

## Appendix F Hazus Methodology and Results Report

The Lycoming County HMP used an enhanced Hazus run to model the 1% annual-chance-flood. Enhancements to the model focused on improving four aspects of the model:

- Structure data
- Demographic data
- Essential Facilities
- Flood depth grids

### STRUCTURE DATA

Point locations for structures within the county were obtained from the Lycoming County Tax Assessors database. The structure data included information such as building type, square footage, address, and total assessed value. This data was aggregated at the Census Block level and imported into Hazus to replace the default 2010 Census structure data.

### DEMOGRAPHIC DATA

HAZUS-MH version 3.2 was used for this analysis, which includes 2010 Census data. The demographic data includes population, households, group quarters, male population by age, female population by age, and population by race at both the Census tract and block level. Income, housing tenure by housing type, housing vacancy by housing type, age of structures, average cash rent, median home value, and educational enrollment are also included.

### ESSENTIAL FACILITIES

Shapefiles of essential facilities were created from MS Excel tables exported CDMS for each county using Latitude and Longitude attributes provided in the exports. Essential facility categories include: Emergency Operations Center (EOC), Fire Stations, Medical Facilities/Hospitals, Police Stations and Schools. The shapefiles were created using Esri's *Create Feature Class from XY Tool* in ArcCatalog. The Geographic Coordinate System (GCS) North American Datum 1983 was assigned.

The essential facilities exported from CDMS were individually reviewed to determine if the facility existed in reality, the location matched reality, and if the attributes were correct.

Each facility was classified as either MATCH, EDIT, KEEP, MOVED or ADD. The rules for classification are listed below:

- MATCH – County data and CDMS data are located on the same parcel and have the same name and address.
- EDIT – Attributes such as Facility Name, Address, City, Zip, and Telephone were modified to match county data.<sup>1</sup>
- MOVED – The CDMS data point was moved to a new location. Several scenarios instigated this classification. For example, the CDMS point was located near the county

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<sup>1</sup> For School Facilities, the School District attribute was updated for all public schools. This update did not change the classification from MATCH to EDIT because none of the essential facilities exported from CDMS had School District populated.

data but not within the same parcel. In this scenario, the point was moved to be within the correct parcel. Another example was the CDMS facility was in the wrong place entirely. In this scenario, the point was moved to coincide with the county data point. In both scenarios, Latitude and Longitude were recalculated in decimal degrees after the point was moved. Even if an attribute was edited, the point was classified as MOVED and a note was added to identify which attributes were updated.

- KEEP – Facility did not exist in county data, but other sources such as Municipal, County and State websites verified the facility existed at that location.
- ADD – Facility exists in County provided data and was added to the dataset for import into CDMS.

Locations of facilities were compared to data provided by each county. If the point fell within the parcel, the point was not moved. If the point did fall within the correct parcel, for example in the public ROW or in the wrong location, it was moved to the parcel and/or building footprint (if available) of the facility and the latitude and longitude were recalculated in decimal degrees.

The facility name, address, city, zip code and telephone number attributes were verified. For school facilities, the School District field was updated.

*State Data Sources*

*Schools*

Pennsylvania Department of Education Educational Names & Addresses database, also known as EdNA.<sup>2</sup> District Offices and Administrative buildings were left out of the essential facilities, as were unlicensed preschools and universities.

*Hospitals*

Pennsylvania Department of 2012-2013 Hospital Reports, “1-A Utilization Data.”<sup>3</sup>

*County Data Sources*

The following summary tables of which sources and attributes were used to update the essential facilities for Lycoming County.

FIELD	EOC	FIRE	MEDICAL	POLICE	SCHOOL
HazusID	UNCHANGED				
Address	Parcels_with_CAMA [SITUS]			Bldgs_DPS [SITUS]	
AHA_ID	n/a	n/a	default value	n/a	n/a
Area	default value				
Back-up Power (Yes or No)	UNCHANGED				
Census Tract	UNCHANGED				
City	Parcels_with_CAMA [SITUS_CITY]				
Contact Person	UNCHANGED				
Facility Class	EFEO	EFFS	EFHM	EFPS	EFSS
Facility Name	UNCHANGED	FireDepts [NAME]	Hospitals [NAME]	PoliceDepts [NAME]	Schools [NAME]
Kitchen Facilities (Yes or No)	UNCHANGED				
Latitude	Calculate Geometry of Y point in GCS NAD83 IF moved from orig loc, [REVIEW]=MOVED				
Longitude	Calculate Geometry of X point in GCS NAD83 IF moved from orig loc, [REVIEW]=MOVED				
Misc. Comments	UNCHANGED				

