

4.3.1 Building and Structure Collapse

This section provides a profile and vulnerability assessment for the building and structure collapse hazard for Dauphin County. According to the Pennsylvania Emergency Management Agency (PEMA), “Buildings and other engineered structures, including bridges, may collapse if their structural integrity is compromised, especially due to effects from other natural or human-made hazards. Older buildings or structures, structures that are not built to standard codes, or structures that have been weakened are more susceptible to be affected by these hazards.” (PEMA 2018)

The cause(s) of the collapse, the force on the structural collapse, the type of structure that collapsed, and the pattern of collapse all affect the overall collapse disaster event. The four main types of forces include tension, compression, bending, and shear. When a force is applied to an individual structural support, it produces a stress factor, and when great enough, it can collapse a structure. Four main types of structural collapse include lean-to, pancake, V, and cantilever (Federal Emergency Management Agency [FEMA 2012]). Any type of collapse can cause damage to safety, health, and welfare.

4.3.1.1 Location and Extent

Adherence to modern building codes can lower a building’s risk to collapse. Building codes – developed by the International Code Council in partnership with FEMA and other federal, state, local, and private authorities – specify the minimum legal design and construction requirements for structural integrity, construction materials, and fire protection (FEMA 2017).

Most buildings constructed after 1961 in Dauphin County were built according to modern building codes with the most comprehensive building code in Pennsylvania being adopted in the Pennsylvania Uniform Construction Code in 2015. Table 4.3.1-1 shows the number of buildings constructed before 1969 in Dauphin County.

Table 4.3.1-1. Structures Built Before 1969

Municipality	Total Structures	Structures Built Before 1969	Percent of Total Structures Built Before 1969
Berrysburg Borough	168	139	82.74
Conewago Township	1152	324	28.13
Dauphin Borough	378	262	69.31
Derry Township	10518	3966	37.71
East Hanover Township	2383	760	31.89
Elizabethville Borough	700	495	70.71
Gratz Borough	356	241	67.70
Halifax Borough	414	340	82.13
Halifax Township	1529	721	47.16
Harrisburg	25450	20913	82.17
Highspire Borough	1267	1034	81.61
Hummelstown Borough	2227	1370	61.52
Jackson Township	734	238	32.43
Jefferson Township	174	66	37.93
Londonderry Township	2311	1087	47.04



Municipality	Total Structures	Structures Built Before 1969	Percent of Total Structures Built Before 1969
Lower Paxton Township	21935	7821	35.66
Lower Swatara Township	3715	1182	31.82
Lykens Borough	942	781	82.91
Lykens Township	534	273	51.12
Middle Paxton Township	2347	1168	49.77
Middletown Borough	4105	2882	70.21
Mifflin Township	268	124	46.27
Millersburg Borough	1438	1095	76.15
Paxtang Borough	699	654	93.56
Penbrook Borough	1305	1122	85.98
Pillow Borough	109	92	84.40
Reed Township	111	59	53.15
Royalton Borough	558	372	66.67
Rush Township	123	52	42.28
South Hanover Township	2679	555	20.72
Steelton Borough	2387	1938	81.19
Susquehanna Township	11239	4592	40.86
Swatara Township	9879	5044	51.06
Upper Paxton Township	1954	893	45.70
Washington Township	883	346	39.18
Wayne Township	526	129	24.52
West Hanover Township	4467	1479	33.11
Wiconisco Township	590	408	69.15
Williams Township	534	317	59.36
Williamstown Borough	652	573	87.88
Totals	123,740	65,907	57.07

Source: U.S. Census 2020

4.3.1.2 Range of Magnitude

Structural collapse severity can range from the failure of a single load-bearing element within or on a structure, (weakening the structure) to the failure of all load-bearing elements within a structure (bringing about the complete collapse of the structure). Overall, Dauphin County’s vulnerability has not changed since the 2018 Pennsylvania Hazard Mitigation Plan (PA HMP) and the entire region continues to be exposed and vulnerable to the building collapse hazard.

