EARTHQUAKE

This section provides a profile and vulnerability assessment for the earthquake hazard.

HAZARD PROFILE

This section provides profile information including description, location and extent, previous occurrences and losses and the probability of future occurrences.

Description

An earthquake is the sudden movement of the Earth's surface caused by the release of stress accumulated within or along the edge of the Earth's tectonic plates, a volcanic eruption or by a manmade explosion (FEMA, 2001; Shedlock and Pakiser, 1997). Most earthquakes occur at the boundaries where the Earth's tectonic plates meet (faults); however, less than 10 percent of earthquakes occur within plate interiors. New York is in an area where plate interior-related earthquakes occur. As plates continue to move and plate boundaries change over geologic time, weakened boundary regions become part of the interiors of the plates. These zones of weakness within the continents can cause earthquakes in response to stresses that originate at the edges of the plate or in the deeper crust (Shedlock and Pakiser, 1997).

The location of an earthquake is commonly described by its focal depth and the geographic position of its epicenter. The focal depth of an earthquake is the depth from the Earth's surface to the region where an earthquake's energy originates (the focus or hypocenter). The epicenter of an earthquake is the point on the Earth's surface directly above the hypocenter (Shedlock and Pakiser, 1997). Earthquakes usually occur without warning and their effects can impact areas a great distance from the epicenter (FEMA, 2001).

According to the USGS Earthquake Hazards Program, an earthquake hazard is anything associated with an earthquake that may affect resident's normal activities. This includes surface faulting, ground shaking, landslides, liquefaction, tectonic deformation, tsunamis, and seiches. A description of each of these is provided below.

Deformation: A change in the original shape of a material due to stress and strain (FEMA, 2006).

Ground shaking: The movement of the earth's surface from earthquakes or explosions. Ground motion or shaking is produced by waves that are generated by sudden slip on a fault or sudden pressure at the explosive source and travel through the earth and along its surface (FEMA, 2006).

Landslide: A movement of surface material down a slope (FEMA, 2006).

Liquefaction: A process by which water-saturated sediment temporarily loses strength and acts as a fluid, like when you wiggle your toes in the wet sand near the water at the beach. This effect can be caused by earthquake shaking (FEMA, 2006).

Seiche: The sloshing of a closed body of water from earthquake shaking (FEMA, 2006).

Surface faulting: Displacement that reaches the earth's surface during slip along a fault. Commonly occurs with shallow earthquakes, those with an epicenter less than 20 km.

Tsunami: A sea wave of local or distant origin that results from large-scale seafloor displacements associated with large earthquakes, major submarine slides, or exploding volcanic islands (FEMA, 2006).

Location and Extent

A direct relationship exists between a fault's length and location and it ability to generate damaging ground motion at a given location. In some areas, smaller local faults produce lower magnitude quakes, but ground shaking can be strong, and damage can be significant as a result of the fault's proximity to the area. In contrast, large regional faults can generate great magnitude but, because of their distance or depth, may result in only moderate shaking in the area.

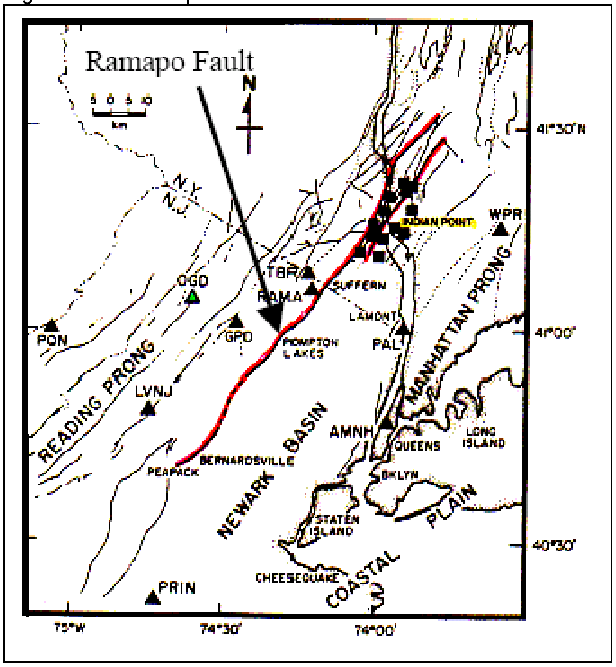
As noted in the NYS HMP, the importance of the earthquake hazard in NYS is often underestimated because other natural hazards (e.g., hurricanes and floods) occur more frequently and because major floods and hurricanes have occurred more recently than a major earthquake event. However, while the earthquake hazard is generally associated with the west coast of the U.S. (which has greater seismic activity than the east coast), the potential for earthquakes exists across the entire Northeast region.

The Ramapo Fault (Figure 5-33) is part of a system of northeast striking, southeast-dipping faults, which runs from southeastern New York to the Hudson River at Stony Point, through eastern Pennsylvania (PA) and beyond. The fault is a hairline fracture, 50 miles long, and is located 35 miles from New York City. Seismographic stations, part of the Advanced National Seismic System, are used to monitor earthquakes and ground motion near important buildings and critical infrastructure along this fault (Lamont-Doherty, 2004; Pasfield, Unknown). In the 1970s and early 1980s, earthquake risk along the Ramapo Fault received attention because of its proximity to the Indian Point, New York, Nuclear Power Generating Station (Dombroski, Unknown). The Village is located within 10 miles of Indian Point and is in the facility's emergency planning zone.

The Dobbs Ferry Fault also extends through WC to the southeast of the Ramapo Fault. The fault zone extends southeastward from the east bank of the Hudson River and crosses the Bronx River to Reservoir No. 1. The fault zone strikes northwest, and is 8-10 km long and 400 meters wide at its widest point.

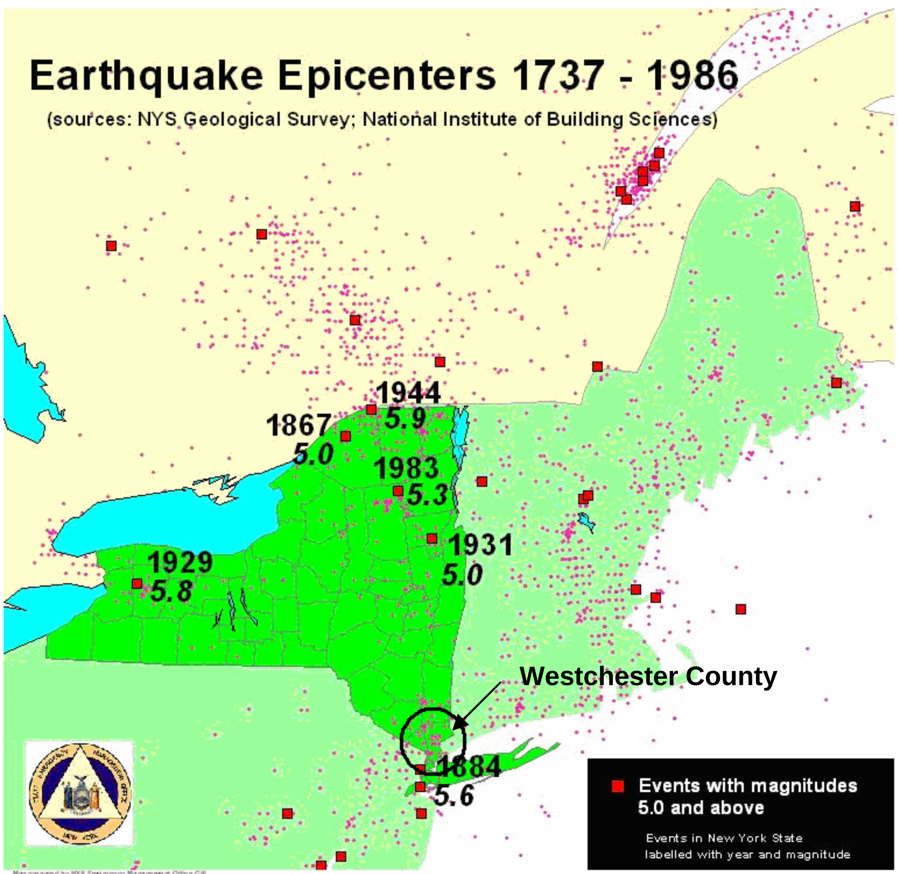
The New York City Area Consortium for Earthquake Loss Mitigation (NYCEM) reports NYS ranks third highest in earthquake activity level east of the Mississippi River. Figures 5-34 and 5-35 illustrate historic earthquake epicenters across the Northeast and New York City metropolitan area, respectively. WC is located within one of three regions in NYS that are characterized as having a higher seismic risk compared to the remainder of the State (see Figure 5-36).

Figure 5-33. Ramapo Fault Line



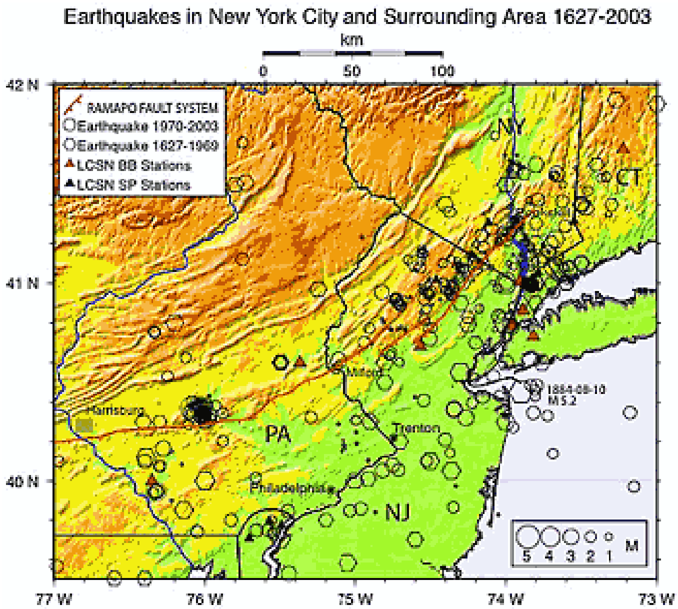
Source: Rasmusson, 2003 http://www.bc.edu/schools/cas/geo/meta-elements/pdf/KNR_MS_Thesis.pdf

Figure 5-34. Earthquake Epicenters across the Northeast from 1737 to 1986



Source: NYS Standard Multi-Hazard Mitigation Plan

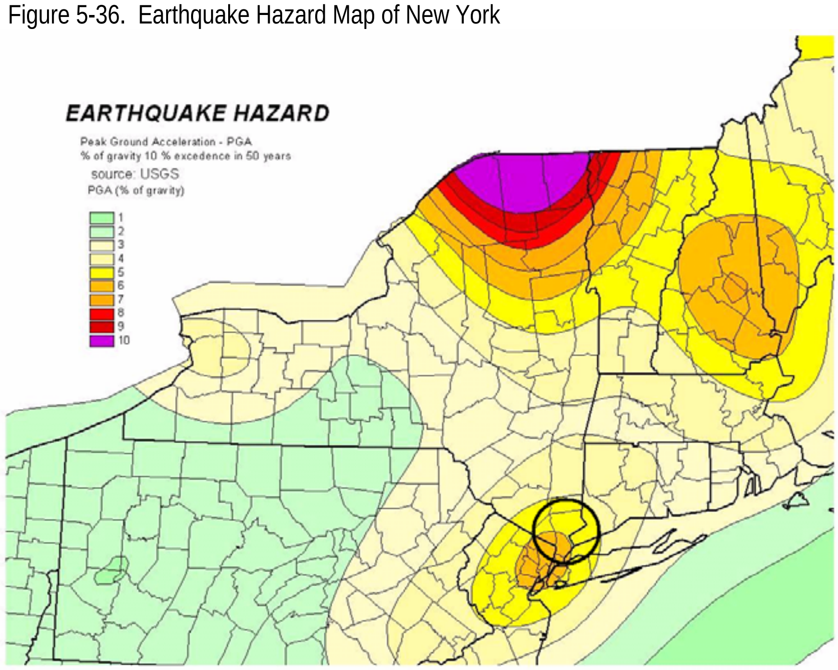
Figure 5-35. Earthquake Epicenters in New York City and Surrounding Areas from 1627 to 2003



Source: http://www.ldeo.columbia.edu/news/2004/04_30_04.htm

Note: The Ramapo Fault System is shown as a red line. Hexagons indicate earthquake events prior to 1970 and circles indicate earthquakes post 1970 (when systematic earthquake monitoring began in the region). The symbol size is proportional to magnitude.