<sup>2</sup> <http://www.edna.ed.state.pa.us/Screens/wfSearchEntity.aspx>

<sup>3</sup> <http://www.portal.state.pa.us/portal/server.pt?open=18&objID=1401353&mode=2>

FIELD	EOC	FIRE	MEDICAL	POLICE	SCHOOL
Number of Beds	n/a	n/a	Report <sup>4</sup>	n/a	n/a
Number of Stories	UNCHANGED		Website <sup>5</sup>	UNCHANGED	
Number of Students	n/a	n/a	n/a	n/a	UNCHANGED
Number of Trucks	n/a	UNCHANGED	n/a	n/a	n/a
Primary Function	UNCHANGED				
Telephone Number	UNCHANGED				
Replacement Cost (thous. \$)	Parcels_with_CAMA.shp [BLDG_VAL] divide BLDG_VAL/1000				
School District	n/a	n/a	n/a	n/a	Lycoming_County_Municipal_Polygon [SCHOOL_DIS]
Shelter Capacity	UNCHANGED				
State	default value = PA				
Year Built	Parcels_with_CAMA [YR_BUILT]				
ZIP Code	Parcels_with_CAMA [SITUS_ZIP]				
FL Contents Damage Function	default value/unchanged				
FL Flood Building Type	default value/unchanged				
FL Flood Pre/Post FIRM Design Level	default value/unchanged				
FL Flood Structure Foundation Type	default value/unchanged				
FL Height of the First Occupied Floor	default value/unchanged				
FL Protection In terms of return period	default value/unchanged				
FL Structure Damage Function Id	default value/unchanged				

The facilities were then imported into CDMS for incorporation into the model.

### DEPTH GRIDS

The Lycoming County Hazus model used the 1%-annual-chance depth grid generated as a part of Lycoming County’s June 2, 2016 Risk MAP update. This depth grid was obtained from FEMA’s Map Service Center and reflects flood depths for the detailed 1%-annual-chance-flood zones in Lycoming County. Approximate zones are not reflected in the depth grid due to the age of their studies and lack of accurate information regarding flood elevations in those areas.

The following pages show the Hazus Global Summary Report associated with this analysis.

<sup>4</sup><http://www.portal.state.pa.us/portal/server.pt?open=18&objID=1401353&mode=2>

<sup>5</sup><http://app2.health.state.pa.us/commonpoc/content/publiccommonpoc/commonpocselect.asp?FORMSUBMITTED=normalSearch&selcty=Lycoming>

## Hazus-MH: Flood Global Risk Report

**Region Name:** Lycoming\_09162017

**Flood Scenario:** Lyc\_Scenario\_09162017

**Print Date:** Monday, September 18, 2017

**Disclaimer:**

*This version of Hazus utilizes 2010 Census Data.  
Totals only reflect data for those census tracts/blocks included in the user's study region.*

*The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.*



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**Table of Contents**

Section	Page #
General Description of the Region	3
Building Inventory	
General Building Stock	4
Essential Facility Inventory	5
Flood Scenario Parameters	6
Building Damage	
General Building Stock	7
Essential Facilities Damage	9
Induced Flood Damage	10
Debris Generation	
Social Impact	10
Shelter Requirements	
Economic Loss	12
Building-Related Losses	
Appendix A: County Listing for the Region	15
Appendix B: Regional Population and Building Value Data	16



## General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Pennsylvania

**Note:**

Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 20 square miles and contains 6,993 census blocks. The region contains over 47 thousand households and has a total population of 116,111 people (2010 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 46,093 buildings in the region with a total building replacement value (excluding contents) of 7,427 million dollars (2010 dollars). Approximately 82.01% of the buildings (and 55.88% of the building value) are associated with residential housing.