The Occupational Safety and Health Administration (OSHA) states that “When internal load bearing structural elements fail, a building will collapse into itself and exterior walls are pulled into the falling structure. This scenario may be caused by construction activity, an earthquake, or fire, and may result in a dense debris field with a small footprint. Alternatively, if the structural failure is caused by an explosion or natural forces such as weather, the building may collapse in an outward direction, resulting in a less dense and more scattered debris field.” (OSHA 2019)





All infrastructure, commercial and industrial businesses, and residential structures within Dauphin County are vulnerable to loss because of structural collapse, whether the collapse is from a cascading event or a catastrophic structural failure. This vulnerability is compounded because of the ground composition, which is prone to subsidence throughout the region. Vacant and abandoned buildings (both residential and commercial) pose a particular threat for structural collapse. According to the International Association of Arson Investigators (IAAI) and U.S. Fire Administration (USFA), vacant and abandoned buildings have two separate definitions, as described below (IAAI and USFA 2006):

- Vacant Buildings: When the owner is known, has kept taxes current, and the building is unoccupied
- Abandoned Buildings: When the owner is unknown, has not kept taxes current, and the building is not legally occupied

IAAI and USFA indicate that it is best to identify these buildings early enough before they go into disrepair. Once buildings and structures have been abandoned, it usually becomes a community issue to maintain and secure the structure. Many communities across the nation face inadequate laws to prevent or reduce vacancies and many do not have the funds for demolition to remove these structurally at-risk buildings.

Vacant and abandoned buildings have enormous negative impacts on neighborhoods and communities. Aesthetics of a community deteriorate, crime increases, and the public safety decreases as a result of social stressors (crime, economic decline, decrease in structural market value) and physical structural disrepair. As further identified by IAAI and USFA, “abandonment is a contagious phenomenon”. This problem can be seen in almost every community across the nation, including Dauphin County.

Bridges are also at risk for structural collapse and disrepair can critically affect the integrity of bridge structures. The level of disrepair depends on how much of the structure is damaged and how critical that portion of the structure is to the safety of drivers. Some structures only need deck replacement or a new superstructure, while others have substructure problems and should be entirely replaced. Dauphin County contains a total of 562 bridges, of which 35 are in poor condition (Pennsylvania Department of Transportation [PennDOT] 2021). Table 4.3.1-2 identifies these bridges in poor condition. In addition, three bridges participated in the PA Rapid Bridge Replacement program and replacements are complete. These bridges include NW Gratz bridge on Valley Drive Road in Lykens Township, W. Enders bridge on West Enders Road in Jackson Township, and Near Mountain Road bridge on SR 225 in Mifflin Township (PennDOT 2021).

Table 4.3.1-2. Dauphin County Bridges in Poor Condition

Locally (L) or State (S) Owned	Condition	Municipality	Year Built	Posting Status	Superstructure Condition (Deck Support)	Substructure Condition (Bridge Support)
L	Poor	Conewago Township	1940	Posted for load	3 - Serious	5 - Fair
S	Poor	Conewago Township	1974	Open, no restriction	4 - Poor	5 - Fair
L	Poor	Conoy Township	1985	Posted for load	4 - Poor	5 - Fair
S	Poor	Derry Township	1917	Open, no restriction	5 - Fair	4 — Poor
L	Poor	East Hanover Township	1930	Posted for load	4 - Poor	5 - Fair
L	Poor	East Hanover Township	1973	Open, no restriction	4 - Poor	6 - Satisfactory



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Locally (L) or State (S) Owned	Condition	Municipality	Year Built	Posting Status	Superstructure Condition (Deck Support)	Substructure Condition (Bridge Support)
L	Poor	Harrisburg City	1940	Open, no restriction	4 - Poor	4 - Poor
L	Poor	Harrisburg City	1900	Open, no restriction	4 - Poor	5 - Fair
L	Poor	Harrisburg City	1940	Open, no restriction	4 - Poor	6 - Satisfactory
L	Poor	Harrisburg City	1960	Open, no restriction	4 - Poor	6 - Satisfactory
L	Poor	Harrisburg City	1914	Open, no restriction	5 - Fair	4 - Poor
S	Poor	Harrisburg City	1940	Open, no restriction	4 - Poor	4 - Poor
S	Poor	Harrisburg City	1950	Open, no restriction	4 - Poor	5 - Fair
S	Poor	Harrisburg City, Wormleysburg Borough	1928	Open, no restriction	4 - Poor	5 - Fair
L	Poor	Jackson Township	1975	Open, no restriction	4 - Poor	5 - Fair
S	Poor	Jackson Township	1974	Open, no restriction	3 - Serious	6 - Satisfactory
S	Poor	Jackson Township	1920	Open, no restriction	4 - Poor	4 - Poor
S	Poor	Jackson Township	1974	Open, no restriction	4 - Poor	6 - Satisfactory
S	Poor	Jackson Township	1974	Open, no restriction	5 - Fair	2 - Critical
L	Poor	Londonderry Township	1910	Posted for load	4 - Poor	5 - Fair
L	Poor	Lower Paxton Township	1950	Posted for load	4 - Poor	6 - Satisfactory
L	Poor	Lower Paxton Township	1950	Open, no restriction	5 - Fair	4 - Poor
S	Poor	Lower Paxton Township	1959	Open, no restriction	3 - Serious	5 - Fair
S	Poor	Lower Paxton Township, South Hanover Township	1984	Open, no restriction	3 - Serious	5 - Fair
L	Poor	Lykens Borough	1981	Posted for load	3 - Serious	5 - Fair
S	Poor	Lykens Borough	1973	Open, no restriction	4 - Poor	5 - Fair
S	Poor	Lykens Township	1910	Bridge, closed to all traffic	4 - Poor	4 - Poor
L	Poor	Mifflin Township	1900	Closed to all traffic	1 - Imminent Failure	5 - Fair
L	Poor	Mount Joy Township	1946	Closed to all traffic	0 - Failed	5 - Fair
S	Poor	Unknown	1938	Open, no restriction	4 - Poor	6 - Satisfactory
S	Poor	Reed Township	1860	Open, no restriction	3 - Serious	4 - Poor



