EARTHQUAKE LOSS ESTIMATION STUDY FOR MONMOUTH COUNTY, NEW JERSEY:

GEOLOGIC COMPONENT

Prepared for the
New Jersey State Police
Office of Emergency Management

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CONTENTS

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Summary

Geologic, topographic, and test-boring data were acquired and analyzed in order to map seismic soil class, liquefaction susceptibility, and landslide susceptibility for Monmouth County (see map plates at end of document). The soil class, liquefaction susceptibility, and landslide susceptibility data were entered into the HAZUS earthquake-simulation model for each census tract in the county (Appendix A). The HAZUS model was run with these upgraded geologic data for earthquakes with magnitudes of 5, 5.5, 6, 6.5, and 7, with epicenters at the county centroid. As a comparison, the HAZUS model was run with its prepackaged geologic data (referred to henceforth as *default* data) at magnitudes of 5.5 and 6. The HAZUS model was also run for expected ground motion with return periods of 500, 1000, and 2500 years, based on probabilistic analysis of regional earthquake history. Each of these runs was made with both upgraded and default geologic data. Selected outputs from these runs are attached in Appendices B through T.

Soils over most of Monmouth County are equal to or weaker than the default classification, so damage estimates from runs using upgraded geology are greater than from runs using default geology. In a few census tracts damage is greater with the upgraded geology because soils are more prone to liquefaction, and hillslopes are more prone to landslides, than indicated by default data. Total economic loss ranges from a low of $0.6B at M5 to a high of $53B at M7. Damage and economic loss for an M5 earthquake at the county centroid are similar to those from the 1000-year return period probabilistic run, indicating that there is a 5% chance of an M5 earthquake occurring in the county in any 50 year period, based on the history of known earthquakes in the region.

In addition to the HAZUS data upgrades and runs, shear-wave velocity was measured on five soil types (Cape May Formation, Cohansey Formation, Kirkwood Formation, sand bedrock, and clay bedrock) at a total of 15 locations (Appendix U). These measurements were made to check the soil-class assignments, which use test-drilling data as a proxy for shear-wave velocity. The measured velocities generally confirmed the assignments.

Geologic Setting

Geologic materials in Monmouth County include surficial deposits and Coastal Plain bedrock formations. Surficial deposits (fig. 1) are sediments laid down within the past 10 million years. They overlie the bedrock formations and include river sediments laid down in terraces and floodplains in valleys; older river deposits that form upland gravels, the Pensauken Formation, and the Beacon Hill Gravel; modern estuary, wetland, and beach sediments; older estuarine and beach sediments that form the Cape May Formation; and hillslope deposits. Surficial deposits are generally less than 25 feet thick, except in estuaries and on Sandy Hook, where they are as much as 240 feet thick. The distribution and thickness of these surficial materials were mapped between 1990 and 2008 at 1:24,000. Map references are listed on the plates at the end of the document.

Coastal Plain bedrock formations (fig. 2) are layered, unconsolidated sand, clay, and silt laid down in marine and coastal settings in the Cretaceous and Tertiary periods, between 90 and 10 million years ago. The layers dip to the southeast and crop out as belts running northeast-southwest across the county. Their total thickness ranges from about 500 feet along the northwest border of the county to about 1500 feet in the southeast corner (Volkert and others, 1996). They are divided into 17 formations based on their composition and age. The mineral glauconite, a greenish clayey mineral deposited in continental-shelf settings, is a distinguishing feature of several formations, including the Merchantville, Marshalltown, Navesink, Hornerstown, Manasquan, and Shark River formations, all of which have high (>30% by volume) glauconite content. These formations have physical properties like clays, even though the glauconite generally occurs in sand-sized grains. Other formations, like the Wenonah, Mount Laurel, Red Bank, Tinton, and Vincentown, are quartz sand with between 5 and 15% glauconite. The Magothy, Englishtown, Kirkwood, and Cohansey formations are quartz sands with little to no glauconite. The Woodbury is nonglauconitic clay. All of the formations are locally cemented or hardened by iron deposition, which is especially pronounced in the Tinton and Red Bank formations. The bedrock formations are mapped at 1:24,000 for most of the county. Map references are listed on the plates at the end of the document. Areas not covered by the 1:24,000 maps are shown on Owens and others (1998) at 1:100,000.

Penetration-Test Data

Shaking behavior and liquefaction susceptibility of soils are determined by their grain size, thickness, compaction, and degree of saturation. These properties, in turn, are determined by the geologic origin of the soils and their topographic position. Soils can be classed into the HAZUS categories using Standard Penetration Test (SPT) data, which are acquired during the drilling of test borings. SPT tests report the number of blows of a 140-pound hammer falling 30 inches that are required to drive a sampling tube 12 inches into the test material. The borings were geographically located and classified in the appropriate geologic units based on geologic-map data and log descriptions. Most borings penetrated more than one soil type. For these borings the layered geologic units were identified and the penetration tests were classed in the appropriate soil type. The mean SPT value and standard deviation were calculated for each soil

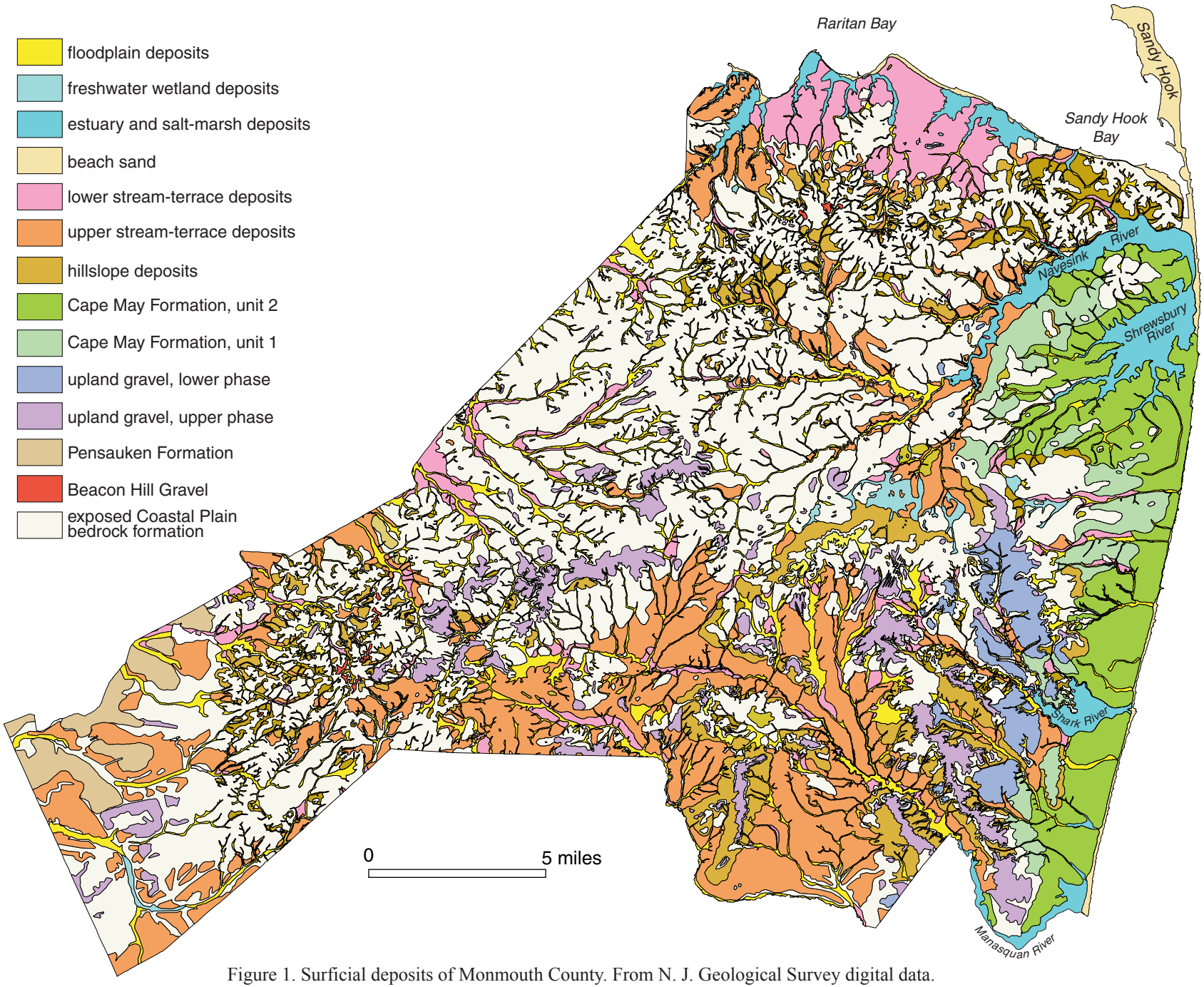


Figure 1. Surficial deposits of Monmouth County. From N. J. Geological Survey digital data.

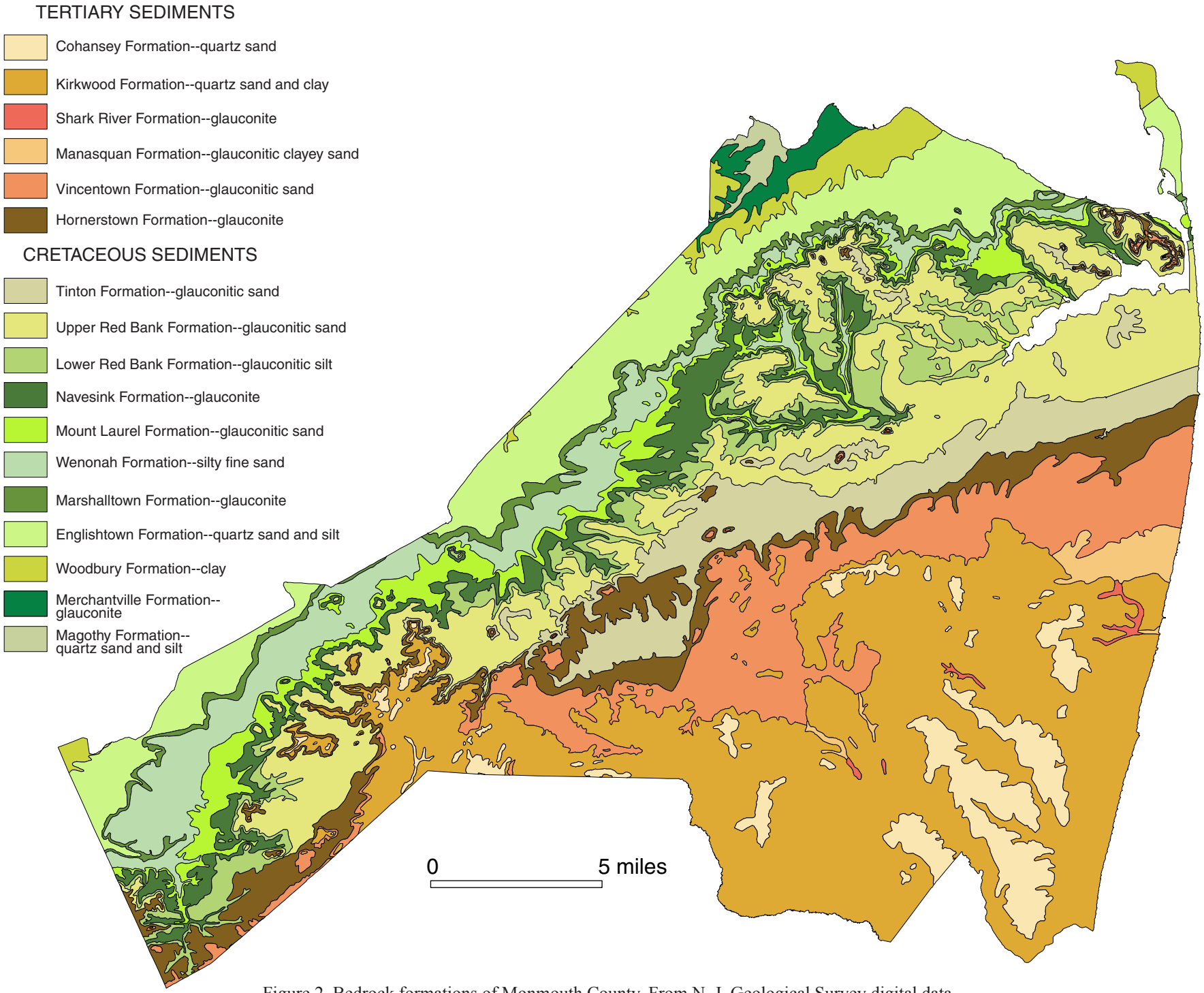


Figure 2. Bedrock formations of Monmouth County. From N. J. Geological Survey digital data.

type.

Table 1. Penetration-test data for Monmouth County.

soil type	number of tests	number of borings	mean±standard deviation	range	percent refused (SPT>100)[1]	percent 0 SPT[2]
fill	114	37	28±21	2-85	0%	0%
Cape May Formation	287	71	31±30	1-198	3%	0%
estuary and salt-marsh deposits	89	20	8±6	0-22	0%	8%
stream-terrace deposits	181	57	18±15	0-88	0%	1%
Woodbury Formation	138	21	40±24	9-122	4%	0%
Cohansey Formation	132	21	44±33	2-166	10%	0%
Kirkwood Formation	534	98	31±31	2-212	0.6%	0%
glauconitic sand bedrock[3]	590	104	44±37	2-295	11%	0%
Vincentown Formation	347	62	21±16	2-115	1%	0%
glauconite clay bedrock[4]	63	11	28±18	1-86	0%	0%

[1]For these tests, the sampling tube failed to advance 6 inches after 100 blows of the hammer. In some tests, hammering continued past 100 blows until the tube was advanced 6 inches. In these cases, the full blow count was included in the data set even if it exceeded 100 blows per 6 inches.
[2]For these tests, the sampling tube was advanced 12 inches by the weight of the hammer or the weight of the drill rods alone, with no blows on the hammer.
[3]Includes Wenonah, Mount Laurel, Navesink, Red Bank, and Tinton formations.
[4]Includes Manasquan and Shark River formations.

Estuarine and salt-marsh deposits have low penetration resistance because they have been continuously saturated since their deposition, contain much soft organic matter, and have not supported sediment or water loads greater than at present, and so have not been preconsolidated. The mean SPT value of these deposits in Monmouth County (8±6) is slightly higher than that for the same deposits in Middlesex (3±5), Essex-Hudson (3±4), and Union (0.25±0.7) counties (Stanford and others, 2001, 2002, 2003), and the percentage of zero values (8%) is much less than in the other counties (48%, 46%, 97%, respectively). The increased resistance in Monmouth County may reflect the greater sand content in estuarine sediments here. Sand is more abundant in the Monmouth County deposits because waves and currents are more active along the Atlantic coast than in the more inland settings of salt marshes in the other counties.

Two other surficial deposits with penetration-test data are the Cape May Formation and stream-terrace deposits. Both are predominantly sand with some gravel. The stream-terrace deposits have a lower mean SPT (18±15) than the Cape May (31±20), perhaps because they are generally thinner and have had less surface erosion, and so are less compacted by the weight of overlying material. Stream-terrace deposits in Middlesex County have a greater mean SPT (32±29) than those in Monmouth because the sampled deposits in Middlesex are primarily along the Raritan River and these sediments are more gravel-rich than those in Monmouth County. The Cape May Formation does not occur in any of the counties where HAZUS studies have been completed to date.

The other soil types are all Coastal Plain bedrock formations. The Woodbury, Cohansey, Kirkwood, and glauconitic sand formations all have similar mean SPT values and ranges. The wide SPT range in these units, and the elevated number of refusals, reflects the presence of iron-cemented beds and masses. The Vincentown and glauconite clay formations have a somewhat lower mean SPT and lesser range because there is less iron cementation in these units. Comparable Coastal Plain bedrock formations in Middlesex County have slightly higher SPT values (51±45 for clay formations, 57±51 for sand formations) than those in Monmouth. The sampled units in Middlesex County were more deeply buried by overlying sediments than those in Monmouth County, and have been more recently uncovered by erosion, and so have had less time to become decompacted by weathering.

Shear-wave Velocity Measurements

To test the accuracy of using SPT tests as a proxy for shear-wave velocity, and to obtain data for deposits lacking SPT tests, seismic velocities were collected at 15 sites in Monmouth County. The tested soil types include Cape May Formation (3 sites), Cohansey Formation (3 sites), Kirkwood Formation (3 sites), sand bedrock of the Englishtown and upper Red Bank formations (3 sites), and clay bedrock of the lower Red Bank and Hornerstown formations (table 2). The measurements were made at sites where the natural deposit was undisturbed and not covered or mixed with man-made fill. At each site, holes were hand-augered to a depth of 5 feet to test for soil disturbance and fill.

The seismic data were collected using a Bison 9000 digital engineering seismograph. Both shear (S) wave (horizontal component) and compression (P) wave data were acquired (Appendix U). P waves are much faster than shear waves and help in isolating the shear-wave signal in the seismic record. To measure P and S velocities, twelve P-wave geophones and twelve S-wave geophones were planted along the survey line at intervals of 6 feet. The source was located 6 feet from the first geophone. For the S-wave measurement, each geophone was oriented with its axis of movement parallel to the generating source. The S-wave source is a 6-inch channel-steel beam that is 5 feet long and has triangular teeth welded to the bottom. A 10-pound sledgehammer is used to impact either side of the source. Two people stand on the source to improve ground coupling while it is hammered. For the P-wave measurement, 8-hertz geophones are used. A 10-pound sledgehammer impacting a strike plate is the source.

