

# Hazus-MH: Flood Global Risk Report

Region Name:EssexFlood Scenario:EssexAllPrint Date:Thursday, April 16, 2020

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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# **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):

- Connecticut

Note:

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

The geographical size of the region is approximately 11 square miles and contains 179 census blocks. The region contains over 3 thousand households and has a total population of 6,683 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 3,181 buildings in the region with a total building replacement value (excluding contents) of 1,480 million dollars. Approximately 87.08% of the buildings (and 72.38% of the building value) are associated with residential housing.







## **Building Inventory**

#### **General Building Stock**

Hazus estimates that there are 3,181 buildings in the region which have an aggregate total replacement value of 1,480 million 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.

| Occupancy    | Exposure (\$1000) | Percent of Total |
|--------------|-------------------|------------------|
| Residential  | 1,070,956         | 72.4%            |
| Commercial   | 288,024           | 19.5%            |
| Industrial   | 75,832            | 5.1%             |
| Agricultural | 6,853             | 0.5%             |
| Religion     | 19,298            | 1.3%             |
| Government   | 4,286             | 0.3%             |
| Education    | 14,373            | 1.0%             |
| Total        | 1,479,622         | 100%             |

 Table 1

 Building Exposure by Occupancy Type for the Study Region









 Table 2

 Building Exposure by Occupancy Type for the Scenario

| Occupancy    | Exposure (\$1000) | Percent of Total |
|--------------|-------------------|------------------|
| Residential  | 804,673           | 70.5%            |
| Commercial   | 238,857           | 20.9%            |
| Industrial   | 67,205            | 5.9%             |
| Agricultural | 4,785             | 0.4%             |
| Religion     | 8,308             | 0.7%             |
| Government   | 4,286             | 0.4%             |
| Education    | 13,733            | 1.2%             |
| Total        | 1,141,847         | 100%             |



#### **Essential Facility Inventory**

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 school, 2 fire stations, 2 police stations and 1 emergency operation center.



RiskMAP



## **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:         | Essex       |
|----------------------------|-------------|
| Scenario Name:             | EssexAll    |
| Return Period Analyzed:    | 10          |
| 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 6 buildings will be at least moderately damaged. This is over 79% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in 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







|             | 1-    | -10 | 11    | -20 | 21    | -30 | 31    | -40 | 41    | -50 | >5    | 0   |
|-------------|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|
| Occupancy   | Count | (%) |
| Agriculture | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Commercial  | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Education   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Government  | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Industrial  | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Religion    | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Residential | 105   | 95  | 6     | 5   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Total       | 105   |     | 6     |     | 0     |     | 0     |     | 0     |     | 0     |     |

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









| Building     | 1.        | ·10 | 11-2      | 20 | 21-3      | 80 | 31-4      | 10 | 41-       | 50 | >50       |   |
|--------------|-----------|-----|-----------|----|-----------|----|-----------|----|-----------|----|-----------|---|
| Туре         | Count (%) |     | Count (%) |    | Count (%) |    | Count (%) |    | Count (%) |    | Count (%) |   |
| Concrete     | 0         | 0   | 0         | 0  | 0         | 0  | 0         | 0  | 0         | 0  | 0         | 0 |
| ManufHousing | 0         | 0   | 0         | 0  | 0         | 0  | 0         | 0  | 0         | 0  | 0         | 0 |
| Masonry      | 1         | 100 | 0         | 0  | 0         | 0  | 0         | 0  | 0         | 0  | 0         | 0 |
| Steel        | 0         | 0   | 0         | 0  | 0         | 0  | 0         | 0  | 0         | 0  | 0         | 0 |
| Wood         | 104       | 95  | 6         | 5  | 0         | 0  | 0         | 0  | 0         | 0  | 0         | 0 |

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







## **Essential Facility Damage**

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

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

|                             |       | # Facilities         |                         |             |  |  |  |
|-----------------------------|-------|----------------------|-------------------------|-------------|--|--|--|
| Classification              | Total | At Least<br>Moderate | At Least<br>Substantial | Loss of Use |  |  |  |
| Emergency Operation Centers | 1     | 0                    | 0                       | 0           |  |  |  |
| Fire Stations               | 2     | 0                    | 0                       | 0           |  |  |  |
| Hospitals                   | 0     | 0                    | 0                       | 0           |  |  |  |
| Police Stations             | 2     | 0                    | 0                       | 0           |  |  |  |
| Schools                     | 1     | 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 133 tons of debris will be generated. Of the total amount, Finishes comprises 100% of the total, Structure comprises 0% of the total, and Foundation comprises 0%. If the debris tonnage is converted into an estimated number of truckloads, it will require 6 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 165 households (or 495 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 19 people (out of a total population of 6,683) will seek temporary shelter in public shelters.









#### Economic Loss

The total economic loss estimated for the flood is 54.63 million dollars, which represents 4.78 % 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 13.45 million dollars. 75% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 19.02% 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 |
|-------------|---------------|-------------|------------|------------|--------|-------|
|             |               |             |            |            |        |       |
| Building Lo | SS            |             |            |            |        |       |
|             | Building      | 3.94        | 1.49       | 0.22       | 0.10   | 5.74  |
|             | Content       | 1.88        | 4.74       | 0.33       | 0.68   | 7.62  |
|             | Inventory     | 0.00        | 0.04       | 0.04       | 0.01   | 0.09  |
|             | Subtotal      | 5.81        | 6.26       | 0.58       | 0.79   | 13.45 |
| Business Ir | nterruption   |             |            |            |        |       |
|             | Income        | 0.03        | 13.87      | 0.05       | 0.91   | 14.86 |
|             | Relocation    | 3.24        | 3.75       | 0.07       | 0.45   | 7.52  |
|             | Rental Income | 1.22        | 2.52       | 0.01       | 0.04   | 3.79  |
|             | Wage          | 0.08        | 11.84      | 0.09       | 3.01   | 15.01 |
|             | Subtotal      | 4.58        | 31.98      | 0.22       | 4.41   | 41.18 |
| <u>ALL</u>  | Total         | 10.39       | 38.24      | 0.80       | 5.20   | 54.63 |









## Appendix A: County Listing for the Region

Connecticut

- Middlesex







## Appendix B: Regional Population and Building Value Data

|                    |            | Building Value (thousands of dollars) |                 |           |  |  |
|--------------------|------------|---------------------------------------|-----------------|-----------|--|--|
|                    | Population | Residential                           | Non-Residential | Total     |  |  |
| Connecticut        |            |                                       |                 |           |  |  |
| Middlesex          | 6,683      | 1,070,956                             | 408,666         | 1,479,622 |  |  |
| Total              | 6,683      | 1,070,956                             | 408,666         | 1,479,622 |  |  |
| Total Study Region | 6,683      | 1,070,956                             | 408,666         | 1,479,622 |  |  |







# Hazus-MH: Flood Global Risk Report

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| 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                                 |        |  |
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# **General Description of the Region**

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

- Connecticut

Note:

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

The geographical size of the region is approximately 11 square miles and contains 179 census blocks. The region contains over 3 thousand households and has a total population of 6,683 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 3,181 buildings in the region with a total building replacement value (excluding contents) of 1,480 million dollars. Approximately 87.08% of the buildings (and 72.38% of the building value) are associated with residential housing.







## **Building Inventory**

#### **General Building Stock**

Hazus estimates that there are 3,181 buildings in the region which have an aggregate total replacement value of 1,480 million 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.

| Occupancy    | Exposure (\$1000) | Percent of Total |
|--------------|-------------------|------------------|
| Residential  | 1,070,956         | 72.4%            |
| Commercial   | 288,024           | 19.5%            |
| Industrial   | 75,832            | 5.1%             |
| Agricultural | 6,853             | 0.5%             |
| Religion     | 19,298            | 1.3%             |
| Government   | 4,286             | 0.3%             |
| Education    | 14,373            | 1.0%             |
| Total        | 1,479,622         | 100%             |

 Table 1

 Building Exposure by Occupancy Type for the Study Region









 Table 2

 Building Exposure by Occupancy Type for the Scenario

| Occupancy    | Exposure (\$1000) | Percent of Total |
|--------------|-------------------|------------------|
| Residential  | 804,673           | 70.5%            |
| Commercial   | 238,857           | 20.9%            |
| Industrial   | 67,205            | 5.9%             |
| Agricultural | 4,785             | 0.4%             |
| Religion     | 8,308             | 0.7%             |
| Government   | 4,286             | 0.4%             |
| Education    | 13,733            | 1.2%             |
| Total        | 1,141,847         | 100%             |



#### **Essential Facility Inventory**

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 school, 2 fire stations, 2 police stations and 1 emergency operation center.



RiskMAP



## **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:         | Essex       |
|----------------------------|-------------|
| Scenario Name:             | EssexAll    |
| Return Period Analyzed:    | 25          |
| 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 13 buildings will be at least moderately damaged. This is over 82% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in 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







|             | 1-    | -10 | 11    | -20 | 21    | -30 | 31    | -40 | 41    | -50 | >5    | 0   |
|-------------|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|
| Occupancy   | Count | (%) |
| Agriculture | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Commercial  | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Education   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Government  | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Industrial  | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Religion    | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Residential | 112   | 90  | 13    | 10  | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Total       | 112   |     | 13    |     | 0     |     | 0     |     | 0     |     | 0     |     |

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









| Building     | 1.    | ·10 | 11-   | 20  | 21-3    | 30 | 31-4    | 40 | 41-     | 50 | >50     | )  |
|--------------|-------|-----|-------|-----|---------|----|---------|----|---------|----|---------|----|
| Туре         | Count | (%) | Count | (%) | Count ( | %) |
| Concrete     | 0     | 0   | 0     | 0   | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |
| ManufHousing | 0     | 0   | 0     | 0   | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |
| Masonry      | 1     | 100 | 0     | 0   | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |
| Steel        | 0     | 0   | 0     | 0   | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |
| Wood         | 111   | 90  | 13    | 10  | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |

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







## **Essential Facility Damage**

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

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

|                             |       | # Facilities         |                         |             |  |  |  |  |
|-----------------------------|-------|----------------------|-------------------------|-------------|--|--|--|--|
| Classification              | Total | At Least<br>Moderate | At Least<br>Substantial | Loss of Use |  |  |  |  |
| Emergency Operation Centers | 1     | 0                    | 0                       | 0           |  |  |  |  |
| Fire Stations               | 2     | 0                    | 0                       | 0           |  |  |  |  |
| Hospitals                   | 0     | 0                    | 0                       | 0           |  |  |  |  |
| Police Stations             | 2     | 0                    | 0                       | 0           |  |  |  |  |
| Schools                     | 1     | 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 170 tons of debris will be generated. Of the total amount, Finishes comprises 100% of the total, Structure comprises 0% of the total, and Foundation comprises 0%. If the debris tonnage is converted into an estimated number of truckloads, it will require 7 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 181 households (or 543 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 23 people (out of a total population of 6,683) will seek temporary shelter in public shelters.









#### Economic Loss

The total economic loss estimated for the flood is 63.46 million dollars, which represents 5.56 % 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 16.84 million dollars. 73% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 19.32% 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 |
|-------------|---------------|-------------|------------|------------|--------|-------|
|             |               |             |            |            |        |       |
| Building Lo | ISS I         |             |            |            |        |       |
| -           | Building      | 4.87        | 1.87       | 0.28       | 0.13   | 7.16  |
|             | Content       | 2.34        | 5.91       | 0.44       | 0.87   | 9.56  |
|             | Inventory     | 0.00        | 0.05       | 0.05       | 0.02   | 0.12  |
|             | Subtotal      | 7.21        | 7.83       | 0.77       | 1.03   | 16.84 |
| Business II | nterruption   |             |            |            |        |       |
|             | Income        | 0.05        | 15.59      | 0.06       | 1.01   | 16.71 |
|             | Relocation    | 3.56        | 4.28       | 0.09       | 0.50   | 8.43  |
|             | Rental Income | 1.33        | 2.88       | 0.01       | 0.05   | 4.27  |
|             | Wage          | 0.11        | 13.78      | 0.12       | 3.21   | 17.22 |
|             | Subtotal      | 5.05        | 36.53      | 0.29       | 4.76   | 46.63 |
| ALL         | Total         | 12.26       | 44.36      | 1.05       | 5.79   | 63.46 |









## Appendix A: County Listing for the Region

Connecticut

- Middlesex







## Appendix B: Regional Population and Building Value Data

|                    |            | Building Value (thousands of dollars) |                 |           |  |  |  |
|--------------------|------------|---------------------------------------|-----------------|-----------|--|--|--|
|                    | Population | Residential                           | Non-Residential | Total     |  |  |  |
| Connecticut        |            |                                       |                 |           |  |  |  |
| Middlesex          | 6,683      | 1,070,956                             | 408,666         | 1,479,622 |  |  |  |
| Total              | 6,683      | 1,070,956                             | 408,666         | 1,479,622 |  |  |  |
| Total Study Region | 6,683      | 1,070,956                             | 408,666         | 1,479,622 |  |  |  |







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

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There are an estimated 3,181 buildings in the region with a total building replacement value (excluding contents) of 1,480 million dollars. Approximately 87.08% of the buildings (and 72.38% of the building value) are associated with residential housing.







## **Building Inventory**

#### **General Building Stock**

Hazus estimates that there are 3,181 buildings in the region which have an aggregate total replacement value of 1,480 million 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.

| Occupancy    | Exposure (\$1000) | Percent of Total |
|--------------|-------------------|------------------|
| Residential  | 1,070,956         | 72.4%            |
| Commercial   | 288,024           | 19.5%            |
| Industrial   | 75,832            | 5.1%             |
| Agricultural | 6,853             | 0.5%             |
| Religion     | 19,298            | 1.3%             |
| Government   | 4,286             | 0.3%             |
| Education    | 14,373            | 1.0%             |
| Total        | 1,479,622         | 100%             |

 Table 1

 Building Exposure by Occupancy Type for the Study Region








 Table 2

 Building Exposure by Occupancy Type for the Scenario

| Occupancy    | Exposure (\$1000) | Percent of Total |
|--------------|-------------------|------------------|
| Residential  | 804,673           | 70.5%            |
| Commercial   | 238,857           | 20.9%            |
| Industrial   | 67,205            | 5.9%             |
| Agricultural | 4,785             | 0.4%             |
| Religion     | 8,308             | 0.7%             |
| Government   | 4,286             | 0.4%             |
| Education    | 13,733            | 1.2%             |
| Total        | 1,141,847         | 100%             |



### **Essential Facility Inventory**

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 school, 2 fire stations, 2 police stations and 1 emergency operation center.



RiskMAP



# **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:         | Essex       |
|----------------------------|-------------|
| Scenario Name:             | EssexAll    |
| Return Period Analyzed:    | 50          |
| 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 24 buildings will be at least moderately damaged. This is over 83% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in 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







| 1-10        |       | -10 | 11-20 |     | 21    | 21-30 |       | 31-40 |       | 41-50 |       | >50 |  |
|-------------|-------|-----|-------|-----|-------|-------|-------|-------|-------|-------|-------|-----|--|
| Occupancy   | Count | (%) | Count | (%) | Count | (%)   | Count | (%)   | Count | (%)   | Count | (%) |  |
| Agriculture | 0     | 0   | 0     | 0   | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0   |  |
| Commercial  | 1     | 100 | 0     | 0   | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0   |  |
| Education   | 0     | 0   | 0     | 0   | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0   |  |
| Government  | 0     | 0   | 0     | 0   | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0   |  |
| Industrial  | 0     | 0   | 0     | 0   | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0   |  |
| Religion    | 0     | 0   | 0     | 0   | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0   |  |
| Residential | 120   | 83  | 24    | 17  | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0   |  |
| Total       | 121   |     | 24    |     | 0     |       | 0     |       | 0     |       | 0     |     |  |

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









| Building<br>Type | 1-10  |     | 11-20 |     | 21-30   |    | 31-40   |    | 41-50   |    | >50     |    |
|------------------|-------|-----|-------|-----|---------|----|---------|----|---------|----|---------|----|
|                  | Count | (%) | Count | (%) | Count ( | %) |
| Concrete         | 0     | 0   | 0     | 0   | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |
| ManufHousing     | 0     | 0   | 0     | 0   | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |
| Masonry          | 1     | 100 | 0     | 0   | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |
| Steel            | 1     | 100 | 0     | 0   | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |
| Wood             | 119   | 83  | 24    | 17  | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |

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







### **Essential Facility Damage**

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

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

|                             |       |                      | # Facilities            |             |
|-----------------------------|-------|----------------------|-------------------------|-------------|
| Classification              | Total | At Least<br>Moderate | At Least<br>Substantial | Loss of Use |
| Emergency Operation Centers | 1     | 0                    | 0                       | 0           |
| Fire Stations               | 2     | 0                    | 0                       | 0           |
| Hospitals                   | 0     | 0                    | 0                       | 0           |
| Police Stations             | 2     | 0                    | 0                       | 0           |
| Schools                     | 1     | 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 219 tons of debris will be generated. Of the total amount, Finishes comprises 100% of the total, Structure comprises 0% of the total, and Foundation comprises 0%. If the debris tonnage is converted into an estimated number of truckloads, it will require 9 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 204 households (or 612 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 28 people (out of a total population of 6,683) will seek temporary shelter in public shelters.









#### Economic Loss

The total economic loss estimated for the flood is 72.48 million dollars, which represents 6.35 % 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 20.74 million dollars. 71% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 20.36% 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 |
|-------------|---------------|-------------|------------|------------|--------|-------|
|             |               |             |            |            |        |       |
| Building Lo | <u>SS</u>     |             |            |            |        |       |
| -           | Building      | 6.20        | 2.26       | 0.40       | 0.15   | 9.01  |
|             | Content       | 2.92        | 7.05       | 0.59       | 1.01   | 11.58 |
|             | Inventory     | 0.00        | 0.06       | 0.07       | 0.02   | 0.15  |
|             | Subtotal      | 9.12        | 9.38       | 1.05       | 1.19   | 20.74 |
| Business Ir | nterruption   |             |            |            |        |       |
|             | Income        | 0.05        | 17.25      | 0.07       | 1.07   | 18.44 |
|             | Relocation    | 3.99        | 4.74       | 0.11       | 0.52   | 9.36  |
|             | Rental Income | 1.47        | 3.21       | 0.01       | 0.05   | 4.74  |
|             | Wage          | 0.13        | 15.54      | 0.14       | 3.39   | 19.20 |
|             | Subtotal      | 5.64        | 40.74      | 0.33       | 5.03   | 51.74 |
| ALL         | Total         | 14.76       | 50.12      | 1.38       | 6.22   | 72.48 |









### Appendix A: County Listing for the Region

Connecticut

- Middlesex







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

|                    |            | Building Value (thousands of dollars) |                 |           |  |  |  |  |
|--------------------|------------|---------------------------------------|-----------------|-----------|--|--|--|--|
|                    | Population | Residential                           | Non-Residential | Total     |  |  |  |  |
| Connecticut        |            |                                       |                 |           |  |  |  |  |
| Middlesex          | 6,683      | 1,070,956                             | 408,666         | 1,479,622 |  |  |  |  |
| Total              | 6,683      | 1,070,956                             | 408,666         | 1,479,622 |  |  |  |  |
| Total Study Region | 6,683      | 1,070,956                             | 408,666         | 1,479,622 |  |  |  |  |







# Hazus-MH: Flood Global Risk Report

Region Name:EssexFlood Scenario:EssexAllPrint Date:Thursday, April 16, 2020

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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# **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):

- Connecticut

Note:

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

The geographical size of the region is approximately 11 square miles and contains 179 census blocks. The region contains over 3 thousand households and has a total population of 6,683 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 3,181 buildings in the region with a total building replacement value (excluding contents) of 1,480 million dollars. Approximately 87.08% of the buildings (and 72.38% of the building value) are associated with residential housing.







### **Building Inventory**

### **General Building Stock**

Hazus estimates that there are 3,181 buildings in the region which have an aggregate total replacement value of 1,480 million 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.

| Occupancy    | Exposure (\$1000) | Percent of Total |
|--------------|-------------------|------------------|
| Residential  | 1,070,956         | 72.4%            |
| Commercial   | 288,024           | 19.5%            |
| Industrial   | 75,832            | 5.1%             |
| Agricultural | 6,853             | 0.5%             |
| Religion     | 19,298            | 1.3%             |
| Government   | 4,286             | 0.3%             |
| Education    | 14,373            | 1.0%             |
| Total        | 1,479,622         | 100%             |

 Table 1

 Building Exposure by Occupancy Type for the Study Region









 Table 2

 Building Exposure by Occupancy Type for the Scenario

| Occupancy    | Exposure (\$1000) | Percent of Total |
|--------------|-------------------|------------------|
| Residential  | 804,673           | 70.5%            |
| Commercial   | 238,857           | 20.9%            |
| Industrial   | 67,205            | 5.9%             |
| Agricultural | 4,785             | 0.4%             |
| Religion     | 8,308             | 0.7%             |
| Government   | 4,286             | 0.4%             |
| Education    | 13,733            | 1.2%             |
| Total        | 1,141,847         | 100%             |



### **Essential Facility Inventory**

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 school, 2 fire stations, 2 police stations and 1 emergency operation center.



RiskMAP



# **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:         | Essex       |
|----------------------------|-------------|
| Scenario Name:             | EssexAll    |
| 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 38 buildings will be at least moderately damaged. This is over 85% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in 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







| 1-10        |       | 11  | 11-20 |     | 21-30 |     | 31-40 |     | 41-50 |     | >50   |     |
|-------------|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|
| Occupancy   | Count | (%) |
| Agriculture | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Commercial  | 3     | 100 | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Education   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Government  | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Industrial  | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Religion    | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Residential | 131   | 78  | 38    | 22  | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Total       | 134   |     | 38    |     | 0     |     | 0     |     | 0     |     | 0     |     |

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









| Building<br>Type | 1-10  |     | 1-10 11-20 |     | 21-30   |    | 31-40   |    | 41-50   |    | >50     |    |
|------------------|-------|-----|------------|-----|---------|----|---------|----|---------|----|---------|----|
|                  | Count | (%) | Count      | (%) | Count ( | %) |
| Concrete         | 0     | 0   | 0          | 0   | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |
| ManufHousing     | 0     | 0   | 0          | 0   | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |
| Masonry          | 2     | 100 | 0          | 0   | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |
| Steel            | 1     | 100 | 0          | 0   | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |
| Wood             | 130   | 77  | 38         | 23  | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |

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







### **Essential Facility Damage**

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

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

|                             |       |                      | # Facilities            |             |
|-----------------------------|-------|----------------------|-------------------------|-------------|
| Classification              | Total | At Least<br>Moderate | At Least<br>Substantial | Loss of Use |
| Emergency Operation Centers | 1     | 0                    | 0                       | 0           |
| Fire Stations               | 2     | 0                    | 0                       | 0           |
| Hospitals                   | 0     | 0                    | 0                       | 0           |
| Police Stations             | 2     | 0                    | 0                       | 0           |
| Schools                     | 1     | 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 279 tons of debris will be generated. Of the total amount, Finishes comprises 100% of the total, Structure comprises 0% of the total, and Foundation comprises 0%. If the debris tonnage is converted into an estimated number of truckloads, it will require 12 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 236 households (or 708 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 32 people (out of a total population of 6,683) will seek temporary shelter in public shelters.