Locally (L) or State (S) Owned	Condition	Municipality	Year Built	Posting Status	Superstructure Condition (Deck Support)	Substructure Condition (Bridge Support)
S	Poor	Washington Township	1973	Posted for load	4 - Poor	6 - Satisfactory
L	Poor	Wayne Township	1975	Posted for load	4 - Poor	6 - Satisfactory
S	Poor	Wiconisco Township	1974	Open, no restriction	4 - Poor	6 - Satisfactory
L	Poor	Williams Township	1987	Open, no restriction	4 - Poor	5 - Fair

Source: PennDOT 2020

4.3.1.3 Past Occurrence

Currently, Dauphin County does not have a comprehensive record of building or structure collapses; however, several recent instances have made the local news. Table 4.3.1-3 lists structural or building collapses since June 2015.

Table 4.3.1-3. Building and Structure Collapse Reports between 2015 and 2020

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
May 5, 2016 and June 25, 2016	Structural Retention Wall Collapse	NA	NA	MacFarland Wall Collapse: Located in Harrisburg, the MacFarland property, an 8-unit building complex, had a 107-year old retaining wall collapse unto Henry’s Tire Shop. The wall had collapsed twice within a 2-month time span because of age, lack of infrastructure maintenance, and saturated soils. Upon the second collapse, the City of Harrisburg’s Bureau of Codes conducted a structural inspection of the property, which revealed various violations according to the 2000 International Property Maintenance code. The City’s Bureau of Codes further identified that the building structure and retaining wall were structurally deteriorated due to lack of maintenance. The building structure was identified as a fire hazard as well as an overall public health and safety hazard. On the same day as inspections, the City of Harrisburg issued a Condemnation Order, “which condemned the McFarland property as dangerous, unsafe, and unfit for human habitation.” McFarland filed a Request for Hearing to disclaim any ownership of the collapsed wall, but it was eventually determined that McFarland did indeed own the wall. Since this determination, a civil lawsuit between McFarland and Henry is still ongoing as to who is responsible in cleaning up the debris and who should rebuild a new retaining wall, estimated to cost \$500,000.
April 3, 2016	Building Fire, Roof Collapse	NA	NA	Holly Hall: Located in Middletown, the Holly Hall building of an apartment complex located in the Village of Pineford is primarily filled with college students or the elderly. In April 2016, the complex caught on fire with eventual roof collapse. During this incidence, firefighters had a difficult time keeping the flames under control due to strong winds.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
January 16, 2020	New Construction Building Collapse	NA	NA	Graceful Acres Therapeutic Riding (2020): Located in Halifax, Graceful Acres is a teaching facility for people with special needs in addition to using therapy horses to help special needs children. The building was under construction in 2020 and strong wind gusts knocked down most of the framework.