The first seismic break on the arrival records from both the S and P data is picked for each geophone and marks the arrival of the seismic wave at the geophone. The regression velocity is calculated using the inverse slope on the time-distance curves. The data are also

presented numerically as the interval velocity between consecutive geophones along each line and as an average of the interval velocities (Appendix U). This is done to check for lateral velocity variation along each seismic line. A large difference between the average velocity and the regression velocity is indicative of lateral heterogeneity within the soil. The regression velocity is statistically more accurate as a bulk soil property.

Table 2 shows that seven of the fifteen sites had two layers, and one site had three layers, that were detectable from shear-wave velocities. At each of these eight sites, P-wave data (Appendix U) also detect two layers, which likely correspond to unsaturated sediment with slower P-wave velocity overlying saturated sediment with faster P-wave velocity. The boundary of these two layers is the water table. Shear-wave velocity does not change with water content of soils because liquids do not transmit shear waves. However, the water table commonly corresponds to a horizon of iron deposition, which hardens the formation and will increase shear-wave velocity. Thus, shear-wave data will record the water table by proxy at sites with iron hardening. At two sites (Palaia Park and Nomoco) the depth of the boundary between layer 1 and layer 2 is greater on the S-wave record than on the P-wave record, indicating that the S-wave data are recording a geologic contact between two formations rather than the water table. In both cases, geologic mapping indicates that the upper formation is thin (<20 feet thick) and overlies a faster material. At two other sites (Wreck Pond, Monmouth Park), P-wave data record the water table but S-wave data show only one layer. Both these sites are on the Cape May Formation, which has low iron content and does not generally exhibit iron deposition at the water table. At five sites (Francis Mill, Manasquan, Rising Sun, Route 537, Witches Hollow), there is only one layer in both P and S-wave data, indicating that the water table is deeper than signal penetration (except at the Route 537 site where hand-augering shows that it is very shallow) and that there is no geologic contact within the sampled depth (about 20-30 feet).

Table 2. Shear-wave velocity measurements. Complete data provided in Appendix U.

Site	Location (latitude; longitude)	Material	Measured shear-wave velocity (feet/second)	Shear-wave velocity range predicted from SPT data (feet/second)	Comments
Monmouth Park	40º18’06”; 74º01’31”	Cape May Formation	636	600-1200	agrees
Palaia Park	40º15’41”; 74º01’55”	Cape May Formation	1141 (layer 1) 3158 (layer 2)	600-1200	agrees (layer 1), layer 2 is iron-cemented Vincentown or Manasquan Formation
Wreck Pond	40º08’23”; 74º02’35”	Cape May Formation	729	600-1200	agrees
Allaire	40º08’04”; 74º08’50”	Cohansey Formation	1364 (layer 1) 1818 (layer 2)	600-1200	faster than predicted, possible iron cementation at contact with Kirkwood Formation
Francis Mill	40º10’58”; 74º23’09”	Cohansey Formation	752	600-1200	agrees

Manasquan	40º07’55”; 74º07’03”	Cohansey Formation	1282	600-1200	slightly faster than predicted
Nomoco	40º10’44”; 74º18’58”	Kirkwood Formation	1094 (layer 1) 2927 (layer 2)	600-1200	agrees (layer 1), layer 2 is iron cementation at contact with Vincentown Formation
Peskin	40º11’09”; 74º13’19”	Kirkwood Formation	759 (layer 1) 2123 (layer 2)	600-1200	agrees (layer 1), layer 2 is iron cementation?
Route 537	40º10’39”; 74º13’19”	Kirkwood Formation	624	600-1200	agrees
Iron Ore	40º16’55”; 74º13’27”	sand bedrock (Englishtown Formation)	690 (layer 1) 1227 (layer 2) 3125 (layer 3)	600-1200	agrees (layer 1), layer 2 is slightly faster than predicted, layer 3 is iron cementation?
Rising Sun	40º12’20”; 74º27’32”	sand bedrock (upper Red Bank Formation)	928	600-1200	agrees
Witches Hollow	40º13’14”; 74º27’32”	sand bedrock (upper Red Bank Formation)	1279	600-1200	slightly faster than predicted
Boundary	40º19’27”; 74º13’27”	clay bedrock (lower Red Bank Formation)	641 (layer 1) 1120 (layer 2)	600-1200	agrees
Burke	40º13’03”; 74º19’44”	clay bedrock (Hornerstown Formation)	916 (layer 1) 2295 (layer 2)	600-1200	agrees (layer 1), layer 2 is iron cementation
Elton	40º13’08”; 74º18’32”	clay bedrock (Hornerstown Formation)	1463 (layer 1) 2979 (layer 2)	600-1200	faster than predicted due to iron cementation

Velocities at thirteen of the fifteen sites agree with, or are negligibly faster than, the velocity range predicted from SPT data. Of the six of the fifteen sites with two or more layers, all but two have lower layers that are faster than predicted. These faster-than-predicted lower layers are likely due to iron-hardening, either in the sampled formation itself or, for example at Palaia Park and Nomoco, in a shallow underlying formation. At four of the thirteen sites (Manasquan, Nomoco, Rising Sun, Palaia Park) the data are of lesser clarity than at the other sites, and the faster lower layer may reflect interference from responses unrelated to the source impulse. Two sites (Allaire and Elton) have significantly faster-than-predicted velocities for both layer 1 and layer 2. Iron cementation was observed at the surface at the Elton site. No cementation was observed at the surface at the Allaire site but the Cohansey Formation here is underlain at shallow depth (about 20 feet) by the Kirkwood Formation, and there may be iron deposition above that contact.

Map Compilation

Seismic soil class (plate 1) was determined using the SPT data according to the procedures described in sections 4.1.2.1, 4.1.2.2, and 4.1.2.3 of the National Earthquake Hazards

Reduction Program (NEHRP) Provisions (Federal Emergency Management Agency, 1998). The mean SPT value from Table 1 was applied to the mapped extent of each soil type to a depth of 100 feet, and equation 4.1.2.3-2 of the NEHRP Provisions was used to assign soil class in cases where the upper 100 feet includes more than one geologic layer. This procedure indicates that salt-marsh and estuarine deposits, where they are more than 10 feet thick, and beach deposits that overlie estuarine deposits, are class E (soft soil). These soils occur along Raritan Bay, the Navesink and Shrewsbury rivers, and the tidal parts of the Shark and Manasquan rivers, and beneath Sandy Hook. Cretaceous sands and clays along the northwest border of the county are class C (very dense soil). These deposits are more compact than similar material elsewhere in the county because they were buried beneath overlying formations that only recently have been removed by stream erosion, and so have not had time to fully decompact. Recent stream erosion here is the result of glacial deepening of the Raritan valley about 20,000 years ago, which did not affect other parts of the county. Soils elsewhere in the county are all class D (stiff soil). Iron-cemented soils have SPT values and shear-wave velocities that classify them as C soils and, in some cases, B class soft rock, but iron-cemented zones are too small, discontinuous, and unpredictable to map and so a blanket D classification is more prudent.

Liquefaction susceptibility (plate 2) was mapped based on Table 9.1 of the HAZUS User's Manual (National Institute of Building Sciences, 1997), with some modifications to the classifications based on SPT data and field observations. Beach, salt-marsh, estuarine, and floodplain deposits have high susceptibility because they contain much fine sand and silt, are saturated, and are noncompact. Low stream-terrace deposits also contain silt and fine sand but are not as saturated and are somewhat more compact than floodplain deposits, and so are moderately susceptible to liquefaction. The Cape May Formation, which is a sand and gravel forming a marine terrace along the Atlantic shore, and high stream-terrace deposits, are drier, more gravelly, and more compact than the low stream terraces, and so have low susceptibility. All other soils in the county are even drier and more compact, and so have very low susceptibility.

Landslide susceptibility (plate 3) was mapped based on slope angle and the soil type underlying the slope, according to the classification in Table 9.2 of the HAZUS User's Manual (National Institute of Building Sciences, 1997). Slope angles were measured from U. S. Geological Survey 1:24,000 topographic quadrangles with 5, 10, or 20 foot contour interval. Soil type was determined from 1:24,000 geologic maps. Slopes susceptible to landslides include coastal bluffs along Raritan Bay, Sandy Hook Bay, and the Navesink River, scarps and banks along rivers and streams throughout the county, and hillslopes in the Atlantic Highlands, Mount Pleasant Hills, Clarksburg Hills, and uplands along the Atlantic coast in the southeastern part of the county. The steep coastal bluffs along Sandy Hook Bay in Highlands and Atlantic Highlands, and smaller bluffs along Raritan Bay at Cliffwood Beach and along the north shore of the Navesink River, are especially noteworthy because they have a history and prehistoric record of repeated failure (Minard, 1974). They are also developed, in part, on wet clay, and so fall into the highest hazard category (class "CX"). Some steep riverbanks in the Matawan area and along Lahaway and Crosswicks Creek in the westernmost part of the county are also in wet clay and so are in landslide class C but are much smaller than the coastal bluffs.

HAZUS Simulations

A total of nineteen simulations were run in order to estimate losses and damage from both specified earthquakes (known as *deterministic* runs) and from approximations of expected ground motion for given time intervals (known as *probabilistic* runs). Deterministic runs were made for earthquake magnitudes of 5, 5.5, 6, 6.5, and 7, with an epicenter at the centroid of the county. The selected magnitudes span the range of potential damaging earthquakes in the region. The largest local earthquake in historic records was an estimated magnitude 5.2 in 1884 with an epicenter offshore from Brooklyn, and earthquakes with magnitudes between 6 and 7 have been recorded or estimated from historical accounts in South Carolina, the Boston area, southern Quebec, and the St. Lawrence Valley. Upgraded soil, liquefaction, and landslide data were used for all runs; runs at magnitude 5.5 and 6 were also made with default geologic data as a comparison.

Probabilistic runs model the expected ground motion (peak ground acceleration and accelerations at specific vibration frequencies) that has a 2%, 5%, and 10% probability of being exceeded in 50 years (Frankel and others, 1997). These probabilities correspond to return periods of 2500, 1000, and 500 years, respectively. The runs are identified by these return periods (table 3 and Appendices I-T). The model is based on statistical smoothing of the location and intensity of historic earthquakes, so there are no specified epicenters or magnitudes for these runs. The magnitudes included with each probabilistic run (table 3) are used only as driving magnitudes for the calculation of liquefaction response and do not represent scenario earthquakes. The probabilistic runs assume that future earthquakes will have locations and magnitudes similar to historic earthquakes. In regions of infrequent earthquakes like the eastern United States this is a less reliable assumption than in areas of frequent earthquakes. Probabilistic runs were made with upgraded geology for return periods of 500, 1000, and 2500 years, with liquefaction-driving magnitudes of 5.5, 6, and 6.5 for each return period. Runs at each return period, at liquefaction-driving magnitude 6, were also made with default geologic data for comparison.

The geologic data were upgraded by modifying data fields for soil type, liquefaction susceptibility, and landslide susceptibility in the HAZUS model for each census tract using the seismic soil class, liquefaction susceptibility, and landslide susceptibility maps (plates at end of document). Some census tracts spanned two or more soil types. In these cases, the dominant soil under the most densely built part of the census tract was selected. Most census tracts spanned two or more liquefaction categories. Again, the dominant category under the most densely built part of the census tracts was selected. Areas subject to landslides cover only a small part of the census tracts that were assigned a landslide hazard. In these census tracts, however, buildings and local roads, and some highways, adjoin slopes that are landslide-prone, so the landslide hazard was included in the upgrade runs. The default geology assigned a uniform soil type (class D), and no liquefaction or landslide susceptibility, for the entire county. Maps of the upgraded and default geology, by census tract, are provided in Appendix A.

Building damage best illustrates the effect of geology on the simulations, because it does not directly incorporate economic and demographic patterns. Appendices B through T provide tables showing the number of the buildings (classed by use) in various states of damage. The appendices also provide maps showing the percent moderate or greater building damage by census tract for the various simulations. The moderate-or-greater cutoff was used because

buildings with moderate damage must be evacuated and inspected prior to reoccupancy. Thus, moderate damage requires significant population disruption and emergency response. A loss estimation sheet summarizing damage, economic loss, casualties, and population displacement for each HAZUS run is also provided. The total economic loss includes repair and replacement costs, contents damage, business inventory damage, relocation costs, capital-related income costs, wage loss, and rental loss. The economic loss, building damage, and displaced households estimates for each run are summarized in table 3.

Table 3. Comparison of total economic loss (TEL, in billions of dollars), major building damage (MBD, in thousands of buildings), and displaced households (DH, actual number of households requiring shelter) for the HAZUS runs (D=deterministic run, number is earthquake magnitude; P=probabilistic run, number is return period in years, M=driving magnitude for liquefaction). Total economic loss includes building damage plus loss of building contents plus loss due to business interruption. Major building damage includes buildings of any type damaged to the "extensive" and "complete" state.

Magnitude	default			full upgrade		
	TEL	MBD	DH	TEL	MBD	DH
D 5.0	-	-	-	0.6-2.3	0-2	400-1800
D 5.5	1.3-5.4	1-5	600-2000	1.9-7.5	3-14	2000-9000
D 6.0	3.7-14.9	6-30	3000-12,000	4.7-18.9	10-40	7000-27,000
D 6.5	-	-	-	8.8-35.2	19-80	13,000-52,000
D 7.0	-	-	-	13.4-53.4	30-120	20,000-81,000
P500 M5.5	-	-	-	0.1-0.4	<1	60-300
P500 M6	0.1-0.4	<1	60-300	0.1-0.6	0-1	170-700
P500 M6.5	-	-	-	0.2-0.6	0-1	200-900
P1000 M5.5	-	-	-	0.6-2.3	1-5	800-3000
P1000 M6	0.4-1.6	0-1	200-900	0.6-2.5	1-6	1100-4000
P1000 M6.5	-	-	-	0.7-2.7	1-6	1200-5000
P2500 M5.5	-	-	-	2-8.1	4-17	3000-12,000
P2500 M6	1.5-5.8	1-7	1100-5000	2.1-8.4	4-17	3000-14,000
P2500 M6.5	-	-	-	2.2-8.8	4-18	4000-15,000

Evaluation of Simulations

The deterministic runs produce significantly more damage that the probabilistic runs because the earthquakes in these runs are deliberately placed at the center of the county in order to simulate the range of maximum credible events. This approach is appropriate for emergency response planning, where extreme events should be considered. The probabilistic runs place Monmouth County within the regional picture of historically based ground motions, an approach appropriate for assessing and managing seismic risk and comparing it to other risks. The 1000-year probabilistic runs generate damage similar to that in the M5 deterministic run. This similarity indicates that an M5 earthquake centered in Monmouth County has about a 5% chance of occurring within any 50-year period, based on the historic earthquake record. However, because earthquakes of M5 or greater are extremely rare in the eastern United States, it is unlikely that the historic catalog of earthquakes has captured the full range of potential epicenter locations, so a greater than 5% probability of an earthquake of M5 or larger in or near Monmouth County in any 50-year period cannot be ruled out.

The upgraded geology produced more total damage that the default geology. This is because 1) two census tracts (in Highlands and Atlantic Highlands) were assigned an extremely high landslide susceptibility in upgrade runs, and 2) eighteen census tracts have moderate or high liquefaction susceptibility, compared to no susceptibility in default runs. The high landslide susceptibility has an especially dramatic effect on damage. For all deterministic runs of M5.5 and greater magnitude, and for the 2500-year probabilistic run, the model predicts that between 90 and 100% of buildings in the two census tracts with extremely high landslide hazard will be damaged to a moderate or greater extent. This is an overestimate, since most buildings in those tracts are not in susceptible locations, but does illustrate the potential hazard.

The effect of liquefaction is less pronounced, but covers more tracts. Generally, tracts with moderate liquefaction susceptibility, and a few with low susceptibility, show an increase of about 10% in damage in the upgrade runs, and tracts with high susceptibility show between 20 and 30% more damage, because the default case is no liquefaction susceptibility. In the probabilistic runs, no census tracts other than those with high landslide hazard, and the E-class soil beneath Sandy Hook, show more than 10% of buildings damaged to a moderate or greater state for 500 or 1000 year return periods. These tracts are closest to the M5.2 Brooklyn earthquake of 1884 and so experience the greatest probabilistic ground motion. For the 2500-year return period, about half of the census tracts in the county show between 10 and 20% of buildings damaged to a moderate-or-greater degree. Upgrade runs at the 2500-year return period, in addition to the greater damage on Sandy Hook due to E soil, and in the Atlantic Highlands due to landslides, show about 10% more damage than the default run for tracts with low or moderate liquefaction susceptibility. Varying the driving magnitude for liquefaction from 5.5 to 6 to 6.5 increases damage by 10% per step in the Atlantic Highlands for the 500-year return period, and in the Atlantic Highlands and Sandy Hook for the 1000-year return period, but has no effect elsewhere in the county for those periods. There is a negligible increase with increased magnitude for the 2500 year period for tracts with moderate liquefaction susceptibility.

References Cited (additional references listed on map plates)

Federal Emergency Management Agency, 1998, NEHRP recommended provisions for seismic

regulations for new buildings and other structures, part 1—provisions: prepared by the National Institute of Building Sciences, FEMA 302, p. 33-41.

Frankel, Arthur, Mueller, C., Barnhard, T., Perkins, D., Leyendecker, E. V., Dickman, N., Hanson, S., and Hopper, M., 1997, Seismic-hazard maps for the conterminous United States: U. S. Geological Survey Open-File Report 97-131, http://earthquake.usgs.gov/research/hazmaps/products_data/1996/natlmap.php

Minard, J. P., 1974, Slump blocks of the Atlantic Highlands of New Jersey: U. S. Geological Survey Professional Paper 898, 24 p.