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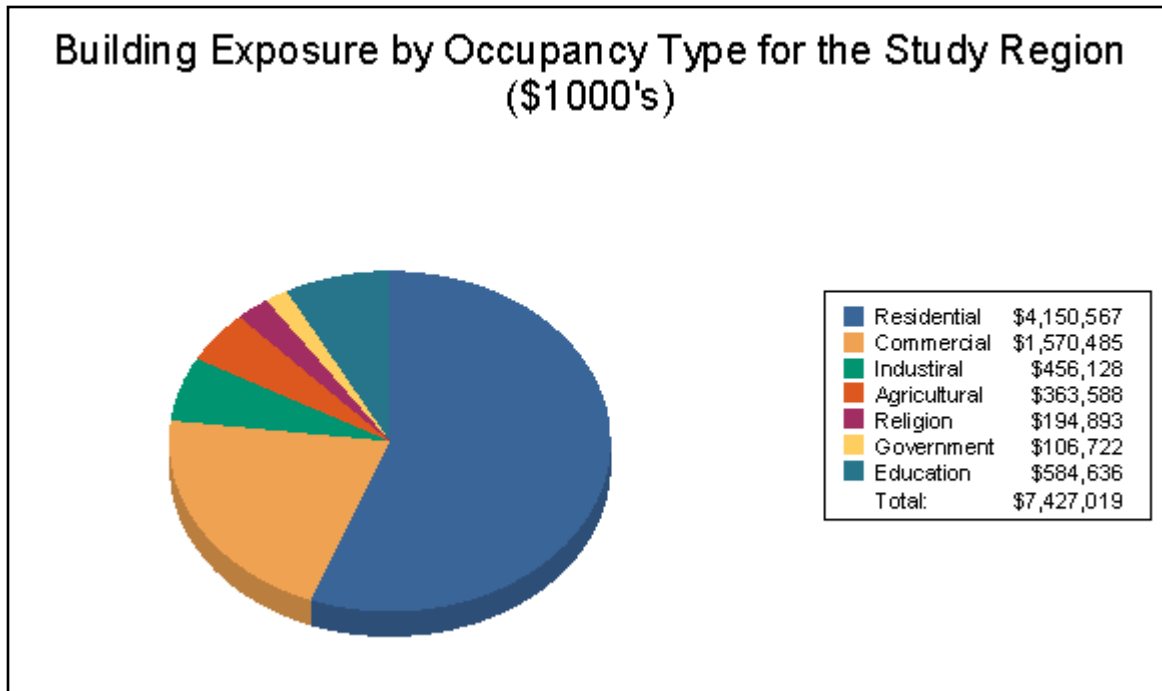
## Building Inventory

### General Building Stock

Hazus estimates that there are 46,093 buildings in the region which have an aggregate total replacement value of 7,427 million (2014 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

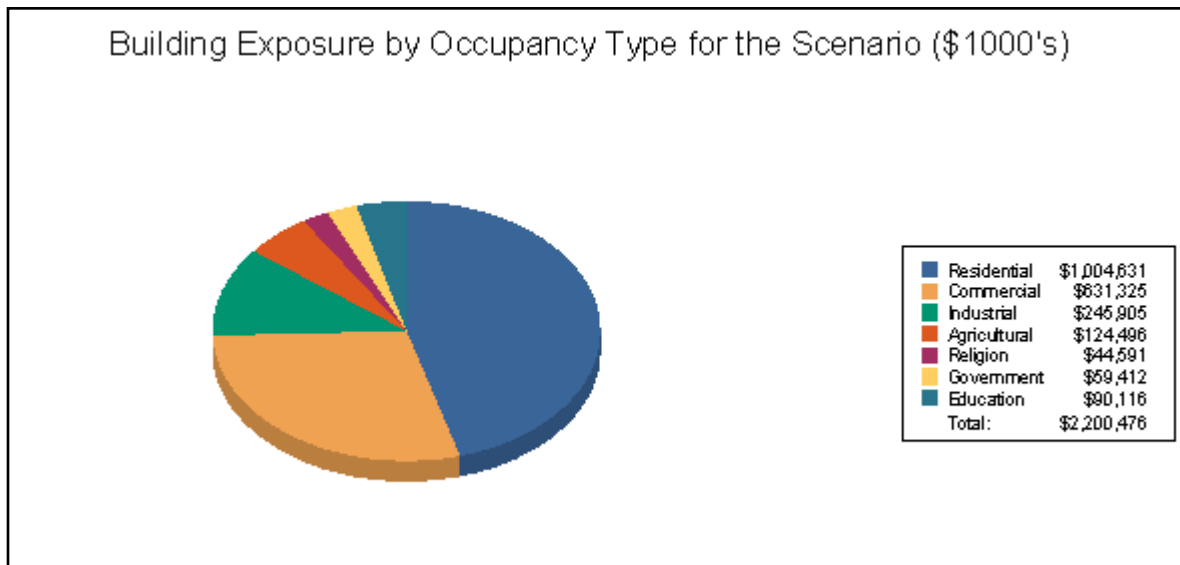
**Table 1**  
**Building Exposure by Occupancy Type for the Study Region**

Occupancy	Exposure (\$1000)	Percent of Total
Residential	4,150,567	55.9%
Commercial	1,570,485	21.1%
Industrial	456,128	6.1%
Agricultural	363,588	4.9%
Religion	194,893	2.6%
Government	106,722	1.4%
Education	584,636	7.9%
<b>Total</b>	<b>7,427,019</b>	<b>100.0%</b>



**Table 2**  
**Building Exposure by Occupancy Type for the Scenario**

Occupancy	Exposure (\$1000)	Percent of Total
Residential	1,004,631	45.7%
Commercial	631,325	28.7%
Industrial	245,905	11.2%
Agricultural	124,496	5.7%
Religion	44,591	2.0%
Government	59,412	2.7%
Education	90,116	4.1%
<b>Total</b>	<b>2,200,476</b>	<b>100.0%</b>



**Essential Facility Inventory**

For essential facilities, there are 4 hospitals in the region with a total bed capacity of no beds. There are 51 schools, 39 fire stations, 17 police stations and 5 emergency operation center.