#### Economic Loss

The total economic loss estimated for the flood is 81.88 million dollars, which represents 7.17 % 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 25.54 million dollars. 69% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 21.85% 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 |
|-------------|---------------|-------------|------------|------------|--------|-------|
|             |               |             |            |            |        |       |
| Building Lo | SS            |             |            |            |        |       |
| -           | Building      | 7.72        | 2.73       | 0.53       | 0.20   | 11.18 |
|             | Content       | 3.58        | 8.51       | 0.84       | 1.24   | 14.16 |
|             | Inventory     | 0.00        | 0.07       | 0.10       | 0.03   | 0.20  |
|             | Subtotal      | 11.30       | 11.31      | 1.47       | 1.46   | 25.54 |
| Business Ir | nterruption   |             |            |            |        |       |
|             | Income        | 0.06        | 18.51      | 0.09       | 1.15   | 19.80 |
|             | Relocation    | 4.66        | 5.12       | 0.13       | 0.55   | 10.46 |
|             | Rental Income | 1.73        | 3.48       | 0.02       | 0.05   | 5.28  |
|             | Wage          | 0.14        | 16.87      | 0.17       | 3.64   | 20.81 |
|             | Subtotal      | 6.59        | 43.97      | 0.39       | 5.38   | 56.34 |
| <u>ALL</u>  | Total         | 17.89       | 55.28      | 1.87       | 6.85   | 81.88 |









### Appendix A: County Listing for the Region

Connecticut

- Middlesex







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

|                    |            | Building Value (thousands of dollars) |                 |           |  |  |  |  |
|--------------------|------------|---------------------------------------|-----------------|-----------|--|--|--|--|
|                    | Population | Residential                           | Non-Residential | Total     |  |  |  |  |
| Connecticut        |            |                                       |                 |           |  |  |  |  |
| Middlesex          | 6,683      | 1,070,956                             | 408,666         | 1,479,622 |  |  |  |  |
| Total              | 6,683      | 1,070,956                             | 408,666         | 1,479,622 |  |  |  |  |
| Total Study Region | 6,683      | 1,070,956                             | 408,666         | 1,479,622 |  |  |  |  |







# Hazus-MH: Flood Global Risk Report

Region Name:EssexFlood Scenario:EssexAllPrint Date:Thursday, April 16, 2020

Disclaimer:

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# **General Description of the Region**

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

- Connecticut

Note:

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

The geographical size of the region is approximately 11 square miles and contains 179 census blocks. The region contains over 3 thousand households and has a total population of 6,683 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 3,181 buildings in the region with a total building replacement value (excluding contents) of 1,480 million dollars. Approximately 87.08% of the buildings (and 72.38% of the building value) are associated with residential housing.







### **Building Inventory**

### **General Building Stock**

Hazus estimates that there are 3,181 buildings in the region which have an aggregate total replacement value of 1,480 million 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.

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|--------------|-------------------|------------------|
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| Industrial   | 75,832            | 5.1%             |
| Agricultural | 6,853             | 0.5%             |
| Religion     | 19,298            | 1.3%             |
| Government   | 4,286             | 0.3%             |
| Education    | 14,373            | 1.0%             |
| Total        | 1,479,622         | 100%             |

 Table 1

 Building Exposure by Occupancy Type for the Study Region









 Table 2

 Building Exposure by Occupancy Type for the Scenario

| Occupancy    | Exposure (\$1000) | Percent of Total |
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| Religion     | 8,308             | 0.7%             |
| Government   | 4,286             | 0.4%             |
| Education    | 13,733            | 1.2%             |
| Total        | 1,141,847         | 100%             |



### **Essential Facility Inventory**

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 school, 2 fire stations, 2 police stations and 1 emergency operation center.



RiskMAP



# **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:         | Essex       |
|----------------------------|-------------|
| Scenario Name:             | EssexAll    |
| Return Period Analyzed:    | 500         |
| 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 83 buildings will be at least moderately damaged. This is over 88% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in 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







| 1-10        |       | 11  | 11-20 |     | 21-30 |     | 31-40 |     | 41-50 |     | >50   |     |
|-------------|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|
| Occupancy   | Count | (%) |
| Agriculture | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Commercial  | 4     | 67  | 2     | 33  | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Education   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Government  | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Industrial  | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Religion    | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   | 0     | 0   |
| Residential | 159   | 66  | 78    | 33  | 3     | 1   | 0     | 0   | 0     | 0   | 0     | 0   |
| Total       | 163   |     | 80    |     | 3     |     | 0     |     | 0     |     | 0     |     |

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








| Building     | 1-    | 10  | 11-   | 20  | 21-3    | 30 | 31-4    | 40 | 41-     | 50 | >50     | )  |
|--------------|-------|-----|-------|-----|---------|----|---------|----|---------|----|---------|----|
| Туре         | Count | (%) | Count | (%) | Count ( | %) |
| Concrete     | 0     | 0   | 0     | 0   | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |
| ManufHousing | 0     | 0   | 0     | 0   | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |
| Masonry      | 6     | 75  | 2     | 25  | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |
| Steel        | 3     | 75  | 1     | 25  | 0       | 0  | 0       | 0  | 0       | 0  | 0       | 0  |
| Wood         | 155   | 66  | 77    | 33  | 3       | 1  | 0       | 0  | 0       | 0  | 0       | 0  |

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







## **Essential Facility Damage**

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

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

|                             |       | # Facilities         |                         |             |  |  |  |  |
|-----------------------------|-------|----------------------|-------------------------|-------------|--|--|--|--|
| Classification              | Total | At Least<br>Moderate | At Least<br>Substantial | Loss of Use |  |  |  |  |
| Emergency Operation Centers | 1     | 0                    | 0                       | 0           |  |  |  |  |
| Fire Stations               | 2     | 0                    | 0                       | 0           |  |  |  |  |
| Hospitals                   | 0     | 0                    | 0                       | 0           |  |  |  |  |
| Police Stations             | 2     | 0                    | 0                       | 0           |  |  |  |  |
| Schools                     | 1     | 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 492 tons of debris will be generated. Of the total amount, Finishes comprises 100% of the total, Structure comprises 0% of the total, and Foundation comprises 0%. If the debris tonnage is converted into an estimated number of truckloads, it will require 20 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 308 households (or 924 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 43 people (out of a total population of 6,683) will seek temporary shelter in public shelters.









#### Economic Loss

The total economic loss estimated for the flood is 116.59 million dollars, which represents 10.21 % 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 44.49 million dollars. 62% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 23.41% 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  |
|-------------|---------------|-------------|------------|------------|--------|--------|
|             |               |             |            |            |        |        |
| Building Lo | <u>SS</u>     |             |            |            |        |        |
|             | Building      | 12.62       | 5.02       | 1.04       | 0.38   | 19.07  |
|             | Content       | 5.81        | 15.28      | 1.73       | 2.19   | 25.00  |
|             | Inventory     | 0.00        | 0.17       | 0.20       | 0.05   | 0.42   |
|             | Subtotal      | 18.43       | 20.47      | 2.97       | 2.62   | 44.49  |
| Business Ir | nterruption   |             |            |            |        |        |
|             | Income        | 0.10        | 23.40      | 0.12       | 1.33   | 24.95  |
|             | Relocation    | 6.20        | 6.58       | 0.17       | 0.62   | 13.57  |
|             | Rental Income | 2.35        | 4.52       | 0.02       | 0.05   | 6.94   |
|             | Wage          | 0.23        | 21.99      | 0.24       | 4.19   | 26.65  |
|             | Subtotal      | 8.87        | 56.49      | 0.55       | 6.19   | 72.10  |
| <u>ALL</u>  | Total         | 27.30       | 76.97      | 3.52       | 8.81   | 116.59 |









## Appendix A: County Listing for the Region

Connecticut

- Middlesex







# Appendix B: Regional Population and Building Value Data

|                    |            | Building Value (thousands of dollars) |                 |           |  |  |  |
|--------------------|------------|---------------------------------------|-----------------|-----------|--|--|--|
|                    | Population | Residential                           | Non-Residential | Total     |  |  |  |
| Connecticut        |            |                                       |                 |           |  |  |  |
| Middlesex          | 6,683      | 1,070,956                             | 408,666         | 1,479,622 |  |  |  |
| Total              | 6,683      | 1,070,956                             | 408,666         | 1,479,622 |  |  |  |
| Total Study Region | 6,683      | 1,070,956                             | 408,666         | 1,479,622 |  |  |  |











# Hazus: Hurricane Global Risk Report

**Region Name:** 

Essex

Hurricane Scenario:

UN-NAMED-1938-4

Print Date:

Monday, October 14, 2019

**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 Hurricane. These results can be improved by using enhanced inventory data.





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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 and the National Institute of Building Sciences. 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 hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:

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

The geographical size of the region is 11.29 square miles and contains 1 census tracts. There are over 2 thousand households in the region and a total population of 6,683 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 1,480 million dollars (2014 dollars). Approximately 87% of the buildings (and 72% of the building value) are associated with residential housing.





#### **Building Inventory**

#### General Building Stock

Hazus estimates that there are 3,181 buildings in the region which have an aggregate total replacement value of 1,480 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



# Building Exposure by Occupancy Type



| Occupancy    | Exposure (\$1000) | Percent of Tot |
|--------------|-------------------|----------------|
| Residential  | 1,070,956         | 72.38%         |
| Commercial   | 288,024           | 19.47%         |
| Industrial   | 75,832            | 5.13%          |
| Agricultural | 6,853             | 0.46%          |
| Religious    | 19,298            | 1.30%          |
| Government   | 4,286             | 0.29%          |
| Education    | 14,373            | 0.97%          |
| Total        | 1,479,622         | 100.00%        |

#### **Essential Facility Inventory**

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities.





### Hurricane Scenario

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

| Scenario Name:                 | UN-NAMED-1938-4 |
|--------------------------------|-----------------|
| Туре:                          | Historic        |
| Max Peak Gust in Study Region: | 114 mph         |

Hurricane Global Risk Report





### **Building Damage**

#### **General Building Stock Damage**

Hazus estimates that about 307 buildings will be at least moderately damaged. This is over 10% of the total number of buildings in the region. There are an estimated 16 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



| Table 2: Expected | Building | Damage by | Occupancy |
|-------------------|----------|-----------|-----------|
|-------------------|----------|-----------|-----------|

|             | Nor      | e     | Mino   | or    | Mode   | rate  | Seve  | re   | Destruct | tion |
|-------------|----------|-------|--------|-------|--------|-------|-------|------|----------|------|
| Occupancy   | Count    | (%)   | Count  | (%)   | Count  | (%)   | Count | (%)  | Count    | (%)  |
| Agriculture | 8.59     | 61.36 | 3.41   | 24.38 | 1.27   | 9.10  | 0.62  | 4.46 | 0.10     | 0.70 |
| Commercial  | 169.12   | 65.05 | 57.25  | 22.02 | 27.59  | 10.61 | 5.99  | 2.30 | 0.05     | 0.02 |
| Education   | 6.13     | 68.12 | 1.94   | 21.52 | 0.82   | 9.10  | 0.11  | 1.26 | 0.00     | 0.00 |
| Government  | 3.37     | 67.36 | 1.05   | 21.01 | 0.50   | 10.03 | 0.08  | 1.60 | 0.00     | 0.00 |
| Industrial  | 68.27    | 66.93 | 20.66  | 20.26 | 10.17  | 9.97  | 2.67  | 2.62 | 0.22     | 0.21 |
| Religion    | 13.62    | 64.86 | 5.20   | 24.74 | 1.91   | 9.10  | 0.27  | 1.29 | 0.00     | 0.00 |
| Residential | 1,707.20 | 61.63 | 807.75 | 29.16 | 216.28 | 7.81  | 23.54 | 0.85 | 15.24    | 0.55 |
| Total       | 1,976.31 |       | 897.25 | ;     | 258.55 | 5     | 33.29 | •    | 15.60    |      |





#### Table 3: Expected Building Damage by Building Type

| Building | Nor   | ne    | Min   | or    | Mode  | erate | Seve  | ere  | Destru | ction |
|----------|-------|-------|-------|-------|-------|-------|-------|------|--------|-------|
| Туре     | Count | (%)   | Count | (%)   | Count | (%)   | Count | (%)  | Count  | (%)   |
| Concrete | 18    | 65.63 | 6     | 21.01 | 3     | 11.69 | 0     | 1.67 | 0      | 0.00  |
| Masonry  | 128   | 60.72 | 47    | 22.40 | 31    | 14.91 | 4     | 1.72 | 1      | 0.24  |
| МН       | 0     | 0.00  | 0     | 0.00  | 0     | 0.00  | 0     | 0.00 | 0      | 0.00  |
| Steel    | 116   | 67.03 | 33    | 19.07 | 19    | 10.90 | 5     | 2.97 | 0      | 0.03  |
| Wood     | 1,664 | 62.20 | 796   | 29.78 | 179   | 6.68  | 22    | 0.81 | 14     | 0.54  |





#### **Essential Facility Damage**

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, none of the beds will be in service. By 30 days, none will be operational.

#### Thematic Map of Essential Facilities with greater than 50% moderate



#### Table 4: Expected Damage to Essential Facilities

|                 |       |   | # Facilities                               |                                    |
|-----------------|-------|---|--|------------------------------------|
| Classification  | Total | Probability of at<br>Least Moderate<br>Damage > 50% | Probability of<br>Complete<br>Damage > 50% | Expected<br>Loss of Use<br>< 1 day |
| EOCs            | 1     | 0   | 0  | 1                                  |
| Fire Stations   | 2     | 0   | 0  | 2                                  |
| Police Stations | 2     | 0   | 0  | 2                                  |
| Schools         | 1     | 0   | 0  | 0                                  |





### Induced Hurricane Damage

#### **Debris Generation**



Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. 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 18,773 tons of debris will be generated. Of the total amount, 9,894 tons (53%) is Other Tree Debris. Of the remaining 8,879 tons, Brick/Wood comprises 48% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 169 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 4,643 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.





### **Social Impact**

#### Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 14 households to be displaced due to the hurricane. Of these, 5 people (out of a total population of 6,683) will seek temporary shelter in public shelters.





#### **Economic Loss**

The total economic loss estimated for the hurricane is 74.3 million dollars, which represents 5.02 % of the total replacement value of the region's buildings.

#### **Building-Related Losses**

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage 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 hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 74 million dollars. 9% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 81% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.













(Thousands of dollars)

| Category     | Area           | Residential | Commercial | Industrial | Others   | Total     |
|--------------|----------------|-------------|------------|------------|----------|-----------|
| Property Da  | mage_          |             |            |            |          |           |
|              | Building       | 42,200.04   | 5,547.71   | 1,397.22   | 741.26   | 49,886.23 |
|              | Content        | 14,252.19   | 2,250.63   | 909.43     | 252.71   | 17,664.96 |
|              | Inventory      | 0.00        | 52.49      | 112.50     | 8.55     | 173.55    |
|              | Subtotal       | 56,452.22   | 7,850.83   | 2,419.16   | 1,002.52 | 67,724.74 |
| Business Int | erruption Loss |             |            |            |          |           |
|              | Income         | 0.00        | 338.13     | 13.96      | 38.14    | 390.24    |
|              | Relocation     | 2,937.22    | 925.59     | 109.28     | 127.23   | 4,099.32  |
|              | Rental         | 1,135.57    | 496.30     | 14.78      | 11.06    | 1,657.71  |
|              | Wage           | 0.00        | 321.04     | 23.54      | 123.55   | 468.13    |
|              | Subtotal       | 4,072.79    | 2,081.06   | 161.56     | 299.99   | 6,615.40  |





| <u>Total</u> |       |           |          |          |          |           |
|--------------|-------|-----------|----------|----------|----------|-----------|
|              | Total | 60,525.01 | 9,931.90 | 2,580.72 | 1,302.51 | 74,340.13 |





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

Connecticut Middlesov

- Middlesex





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

|                    |            | 1           |                 |           |
|--------------------|------------|-------------|-----------------|-----------|
|                    | Population | Residential | Non-Residential | Total     |
| Connecticut        |            |             |                 |           |
| Middlesex          | 6,683      | 1,070,956   | 408,666         | 1,479,622 |
| Total              | 6,683      | 1,070,956   | 408,666         | 1,479,622 |
| Study Region Total | 6,683      | 1,070,956   | 408,666         | 1,479,622 |







# Hazus: Hurricane Global Risk Report

Region Name: Essex

Hurricane Scenario: Probabilistic 10-year Return Period

Print Date:

Thursday, October 3, 2019

**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 Hurricane. These results can be improved by using enhanced inventory data.





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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 and the National Institute of Building Sciences. 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 hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:

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

The geographical size of the region is 11.29 square miles and contains 1 census tracts. There are over 2 thousand households in the region and a total population of 6,683 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 1,480 million dollars (2014 dollars). Approximately 87% of the buildings (and 72% of the building value) are associated with residential housing.





# **Building Inventory**

#### **General Building Stock**

Hazus estimates that there are 3,181 buildings in the region which have an aggregate total replacement value of 1,480 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



# Building Exposure by Occupancy Type



| Occupancy    | Exposure (\$1000) | Percent of Tot |
|--------------|-------------------|----------------|
| Residential  | 1,070,956         | 72.38 %        |
| Commercial   | 288,024           | 19.47%         |
| Industrial   | 75,832            | 5.13%          |
| Agricultural | 6,853             | 0.46%          |
| Religious    | 19,298            | 1.30%          |
| Government   | 4,286             | 0.29%          |
| Education    | 14,373            | 0.97%          |
| Total        | 1,479,622         | 100.00%        |

#### **Essential Facility Inventory**

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities.





# **Hurricane Scenario**

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

Scenario Name:

Type:

Probabilistic Probabilistic





# **Building Damage**

#### General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



# **Expected Building Damage by Occupancy**

Table 2: Expected Building Damage by Occupancy : 10 - year Event

|             | No       | ne     | Min   | or   | Mode  | rate | Seve  | ere  | Destruc | tion |
|-------------|----------|--------|-------|------|-------|------|-------|------|---------|------|
| Occupancy   | Count    | (%)    | Count | (%)  | Count | (%)  | Count | (%)  | Count   | (%)  |
| Agriculture | 14.00    | 100.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00    | 0.00 |
| Commercial  | 260.00   | 100.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00    | 0.00 |
| Education   | 9.00     | 100.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00    | 0.00 |
| Government  | 5.00     | 100.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00    | 0.00 |
| Industrial  | 102.00   | 100.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00    | 0.00 |
| Religion    | 21.00    | 100.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00    | 0.00 |
| Residential | 2,770.00 | 100.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00    | 0.00 |
| Total       | 3,181.0  | 0      | 0.00  | )    | 0.00  | )    | 0.00  | )    | 0.00    |      |





# Table 3: Expected Building Damage by Building Type : 10 - year Event

| Building | None  |        | e Minor |      | Mode  | Moderate |       | Severe |       | Destruction |  |
|----------|-------|--------|---------|------|-------|----------|-------|--------|-------|-------------|--|
| Туре     | Count | : (%)  | Count   | (%)  | Count | (%)      | Count | (%)    | Count | (%)         |  |
| Concrete | 28    | 100.00 | 0       | 0.00 | 0     | 0.00     | 0     | 0.00   | 0     | 0.00        |  |
| Masonry  | 210   | 100.00 | 0       | 0.00 | 0     | 0.00     | 0     | 0.00   | 0     | 0.00        |  |
| MH       | 0     | 0.00   | 0       | 0.00 | 0     | 0.00     | 0     | 0.00   | 0     | 0.00        |  |
| Steel    | 173   | 100.00 | 0       | 0.00 | 0     | 0.00     | 0     | 0.00   | 0     | 0.00        |  |
| Wood     | 2,675 | 100.00 | 0       | 0.00 | 0     | 0.00     | 0     | 0.00   | 0     | 0.00        |  |





#### **Essential Facility Damage**

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, none of the beds will be in service. By 30 days, none will be operational.





#### Thematic Map of Essential Facilities with greater than 50% moderate



#### Table 4: Expected Damage to Essential Facilities

|                 |       |   | # Facilities                               |                                    |  |
|-----------------|-------|---|--|------------------------------------|--|
| Classification  | Total | Probability of at<br>Least Moderate<br>Damage > 50% | Probability of<br>Complete<br>Damage > 50% | Expected<br>Loss of Use<br>< 1 day |  |
| EOCs            | 1     | 0   | 0  | 1                                  |  |
| Fire Stations   | 2     | 0   | 0  | 2                                  |  |
| Police Stations | 2     | 0   | 0  | 2                                  |  |
| Schools         | 1     | 0   | 0  | 1                                  |  |





# **Induced Hurricane Damage**

#### **Debris Generation**



Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. 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 0 tons of debris will be generated. Of the total amount, 0 tons (0%) is Other Tree Debris. Of the remaining 0 tons, Brick/Wood comprises 0% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 0 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.





# **Social Impact**

# Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 6,683) will seek temporary shelter in public shelters.





### **Economic Loss**

The total economic loss estimated for the hurricane is 0.0 million dollars, which represents 0.00 % of the total replacement value of the region's buildings.

#### **Building-Related Losses**

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage 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 hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 0 million dollars. 0% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 0% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.





#### Loss by Business Interruption Type (left) and Building Damage Type (right)





Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

| Category    | Area            | Residential | Commercial | Industrial | Others | Total |
|-------------|-----------------|-------------|------------|------------|--------|-------|
| Property Da | amage           |             |            |            |        |       |
|             | Building        | 0.00        | 0.00       | 0.00       | 0.00   | 0.00  |
|             | Content         | 0.00        | 0.00       | 0.00       | 0.00   | 0.00  |
|             | Inventory       | 0.00        | 0.00       | 0.00       | 0.00   | 0.00  |
|             | Subtotal        | 0.00        | 0.00       | 0.00       | 0.00   | 0.00  |
| Business In | terruption Loss |             |            |            |        |       |
|             | Income          | 0.00        | 0.00       | 0.00       | 0.00   | 0.00  |
|             | Relocation      | 0.00        | 0.00       | 0.00       | 0.00   | 0.00  |
|             | Rental          | 0.00        | 0.00       | 0.00       | 0.00   | 0.00  |
|             | Wage            | 0.00        | 0.00       | 0.00       | 0.00   | 0.00  |
|             | Subtotal        | 0.00        | 0.00       | 0.00       | 0.00   | 0.00  |




| <u>Total</u> |       |      |      |      |      |      |
|--------------|-------|------|------|------|------|------|
|              | Total | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |





# Appendix A: County Listing for the Region

Connecticut - Middlesex





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

|                    |            | Building Value (thousands of dollars |                 |           |  |  |
|--------------------|------------|--------------------------------------|-----------------|-----------|--|--|
|                    | Population | Residential                          | Non-Residential | Total     |  |  |
| Connecticut        |            |                                      |                 |           |  |  |
| Middlesex          | 6,683      | 1,070,956                            | 408,666         | 1,479,622 |  |  |
| Total              | 6,683      | 1,070,956                            | 408,666         | 1,479,622 |  |  |
| Study Region Total | 6,683      | 1,070,956                            | 408,666         | 1,479,622 |  |  |







# Hazus: Hurricane Global Risk Report

Region Name: Essex

Hurricane Scenario: Probabilistic 20-year Return Period

Print Date:

Thursday, October 3, 2019

**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 Hurricane. These results can be improved by using enhanced inventory data.





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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 and the National Institute of Building Sciences. 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 hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:

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

The geographical size of the region is 11.29 square miles and contains 1 census tracts. There are over 2 thousand households in the region and a total population of 6,683 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 1,480 million dollars (2014 dollars). Approximately 87% of the buildings (and 72% of the building value) are associated with residential housing.





# **Building Inventory**

### **General Building Stock**

Hazus estimates that there are 3,181 buildings in the region which have an aggregate total replacement value of 1,480 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



# Building Exposure by Occupancy Type



| Occupancy    | Exposure (\$1000) | Percent of Tot |
|--------------|-------------------|----------------|
| Residential  | 1,070,956         | 72.38 %        |
| Commercial   | 288,024           | 19.47%         |
| Industrial   | 75,832            | 5.13%          |
| Agricultural | 6,853             | 0.46%          |
| Religious    | 19,298            | 1.30%          |
| Government   | 4,286             | 0.29%          |
| Education    | 14,373            | 0.97%          |
| Total        | 1,479,622         | 100.00%        |

### **Essential Facility Inventory**

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities.