Figure 5-36. Earthquake Hazard Map of New York



Source: NYS Standard Multi-Hazard Mitigation Plan, 2004

The severity of an earthquake is dependent upon the amount of energy released from the hypocenter and can be expressed by its magnitude and intensity. The magnitude of an earthquake is a measured value of the earthquake size, or amplitude of the seismic waves, using a seismograph. The Richter Scale, a logarithmic scale, is the most widely-known scale that measures the magnitude of earthquakes (Shedlock and Pakiser, 1997; USGS, 2004). Table 5-25 presents the Richter Scale magnitudes and corresponding earthquake effects.

Table 5-25. Richter Scale

Richter Magnitudes	Earthquake Effects
< 3.5	Generally not felt, but recorded
3.5 – 5.4	Often felt, but rarely causes damage
Under 6.0	At most slight damage to well-designed buildings; can cause major damage to poorly constructed buildings over small regions.
6.1 – 6.9	Can be destructive in areas up to about 100 kilometers.
7.0 – 7.9	Major earthquake; can cause serious damage over larger areas.
≥ 8	Great earthquake; can cause serious damage in areas several hundred kilometers across.

Source: Nevada Seismological Laboratory, 1996
Notes: < = Less than; ≥ = Greater than or equal to

The intensity of an earthquake is based on the observed effects of ground shaking on people, buildings, and natural features, and varies with location. Intensity is expressed by the Modified Mercalli Scale; a subjective measure that describes how strong a shock was felt at a particular location (Shedlock and Pakiser, 1997; USGS, 2004). The Modified Mercalli Scale expresses the intensity of an earthquake's effects in a given locality in values ranging from I to XII. Table 5-26 summarizes earthquake intensity as expressed by the Modified Mercalli Scale.

Table 5-26. Modified Mercalli Intensity Scale

Intensity	Description
I	People do not feel any Earth movement.
II	A few people might notice movement if they are at rest and/or on the upper floors of tall buildings.
III	Many people indoors feel movement. Hanging objects swing back and forth. People outdoors might not realize that an earthquake is occurring.
IV	Most people indoors feel movement. Hanging objects swing. Dishes, windows, and doors rattle. The earthquake feels like a heavy truck hitting the walls. A few people outdoors may feel movement. Parked cars rock.
V	Almost everyone feels movement. Sleeping people are awakened. Doors swing open or close. Dishes are broken. Pictures on the wall move. Small objects move or are turned over. Trees might shake. Liquids might spill out of open containers.
VI	Everyone feels movement. People have trouble walking. Objects fall from shelves. Pictures fall off walls. Furniture moves. Plaster in walls might crack. Trees and bushes shake. Damage is slight in poorly built buildings. No structural damage.

Intensity	Description
VII	People have difficulty standing. Drivers feel their cars shaking. Some furniture breaks. Loose bricks fall from buildings. Damage is slight to moderate in well-built buildings; considerable in poorly built buildings.
VIII	Drivers have trouble steering. Houses that are not bolted down might shift on their foundations. Tall structures such as towers and chimneys might twist and fall. Well-built buildings suffer slight damage. Poorly built structures suffer severe damage. Tree branches break. Hillsides might crack if the ground is wet. Water levels in wells might change.
IX	Well-built buildings suffer considerable damage. Houses that are not bolted down move off their foundations. Some underground pipes are broken. The ground cracks. Reservoirs suffer serious damage.
X	Most buildings and their foundations are destroyed. Some bridges are destroyed. Dams are seriously damaged. Large landslides occur. Water is thrown on the banks of canals, rivers, lakes. The ground cracks in large areas. Railroad tracks are bent slightly.
XI	Most buildings collapse. Some bridges are destroyed. Large cracks appear in the ground. Underground pipelines are destroyed. Railroad tracks are badly bent.
XII	Almost everything is destroyed. Objects are thrown into the air. The ground moves in waves or ripples. Large amounts of rock may move.

Source: Nevada Seismological Laboratory, 1996

Peak Ground Acceleration (PGA) also expresses the severity of an earthquake. PGS is a measure of how hard the earth shakes, or accelerates, in a given geographic area. PGA is expressed as a percent acceleration force of gravity (%g). Figure 5-37 illustrates the percent PGA for NYS with a 10% chance of being exceeded in 50 years. A 5-6%g has a 10-percent chance of being exceeded in a period of 50 years in WC. According to USGS Earthquake Hazards Program, PGA maps (also known as earthquake hazard maps) are used as planning tools when designing buildings, bridges, highways, and utilities so that they can withstand shaking associated with earthquake events. These maps are also used as planning tools for the development of building codes that establish construction requirements appropriate to preserve public safety.

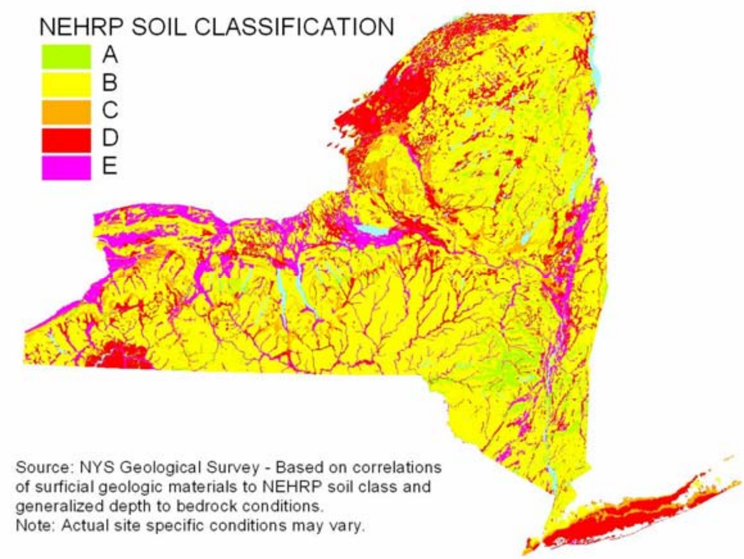
In addition to magnitude and intensity, local soil type can substantially affect an earthquake's risk. The National Earthquake Hazard Reduction Program (NEHRP) developed five soil classifications that impact the severity of an earthquake. The soil classification system ranges from A to E, where A represents hard rock that reduces ground motions from an earthquake and E represents soft soils that amplify and magnify ground shaking and increase building damage and losses (NYSEMO, 2004; NYCEM, 2003). Table 5-27 summarizes the NEHRP soil classifications that are illustrated on Figure 5-37. WC mainly contains soil classifications B, C and D.

Table 5-27. National Earthquake Hazard Reduction Program Soil Classifications

Soil Classification	Description	Map Color
A	Very hard rock (e.g., granite, gneisses)	Green
B	Sedimentary rock or firm ground	Yellow
C	Stiff clay	Orange
D	Soft to medium clays or sands	Red
E	Soft soil including fill, loose sand, waterfront, lake bed clays)	Pink/Purple