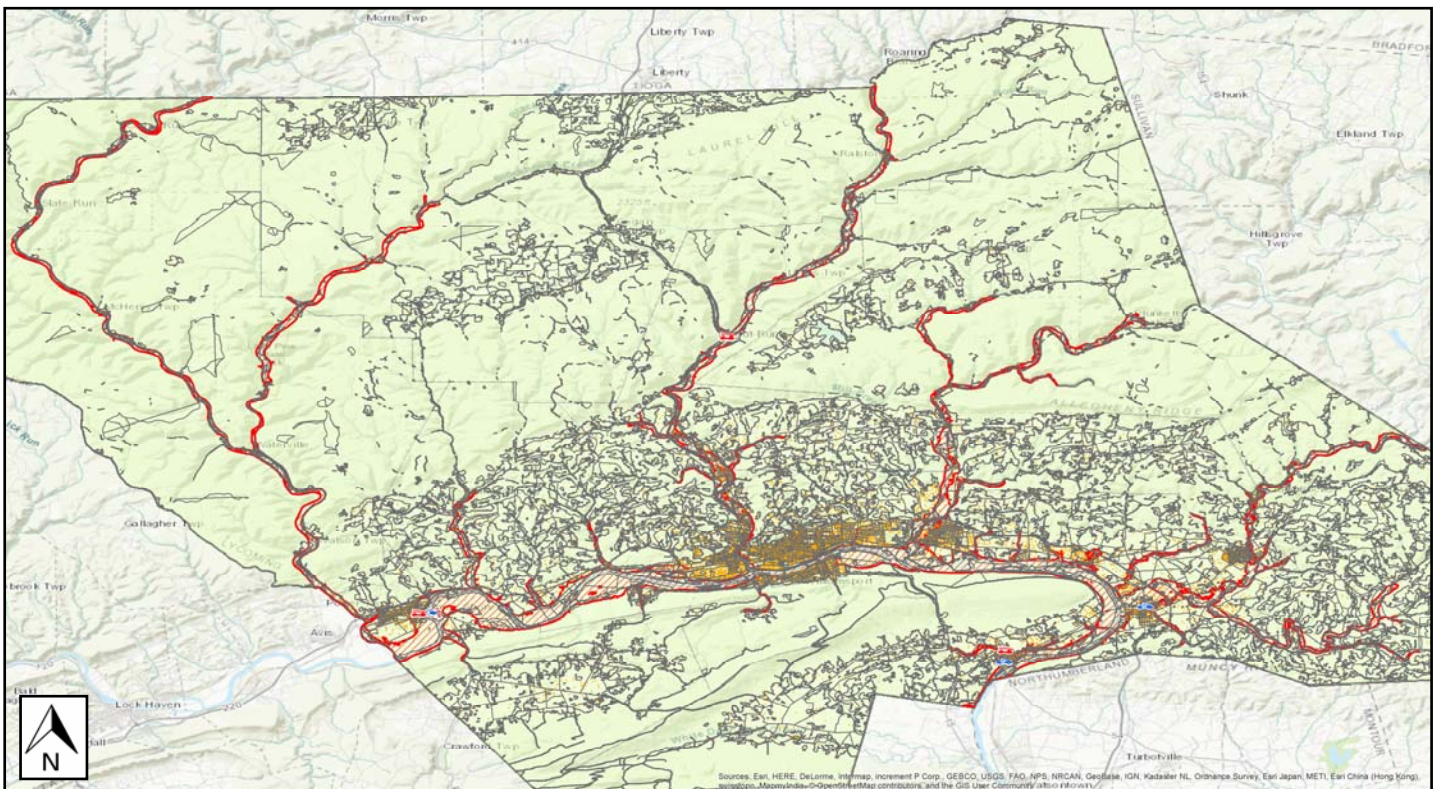
## Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

**Study Region Name:** Lycoming\_09162017  
**Scenario Name:** Lyc\_Scenario\_09162017  
**Return Period Analyzed:** 100  
**Analysis Options Analyzed:** No What-Ifs

### Study Region Overview Map

Illustrating scenario flood extent, as well as exposed essential facilities and total exposure

