					
Building	33.02	6.95	1.91	5.12	<b>46.99</b>
Content	18.64	22.81	3.84	38.33	<b>83.62</b>
Inventory	0	0.34	0.64	0.10	<b>1.07</b>
<b><i>Business Interruption</i></b>					
Income	1.02	19.33	0.12	32.83	<b>53.29</b>
Relocation	12.91	4.60	0.10	10.79	<b>28.39</b>
Rental Income	6.55	3.39	0.02	1.16	<b>11.11</b>
Wage	2.39	22.74	0.19	83.81	<b>109.13</b>
<b>Total</b>	<b>74.54</b>	<b>80.16</b>	<b>6.80</b>	<b>172.11</b>	<b>333.61</b>

### **7.2.2 Earthquake**

The simulated earthquake epicenter was assumed to be in Mount Vernon, the county's most populated jurisdiction. The simulated earthquake had a magnitude of 5.0 on the Richter Scale and a dept of 5.0 km. The HAZUS loss estimation program utilized 2010 U.S. Census data for this scenario. There are an estimated 25,000 buildings in the county with a replacement value of \$6,994M.

#### *Critical Facility Inventory*

HAZUS separates critical facilities into essential facilities and high potential loss (HPL) facilities. Essential facilities are healthcare facilities like hospitals and clinics, fire and EMS stations, police stations, and operations centers. Schools are included in essential facilities. HPL facilities include dams, levees, nuclear power plants, military installations and hazardous material sites. Note that these inventory numbers are based on 2010 US Census data and may vary slightly from the county's current inventory.

**Table 7-7: Critical Facility Inventory**

Essential Facilities		High Potential Loss Facilities	
Facility Type	Number	Facility Type	Number
Hospital	1 (75 beds)	Hazardous Materials Sites	4
Schools	24		
Fire Stations	6		
Police Stations	5		

*Transportation and Utility Lifeline Inventory*

Lifeline systems are defined as transportation and utilities. Transportation systems include highways, railways, and airports. Utility systems include water treatment and potable water plants, wastewater treatment plants, natural gas suppliers, fuel oil suppliers, electrical power plants, and communications hubs. The total value of these lifeline systems exceeds \$1,681M and includes 98.8 miles of highway, 302 bridges, and 9,819 miles of pipes.

**Table 7-8: Transportation System Inventory**

System	Components	Quantity	Replacement Value
Highways	Bridges	302	\$96.17M
	Segments	24	\$732.21M
Railways	Facilities	1	\$2.66M
	Segments	4	\$16.52M
Airport	Facilities	2	\$21.30M
	Runways	2	\$75.92M
<b>Total</b>			<b>\$944.80M</b>

**Table 7-9: Utility System Inventory**

System	Components	Quantity	Replacement Value
Potable Water	Distribution Lines	N/A	\$158.03M
Waste Water	Distribution Lines	N/A	\$94.81M
	Facilities	6	\$419.58M
Natural Gas	Distribution Lines	N/A	\$63.21M
	Facilities	1	\$1.14M
Communication	Facilities	4	\$0.42M
<b>Total</b>			<b>\$737.20M</b>

*Building Damage*

The estimated building damage according to HAZUS is extensive. The number of buildings projected to sustain moderate damage is 4,781, approximately 19% of all buildings in the county. It is estimated that 295 buildings would be destroyed. Table 7-10 summarizes the anticipated building damages.

**Table 7-10: Expected Building Damage by Occupancy**

Occupancy	None	Slight	Moderate	Extensive	Complete
Agriculture	141	56	62	30	7
Commercial	543	301	348	171	50
Education	40	17	18	7	2
Government	18	8	10	4	2
Industrial	217	105	126	66	18
Other Residential	1,119	556	536	212	47
Religion	95	44	40	20	6
Single Family Residential	12,610	4,695	2,240	596	164
<b>Total</b>	<b>14,783</b>	<b>5,782</b>	<b>3,380</b>	<b>1,106</b>	<b>296</b>

Depending on the type of building construction, damage from an earthquake can be more or less serious. Based on common types of construction, the scenario is extrapolated into damage according to type of construction type.

