

# HAZUS-MH: Flood Event Report

**Region Name:** DelawareMR2

**Flood Study Case:** DelawareMR2

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***Disclaimer:***

*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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## 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 184 square miles and contains 8,006 census blocks. There are over 206 thousand households in the region and has a total population of 550,864 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 160,161 buildings in the region with a total building replacement value (excluding contents) of 32,373 million dollars (2002 dollars). Approximately 98.67% of the buildings (and 86.08% of the building value) are associated with residential housing.

## Building Inventory

### General Building Stock

HAZUS estimates that there are 160,161 buildings in the region which have an aggregate total replacement value of 32,373 million (2002 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Study Case 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**

<b>Occupancy</b>	<b>Exposure (\$1000)</b>	<b>Percent of Total</b>
Residential	27,866,433	86.1%
Commercial	3,382,629	10.4%
Industrial	600,382	1.9%
Agricultural	33,505	0.1%
Religion	191,040	0.6%
Government	61,017	0.2%
Education	237,910	0.7%
Total	32,372,916	100.00%

**Table 2**  
**Building Exposure by Occupancy Type for the Study Case**

<b>Occupancy</b>	<b>Exposure (\$1000)</b>	<b>Percent of Total</b>
Residential	3,671,489	85.8%
Commercial	433,604	10.1%
Industrial	94,081	2.2%
Agricultural	4,062	0.1%
Religion	28,486	0.7%
Government	5,202	0.1%
Education	43,631	1.0%
Total	4,280,555	100.00%

### Essential Facility Inventory

For essential facilities, there are 6 hospitals in the region with a total bed capacity of 1,327 beds. There are 216 schools, 29 fire stations, 35 police stations and 2 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.

<b>Study Region Name:</b>	DelawareMR2
<b>Scenario Name:</b>	DelawareMR2
<b>Return Period Analyzed:</b>	200
<b>Analysis Options Analyzed:</b>	0

## General Building Stock Damage

HAZUS estimates that about 1,050 buildings will be at least moderately damaged. This is over 58% of the total number of buildings in the region. There are an estimated 18 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 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.

**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	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	2	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	918	84.76	91	8.40	36	3.32	13	1.20	7	0.65	18	1.66
<b>Total</b>	<b>923</b>		<b>91</b>		<b>36</b>		<b>13</b>		<b>7</b>		<b>18</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	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	299	85.67	28	8.02	10	2.87	4	1.15	2	0.57	6	1.72
Steel	2	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	619	84.33	63	8.58	26	3.54	9	1.23	5	0.68	12	1.63

## Essential Facility Damage

Before the flood analyzed in this study case, the region had 0 hospital beds available for use. On the day of the study case flood event, the model estimates that 0 hospital beds are available in the region.

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

Classification	# Facilities			
	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	29	0	0	0
Hospitals	6	0	0	0
Police Stations	35	0	0	0
Schools	216	0	0	0

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 66,521 tons of debris will be generated. Of the total amount, Finishes comprises 38% of the total, Structure comprises 37% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 2,661 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 2,331 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 5,493 people (out of a total population of 550,864) will seek temporary shelter in public shelters.



## Economic Loss

The total economic loss estimated for the flood is 296.59 million dollars, which represents 9.28 % of the total replacement value of the study case 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 242.37 million dollars. 18% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 63.52% 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)

<b>Category</b>	<b>Area</b>	<b>Residential</b>	<b>Commercial</b>	<b>Industrial</b>	<b>Others</b>	<b>Total</b>
<b><u>Building Loss</u></b>						
	Building	117.54	9.46	4.46	0.69	132.15
	Content	69.87	23.55	11.43	2.97	107.82
	Inventory	0.00	0.65	1.72	0.02	2.39
	<b>Subtotal</b>	<b>187.41</b>	<b>33.66</b>	<b>17.61</b>	<b>3.68</b>	<b>242.37</b>
<b><u>Business Interruption</u></b>						
	Income	0.08	18.14	0.27	0.81	19.30
	Relocation	0.44	0.50	0.05	0.03	1.01
	Rental Income	0.28	0.34	0.01	0.00	0.63
	Wage	0.19	16.69	0.47	15.93	33.28
	<b>Subtotal</b>	<b>0.99</b>	<b>35.67</b>	<b>0.80</b>	<b>16.76</b>	<b>54.22</b>
<b>ALL</b>	<b>Total</b>	<b>188.40</b>	<b>69.33</b>	<b>18.41</b>	<b>20.45</b>	<b>296.59</b>

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

Pennsylvania  
- Delaware

## Appendix B: Regional Population and Building Value Data

	Building Value (thousands of dollars)			Total
	Population	Residential	Non-Residential	
<b>Pennsylvania</b>				
Delaware	550,864	27,866,433	4,506,483	32,372,916
<b>Total State</b>	<b>550,864</b>	<b>27,866,433</b>	<b>4,506,483</b>	<b>32,372,916</b>
<b>Total Study Region</b>	<b>550,864</b>	<b>27,866,433</b>	<b>4,506,483</b>	<b>32,372,916</b>