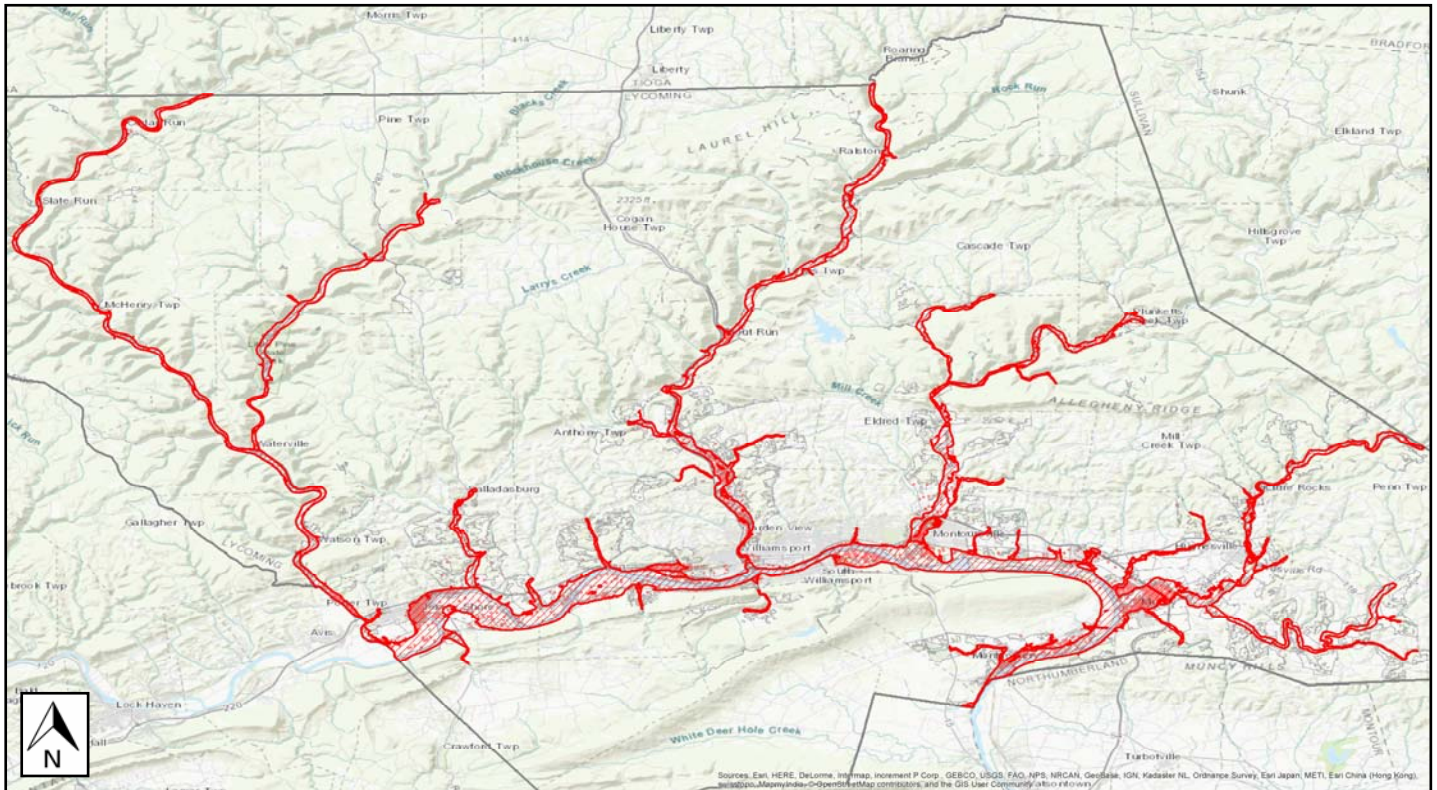


**Building Damage**

**General Building Stock Damage**

Hazus estimates that about 1,174 buildings will be at least moderately damaged. This is over 61% of the total number of buildings in the scenario. There are an estimated 240 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