**Table 7-11: Expected Building Damage by Building Type**

Building Type	None	Slight	Moderate	Extensive	Complete
Wood	11,205	3,953	1,397	168	13
Steel	270	124	217	141	40
Concrete	98	42	53	26	6
Precast	92	34	57	40	8
Reinforced Masonry	38	11	19	13	2
Unreinforced Masonry	2,518	1,324	1,254	559	195
Manufactured Housing	562	294	383	159	32
<b>Total</b>	<b>14,783</b>	<b>5,782</b>	<b>3,380</b>	<b>1,106</b>	<b>296</b>

#### *Essential Facility Damage*

According to HAZUS estimates, only 13 of the county's hospital beds (17%) would be available and functional on the day of the earthquake. After one week, it is estimated that 30% of the beds would be available. By the 30-day mark, an estimated 61% would be fully functional. Anticipated damage to other essential facilities is detailed in Table 7-12.

**Table 7-12: Expected Damage to Essential Facilities**

Classification	Total	Moderate Damage >50%	Complete Damage > 50%	With Functionality >50% on Day 1
Hospitals	1	1	0	0
Schools	24	11	0	8
Police Stations	5	2	0	3
Fire Stations	6	1	0	3

### *Transportation and Utility Lifeline Damage*

Per HAZUS estimates, most highways, bridges, railways, and airports will have more than 50% functionality on the first day after an earthquake and will continue to experience greater than 50% function throughout the recovery period. Limited damage to these transportation systems is expected.

Tables 7-13 and 7-14 describe the anticipated damage to utility system facilities and pipelines.

**Table 7-13: Expected Utility System Facility Damage**

System	Total	Moderate Damage	Complete Damage	Day 1 >50% Functionality	Day 7 >50% Functionality
Waste Water	6	3	0	3	6
Natural Gas	1	1	0	0	1
Communication	4	4	0	1	4

**Table 7-14: Expected Utility System Pipeline Damage**

Utility	Total Pipeline	Anticipated Leaks	Anticipated Line Breaks
Potable Water	4,910	591	148
Waste Water	2,946	297	74
Natural Gas	1,964	102	25

Electrical service and potable water systems are more difficult to restore. Table 7-15 outlines the number of customers anticipated to be without potable water or electric service following the incident. There are 22,607 households in the county.

**Table 7-15: Expected Without Service**

Days Post-Event	Potable Water	Electric Power
Day 1	324	9,616
Day 3	59	5,909
Day 7	0	2,205
Day 30	0	358
Day 90	0	12

### *Debris Generation*

The amount of debris generated by an earthquake can be substantial. HAZUS classifies debris into two types based on the handling equipment required: brick/wood and reinforced concrete/steel. In the given scenario, a total of 201,000 tons of debris is anticipated.

Brick/wood would comprise 49% of that amount. When converting these totals to truckloads, debris removal would require 8,040 truckloads, assuming 25 tons per truck.

### *Shelter Needs*

Temporary public shelters are often necessary post-quake to provide housing for people displaced by the event. HAZUS estimates that 368 households would be displaced and 239 people would seek temporary housing in a public shelter.

### *Casualties*

The number of people estimated to be injured or killed by the earthquake is divided into four categories based on the extent of the victim's injuries:

- Severity Level 1 – Require medical attention but not hospitalization
- Severity Level 2 – Require hospitalization for non-life-threatening injuries
- Severity Level 3 – Require hospitalization for critical injuries
- Severity Level 4 – Fatalities

Casualty estimates are provided for 3 times of day that represent periods of the day that various sectors of the community operate at peak capacity loads. These figures are provided in Table 7-16.