Source: NYS Standard Multi-Hazard Mitigation Plan, 2004

Figure 5-37. National Earthquake Hazard Reduction Program Soils in New York

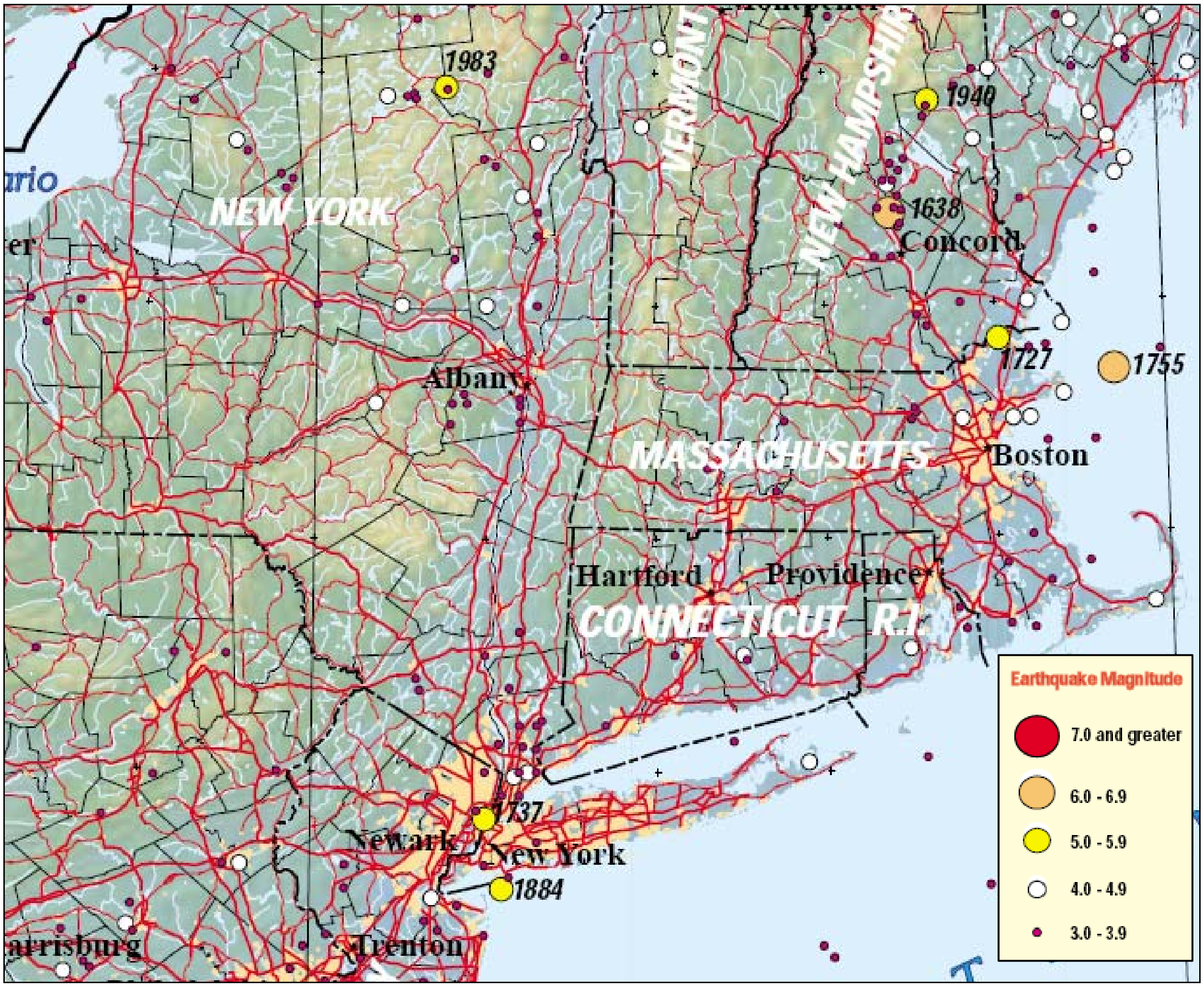


Source: NYS Standard Multi-Hazard Mitigation Plan, 2004

Previous Occurrences and Losses

Although WC is located within one of three regions in NYS that is characterized as having a higher seismic risk compared to the remainder of the State, reported occurrences of earthquakes within WC are not common. However, the communities of WC have felt the minor cascading effects of earthquakes that have taken place in surrounding counties within northeastern states, particularly NYS, New Jersey (NJ) and Connecticut (CT). Figure 5-38 identifies earthquake events that have occurred within the northeastern U.S. between 1638 and 1998.

Figure 5-38. Earthquakes In and Near the Northeastern United States 1638 - 1998



Source: Russell L. Wheeler, Nathan K. Trevor, Arthur C. Tarr and Anthony J. Crone. - U.S. Geological Survey Fact Sheet 0006-01 Version 1.0 - http://pubs.usgs.gov/fs/fs-0006-01/ and http://pubs.usgs.gov/imap/i-2737/i-2737.pdf.

Many sources were used to identify earthquake events that have occurred within NYS, including the Lamont-Doherty Earth Observatory of Columbia University (Lamont Doherty), the 2005 approved NYS HMP and the 2004 New York State Statistical Yearbook developed by the Nelson A. Rockefeller Institute of Government, State University of New York. Not all sources identify the same earthquake events, as can be seen in Tables 5-28 through 5-30. Based on all these sources, NYS has experienced approximately 48 earthquake events between 1737 and 2002.

The Lamont-Doherty Earth Observatory of Columbia University includes recorded earthquake data for the area for the period from 1627 to 2001. According to the Lamont-Doherty, as of 1999, the largest earthquakes to occur within the New York City area (including WC) are listed in Table 5-28 and identified on Figure 5-39. Of those listed, the December 11, 1974, and October 19, 1985, events took place within WC (Kim, 1999). Events that took place within surrounding counties and states have impacted WC in the past.

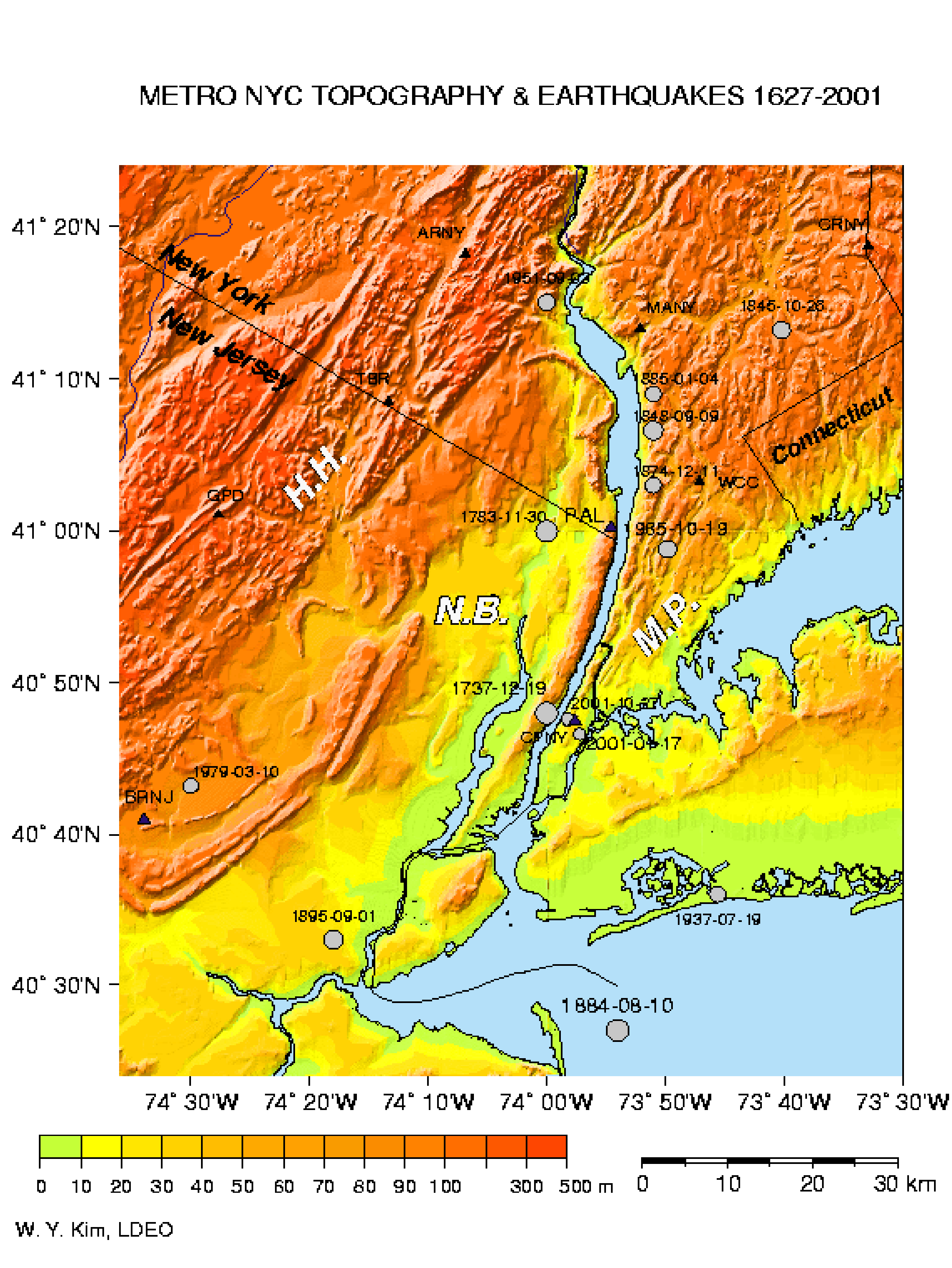
Table 5-28. The Lamont-Doherty Earth Observatory of Columbia University - Largest Earthquakes in the New York City Area (1627 – 2001)

Date	Time (hh:mm:sec)	Latitude (°N)	Longitude (°W)	Location	Magnitude Richter	Max. Intensity (MMI)	Remark
December 19, 1737	3:45	40.8	74	Greater N.Y. City area*	5.2	VII	Threw down chimneys
November 30, 1783	3:50	41	74	N. Central N.J.*	4.9	VI	Threw down chimneys
October 26, 1845	23:15	41.22	73.67	Greater N.Y. City area*	3.8	VI	NA
September 9, 1848	NA	41.11	73.85	Greater N.Y. City area*	4.4	V	Many people in the NY City area felt the earthquake
December 11, 1874	3:25	41.05	73.85	Near Nyack and Tarry-town, N.Y.	3.4	VI	NA
August 10, 1884	19:07	40.45	73.9	Greater N.Y. City area	5.2	VII	Threw down chimneys - felt from Virginia to Maine;
January 4, 1885	11:06	41.15	73.85	Hudson Valley	3.4	VI	NA
September 1, 1895	11:09	40.55	74.3	N. Central N.J.	4.3	VI	Location determined by fire and aftershock
January 20, 1905	NA	NA	NA	Greater N.Y. City area*	4.5	V	Probably Offshore
June 1, 1927	12:23	40.3	74	Near Asbury Park, N.J.	3.9	VI-VII	Very high intensity in Asbury Park, NJ - perhaps shallow event
July 19, 1937	3:51	40.6	73.76	Western Long Is., N.Y.	3.5	IV	One or few earthquakes beneath Long Island
August 23, 1938	5:04:53	40.1	74.5	Central N.J.	3.8	VI	NA

Date	Time (hh:mm:sec)	Latitude (°N)	Longitude (°W)	Location	Magnitude Richter	Max. Intensity (MMI)	Remark
September 3, 1951	21:26:24	41.25	74	Rockland Co., N.Y.	3.6	V	NA
March 23, 1957	19:02	40.6	74.8	Central N.J.	3.5	VI	NA
March 10, 1979	4:49:39	40.72	74.5	Central N.J.	3.2	V-VI	Felt by some people in Manhattan [it is called Chesequake earthquake]
October 19, 1985	10:07	40.98	73.83	Ardsley, N.Y.	4	IV	Many people in the NY City area felt this earthquake
January 17, 2001	12:34:22	40.78	73.95	Manhattan, New York City	2.4	IV	Felt in Upper East Side of Manhattan, Long Island City and Queens, NYC
October 17, 2001	1:42:21	40.79	73.97	Manhattan, New York City	2.6	IV	Felt in Upper West Side of Manhattan, Astoria and Queens, NYC

Source: Won-Young Kim, Lamont-Doherty Earth Observatory of Columbia University, 1999
Note:
* = Location very poorly determined; may be uncertain by 50 miles.
hh = Hours
mm = Minutes
MMI = Modified Mercalli Scale
NA = Not applicable
NJ = New Jersey
NY = New York
NYC = New York City
Sec = Seconds

Figure 5-39. The Lamont-Doherty Earth Observatory of Columbia University - Largest Earthquakes in the New York City Area (1627 – 2001)



Source: Won-Young Kim, Lamont-Doherty Earth Observatory of Columbia University, 1999

Table 5-29. New York State Hazard Mitigation Plan - Significant Earthquakes in New York State (1737 – 2002)

Date	County	Community	Maximum Modified Mercalli Intensity	General Magnitude
1737 – Dec. 18	New York	New York City	VI	5.0est.
1853 – Mar. 12	Lewis	Lowville	VI	4.8est.
1857 – Oct. 23	Erie	Buffalo	V	4.6est.
1867 – Dec. 18	St. Lawrence	Canton	VI	4.8est.
1874 – Dec. 11	Westchester	Tarrytown	VI	4.8est.
1884 – Aug. 10	New York	Rockaway Beach	VI	5.3est.
1897 – May 28	Clinton	Plattsburgh	VI	Not Stated
1928 – Mar. 18	Franklin	Saranac Lake	VI	4.5est.
1929 – Aug. 12	Wyoming	Attica	VII	5.2
1931 – Apr. 20	Warren	Warrensburg	VII	4.5
1934 – Apr. 15	Clinton	Dannemora	VI	4.5
1944 – Sep. 5	St. Lawrence	Massena	VIII	6.0
1944 – Sep. 5	St. Lawrence	Massena	V	4.5
1966 – Jan. 1	Wyoming	Attica	VI	4.6
1967 – Jun. 13	Wyoming	Attica	V	4.4
1983 – Oct. 7	Essex	Newcomb	VI	5.1
1985 – Oct. 19	Westchester	White Plains	V	4.0
1991 – Jun. 17	Schoharie	Summit	V	4.1
1994 – Mar. 22	Livingston	Cuylerville	VI	3.6a

Source: NYS HMP, 2006.