National Institute of Building Sciences, 1997, HAZUS user's manual: Washington, D. C., National Institute of Building Sciences Publication 5200.

Owens, J. P., Sugarman, P. J., Sohl, N. F., Parker, R. A., Houghton, H. F., Volkert, R. A., Drake, A. A., Jr., and Orndorff, R. C., 1998, Bedrock geologic map of central and southern new Jersey: U. S. Geological Survey Miscellaneous Investigations Series Map I-2540B, scale 1:100,000.

Stanford, S. D., Pristas, R. S., Hall, D. W., and Waldner, J. S., 2001, Earthquake loss estimation study for Essex County, New Jersey: geologic component: report prepared by the N. J. Geological Survey for the N. J. State Police Office of Emergency Management, 9 p. plus appendices, http://www.njgeology.org/enviroed/freedwn/essex_hazus.pdf .

Stanford, S. D., Pristas, R. S., Hall, D. W., and Waldner, J. S., 2002, Earthquake loss estimation study for Union County, New Jersey: geologic component: report prepared by the N. J. Geological Survey for the N. J. State Police Office of Emergency Management, 10 p. plus appendices, http://www.njgeology.org/enviroed/freedwn/union_hazus.pdf.

Stanford, S. D., Pristas, R. S., Hall, D. W., and Waldner, J. S., 2003, Earthquake loss estimation study for Middlesex County, New Jersey: geologic component: report prepared by the N. J. Geological Survey for the N. J. State Police Office of Emergency Management, 12 p. plus appendices, http://www.njgeology.org/enviroed/freedwn/middlesex_hazus.pdf .

Volkert, R. A., Drake, A. A., Jr., and Sugarman, P. J., 1996. Geology, geochemistry, and tectonostratigraphic relations of the crystalline basement beneath the Coastal Plain of New Jersey and contiguous areas: U. S. Geological Survey Professional Paper 1565B, 48 p.

APPENDIX A

Maps of Monmouth County, with census tracts, showing:

Epicenter location
Default soil type
Default liquefaction susceptibility
Default landslide susceptibility
Upgraded soil type
Upgraded liquefaction susceptibility
Upgraded landslide susceptibility

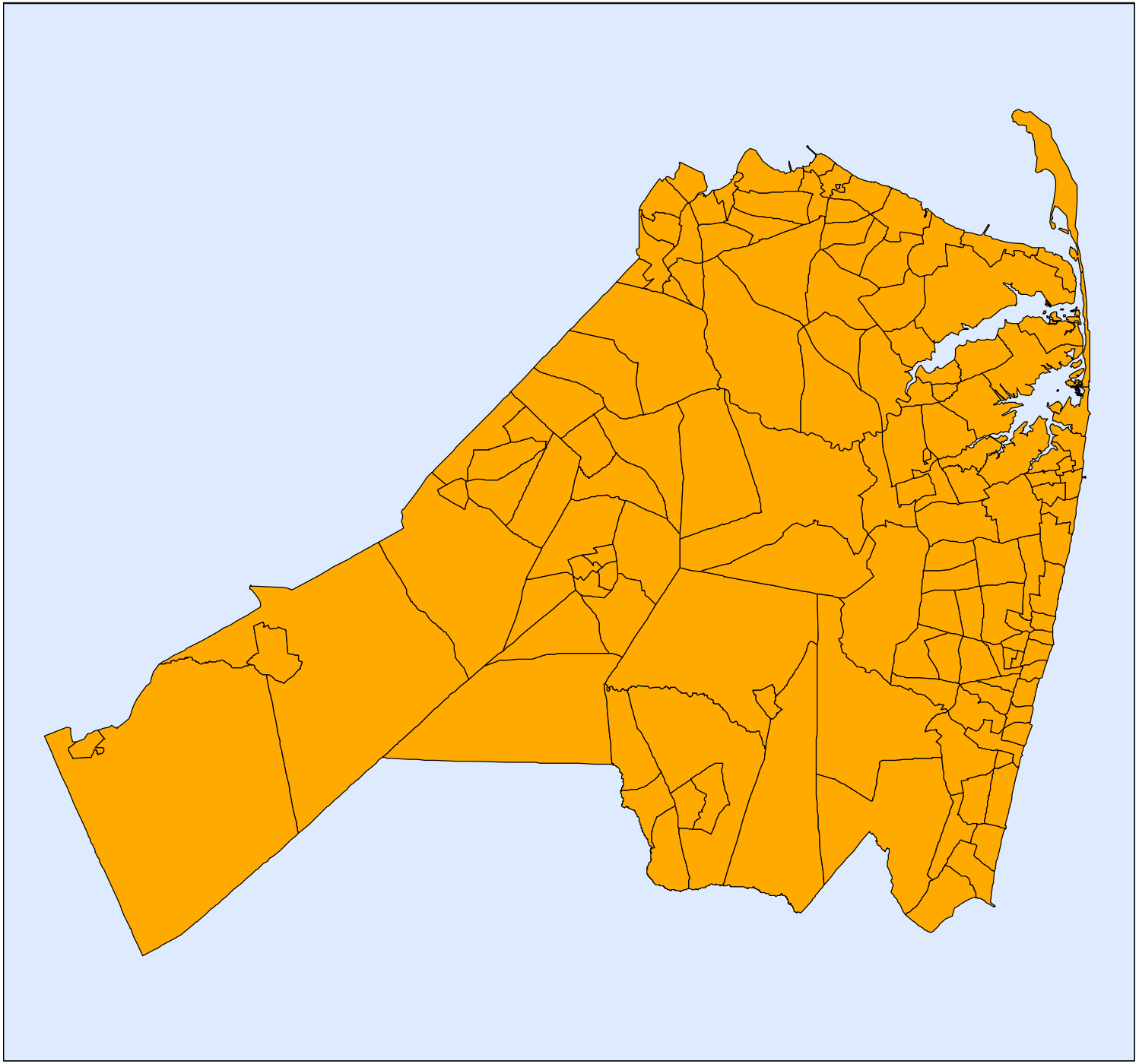
5 2.5 0 5 Miles

Study Region:
Monmouth County

Table Description:
Study Region Epicenter

^ Epicenter (Arbitary)
74.292 degrees longitude
40.271 degrees latitude

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 14, 2008



Study Region:
Monmouth County

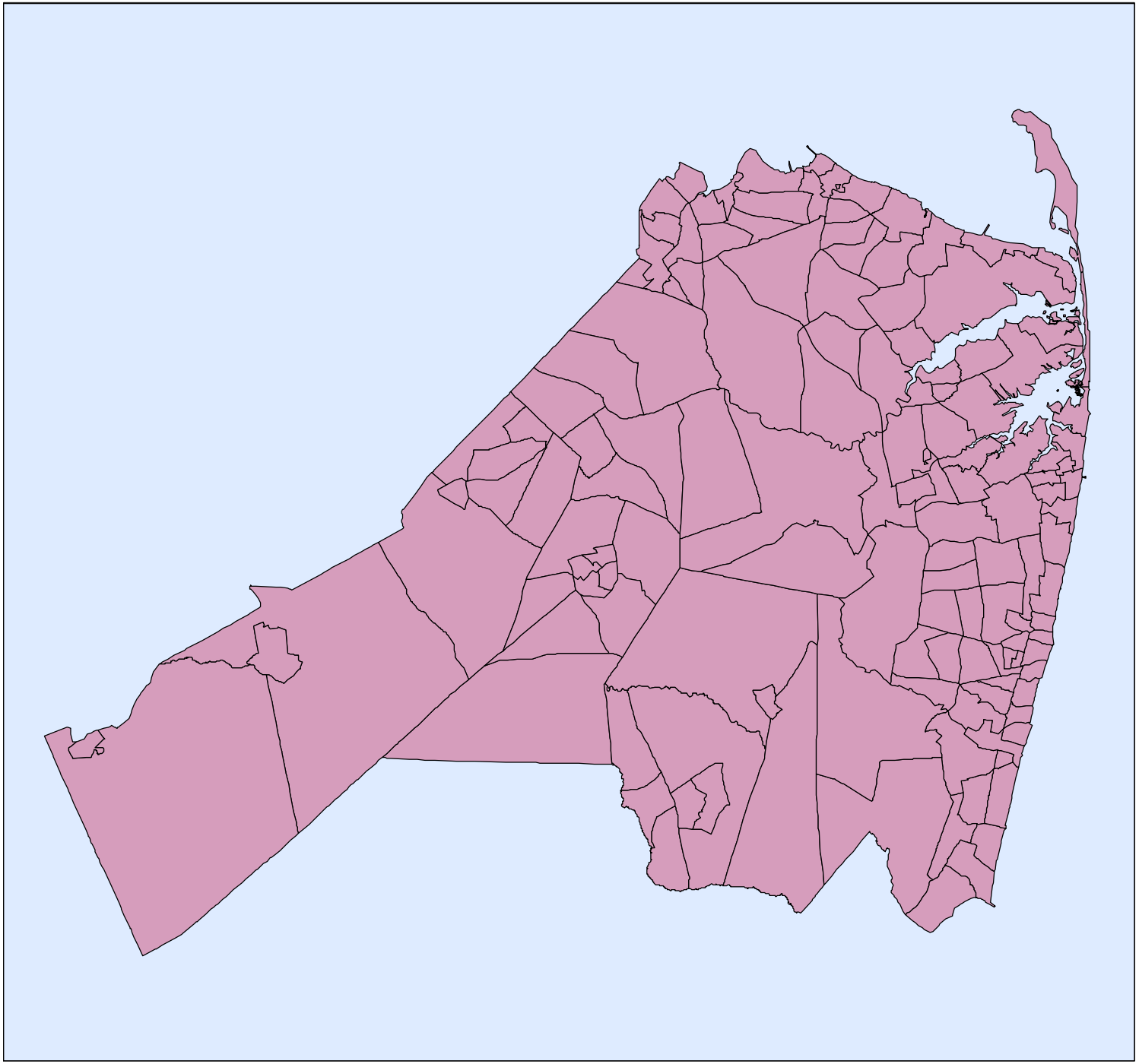
Table Description:
Default Soil Map

Soil Type

Class D

5 2.5 0 5 Miles

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 14, 2008



Study Region:
Monmouth County

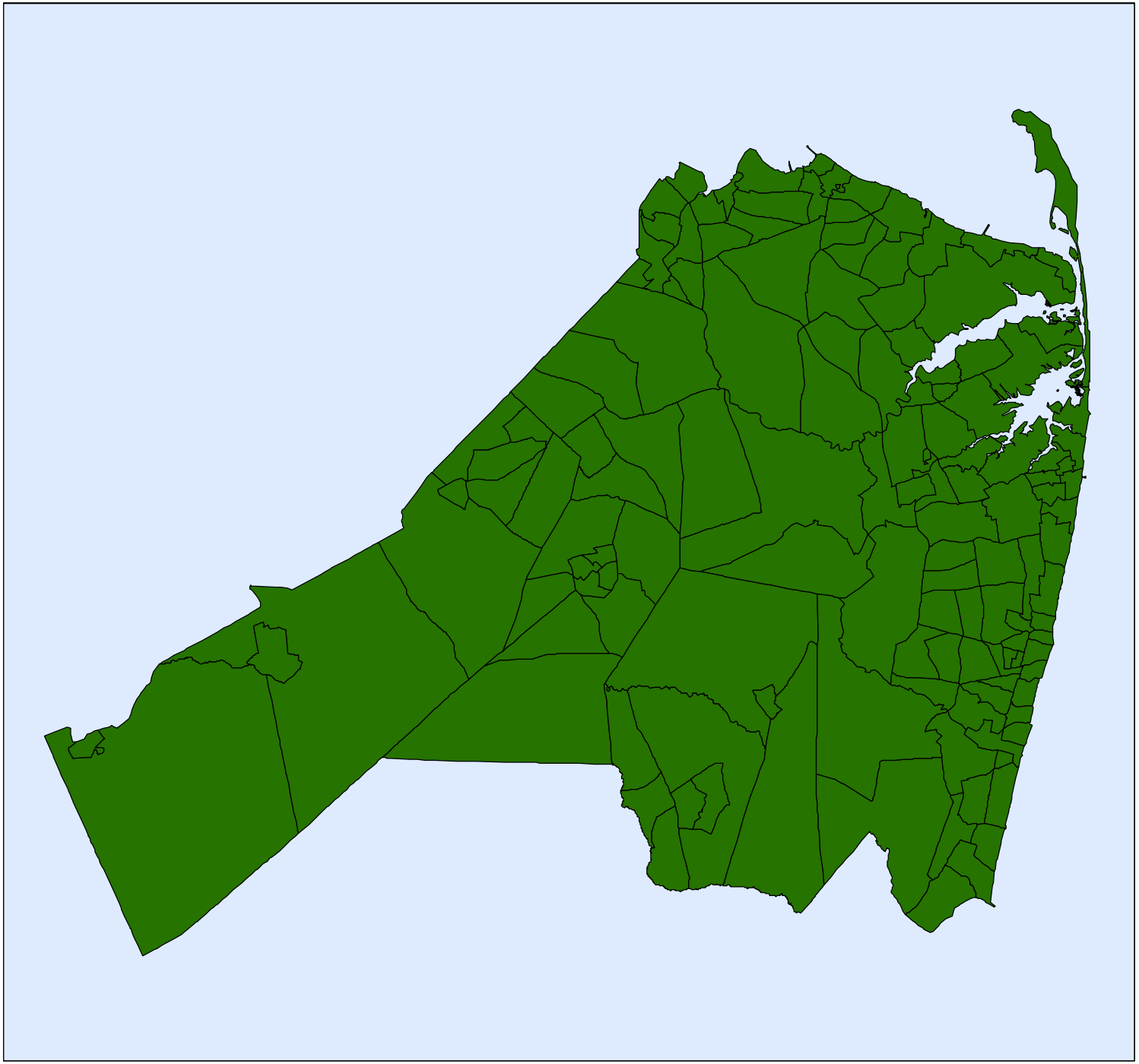
Table Description:
Default Liquefaction Map

Liquefaction Susceptibility

None (Class 0)

5 2.5 0 5 Miles

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 15, 2008



5 2.5 0 5 Miles

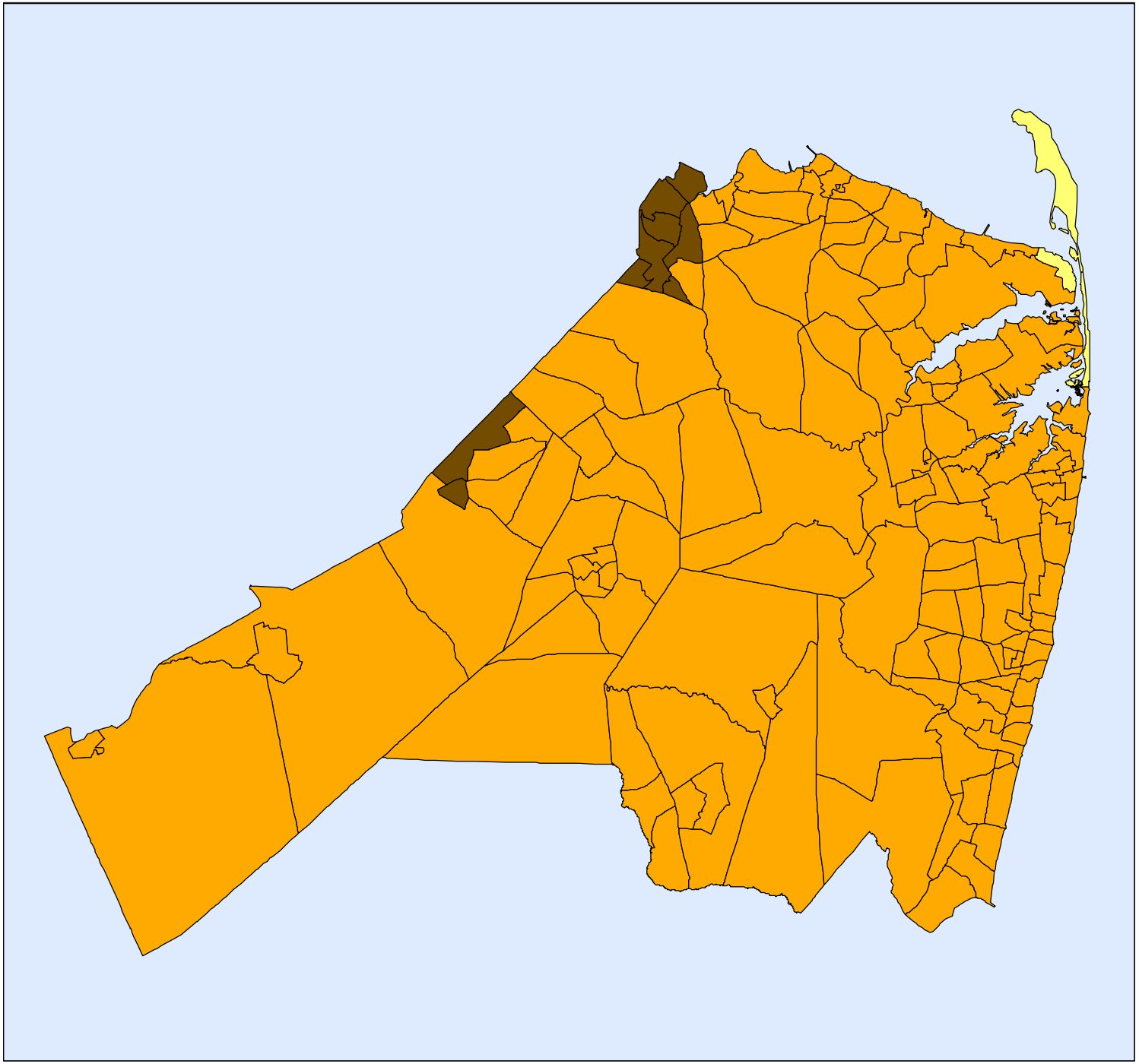
Study Region:
Monmouth County

Table Description:
Default Landslide Map

Landslide Susceptibility

None (Class 0)