**Table 7-16: Casualty Estimates**

<b>Time</b>	<b>Location</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
<b>2 AM</b>	Commercial	1.55	0.35	0.05	0.09
	Commuting	0	0.01	0.01	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	3.44	0.76	0.09	0.18
	Other Residential	45.21	10.34	1.37	2.68
	Single Family Residential	95.06	20.77	2.75	5.38
	<b>TOTAL</b>	<b>145</b>	<b>32</b>	<b>4</b>	<b>8</b>
<b>2 PM</b>	Commercial	93.85	21.57	2.80	5.43
	Commuting	0.04	0.05	0.09	0.02
	Educational	60.82	14.92	2.16	4.17
	Hotels	0	0	0	0
	Industrial	25.34	5.63	0.69	1.32
	Other Residential	10.29	2.42	0.34	0.63
	Single Family	20.95	4.75	0.66	1.23
	<b>TOTAL</b>	<b>211</b>	<b>49</b>	<b>7</b>	<b>13</b>
<b>5 PM</b>	Commercial	69.18	15.97	2.10	4.01
	Commuting	0.67	0.92	1.52	0.30
	Educational	13.83	3.44	0.50	0.97
	Hotels	0	0	0	0
	Industrial	15.83	3.52	0.43	0.83
	Other Residential	17.60	4.11	0.56	1.06
	Single Family Residential	38.12	8.60	1.19	2.23
	<b>TOTAL</b>	<b>155</b>	<b>37</b>	<b>6</b>	<b>9</b>

### *Economic Loss*

Total economic loss for this earthquake scenario is estimated to be \$803.91M. This includes building and lifeline related losses and is based on the building inventory in the county. Building losses are examined in two categories: direct building loss and business interruption loss. Direct building losses include structural damage and damage to contents. Business interruption losses



include the costs associated with not being able to conduct normal business, displaced workers, and lost opportunities.

Total estimated building losses are anticipated to be \$716.81M. Business interruption expenses account for 18% of this total. Residential structures are expected to sustain the greatest loss by far, more than 53% of the total loss for the county.

Table 7-17 provides a summary of the anticipated building-related losses. All figures are expressed in millions of dollars.

**Table 7-17: Building-Related Economic Loss Estimates**

Area	Single-Family	Other Residential	Commercial	Industrial	Other	Total
<b><i>Income Losses</i></b>						
Wage	0	2.14	21.43	1.50	2.14	27.21
Capital Related	0	0.91	18.44	0.91	0.71	20.97
Rental	6.68	6.88	9.65	0.46	1.05	24.72
Relocation	23.30	3.85	16.42	2.07	9.83	55.48
<b><i>Capital Stock Losses</i></b>						
Structural	37.59	14.01	25.20	7.67	11.57	96.03
Non-Structural	147.56	60.91	71.99	23.90	29.62	333.98
Content	60.02	18.24	40.03	16.77	18.64	153.70
Inventory	0	0	0.83	3.51	0.37	4.71
<b>TOTAL</b>	<b>275.15</b>	<b>106.95</b>	<b>204.00</b>	<b>56.80</b>	<b>73.92</b>	<b>716.81</b>

#### *Transportation and Utility Lifeline Losses*

Earthquakes often cause extensive damage to a community's infrastructure. Tables 7-18 and 7-19 depict the potential damage Knox County could expect to its transportation and utility systems. Loss figures address only the cost to repair, not business interruption costs.

**Table 7-18: Transportation System Economic Losses**

System	Component	Inventory Value	Economic Loss
Highway	Segments	\$732.21M	0
	Bridges	\$96.18M	\$1.51M
Railways	Segments	\$16.52M	0
	Facilities	\$2.66M	\$1.19M
Airport	Facilities	\$21.30M	\$8.55M
	Runways	\$75.93M	\$8.56M
<b>Total</b>		<b>\$944.81M</b>	<b>\$11.27M</b>

**Table 7-19: Utility System Economic Losses**

<b>System</b>	<b>Component</b>	<b>Inventory Value</b>	<b>Economic Loss</b>
Potable Water	Distribution Lines	\$158.03M	\$2.66M
Waste Water	Facilities	\$419.58M	\$70.93M
	Distribution Lines	\$94.82M	\$1.34M
Natural Gas	Distribution Lines	\$63.21M	\$0.46M
	Facilities	\$1.14M	\$0.32M
Communication	Facilities	\$0.42M	\$0.13M
<b>Total</b>		<b>\$737.21M</b>	<b>\$75.83M</b>