Table 5-30. Location and Intensity of Significant Earthquakes in New York State (1737 – 2002)

Date	Locality	Size	Damage in New York
Dec. 18, 1737	New York City	5.2	Bells rang, several chimneys fell
January 16, 1840	Herkimer	3.7	
September 2, 1847	Offshore New York City	3.5	No reference. No damage reported
September 9, 1848	Rockland Lake	V	Felt by many
March 12, 1853	Lowville	VI	Machinery knocked over
February 7, 1855	Saugerties[1]	VI	Cryoseism[2,3]
October 23, 1857	Buffalo (Lockport[1])	4.0	Bells rang, crocks fell from shelves
December 18, 1867	Canton	4.7	Sleepers awakened
December 11, 1874	Tarrytown	3.4	
November 4, 1877	Lyon Mountain[1]	VII	Chimneys down, walls cracked, window damaged, crocks overturned
August 10, 1884	New York Bight (New York City)	5.2	Chimneys and bricks fell, walls cracked
May 28, 1897	Dannemora	4.5	No damage reported
February 3, 1916	Schenectady	3.8	Broke windows, people thrown out of bed
March 18, 1928	Saranac Lake	4.0	
August 12, 1929	Attica	5.2	250 chimneys fell, brick buildings damaged, Attica prison walls, wells went dry
April 20, 1931	Warrensburg	4.8	Chimneys fell, church spire twisted
April 15, 1934	Dannemora	3.9	House shifted
July 9, 1937	Brooklyn[1]	3.5	No damage reported
September 5, 1944	Corwall, Ontario/Massena, New York	5.8	Nearly all chimneys fell, buildings damaged, $2 million damage
September 5, 1944	Corwall, Ontario/Massena, New York	4.5	Chimneys destroyed, houses damaged
September 3, 1951	Rockland County	3.6	No damage reported
January 1, 1966	Attica	4.7	Chimneys and walls damaged
June 13, 1967	Attica	3.9	Chimneys and walls damaged
May 23, 1971	Blue Mountain Lake	4.1	No damage reported
May 23, 1971	Blue Mountain Lake	3.5	No damage reported
June 7, 1974	Wappingers Falls	3.0	Windows broken
June 9, 1975	Plattsburgh (Altona)	3.5	Chimneys and fire places cracked
November 3, 1975	Raquette Lake	4.0	No damage reported
February 2, 1983	Scarsdale-Lagrangeville	3.0	Chimneys cracked
October 7, 1983	Goodnow, Adirondack Mountains	5.1	Tombstones rotated, some cracked chimneys, windows broken, walls damaged
October 19, 1985	Ardsley	4.0	Windows broken, walls damaged
June 17, 1991	Richmondville	4.0	No damage reported
March 10, 1992	East Hampton, Suffolk County	4.1	No damage reported[2]
April 20, 2000	Newcomb	3.8	Aftershock of the 1983 event. No damage reported
April 20, 2002	Au Sable Forks	5.1	Cracked walls, chimneys fell, road collapsed, power outages
May 24, 2002	Au Sable Forks	3.1	Aftershock of the April 20, 2002 event, no damage reported

1 Locality uncertain.
2 Damage uncertain.
3 Frostquake.
SOURCE: New York State Education Department, Geological Survey.

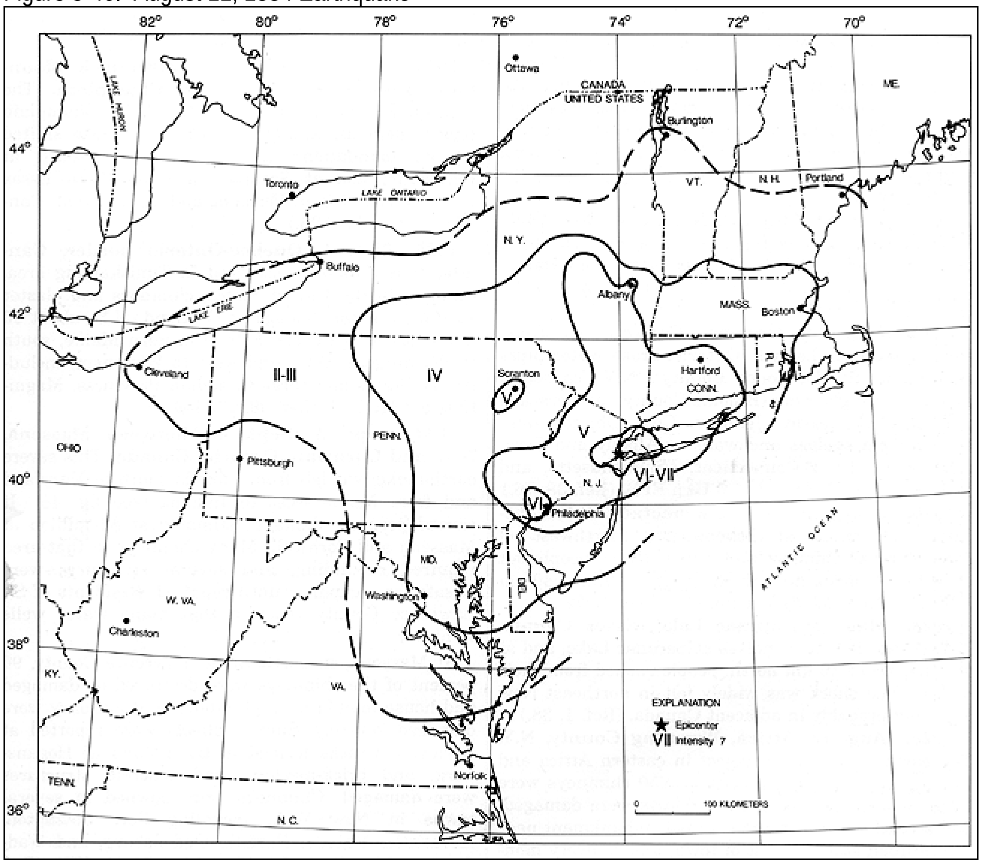
Source: New York State Statistical Yearbook, 2004 - http://www.nysstatistics.org/yearbook/04/toc2004.htm and http://www.nysstatistics.org/yearbook/04/data/O_1.pdf. The Nelson A. Rockefeller Institute of Government, State University of New York In cooperation with the New York State Division of Budget

Details regarding earthquakes events that have directly or indirectly impacted WC include the following:

December 11, 1874: A 3.4 earthquake occurred near Nyack and Tarrytown, New York in WC. However, details regarding the impacts of this event were not documented.

August 10, 1884: The August 10, 1884 earthquake affected an area roughly extending along the Atlantic Coast from southern Maine to central Virginia and westward to Cleveland, Ohio (Figure 5-40). Chimneys were knocked down and walls were cracked in several states, including Connecticut (CT), New Jersey (NJ), NY, and Pennsylvania (PA). Property damage was severe at Amityville and Jamaica, NY, where several chimneys were "overturned" and large cracks formed in walls. Two chimneys were thrown down and bricks were shaken from other chimneys at Stratford (Fairfield County), CT; water in the Housatonic River was agitated violently. At Bloomfield, NJ, and Chester, PA, several chimneys were downed and crockery was broken. Chimneys also were damaged at Mount Vernon, NY, and Allentown, Easton, and Philadelphia, PA. Three aftershocks occurred, the second of which was most violent. This earthquake also was reportedly felt in Vermont, Virginia, and Washington, D.C. Several slight aftershocks were reported on August 11 (USGS, 1993)

Figure 5-40. August 11, 1884 Earthquake

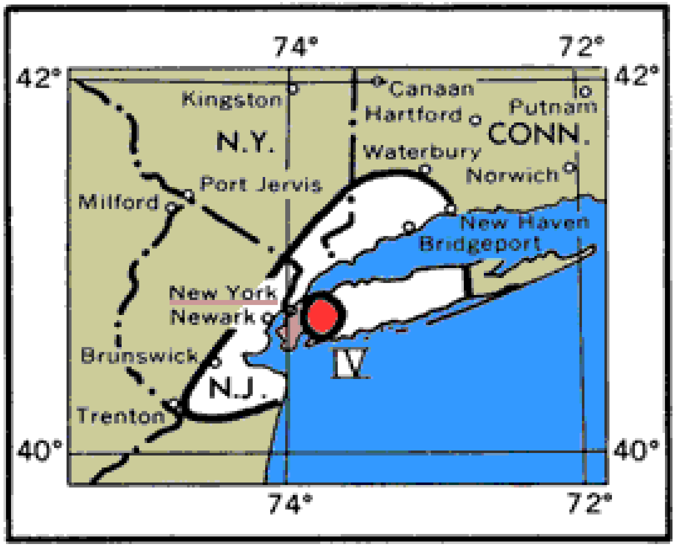


Source: USGS - http://earthquake.usgs.gov/regional/states/events/1884_08_10_iso.php
Abridged from Seismicity of the United States, 1568-1989 (Revised), by Carl W. Stover and Jerry L. Coffman, U.S. Geological Survey Professional Paper 1527, United States Government Printing Office, Washington: 1993.

The Earthquake Newspaper Archive includes a New York Times (NY Times) August 11, 1884, news article that indicates that people in impacted states were terrified by this earthquake event, which rocked the ground from Maryland to Maine. This article identified specific locations throughout NYS that experienced an impact from this event, including many locations throughout WC. The article indicated that Mount Vernon, Yonkers, New-Rochelle, Port Chester, White Plains and other places in WC experienced minor shaking from the earthquake. Houses were shaken and the contents were rattled, creating great alarm among occupants. The chimneys of a house were shaken down and brick walls were shattered. The earthquake rattled WC communities for 10 to 15 minutes (NY Times, 1884 - http://www.earthquakearchive.com/).