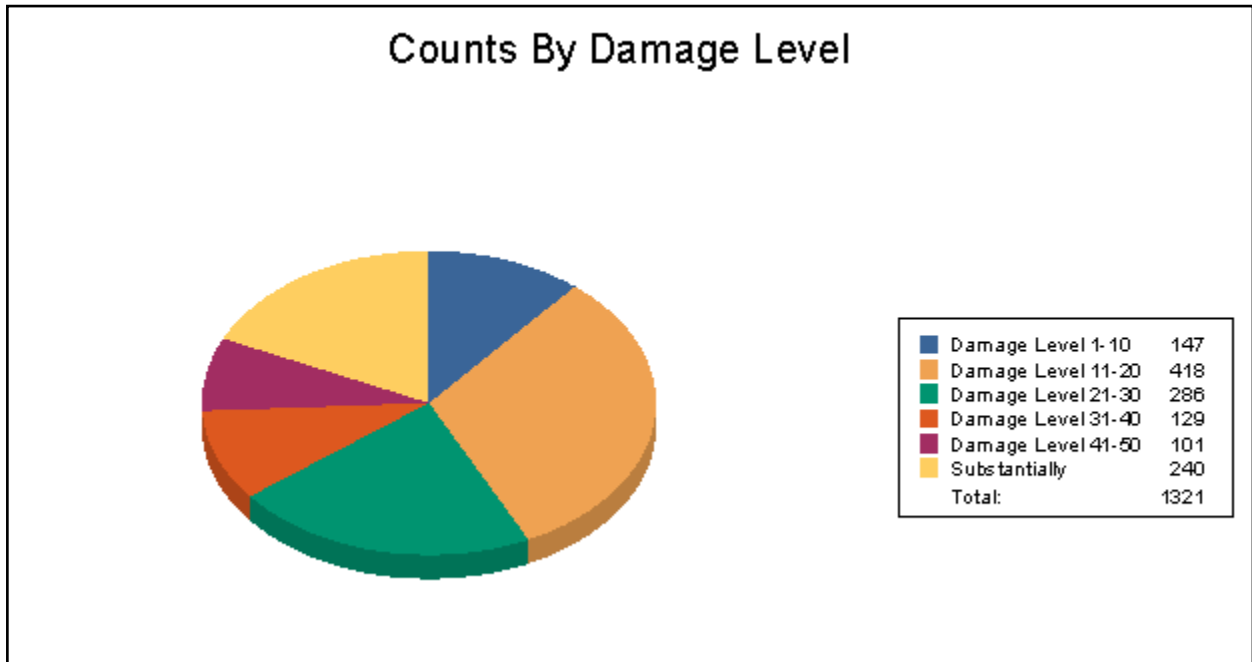
**Total Economic Loss (1 dot = \$300K) Overview Map**





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

Occupancy	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	1	2.08	2	4.17	1	2.08	5	10.42	17	35.42	22	45.83
Commercial	3	4.92	34	55.74	15	24.59	0	0.00	1	1.64	8	13.11
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	1	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	2	3.57	13	23.21	9	16.07	10	17.86	9	16.07	13	23.21
Religion	0	0.00	8	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	140	12.21	361	31.47	261	22.76	114	9.94	74	6.45	197	17.18
<b>Total</b>	<b>147</b>		<b>418</b>		<b>286</b>		<b>129</b>		<b>101</b>		<b>240</b>	



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

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	1	33	0	0	1	33	0	0	1	33	0	0
ManufHousing	6	8	6	8	6	8	0	0	5	6	54	70
Masonry	22	8	101	37	66	24	27	10	18	7	36	13
Steel	3	3	31	33	15	16	9	10	13	14	23	24
Wood	109	13	267	32	192	23	91	11	64	8	121	14

## Essential Facility Damage

Before the flood analyzed in this scenario, the region had 283 hospital beds available for use. On the day of the scenario flood event, the model estimates that 283 hospital beds are available in the region.

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

Classification	Total	# Facilities		Loss of Use
		At Least Moderate	At Least Substantial	
Fire Stations	39	3	0	2
Hospitals	4	0	0	0
Police Stations	17	3	1	4
Schools	51	1	0	1