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 15, 2008



Study Region:
Monmouth County

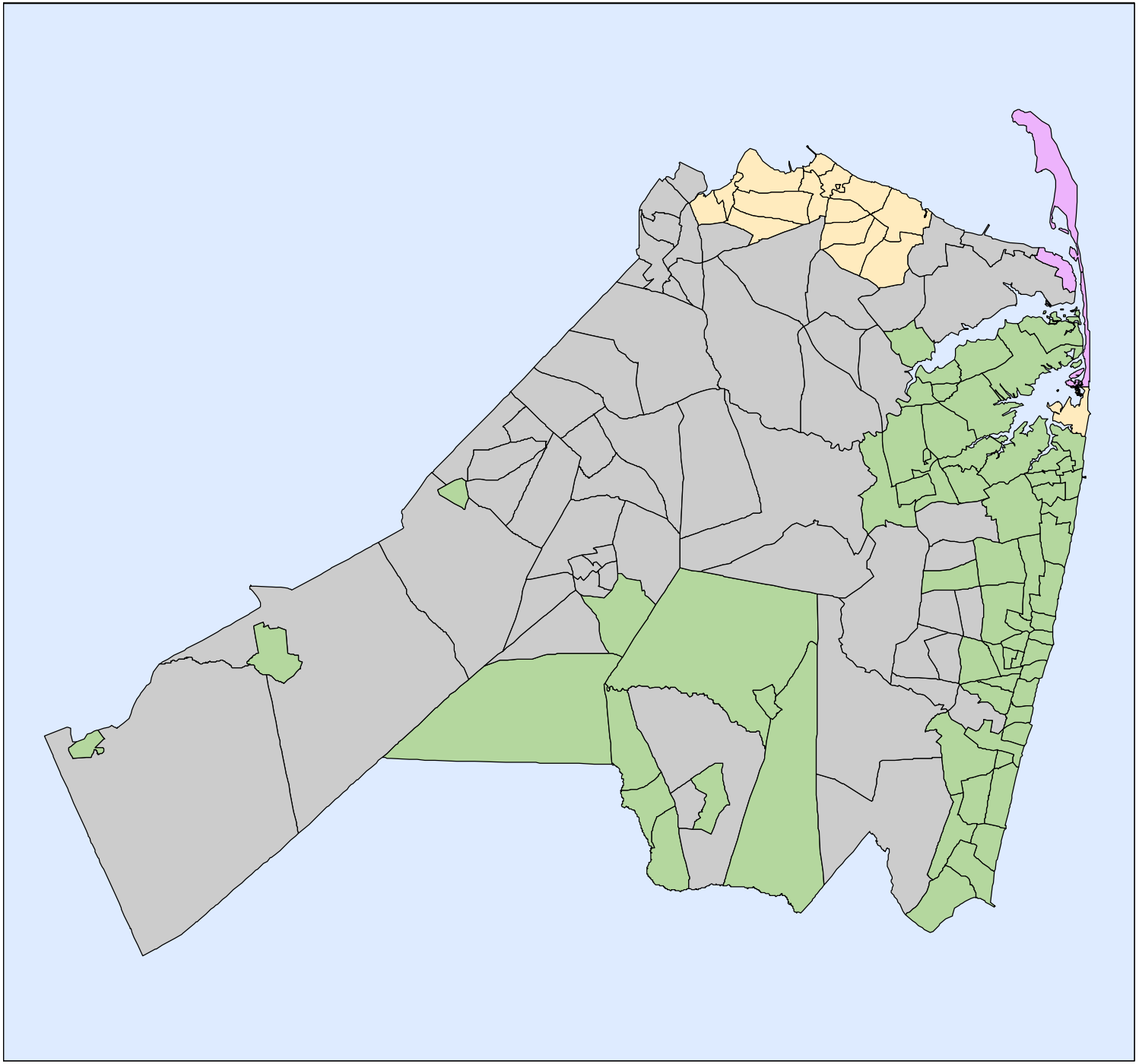
Table Description:
Upgraded Soil Map

Soil Type

- Class C
- Class D
- Class E

5 2.5 0 5 Miles

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 15, 2008



5 2.5 0 5 Miles

Study Region:
Monmouth County

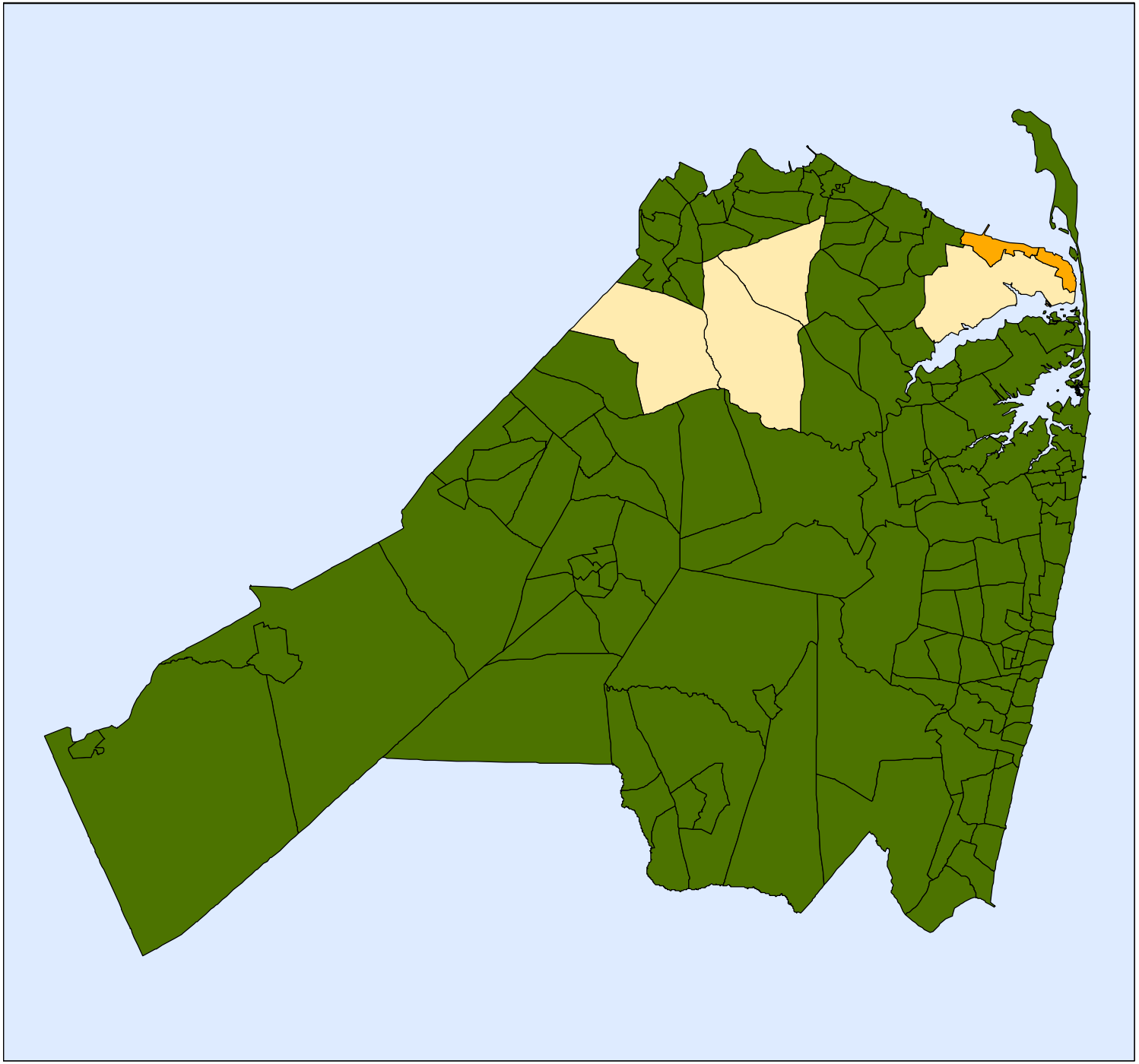
Table Description:
Upgraded Liquefaction Map

Liquefaction Susceptibility

- Very Low (Class 1)
- Low (Class 2)
- Moderate (Class 3)
- High (Class 4)

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey. October 15, 2008



5 2.5 0 5 Miles

Study Region:
Monmouth County

Table Description:
Upgraded Landslide Map

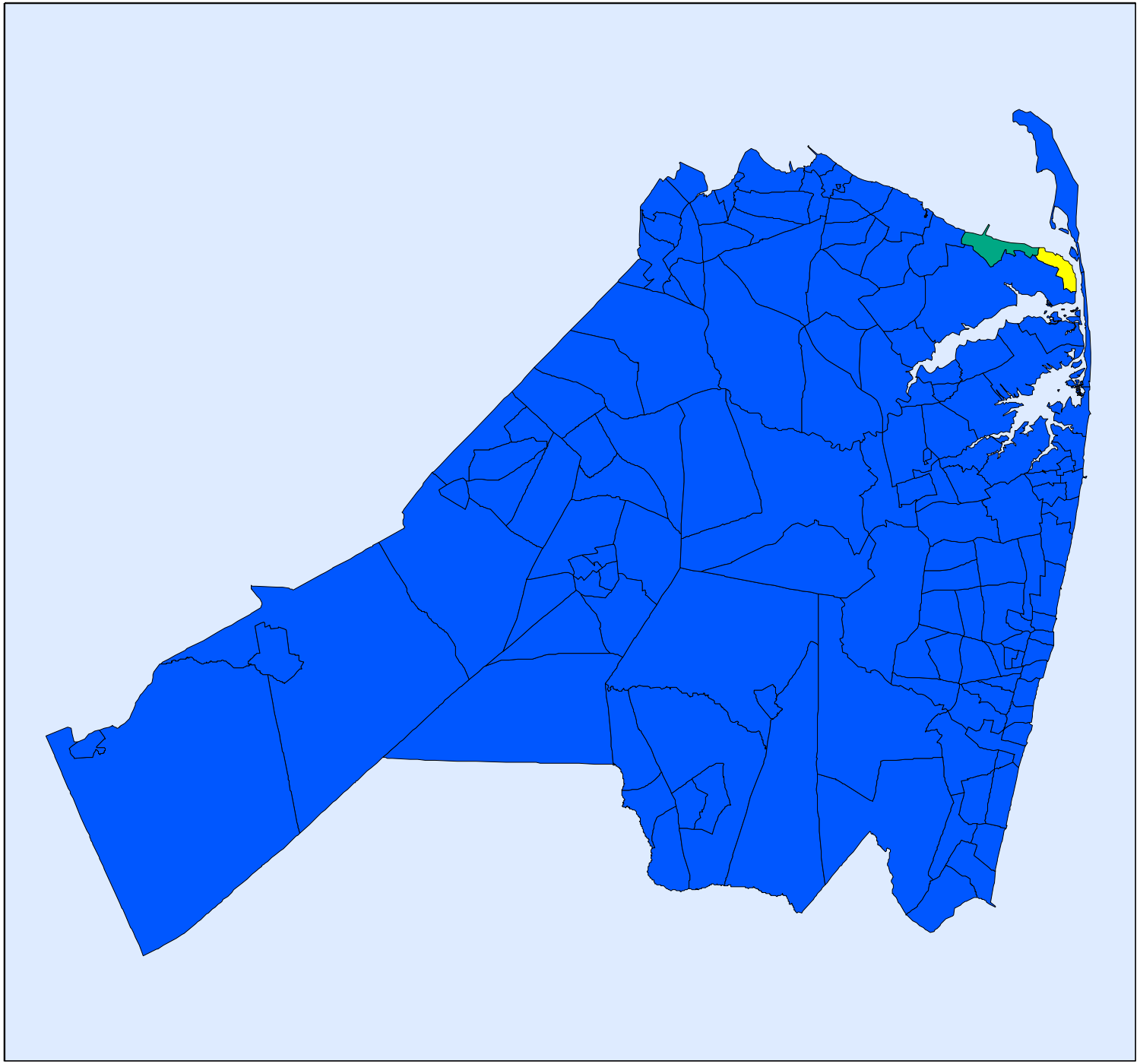
Landslide Susceptibility

- None (Class 0)
- Moderate (Class 3)
- Extremely High (Class 10)

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey. October 15, 2008

APPENDIX B

Magnitude 5 with upgraded geology



Study Region:
Monmouth County

Scenario Description:
5.0 Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

5 2.5 0 5 Miles

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 20, 2008

Building Damage by Count by General Occupancy

October 15, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*168*	*10*	*4*	*1*	*0*	*182*
Commercial	*4,118*	*263*	*119*	*25*	*9*	*4,534*
Education	*134*	*9*	*4*	*1*	*0*	*148*
Government	*235*	*16*	*8*	*2*	*1*	*261*
Industrial	*749*	*46*	*21*	*4*	*2*	*823*
Religion	*279*	*20*	*10*	*2*	*1*	*313*
Other Residential	*11,222*	*828*	*430*	*95*	*61*	*12,637*
Single Family	*168,477*	*8,991*	*2,668*	*659*	*417*	*181,212*
Total	**185,382**	**10,183**	**3,263**	**790**	**492**	**200,110**
Region Total	**185,382**	**10,183**	**3,263**	**790**	**492**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.40 - 1.50
	Building Contents	0.00 - 0.10
	Business Interruption	0.00 - 0.10
Infrastructure	Lifelines Damage	
	Total	0.60 - 2.30

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	6 - 30	< 1.0	< 1.0	6 - 30
Major	0 - 2	< 1.0	< 1.0	0 - 2
Total	7 - 30	< 1.0	< 1.0	7 - 30

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	70 - 300
Level 2	Hospital Care	20 - 60
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	400 - 1,800	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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

Earthquake Information

Location :

Origin Time:

Magnitude : 5.00

Epicenter Latitude/Longitude :
40.27 / -74.29

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

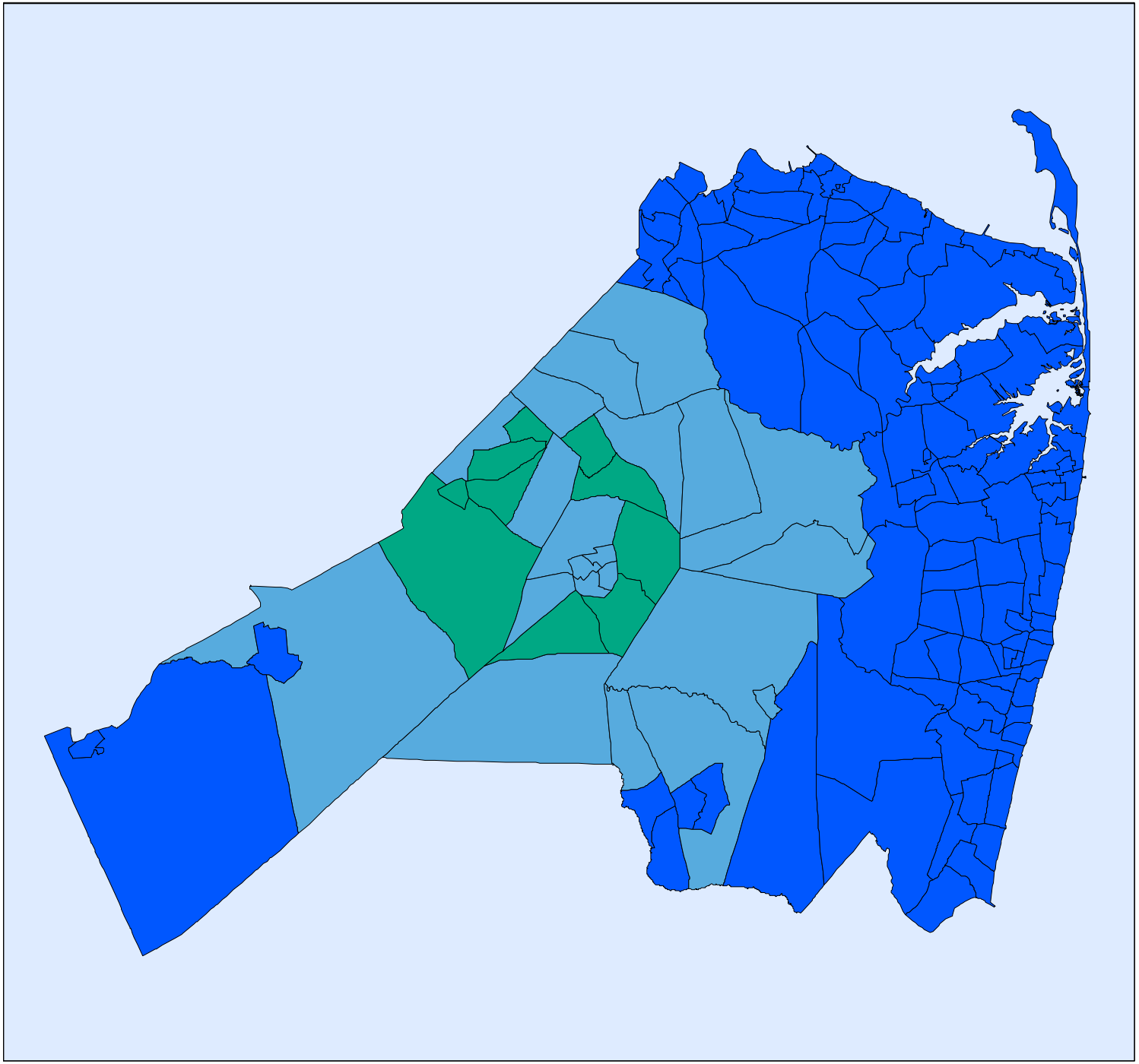
State: 200 - 1,000

Counties :
- Monmouth,NJ

Major Metro Area :