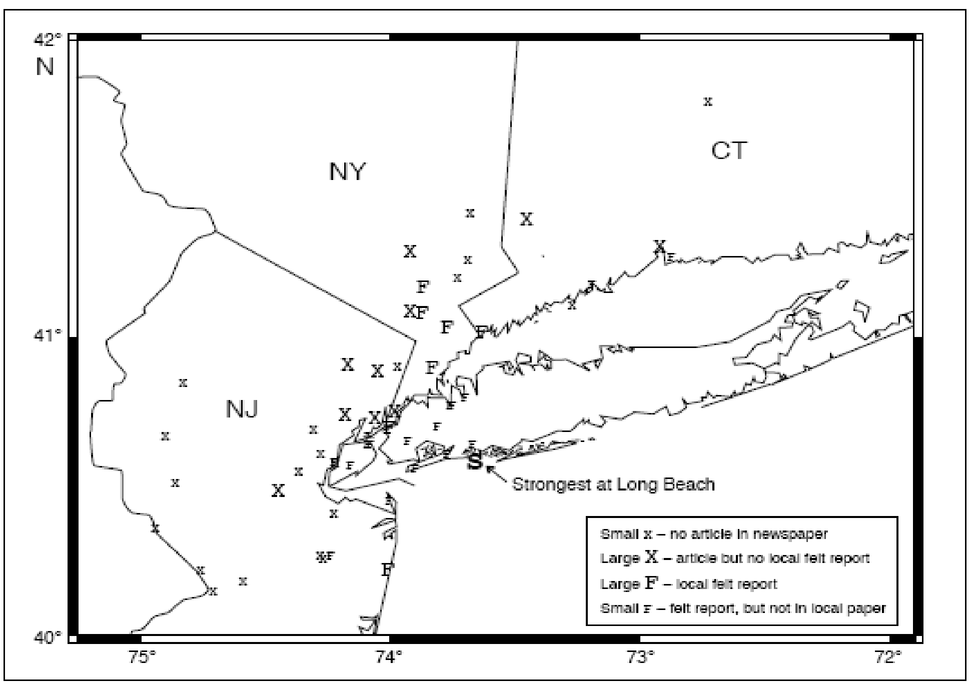
July 18, 1937: According to the Columbia Earth Institute, an earthquake with a maximum intensity of IV on the Modified Mercalli Scale occurred in western Long Island, NY on July 18, 1937 (Figure 5-41). A canvass made by the U.S. Department of Commerce, Environmental Science Services Administration, Coast and Geodetic Survey revealed that places within this area experienced an intensity of less than IV and quite a number of widely scattered points far beyond the epicenter had a reported intensity of IV. Such relatively high intensities at isolated, distant points are believed to have occurred based on resonance phenomena in local geological formations and in structures themselves. Resonance is a condition in which the natural frequency (number of vibrations per second) of vibration of an object is matched in frequency by an outside source of vibration energy. Resonance results in an increase in the size of the vibrations. In addition, there was probably a considerable variation of intensity across the area because of the complex nature of the transmission of earthquake waves through the layered crust of the earth. It appears that the south-southeastern section of WC was impacted by this earthquake. It was reported that a community within WC that experienced an intensity of IV includes the Town of Scarsdale (The Columbia Earth Institute of Columbia, 2001) (Kim, 2003). As identified in Figure 5-42, many communities within WC had experienced reports of impacts associated with this event.

Figure 5-41. July 18, 1937 Earthquake



Source: The Columbia Earth Institute of Columbia University, 2001
http://www.ldeo.columbia.edu/LCSN/News/about1_2_01b.html

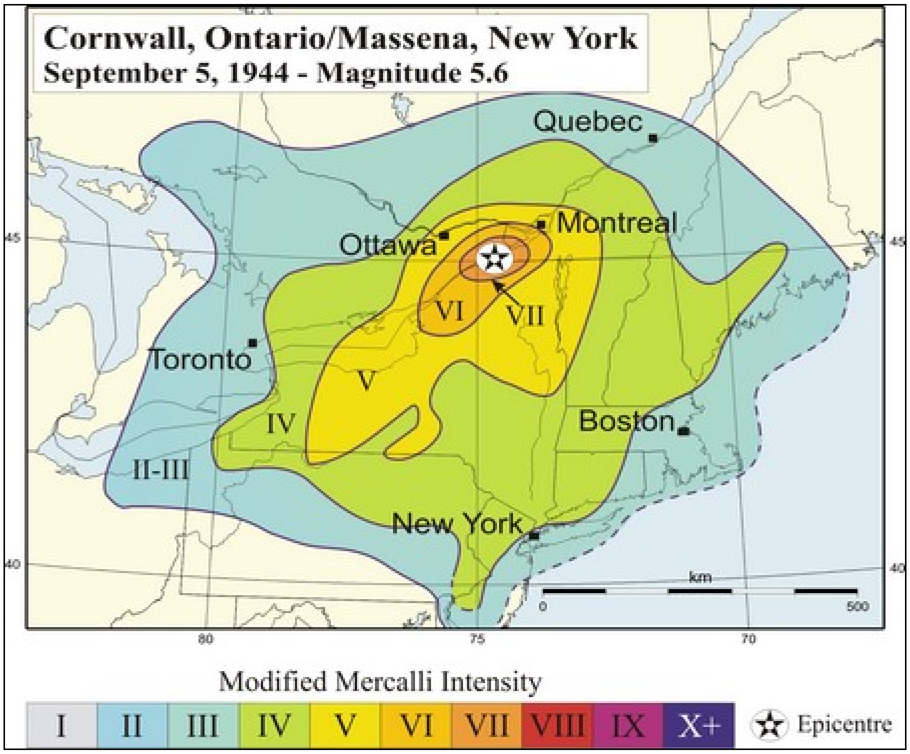
Figure 5-42. July 1937 Earthquake



Source:
http://www.ldeo.columbia.edu/~sykes/images/Earthquake_Catalog_NYC_Phil_area/Fig.A3_1937.pdf

September 5, 1944: On September 5, 1944 an earthquake of Intensity VIII on the Modified Mercalli Scale (and 5.6 on the Richter Scale) shook the Massena-Cornwall area within northern NYS (Figure 5-43). This was the largest earthquake to occur in NYS and its location in a populated region caused damage estimated at $18,000,000 (Spinner, 2005). This severe earthquake took place to the north of WC and was felt from Canada south to Maryland and from Maine west to Indiana.

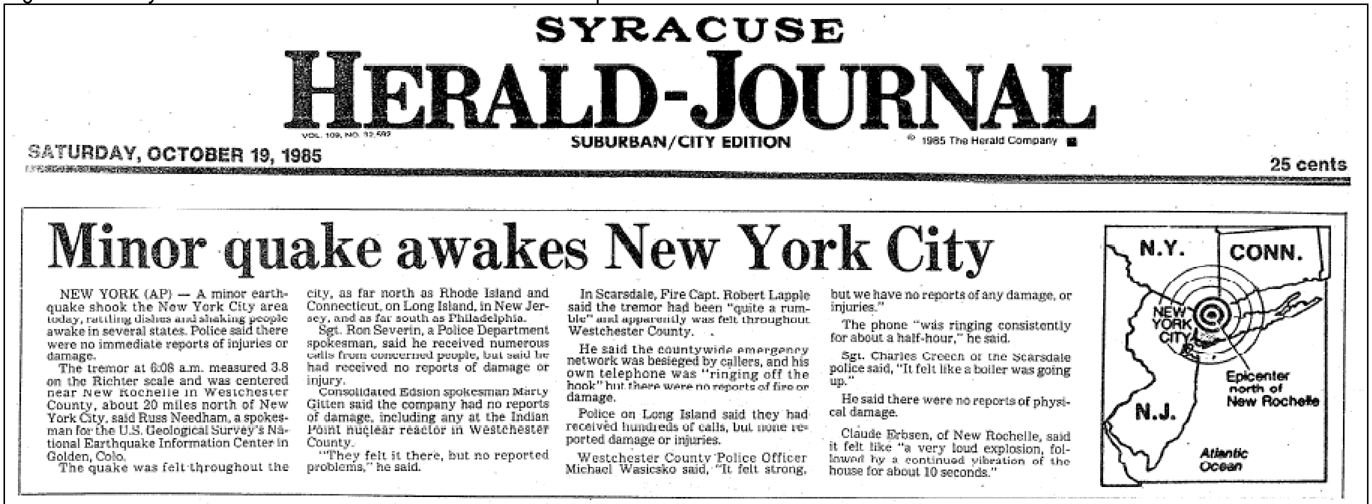
Figure 5-43. Largest Earthquake in NYS - September 5, 1944



Source: http://earthquakescanada.nrcan.gc.ca/historic_eq/20th/1944_e.php

October 19, 1985: On October 19, 1985, an earthquake measuring 4.0 on the Richter Scale impacted NY; its epicenter was located between Scarsdale, Ardsley, and Greenburgh in WC, as identified in Figures 5-44 and 5-45. This earthquake was widely felt in New York City (SWRPA 2005). Many people were awakened in their homes by a noticeable rumble. Mr. Leonardo Seeber of the Lamont-Doherty Geological Observatory has stated that this event was probably caused by movement along the nearly vertical northwest trending Dobbs Ferry Fault (Mcguire, 1991).

Figure 5-44. Syracuse Herald Journal – October 1985 Earthquake in WC



SYRACUSE
HERALD-JOURNAL

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Minor quake awakes New York City

NEW YORK (AP) — A minor earthquake shook the New York City area today, rattling dishes and shaking people awake in several states. Police said there were no immediate reports of injuries or damage.

The tremor at 6:08 a.m. measured 3.8 on the Richter scale and was centered near New Rochelle in Westchester County, about 20 miles north of New York City, said Russ Needham, a spokesman for the U.S. Geological Survey's National Earthquake Information Center in Golden, Colo.

The quake was felt throughout the city, as far north as Rhode Island and Connecticut, on Long Island, in New Jersey, and as far south as Philadelphia.

Sgt. Ron Severin, a Police Department spokesman, said he received numerous calls from concerned people, but said he had received no reports of damage or injury.

Consolidated Edsion spokesman Marty Gitten said the company had no reports of damage, including any at the Indian Point nuclear reactor in Westchester County.

"They felt it there, but no reported problems," he said.

In Scarsdale, Fire Capt. Robert Lapple said the tremor had been "quite a rumble" and apparently was felt throughout Westchester County.

He said the countywide emergency network was besieged by callers, and his own telephone was "ringing off the hook" but there were no reports of fire or damage.

Police on Long Island said they had received hundreds of calls, but none reported damage or injuries.

Westchester County Police Officer Michael Wasicsko said, "It felt strong, but we have no reports of any damage, or injuries."

The phone "was ringing consistently for about a half-hour," he said.