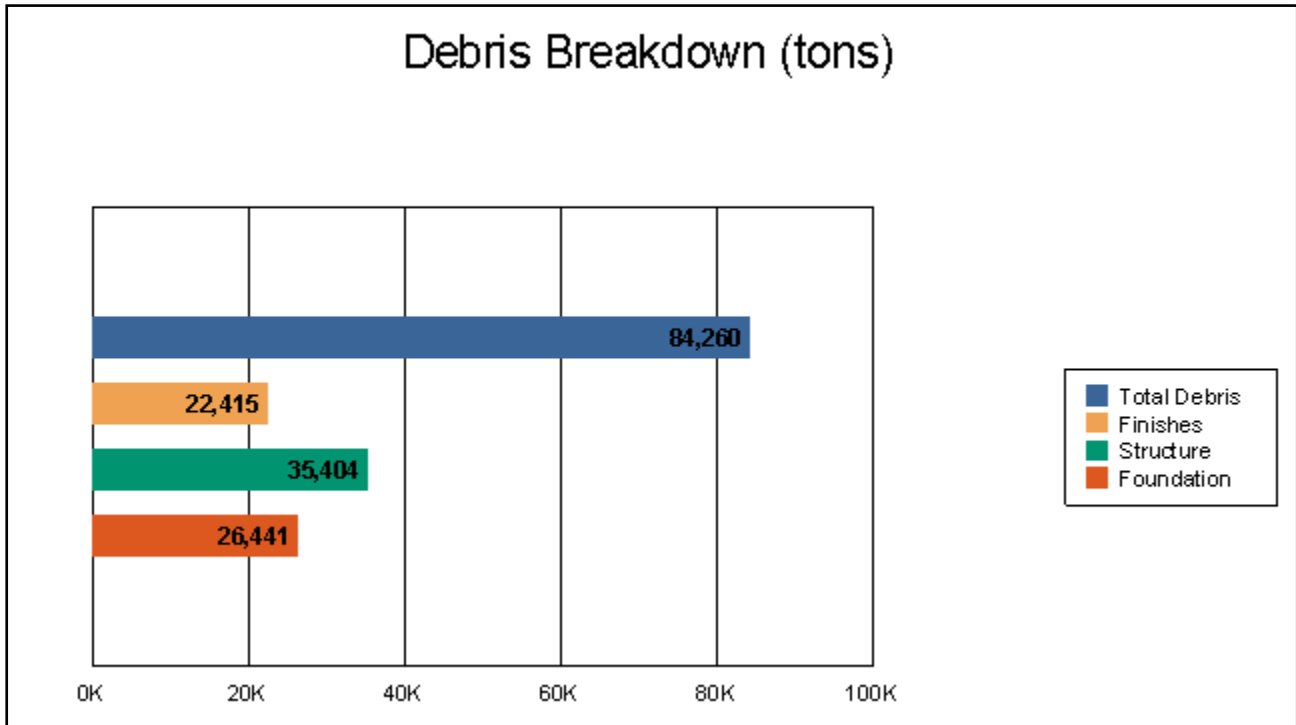
If this report displays all zeros or is blank, two possibilities can explain this.

- (1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.
- (2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

**Induced Flood Damage**

**Debris Generation**

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

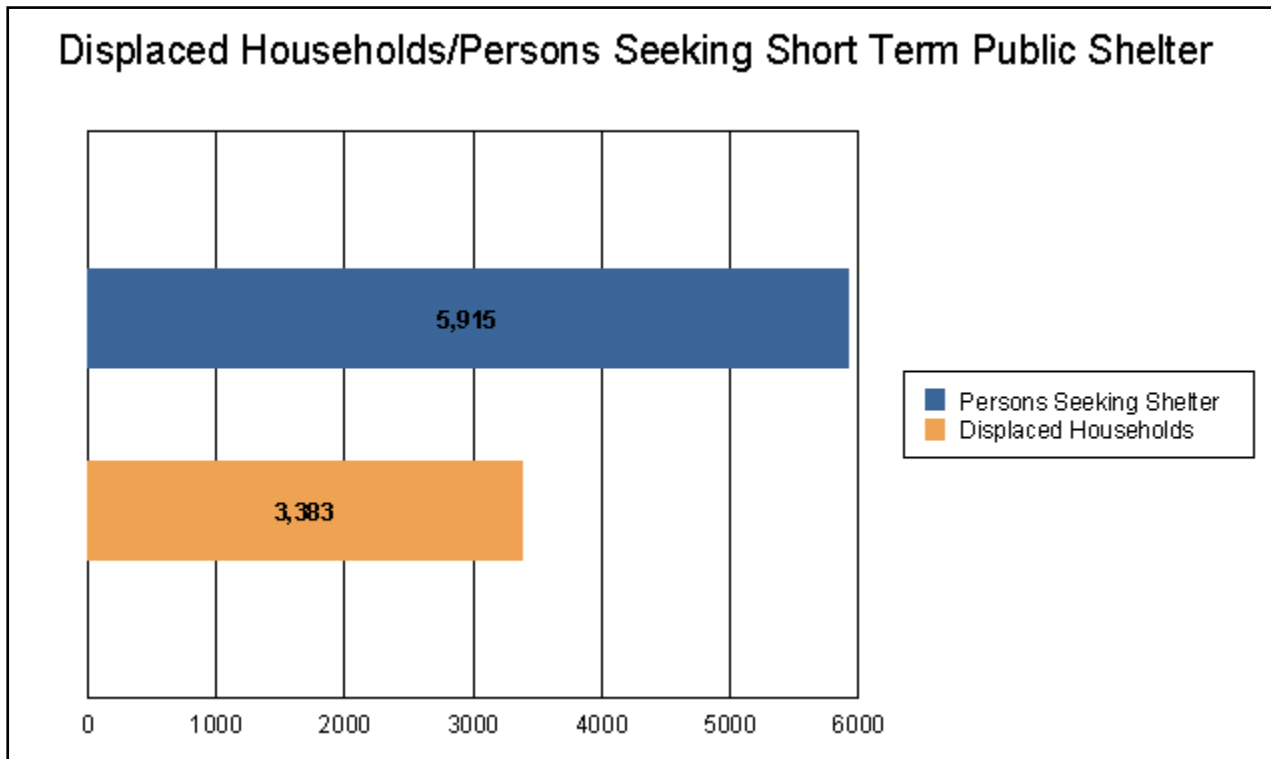


The model estimates that a total of 84,260 tons of debris will be generated. Of the total amount, Finishes comprises 27% of the total, Structure comprises 42% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 3,370 truckloads (@25 tons/truck) to remove the debris generated by the flood.