# **Hurricane Scenario**

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

Scenario Name:

Type:

Probabilistic Probabilistic





### **Building Damage**

### General Building Stock Damage

Hazus estimates that about 0 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



**Expected Building Damage by Occupancy** 

Table 2: Expected Building Damage by Occupancy : 20 - year Event

|             | Nor      | ne    | Mino  | or   | Mode  | rate | Seve  | re   | Destruc | tion |
|-------------|----------|-------|-------|------|-------|------|-------|------|---------|------|
| Occupancy   | Count    | (%)   | Count | (%)  | Count | (%)  | Count | (%)  | Count   | (%)  |
| Agriculture | 13.97    | 99.80 | 0.03  | 0.20 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00    | 0.00 |
| Commercial  | 259.30   | 99.73 | 0.70  | 0.27 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00    | 0.00 |
| Education   | 8.98     | 99.73 | 0.02  | 0.27 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00    | 0.00 |
| Government  | 4.99     | 99.70 | 0.01  | 0.30 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00    | 0.00 |
| Industrial  | 101.71   | 99.71 | 0.29  | 0.29 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00    | 0.00 |
| Religion    | 20.95    | 99.77 | 0.05  | 0.23 | 0.00  | 0.00 | 0.00  | 0.00 | 0.00    | 0.00 |
| Residential | 2,768.59 | 99.95 | 1.35  | 0.05 | 0.06  | 0.00 | 0.00  | 0.00 | 0.00    | 0.00 |
| Total       | 3,178.49 | )     | 2.45  |      | 0.06  |      | 0.00  | )    | 0.00    |      |





# Table 3: Expected Building Damage by Building Type : 20 - year Event

| Building | None  |       | Minor |      | Mode  | Moderate |       | Severe |       | Destruction |  |
|----------|-------|-------|-------|------|-------|----------|-------|--------|-------|-------------|--|
| Туре     | Count | (%)   | Count | (%)  | Count | (%)      | Count | (%)    | Count | (%)         |  |
| Concrete | 28    | 99.66 | 0     | 0.34 | 0     | 0.00     | 0     | 0.00   | 0     | 0.00        |  |
| Masonry  | 209   | 99.62 | 1     | 0.37 | 0     | 0.01     | 0     | 0.00   | 0     | 0.00        |  |
| МН       | 0     | 0.00  | 0     | 0.00 | 0     | 0.00     | 0     | 0.00   | 0     | 0.00        |  |
| Steel    | 172   | 99.70 | 1     | 0.30 | 0     | 0.00     | 0     | 0.00   | 0     | 0.00        |  |
| Wood     | 2,674 | 99.98 | 1     | 0.02 | 0     | 0.00     | 0     | 0.00   | 0     | 0.00        |  |





### **Essential Facility Damage**

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, none of the beds will be in service. By 30 days, none will be operational.





### Thematic Map of Essential Facilities with greater than 50% moderate

| duren: Sad, HSEE, dareda, karneza, karnezat P. Daya, 463000, 19688, 1910, 1976, 1976597, Gardisan, KM, Radusar VII., Ordenen Burry, Sad. Agen, MSE, Sad. Kate, Karey, Ag |
|--|

#### Table 4: Expected Damage to Essential Facilities

|                 |       | # Facilities  |  |                                    |  |  |
|-----------------|-------|---|--|------------------------------------|--|--|
| Classification  | Total | Probability of at<br>Least Moderate<br>Damage > 50% | Probability of<br>Complete<br>Damage > 50% | Expected<br>Loss of Use<br>< 1 day |  |  |
| EOCs            | 1     | 0   | 0  | 1                                  |  |  |
| Fire Stations   | 2     | 0   | 0  | 2                                  |  |  |
| Police Stations | 2     | 0   | 0  | 2                                  |  |  |
| Schools         | 1     | 0   | 0  | 1                                  |  |  |





# **Induced Hurricane Damage**

### **Debris Generation**



Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. 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 73 tons of debris will be generated. Of the total amount, 48 tons (66%) is Other Tree Debris. Of the remaining 25 tons, Brick/Wood comprises 8% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 23 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.





# **Social Impact**

# Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 6,683) will seek temporary shelter in public shelters.





### **Economic Loss**

The total economic loss estimated for the hurricane is 0.2 million dollars, which represents 0.02 % of the total replacement value of the region's buildings.

#### **Building-Related Losses**

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage 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 hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 0 million dollars. 0% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 100% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.









Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

| Category    | Area            | Residential | Commercial | Industrial | Others | Total  |
|-------------|-----------------|-------------|------------|------------|--------|--------|
| Property Da | amage           |             |            |            |        |        |
|             | Building        | 187.95      | 0.01       | 0.00       | 0.00   | 187.96 |
|             | Content         | 59.38       | 0.00       | 0.00       | 0.00   | 59.38  |
|             | Inventory       | 0.00        | 0.00       | 0.00       | 0.00   | 0.00   |
|             | Subtotal        | 247.33      | 0.01       | 0.00       | 0.00   | 247.34 |
| Business In | terruption Loss |             |            |            |        |        |
|             | Income          | 0.00        | 0.00       | 0.00       | 0.00   | 0.00   |
|             | Relocation      | 0.12        | 0.00       | 0.00       | 0.00   | 0.12   |
|             | Rental          | 0.00        | 0.00       | 0.00       | 0.00   | 0.00   |
|             | Wage            | 0.00        | 0.00       | 0.00       | 0.00   | 0.00   |
|             | Subtotal        | 0.12        | 0.00       | 0.00       | 0.00   | 0.12   |





| <u>Total</u> |       |        |      |      |      |        |
|--------------|-------|--------|------|------|------|--------|
|              | Total | 247.45 | 0.01 | 0.00 | 0.00 | 247.46 |





# Appendix A: County Listing for the Region

Connecticut - Middlesex





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

|                    |            | Building Value (thousands of dollars |                 |           |  |  |
|--------------------|------------|--------------------------------------|-----------------|-----------|--|--|
|                    | Population | Residential                          | Non-Residential | Total     |  |  |
| Connecticut        |            |                                      |                 |           |  |  |
| Middlesex          | 6,683      | 1,070,956                            | 408,666         | 1,479,622 |  |  |
| Total              | 6,683      | 1,070,956                            | 408,666         | 1,479,622 |  |  |
| Study Region Total | 6,683      | 1,070,956                            | 408,666         | 1,479,622 |  |  |







# Hazus: Hurricane Global Risk Report

Region Name: Essex

Hurricane Scenario: Probabilistic 50-year Return Period

Print Date:

Thursday, October 3, 2019

**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 Hurricane. These results can be improved by using enhanced inventory data.





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| General Building Stock                                  |        |  |
| Essential Facilities Damage                             |        |  |
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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 and the National Institute of Building Sciences. 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 hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:

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

The geographical size of the region is 11.29 square miles and contains 1 census tracts. There are over 2 thousand households in the region and a total population of 6,683 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 1,480 million dollars (2014 dollars). Approximately 87% of the buildings (and 72% of the building value) are associated with residential housing.





# **Building Inventory**

### **General Building Stock**

Hazus estimates that there are 3,181 buildings in the region which have an aggregate total replacement value of 1,480 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



# Building Exposure by Occupancy Type



| Occupancy    | Exposure (\$1000) | Percent of Tot |
|--------------|-------------------|----------------|
| Residential  | 1,070,956         | 72.38 %        |
| Commercial   | 288,024           | 19.47%         |
| Industrial   | 75,832            | 5.13%          |
| Agricultural | 6,853             | 0.46%          |
| Religious    | 19,298            | 1.30%          |
| Government   | 4,286             | 0.29%          |
| Education    | 14,373            | 0.97%          |
| Total        | 1,479,622         | 100.00%        |

### **Essential Facility Inventory**

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities.





# **Hurricane Scenario**

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

Scenario Name:

Type:

Probabilistic Probabilistic





### **Building Damage**

### General Building Stock Damage

Hazus estimates that about 3 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



**Expected Building Damage by Occupancy** 

Table 2: Expected Building Damage by Occupancy : 50 - year Event

|             | Nor      | ne    | Mino  | or   | Mode  | rate | Seve  | re   | Destruct | ion  |
|-------------|----------|-------|-------|------|-------|------|-------|------|----------|------|
| Occupancy   | Count    | (%)   | Count | (%)  | Count | (%)  | Count | (%)  | Count    | (%)  |
| Agriculture | 13.81    | 98.62 | 0.17  | 1.24 | 0.02  | 0.11 | 0.00  | 0.03 | 0.00     | 0.00 |
| Commercial  | 256.45   | 98.63 | 3.26  | 1.25 | 0.29  | 0.11 | 0.01  | 0.00 | 0.00     | 0.00 |
| Education   | 8.89     | 98.79 | 0.11  | 1.19 | 0.00  | 0.02 | 0.00  | 0.00 | 0.00     | 0.00 |
| Government  | 4.94     | 98.72 | 0.06  | 1.26 | 0.00  | 0.02 | 0.00  | 0.00 | 0.00     | 0.00 |
| Industrial  | 100.64   | 98.67 | 1.30  | 1.28 | 0.05  | 0.05 | 0.01  | 0.01 | 0.00     | 0.00 |
| Religion    | 20.76    | 98.84 | 0.24  | 1.13 | 0.01  | 0.04 | 0.00  | 0.00 | 0.00     | 0.00 |
| Residential | 2,728.93 | 98.52 | 38.44 | 1.39 | 2.57  | 0.09 | 0.05  | 0.00 | 0.00     | 0.00 |
| Total       | 3,134.41 |       | 43.58 |      | 2.94  |      | 0.07  | ,    | 0.00     |      |





# Table 3: Expected Building Damage by Building Type : 50 - year Event

| Building | No    | None  |       | Minor |       | Moderate |       | Severe |       | Destruction |  |
|----------|-------|-------|-------|-------|-------|----------|-------|--------|-------|-------------|--|
| Туре     | Count | (%)   | Count | (%)   | Count | (%)      | Count | (%)    | Count | (%)         |  |
| Concrete | 28    | 98.54 | 0     | 1.44  | 0     | 0.02     | 0     | 0.00   | 0     | 0.00        |  |
| Masonry  | 205   | 97.42 | 5     | 2.16  | 1     | 0.41     | 0     | 0.01   | 0     | 0.00        |  |
| MH       | 0     | 0.00  | 0     | 0.00  | 0     | 0.00     | 0     | 0.00   | 0     | 0.00        |  |
| Steel    | 171   | 98.68 | 2     | 1.22  | 0     | 0.09     | 0     | 0.00   | 0     | 0.00        |  |
| Wood     | 2,641 | 98.74 | 33    | 1.22  | 1     | 0.03     | 0     | 0.00   | 0     | 0.00        |  |





### **Essential Facility Damage**

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, none of the beds will be in service. By 30 days, none will be operational.





### Thematic Map of Essential Facilities with greater than 50% moderate

| 0 | Sources Bad, HERE, Osumby, Interney, Increment P. Coxy., (6800), UKIOS, REO, NPA, | 19503X, Geobaca, 186, Xobastar XB, Gebaues Bervey, Bal Ayası, WEN, Bal Salas (Sang, Kang), (d |
|---|---|---|
|   |   |   |

#### Table 4: Expected Damage to Essential Facilities

|                 |       | # Facilities  |  |                                    |  |  |
|-----------------|-------|---|--|------------------------------------|--|--|
| Classification  | Total | Probability of at<br>Least Moderate<br>Damage > 50% | Probability of<br>Complete<br>Damage > 50% | Expected<br>Loss of Use<br>< 1 day |  |  |
| EOCs            | 1     | 0   | 0  | 1                                  |  |  |
| Fire Stations   | 2     | 0   | 0  | 2                                  |  |  |
| Police Stations | 2     | 0   | 0  | 2                                  |  |  |
| Schools         | 1     | 0   | 0  | 1                                  |  |  |





# **Induced Hurricane Damage**

### **Debris Generation**



Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. 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 1,349 tons of debris will be generated. Of the total amount, 787 tons (58%) is Other Tree Debris. Of the remaining 562 tons, Brick/Wood comprises 34% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 8 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 369 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.





# **Social Impact**

# Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 6,683) will seek temporary shelter in public shelters.





### **Economic Loss**

The total economic loss estimated for the hurricane is 3.7 million dollars, which represents 0.25 % of the total replacement value of the region's buildings.

#### **Building-Related Losses**

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage 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 hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 4 million dollars. 2% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 95% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.











Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

| Category    | Area            | Residential | Commercial | Industrial | Others | Total    |
|-------------|-----------------|-------------|------------|------------|--------|----------|
| Property Da | amage           |             |            |            |        |          |
|             | Building        | 2,866.24    | 132.40     | 22.61      | 16.08  | 3,037.34 |
|             | Content         | 549.22      | 3.18       | 1.00       | 0.09   | 553.50   |
|             | Inventory       | 0.00        | 0.01       | 0.18       | 0.01   | 0.20     |
|             | Subtotal        | 3,415.46    | 135.60     | 23.80      | 16.18  | 3,591.04 |
| Business In | terruption Loss |             |            |            |        |          |
|             | Income          | 0.00        | 0.02       | 0.00       | 0.00   | 0.02     |
|             | Relocation      | 31.68       | 2.97       | 0.12       | 0.12   | 34.90    |
|             | Rental          | 29.97       | 0.01       | 0.00       | 0.00   | 29.98    |
|             | Wage            | 0.00        | 0.01       | 0.00       | 0.00   | 0.01     |
|             | Subtotal        | 61.65       | 3.00       | 0.12       | 0.12   | 64.90    |





| <u>Total</u> |       |          |        |       |       |          |
|--------------|-------|----------|--------|-------|-------|----------|
|              | Total | 3,477.11 | 138.60 | 23.92 | 16.30 | 3,655.93 |





# Appendix A: County Listing for the Region

Connecticut - Middlesex





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

|                    |            | Building    | ars)            |           |
|--------------------|------------|-------------|-----------------|-----------|
|                    | Population | Residential | Non-Residential | Total     |
| Connecticut        |            |             |                 |           |
| Middlesex          | 6,683      | 1,070,956   | 408,666         | 1,479,622 |
| Total              | 6,683      | 1,070,956   | 408,666         | 1,479,622 |
| Study Region Total | 6,683      | 1,070,956   | 408,666         | 1,479,622 |







# Hazus: Hurricane Global Risk Report

Region Name: Essex

Hurricane Scenario: Probabilistic 100-year Return Period

Print Date:

Thursday, October 3, 2019

**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 Hurricane. These results can be improved by using enhanced inventory data.




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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 and the National Institute of Building Sciences. 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 hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:

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

The geographical size of the region is 11.29 square miles and contains 1 census tracts. There are over 2 thousand households in the region and a total population of 6,683 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 1,480 million dollars (2014 dollars). Approximately 87% of the buildings (and 72% of the building value) are associated with residential housing.





# **Building Inventory**

#### **General Building Stock**

Hazus estimates that there are 3,181 buildings in the region which have an aggregate total replacement value of 1,480 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



# Building Exposure by Occupancy Type



| Occupancy    | Exposure (\$1000) | Percent of Tot |  |  |
|--------------|-------------------|----------------|--|--|
| Residential  | 1,070,956         | 72.38 %        |  |  |
| Commercial   | 288,024           | 19.47%         |  |  |
| Industrial   | 75,832            | 5.13%          |  |  |
| Agricultural | 6,853             | 0.46%          |  |  |
| Religious    | 19,298            | 1.30%          |  |  |
| Government   | 4,286             | 0.29%          |  |  |
| Education    | 14,373            | 0.97%          |  |  |
| Total        | 1,479,622         | 100.00%        |  |  |

#### **Essential Facility Inventory**

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities.





# **Hurricane Scenario**

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

Scenario Name:

Type:

Probabilistic Probabilistic





### **Building Damage**

#### General Building Stock Damage

Hazus estimates that about 20 buildings will be at least moderately damaged. This is over 1% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



Table 2: Expected Building Damage by Occupancy : 100 - year Event

|             | None     |       | Minor  |      | Moder | Moderate |       | Severe |       | Destruction |  |
|-------------|----------|-------|--------|------|-------|----------|-------|--------|-------|-------------|--|
| Occupancy   | Count    | (%)   | Count  | (%)  | Count | (%)      | Count | (%)    | Count | (%)         |  |
| Agriculture | 13.16    | 94.00 | 0.68   | 4.83 | 0.11  | 0.82     | 0.05  | 0.34   | 0.00  | 0.02        |  |
| Commercial  | 247.19   | 95.07 | 10.94  | 4.21 | 1.69  | 0.65     | 0.18  | 0.07   | 0.00  | 0.00        |  |
| Education   | 8.63     | 95.94 | 0.35   | 3.83 | 0.02  | 0.22     | 0.00  | 0.00   | 0.00  | 0.00        |  |
| Government  | 4.79     | 95.77 | 0.20   | 3.97 | 0.01  | 0.26     | 0.00  | 0.00   | 0.00  | 0.00        |  |
| Industrial  | 97.39    | 95.48 | 4.04   | 3.96 | 0.45  | 0.44     | 0.11  | 0.11   | 0.00  | 0.00        |  |
| Religion    | 20.02    | 95.33 | 0.92   | 4.39 | 0.06  | 0.26     | 0.00  | 0.01   | 0.00  | 0.00        |  |
| Residential | 2,581.62 | 93.20 | 171.24 | 6.18 | 16.72 | 0.60     | 0.31  | 0.01   | 0.11  | 0.00        |  |
| Total       | 2,972.81 |       | 188.37 |      | 19.06 |          | 0.65  |        | 0.11  |             |  |





# Table 3: Expected Building Damage by Building Type : 100 - year Event

| Building | None  |       | Mine  | Minor |       | Moderate |       | Severe |       | Destruction |  |
|----------|-------|-------|-------|-------|-------|----------|-------|--------|-------|-------------|--|
| Туре     | Count | (%)   | Count | (%)   | Count | (%)      | Count | (%)    | Count | (%)         |  |
| Concrete | 27    | 95.31 | 1     | 4.35  | 0     | 0.34     | 0     | 0.00   | 0     | 0.00        |  |
| Masonry  | 193   | 91.95 | 13    | 5.99  | 4     | 1.99     | 0     | 0.07   | 0     | 0.00        |  |
| МН       | 0     | 0.00  | 0     | 0.00  | 0     | 0.00     | 0     | 0.00   | 0     | 0.00        |  |
| Steel    | 165   | 95.62 | 6     | 3.70  | 1     | 0.60     | 0     | 0.08   | 0     | 0.00        |  |
| Wood     | 2,506 | 93.66 | 160   | 5.97  | 9     | 0.35     | 0     | 0.01   | 0     | 0.00        |  |





#### **Essential Facility Damage**

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, none of the beds will be in service. By 30 days, none will be operational.





#### Thematic Map of Essential Facilities with greater than 50% moderate



#### Table 4: Expected Damage to Essential Facilities

|                 |       | # Facilities  |  |                                    |  |  |  |  |
|-----------------|-------|---|--|------------------------------------|--|--|--|--|
| Classification  | Total | Probability of at<br>Least Moderate<br>Damage > 50% | Probability of<br>Complete<br>Damage > 50% | Expected<br>Loss of Use<br>< 1 day |  |  |  |  |
| EOCs            | 1     | 0   | 0  | 1                                  |  |  |  |  |
| Fire Stations   | 2     | 0   | 0  | 2                                  |  |  |  |  |
| Police Stations | 2     | 0   | 0  | 2                                  |  |  |  |  |
| Schools         | 1     | 0   | 0  | 1                                  |  |  |  |  |





# **Induced Hurricane Damage**

#### **Debris Generation**



Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. 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 4,584 tons of debris will be generated. Of the total amount, 2,673 tons (58%) is Other Tree Debris. Of the remaining 1,911 tons, Brick/Wood comprises 34% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 26 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 1,254 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.





# **Social Impact**

# Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 6,683) will seek temporary shelter in public shelters.





#### **Economic Loss**

The total economic loss estimated for the hurricane is 10.1 million dollars, which represents 0.69 % of the total replacement value of the region's buildings.

#### **Building-Related Losses**

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage 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 hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 10 million dollars. 6% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 89% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.













(Thousands of dollars)

| Category    | Area            | Residential | Commercial | Industrial | Others | Total    |
|-------------|-----------------|-------------|------------|------------|--------|----------|
| Property Da | amage           |             |            |            |        |          |
|             | Building        | 7,314.34    | 501.38     | 96.58      | 67.87  | 7,980.17 |
|             | Content         | 1,429.99    | 82.91      | 31.48      | 10.53  | 1,554.92 |
|             | Inventory       | 0.00        | 1.82       | 4.43       | 0.43   | 6.68     |
|             | Subtotal        | 8,744.33    | 586.11     | 132.49     | 78.83  | 9,541.76 |
| Business In | terruption Loss |             |            |            |        |          |
|             | Income          | 0.00        | 68.32      | 0.42       | 11.27  | 80.00    |
|             | Relocation      | 188.52      | 69.62      | 2.66       | 9.58   | 270.39   |
|             | Rental          | 125.40      | 39.45      | 0.33       | 0.91   | 166.09   |
|             | Wage            | 0.00        | 62.33      | 0.69       | 27.61  | 90.64    |
|             | Subtotal        | 313.92      | 239.72     | 4.10       | 49.37  | 607.12   |





| <u>Total</u> |       |          |        |        |        |           |
|--------------|-------|----------|--------|--------|--------|-----------|
|              | Total | 9,058.25 | 825.84 | 136.59 | 128.19 | 10,148.88 |





# Appendix A: County Listing for the Region

Connecticut - Middlesex





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

|                    |            | Building    | ars)            |           |
|--------------------|------------|-------------|-----------------|-----------|
|                    | Population | Residential | Non-Residential | Total     |
| Connecticut        |            |             |                 |           |
| Middlesex          | 6,683      | 1,070,956   | 408,666         | 1,479,622 |
| Total              | 6,683      | 1,070,956   | 408,666         | 1,479,622 |
| Study Region Total | 6,683      | 1,070,956   | 408,666         | 1,479,622 |







# Hazus: Hurricane Global Risk Report

Region Name: Essex

Hurricane Scenario: Probabilistic 200-year Return Period

Print Date:

Thursday, October 3, 2019

**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 Hurricane. These results can be improved by using enhanced inventory data.





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| Building Damage   | 6      |  |
| General Building Stock                                  |        |  |
| Essential Facilities Damage                             |        |  |
| Induced Hurricane Damage                                | 8      |  |
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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 and the National Institute of Building Sciences. 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 hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:

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

The geographical size of the region is 11.29 square miles and contains 1 census tracts. There are over 2 thousand households in the region and a total population of 6,683 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 1,480 million dollars (2014 dollars). Approximately 87% of the buildings (and 72% of the building value) are associated with residential housing.





# **Building Inventory**

#### **General Building Stock**

Hazus estimates that there are 3,181 buildings in the region which have an aggregate total replacement value of 1,480 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



# Building Exposure by Occupancy Type



| Occupancy    | Exposure (\$1000) | Percent of Tot |  |  |
|--------------|-------------------|----------------|--|--|
| Residential  | 1,070,956         | 72.38 %        |  |  |
| Commercial   | 288,024           | 19.47%         |  |  |
| Industrial   | 75,832            | 5.13%          |  |  |
| Agricultural | 6,853             | 0.46%          |  |  |
| Religious    | 19,298            | 1.30%          |  |  |
| Government   | 4,286             | 0.29%          |  |  |
| Education    | 14,373            | 0.97%          |  |  |
| Total        | 1,479,622         | 100.00%        |  |  |

#### **Essential Facility Inventory**

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities.