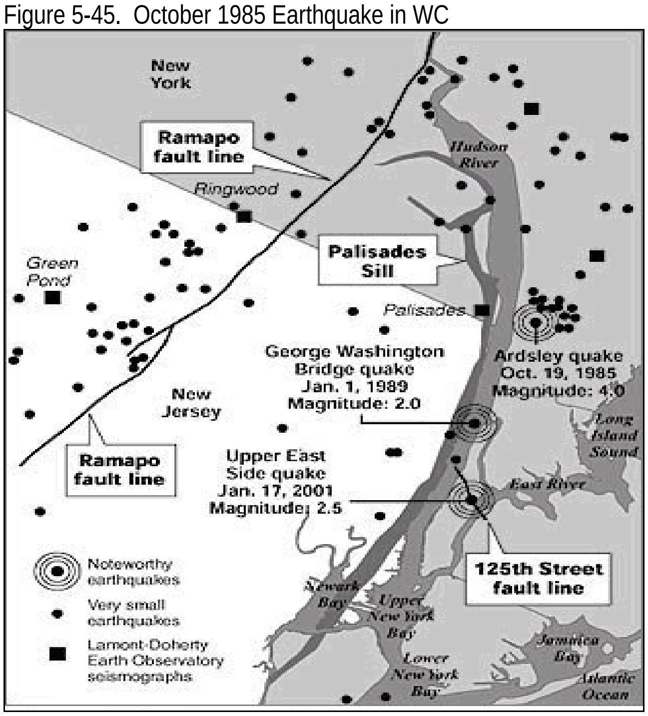
Sgt. Charles Creech of the Scarsdale police said, "It felt like a boiler was going up."

He said there were no reports of physical damage.

Claude Erbsen, of New Rochelle, said it felt like "a very loud explosion, followed by a continued vibration of the house for about 10 seconds."

Source: Syracuse Herald Journal – October 1985

Figure 5-45. October 1985 Earthquake in WC



Source: Zakir Hussain "Waiting for the big one: Is New York prepared for earthquakes?" February 15, 2005

January 4, 1986: According to The Daily Herald, an earthquake measuring 2.0 Richter Scale occurred in Ardsley, WC on January 4, 1986. Buildings were shaken, but no damage occurred as a result of this minor earthquake. Authorities indicated that over 150,000 people in the lower WC area felt this earthquake's tremors (Daily Herald 1986).

April 20, 2002: In a 2002 Associated Press news article, Mr. William Ott, a seismologist at Weston Observatory at Boston College, stated that an earthquake measuring 5.1 on the Richter Scale occurred in upstate NY. The epicenter was about 15 miles southwest of Plattsburgh, NY. Although it did not directly occur within WC, it was felt throughout NYS. Amanda Slattery, of Yorktown Heights in WC, said she was in bed when the tremor struck. "Nothing fell off the shelves, but we have a wood frame house and I could hear the frame of the house shaking. ... I lay there long enough to realize it was an earthquake. I got up and I was relieved when it stopped" (Brookhaven National Laboratory, 2005).

January 10, 2003: The Lamont Doherty Cooperative Seismographic Network (LCSN) of Columbia University detected a small earthquake of magnitude 1.2 on the Richter Scale around Greenburg, WC on January 10, 2003, at approximately 11:30 p.m. According to Lieutenant Arduino at the WC Department of Emergency Service, 5 people in Greenburg and a resident in Irvington, WC, NY felt the shock. Seismic observation from five stations put the epicenter at Hastings-On-Hudson, NY; 4 kilometers south of Irvington, NY or 1.3 kilometers southwest of Dobbs Ferry, NY, at a depth of 3 kilometers (Kim, 2003).

January 14, 2003: Mr. Kim of Lamont-Doherty, indicated that on January 14, 2003, a small earthquake of magnitude 1.4 on the Richter Scale occurred around Greenburgh, WC, NY. This event occurred very close to a similar sized shock that preceded this event (January 10, 2003). According to a resident in Hastings-on-Hudson, WC; "this shock was felt not as severe as the one on January 10th, but more rumbly." Seismic observation from seven stations in the area put the epicenter at about 2 kilometers southeast of Hastings-On-Hudson; about 3 kilometers south of Dobbs Ferry; 7 kilometers northeast of Yonkers, NY, and at a depth of about 3.5 kilometers from the surface (Kim, 2003).

Probability of Future Events

Earthquake hazard maps illustrate the distribution of earthquake shaking levels that have a certain probability of occurring over a given time period. Figure 5-36 illustrates that in WC, there is a 10% chance of 5-6%g being exceeded over a 50-year period. Moderate shaking and very light damage is generally associated with a 5-6%g earthquake.

The NYS HMP indicates that based on historical information, "NYS can expect to experience damaging earthquake events on average only once every 22 years." These damaging earthquakes are more likely to occur in one of the three regions with higher seismic activity; WC is located in one of these regions. In addition, the NYS HMP discusses a study by W. Mitronovas, "Earthquake Hazard in New York State" that states "… at present an earthquake of magnitude 3.5 to 4 occurs, on the average every 3 years somewhere in the State. Such earthquakes do not cause any appreciable damage (except for cracks in plaster, perhaps) but are large enough to be felt strongly by many people near the epicenter."

Earlier in this section, the identified hazards of concern for the Village were ranked. The NYS Plan conducts a similar ranking process for hazards that affect the State. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and input from the Planning Committee, the probability of occurrence for earthquakes in the Village is considered occasional (likely to occur less often than once every 5 years, but more often that once every 30 years, as presented in Table 5-4). It is estimated that WC and all of its jurisdictions, will experience earthquakes that may affect the general building stock, local economy and may induce secondary hazards such ignite fires and cause utility failure.

VULNERABILITY ASSESSMENT

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the earthquake hazard, the entire Village has been identified as the exposed hazard area. Therefore, all assets in the Village (population, structures, critical facilities and lifelines), as described in the Village Profile section, are vulnerable. The following text evaluates and estimates the potential impact of the earthquake on the Village including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact, including: (1) impact on life, safety and health of Village residents, (2) general building stock, (3) critical facilities and infrastructure, and (4) economy
- Impact on new buildings, critical facilities and infrastructure
- Further data collections that will assist understanding of this hazard over time
- Overall vulnerability conclusion

Overview of Vulnerability

Earthquakes usually occur without warning and can impact areas a great distance from their point of origin. The extent of damage depends on the density of population and construction in the area shaken by the quake. Some areas may be more vulnerable than others based on soil type, the age of the buildings and building codes in place. Compounding the potential for damage – historically, Building Officials Code Administration (BOCA) used in the Northeast were developed to address local concerns including heavy snow loads and wind; seismic requirements for design criteria are not as stringent compared to the west coast's reliance on the more seismically-focused Uniform Building Code). As such, a smaller earthquake in the Northeast can cause more structural damage than if it occurred out west.

The entire inventory of the Village is at risk of being damaged or experiencing losses due to impacts of an earthquake. Potential losses associated with the earth shaking were calculated for the Village for three probabilistic earthquake events, the 100-year, 500- and 2,500-year MRP earthquake events. The impacts on population, existing structures, critical facilities and the economy are presented below, following a summary of the data and methodology used.

Data and Methodology

After reviewing historic data, the HAZUS-MH methodology and model were used to analyze the earthquake hazard for the Village. Data used to assess this hazard include data available in the HAZUS-MH earthquake model, USGS data, professional knowledge, information provided by the Village's Planning Committee, and input from public citizens.

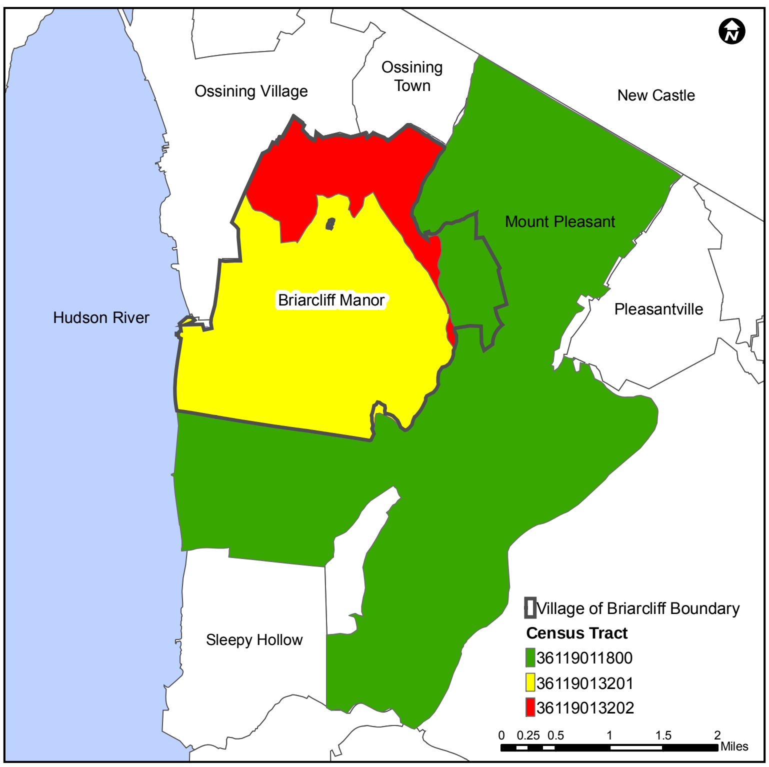
Earthquake and inventory data available in HAZUS-MH were used to evaluate potential losses. A probalistic assessment was conducted for three return periods, 100-, 500- and 2,500-year, to provide a range of potential earthquake loss estimates. A 100-year MRP means there is 1% chance that the mapped ground motion levels (PGA) will be exceeded in any given year. For a 500-year MRP, there is a 0.2% chance the mapped PGA will be exceeded in any given year; and for a 2,500-year MRP, there is a 0.04% chance the mapped PGA will be exceeded in any give year. For HAZUS ground failure estimates, the magnitude in all cases was set at 7.0.

The NEHRP soil classification of D was used as the default soil type across the study region. WC mainly contains soil classifications B, C and D, with D being the most vulnerable to earthquake impacts; therefore, selecting D is a conservative approach to the risk assessment.

Other than data for critical facilities, the default data in HAZUS-MH was the best available for use in this evaluation. The occupancy classes available in HAZUS-MH were condensed into the following categories (residential, commercial, industrial, agricultural, religious, government, and educational) to facilitate the analysis and the presentation of results. Residential loss estimates address both multi-family and single family dwellings. Impacts to critical facilities were also evaluated. In addition, the 36 structural building classifications available in HAZUS-MH were condensed into the following categories (wood, concrete, reinforced and un-reinforced masonry, steel, and mobile homes).

It should be noted that the earthquake model is run at the Census tract level. The three Census tracts that encompass the Village also include a portion of the Town of Mount Pleasant defining the study region in HAZUS-MH (see Figure 5-46). Therefore, the general building stock used by the earthquake model includes that portion of the building stock within the Census tract including the Town of Mount Pleasant. The data at the Census-block level in HAZUS-MH estimates that there are 2,433 structures in the Village, whereas the earthquake model based on Census tract estimates there are 3,808 structures in the study region evaluated (a +35.8% difference). Using all three Census tracts in the earthquake model is a conservative approach to estimating losses for the Village.