APPENDIX C

Magnitude 5.5 with default geology



Study Region:
Monmouth County

Scenario Description:
5.5 Default Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

5 2.5 0 5 Miles

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 20, 2008

Building Damage by Count by General Occupancy

October 15, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*135*	*28*	*15*	*3*	*0*	*182*
Commercial	*3,255*	*681*	*456*	*124*	*19*	*4,534*
Education	*108*	*21*	*15*	*4*	*1*	*148*
Government	*188*	*37*	*27*	*7*	*1*	*261*
Industrial	*599*	*116*	*83*	*21*	*3*	*823*
Religion	*219*	*52*	*32*	*9*	*2*	*313*
Other Residential	*9,222*	*2,020*	*1,157*	*211*	*27*	*12,637*
Single Family	*134,343*	*32,752*	*11,684*	*2,070*	*363*	*181,212*
Total	**148,070**	**35,707**	**13,468**	**2,449**	**416**	**200,110**
Region Total	**148,070**	**35,707**	**13,468**	**2,449**	**416**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.90 - 3.40
	Building Contents	0.10 - 0.20
	Business Interruption	0.10 - 0.40
Infrastructure	Lifelines Damage	
	Total	1.30 - 5.40

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	20 - 100	0 - 2	< 1.0	20 - 100
Major	1 - 5	< 1.0	< 1.0	1 - 5
Total	30 - 100	0 - 2	< 1.0	30 - 100

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	200 - 900
Level 2	Hospital Care	40 - 160
Level 3	Life-threatening	< 20
Level 4	Fatalities	10 - 30

Estimated Shelter Needs

Type	Households	People
Displaced Households	600 - 2,000	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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

Earthquake Information

Location :

Origin Time:

Magnitude : 5.50

Epicenter Latitude/Longitude :
40.27 / -74.29

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 1.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

State: 400 - 1,500

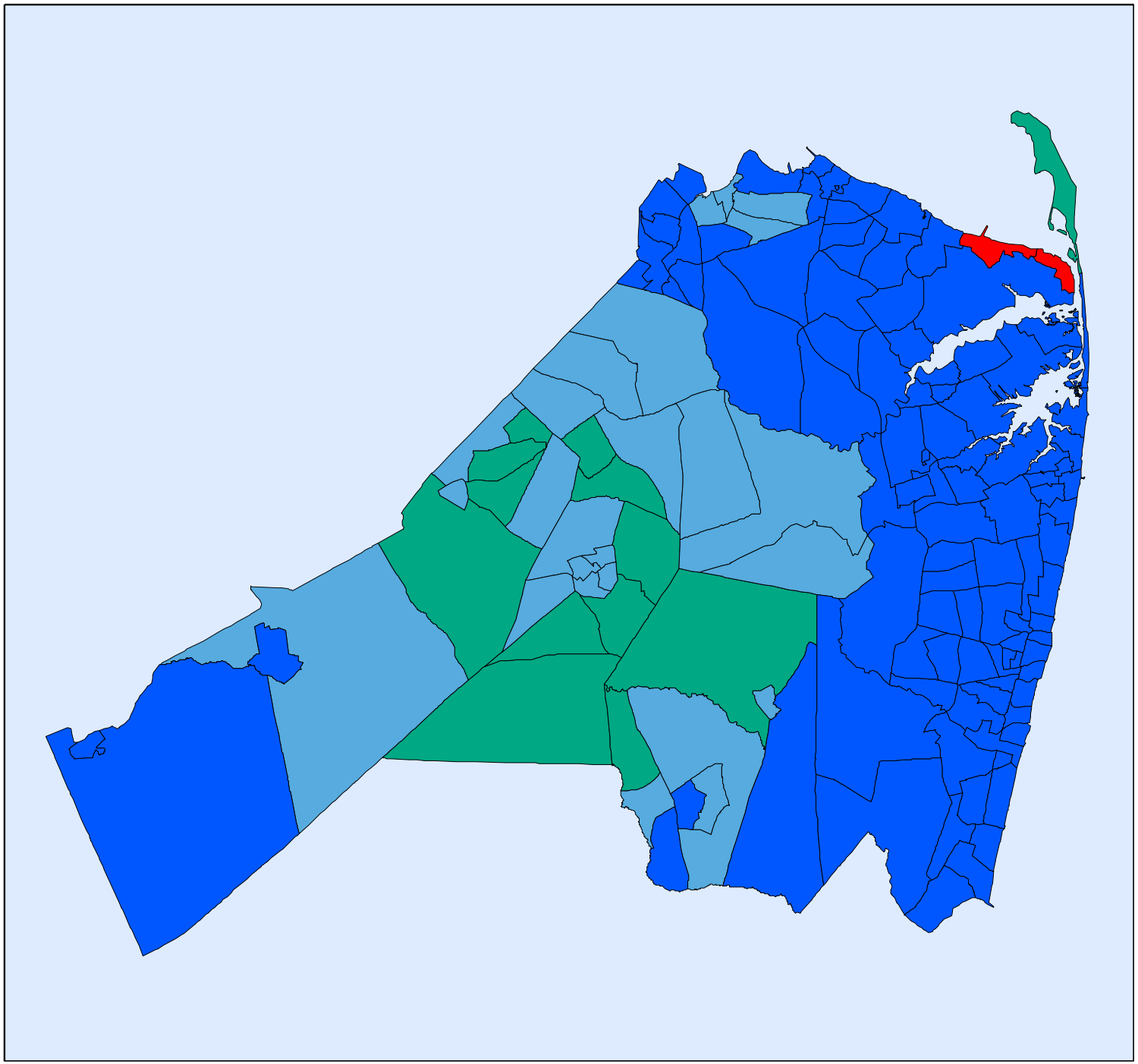
Counties :
- Monmouth,NJ

Major Metro Area :

Time of report: October 15, 2008 3:13 pm

APPENDIX D

Magnitude 5.5 with upgraded geology



Study Region:
Monmouth County

Scenario Description:
5.5 Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

5 2.5 0 5 Miles

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 20, 2008

Building Damage by Count by General Occupancy

October 15, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*133*	*27*	*15*	*5*	*2*	*182*
Commercial	*3,210*	*663*	*458*	*149*	*54*	*4,534*
Education	*105*	*21*	*15*	*5*	*2*	*148*
Government	*184*	*36*	*27*	*10*	*4*	*261*
Industrial	*587*	*113*	*85*	*27*	*11*	*823*
Religion	*213*	*50*	*32*	*13*	*5*	*313*
Other Residential	*8,792*	*1,918*	*1,151*	*494*	*282*	*12,637*
Single Family	*131,482*	*31,632*	*12,049*	*3,764*	*2,286*	*181,212*
Total	**144,704**	**34,459**	**13,832**	**4,467**	**2,647**	**200,110**
Region Total	**144,704**	**34,459**	**13,832**	**4,467**	**2,647**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	1.20 - 5.00
	Building Contents	0.10 - 0.30
	Business Interruption	0.10 - 0.60
Infrastructure	Lifelines Damage	
	Total	1.90 - 7.50

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	20 - 90	0 - 2	< 1.0	20 - 100
Major	3 - 13	< 1.0	< 1.0	3 - 14
Total	30 - 110	0 - 2	< 1.0	30 - 110

Estimated Casualties : Day Time

Severity Level	Description	# Persons
Level 1	Medical Aid	400 - 1,600
Level 2	Hospital Care	90 - 400
Level 3	Life-threatening	10 - 50
Level 4	Fatalities	20 - 90

Estimated Shelter Needs

Type	Households	People
Displaced Households	2,000 - 9,000	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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

Earthquake Information

Location :

Origin Time:

Magnitude : 5.50

Epicenter Latitude/Longitude :
40.27 / -74.29

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 1.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

State: 1,300 - 5,000

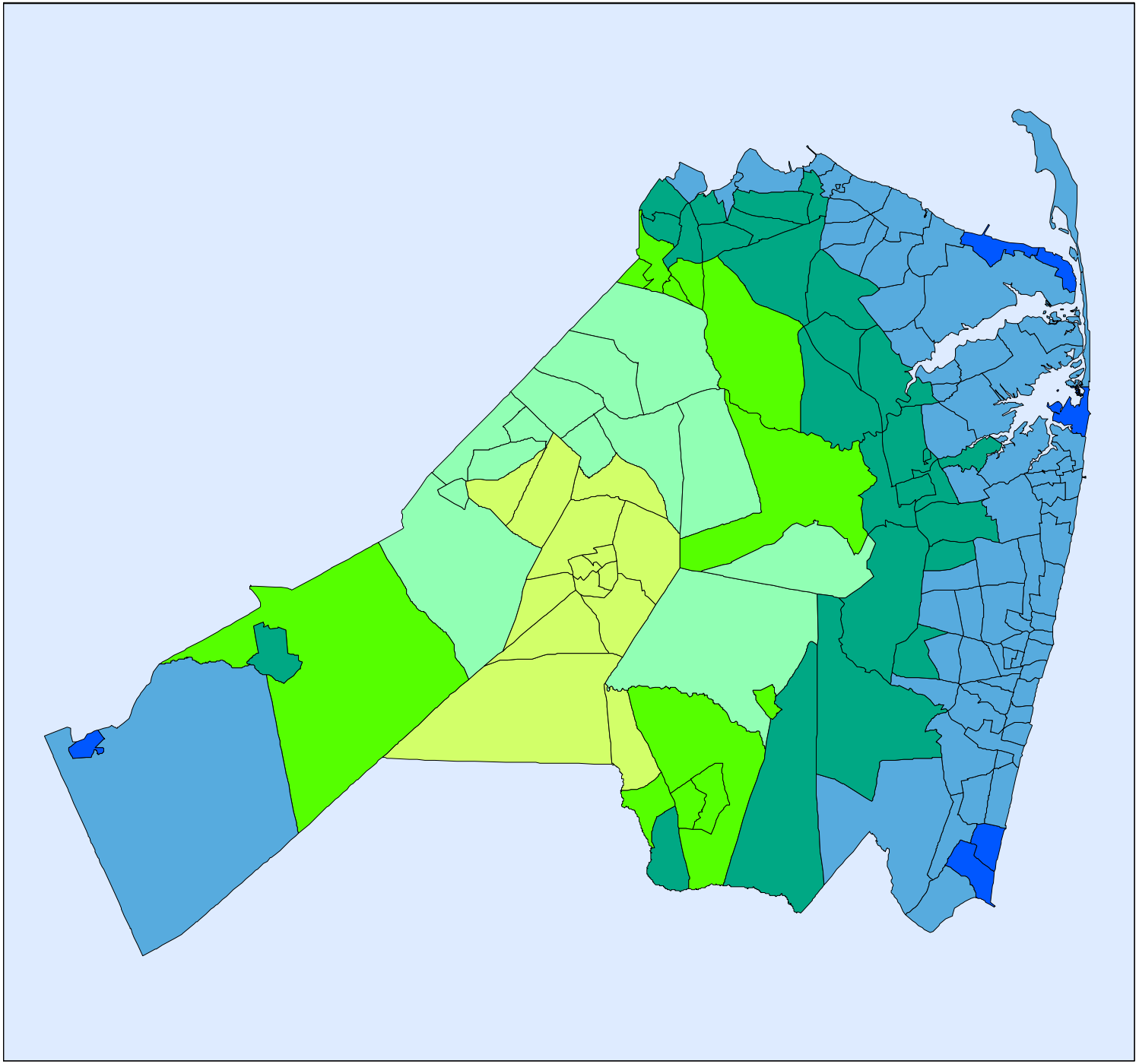
Counties :
- Monmouth,NJ

Major Metro Area :

Time of report: October 15, 2008 2:15 pm

APPENDIX E

Magnitude 6 with default geology



Study Region:
Monmouth County

Scenario Description:
6.0 Default Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

5 2.5 0 5 Miles

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 20, 2008

Building Damage by Count by General Occupancy

October 15, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*72*	*45*	*43*	*17*	*5*	*182*
Commercial	*1,680*	*969*	*1,148*	*548*	*189*	*4,534*
Education	*57*	*30*	*37*	*18*	*6*	*148*
Government	*96*	*51*	*67*	*34*	*13*	*261*
Industrial	*304*	*162*	*214*	*106*	*36*	*823*
Religion	*124*	*73*	*70*	*33*	*12*	*313*
Other Residential	*5,541*	*2,998*	*2,701*	*1,111*	*287*	*12,637*
Single Family	*84,476*	*53,451*	*32,358*	*8,608*	*2,319*	*181,212*
Total	**92,349**	**57,778**	**36,640**	**10,475**	**2,867**	**200,110**
Region Total	**92,349**	**57,778**	**36,640**	**10,475**	**2,867**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	2.50 - 10.00
	Building Contents	0.10 - 0.50
	Business Interruption	0.40 - 1.60
Infrastructure	Lifelines Damage	
	Total	3.70 - 14.90

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	50 - 180	1 - 4	0 - 1	50 - 190
Major	6 - 20	0 - 1	< 1.0	6 - 30
Total	50 - 200	1 - 5	0 - 2	50 - 200

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	1,000 - 4,000
Level 2	Hospital Care	200 - 800
Level 3	Life-threatening	30 - 110
Level 4	Fatalities	50 - 200

Estimated Shelter Needs

Type	Households	People
Displaced Households	3,000 - 12,000	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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

Earthquake Information

Location :

Origin Time:

Magnitude : 6.00

Epicenter Latitude/Longitude :
40.27 / -74.29

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 1.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

State: 1,900 - 8,000

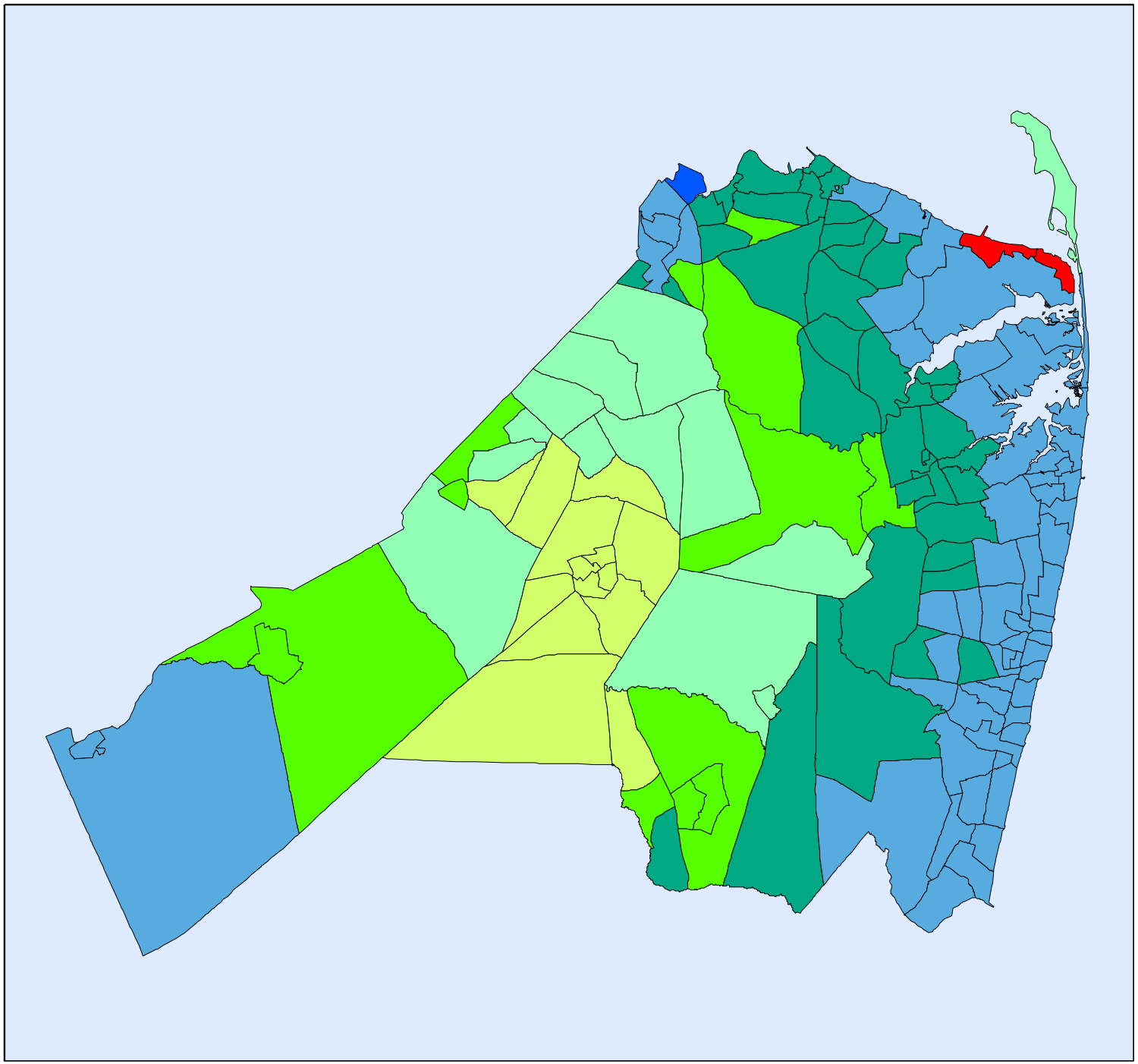
Counties :
- Monmouth,NJ

Major Metro Area :