# **Hurricane Scenario**

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

Scenario Name:

Type:

Probabilistic Probabilistic





### **Building Damage**

#### General Building Stock Damage

Hazus estimates that about 70 buildings will be at least moderately damaged. This is over 2% of the total number of buildings in the region. There are an estimated 1 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



**Expected Building Damage by Occupancy** 

Table 2: Expected Building Damage by Occupancy : 200 - year Event

|             | None     |       | Min    | Minor |       | Moderate |       | Severe |       | Destruction |  |
|-------------|----------|-------|--------|-------|-------|----------|-------|--------|-------|-------------|--|
| Occupancy   | Count    | (%)   | Count  | (%)   | Count | (%)      | Count | (%)    | Count | (%)         |  |
| Agriculture | 11.88    | 84.88 | 1.56   | 11.17 | 0.37  | 2.61     | 0.17  | 1.23   | 0.02  | 0.12        |  |
| Commercial  | 227.41   | 87.47 | 25.66  | 9.87  | 6.04  | 2.32     | 0.89  | 0.34   | 0.00  | 0.00        |  |
| Education   | 8.05     | 89.41 | 0.82   | 9.17  | 0.12  | 1.36     | 0.01  | 0.07   | 0.00  | 0.00        |  |
| Government  | 4.45     | 88.99 | 0.47   | 9.32  | 0.08  | 1.61     | 0.00  | 0.08   | 0.00  | 0.00        |  |
| Industrial  | 90.28    | 88.51 | 9.23   | 9.05  | 1.99  | 1.95     | 0.47  | 0.46   | 0.03  | 0.03        |  |
| Religion    | 18.40    | 87.63 | 2.27   | 10.79 | 0.31  | 1.50     | 0.02  | 0.08   | 0.00  | 0.00        |  |
| Residential | 2,322.42 | 83.84 | 387.82 | 14.00 | 56.53 | 2.04     | 1.98  | 0.07   | 1.26  | 0.05        |  |
| Total       | 2,682.89 | •     | 427.83 | ;     | 65.44 |          | 3.53  |        | 1.31  |             |  |





# Table 3: Expected Building Damage by Building Type : 200 - year Event

| Building | None  |       | None Minor |       | Mode  | Moderate |       | Severe |       | Destruction |  |
|----------|-------|-------|------------|-------|-------|----------|-------|--------|-------|-------------|--|
| Туре     | Count | (%)   | Count      | (%)   | Count | (%)      | Count | (%)    | Count | (%)         |  |
| Concrete | 25    | 88.08 | 3          | 9.82  | 1     | 2.02     | 0     | 0.09   | 0     | 0.00        |  |
| Masonry  | 174   | 82.87 | 25         | 11.75 | 11    | 5.07     | 1     | 0.28   | 0     | 0.03        |  |
| МН       | 0     | 0.00  | 0          | 0.00  | 0     | 0.00     | 0     | 0.00   | 0     | 0.00        |  |
| Steel    | 154   | 88.75 | 15         | 8.53  | 4     | 2.27     | 1     | 0.45   | 0     | 0.00        |  |
| Wood     | 2,259 | 84.45 | 373        | 13.96 | 39    | 1.47     | 2     | 0.07   | 1     | 0.05        |  |





#### **Essential Facility Damage**

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, none of the beds will be in service. By 30 days, none will be operational.





#### Thematic Map of Essential Facilities with greater than 50% moderate

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#### Table 4: Expected Damage to Essential Facilities

|                 |       | # Facilities  |  |                                    |  |
|-----------------|-------|---|--|------------------------------------|--|
| Classification  | Total | Probability of at<br>Least Moderate<br>Damage > 50% | Probability of<br>Complete<br>Damage > 50% | Expected<br>Loss of Use<br>< 1 day |  |
| EOCs            | 1     | 0   | 0  | 1                                  |  |
| Fire Stations   | 2     | 0   | 0  | 2                                  |  |
| Police Stations | 2     | 0   | 0  | 2                                  |  |
| Schools         | 1     | 0   | 0  | 1                                  |  |





# **Induced Hurricane Damage**

#### **Debris Generation**



Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. 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 7,301 tons of debris will be generated. Of the total amount, 3,980 tons (55%) is Other Tree Debris. Of the remaining 3,321 tons, Brick/Wood comprises 44% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 58 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 1,867 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.





# **Social Impact**

#### **Shelter Requirement**



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 2 households to be displaced due to the hurricane. Of these, 1 people (out of a total population of 6,683) will seek temporary shelter in public shelters.





#### **Economic Loss**

The total economic loss estimated for the hurricane is 21.7 million dollars, which represents 1.47 % of the total replacement value of the region's buildings.

#### **Building-Related Losses**

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage 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 hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 22 million dollars. 7% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 85% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.













(Thousands of dollars)

| Category    | Area            | Residential | Commercial | Industrial | Others | Total     |
|-------------|-----------------|-------------|------------|------------|--------|-----------|
| Property Da | amage           |             |            |            |        |           |
|             | Building        | 14,347.15   | 1,347.28   | 306.48     | 185.11 | 16,186.02 |
|             | Content         | 3,453.45    | 343.76     | 150.02     | 41.25  | 3,988.49  |
|             | Inventory       | 0.00        | 8.58       | 20.00      | 1.87   | 30.46     |
|             | Subtotal        | 17,800.61   | 1,699.62   | 476.50     | 228.24 | 20,204.97 |
| Business In | terruption Loss |             |            |            |        |           |
|             | Income          | 0.00        | 189.21     | 3.60       | 21.90  | 214.70    |
|             | Relocation      | 469.93      | 207.85     | 18.65      | 29.94  | 726.37    |
|             | Rental          | 259.55      | 111.84     | 2.88       | 2.54   | 376.82    |
|             | Wage            | 0.00        | 157.46     | 6.06       | 61.57  | 225.09    |
|             | Subtotal        | 729.48      | 666.37     | 31.19      | 115.95 | 1,542.98  |





| <u>Total</u> |       |           |          |        |        |           |
|--------------|-------|-----------|----------|--------|--------|-----------|
|              | Total | 18,530.09 | 2,365.99 | 507.69 | 344.19 | 21,747.95 |





# Appendix A: County Listing for the Region

Connecticut - Middlesex





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

|                    |            | Building    | Value (thousands of dolla | ars)      |
|--------------------|------------|-------------|---------------------------|-----------|
|                    | Population | Residential | Non-Residential           | Total     |
| Connecticut        |            |             |                           |           |
| Middlesex          | 6,683      | 1,070,956   | 408,666                   | 1,479,622 |
| Total              | 6,683      | 1,070,956   | 408,666                   | 1,479,622 |
| Study Region Total | 6,683      | 1,070,956   | 408,666                   | 1,479,622 |







# Hazus: Hurricane Global Risk Report

Region Name: Essex

Hurricane Scenario: Probabilistic 500-year Return Period

Print Date:

Thursday, October 3, 2019

**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 Hurricane. These results can be improved by using enhanced inventory data.





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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 and the National Institute of Building Sciences. 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 hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:

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

The geographical size of the region is 11.29 square miles and contains 1 census tracts. There are over 2 thousand households in the region and a total population of 6,683 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 1,480 million dollars (2014 dollars). Approximately 87% of the buildings (and 72% of the building value) are associated with residential housing.





# **Building Inventory**

#### **General Building Stock**

Hazus estimates that there are 3,181 buildings in the region which have an aggregate total replacement value of 1,480 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



# Building Exposure by Occupancy Type



| Occupancy    | Exposure (\$1000) | Percent of Tot |  |
|--------------|-------------------|----------------|--|
| Residential  | 1,070,956         | 72.38 %        |  |
| Commercial   | 288,024           | 19.47%         |  |
| Industrial   | 75,832            | 5.13%          |  |
| Agricultural | 6,853             | 0.46%          |  |
| Religious    | 19,298            | 1.30%          |  |
| Government   | 4,286             | 0.29%          |  |
| Education    | 14,373            | 0.97%          |  |
| Total        | 1,479,622         | 100.00%        |  |

#### **Essential Facility Inventory**

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities.





# **Hurricane Scenario**

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

Scenario Name:

Type:

Probabilistic Probabilistic




### **Building Damage**

#### General Building Stock Damage

Hazus estimates that about 220 buildings will be at least moderately damaged. This is over 7% of the total number of buildings in the region. There are an estimated 9 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



Table 2: Expected Building Damage by Occupancy : 500 - year Event

|             | None     |       | Min    | Minor |        | Moderate |       | Severe |       | Destruction |  |
|-------------|----------|-------|--------|-------|--------|----------|-------|--------|-------|-------------|--|
| Occupancy   | Count    | (%)   | Count  | (%)   | Count  | (%)      | Count | (%)    | Count | (%)         |  |
| Agriculture | 9.56     | 68.27 | 2.94   | 20.98 | 0.97   | 6.92     | 0.47  | 3.35   | 0.07  | 0.48        |  |
| Commercial  | 187.14   | 71.98 | 49.37  | 18.99 | 19.72  | 7.58     | 3.74  | 1.44   | 0.03  | 0.01        |  |
| Education   | 6.75     | 74.95 | 1.65   | 18.32 | 0.55   | 6.10     | 0.06  | 0.63   | 0.00  | 0.00        |  |
| Government  | 3.71     | 74.24 | 0.90   | 18.09 | 0.34   | 6.86     | 0.04  | 0.81   | 0.00  | 0.00        |  |
| Industrial  | 75.21    | 73.74 | 17.79  | 17.44 | 7.12   | 6.98     | 1.73  | 1.70   | 0.15  | 0.15        |  |
| Religion    | 15.10    | 71.88 | 4.45   | 21.20 | 1.31   | 6.24     | 0.14  | 0.68   | 0.00  | 0.00        |  |
| Residential | 1,882.10 | 67.95 | 704.07 | 25.42 | 161.54 | 5.83     | 13.54 | 0.49   | 8.76  | 0.32        |  |
| Total       | 2,179.56 | 6     | 781.17 | ,     | 191.54 |          | 19.72 | 2      | 9.00  |             |  |





### Table 3: Expected Building Damage by Building Type : 500 - year Event

| Building | None  |       | Minor |       | Moderate |       | Severe |      | Destruction |      |
|----------|-------|-------|-------|-------|----------|-------|--------|------|-------------|------|
| Туре     | Count | (%)   | Count | (%)   | Count    | (%)   | Count  | (%)  | Count       | (%)  |
| Concrete | 20    | 72.69 | 5     | 18.36 | 2        | 8.08  | 0      | 0.86 | 0           | 0.00 |
| Masonry  | 141   | 67.18 | 42    | 19.90 | 25       | 11.68 | 2      | 1.08 | 0           | 0.15 |
| MH       | 0     | 0.00  | 0     | 0.00  | 0        | 0.00  | 0      | 0.00 | 0           | 0.00 |
| Steel    | 128   | 73.92 | 28    | 16.47 | 13       | 7.71  | 3      | 1.88 | 0           | 0.02 |
| Wood     | 1,834 | 68.56 | 691   | 25.82 | 130      | 4.85  | 13     | 0.47 | 8           | 0.31 |





#### **Essential Facility Damage**

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, none of the beds will be in service. By 30 days, none will be operational.





#### Thematic Map of Essential Facilities with greater than 50% moderate

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#### Table 4: Expected Damage to Essential Facilities

|                 |       |   | # Facilities                               |                                    |
|-----------------|-------|---|--|------------------------------------|
| Classification  | Total | Probability of at<br>Least Moderate<br>Damage > 50% | Probability of<br>Complete<br>Damage > 50% | Expected<br>Loss of Use<br>< 1 day |
| EOCs            | 1     | 0   | 0  | 1                                  |
| Fire Stations   | 2     | 0   | 0  | 2                                  |
| Police Stations | 2     | 0   | 0  | 2                                  |
| Schools         | 1     | 0   | 0  | 1                                  |





### **Induced Hurricane Damage**

#### **Debris Generation**



Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. 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 14,879 tons of debris will be generated. Of the total amount, 7,912 tons (53%) is Other Tree Debris. Of the remaining 6,967 tons, Brick/Wood comprises 47% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 130 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 3,713 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.





### **Social Impact**

#### **Shelter Requirement**



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 9 households to be displaced due to the hurricane. Of these, 4 people (out of a total population of 6,683) will seek temporary shelter in public shelters.





#### **Economic Loss**

The total economic loss estimated for the hurricane is 54.7 million dollars, which represents 3.70 % of the total replacement value of the region's buildings.

#### **Building-Related Losses**

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage 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 hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 55 million dollars. 9% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 82% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.













(Thousands of dollars)

| Category    | Area            | Residential | Commercial | Industrial | Others | Total     |
|-------------|-----------------|-------------|------------|------------|--------|-----------|
| Property Da | amage           |             |            |            |        |           |
|             | Building        | 32,066.41   | 3,897.33   | 969.31     | 528.01 | 37,461.05 |
|             | Content         | 10,291.32   | 1,404.26   | 591.36     | 162.56 | 12,449.51 |
|             | Inventory       | 0.00        | 34.10      | 74.81      | 6.13   | 115.05    |
|             | Subtotal        | 42,357.73   | 5,335.70   | 1,635.49   | 696.70 | 50,025.61 |
| Business In | terruption Loss |             |            |            |        |           |
|             | Income          | 0.00        | 326.14     | 10.80      | 40.16  | 377.10    |
|             | Relocation      | 1,874.01    | 657.18     | 74.22      | 91.72  | 2,697.12  |
|             | Rental          | 770.84      | 350.71     | 10.37      | 7.90   | 1,139.82  |
|             | Wage            | 0.00        | 308.44     | 18.25      | 122.95 | 449.64    |
|             | Subtotal        | 2,644.85    | 1,642.46   | 113.64     | 262.72 | 4,663.68  |





| <u>Total</u> |       |           |          |          |        |           |
|--------------|-------|-----------|----------|----------|--------|-----------|
|              | Total | 45,002.58 | 6,978.16 | 1,749.13 | 959.42 | 54,689.29 |





### Appendix A: County Listing for the Region

Connecticut - Middlesex





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

|                    |            | Building Value (thousands of dollars |                 |           |  |  |
|--------------------|------------|--------------------------------------|-----------------|-----------|--|--|
|                    | Population | Residential                          | Non-Residential | Total     |  |  |
| Connecticut        |            |                                      |                 |           |  |  |
| Middlesex          | 6,683      | 1,070,956                            | 408,666         | 1,479,622 |  |  |
| Total              | 6,683      | 1,070,956                            | 408,666         | 1,479,622 |  |  |
| Study Region Total | 6,683      | 1,070,956                            | 408,666         | 1,479,622 |  |  |







# Hazus: Hurricane Global Risk Report

Region Name: Essex

Hurricane Scenario: Probabilistic 1000-year Return Period

Print Date:

Thursday, October 3, 2019

**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 Hurricane. These results can be improved by using enhanced inventory data.





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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 and the National Institute of Building Sciences. 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 hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Connecticut

Note:

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

The geographical size of the region is 11.29 square miles and contains 1 census tracts. There are over 2 thousand households in the region and a total population of 6,683 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 1,480 million dollars (2014 dollars). Approximately 87% of the buildings (and 72% of the building value) are associated with residential housing.





### **Building Inventory**

#### **General Building Stock**

Hazus estimates that there are 3,181 buildings in the region which have an aggregate total replacement value of 1,480 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.



### Building Exposure by Occupancy Type



| Occupancy    | Exposure (\$1000) | Percent of Tot |  |  |
|--------------|-------------------|----------------|--|--|
| Residential  | 1,070,956         | 72.38 %        |  |  |
| Commercial   | 288,024           | 19.47%         |  |  |
| Industrial   | 75,832            | 5.13%          |  |  |
| Agricultural | 6,853             | 0.46%          |  |  |
| Religious    | 19,298            | 1.30%          |  |  |
| Government   | 4,286             | 0.29%          |  |  |
| Education    | 14,373            | 0.97%          |  |  |
| Total        | 1,479,622         | 100.00%        |  |  |

#### **Essential Facility Inventory**

For essential facilities, there are no hospitals in the region with a total bed capacity of no beds. There are 1 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities.





### **Hurricane Scenario**

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

Scenario Name:

Type:

Probabilistic Probabilistic





### **Building Damage**

#### General Building Stock Damage

Hazus estimates that about 425 buildings will be at least moderately damaged. This is over 13% of the total number of buildings in the region. There are an estimated 27 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.



**Expected Building Damage by Occupancy** 

Table 2: Expected Building Damage by Occupancy : 1000 - year Event

| None        |          | Min   | Minor    |       | Moderate |       | Severe |      | Destruction |      |
|-------------|----------|-------|----------|-------|----------|-------|--------|------|-------------|------|
| Occupancy   | Count    | (%)   | Count    | (%)   | Count    | (%)   | Count  | (%)  | Count       | (%)  |
| Agriculture | 7.51     | 53.65 | 3.87     | 27.62 | 1.66     | 11.84 | 0.82   | 5.84 | 0.15        | 1.05 |
| Commercial  | 148.75   | 57.21 | 64.09    | 24.65 | 37.48    | 14.42 | 9.59   | 3.69 | 0.09        | 0.04 |
| Education   | 5.42     | 60.24 | 2.19     | 24.32 | 1.17     | 13.04 | 0.22   | 2.41 | 0.00        | 0.00 |
| Government  | 2.97     | 59.50 | 1.18     | 23.52 | 0.70     | 14.01 | 0.15   | 2.97 | 0.00        | 0.00 |
| Industrial  | 60.31    | 59.12 | 23.14    | 22.69 | 14.07    | 13.79 | 4.15   | 4.07 | 0.33        | 0.33 |
| Religion    | 11.99    | 57.10 | 5.85     | 27.88 | 2.66     | 12.65 | 0.50   | 2.38 | 0.00        | 0.00 |
| Residential | 1,513.75 | 54.65 | 904.88   | 32.67 | 283.99   | 10.25 | 40.73  | 1.47 | 26.65       | 0.96 |
| Total       | 1,750.70 | )     | 1,005.20 | )     | 341.73   | 3     | 56.15  | 5    | 27.22       |      |





#### Table 3: Expected Building Damage by Building Type : 1000 - year Event

| Building | None  |       | Minor |       | Mode  | Moderate |       | Severe |       | Destruction |  |
|----------|-------|-------|-------|-------|-------|----------|-------|--------|-------|-------------|--|
| Туре     | Count | (%)   | Count | (%)   | Count | (%)      | Count | (%)    | Count | (%)         |  |
| Concrete | 16    | 57.66 | 6     | 23.09 | 5     | 16.16    | 1     | 3.09   | 0     | 0.00        |  |
| Masonry  | 113   | 53.59 | 52    | 24.54 | 39    | 18.71    | 6     | 2.76   | 1     | 0.40        |  |
| MH       | 0     | 0.00  | 0     | 0.00  | 0     | 0.00     | 0     | 0.00   | 0     | 0.00        |  |
| Steel    | 102   | 59.17 | 37    | 21.20 | 26    | 14.87    | 8     | 4.70   | 0     | 0.06        |  |
| Wood     | 1,475 | 55.13 | 897   | 33.53 | 241   | 9.01     | 37    | 1.39   | 25    | 0.94        |  |





#### **Essential Facility Damage**

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 0 hospital beds (0%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, none of the beds will be in service. By 30 days, none will be operational.





#### Thematic Map of Essential Facilities with greater than 50% moderate

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#### Table 4: Expected Damage to Essential Facilities

|                     |   | # Facilities  |  |                                    |  |  |  |
|---------------------|---|---|--|------------------------------------|--|--|--|
| Classification Tota |   | Probability of at<br>Least Moderate<br>Damage > 50% | Probability of<br>Complete<br>Damage > 50% | Expected<br>Loss of Use<br>< 1 day |  |  |  |
| EOCs                | 1 | 0   | 0  | 1                                  |  |  |  |
| Fire Stations       | 2 | 0   | 0  | 2                                  |  |  |  |
| Police Stations     | 2 | 0   | 0  | 2                                  |  |  |  |
| Schools             | 1 | 0   | 0  | 0                                  |  |  |  |





### **Induced Hurricane Damage**

#### **Debris Generation**



Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. 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 24,388 tons of debris will be generated. Of the total amount, 12,774 tons (52%) is Other Tree Debris. Of the remaining 11,614 tons, Brick/Wood comprises 48% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 225 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 5,994 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.





### **Social Impact**

### **Shelter Requirement**



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 30 households to be displaced due to the hurricane. Of these, 9 people (out of a total population of 6,683) will seek temporary shelter in public shelters.





#### **Economic Loss**

The total economic loss estimated for the hurricane is 104.0 million dollars, which represents 7.03 % of the total replacement value of the region's buildings.

#### **Building-Related Losses**

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage 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 hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 104 million dollars. 9% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 81% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.













(Thousands of dollars)

| Category    | Area            | Residential | Commercial | Industrial | Others   | Total     |
|-------------|-----------------|-------------|------------|------------|----------|-----------|
| Property Da | amage           |             |            |            |          |           |
|             | Building        | 57,206.18   | 7,828.06   | 1,994.05   | 1,040.44 | 68,068.73 |
|             | Content         | 20,914.41   | 3,439.52   | 1,347.07   | 387.16   | 26,088.17 |
|             | Inventory       | 0.00        | 78.57      | 163.74     | 11.83    | 254.14    |
|             | Subtotal        | 78,120.59   | 11,346.16  | 3,504.85   | 1,439.44 | 94,411.04 |
| Business In | terruption Loss |             |            |            |          |           |
|             | Income          | 0.02        | 417.13     | 18.82      | 34.98    | 470.95    |
|             | Relocation      | 4,486.14    | 1,315.39   | 160.33     | 182.53   | 6,144.39  |
|             | Rental          | 1,662.37    | 717.24     | 21.64      | 16.29    | 2,417.54  |
|             | Wage            | 0.04        | 404.21     | 31.55      | 120.56   | 556.36    |
|             | Subtotal        | 6,148.56    | 2,853.97   | 232.34     | 354.36   | 9,589.24  |





| <u>Total</u> |       |           |           |          |          |            |  |
|--------------|-------|-----------|-----------|----------|----------|------------|--|
|              | Total | 84,269.16 | 14,200.12 | 3,737.20 | 1,793.80 | 104,000.28 |  |





### Appendix A: County Listing for the Region

Connecticut - Middlesex





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

|                    |            | Building Value (thousands of dollars) |                 |           |  |  |
|--------------------|------------|---------------------------------------|-----------------|-----------|--|--|
|                    | Population | Residential                           | Non-Residential | Total     |  |  |
| Connecticut        |            |                                       |                 |           |  |  |
| Middlesex          | 6,683      | 1,070,956                             | 408,666         | 1,479,622 |  |  |
| Total              | 6,683      | 1,070,956                             | 408,666         | 1,479,622 |  |  |
| Study Region Total | 6,683      | 1,070,956                             | 408,666         | 1,479,622 |  |  |







## Hazus: Earthquake Global Risk Report

| Region Name:         | Essex            |
|----------------------|------------------|
| Earthquake Scenario: | EastHaddam       |
| Print Date:          | October 17, 2019 |

**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 earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.





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### **General Description of the Region**

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. 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 earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Connecticut

Note:

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

The geographical size of the region is 11.29 square miles and contains 1 census tracts. There are over 2 thousand households in the region which has a total population of 6,683 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 1,479 (millions of dollars). Approximately 87.00 % of the buildings (and 72.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 581 and 8 (millions of dollars), respectively.





### **Building and Lifeline Inventory**

#### **Building Inventory**

Hazus estimates that there are 3 thousand buildings in the region which have an aggregate total replacement value of 1,479 (millions of dollars). Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 85% of the building inventory. The remaining percentage is distributed between the other general building types.

#### **Critical Facility Inventory**

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of beds. There are 1 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 2 hazardous material sites, no military installations and no nuclear power plants.

#### Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 589.00 (millions of dollars). This inventory includes over 36.04 miles of highways, 15 bridges, 260.98 miles of pipes.





| System     | Component  | # Locations/<br># Segments | Replacement value<br>(millions of dollars) |
|------------|------------|----------------------------|--|
| Highway    | Bridges    | 15                         | 181.0834                                   |
|            | Segments   | 26                         | 385.5240                                   |
|            | Tunnels    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 566.6074                                   |
| Railways   | Bridges    | 0                          | 0.0000                                     |
|            | Facilities | 0                          | 0.0000                                     |
| -          | Segments   | 2                          | 13.2639                                    |
|            | Tunnels    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 13.2639                                    |
| Light Rail | Bridges    | 0                          | 0.0000                                     |
| -          | Facilities | 0                          | 0.0000                                     |
|            | Segments   | 0                          | 0.0000                                     |
|            | Tunnels    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
| Bus        | Facilities | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
| Ferry      | Facilities | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
| Port       | Facilities | 1                          | 1.9970                                     |
|            |            | Subtotal                   | 1.9970                                     |
| Airport    | Facilities | 0                          | 0.0000                                     |
| -          | Runways    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
|            |            | Total                      | 581.90                                     |

#### Table 1. Tr tio n S. Lifolin ~ I.





| Table 2. Othery Oystein Elfenne inventory |                    |                           |  |  |  |  |  |  |
|---|--------------------|---------------------------|--|--|--|--|--|--|
| System                                    | Component          | # Locations /<br>Segments | Replacement value<br>(millions of dollars) |  |  |  |  |  |
| Potable Water                             | Distribution Lines | NA                        | 4.2050                                     |  |  |  |  |  |
|   | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |
|   | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |
|   |                    | Subtotal                  | 4.2050                                     |  |  |  |  |  |
| Waste Water                               | Distribution Lines | NA                        | 2.5230                                     |  |  |  |  |  |
|   | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |
|   | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |
|   |                    | Subtotal                  | 2.5230                                     |  |  |  |  |  |
| Natural Gas                               | Distribution Lines | NA                        | 1.6820                                     |  |  |  |  |  |
|   | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |
|   | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |
|   |                    | Subtotal                  | 1.6820                                     |  |  |  |  |  |
| Oil Systems                               | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |
|   | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |
|   |                    | Subtotal                  | 0.0000                                     |  |  |  |  |  |
| Electrical Power                          | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |
|   |                    | Subtotal                  | 0.0000                                     |  |  |  |  |  |
| Communication                             | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |
|   |                    | Subtotal                  | 0.0000                                     |  |  |  |  |  |
|   |                    | Total                     | 8.40                                       |  |  |  |  |  |
| _   |                    |                           |  |  |  |  |  |  |

#### Table 2: Utility System Lifeline Inventory





### Earthquake Scenario

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



| Scenario Name                 | EastHaddam                    |
|-------------------------------|-------------------------------|
| Type of Earthquake            | Arbitrary                     |
| Fault Name                    | NA                            |
| Historical Epicenter ID #     | NA                            |
| Probabilistic Return Period   | NA                            |
| Longitude of Epicenter        | -72.40                        |
| Latitude of Epicenter         | 41.50                         |
| Earthquake Magnitude          | 6.40                          |
| Depth (km)                    | 10.00                         |
| Rupture Length (Km)           | NA                            |
| Rupture Orientation (degrees) | NA                            |
| Attenuation Function          | Central & East US (CEUS 2008) |





#### **Direct Earthquake Damage**

#### **Building Damage**

Hazus estimates that about 1,288 buildings will be at least moderately damaged. This is over 40.00 % of the buildings in the region. There are an estimated 288 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

#### Damage Categories by General Occupancy Type



Table 3: Expected Building Damage by Occupancy

|                   | None   |       | Slight |       | Moderate |       | Extensive |       | Complete |       |
|-------------------|--------|-------|--------|-------|----------|-------|-----------|-------|----------|-------|
|                   | Count  | (%)   | Count  | (%)   | Count    | (%)   | Count     | (%)   | Count    | (%)   |
| Agriculture       | 0.18   | 0.02  | 0.63   | 0.06  | 2.96     | 0.41  | 4.17      | 1.48  | 6.07     | 2.10  |
| Commercial        | 3.58   | 0.40  | 9.71   | 0.98  | 42.05    | 5.86  | 74.21     | 26.29 | 130.45   | 45.16 |
| Education         | 0.13   | 0.01  | 0.33   | 0.03  | 1.39     | 0.19  | 2.64      | 0.93  | 4.52     | 1.56  |
| Government        | 0.06   | 0.01  | 0.13   | 0.01  | 0.62     | 0.09  | 1.42      | 0.50  | 2.77     | 0.96  |
| Industrial        | 1.16   | 0.13  | 2.84   | 0.29  | 13.15    | 1.83  | 28.63     | 10.14 | 56.21    | 19.46 |
| Other Residential | 24.28  | 2.70  | 27.66  | 2.79  | 24.16    | 3.37  | 16.38     | 5.80  | 23.52    | 8.14  |
| Religion          | 2.86   | 0.32  | 3.44   | 0.35  | 3.91     | 0.55  | 3.98      | 1.41  | 6.80     | 2.35  |
| Single Family     | 867.33 | 96.42 | 947.81 | 95.49 | 629.51   | 87.71 | 150.82    | 53.43 | 58.53    | 20.26 |
| Total             | 900    |       | 993    |       | 718      |       | 282       |       | 289      |       |





|          | None   |       | Slight |       | Moderate |       | Extensive |       | Complete |       |
|----------|--------|-------|--------|-------|----------|-------|-----------|-------|----------|-------|
|          | Count  | (%)   | Count  | (%)   | Count    | (%)   | Count     | (%)   | Count    | (%)   |
| Wood     | 890.36 | 98.98 | 971.59 | 97.89 | 648.41   | 90.34 | 151.72    | 53.75 | 30.75    | 10.65 |
| Steel    | 1.15   | 0.13  | 2.40   | 0.24  | 16.80    | 2.34  | 53.71     | 19.03 | 117.20   | 40.57 |
| Concrete | 0.18   | 0.02  | 0.39   | 0.04  | 2.77     | 0.39  | 8.44      | 2.99  | 18.23    | 6.31  |
| Precast  | 0.09   | 0.01  | 0.17   | 0.02  | 1.17     | 0.16  | 2.93      | 1.04  | 8.43     | 2.92  |
| RM       | 0.79   | 0.09  | 1.03   | 0.10  | 5.95     | 0.83  | 12.53     | 4.44  | 21.56    | 7.46  |
| URM      | 7.01   | 0.78  | 16.97  | 1.71  | 42.64    | 5.94  | 52.93     | 18.75 | 92.71    | 32.09 |
| МН       | 0.00   | 0.00  | 0.00   | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  | 0.00     | 0.00  |
| Total    | 900    |       | 993    |       | 718      |       | 282       |       | 289      |       |

#### Table 4: Expected Building Damage by Building Type (All Design Levels)

\*Note:

RM Reinforced Masonry

URM Unreinforced Masonry

MH Manufactured Housing




### **Essential Facility Damage**

Before the earthquake, the region had hospital beds available for use. On the day of the earthquake, the model estimates that only hospital beds (%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, % of the beds will be back in service. By 30 days, % will be operational.

|                |       | # Facilities                      |                          |                                      |  |  |
|----------------|-------|-----------------------------------|--------------------------|--------------------------------------|--|--|
| Classification | Total | At Least Moderate<br>Damage > 50% | Complete<br>Damage > 50% | With Functionality<br>> 50% on day 1 |  |  |
| Hospitals      | 0     | 0                                 | 0                        | 0                                    |  |  |
| Schools        | 1     | 1                                 | 1                        | 0                                    |  |  |
| EOCs           | 1     | 1                                 | 1                        | 0                                    |  |  |
| PoliceStations | 2     | 2                                 | 2                        | 0                                    |  |  |
| FireStations   | 2     | 2                                 | 1                        | 0                                    |  |  |

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





### Transportation Lifeline Damage







|            |            |            | Number of Locations_ |               |             |                   |  |
|------------|------------|------------|----------------------|---------------|-------------|-------------------|--|
| System     | Component  | Locations/ | With at Least        | With Complete | With Fun    | ctionality > 50 % |  |
|            |            | Segments   | Mod. Damage          | Damage        | After Day 1 | After Day 7       |  |
| Highway    | Segments   | 26         | 0                    | 0             | 26          | 26                |  |
| 0          | Bridges    | 15         | 4                    | 3             | 11          | 11                |  |
|            | Tunnels    | 0          | 0                    | 0             | 0           | 0                 |  |
| Railways   | Segments   | 2          | 0                    | 0             | 2           | 2                 |  |
|            | Bridges    | 0          | 0                    | 0             | 0           | 0                 |  |
|            | Tunnels    | 0          | 0                    | 0             | 0           | 0                 |  |
|            | Facilities | 0          | 0                    | 0             | 0           | 0                 |  |
| Light Rail | Segments   | 0          | 0                    | 0             | 0           | 0                 |  |
|            | Bridges    | 0          | 0                    | 0             | 0           | 0                 |  |
|            | Tunnels    | 0          | 0                    | 0             | 0           | 0                 |  |
|            | Facilities | 0          | 0                    | 0             | 0           | 0                 |  |
| Bus        | Facilities | 0          | 0                    | 0             | 0           | 0                 |  |
| Ferry      | Facilities | 0          | 0                    | 0             | 0           | 0                 |  |
| Port       | Facilities | 1          | 1                    | 0             | 1           | 1                 |  |
| Airport    | Facilities | 0          | 0                    | 0             | 0           | 0                 |  |
|            | Runways    | 0          | 0                    | 0             | 0           | 0                 |  |

#### Table 6: Expected Damage to the Transportation Systems

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.





|                  | # of Locations |                 |               |                           |             |  |  |
|------------------|----------------|-----------------|---------------|---------------------------|-------------|--|--|
| System           | Total #        | With at Least   | With Complete | with Functionality > 50 % |             |  |  |
|                  |                | Moderate Damage | Damage        | After Day 1               | After Day 7 |  |  |
| Potable Water    | 0              | 0               | 0             | 0                         | 0           |  |  |
| Waste Water      | 0              | 0               | 0             | 0                         | 0           |  |  |
| Natural Gas      | 0              | 0               | 0             | 0                         | 0           |  |  |
| Oil Systems      | 0              | 0               | 0             | 0                         | 0           |  |  |
| Electrical Power | 0              | 0               | 0             | 0                         | 0           |  |  |
| Communication    | 0              | 0               | 0             | 0                         | 0           |  |  |

#### Table 7 : Expected Utility System Facility Damage

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

| System        | Total Pipelines<br>Length (miles) | Number of<br>Leaks | Number of<br>Breaks |
|---------------|-----------------------------------|--------------------|---------------------|
| Potable Water | 131                               | 0                  | 0                   |
| Waste Water   | 78                                | 0                  | 0                   |
| Natural Gas   | 52                                | 0                  | 0                   |
| Oil           | 0                                 | 0                  | 0                   |

#### Table 9: Expected Potable Water and Electric Power System Performance

|                | Total # of | Number of Households without Service |          |          |           |           |
|----------------|------------|--------------------------------------|----------|----------|-----------|-----------|
|                | Households | At Day 1                             | At Day 3 | At Day 7 | At Day 30 | At Day 90 |
| Potable Water  |            |                                      |          |          |           |           |
| Electric Power |            |                                      |          |          |           |           |





### Induced Earthquake Damage

### **Fire Following Earthquake**

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

### **Debris Generation**

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. 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 137,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 31.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 5,480 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.







### **Social Impact**

#### **Shelter Requirement**

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 300 households to be displaced due to the earthquake. Of these, 131 people (out of a total population of 6,683) will seek temporary shelter in public shelters.



#### **Casualties**

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

Injuries will require medical attention but hospitalization is not needed. Injuries will require hospitalization but are not considered life-threatening

Injuries will require hospitalization and can become life threatening if not

- Severity Level 1:
- Severity Level 2:
- · Severity Level 3:
  - promptly treated.
- · Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake





### Table 10: Casualty Estimates

|      |                   | Level 1 | Level 2 | Level 3 | Level 4 |
|------|-------------------|---------|---------|---------|---------|
| 2 AM | Commercial        | 2.36    | 0.72    | 0.11    | 0.22    |
|      | Commuting         | 0.01    | 0.02    | 0.03    | 0.01    |
|      | Educational       | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Hotels            | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Industrial        | 3.87    | 1.20    | 0.19    | 0.38    |
|      | Other-Residential | 24.99   | 7.87    | 1.32    | 2.61    |
|      | Single Family     | 24.02   | 5.83    | 0.79    | 1.54    |
|      | Total             | 55      | 16      | 2       | 5       |
|      |                   |         |         |         |         |
| 2 PM | Commercial        | 138.38  | 42.34   | 6.66    | 13.02   |
|      | Commuting         | 0.10    | 0.14    | 0.23    | 0.05    |
|      | Educational       | 43.07   | 13.55   | 2.25    | 4.39    |
|      | Hotels            | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Industrial        | 28.71   | 8.92    | 1.43    | 2.78    |
|      | Other-Residential | 5.73    | 1.81    | 0.31    | 0.59    |
|      | Single Family     | 5.54    | 1.39    | 0.20    | 0.37    |
|      | Total             | 222     | 68      | 11      | 21      |
|      |                   |         |         |         |         |
| 5 PM | Commercial        | 97.06   | 29.72   | 4.71    | 9.08    |
|      | Commuting         | 1.92    | 2.61    | 4.35    | 0.84    |
|      | Educational       | 2.50    | 0.79    | 0.13    | 0.26    |
|      | Hotels            | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Industrial        | 17.94   | 5.58    | 0.89    | 1.74    |
|      | Other-Residential | 9.93    | 3.15    | 0.54    | 1.02    |
|      | Single Family     | 9.60    | 2.41    | 0.34    | 0.64    |
|      | Total             | 139     | 44      | 11      | 14      |





### **Economic Loss**

The total economic loss estimated for the earthquake is 633.71 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.





#### **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 earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 582.35 (millions of dollars); 18 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 32 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.



#### Table 11: Building-Related Economic Loss Estimates (Millions of dollars)

| Category     | Area            | Single<br>Family | Other<br>Residential | Commercial | Industrial | Others  | Total    |
|--------------|-----------------|------------------|----------------------|------------|------------|---------|----------|
| Income Loss  | es              |                  |                      |            |            |         |          |
|              | Wage            | 0.0000           | 4.0172               | 23.7323    | 1.0325     | 0.6527  | 29.4347  |
|              | Capital-Related | 0.0000           | 1.7009               | 22.6872    | 0.5976     | 0.2307  | 25.2164  |
|              | Rental          | 2.1087           | 3.0120               | 11.4056    | 0.3343     | 0.4015  | 17.2621  |
|              | Relocation      | 7.4777           | 1.4969               | 16.5715    | 1.6236     | 3.1489  | 30.3186  |
|              | Subtotal        | 9.5864           | 10.2270              | 74.3966    | 3.5880     | 4.4338  | 102.2318 |
| Capital Stoc | k Losses        |                  |                      |            |            |         |          |
|              | Structural      | 18.2606          | 5.5487               | 39.8372    | 8.3916     | 5.9467  | 77.9848  |
|              | Non_Structural  | 81.0540          | 28.2079              | 121.6178   | 33.5591    | 16.0802 | 280.5190 |
|              | Content         | 27.1171          | 6.3177               | 56.0439    | 20.3568    | 7.3599  | 117.1954 |
|              | Inventory       | 0.0000           | 0.0000               | 1.3666     | 2.9041     | 0.1481  | 4.4188   |
|              | Subtotal        | 126.4317         | 40.0743              | 218.8655   | 65.2116    | 29.5349 | 480.1180 |
|              | Total           | 136.02           | 50.30                | 293.26     | 68.80      | 33.97   | 582.35   |





### **Transportation and Utility Lifeline Losses**

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

| System     | Component  | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------|------------|-----------------|---------------|----------------|
| Highway    | Segments   | 385.5240        | 0.0000        | 0.00           |
|            | Bridges    | 181.0834        | 50.5002       | 27.89          |
|            | Tunnels    | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 566.6074        | 50.5002       |                |
| Railways   | Segments   | 13.2639         | 0.0000        | 0.00           |
|            | Bridges    | 0.0000          | 0.0000        | 0.00           |
|            | Tunnels    | 0.0000          | 0.0000        | 0.00           |
|            | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 13.2639         | 0.0000        |                |
| Light Rail | Segments   | 0.0000          | 0.0000        | 0.00           |
|            | Bridges    | 0.0000          | 0.0000        | 0.00           |
|            | Tunnels    | 0.0000          | 0.0000        | 0.00           |
|            | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| Bus        | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| Ferry      | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| Port       | Facilities | 1.9970          | 0.8539        | 42.76          |
|            | Subtotal   | 1.9970          | 0.8539        |                |
| Airport    | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Runways    | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| l          | Total      | 581.87          | 51.35         |                |

### Table 12: Transportation System Economic Losses

(Millions of dollars)





### Table 13: Utility System Economic Losses

(Millions of dollars)

| System           | Component          | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------------|--------------------|-----------------|---------------|----------------|
| Potable Water    | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Distribution Lines | 4.2050          | 0.0000        | 0.00           |
|                  | Subtotal           | 4.2050          | 0.0000        |                |
| Waste Water      | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Distribution Lines | 2.5230          | 0.0000        | 0.00           |
|                  | Subtotal           | 2.5230          | 0.0000        |                |
| Natural Gas      | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Distribution Lines | 1.6820          | 0.0000        | 0.00           |
|                  | Subtotal           | 1.6820          | 0.0000        |                |
| Oil Systems      | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Subtotal           | 0.0000          | 0.0000        |                |
| Electrical Power | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Subtotal           | 0.0000          | 0.0000        |                |
| Communication    | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Subtotal           | 0.0000          | 0.0000        |                |
|                  | Total              | 8.41            | 0.00          |                |





### Appendix A: County Listing for the Region

Middlesex,CT





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

|              | County Name | Population | Building Value (millions of dollars) |                 |       |  |
|--------------|-------------|------------|--------------------------------------|-----------------|-------|--|
| State        |             |            | Residential                          | Non-Residential | Total |  |
| Connecticut  |             |            |                                      |                 |       |  |
|              | Middlesex   | 6,683      | 1,070                                | 408             | 1,479 |  |
| Total Region |             | 6,683      | 1,070                                | 408             | 1,479 |  |







# Hazus: Earthquake Global Risk Report

| Region Name:         | Essex            |
|----------------------|------------------|
| Earthquake Scenario: | Haddam           |
| Print Date:          | October 17, 2019 |

**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 earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.





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Appendix A: County Listing for the Region Appendix B: Regional Population and Building Value Data





### **General Description of the Region**

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. 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 earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Connecticut

Note:

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

The geographical size of the region is 11.29 square miles and contains 1 census tracts. There are over 2 thousand households in the region which has a total population of 6,683 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 1,479 (millions of dollars). Approximately 87.00 % of the buildings (and 72.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 581 and 8 (millions of dollars), respectively.





### **Building and Lifeline Inventory**

### **Building Inventory**

Hazus estimates that there are 3 thousand buildings in the region which have an aggregate total replacement value of 1,479 (millions of dollars). Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 85% of the building inventory. The remaining percentage is distributed between the other general building types.

### **Critical Facility Inventory**

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of beds. There are 1 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 2 hazardous material sites, no military installations and no nuclear power plants.

### Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 589.00 (millions of dollars). This inventory includes over 36.04 miles of highways, 15 bridges, 260.98 miles of pipes.





| System     | Component  | # Locations/<br># Segments | Replacement value<br>(millions of dollars) |
|------------|------------|----------------------------|--|
| Highway    | Bridges    | 15                         | 181.0834                                   |
|            | Segments   | 26                         | 385.5240                                   |
|            | Tunnels    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 566.6074                                   |
| Railways   | Bridges    | 0                          | 0.0000                                     |
|            | Facilities | 0                          | 0.0000                                     |
|            | Segments   | 2                          | 13.2639                                    |
|            | Tunnels    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 13.2639                                    |
| Light Rail | Bridges    | 0                          | 0.0000                                     |
| U          | Facilities | 0                          | 0.0000                                     |
|            | Segments   | 0                          | 0.0000                                     |
|            | Tunnels    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
| Bus        | Facilities | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
| Ferry      | Facilities | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
| Port       | Facilities | 1                          | 1.9970                                     |
|            |            | Subtotal                   | 1.9970                                     |
| Airport    | Facilities | 0                          | 0.0000                                     |
| -          | Runways    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
|            |            | Total                      | 581.90                                     |

#### Table 1. Tr tio n S. Lifolin ~ I.





| System           | Component          | # Locations /<br>Segments | Replacement value<br>(millions of dollars) |  |  |  |  |  |  |  |
|------------------|--------------------|---------------------------|--|--|--|--|--|--|--|--|
| Potable Water    | Distribution Lines | NA                        | 4.2050                                     |  |  |  |  |  |  |  |
|                  | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |  |  |
|                  | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |  |  |
|                  |                    | Subtotal                  | 4.2050                                     |  |  |  |  |  |  |  |
| Waste Water      | Distribution Lines | NA                        | 2.5230                                     |  |  |  |  |  |  |  |
|                  | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |  |  |
|                  | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |  |  |
|                  |                    | Subtotal                  | 2.5230                                     |  |  |  |  |  |  |  |
| Natural Gas      | Distribution Lines | NA                        | 1.6820                                     |  |  |  |  |  |  |  |
|                  | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |  |  |
|                  | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |  |  |
|                  |                    | Subtotal                  | 1.6820                                     |  |  |  |  |  |  |  |
| Oil Systems      | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |  |  |
|                  | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |  |  |
|                  |                    | Subtotal                  | 0.0000                                     |  |  |  |  |  |  |  |
| Electrical Power | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |  |  |
|                  |                    | Subtotal                  | 0.0000                                     |  |  |  |  |  |  |  |
| Communication    | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |  |  |
|                  |                    | Subtotal                  | 0.0000                                     |  |  |  |  |  |  |  |
|                  |                    | Total                     | 8.40                                       |  |  |  |  |  |  |  |
| _                |                    |                           |  |  |  |  |  |  |  |  |

### Table 2: Utility System Lifeline Inventory





### Earthquake Scenario

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



| Scenario Name                 | Haddam                        |
|-------------------------------|-------------------------------|
| Type of Earthquake            | Arbitrary                     |
| Fault Name                    | NA                            |
| Historical Epicenter ID #     | NA                            |
| Probabilistic Return Period   | NA                            |
| Longitude of Epicenter        | -72.50                        |
| Latitude of Epicenter         | 41.50                         |
| Earthquake Magnitude          | 5.70                          |
| Depth (km)                    | 10.00                         |
| Rupture Length (Km)           | NA                            |
| Rupture Orientation (degrees) | NA                            |
| Attenuation Function          | Central & East US (CEUS 2008) |





### **Direct Earthquake Damage**

#### **Building Damage**

Hazus estimates that about 620 buildings will be at least moderately damaged. This is over 19.00 % of the buildings in the region. There are an estimated 51 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