## Social Impact

### Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 3,383 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 5,915 people (out of a total population of 116,111) will seek temporary shelter in public shelters.



## Economic Loss

The total economic loss estimated for the flood is 597.40 million dollars, which represents 27.15 % of the total replacement value of the scenario buildings.

### **Building-Related Losses**

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

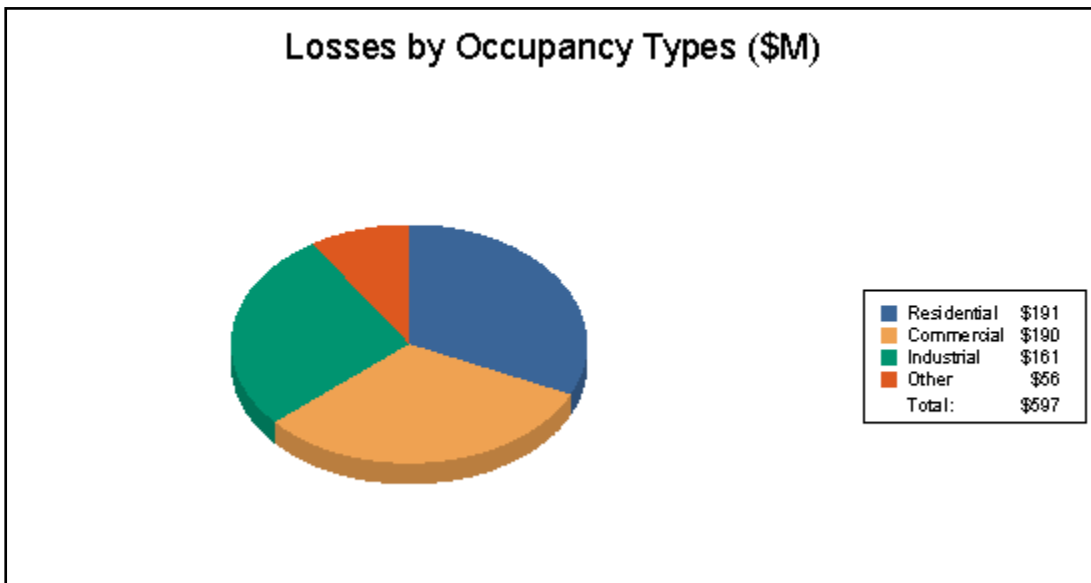
The total building-related losses were 592.13 million dollars. 1% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 31.90% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.





**Table 6: Building-Related Economic Loss Estimates**  
(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
<u>Building Loss</u>						
	Building	91.41	38.96	20.52	9.98	160.87
	Content	98.89	138.84	102.12	39.83	379.68
	Inventory	0.00	10.15	38.68	2.74	51.58
	<b>Subtotal</b>	<b>190.30</b>	<b>187.96</b>	<b>161.32</b>	<b>52.55</b>	<b>592.13</b>
<u>Business Interruption</u>						
	Income	0.01	0.59	0.01	0.13	0.74
	Relocation	0.17	0.24	0.02	0.07	0.50
	Rental Income	0.04	0.16	0.00	0.00	0.20
	Wage	0.04	0.95	0.03	2.82	3.84
	<b>Subtotal</b>	<b>0.26</b>	<b>1.94</b>	<b>0.06</b>	<b>3.02</b>	<b>5.27</b>
<u>ALL</u>	<b>Total</b>	<b>190.56</b>	<b>189.90</b>	<b>161.38</b>	<b>55.57</b>	<b>597.40</b>





## **Appendix A: County Listing for the Region**

- Pennsylvania
  - Lycoming



**FEMA**



**Appendix B: Regional Population and Building Value Data**

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
<b>Pennsylvania</b>				
Lycoming	116,111	4,150,567	3,276,452	7,427,019
<b>Total</b>	<b>116,111</b>	<b>4,150,567</b>	<b>3,276,452</b>	<b>7,427,019</b>
<b>Total Study Region</b>	<b>116,111</b>	<b>4,150,567</b>	<b>3,276,452</b>	<b>7,427,019</b>