Time of report: October 15, 2008 3:24 pm

APPENDIX F

Magnitude 6 with upgraded geology



Study Region:
Monmouth County

Scenario Description:
6.0 Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

5 2.5 0 5 Miles

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 20, 2008

Building Damage by Count by General Occupancy

October 15, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*70*	*44*	*42*	*17*	*9*	*182*
Commercial	*1,648*	*942*	*1,108*	*557*	*279*	*4,534*
Education	*55*	*29*	*36*	*18*	*10*	*148*
Government	*93*	*49*	*65*	*36*	*20*	*261*
Industrial	*296*	*157*	*206*	*109*	*55*	*823*
Religion	*120*	*70*	*67*	*36*	*21*	*313*
Other Residential	*5,203*	*2,807*	*2,526*	*1,260*	*842*	*12,637*
Single Family	*81,796*	*51,378*	*30,978*	*9,908*	*7,152*	*181,212*
Total	**89,280**	**55,475**	**35,027**	**11,941**	**8,388**	**200,110**
Region Total	**89,280**	**55,475**	**35,027**	**11,941**	**8,388**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	3.20 - 13.00
	Building Contents	0.20 - 0.60
	Business Interruption	0.50 - 1.90
Infrastructure	Lifelines Damage	
	Total	4.70 - 18.90

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	40 - 180	1 - 4	0 - 1	50 - 180
Major	9 - 40	0 - 1	< 1.0	10 - 40
Total	50 - 200	1 - 5	0 - 2	60 - 200

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	1,500 - 6,000
Level 2	Hospital Care	400 - 1,500
Level 3	Life-threatening	40 - 170
Level 4	Fatalities	80 - 300

Estimated Shelter Needs

Type	Households	People
Displaced Households	7,000 - 27,000	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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

Earthquake Information

Location :

Origin Time:

Magnitude : 6.00

Epicenter Latitude/Longitude :
40.27 / -74.29

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 1.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

State: 4,000 - 16,000

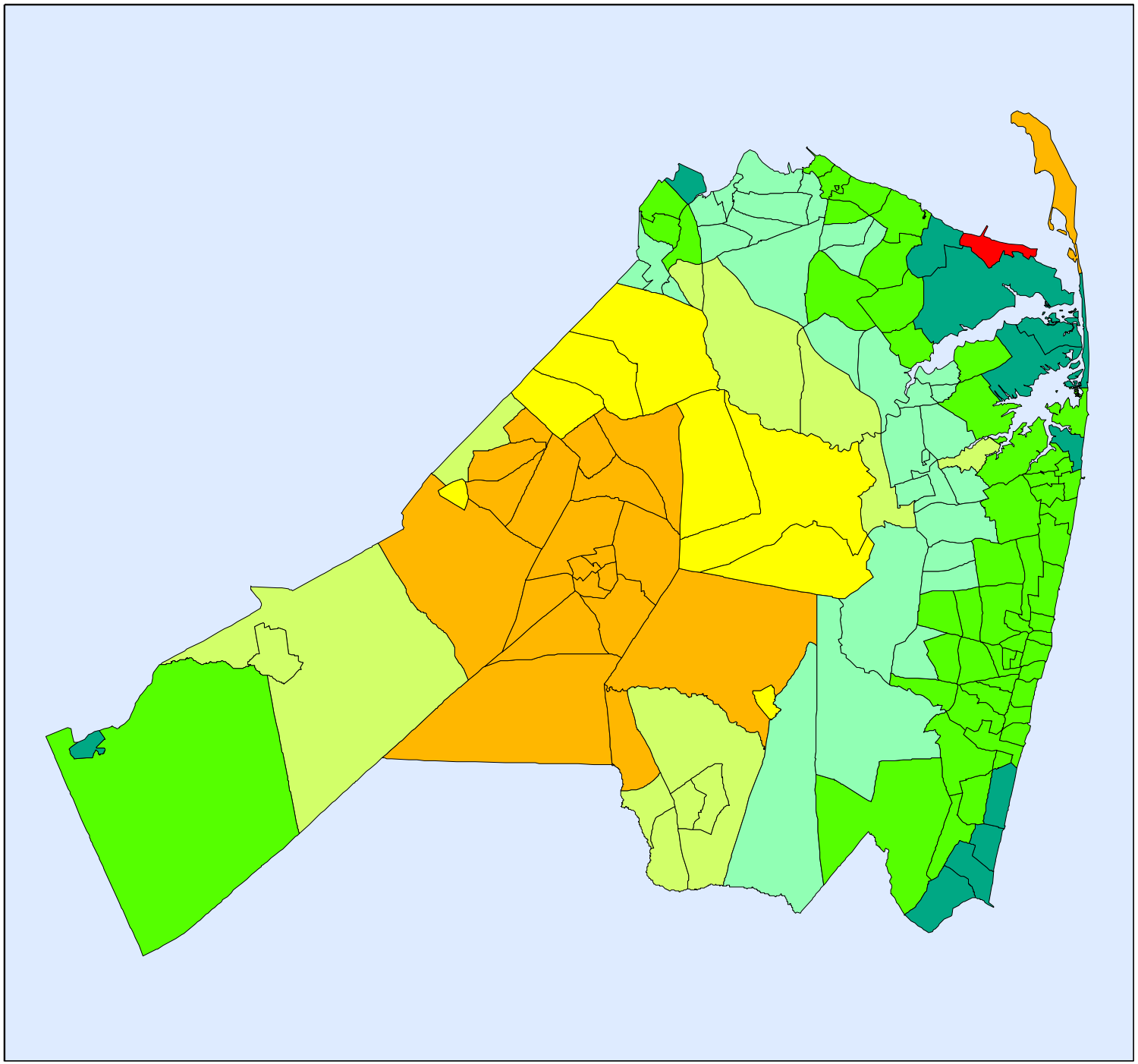
Counties :
- Monmouth,NJ

Major Metro Area :

Time of report: October 15, 2008 4:19 pm

APPENDIX G

Magnitude 6.5 with upgraded geology



Study Region:
Monmouth County

Scenario Description:
6.5 Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

5 2.5 0 5 Miles

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey. October 20, 2008

Building Damage by Count by General Occupancy

October 16, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*28*	*36*	*58*	*34*	*25*	*182*
Commercial	*641*	*713*	*1,356*	*1,021*	*803*	*4,534*
Education	*21*	*22*	*43*	*34*	*28*	*148*
Government	*35*	*35*	*74*	*63*	*54*	*261*
Industrial	*112*	*113*	*239*	*199*	*160*	*823*
Religion	*55*	*63*	*85*	*58*	*51*	*313*
Other Residential	*2,541*	*2,774*	*3,265*	*2,145*	*1,912*	*12,637*
Single Family	*43,617*	*55,155*	*49,772*	*18,218*	*14,450*	*181,212*
Total	**47,052**	**58,911**	**54,892**	**21,772**	**17,484**	**200,110**
Region Total	**47,052**	**58,911**	**54,892**	**21,772**	**17,484**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	6.10 - 24.50
	Building Contents	0.30 - 1.20
	Business Interruption	0.90 - 3.70
Infrastructure	Lifelines Damage	
	Total	8.80 - 35.20

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	60 - 200	1 - 4	0 - 1	60 - 200
Major	18 - 70	0 - 3	0 - 1	19 - 80
Total	70 - 300	1 - 7	0 - 2	80 - 300

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	3,000 - 12,000
Level 2	Hospital Care	800 - 3,000
Level 3	Life-threatening	100 - 400
Level 4	Fatalities	180 - 700

Estimated Shelter Needs

Type	Households	People
Displaced Households	13,000 - 52,000	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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Earthquake Information

Location :

Origin Time:

Magnitude : 6.50

Epicenter Latitude/Longitude :
40.27 / -74.29

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 1.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

State: 8,000 - 31,000

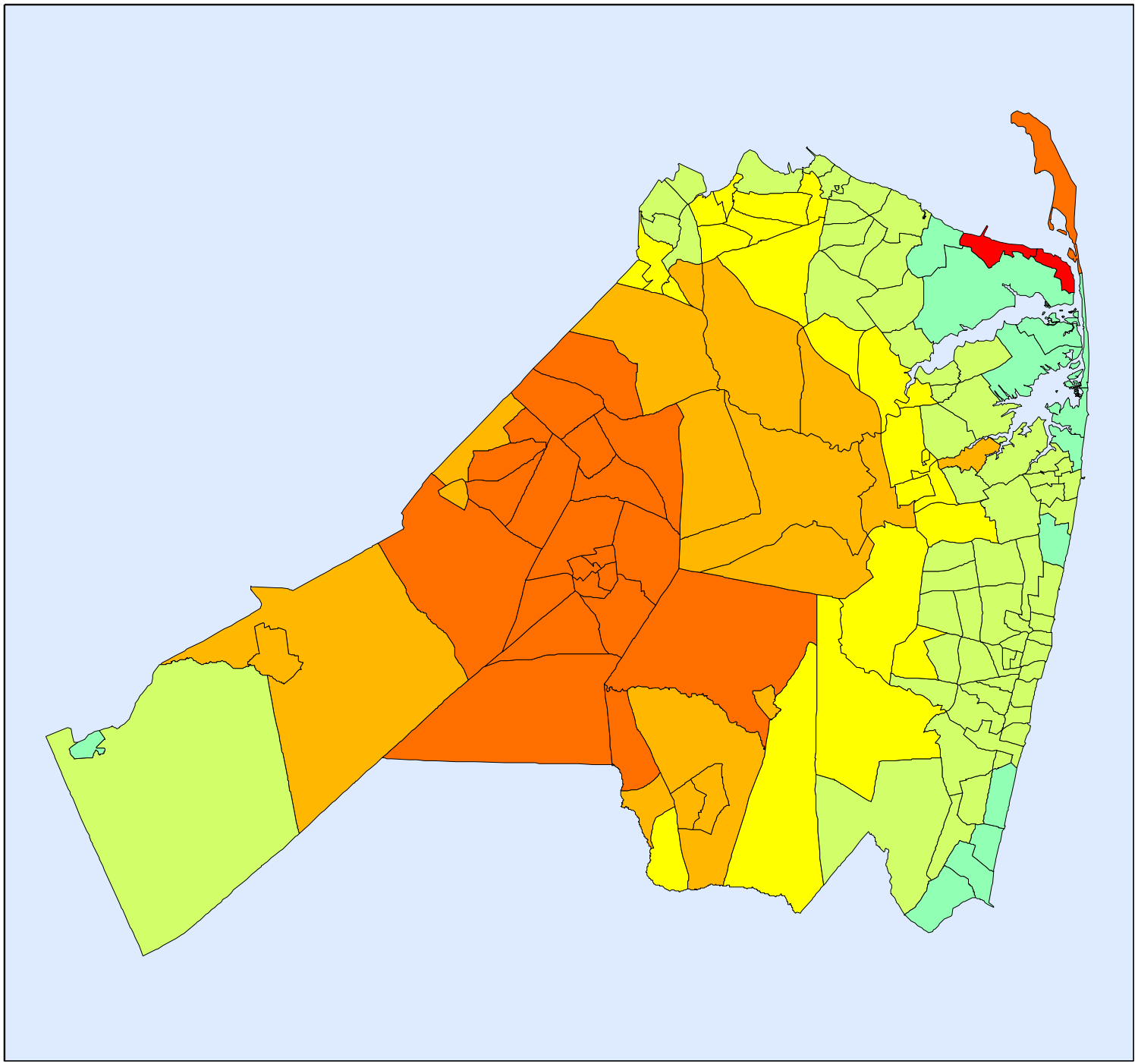
Counties :
- Monmouth,NJ

Major Metro Area :

Time of report: October 16, 2008 8:44 am

APPENDIX H

Magnitude 7 with upgraded geology



Study Region:
Monmouth County

Scenario Description:
7.0 Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

5 2.5 0 5 Miles

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 20, 2008

Building Damage by Count by General Occupancy

October 16, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*9*	*20*	*54*	*47*	*51*	*182*
Commercial	*199*	*370*	*1,100*	*1,280*	*1,585*	*4,534*
Education	*7*	*11*	*34*	*43*	*53*	*148*
Government	*10*	*17*	*55*	*76*	*103*	*261*
Industrial	*33*	*54*	*179*	*243*	*315*	*823*
Religion	*23*	*46*	*82*	*73*	*89*	*313*
Other Residential	*1,156*	*2,202*	*3,325*	*2,746*	*3,208*	*12,637*
Single Family	*21,217*	*46,734*	*61,937*	*28,811*	*22,513*	*181,212*
Total	**22,654**	**49,454**	**66,765**	**33,318**	**27,918**	**200,110**
Region Total	**22,654**	**49,454**	**66,765**	**33,318**	**27,918**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	9.40 - 37.60
	Building Contents	0.50 - 1.90
	Business Interruption	1.40 - 5.70
Infrastructure	Lifelines Damage	
	Total	13.40 - 53.40

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	60 - 200	0 - 2	0 - 1	60 - 200
Major	30 - 110	1 - 5	0 - 2	30 - 120
Total	90 - 300	2 - 8	0 - 3	90 - 400

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	5,000 - 19,000
Level 2	Hospital Care	1,300 - 5,000
Level 3	Life-threatening	160 - 700
Level 4	Fatalities	300 - 1,300

Estimated Shelter Needs

Type	Households	People
Displaced Households	20,000 - 81,000	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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

Earthquake Information

Location :

Origin Time:

Magnitude : 7.00

Epicenter Latitude/Longitude :
40.27 / -74.29

Depth & Type :10.00/A

Fault Name :
NA

Maximum PGA : 1.00

Ground Motion /Attenuation : CEUS Event

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

State: 12,000 - 49,000

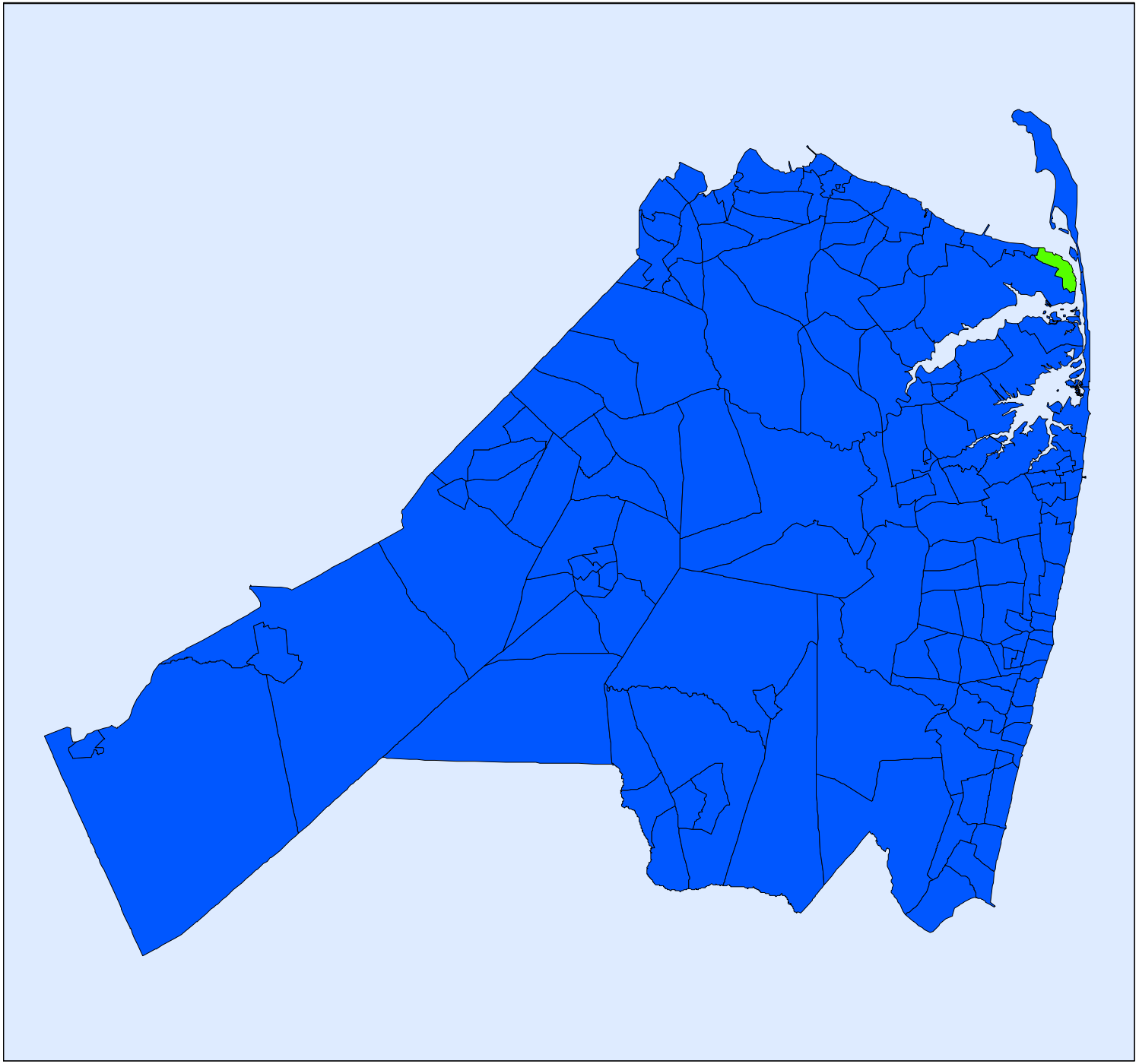
Counties :
- Monmouth,NJ

Major Metro Area :