### Damage Categories by General Occupancy Type



Table 3: Expected Building Damage by Occupancy

|                   | None    |       | Slight |       | Moderate |       | Extensive |       | Complete |       |
|-------------------|---------|-------|--------|-------|----------|-------|-----------|-------|----------|-------|
|                   | Count   | (%)   | Count  | (%)   | Count    | (%)   | Count     | (%)   | Count    | (%)   |
| Agriculture       | 2.34    | 0.13  | 2.99   | 0.37  | 4.85     | 1.14  | 2.65      | 1.82  | 1.17     | 2.28  |
| Commercial        | 45.67   | 2.62  | 46.89  | 5.73  | 84.27    | 19.90 | 57.87     | 39.68 | 25.30    | 49.43 |
| Education         | 1.68    | 0.10  | 1.59   | 0.19  | 2.91     | 0.69  | 2.00      | 1.37  | 0.83     | 1.62  |
| Government        | 0.74    | 0.04  | 0.75   | 0.09  | 1.63     | 0.38  | 1.29      | 0.89  | 0.59     | 1.15  |
| Industrial        | 15.59   | 0.89  | 15.59  | 1.90  | 32.76    | 7.74  | 26.11     | 17.90 | 11.95    | 23.36 |
| Other Residential | 54.56   | 3.13  | 27.44  | 3.35  | 20.26    | 4.78  | 10.25     | 7.03  | 3.49     | 6.83  |
| Religion          | 8.01    | 0.46  | 4.56   | 0.56  | 4.60     | 1.09  | 2.81      | 1.93  | 1.02     | 2.00  |
| Single Family     | 1613.44 | 92.62 | 718.61 | 87.81 | 272.28   | 64.28 | 42.85     | 29.38 | 6.82     | 13.33 |
| Total             | 1,742   |       | 818    |       | 424      |       | 146       |       | 51       |       |





|          | None    |       | Slight |       | Modera | Moderate |       | ve    | Comple | Complete |  |
|----------|---------|-------|--------|-------|--------|----------|-------|-------|--------|----------|--|
|          | Count   | (%)   | Count  | (%)   | Count  | (%)      | Count | (%)   | Count  | (%)      |  |
| Wood     | 1639.41 | 94.11 | 734.32 | 89.73 | 279.10 | 65.89    | 36.52 | 25.05 | 3.48   | 6.79     |  |
| Steel    | 20.48   | 1.18  | 22.84  | 2.79  | 62.57  | 14.77    | 56.80 | 38.95 | 28.56  | 55.80    |  |
| Concrete | 2.95    | 0.17  | 3.33   | 0.41  | 10.18  | 2.40     | 9.36  | 6.42  | 4.18   | 8.17     |  |
| Precast  | 1.80    | 0.10  | 1.40   | 0.17  | 3.83   | 0.90     | 4.20  | 2.88  | 1.57   | 3.06     |  |
| RM       | 10.17   | 0.58  | 5.41   | 0.66  | 12.42  | 2.93     | 11.17 | 7.66  | 2.69   | 5.26     |  |
| URM      | 67.22   | 3.86  | 51.10  | 6.24  | 55.47  | 13.10    | 27.77 | 19.04 | 10.71  | 20.92    |  |
| мн       | 0.00    | 0.00  | 0.00   | 0.00  | 0.00   | 0.00     | 0.00  | 0.00  | 0.00   | 0.00     |  |
| Total    | 1,742   |       | 818    |       | 424    |          | 146   |       | 51     |          |  |

### Table 4: Expected Building Damage by Building Type (All Design Levels)

\*Note:

RM Reinforced Masonry

URM Unreinforced Masonry

MH Manufactured Housing





### **Essential Facility Damage**

Before the earthquake, the region had hospital beds available for use. On the day of the earthquake, the model estimates that only hospital beds (%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, % of the beds will be back in service. By 30 days, % will be operational.

|                |       | # Facilities                      |                          |                                      |  |  |  |
|----------------|-------|-----------------------------------|--------------------------|--------------------------------------|--|--|--|
| Classification | Total | At Least Moderate<br>Damage > 50% | Complete<br>Damage > 50% | With Functionality<br>> 50% on day 1 |  |  |  |
| Hospitals      | 0     | 0                                 | 0                        | 0                                    |  |  |  |
| Schools        | 1     | 0                                 | 0                        | 0                                    |  |  |  |
| EOCs           | 1     | 0                                 | 0                        | 0                                    |  |  |  |
| PoliceStations | 2     | 0                                 | 0                        | 0                                    |  |  |  |
| FireStations   | 2     | 1                                 | 0                        | 0                                    |  |  |  |

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





### Transportation Lifeline Damage







|            |            |            | Number of Locations_ |               |             |                   |  |  |  |
|------------|------------|------------|----------------------|---------------|-------------|-------------------|--|--|--|
| System     | Component  | Locations/ | With at Least        | With Complete | With Fun    | ctionality > 50 % |  |  |  |
|            |            | Segments   | Mod. Damage          | Damage        | After Day 1 | After Day 7       |  |  |  |
| Highway    | Segments   | 26         | 0                    | 0             | 26          | 26                |  |  |  |
|            | Bridges    | 15         | 3                    | 0             | 12          | 13                |  |  |  |
|            | Tunnels    | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
| Railways   | Segments   | 2          | 0                    | 0             | 2           | 2                 |  |  |  |
|            | Bridges    | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
|            | Tunnels    | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
|            | Facilities | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
| Light Rail | Segments   | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
|            | Bridges    | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
|            | Tunnels    | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
|            | Facilities | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
| Bus        | Facilities | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
| Ferry      | Facilities | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
| Port       | Facilities | 1          | 0                    | 0             | 1           | 1                 |  |  |  |
| Airport    | Facilities | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
|            | Runways    | 0          | 0                    | 0             | 0           | 0                 |  |  |  |

#### Table 6: Expected Damage to the Transportation Systems

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.





|                  | # of Locations |                 |               |                           |             |  |  |  |  |  |
|------------------|----------------|-----------------|---------------|---------------------------|-------------|--|--|--|--|--|
| System           | Total #        | With at Least   | With Complete | with Functionality > 50 % |             |  |  |  |  |  |
|                  |                | Moderate Damage | Damage        | After Day 1               | After Day 7 |  |  |  |  |  |
| Potable Water    | 0              | 0               | 0             | 0                         | 0           |  |  |  |  |  |
| Waste Water      | 0              | 0               | 0             | 0                         | 0           |  |  |  |  |  |
| Natural Gas      | 0              | 0               | 0             | 0                         | 0           |  |  |  |  |  |
| Oil Systems      | 0              | 0               | 0             | 0                         | 0           |  |  |  |  |  |
| Electrical Power | 0              | 0               | 0             | 0                         | 0           |  |  |  |  |  |
| Communication    | 0              | 0               | 0             | 0                         | 0           |  |  |  |  |  |

#### Table 7 : Expected Utility System Facility Damage

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

| System        | Total Pipelines<br>Length (miles) | Number of<br>Leaks | Number of<br>Breaks |
|---------------|-----------------------------------|--------------------|---------------------|
| Potable Water | 131                               | 0                  | 0                   |
| Waste Water   | 78                                | 0                  | 0                   |
| Natural Gas   | 52                                | 0                  | 0                   |
| Oil           | 0                                 | 0                  | 0                   |

#### Table 9: Expected Potable Water and Electric Power System Performance

|                | Total # of | Number of Households without Service |          |          |           |           |  |  |
|----------------|------------|--------------------------------------|----------|----------|-----------|-----------|--|--|
|                | Households | At Day 1                             | At Day 3 | At Day 7 | At Day 30 | At Day 90 |  |  |
| Potable Water  |            |                                      |          |          |           |           |  |  |
| Electric Power |            |                                      |          |          |           |           |  |  |





### Induced Earthquake Damage

### **Fire Following Earthquake**

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

### **Debris Generation**

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. 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 44,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 32.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 1,760 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.







### **Social Impact**

#### **Shelter Requirement**

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 87 households to be displaced due to the earthquake. Of these, 37 people (out of a total population of 6,683) will seek temporary shelter in public shelters.



#### **Casualties**

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

Injuries will require medical attention but hospitalization is not needed. Injuries will require hospitalization but are not considered life-threatening

Injuries will require hospitalization and can become life threatening if not

- Severity Level 1:
- · Severity Level 2:
- · Severity Level 3:
  - promptly treated.
- · Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake





### Table 10: Casualty Estimates

|      |                   | Level 1 | Level 2 | Level 3 | Level 4 |
|------|-------------------|---------|---------|---------|---------|
| 2 AM | Commercial        | 0.55    | 0.14    | 0.02    | 0.04    |
|      | Commuting         | 0.00    | 0.00    | 0.01    | 0.00    |
|      | Educational       | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Hotels            | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Industrial        | 0.99    | 0.26    | 0.04    | 0.07    |
|      | Other-Residential | 4.92    | 1.27    | 0.20    | 0.39    |
|      | Single Family     | 5.30    | 0.88    | 0.09    | 0.18    |
|      | Total             | 12      | 3       | 0       | 1       |
|      |                   |         |         |         |         |
| 2 PM | Commercial        | 32.32   | 8.33    | 1.17    | 2.28    |
|      | Commuting         | 0.03    | 0.04    | 0.06    | 0.01    |
|      | Educational       | 9.90    | 2.65    | 0.41    | 0.79    |
|      | Hotels            | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Industrial        | 7.35    | 1.94    | 0.28    | 0.54    |
|      | Other-Residential | 1.12    | 0.29    | 0.05    | 0.09    |
|      | Single Family     | 1.20    | 0.21    | 0.02    | 0.04    |
|      | Total             | 52      | 13      | 2       | 4       |
|      |                   |         |         |         |         |
| 5 PM | Commercial        | 22.57   | 5.82    | 0.83    | 1.59    |
|      | Commuting         | 0.54    | 0.66    | 1.19    | 0.23    |
|      | Educational       | 0.58    | 0.15    | 0.02    | 0.05    |
|      | Hotels            | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Industrial        | 4.59    | 1.22    | 0.18    | 0.34    |
|      | Other-Residential | 1.94    | 0.50    | 0.08    | 0.15    |
|      | Single Family     | 2.08    | 0.36    | 0.04    | 0.07    |
|      | Total             | 32      | 9       | 2       | 2       |





### **Economic Loss**

The total economic loss estimated for the earthquake is 216.14 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.





#### **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 earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 194.12 (millions of dollars); 21 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 34 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.



#### Table 11: Building-Related Economic Loss Estimates (Millions of dollars)

| Category      | Area            | Single<br>Family | Other       | Commercial | Industrial | Others | Total    |
|---------------|-----------------|------------------|-------------|------------|------------|--------|----------|
|               |                 | Failing          | Residential |            |            |        |          |
| Income Loss   | es              |                  |             |            |            |        |          |
|               | Wage            | 0.0000           | 1.4140      | 9.8204     | 0.4227     | 0.2643 | 11.9214  |
|               | Capital-Related | 0.0000           | 0.5987      | 9.0641     | 0.2458     | 0.0838 | 9.9924   |
|               | Rental          | 0.6754           | 1.0312      | 5.0159     | 0.1583     | 0.1635 | 7.0443   |
|               | Relocation      | 2.4047           | 0.5544      | 7.5868     | 0.8785     | 1.2532 | 12.6776  |
|               | Subtotal        | 3.0801           | 3.5983      | 31.4872    | 1.7053     | 1.7648 | 41.6357  |
| Capital Stock | Losses          |                  |             |            |            |        |          |
|               | Structural      | 5.9466           | 1.8589      | 14.7337    | 3.3466     | 2.0920 | 27.9778  |
|               | Non_Structural  | 30.0015          | 7.9662      | 34.7386    | 9.5413     | 4.4780 | 86.7256  |
|               | Content         | 11.7178          | 1.8988      | 15.2224    | 5.7129     | 1.9915 | 36.5434  |
|               | Inventory       | 0.0000           | 0.0000      | 0.3777     | 0.8136     | 0.0414 | 1.2327   |
|               | Subtotal        | 47.6659          | 11.7239     | 65.0724    | 19.4144    | 8.6029 | 152.4795 |
|               | Total           | 50.75            | 15.32       | 96.56      | 21.12      | 10.37  | 194.12   |





### **Transportation and Utility Lifeline Losses**

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

| System     | Component  | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------|------------|-----------------|---------------|----------------|
| Highway    | Segments   | 385.5240        | 0.0000        | 0.00           |
|            | Bridges    | 181.0834        | 21.5703       | 11.91          |
|            | Tunnels    | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 566.6074        | 21.5703       |                |
| Railways   | Segments   | 13.2639         | 0.0000        | 0.00           |
|            | Bridges    | 0.0000          | 0.0000        | 0.00           |
|            | Tunnels    | 0.0000          | 0.0000        | 0.00           |
|            | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 13.2639         | 0.0000        |                |
| Light Rail | Segments   | 0.0000          | 0.0000        | 0.00           |
|            | Bridges    | 0.0000          | 0.0000        | 0.00           |
|            | Tunnels    | 0.0000          | 0.0000        | 0.00           |
|            | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| Bus        | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| Ferry      | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| Port       | Facilities | 1.9970          | 0.4506        | 22.56          |
|            | Subtotal   | 1.9970          | 0.4506        |                |
| Airport    | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Runways    | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| l          | Total      | 581.87          | 22.02         |                |

### Table 12: Transportation System Economic Losses

(Millions of dollars)





### Table 13: Utility System Economic Losses

(Millions of dollars)

| System           | Component          | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------------|--------------------|-----------------|---------------|----------------|
| Potable Water    | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Distribution Lines | 4.2050          | 0.0000        | 0.00           |
|                  | Subtotal           | 4.2050          | 0.0000        |                |
| Waste Water      | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Distribution Lines | 2.5230          | 0.0000        | 0.00           |
|                  | Subtotal           | 2.5230          | 0.0000        |                |
| Natural Gas      | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Distribution Lines | 1.6820          | 0.0000        | 0.00           |
|                  | Subtotal           | 1.6820          | 0.0000        |                |
| Oil Systems      | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Subtotal           | 0.0000          | 0.0000        |                |
| Electrical Power | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Subtotal           | 0.0000          | 0.0000        |                |
| Communication    | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Subtotal           | 0.0000          | 0.0000        |                |
|                  | Total              | 8.41            | 0.00          |                |





### Appendix A: County Listing for the Region

Middlesex,CT





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

| State        | County Name | Population | Building Value (millions of dollars) |                 |       |
|--------------|-------------|------------|--------------------------------------|-----------------|-------|
|              |             |            | Residential                          | Non-Residential | Total |
| Connecticut  |             |            |                                      |                 |       |
|              | Middlesex   | 6,683      | 1,070                                | 408             | 1,479 |
| Total Region |             | 6,683      | 1,070                                | 408             | 1,479 |







# Hazus: Earthquake Global Risk Report

| Region Name:         | Essex            |  |
|----------------------|------------------|--|
| Earthquake Scenario: | Portland         |  |
| Print Date:          | October 17, 2019 |  |

**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 earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.




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Appendix A: County Listing for the Region Appendix B: Regional Population and Building Value Data





### **General Description of the Region**

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. 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 earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Connecticut

Note:

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

The geographical size of the region is 11.29 square miles and contains 1 census tracts. There are over 2 thousand households in the region which has a total population of 6,683 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 1,479 (millions of dollars). Approximately 87.00 % of the buildings (and 72.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 581 and 8 (millions of dollars), respectively.





### **Building and Lifeline Inventory**

### **Building Inventory**

Hazus estimates that there are 3 thousand buildings in the region which have an aggregate total replacement value of 1,479 (millions of dollars). Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 85% of the building inventory. The remaining percentage is distributed between the other general building types.

### **Critical Facility Inventory**

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of beds. There are 1 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 2 hazardous material sites, no military installations and no nuclear power plants.

### Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 589.00 (millions of dollars). This inventory includes over 36.04 miles of highways, 15 bridges, 260.98 miles of pipes.





| System     | Component  | # Locations/<br># Segments | Replacement value<br>(millions of dollars) |
|------------|------------|----------------------------|--|
| Highway    | Bridges    | 15                         | 181.0834                                   |
|            | Segments   | 26                         | 385.5240                                   |
|            | Tunnels    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 566.6074                                   |
| Railways   | Bridges    | 0                          | 0.0000                                     |
|            | Facilities | 0                          | 0.0000                                     |
|            | Segments   | 2                          | 13.2639                                    |
|            | Tunnels    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 13.2639                                    |
| Light Rail | Bridges    | 0                          | 0.0000                                     |
|            | Facilities | 0                          | 0.0000                                     |
|            | Segments   | 0                          | 0.0000                                     |
|            | Tunnels    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
| Bus        | Facilities | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
| Ferry      | Facilities | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
| Port       | Facilities | 1                          | 1.9970                                     |
|            |            | Subtotal                   | 1.9970                                     |
| Airport    | Facilities | 0                          | 0.0000                                     |
| -          | Runways    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
|            |            | Total                      | 581.90                                     |

#### Table 1. Tr tio n 91 Lifolin ~ I.





| System           | Component          | # Locations /<br>Segments | Replacement value<br>(millions of dollars) |  |  |  |  |  |  |
|------------------|--------------------|---------------------------|--|--|--|--|--|--|--|
| Potable Water    | Distribution Lines | NA                        | 4.2050                                     |  |  |  |  |  |  |
|                  | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  |                    | Subtotal                  | 4.2050                                     |  |  |  |  |  |  |
| Waste Water      | Distribution Lines | NA                        | 2.5230                                     |  |  |  |  |  |  |
|                  | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  |                    | Subtotal                  | 2.5230                                     |  |  |  |  |  |  |
| Natural Gas      | Distribution Lines | NA                        | 1.6820                                     |  |  |  |  |  |  |
|                  | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  |                    | Subtotal                  | 1.6820                                     |  |  |  |  |  |  |
| Oil Systems      | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  |                    | Subtotal                  | 0.0000                                     |  |  |  |  |  |  |
| Electrical Power | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  |                    | Subtotal                  | 0.0000                                     |  |  |  |  |  |  |
| Communication    | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  |                    | Subtotal                  | 0.0000                                     |  |  |  |  |  |  |
|                  |                    | Total                     | 8.40                                       |  |  |  |  |  |  |
| _                |                    |                           |  |  |  |  |  |  |  |

### Table 2: Utility System Lifeline Inventory





### Earthquake Scenario

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



| Scenario Name                 | Portland                      |
|-------------------------------|-------------------------------|
| Type of Earthquake            | Arbitrary                     |
| Fault Name                    | NA                            |
| Historical Epicenter ID #     | NA                            |
| Probabilistic Return Period   | NA                            |
| Longitude of Epicenter        | -72.60                        |
| Latitude of Epicenter         | 41.60                         |
| Earthquake Magnitude          | 5.70                          |
| Depth (km)                    | 10.00                         |
| Rupture Length (Km)           | NA                            |
| Rupture Orientation (degrees) | NA                            |
| Attenuation Function          | Central & East US (CEUS 2008) |





### **Direct Earthquake Damage**

#### **Building Damage**

Hazus estimates that about 173 buildings will be at least moderately damaged. This is over 5.00 % of the buildings in the region. There are an estimated 3 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

### Damage Categories by General Occupancy Type



Table 3: Expected Building Damage by Occupancy

|                   | None    |       | Slight |       | Moderate | 9     | Extensiv | e     | Complete |       |
|-------------------|---------|-------|--------|-------|----------|-------|----------|-------|----------|-------|
|                   | Count   | (%)   | Count  | (%)   | Count    | (%)   | Count    | (%)   | Count    | (%)   |
| Agriculture       | 8.97    | 0.35  | 2.82   | 0.66  | 1.72     | 1.19  | 0.44     | 1.72  | 0.05     | 1.51  |
| Commercial        | 161.65  | 6.27  | 49.23  | 11.50 | 37.94    | 26.23 | 9.76     | 38.15 | 1.42     | 40.24 |
| Education         | 5.70    | 0.22  | 1.66   | 0.39  | 1.29     | 0.90  | 0.29     | 1.15  | 0.05     | 1.42  |
| Government        | 3.00    | 0.12  | 0.94   | 0.22  | 0.83     | 0.57  | 0.20     | 0.79  | 0.03     | 0.94  |
| Industrial        | 61.21   | 2.37  | 18.97  | 4.43  | 16.79    | 11.61 | 4.39     | 17.14 | 0.64     | 18.20 |
| Other Residential | 89.23   | 3.46  | 16.50  | 3.86  | 8.22     | 5.68  | 1.80     | 7.02  | 0.25     | 7.08  |
| Religion          | 15.09   | 0.58  | 3.26   | 0.76  | 2.06     | 1.42  | 0.52     | 2.02  | 0.08     | 2.21  |
| Single Family     | 2234.48 | 86.63 | 334.54 | 78.18 | 75.78    | 52.40 | 8.19     | 32.01 | 1.00     | 28.40 |
| Total             | 2,579   |       | 428    |       | 145      |       | 26       |       | 4        |       |





|          | None    |       | Sligh  | Slight |       | Moderate |       | Extensive |       | Complete |  |
|----------|---------|-------|--------|--------|-------|----------|-------|-----------|-------|----------|--|
|          | Count   | (%)   | Count  | (%)    | Count | (%)      | Count | (%)       | Count | (%)      |  |
| Wood     | 2280.39 | 88.41 | 339.37 | 79.31  | 68.21 | 47.16    | 4.57  | 17.88     | 0.28  | 7.91     |  |
| Steel    | 106.45  | 4.13  | 36.42  | 8.51   | 36.99 | 25.58    | 9.86  | 38.51     | 1.54  | 43.49    |  |
| Concrete | 17.28   | 0.67  | 5.60   | 1.31   | 5.78  | 4.00     | 1.20  | 4.68      | 0.15  | 4.23     |  |
| Precast  | 7.86    | 0.30  | 1.87   | 0.44   | 2.19  | 1.52     | 0.83  | 3.26      | 0.03  | 0.97     |  |
| RM       | 31.08   | 1.21  | 4.81   | 1.12   | 4.60  | 3.18     | 1.34  | 5.25      | 0.02  | 0.53     |  |
| URM      | 136.27  | 5.28  | 39.84  | 9.31   | 26.85 | 18.56    | 7.79  | 30.43     | 1.51  | 42.88    |  |
| мн       | 0.00    | 0.00  | 0.00   | 0.00   | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  | 0.00     |  |
| Total    | 2,579   |       | 428    |        | 145   |          | 26    |           | 4     |          |  |

### Table 4: Expected Building Damage by Building Type (All Design Levels)

\*Note:

RM Reinforced Masonry

URM Unreinforced Masonry

MH Manufactured Housing





### **Essential Facility Damage**

Before the earthquake, the region had hospital beds available for use. On the day of the earthquake, the model estimates that only hospital beds (%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, % of the beds will be back in service. By 30 days, % will be operational.

|                |       | # Facilities                      |                          |                                      |  |  |  |
|----------------|-------|-----------------------------------|--------------------------|--------------------------------------|--|--|--|
| Classification | Total | At Least Moderate<br>Damage > 50% | Complete<br>Damage > 50% | With Functionality<br>> 50% on day 1 |  |  |  |
| Hospitals      | 0     | 0                                 | 0                        | 0                                    |  |  |  |
| Schools        | 1     | 0                                 | 0                        | 1                                    |  |  |  |
| EOCs           | 1     | 0                                 | 0                        | 1                                    |  |  |  |
| PoliceStations | 2     | 0                                 | 0                        | 2                                    |  |  |  |
| FireStations   | 2     | 0                                 | 0                        | 2                                    |  |  |  |

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





### Transportation Lifeline Damage







|            |            |            | Number of Locations_ |               |             |                   |  |  |  |
|------------|------------|------------|----------------------|---------------|-------------|-------------------|--|--|--|
| System     | Component  | Locations/ | With at Least        | With Complete | With Fun    | ctionality > 50 % |  |  |  |
|            |            | Segments   | Mod. Damage          | Damage        | After Day 1 | After Day 7       |  |  |  |
| Highway    | Segments   | 26         | 0                    | 0             | 26          | 26                |  |  |  |
|            | Bridges    | 15         | 0                    | 0             | 15          | 15                |  |  |  |
|            | Tunnels    | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
| Railways   | Segments   | 2          | 0                    | 0             | 2           | 2                 |  |  |  |
|            | Bridges    | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
|            | Tunnels    | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
|            | Facilities | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
| Light Rail | Segments   | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
|            | Bridges    | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
|            | Tunnels    | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
|            | Facilities | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
| Bus        | Facilities | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
| Ferry      | Facilities | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
| Port       | Facilities | 1          | 0                    | 0             | 1           | 1                 |  |  |  |
| Airport    | Facilities | 0          | 0                    | 0             | 0           | 0                 |  |  |  |
|            | Runways    | 0          | 0                    | 0             | 0           | 0                 |  |  |  |

#### Table 6: Expected Damage to the Transportation Systems

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.





|                  | # of Locations |                 |               |                           |             |  |  |  |
|------------------|----------------|-----------------|---------------|---------------------------|-------------|--|--|--|
| System           | Total #        | With at Least   | With Complete | with Functionality > 50 % |             |  |  |  |
|                  |                | Moderate Damage | Damage        | After Day 1               | After Day 7 |  |  |  |
| Potable Water    | 0              | 0               | 0             | 0                         | 0           |  |  |  |
| Waste Water      | 0              | 0               | 0             | 0                         | 0           |  |  |  |
| Natural Gas      | 0              | 0               | 0             | 0                         | 0           |  |  |  |
| Oil Systems      | 0              | 0               | 0             | 0                         | 0           |  |  |  |
| Electrical Power | 0              | 0               | 0             | 0                         | 0           |  |  |  |
| Communication    | 0              | 0               | 0             | 0                         | 0           |  |  |  |

#### Table 7 : Expected Utility System Facility Damage

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

| System        | Total Pipelines<br>Length (miles) | Number of<br>Leaks | Number of<br>Breaks |
|---------------|-----------------------------------|--------------------|---------------------|
| Potable Water | 131                               | 0                  | 0                   |
| Waste Water   | 78                                | 0                  | 0                   |
| Natural Gas   | 52                                | 0                  | 0                   |
| Oil           | 0                                 | 0                  | 0                   |

#### Table 9: Expected Potable Water and Electric Power System Performance

|                | Total # of | Number of Households without Service |          |          |           |           |  |
|----------------|------------|--------------------------------------|----------|----------|-----------|-----------|--|
|                | Households | At Day 1                             | At Day 3 | At Day 7 | At Day 30 | At Day 90 |  |
| Potable Water  |            |                                      |          |          |           |           |  |
| Electric Power |            |                                      |          |          |           |           |  |





### Induced Earthquake Damage

### **Fire Following Earthquake**

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

### **Debris Generation**

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. 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 7,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 46.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 280 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.