Figure 5-46. Census Tracts for the Village of Briarcliff Manor



Source: HAZUS-MH

Impact on Life, Health and Safety

Overall, the impact of earthquakes on life, health and safety is dependent upon the severity of the event. Risk to public safety and loss of life from an earthquake in this area is minimal with higher risk occurring in buildings as a result of damage to the structure. Residents may be displaced or require temporary to long-term sheltering. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. According to the 2000 Census, 14.7% of the Village's total population is 65 years of age and above. Few manufactured homes (trailer homes) are located in the area; citizens living in these types of structures are particularly vulnerable.

100-Year MRP Event – For a 100-year MRP event, HAZUS-MH estimates no households will be displaced or require temporary shelter. Fires often occur after an earthquake and can be difficult to control due to the shear number and lack of available water. HAZUS-MH does not estimate there will be any ignitions of buildings in the Village associated with this earthquake event.

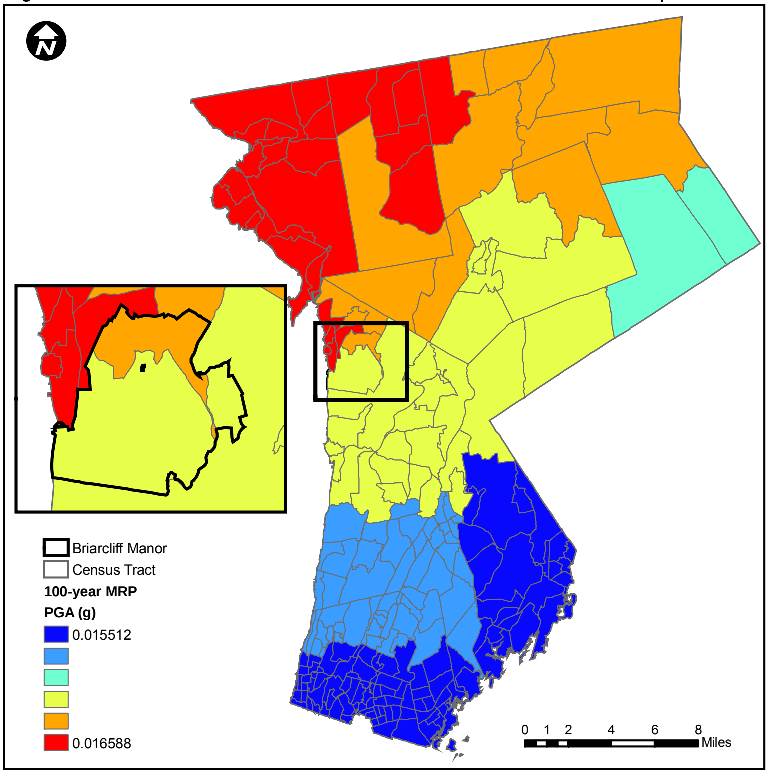
500-Year MRP Event – For a 500-year MRP event, HAZUS-MH estimates that one household will be displaced and zero people will seek temporary shelter in public shelters. The number of people requiring shelter is generally less than the number displaced as some displaced persons use hotels or stay with family or friends following a disaster event. HAZUS-MH estimates that five people will require medical attention due to earthquake-related injuries, but none will require hospitalization.

2,500-Year MRP Event – For the 2,500-year MRP event, HAZUS-MH estimates that 38 households will be displaced due to the earthquake with seven people requiring temporary shelter. The model estimates 59 people will be injured and require medical attention, with 16 people suffering injuries that require hospitalization. The model estimated approximately three casualties.

Impact on General Building Stock

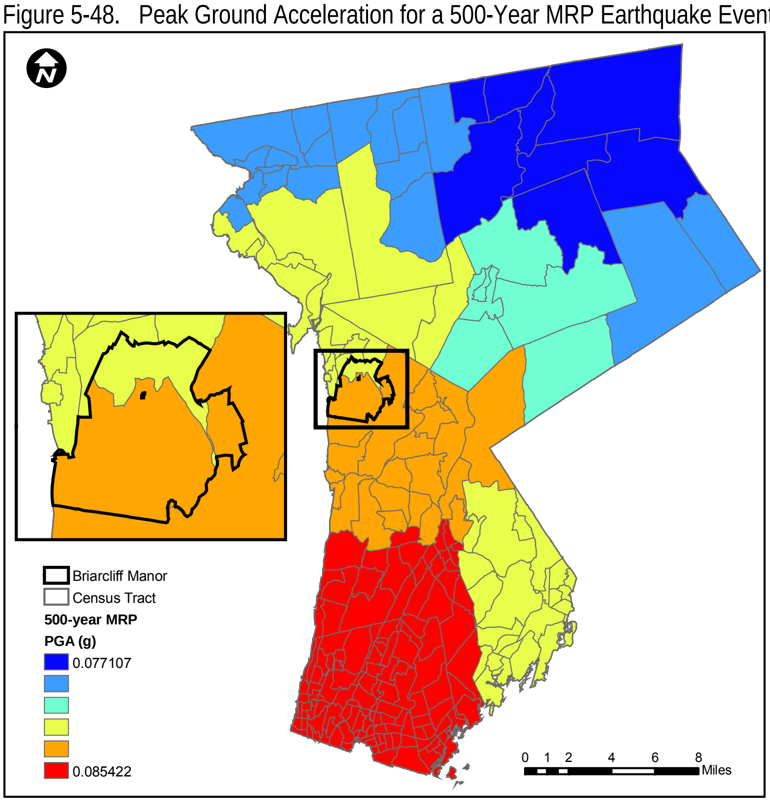
Most damage and loss caused by an earthquake is directly or indirectly the result of ground shaking (NYCEM, 1999). As discussed earlier, PGA is a measure of ground motion as a percentage of the force of gravity and can serve as a good index of a hazard event's potential impact on buildings. NYCEM indicates there is a strong correlation between PGA and the damage a building might experience. The HAZUS-MH model is based on the best available earthquake science and aligns with these statements. HAZUS-MH methodology and model were used to analyze the earthquake hazard for the general building stock for the Village. Figures 5-47 through 5-49 illustrate the geographic distribution of PGA across WC for a 100-, 500- and 2,500-year MRP.

Figure 5-47. Peak Ground Acceleration for a 100-Year MRP Earthquake Event



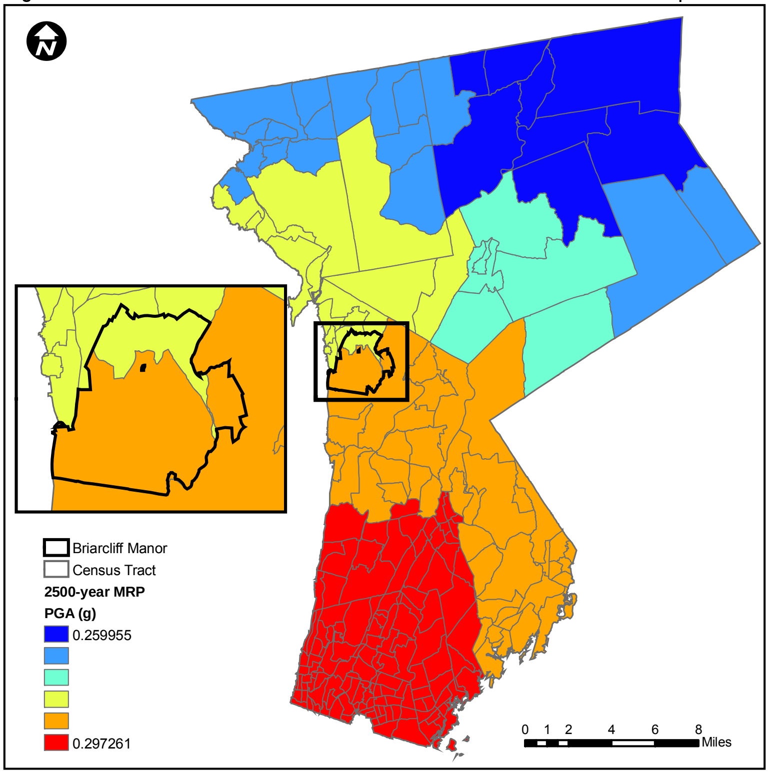
Source: HAZUS-MH

Figure 5-48. Peak Ground Acceleration for a 500-Year MRP Earthquake Event



Source: HAZUS-MH

Figure 5-49. Peak Ground Acceleration for a 2,500-Year MRP Earthquake Event



Source: HAZUS-MH

After considering the population exposed to the earthquake hazard, the value of general building stock exposed to, and damaged by, 100-, 500- and 2,500-year MRP earthquake events was evaluated. The entire study area's general building stock is considered at risk. HAZUS-MH considers the age of buildings as part of the analysis. HAZUS-MH estimates that approximately 60% of the general building stock in the study region was built prior to 1970. The model estimates the value of the exposed building stock and the loss (in terms of damage to the exposed stock). Table 5-31 presents the total exposure value for general building stock by occupancy class evaluated by the earthquake model at the Census-tract level. Refer to Table 4-2 for general building stock data at the Census-block level. Using all three Census tracts in the earthquake model is a conservative approach to estimating losses for the Village.

Table 5-31. Building Stock Exposure by Occupancy Class for the Village of Briarcliff Manor Evaluated by the HAZUS-MH Earthquake Model

Building Occupancy Class	Number of Buildings	Exposure Value	Percent of Total Exposure Value
Residential	3,769	$1,074,198,000	92.2%
Commercial	36	$70,546,000	6.05%
Industrial	0	$5,593,000	0.5%
Agricultural	0	$576,000	0.05%
Religious	1	$4,121,000	0.4%
Government	2	$2,253,000	0.2%
Educational*	0	$7,558,000	0.6%

Sources: Data presented is HAZUS-MH provided data (2005). Notes: Exposure value is structure only. *HAZUS-MH default data indicates there are no educational buildings present in the three Census tracts but assigns an exposure value of greater than $7.5million to this occupancy class. There are 5 schools located in the Village.

According to NYCEM, a building's construction determines how well it can withstand the force of an earthquake. The NYCEM report indicates that un-reinforced masonry buildings are most at risk during an earthquake because the walls are prone to collapse outward, whereas steel and wood buildings absorb more of the earthquake's energy. According to the HAZUS-MH default inventory, 14 percent of the general building stock in the three Census tracts within the study region is un-reinforced masonry with an estimated exposure value of $167,402,900. Table 5-32 presents the percentage of each building type in the study region as generated by HAZUS-MH. Note these values include a portion of the Town of Mount Pleasant's general building stock.