Sources: CBS Local News 2020, Dauphin County 2019, Fox 43 2016

4.3.1.4 Future Occurrence

As previously mentioned, Dauphin County does not record a comprehensive list of building collapse events. However, issues with building integrity can grow without proper maintenance and code enforcement, increasing the risk of building collapse in a community. Age of a structure also needs to be taken into consideration. As identified in the Pennsylvania’s State Hazard Mitigation Plan, Dauphin County has 147 homes registered as a historic building as of Pennsylvania Historic Museum Commission 2018 data (PEMA 2018). Although many older homes may have been built to code compliance at the time of construction, now these homes may not be structurally stable, and may not conform to current enhanced International Building Codes. Other hazards events, such as winter storms, tropical storms, and fires, could create conditions for a collapse to occur. According to the PA HMP, it is estimated that over 39,200 people and 15,500 buildings are vulnerable to structure collapse with nearly \$4 billion of building value at risk. This includes 12 percent of the building stock value in Dauphin County. That said, the likelihood of a building or structure collapse in Dauphin County is considered to be *unlikely*.

4.3.1.5 Vulnerability Assessment

To understand risk, a community must evaluate the assets that are exposed or vulnerable in the area identified. The following sections discuss the potential impact of the building and structure collapse hazard on Dauphin County, including:

- Overview of vulnerability
- Impact on (1) life, health, and safety; (2) general building stock and critical facilities; (3) the economy; and (4) the environment
- Future growth and development
- Effect of climate change on vulnerability

Overview of Vulnerability

Structural collapse severity can range from the failure of a single load-bearing element within or on a structure (weakening the structure) to the failure of all load-bearing elements within a structure (bringing about the complete collapse of the structure). Overall, Dauphin County’s vulnerability has not changed since the 2018 PA HMP and the entire county continues to be exposed and vulnerable to the building and structure collapse hazard.

Many factors influence vulnerability to a structure and building collapse. Age of structure, building materials, density of the area of the building location, maintenance, and enforceable measures. Older structures may not have been built with the same level of structural stability required by modern building codes and therefore may be more susceptible to collapse than a modern structure. More densely populated areas of Dauphin County face a higher vulnerability because of the proximity of residences to each other, commercial structures, and urban blight.

Impact on Life, Health, and Safety

As discussed in this section, with any type of collapse, additional effects must be anticipated. Structures can house transmission lines for gases; liquids; and other products, such as sheetrock dust, asbestos, etc., which could be released into the environment during a failure. In addition, the public, residents, or individuals trapped by the collapse may cause hysteria, creating the possibility of civil unrest.

Following the initial events of a structural collapse, residents and/or businesses may be displaced. Depending on the type of structural collapse, it could cause disruption to the local economy, housing, and healthcare access.

Impact on General Building Stock and Critical Facilities

All infrastructure, commercial and industrial businesses, and residential structures within Dauphin County are vulnerable to loss because of structural collapse, whether from cascading event or a catastrophic structural failure. This vulnerability is compounded because of the ground composition, which is prone to subsidence throughout the region.

Impact on the Economy

Structural and building collapse may cause impacts on the economy depending on the scale and severity of the collapse. Economic impacts of structural and building collapse may result in lost wages from temporarily or permanently closed businesses, destruction and damage involving business and personal assets, loss of tax base, recovery costs, and lost investments in destroyed property.

Impact on the Environment

Environmental impacts from a structural fire could occur if hazardous materials are released. Debris from fire can also contain chemicals or substances, which may also impact the environment.

Future Growth and Development

Areas targeted for potential future growth and development in the next 5 to 10 years have been identified across Dauphin County (further discussed in Section 2.4 of this HMP). Any areas of growth could be potentially impacted by the structural collapse hazard because Dauphin County is exposed and vulnerable to flooding, subsidence, and karst (limestone) features. Working with the Tri-County Regional Planning Commission (TCRPC), which provides planning services for Dauphin, Cumberland, and Perry counties, is key as TCRPC adopted a Regional Growth Management Plan (RGMP) in 2017.

Effect of Climate Change on Vulnerability

One trigger for structural collapse is a sinkhole. Climatologists expect an increase in annual precipitation amounts. This increase will coincide with an increased risk in sinkholes in vulnerable areas. As these areas become increasingly developed, the strain on underground aquifers will increase, especially during periods of drought. Precipitation is expected to increase over the next several decades. Annual precipitation has increased by nearly 10 percent since the early 20th century and is expected to increase by another 8 percent by 2050. Over 14 percent of the additional precipitation is expected to occur during the winter months (PA DEP 2018). This will pose an even greater threat for sinkholes in developed areas, resulting in a greater risk of structural collapse. For more information about subsidence and sinkholes, see Section 4.3.13 of this plan.