### **Social Impact**

#### **Shelter Requirement**

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 13 households to be displaced due to the earthquake. Of these, 5 people (out of a total population of 6,683) will seek temporary shelter in public shelters.



#### **Casualties**

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

Injuries will require medical attention but hospitalization is not needed.

Injuries will require hospitalization but are not considered life-threatening

Injuries will require hospitalization and can become life threatening if not

- Severity Level 1:
- Severity Level 2:
- · Severity Level 3:
  - promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake





### Table 10: Casualty Estimates

|      |                   | Level 1 | Level 2 | Level 3 | Level 4 |
|------|-------------------|---------|---------|---------|---------|
| 2 AM | Commercial        | 0.07    | 0.01    | 0.00    | 0.00    |
|      | Commuting         | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Educational       | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Hotels            | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Industrial        | 0.11    | 0.02    | 0.00    | 0.00    |
|      | Other-Residential | 0.73    | 0.13    | 0.01    | 0.03    |
|      | Single Family     | 1.30    | 0.16    | 0.01    | 0.03    |
|      | Total             | 2       | 0       | 0       | 0       |
|      |                   |         |         |         |         |
| 2 PM | Commercial        | 3.96    | 0.72    | 0.08    | 0.15    |
|      | Commuting         | 0.00    | 0.00    | 0.01    | 0.00    |
|      | Educational       | 1.18    | 0.22    | 0.03    | 0.05    |
|      | Hotels            | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Industrial        | 0.84    | 0.15    | 0.02    | 0.03    |
|      | Other-Residential | 0.17    | 0.03    | 0.00    | 0.01    |
|      | Single Family     | 0.29    | 0.04    | 0.00    | 0.01    |
|      | Total             | 6       | 1       | 0       | 0       |
|      |                   |         |         |         |         |
| 5 PM | Commercial        | 2.76    | 0.51    | 0.06    | 0.11    |
|      | Commuting         | 0.08    | 0.09    | 0.16    | 0.03    |
|      | Educational       | 0.07    | 0.01    | 0.00    | 0.00    |
|      | Hotels            | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Industrial        | 0.53    | 0.10    | 0.01    | 0.02    |
|      | Other-Residential | 0.29    | 0.05    | 0.01    | 0.01    |
|      | Single Family     | 0.50    | 0.06    | 0.01    | 0.01    |
|      | Total             | 4       | 1       | 0       | 0       |





### **Economic Loss**

The total economic loss estimated for the earthquake is 45.12 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.





#### **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 earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 39.01 (millions of dollars); 22 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 43 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.



#### Table 11: Building-Related Economic Loss Estimates (Millions of dollars)

| Category      | Area            | Single<br>Family | Other<br>Residential | Commercial | Industrial | Others | Total   |
|---------------|-----------------|------------------|----------------------|------------|------------|--------|---------|
| Income Loss   | es              |                  |                      |            |            |        |         |
|               | Wage            | 0.0000           | 0.2084               | 1.9780     | 0.0762     | 0.0524 | 2.3150  |
|               | Capital-Related | 0.0000           | 0.0882               | 1.7553     | 0.0445     | 0.0158 | 1.9038  |
|               | Rental          | 0.1722           | 0.2079               | 1.0717     | 0.0346     | 0.0317 | 1.5181  |
|               | Relocation      | 0.5907           | 0.1319               | 1.6090     | 0.2174     | 0.2497 | 2.7987  |
|               | Subtotal        | 0.7629           | 0.6364               | 6.4140     | 0.3727     | 0.3496 | 8.5356  |
| Capital Stocl | Losses          |                  |                      |            |            |        |         |
|               | Structural      | 1.6645           | 0.3696               | 2.5438     | 0.5871     | 0.3650 | 5.5300  |
|               | Non_Structural  | 8.3455           | 1.5978               | 5.3676     | 1.4436     | 0.7534 | 17.5079 |
|               | Content         | 3.0272           | 0.4123               | 2.5461     | 0.8860     | 0.3663 | 7.2379  |
|               | Inventory       | 0.0000           | 0.0000               | 0.0611     | 0.1265     | 0.0068 | 0.1944  |
|               | Subtotal        | 13.0372          | 2.3797               | 10.5186    | 3.0432     | 1.4915 | 30.4702 |
|               | Total           | 13.80            | 3.02                 | 16.93      | 3.42       | 1.84   | 39.01   |





### **Transportation and Utility Lifeline Losses**

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

| System     | Component  | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------|------------|-----------------|---------------|----------------|
| Highway    | Segments   | 385.5240        | 0.0000        | 0.00           |
|            | Bridges    | 181.0834        | 5.9176        | 3.27           |
|            | Tunnels    | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 566.6074        | 5.9176        |                |
| Railways   | Segments   | 13.2639         | 0.0000        | 0.00           |
|            | Bridges    | 0.0000          | 0.0000        | 0.00           |
|            | Tunnels    | 0.0000          | 0.0000        | 0.00           |
|            | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 13.2639         | 0.0000        |                |
| Light Rail | Segments   | 0.0000          | 0.0000        | 0.00           |
|            | Bridges    | 0.0000          | 0.0000        | 0.00           |
|            | Tunnels    | 0.0000          | 0.0000        | 0.00           |
|            | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| Bus        | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| Ferry      | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| Port       | Facilities | 1.9970          | 0.1950        | 9.76           |
|            | Subtotal   | 1.9970          | 0.1950        |                |
| Airport    | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Runways    | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| l          | Total      | 581.87          | 6.11          |                |

### Table 12: Transportation System Economic Losses

(Millions of dollars)





### Table 13: Utility System Economic Losses

(Millions of dollars)

| System           | Component          | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------------|--------------------|-----------------|---------------|----------------|
| Potable Water    | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Distribution Lines | 4.2050          | 0.0000        | 0.00           |
|                  | Subtotal           | 4.2050          | 0.0000        |                |
| Waste Water      | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Distribution Lines | 2.5230          | 0.0000        | 0.00           |
|                  | Subtotal           | 2.5230          | 0.0000        |                |
| Natural Gas      | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Distribution Lines | 1.6820          | 0.0000        | 0.00           |
|                  | Subtotal           | 1.6820          | 0.0000        |                |
| Oil Systems      | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Subtotal           | 0.0000          | 0.0000        |                |
| Electrical Power | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Subtotal           | 0.0000          | 0.0000        |                |
| Communication    | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Subtotal           | 0.0000          | 0.0000        |                |
|                  | Total              | 8.41            | 0.00          |                |





### Appendix A: County Listing for the Region

Middlesex,CT





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

|              |             |            | Building Value (millions of dollars) |                 |       |  |  |
|--------------|-------------|------------|--------------------------------------|-----------------|-------|--|--|
| State        | County Name | Population | Residential                          | Non-Residential | Total |  |  |
| Connecticut  |             |            |                                      |                 |       |  |  |
|              | Middlesex   | 6,683      | 1,070                                | 408             | 1,479 |  |  |
| Total Region |             | 6,683      | 1,070                                | 408             | 1,479 |  |  |







# Hazus: Earthquake Global Risk Report

| Region Name:         | Essex            |  |  |
|----------------------|------------------|--|--|
| Earthquake Scenario: | Stamford         |  |  |
| Print Date:          | October 17, 2019 |  |  |

**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 earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.





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Appendix A: County Listing for the Region Appendix B: Regional Population and Building Value Data





### **General Description of the Region**

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. 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 earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Connecticut

Note:

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

The geographical size of the region is 11.29 square miles and contains 1 census tracts. There are over 2 thousand households in the region which has a total population of 6,683 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 1,479 (millions of dollars). Approximately 87.00 % of the buildings (and 72.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 581 and 8 (millions of dollars), respectively.





### **Building and Lifeline Inventory**

### **Building Inventory**

Hazus estimates that there are 3 thousand buildings in the region which have an aggregate total replacement value of 1,479 (millions of dollars). Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 85% of the building inventory. The remaining percentage is distributed between the other general building types.

### **Critical Facility Inventory**

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of beds. There are 1 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 2 hazardous material sites, no military installations and no nuclear power plants.

### Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 589.00 (millions of dollars). This inventory includes over 36.04 miles of highways, 15 bridges, 260.98 miles of pipes.





| System     | Component  | # Locations/<br># Segments | Replacement value<br>(millions of dollars) |
|------------|------------|----------------------------|--|
| Highway    | Bridges    | 15                         | 181.0834                                   |
|            | Segments   | 26                         | 385.5240                                   |
|            | Tunnels    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 566.6074                                   |
| Railways   | Bridges    | 0                          | 0.0000                                     |
|            | Facilities | 0                          | 0.0000                                     |
|            | Segments   | 2                          | 13.2639                                    |
|            | Tunnels    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 13.2639                                    |
| Light Rail | Bridges    | 0                          | 0.0000                                     |
| U          | Facilities | 0                          | 0.0000                                     |
|            | Segments   | 0                          | 0.0000                                     |
|            | Tunnels    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
| Bus        | Facilities | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
| Ferry      | Facilities | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
| Port       | Facilities | 1                          | 1.9970                                     |
|            |            | Subtotal                   | 1.9970                                     |
| Airport    | Facilities | 0                          | 0.0000                                     |
| -          | Runways    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
|            |            | Total                      | 581.90                                     |

#### Table 1. Tr tio n 91 Lifolin ~ I.





| System           | Component          | # Locations /<br>Segments | Replacement value<br>(millions of dollars) |  |  |  |  |  |  |
|------------------|--------------------|---------------------------|--|--|--|--|--|--|--|
| Potable Water    | Distribution Lines | NA                        | 4.2050                                     |  |  |  |  |  |  |
|                  | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  |                    | Subtotal                  | 4.2050                                     |  |  |  |  |  |  |
| Waste Water      | Distribution Lines | NA                        | 2.5230                                     |  |  |  |  |  |  |
|                  | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  |                    | Subtotal                  | 2.5230                                     |  |  |  |  |  |  |
| Natural Gas      | Distribution Lines | NA                        | 1.6820                                     |  |  |  |  |  |  |
|                  | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  |                    | Subtotal                  | 1.6820                                     |  |  |  |  |  |  |
| Oil Systems      | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  |                    | Subtotal                  | 0.0000                                     |  |  |  |  |  |  |
| Electrical Power | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  |                    | Subtotal                  | 0.0000                                     |  |  |  |  |  |  |
| Communication    | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |  |
|                  |                    | Subtotal                  | 0.0000                                     |  |  |  |  |  |  |
|                  |                    | Total                     | 8.40                                       |  |  |  |  |  |  |
| _                |                    |                           |  |  |  |  |  |  |  |

### Table 2: Utility System Lifeline Inventory





### Earthquake Scenario

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



| Scenario Name                 | Stamford                      |
|-------------------------------|-------------------------------|
| Type of Earthquake            | Arbitrary                     |
| Fault Name                    | NA                            |
| Historical Epicenter ID #     | NA                            |
| Probabilistic Return Period   | NA                            |
| Longitude of Epicenter        | -73.56                        |
| Latitude of Epicenter         | 41.11                         |
| Earthquake Magnitude          | 5.70                          |
| Depth (km)                    | 10.00                         |
| Rupture Length (Km)           | NA                            |
| Rupture Orientation (degrees) | NA                            |
| Attenuation Function          | Central & East US (CEUS 2008) |





### **Direct Earthquake Damage**

#### **Building Damage**

Hazus estimates that about 14 buildings will be at least moderately damaged. This is over 0.00 % of the buildings in the region. There are an estimated 0 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

### Damage Categories by General Occupancy Type



Table 3: Expected Building Damage by Occupancy

|                   | None    |       | Slight |       | Moderate |       | Extensive |       | Complete |       |
|-------------------|---------|-------|--------|-------|----------|-------|-----------|-------|----------|-------|
|                   | Count   | (%)   | Count  | (%)   | Count    | (%)   | Count     | (%)   | Count    | (%)   |
| Agriculture       | 13.28   | 0.43  | 0.54   | 0.86  | 0.15     | 1.22  | 0.02      | 1.26  | 0.00     | 0.87  |
| Commercial        | 245.29  | 7.90  | 10.56  | 16.84 | 3.64     | 28.72 | 0.48      | 29.68 | 0.03     | 28.18 |
| Education         | 8.53    | 0.27  | 0.34   | 0.54  | 0.11     | 0.89  | 0.01      | 0.85  | 0.00     | 1.03  |
| Government        | 4.75    | 0.15  | 0.18   | 0.29  | 0.06     | 0.47  | 0.01      | 0.41  | 0.00     | 0.38  |
| Industrial        | 96.51   | 3.11  | 3.93   | 6.27  | 1.39     | 10.93 | 0.17      | 10.47 | 0.01     | 8.60  |
| Other Residential | 111.53  | 3.59  | 3.27   | 5.22  | 1.04     | 8.20  | 0.15      | 9.07  | 0.01     | 11.00 |
| Religion          | 19.88   | 0.64  | 0.78   | 1.25  | 0.29     | 2.32  | 0.04      | 2.70  | 0.00     | 3.38  |
| Single Family     | 2604.14 | 83.90 | 43.09  | 68.72 | 5.99     | 47.25 | 0.73      | 45.57 | 0.05     | 46.56 |
| Total             | 3,104   |       | 63     |       | 13       |       | 2         |       | 0        |       |





|          | None    |       | Slight |       | Moderate |       | Extensive |       | Complete |       |
|----------|---------|-------|--------|-------|----------|-------|-----------|-------|----------|-------|
|          | Count   | (%)   | Count  | (%)   | Count    | (%)   | Count     | (%)   | Count    | (%)   |
| Wood     | 2650.03 | 85.38 | 39.28  | 62.64 | 3.26     | 25.70 | 0.26      | 16.33 | 0.00     | 0.00  |
| Steel    | 182.15  | 5.87  | 6.68   | 10.66 | 2.20     | 17.35 | 0.21      | 13.20 | 0.00     | 4.53  |
| Concrete | 28.75   | 0.93  | 0.97   | 1.54  | 0.28     | 2.22  | 0.01      | 0.82  | 0.00     | 0.00  |
| Precast  | 11.74   | 0.38  | 0.60   | 0.96  | 0.38     | 3.01  | 0.07      | 4.19  | 0.00     | 0.94  |
| RM       | 39.91   | 1.29  | 1.24   | 1.98  | 0.63     | 4.95  | 0.09      | 5.29  | 0.00     | 0.00  |
| URM      | 191.33  | 6.16  | 13.93  | 22.22 | 5.93     | 46.76 | 0.97      | 60.18 | 0.10     | 94.53 |
| МН       | 0.00    | 0.00  | 0.00   | 0.00  | 0.00     | 0.00  | 0.00      | 0.00  | 0.00     | 0.00  |
| Total    | 3,104   |       | 63     |       | 13       |       | 2         |       | 0        |       |

### Table 4: Expected Building Damage by Building Type (All Design Levels)

\*Note:

RM Reinforced Masonry

URM Unreinforced Masonry

MH Manufactured Housing





### **Essential Facility Damage**

Before the earthquake, the region had hospital beds available for use. On the day of the earthquake, the model estimates that only hospital beds (%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, % of the beds will be back in service. By 30 days, % will be operational.

|                |       | # Facilities                      |                          |                                      |  |  |  |
|----------------|-------|-----------------------------------|--------------------------|--------------------------------------|--|--|--|
| Classification | Total | At Least Moderate<br>Damage > 50% | Complete<br>Damage > 50% | With Functionality<br>> 50% on day 1 |  |  |  |
| Hospitals      | 0     | 0                                 | 0                        | 0                                    |  |  |  |
| Schools        | 1     | 0                                 | 0                        | 1                                    |  |  |  |
| EOCs           | 1     | 0                                 | 0                        | 1                                    |  |  |  |
| PoliceStations | 2     | 0                                 | 0                        | 2                                    |  |  |  |
| FireStations   | 2     | 0                                 | 0                        | 2                                    |  |  |  |

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





### Transportation Lifeline Damage







|            | Component  |            | Number of Locations_ |               |                           |             |  |
|------------|------------|------------|----------------------|---------------|---------------------------|-------------|--|
| System     |            | Locations/ | With at Least        | With Complete | With Functionality > 50 % |             |  |
|            |            | Segments   | Mod. Damage          | Damage        | After Day 1               | After Day 7 |  |
| Highway    | Segments   | 26         | 0                    | 0             | 26                        | 26          |  |
|            | Bridges    | 15         | 0                    | 0             | 15                        | 15          |  |
|            | Tunnels    | 0          | 0                    | 0             | 0                         | 0           |  |
| Railways   | Segments   | 2          | 0                    | 0             | 2                         | 2           |  |
|            | Bridges    | 0          | 0                    | 0             | 0                         | 0           |  |
|            | Tunnels    | 0          | 0                    | 0             | 0                         | 0           |  |
|            | Facilities | 0          | 0                    | 0             | 0                         | 0           |  |
| Light Rail | Segments   | 0          | 0                    | 0             | 0                         | 0           |  |
|            | Bridges    | 0          | 0                    | 0             | 0                         | 0           |  |
|            | Tunnels    | 0          | 0                    | 0             | 0                         | 0           |  |
|            | Facilities | 0          | 0                    | 0             | 0                         | 0           |  |
| Bus        | Facilities | 0          | 0                    | 0             | 0                         | 0           |  |
| Ferry      | Facilities | 0          | 0                    | 0             | 0                         | 0           |  |
| Port       | Facilities | 1          | 0                    | 0             | 1                         | 1           |  |
| Airport    | Facilities | 0          | 0                    | 0             | 0                         | 0           |  |
|            | Runways    | 0          | 0                    | 0             | 0                         | 0           |  |

#### Table 6: Expected Damage to the Transportation Systems

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.





|                  | # of Locations |                                  |               |                           |             |  |  |
|------------------|----------------|----------------------------------|---------------|---------------------------|-------------|--|--|
| System           | Total #        | With at Least<br>Moderate Damage | With Complete | with Functionality > 50 % |             |  |  |
|                  |                |                                  |               | After Day 1               | After Day 7 |  |  |
| Potable Water    | 0              | 0                                | 0             | 0                         | 0           |  |  |
| Waste Water      | 0              | 0                                | 0             | 0                         | 0           |  |  |
| Natural Gas      | 0              | 0                                | 0             | 0                         | 0           |  |  |
| Oil Systems      | 0              | 0                                | 0             | 0                         | 0           |  |  |
| Electrical Power | 0              | 0                                | 0             | 0                         | 0           |  |  |
| Communication    | 0              | 0                                | 0             | 0                         | 0           |  |  |

#### Table 7 : Expected Utility System Facility Damage

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

| System        | Total Pipelines<br>Length (miles) | Number of<br>Leaks | Number of<br>Breaks |
|---------------|-----------------------------------|--------------------|---------------------|
| Potable Water | 131                               | 0                  | 0                   |
| Waste Water   | 78                                | 0                  | 0                   |
| Natural Gas   | 52                                | 0                  | 0                   |
| Oil           | 0                                 | 0                  | 0                   |

#### Table 9: Expected Potable Water and Electric Power System Performance

|                | Total # of |          | Number of Households without Service |          |           |           |
|----------------|------------|----------|--------------------------------------|----------|-----------|-----------|
|                | Households | At Day 1 | At Day 3                             | At Day 7 | At Day 30 | At Day 90 |
| Potable Water  |            |          |                                      |          |           |           |
| Electric Power |            |          |                                      |          |           |           |





### Induced Earthquake Damage

### **Fire Following Earthquake**

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

### **Debris Generation**

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. 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 0 tons of debris will be generated. Of the total amount, Brick/Wood comprises 71.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

| Earthquake Debris (millions of tons) |                                  |                     |                    |  |  |  |
|--------------------------------------|----------------------------------|---------------------|--------------------|--|--|--|
| Brick/ Wood                          | <b>Reinforced Concrete/Steel</b> | <u>Total Debris</u> | Truck Load         |  |  |  |
| 0.00                                 | 0.00                             | 0.00                | 0 (@25 tons/truck) |  |  |  |





### **Social Impact**

#### **Shelter Requirement**

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 1 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 6,683) will seek temporary shelter in public shelters.



#### **Casualties**

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

Injuries will require medical attention but hospitalization is not needed.

Injuries will require hospitalization but are not considered life-threatening

Injuries will require hospitalization and can become life threatening if not

- Severity Level 1:
- Severity Level 2:
- · Severity Level 3:
  - promptly treated.
- Severity Level 4:
- 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake




## Table 10: Casualty Estimates

|      |                   | Level 1 | Level 2 | Level 3 | Level 4 |
|------|-------------------|---------|---------|---------|---------|
| 2 AM | Commercial        | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Commuting         | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Educational       | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Hotels            | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Industrial        | 0.01    | 0.00    | 0.00    | 0.00    |
|      | Other-Residential | 0.07    | 0.01    | 0.00    | 0.00    |
|      | Single Family     | 0.12    | 0.01    | 0.00    | 0.00    |
|      | Total             | 0       | 0       | 0       | 0       |
|      |                   |         |         |         |         |
| 2 PM | Commercial        | 0.28    | 0.03    | 0.00    | 0.00    |
|      | Commuting         | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Educational       | 0.08    | 0.01    | 0.00    | 0.00    |
|      | Hotels            | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Industrial        | 0.05    | 0.01    | 0.00    | 0.00    |
|      | Other-Residential | 0.02    | 0.00    | 0.00    | 0.00    |
|      | Single Family     | 0.03    | 0.00    | 0.00    | 0.00    |
|      | Total             | 0       | 0       | 0       | 0       |
|      |                   | 0.00    | 0.00    | 0.00    | 0.00    |
| 5 PM | Commercial        | 0.20    | 0.02    | 0.00    | 0.00    |
|      | Commuting         | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Educational       | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Hotels            | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Industrial        | 0.03    | 0.00    | 0.00    | 0.00    |
|      | Other-Residential | 0.03    | 0.00    | 0.00    | 0.00    |
|      | Single Family     | 0.05    | 0.00    | 0.00    | 0.00    |
|      | Total             | 0       | 0       | 0       | 0       |





## **Economic Loss**

The total economic loss estimated for the earthquake is 2.59 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.





### **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 earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 2.39 (millions of dollars); 27 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 44 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.