Time of report: October 16, 2008 9:04 am

APPENDIX I

500-year return period with upgraded geology (M5.5)



Study Region:
Monmouth County

Scenario Description:
5.5 Probabilistic 500 Year Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

5 2.5 0 5 Miles

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey. October 20, 2008

Building Damage by Count by General Occupancy

October 16, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*168*	*10*	*3*	*1*	*0*	*182*
Commercial	*4,138*	*271*	*106*	*16*	*2*	*4,534*
Education	*135*	*9*	*4*	*1*	*0*	*148*
Government	*238*	*16*	*6*	*1*	*0*	*261*
Industrial	*754*	*47*	*19*	*3*	*0*	*823*
Religion	*285*	*19*	*8*	*1*	*0*	*313*
Other Residential	*11,323*	*882*	*365*	*56*	*10*	*12,637*
Single Family	*172,587*	*6,660*	*1,592*	*317*	*56*	*181,212*
Total	**189,627**	**7,915**	**2,104**	**396**	**68**	**200,110**
Region Total	**189,627**	**7,915**	**2,104**	**396**	**68**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.10 - 0.40
	Building Contents	< 0.1
	Business Interruption	0.00 - 0.10
Infrastructure	Lifelines Damage	
	Total	0.10 - 0.50

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	4 - 19	< 1.0	< 1.0	5 - 20
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	5 - 19	< 1.0	< 1.0	5 - 20

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	30 - 140
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	140 - 600	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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Earthquake Information

Location :

Origin Time:

Magnitude : 5.50

Epicenter Latitude/Longitude :

/

Depth & Type :/P

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

State: 80 - 300

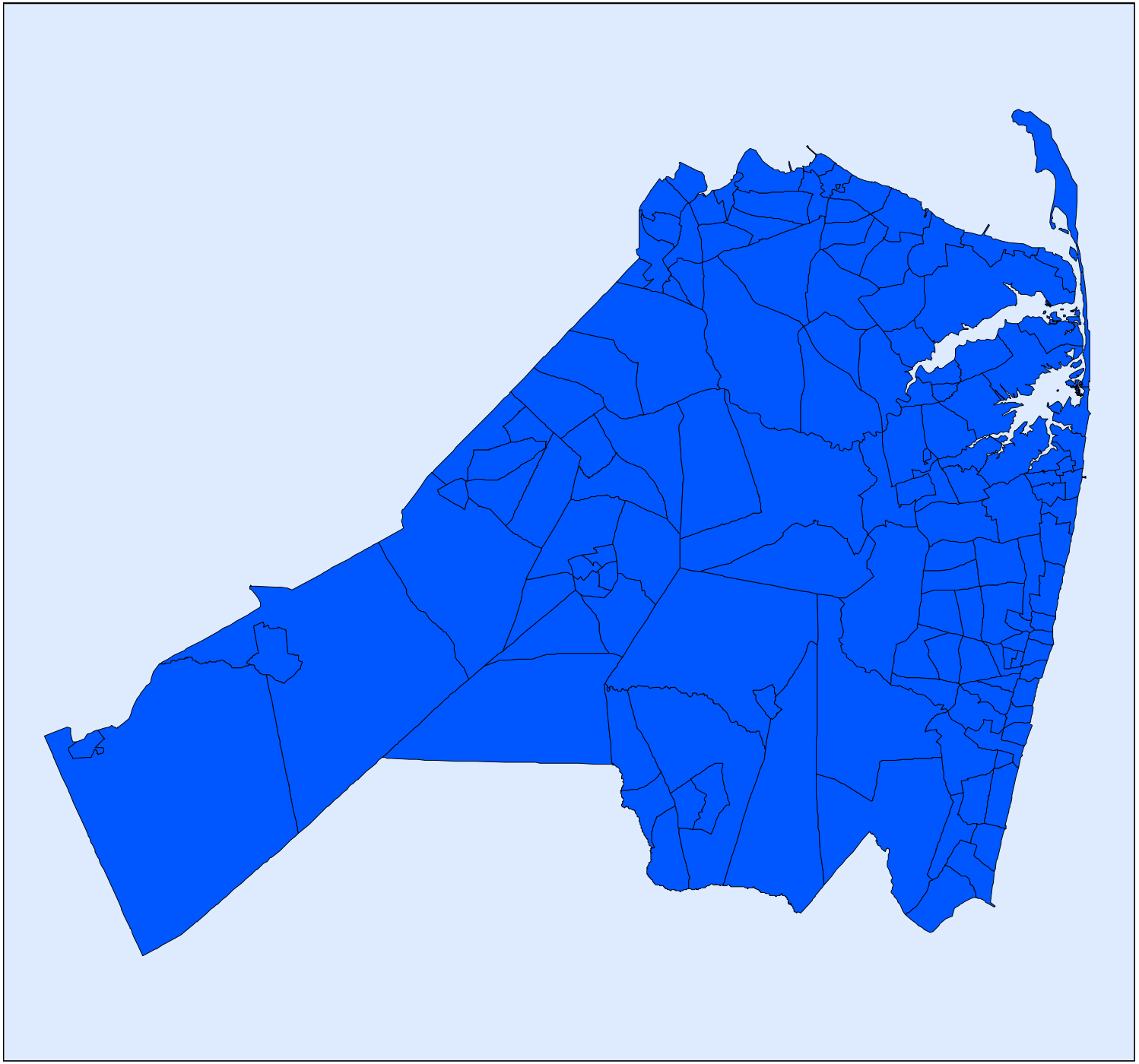
Counties :
- Monmouth,NJ

Major Metro Area :

Time of report: October 16, 2008 10:47 am

APPENDIX J

500-year return period with default geology (M6)



5 2.5 0 5 Miles

Study Region:
Monmouth County

Scenario Description:
6.0 Probabilistic 500 Year Default Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 20, 2008

Building Damage by Count by General Occupancy

October 15, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*168*	*10*	*3*	*0*	*0*	*182*
Commercial	*4,147*	*267*	*104*	*15*	*1*	*4,534*
Education	*136*	*8*	*3*	*0*	*0*	*148*
Government	*240*	*15*	*6*	*1*	*0*	*261*
Industrial	*755*	*47*	*18*	*2*	*0*	*823*
Religion	*288*	*17*	*7*	*1*	*0*	*313*
Other Residential	*11,600*	*725*	*285*	*25*	*2*	*12,637*
Single Family	*173,752*	*5,972*	*1,281*	*188*	*20*	*181,212*
Total	**191,087**	**7,061**	**1,707**	**233**	**23**	**200,110**
Region Total	**191,087**	**7,061**	**1,707**	**233**	**23**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.10 - 0.30
	Building Contents	< 0.1
	Business Interruption	0.00 - 0.10
Infrastructure	Lifelines Damage	
	Total	0.10 - 0.40

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	4 - 16	< 1.0	< 1.0	4 - 17
Major	< 1.0	< 1.0	< 1.0	< 1.0
Total	4 - 17	< 1.0	< 1.0	4 - 18

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	30 - 100
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	60 - 300	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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Earthquake Information

Location :

Origin Time:

Magnitude : 6.00

Epicenter Latitude/Longitude :
/

Depth & Type :/P

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

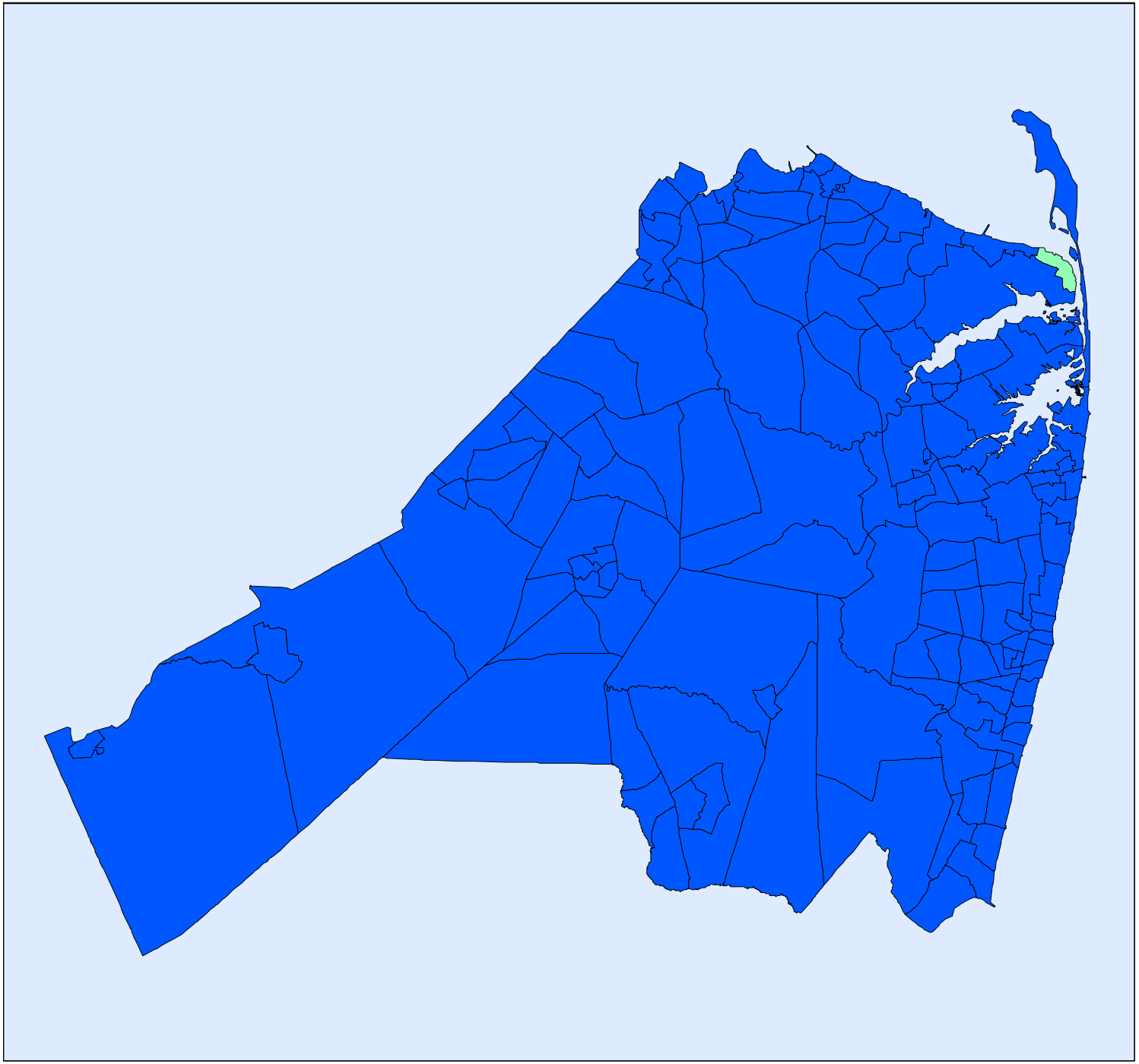
State: 40 - 160

Counties :
- Monmouth,NJ

Major Metro Area :

APPENDIX K

500-year return period with upgraded geology (M6)



Study Region:
Monmouth County

Scenario Description:
6.0 Probabilistic 500 Year Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

NEW JERSEY GEOLOGICAL SURVEY 1835

5 2.5 0 5 Miles

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey. October 20, 2008

Building Damage by Count by General Occupancy

October 16, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*167*	*10*	*3*	*1*	*0*	*182*
Commercial	*4,134*	*272*	*109*	*17*	*2*	*4,534*
Education	*134*	*9*	*4*	*1*	*0*	*148*
Government	*237*	*16*	*7*	*1*	*0*	*261*
Industrial	*753*	*48*	*19*	*3*	*0*	*823*
Religion	*284*	*19*	*8*	*2*	*0*	*313*
Other Residential	*11,272*	*879*	*400*	*72*	*14*	*12,637*
Single Family	*172,299*	*6,697*	*1,758*	*384*	*74*	*181,212*
Total	**189,282**	**7,950**	**2,307**	**479**	**91**	**200,110**
Region Total	**189,282**	**7,950**	**2,307**	**479**	**91**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.10 - 0.40
	Building Contents	< 0.1
	Business Interruption	0.00 - 0.10
Infrastructure	Lifelines Damage	
	Total	0.10 - 0.60

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	4 - 19	< 1.0	< 1.0	5 - 20
Major	0 - 1	< 1.0	< 1.0	0 - 1
Total	5 - 20	< 1.0	< 1.0	5 - 20

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	40 - 150
Level 2	Hospital Care	< 20
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	170 - 700	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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

Earthquake Information

Location :

Origin Time:

Magnitude : 6.00

Epicenter Latitude/Longitude :

/

Depth & Type :/P

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

State: 90 - 400

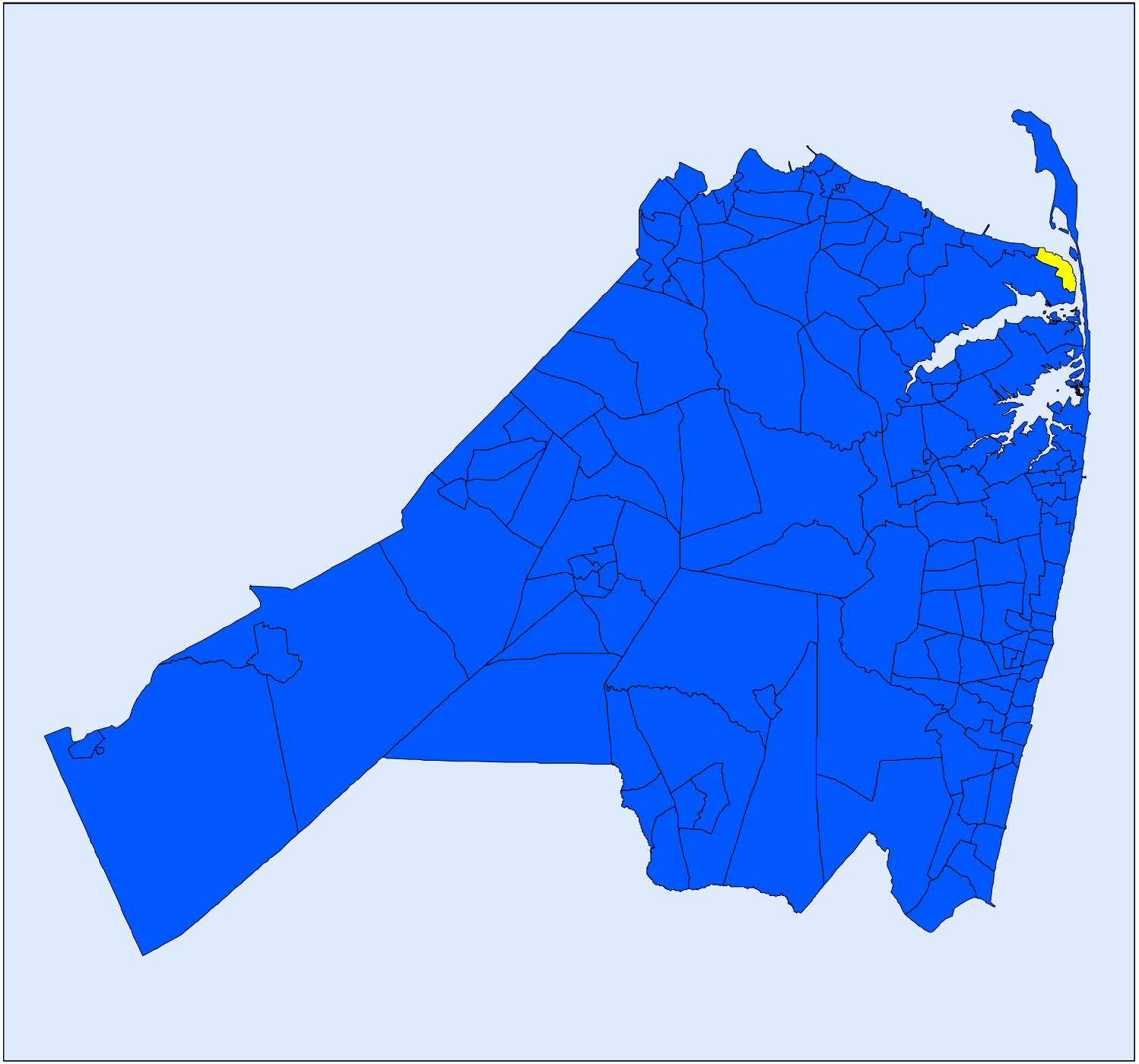
Counties :
- Monmouth,NJ

Major Metro Area :

Time of report: October 16, 2008 11:05 am

APPENDIX L

500-year return period with upgraded geology (M6.5)



5 2.5 0 5 Miles

Study Region:
Monmouth County

Scenario Description:
6.5 Probabilistic 500 Year Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 20, 2008

Building Damage by Count by General Occupancy

October 16, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*167*	*10*	*4*	*1*	*0*	*182*
Commercial	*4,133*	*270*	*111*	*18*	*2*	*4,534*
Education	*134*	*9*	*4*	*1*	*0*	*148*
Government	*237*	*16*	*7*	*1*	*0*	*261*
Industrial	*753*	*47*	*20*	*3*	*0*	*823*
Religion	*284*	*18*	*9*	*2*	*0*	*313*
Other Residential	*11,267*	*822*	*439*	*89*	*19*	*12,637*
Single Family	*172,213*	*6,494*	*1,949*	*461*	*94*	*181,212*
Total	**189,188**	**7,687**	**2,543**	**575**	**117**	**200,110**
Region Total	**189,188**	**7,687**	**2,543**	**575**	**117**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.10 - 0.40
	Building Contents	< 0.1
	Business Interruption	0.00 - 0.10
Infrastructure	Lifelines Damage	
	Total	0.20 - 0.60