Table 5-32. Building Stock Exposure by Occupancy Class for the Village of Briarcliff Manor Evaluated by the HAZUS-MH Earthquake Model

Building Type	Percentage of Total
Wood	83%
Steel	< 1%
Concrete	1.5%
Un-reinforced Concrete	< 1%
Reinforced Masonry	< 1%
Un-reinforced Masonry	14%
Mobile Homes	< 1%
TOTAL	**100%**

Sources: Data presented is HAZUS-MH (2005).

Table 5-33 summarizes the building damage estimated for the 100-, 500- and 2,500-year MRP earthquake event (rounded to the nearest thousand dollars).

Table 5-33. Total Building Value Damaged by the 100-, 500- and 2,500-Year MRP Earthquake Events in Village of Briarcliff Manor

Building Occupancy Class	Building Loss (Structural Damage Only)		
	100-Year Event	500-Year Event	2,500-Year Event
Residential	$0	$871,200	$9,096,630
Commercial	$0	$90,010	$1,067,890
Industrial	$0	$5,810	$7,263
Agricultural	$0	$1,440	$17,800
Religious	$0	$5,650	$59,020
Government	$0	$2,220	$31,450
Education	$0	$8,820	$108,350
TOTAL	$0	$985,150	$10,388,403

Sources: Data presented is HAZUS-MH provided data (2005). Note: Building loss is structure damage only and does not include non-structural damage, content damage or inventory losses.

Expected building damage was evaluated by HAZUS-MH across the following damage categories (none, slight, moderate, extensive and complete). Table 5-34 provides definitions of these five categories of damage for a light wood-framed building; definitions for other building types are included in HAZUS-MH documentation. General building stock damage for these damage categories by occupancy class and building type is summarized for the 100-, 500- and 2,500-year events in Tables 5-35 and 5-36.

Table 5-34. Example of Structural Damage State Definitions for a Light Wood-Framed Building

Damage Category	Description
Slight	Small plaster or gypsum-board cracks at corners of door and window openings and wall-ceiling intersections; small cracks in masonry chimneys and masonry veneer.
Moderate	Large plaster or gypsum-board cracks at corners of door and window openings; small diagonal cracks across shear wall panels exhibited by small cracks in stucco and gypsum wall panels; large cracks in brick chimneys; toppling of tall masonry chimneys.
Extensive	Large diagonal cracks across shear wall panels or large cracks at plywood joints; permanent lateral movement of floors and roof; toppling of most brick chimneys; cracks in foundations; splitting of wood sill plates and/or slippage of structure over foundations; partial collapse of room-over-garage or other soft-story configurations.
Complete	Structure may have large permanent lateral displacement, may collapse, or be in imminent danger of collapse due to cripple wall failure or the failure of the lateral load resisting system; some structures may slip and fall off the foundations; large foundation cracks.

Source: HAZUS-MH, 2005

Table 5-35. Estimated Number of Buildings Damaged by General Occupancy for 100-year, 500-year and 2,500-year MRP Earthquake Events

Category	Average Damage State														
	100-Year MRP					500-Year MRP					2,500-Year MRP				
	None	Slight	Moderate	Extensive	Complete	None	Slight	Moderate	Extensive	Complete	None	Slight	Moderate	Extensive	Complete
Residential (Single and Multi-Family Dwellings)	3,769	0	0	0	0	3,538	180	44	6	1	2,361	909	387	91	22
Commercial Buildings	36	0	0	0	0	32	2	1	0	0	16	8	8	3	1
Industrial Buildings	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Education, Government, Religious and Agricultural Facilities	3	0	0	0	0	3	0	0	0	0	2	0	0	0	0
TOTAL*	**3,808**	**0**	**0**	**0**	**0**	**3,573**	**182**	**45**	**6**	**1**	**2,379**	**917**	**395**	**94**	**23**

Source: HAZUS-MH, 2005. *There are approximately 2,443 structures in the Village of Briarcliff Manor. This value includes a portion of the building stock located in the Town of Mount Pleasant.

Table 5-36. Estimated Number of Buildings Damaged by Building Type for 100-year, 500-year and 2,500-year MRP Earthquake Events

Category	Average Damage State														
	100-Year MRP					500-Year MRP					2,500-Year MRP				
	None	Slight	Moderate	Extensive	Complete	None	Slight	Moderate	Extensive	Complete	None	Slight	Moderate	Extensive	Complete
Wood	3,177	0	0	0	0	3,043	119	14	1	0	2,140	768	242	25	1
Steel	24	0	0	0	0	22	1	1	0	0	11	5	6	2	0
Concrete	53	0	0	0	0	44	4	1	0	0	22	12	13	5	0
Reinforced Masonry	10	0	0	0	0	9	0	0	0	0	5	2	2	1	0
Un-reinforced Masonry	541	0	0	0	0	450	57	28	6	1	198	131	131	60	21
Mobile Homes	4	0	0	0	0	3	1	0	0	0	1	1	1	0	3
TOTAL*	**3,808**	**0**	**0**	**0**	**0**	**3,571**	**182**	**44**	**7**	**1**	**2,377**	**919**	**395**	**93**	**25**

Source: HAZUS-MH, 2005. *There are approximately 2,443 structures in the Village of Briarcliff Manor. This value includes a portion of the building stock located in the Town of Mount Pleasant.

Generally, residential buildings account for most of the damage for earthquake events (greater than 90% for the 500- and 2,500-year MRP events). This is likely because they comprise the majority of the building inventory and because residential structure building construction is generally more susceptible to earthquake damage than commercial and industrial structures.

Impact on Critical Facilities and Infrastructure

100-Year MRP Event – With regard to critical facilities, HAZUS-MH estimates that the fire stations, police station, and EMS facility have a 1.4% chance of suffering slight structural damage and 0.04% chance of suffering moderate structural damage. These facilities are estimated to be nearly 100% functional following the 100-year MRP earthquake event. HAZUS-MH estimates that schools, senior care facilities, and the DPW building have a 0.3% chance of suffering minor structural damage with essentially no loss of use. Therefore, the impact to critical facilities is not significant for the 100-year event.

500-Year MRP Event – HAZUS-MH estimates that the fire stations, police station, and EMS facility in the Village have a 7.6% change of suffering slight structural damage and a 3.0% chance of suffering moderate structural damage. These facilities are estimated to be functioning at 90% capacity within 1 week of the earthquake event. HAZUS-MH estimates that schools, senior care facilities, and the DPW building have an estimated 8% change of suffering slight structural damage and a 3% chance of suffering moderate structural damage. On the day of the earthquake, the model estimates functionality at nearly 90% for these facilities.

2,500-Year MRP Event – HAZUS-MH estimates that the fire stations, police station and EMS facility have a 25.7% chance of suffering moderate structural damage and a 4.9% chance of suffering complete damage. Within 1 week of the event, these facilities are estimated to be approximately 50% functional. HAZUS-MH estimates that schools, senior care facilities, and the DPW building have an estimated 21.6% chance of suffering structural damage with an estimated 2% chance of complete destruction. On the day of the earthquake, the model estimates functionality at less than 50%; within one month, HAZUS-MH estimates that facility functionality will return to approximately 90%.

Transportation lifelines are considered vulnerable to ground failure associated with earthquake events. Sufficient information was not available (i.e., ground failure maps) to compute and estimate damages to road segments and railroad tracks in HAZUS-MH. Over time, if such maps become available, additional modeling could be implemented. Utility structures also could suffer damage (i.e., pipeline leaks/breaks) resulting in the loss of power and potable water to residents. Damage to the utility lifeline systems can impact business operations and heating or cooling provision to citizens (including the young and elderly, who are particularly vulnerable to temperature-related health impacts). For this risk assessment, ground failure data and utility structure detail were not sufficient to model losses in this area. Over time if such data become available, additional modeling could be implemented.

Impact on Economy

Earthquakes also have impacts on the economy, including: loss of business function, damage to inventory, relocation costs, wage loss and rental loss due to the repair/replacement of buildings. HAZUS-MH estimates the total economic loss associated with each earthquake scenario, which includes building- (direct building losses and business interruption losses) and lifeline-related losses based on the available inventory. Direct building losses are the estimated costs to repair or replace the damage caused to the building. This is reported in the Impact on General Building Stock section discussed earlier. Business interruption losses are the losses associated with the inability to operate a business because of the damage sustained during the earthquake. Lifeline-related losses include the direct repair cost to transportation and utility systems. HAZUS-MH also estimates that the long-term indirect economic impacts to the region for up to 15 years after the event.

HAZUS-MH does not estimate that any economic loss will occur for the 100-year MRP earthquake event. For the 500-year MRP earthquake event, HAZUS-MH estimates a loss of $5.24 million dollars for the study region (three census tracts); a majority of which is associated with direct building losses (mainly residential loss). Nine percent of the estimated losses were related to business interruption in the study region. HAZUS-MH does not estimate any transportation or utility-related losses. HAZUS-MH estimates that there will be no long-term economic impact to the Village in terms of employment and income associated with a 500-year MRP event.

The total economic loss estimated for a 2,500-year MRP earthquake event is $72 million, which includes building- and lifeline-related losses for the study region. Similar to the 500-year earthquake event, a majority of the economic losses sustained for the 2,500-year event is associated with direct building-related losses. The largest lost is sustained by the residential occupancies (approximately 85%). HAZUS-MH estimates 8% of the total economic loss is related to business interruption in the region. There are no losses computed by HAZUS-MH for business interruption due to lifeline outages. It is estimated the Village will suffer minimal long-term economic loss (employment and income) as a result of a 2,500-year event.

Impact on New Buildings, Critical Facilities and Infrastructure

As identified in Section 4, "Village Profile – Future Development", at this time the Village anticipates residential and limited business development within the Scarborough Road Corridor. It may be assumed that any buildings, facilities or infrastructure improvements in this area will be vulnerable to impacts from earthquakes, similar to existing conditions within the Village.

Additional Data and Next Steps

A Level 1 HAZUS analysis was conducted for the Village using the default data, with the exception of the critical facility inventory. For future plan updates, a Level 2 HAZUS analysis can be conducted if additional, locally-generated data become available. Such data would include: (1) local soil type data to replace the default assumption; (2) demographic and building stock data to refine or update the default data; (3) soil liquefaction data; and (4) utility line and equipment data sufficient to support utility modeling. If additional, refined local data become available, the modeling assumptions could be refined over time and the analysis could also be refined. Data that will support the refined analysis would include information on particular buildings or infrastructure including their age, construction, and value. Additionally, utility data would support an improved assessment of potential damage for this infrastructure category. Soil data would also be valuable. Details on past hazard events and impacts, additional information on estimated frequency of these events, and future data regarding events and damages as they occur would also support this analysis.

Overall Vulnerability Assessment

The Village is located in an area of moderate seismic activity. Earthquakes are occasional events in the study area, causing minor impacts and losses mainly to the Village's structures and facilities. Existing and future mitigation efforts should continue to be developed and employed that will enable the study area to be prepared for these events when they occur. The overall hazard ranking determined by the Planning Committee for this hazard is "low" (see Table 5-7).