### Table 11: Building-Related Economic Loss Estimates (Millions of dollars)

| Category      | Area            | Single<br>Family | Other<br>Residential | Commercial | Industrial | Others | Total  |
|---------------|-----------------|------------------|----------------------|------------|------------|--------|--------|
| Income Losses |                 |                  |                      |            |            |        |        |
|               | Wage            | 0.0000           | 0.0127               | 0.1482     | 0.0044     | 0.0048 | 0.1701 |
|               | Capital-Related | 0.0000           | 0.0053               | 0.1265     | 0.0026     | 0.0015 | 0.1359 |
|               | Rental          | 0.0147           | 0.0207               | 0.0933     | 0.0024     | 0.0024 | 0.1335 |
|               | Relocation      | 0.0470           | 0.0142               | 0.1207     | 0.0147     | 0.0203 | 0.2169 |
|               | Subtotal        | 0.0617           | 0.0529               | 0.4887     | 0.0241     | 0.0290 | 0.6564 |
| Capital Stock | Losses          |                  |                      |            |            |        |        |
|               | Structural      | 0.1625           | 0.0387               | 0.1884     | 0.0391     | 0.0301 | 0.4588 |
|               | Non_Structural  | 0.5206           | 0.1002               | 0.2838     | 0.0626     | 0.0423 | 1.0095 |
|               | Content         | 0.0953           | 0.0148               | 0.0990     | 0.0344     | 0.0141 | 0.2576 |
|               | Inventory       | 0.0000           | 0.0000               | 0.0023     | 0.0049     | 0.0002 | 0.0074 |
|               | Subtotal        | 0.7784           | 0.1537               | 0.5735     | 0.1410     | 0.0867 | 1.7333 |
|               | Total           | 0.84             | 0.21                 | 1.06       | 0.17       | 0.12   | 2.39   |





## **Transportation and Utility Lifeline Losses**

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

| System     | Component  | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------|------------|-----------------|---------------|----------------|
| Highway    | Segments   | 385.5240        | 0.0000        | 0.00           |
|            | Bridges    | 181.0834        | 0.1817        | 0.10           |
|            | Tunnels    | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 566.6074        | 0.1817        |                |
| Railways   | Segments   | 13.2639         | 0.0000        | 0.00           |
|            | Bridges    | 0.0000          | 0.0000        | 0.00           |
|            | Tunnels    | 0.0000          | 0.0000        | 0.00           |
|            | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 13.2639         | 0.0000        |                |
| Light Rail | Segments   | 0.0000          | 0.0000        | 0.00           |
|            | Bridges    | 0.0000          | 0.0000        | 0.00           |
|            | Tunnels    | 0.0000          | 0.0000        | 0.00           |
|            | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| Bus        | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| Ferry      | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| Port       | Facilities | 1.9970          | 0.0178        | 0.89           |
|            | Subtotal   | 1.9970          | 0.0178        |                |
| Airport    | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Runways    | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| l          | Total      | 581.87          | 0.20          |                |

## Table 12: Transportation System Economic Losses

(Millions of dollars)





## Table 13: Utility System Economic Losses

(Millions of dollars)

| System           | Component          | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------------|--------------------|-----------------|---------------|----------------|
| Potable Water    | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Distribution Lines | 4.2050          | 0.0000        | 0.00           |
|                  | Subtotal           | 4.2050          | 0.0000        |                |
| Waste Water      | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Distribution Lines | 2.5230          | 0.0000        | 0.00           |
|                  | Subtotal           | 2.5230          | 0.0000        |                |
| Natural Gas      | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Distribution Lines | 1.6820          | 0.0000        | 0.00           |
|                  | Subtotal           | 1.6820          | 0.0000        |                |
| Oil Systems      | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Subtotal           | 0.0000          | 0.0000        |                |
| Electrical Power | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Subtotal           | 0.0000          | 0.0000        |                |
| Communication    | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Subtotal           | 0.0000          | 0.0000        |                |
|                  | Total              | 8.41            | 0.00          |                |





## Appendix A: County Listing for the Region

Middlesex,CT





## Appendix B: Regional Population and Building Value Data

|              |             |            | Building Value (millions of dollars) |                 |       |  |  |
|--------------|-------------|------------|--------------------------------------|-----------------|-------|--|--|
| State        | County Name | Population | Residential                          | Non-Residential | Total |  |  |
| Connecticut  |             |            |                                      |                 |       |  |  |
|              | Middlesex   | 6,683      | 1,070                                | 408             | 1,479 |  |  |
| Total Region |             | 6,683      | 1,070                                | 408             | 1,479 |  |  |







# Hazus: Earthquake Global Risk Report

October 17, 2019

| Region Name:         | Essex      |
|----------------------|------------|
| Earthquake Scenario: | Annualized |

Print Date:

**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 earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.





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Appendix A: County Listing for the Region Appendix B: Regional Population and Building Value Data





## **General Description of the Region**

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. 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 earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Connecticut

Note:

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

The geographical size of the region is 11.29 square miles and contains 1 census tracts. There are over 2 thousand households in the region which has a total population of 6,683 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 3 thousand buildings in the region with a total building replacement value (excluding contents) of 1,479 (millions of dollars). Approximately 87.00 % of the buildings (and 72.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 581 and 8 (millions of dollars), respectively.





## **Building and Lifeline Inventory**

## **Building Inventory**

Hazus estimates that there are 3 thousand buildings in the region which have an aggregate total replacement value of 1,479 (millions of dollars). Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 85% of the building inventory. The remaining percentage is distributed between the other general building types.

## **Critical Facility Inventory**

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 0 hospitals in the region with a total bed capacity of beds. There are 1 schools, 2 fire stations, 2 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 2 hazardous material sites, no military installations and no nuclear power plants.

## Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 589.00 (millions of dollars). This inventory includes over 36.04 miles of highways, 15 bridges, 260.98 miles of pipes.





| System     | Component  | # Locations/<br># Segments | Replacement value<br>(millions of dollars) |
|------------|------------|----------------------------|--|
| Highway    | Bridges    | 15                         | 181.0834                                   |
| . ngnway   | Segments   | 26                         | 385.5240                                   |
|            | Tunnels    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 566.6074                                   |
| Railways   | Bridges    | 0                          | 0.0000                                     |
|            | Facilities | 0                          | 0.0000                                     |
|            | Segments   | 2                          | 13.2639                                    |
|            | Tunnels    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 13.2639                                    |
| Light Rail | Bridges    | 0                          | 0.0000                                     |
|            | Facilities | 0                          | 0.0000                                     |
|            | Segments   | 0                          | 0.0000                                     |
|            | Tunnels    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
| Bus        | Facilities | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
| Ferry      | Facilities | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
| Port       | Facilities | 1                          | 1.9970                                     |
|            |            | Subtotal                   | 1.9970                                     |
| Airport    | Facilities | 0                          | 0.0000                                     |
| -          | Runways    | 0                          | 0.0000                                     |
|            |            | Subtotal                   | 0.0000                                     |
|            |            | Total                      | 581.90                                     |

#### Table 1. Tr tio n 91 Lifolin ~ I.





| System           | Component          | # Locations /<br>Segments | Replacement value<br>(millions of dollars) |  |  |  |  |  |
|------------------|--------------------|---------------------------|--|--|--|--|--|--|
| Potable Water    | Distribution Lines | NA                        | 4.2050                                     |  |  |  |  |  |
|                  | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |
|                  | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |
|                  |                    | Subtotal                  | 4.2050                                     |  |  |  |  |  |
| Waste Water      | Distribution Lines | NA                        | 2.5230                                     |  |  |  |  |  |
|                  | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |
|                  | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |
|                  |                    | Subtotal                  | 2.5230                                     |  |  |  |  |  |
| Natural Gas      | Distribution Lines | NA                        | 1.6820                                     |  |  |  |  |  |
|                  | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |
|                  | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |
|                  |                    | Subtotal                  | 1.6820                                     |  |  |  |  |  |
| Oil Systems      | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |
|                  | Pipelines          | 0                         | 0.0000                                     |  |  |  |  |  |
|                  |                    | Subtotal                  | 0.0000                                     |  |  |  |  |  |
| Electrical Power | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |
|                  |                    | Subtotal                  | 0.0000                                     |  |  |  |  |  |
| Communication    | Facilities         | 0                         | 0.0000                                     |  |  |  |  |  |
|                  |                    | Subtotal                  | 0.0000                                     |  |  |  |  |  |
|                  |                    | Total                     | 8.40                                       |  |  |  |  |  |
| _                |                    |                           |  |  |  |  |  |  |

## Table 2: Utility System Lifeline Inventory





## Earthquake Scenario

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



| Scenario Name                 | Annualized    |
|-------------------------------|---------------|
| Type of Earthquake            | Probabilistic |
| Fault Name                    | NA            |
| Historical Epicenter ID #     | NA            |
| Probabilistic Return Period   | Annualized    |
| Longitude of Epicenter        | NA            |
| Latitude of Epicenter         | NA            |
| Earthquake Magnitude          | NA            |
| Depth (km)                    | NA            |
| Rupture Length (Km)           | NA            |
| Rupture Orientation (degrees) | NA            |
| Attenuation Function          | NA            |





## **Direct Earthquake Damage**

## **Building Damage**

Hazus estimates that about 5 buildings will be at least moderately damaged. This is over 0.00 % of the buildings in the region. There are an estimated 0 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

## Damage Categories by General Occupancy Type



Table 3: Expected Building Damage by Occupancy

|                   | None    |       | Slight |        | Moderate |        | Extensive |      | Complete |      |
|-------------------|---------|-------|--------|--------|----------|--------|-----------|------|----------|------|
|                   | Count   | (%)   | Count  | (%)    | Count    | (%)    | Count     | (%)  | Count    | (%)  |
| Agriculture       | 7.00    | 0.24  | 0.00   | 0.00   | 0.00     | 0.00   | 0.00      | 0.00 | 0.00     | 0.00 |
| Commercial        | 176.00  | 5.98  | 0.00   | 0.00   | 0.00     | 0.00   | 0.00      | 0.00 | 0.00     | 0.00 |
| Education         | 2.00    | 0.07  | 0.00   | 0.00   | 0.00     | 0.00   | 0.00      | 0.00 | 0.00     | 0.00 |
| Government        | 0.00    | 0.00  | 0.00   | 0.00   | 0.00     | 0.00   | 0.00      | 0.00 | 0.00     | 0.00 |
| Industrial        | 57.00   | 1.94  | 0.00   | 0.00   | 0.00     | 0.00   | 0.00      | 0.00 | 0.00     | 0.00 |
| Other Residential | 87.00   | 2.95  | 0.00   | 0.00   | 0.00     | 0.00   | 0.00      | 0.00 | 0.00     | 0.00 |
| Religion          | 13.00   | 0.44  | 0.00   | 0.00   | 0.00     | 0.00   | 0.00      | 0.00 | 0.00     | 0.00 |
| Single Family     | 2603.00 | 88.39 | 42.00  | 100.00 | 5.00     | 100.00 | 0.00      | 0.00 | 0.00     | 0.00 |
| Total             | 2,945   |       | 42     |        | 5        |        | 0         |      | 0        |      |





|          | None    |       | Slight |       | Moderate |       | Extensive |      | Complete |      |
|----------|---------|-------|--------|-------|----------|-------|-----------|------|----------|------|
|          | Count   | (%)   | Count  | (%)   | Count    | (%)   | Count     | (%)  | Count    | (%)  |
| Wood     | 2632.00 | 89.37 | 36.00  | 85.71 | 3.00     | 60.00 | 0.00      | 0.00 | 0.00     | 0.00 |
| Steel    | 122.00  | 4.14  | 0.00   | 0.00  | 0.00     | 0.00  | 0.00      | 0.00 | 0.00     | 0.00 |
| Concrete | 7.00    | 0.24  | 0.00   | 0.00  | 0.00     | 0.00  | 0.00      | 0.00 | 0.00     | 0.00 |
| Precast  | 1.00    | 0.03  | 0.00   | 0.00  | 0.00     | 0.00  | 0.00      | 0.00 | 0.00     | 0.00 |
| RM       | 13.00   | 0.44  | 0.00   | 0.00  | 0.00     | 0.00  | 0.00      | 0.00 | 0.00     | 0.00 |
| URM      | 170.00  | 5.77  | 6.00   | 14.29 | 2.00     | 40.00 | 0.00      | 0.00 | 0.00     | 0.00 |
| МН       | 0.00    | 0.00  | 0.00   | 0.00  | 0.00     | 0.00  | 0.00      | 0.00 | 0.00     | 0.00 |
| Total    | 2,945   |       | 42     |       | 5        |       | 0         |      | 0        |      |

## Table 4: Expected Building Damage by Building Type (All Design Levels)

\*Note:

RM Reinforced Masonry

URM Unreinforced Masonry

MH Manufactured Housing





## **Essential Facility Damage**

Before the earthquake, the region had hospital beds available for use. On the day of the earthquake, the model estimates that only hospital beds (%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, % of the beds will be back in service. By 30 days, % will be operational.

|                |       | # Facilities                      |                          |                                      |  |
|----------------|-------|-----------------------------------|--------------------------|--------------------------------------|--|
| Classification | Total | At Least Moderate<br>Damage > 50% | Complete<br>Damage > 50% | With Functionality<br>> 50% on day 1 |  |
| Hospitals      | 0     | 0                                 | 0                        | 0                                    |  |
| Schools        | 1     | 0                                 | 0                        | 1                                    |  |
| EOCs           | 1     | 0                                 | 0                        | 1                                    |  |
| PoliceStations | 2     | 0                                 | 0                        | 2                                    |  |
| FireStations   | 2     | 0                                 | 0                        | 2                                    |  |

### Table 5: Expected Damage to Essential Facilities





## Transportation Lifeline Damage







|            |            |            | Number of Locations_ |               |             |                   |
|------------|------------|------------|----------------------|---------------|-------------|-------------------|
| System     | Component  | Locations/ | With at Least        | With Complete | With Fun    | ctionality > 50 % |
|            |            | Segments   | Mod. Damage          | Damage        | After Day 1 | After Day 7       |
| Highway    | Segments   | 26         | 0                    | 0             | 26          | 26                |
|            | Bridges    | 15         | 0                    | 0             | 15          | 15                |
|            | Tunnels    | 0          | 0                    | 0             | 0           | 0                 |
| Railways   | Segments   | 2          | 0                    | 0             | 2           | 2                 |
|            | Bridges    | 0          | 0                    | 0             | 0           | 0                 |
|            | Tunnels    | 0          | 0                    | 0             | 0           | 0                 |
|            | Facilities | 0          | 0                    | 0             | 0           | 0                 |
| Light Rail | Segments   | 0          | 0                    | 0             | 0           | 0                 |
|            | Bridges    | 0          | 0                    | 0             | 0           | 0                 |
|            | Tunnels    | 0          | 0                    | 0             | 0           | 0                 |
|            | Facilities | 0          | 0                    | 0             | 0           | 0                 |
| Bus        | Facilities | 0          | 0                    | 0             | 0           | 0                 |
| Ferry      | Facilities | 0          | 0                    | 0             | 0           | 0                 |
| Port       | Facilities | 1          | 0                    | 0             | 1           | 1                 |
| Airport    | Facilities | 0          | 0                    | 0             | 0           | 0                 |
|            | Runways    | 0          | 0                    | 0             | 0           | 0                 |

### Table 6: Expected Damage to the Transportation Systems

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.





|                  | # of Locations |                 |               |               |                           |  |  |
|------------------|----------------|-----------------|---------------|---------------|---------------------------|--|--|
| System           | Total #        | With at Least   | With Complete | with Function | with Functionality > 50 % |  |  |
|                  |                | Moderate Damage | Damage        | After Day 1   | After Day 7               |  |  |
| Potable Water    | 0              | 0               | 0             | 0             | 0                         |  |  |
| Waste Water      | 0              | 0               | 0             | 0             | 0                         |  |  |
| Natural Gas      | 0              | 0               | 0             | 0             | 0                         |  |  |
| Oil Systems      | 0              | 0               | 0             | 0             | 0                         |  |  |
| Electrical Power | 0              | 0               | 0             | 0             | 0                         |  |  |
| Communication    | 0              | 0               | 0             | 0             | 0                         |  |  |

### Table 7 : Expected Utility System Facility Damage

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

| System        | Total Pipelines<br>Length (miles) | Number of<br>Leaks | Number of<br>Breaks |
|---------------|-----------------------------------|--------------------|---------------------|
| Potable Water | 131                               | 0                  | 0                   |
| Waste Water   | 78                                | 0                  | 0                   |
| Natural Gas   | 52                                | 0                  | 0                   |
| Oil           | 0                                 | 0                  | 0                   |

### Table 9: Expected Potable Water and Electric Power System Performance

|                | Total # of | of Number of Households without Service |          |          |           |           |
|----------------|------------|---|----------|----------|-----------|-----------|
|                | Households | At Day 1                                | At Day 3 | At Day 7 | At Day 30 | At Day 90 |
| Potable Water  |            |   |          |          |           |           |
| Electric Power |            |   |          |          |           |           |





## Induced Earthquake Damage

## **Fire Following Earthquake**

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

## **Debris Generation**

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. 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 0 tons of debris will be generated. Of the total amount, Brick/Wood comprises 71.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

| Earthquake Debris (millions of tons) |                           |                     |                    |  |  |
|--------------------------------------|---------------------------|---------------------|--------------------|--|--|
| Brick/ Wood                          | Reinforced Concrete/Steel | <u>Total Debris</u> | Truck Load         |  |  |
| 0.00                                 | 0.00                      | 0.00                | 0 (@25 tons/truck) |  |  |





## **Social Impact**

### **Shelter Requirement**

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 1 households to be displaced due to the earthquake. Of these, 0 people (out of a total population of 6,683) will seek temporary shelter in public shelters.



### **Casualties**

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

Injuries will require medical attention but hospitalization is not needed.

Injuries will require hospitalization but are not considered life-threatening

Injuries will require hospitalization and can become life threatening if not

- Severity Level 1:
- Severity Level 2:
- · Severity Level 3:
  - promptly treated.
- Severity Level 4:
- 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake





## Table 10: Casualty Estimates

|      |                   | Level 1 | Level 2 | Level 3 | Level 4 |
|------|-------------------|---------|---------|---------|---------|
| 2 AM | Commercial        | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Commuting         | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Educational       | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Hotels            | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Industrial        | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Other-Residential | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Single Family     | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Total             | 0       | 0       | 0       | 0       |
|      |                   |         |         |         |         |
| 2 PM | Commercial        | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Commuting         | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Educational       | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Hotels            | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Industrial        | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Other-Residential | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Single Family     | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Total             | 0       | 0       | 0       | 0       |
|      |                   |         |         |         |         |
| 5 PM | Commercial        | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Commuting         | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Educational       | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Hotels            | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Industrial        | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Other-Residential | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Single Family     | 0.00    | 0.00    | 0.00    | 0.00    |
|      | Total             | 0       | 0       | 0       | 0       |





## **Economic Loss**

The total economic loss estimated for the earthquake is 0.22 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.





### **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 earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 0.02 (millions of dollars); 18 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 48 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.



### Table 11: Building-Related Economic Loss Estimates

| (Millions | of | dol | lars |
|-----------|----|-----|------|
|-----------|----|-----|------|

| Category      | Area            | Single<br>Family | Other<br>Residential | Commercial | Industrial | Others | Total  |
|---------------|-----------------|------------------|----------------------|------------|------------|--------|--------|
| Income Loss   | es              |                  |                      |            |            |        |        |
|               | Wage            | 0.0000           | 0.0000               | 0.0009     | 0.0000     | 0.0000 | 0.0009 |
|               | Capital-Related | 0.0000           | 0.0000               | 0.0008     | 0.0000     | 0.0000 | 0.0008 |
|               | Rental          | 0.0000           | 0.0001               | 0.0005     | 0.0000     | 0.0000 | 0.0006 |
|               | Relocation      | 0.0003           | 0.0000               | 0.0007     | 0.0000     | 0.0001 | 0.0011 |
|               | Subtotal        | 0.0003           | 0.0001               | 0.0029     | 0.0000     | 0.0001 | 0.0034 |
| Capital Stock | Losses          |                  |                      |            |            |        |        |
|               | Structural      | 0.0010           | 0.0002               | 0.0011     | 0.0002     | 0.0001 | 0.0026 |
|               | Non_Structural  | 0.0048           | 0.0009               | 0.0026     | 0.0007     | 0.0003 | 0.0093 |
|               | Content         | 0.0017           | 0.0002               | 0.0014     | 0.0004     | 0.0002 | 0.0039 |
|               | Inventory       | 0.0000           | 0.0000               | 0.0000     | 0.0000     | 0.0000 | 0.0000 |
|               | Subtotal        | 0.0075           | 0.0013               | 0.0051     | 0.0013     | 0.0006 | 0.0158 |
|               | Total           | 0.01             | 0.00                 | 0.01       | 0.00       | 0.00   | 0.02   |





## **Transportation and Utility Lifeline Losses**

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

| System     | Component  | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------|------------|-----------------|---------------|----------------|
| Highway    | Segments   | 385.5240        | 0.0000        | 0.00           |
|            | Bridges    | 181.0834        | 0.1817        | 0.10           |
|            | Tunnels    | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 566.6074        | 0.1817        |                |
| Railways   | Segments   | 13.2639         | 0.0000        | 0.00           |
|            | Bridges    | 0.0000          | 0.0000        | 0.00           |
|            | Tunnels    | 0.0000          | 0.0000        | 0.00           |
|            | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 13.2639         | 0.0000        |                |
| Light Rail | Segments   | 0.0000          | 0.0000        | 0.00           |
|            | Bridges    | 0.0000          | 0.0000        | 0.00           |
|            | Tunnels    | 0.0000          | 0.0000        | 0.00           |
|            | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| Bus        | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| Ferry      | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| Port       | Facilities | 1.9970          | 0.0178        | 0.89           |
|            | Subtotal   | 1.9970          | 0.0178        |                |
| Airport    | Facilities | 0.0000          | 0.0000        | 0.00           |
|            | Runways    | 0.0000          | 0.0000        | 0.00           |
|            | Subtotal   | 0.0000          | 0.0000        |                |
| l          | Total      | 581.87          | 0.20          |                |

## Table 12: Transportation System Economic Losses

(Millions of dollars)





## Table 13: Utility System Economic Losses

(Millions of dollars)

| System           | Component          | Inventory Value | Economic Loss | Loss Ratio (%) |
|------------------|--------------------|-----------------|---------------|----------------|
| Potable Water    | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Distribution Lines | 4.2050          | 0.0000        | 0.00           |
|                  | Subtotal           | 4.2050          | 0.0000        |                |
| Waste Water      | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Distribution Lines | 2.5230          | 0.0000        | 0.00           |
|                  | Subtotal           | 2.5230          | 0.0000        |                |
| Natural Gas      | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Distribution Lines | 1.6820          | 0.0000        | 0.00           |
|                  | Subtotal           | 1.6820          | 0.0000        |                |
| Oil Systems      | Pipelines          | 0.0000          | 0.0000        | 0.00           |
|                  | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Subtotal           | 0.0000          | 0.0000        |                |
| Electrical Power | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Subtotal           | 0.0000          | 0.0000        |                |
| Communication    | Facilities         | 0.0000          | 0.0000        | 0.00           |
|                  | Subtotal           | 0.0000          | 0.0000        |                |
|                  | Total              | 8.41            | 0.00          |                |





## Appendix A: County Listing for the Region

Middlesex,CT





## Appendix B: Regional Population and Building Value Data

|              |             |            | Building Value (millions of dollars) |                 |       |  |
|--------------|-------------|------------|--------------------------------------|-----------------|-------|--|
| State        | County Name | Population | Residential                          | Non-Residential | Total |  |
| Connecticut  |             |            |                                      |                 |       |  |
|              | Middlesex   | 6,683      | 1,070                                | 408             | 1,479 |  |
| Total Region |             | 6,683      | 1,070                                | 408             | 1,479 |  |