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	4 - 19	< 1.0	< 1.0	5 - 20
Major	0 - 1	< 1.0	< 1.0	0 - 1
Total	5 - 20	< 1.0	< 1.0	5 - 20

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	40 - 170
Level 2	Hospital Care	10 - 30
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	200 - 900	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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

Earthquake Information

Location :

Origin Time:

Magnitude : 6.50

Epicenter Latitude/Longitude :

/

Depth & Type :/P

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

State: 120 - 500

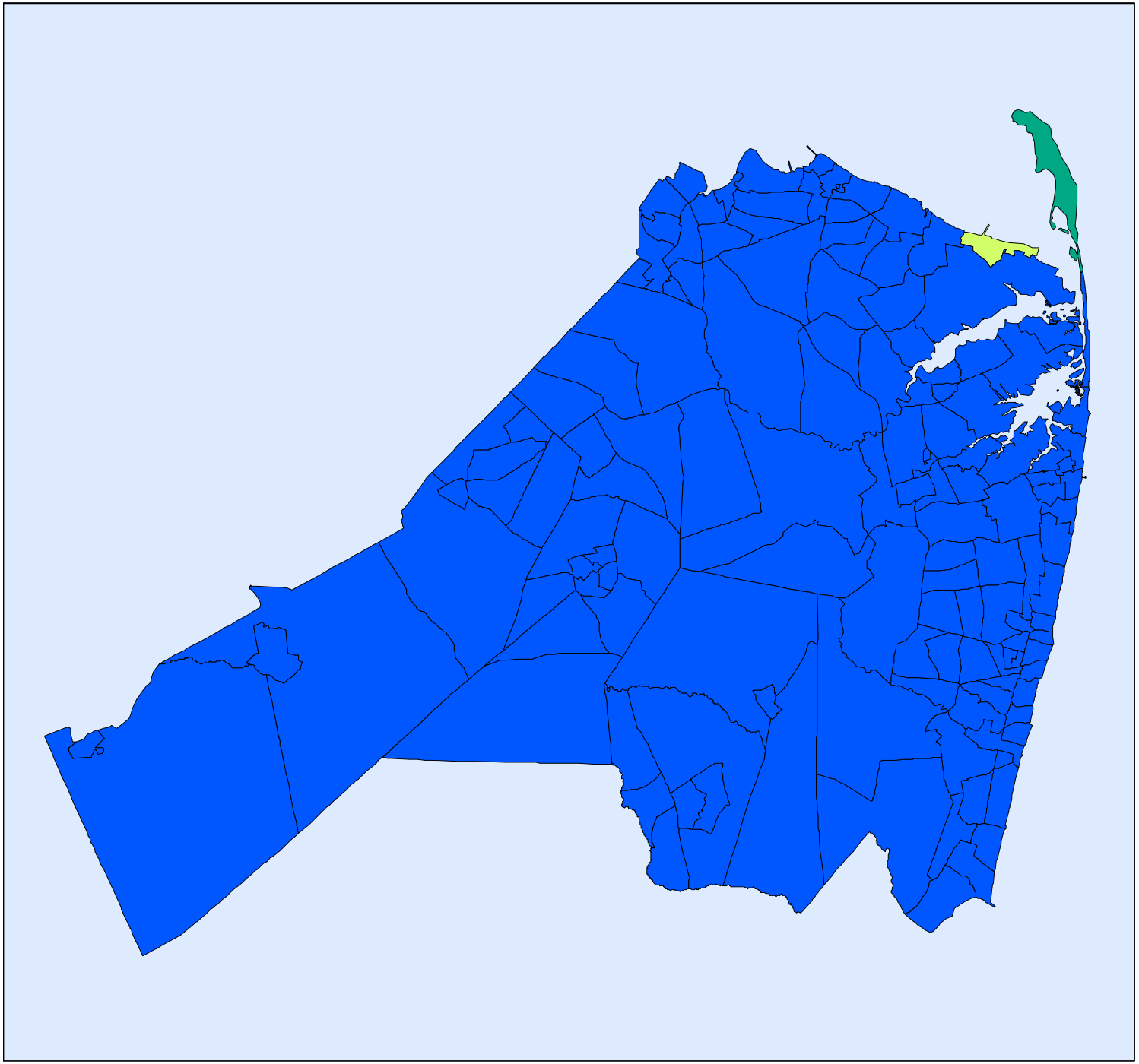
Counties :
- Monmouth,NJ

Major Metro Area :

Time of report: October 16, 2008 12:49 pm

APPENDIX M

1000-year return period with upgraded geology (M5.5)



Study Region:
Monmouth County

Scenario Description:
5.5 Probabilistic 1000 Year Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

5 2.5 0 5 Miles

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 20, 2008

Building Damage by Count by General Occupancy

October 16, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*142*	*25*	*12*	*3*	*0*	*182*
Commercial	*3,509*	*601*	*337*	*76*	*11*	*4,534*
Education	*116*	*18*	*10*	*3*	*1*	*148*
Government	*203*	*33*	*20*	*5*	*1*	*261*
Industrial	*640*	*104*	*63*	*13*	*2*	*823*
Religion	*250*	*36*	*20*	*6*	*2*	*313*
Other Residential	*9,788*	*1,516*	*941*	*294*	*99*	*12,637*
Single Family	*158,075*	*16,344*	*4,813*	*1,499*	*481*	*181,212*
Total	**172,722**	**18,677**	**6,216**	**1,898**	**597**	**200,110**
Region Total	**172,722**	**18,677**	**6,216**	**1,898**	**597**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.40 - 1.60
	Building Contents	0.00 - 0.10
	Business Interruption	0.10 - 0.30
Infrastructure	Lifelines Damage	
	Total	0.60 - 2.30

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	11 - 50	0 - 1	< 1.0	12 - 50
Major	1 - 4	< 1.0	< 1.0	1 - 5
Total	13 - 50	0 - 2	< 1.0	13 - 50

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	150 - 600
Level 2	Hospital Care	30 - 110
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	800 - 3,000	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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

Earthquake Information

Location :

Origin Time:

Magnitude : 5.50

Epicenter Latitude/Longitude :

/

Depth & Type :/P

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

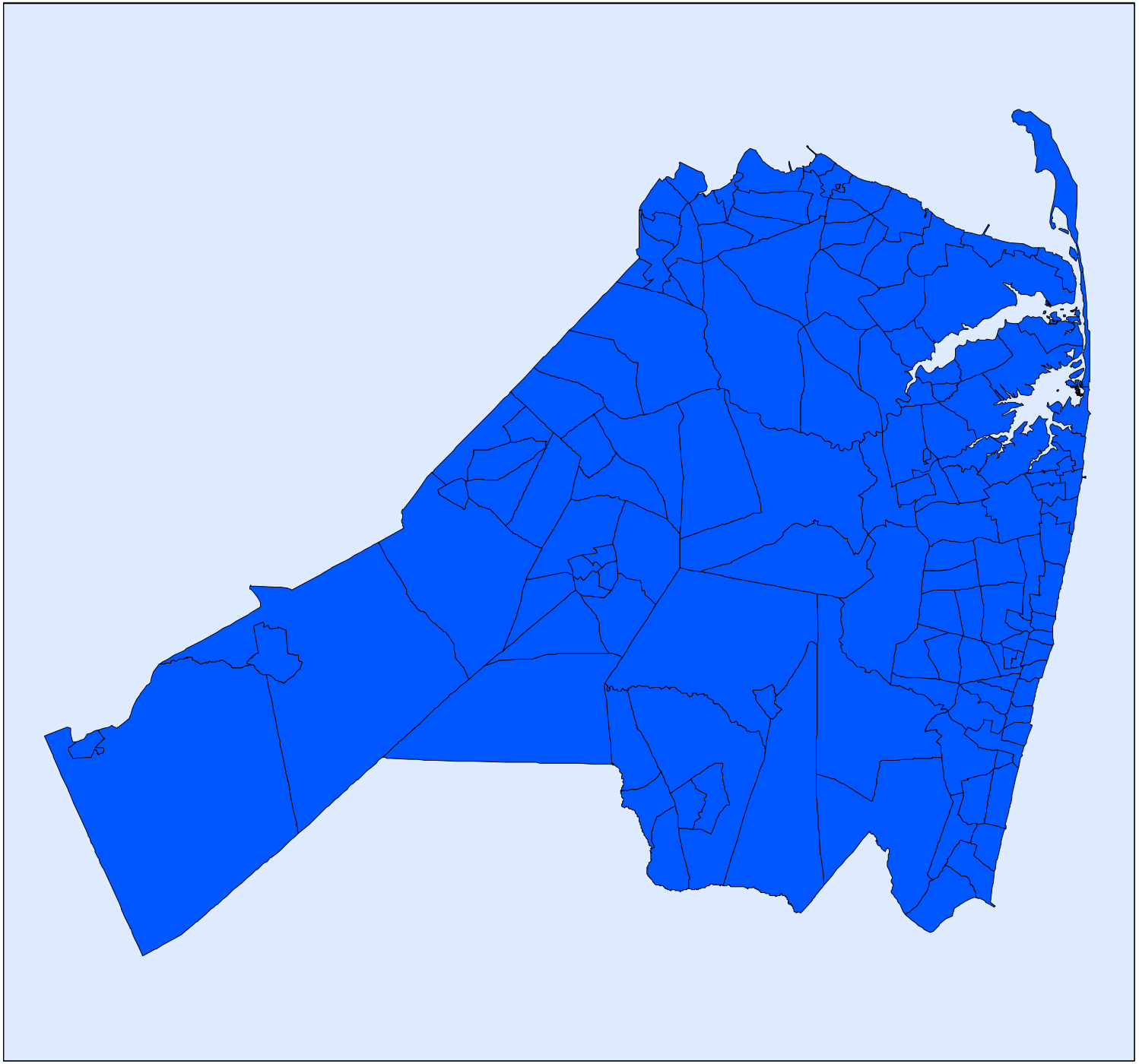
State: 400 - 1,800

Counties :
- Monmouth,NJ

Major Metro Area :

APPENDIX N

1000-year return period with default geology (M6)



5 2.5 0 5 Miles

Study Region:
Monmouth County

Scenario Description:
6.0 Probabilistic 1000 Year Default Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 20, 2008

Building Damage by Count by General Occupancy

October 15, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*143*	*26*	*11*	*2*	*0*	*182*
Commercial	*3,527*	*607*	*330*	*65*	*6*	*4,534*
Education	*118*	*19*	*10*	*2*	*0*	*148*
Government	*206*	*33*	*19*	*3*	*0*	*261*
Industrial	*645*	*105*	*61*	*11*	*1*	*823*
Religion	*255*	*36*	*18*	*4*	*0*	*313*
Other Residential	*10,111*	*1,560*	*844*	*112*	*10*	*12,637*
Single Family	*160,252*	*16,329*	*3,946*	*605*	*80*	*181,212*
Total	**175,257**	**18,714**	**5,239**	**803**	**98**	**200,110**
Region Total	**175,257**	**18,714**	**5,239**	**803**	**98**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.30 - 1.10
	Building Contents	0.00 - 0.10
	Business Interruption	0.10 - 0.20
Infrastructure	Lifelines Damage	
	Total	0.40 - 1.60

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	11 - 50	0 - 1	< 1.0	12 - 50
Major	0 - 1	< 1.0	< 1.0	0 - 1
Total	11 - 50	0 - 2	< 1.0	12 - 50

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	80 - 300
Level 2	Hospital Care	10 - 50
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	200 - 900	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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Earthquake Information

Location :

Origin Time:

Magnitude : 6.00

Epicenter Latitude/Longitude :

/

Depth & Type :/P

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

State: 140 - 600

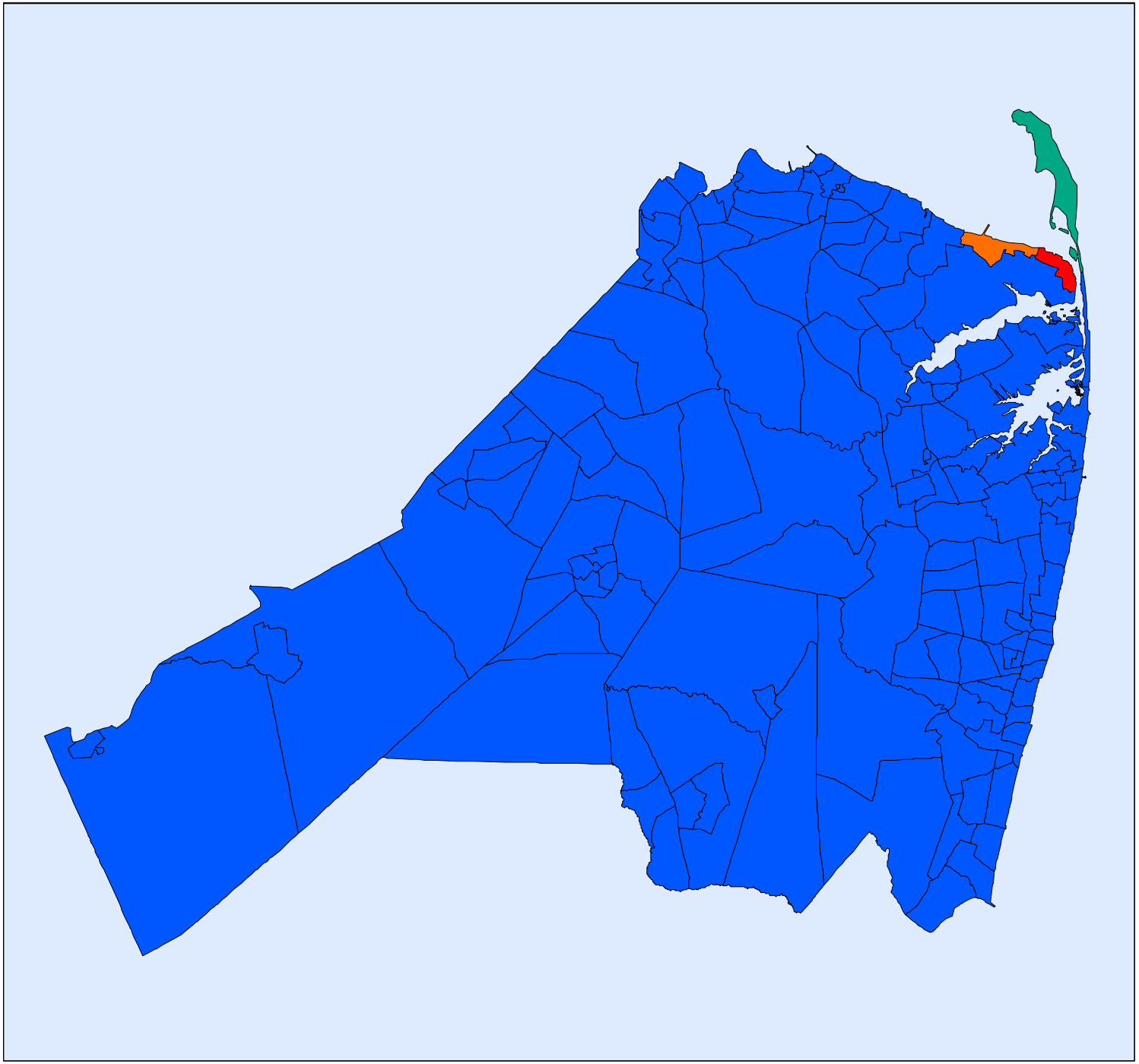
Counties :
- Monmouth,NJ

Major Metro Area :

Time of report: October 15, 2008 3:50 pm

APPENDIX O

1000-year return period with upgraded geology (M6)



5 2.5 0 5 Miles

Study Region:
Monmouth County

Scenario Description:
6.0 Probabilistic 1000 Year Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 20, 2008

Building Damage by Count by General Occupancy

October 16, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*142*	*25*	*11*	*3*	*1*	*182*
Commercial	*3,509*	*593*	*337*	*83*	*13*	*4,534*
Education	*116*	*18*	*10*	*3*	*1*	*148*
Government	*203*	*32*	*19*	*6*	*1*	*261*
Industrial	*640*	*102*	*64*	*15*	*2*	*823*
Religion	*250*	*35*	*19*	*7*	*2*	*313*
Other Residential	*9,788*	*1,490*	*851*	*381*	*127*	*12,637*
Single Family	*158,075*	*15,920*	*4,655*	*1,945*	*617*	*181,212*
Total	**172,722**	**18,215**	**5,966**	**2,443**	**764**	**200,110**
Region Total	**172,722**	**18,215**	**5,966**	**2,443**	**764**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.40 - 1.70
	Building Contents	0.00 - 0.10
	Business Interruption	0.10 - 0.30
Infrastructure	Lifelines Damage	
	Total	0.60 - 2.50

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	11 - 50	0 - 1	< 1.0	12 - 50
Major	1 - 6	< 1.0	< 1.0	1 - 6
Total	13 - 50	0 - 2	< 1.0	13 - 50

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	170 - 700
Level 2	Hospital Care	30 - 130
Level 3	Life-threatening	< 20
Level 4	Fatalities	< 20

Estimated Shelter Needs

Type	Households	People
Displaced Households	1,100 - 4,000	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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Earthquake Information

Location :

Origin Time:

Magnitude : 6.00

Epicenter Latitude/Longitude :

/

Depth & Type :/P

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

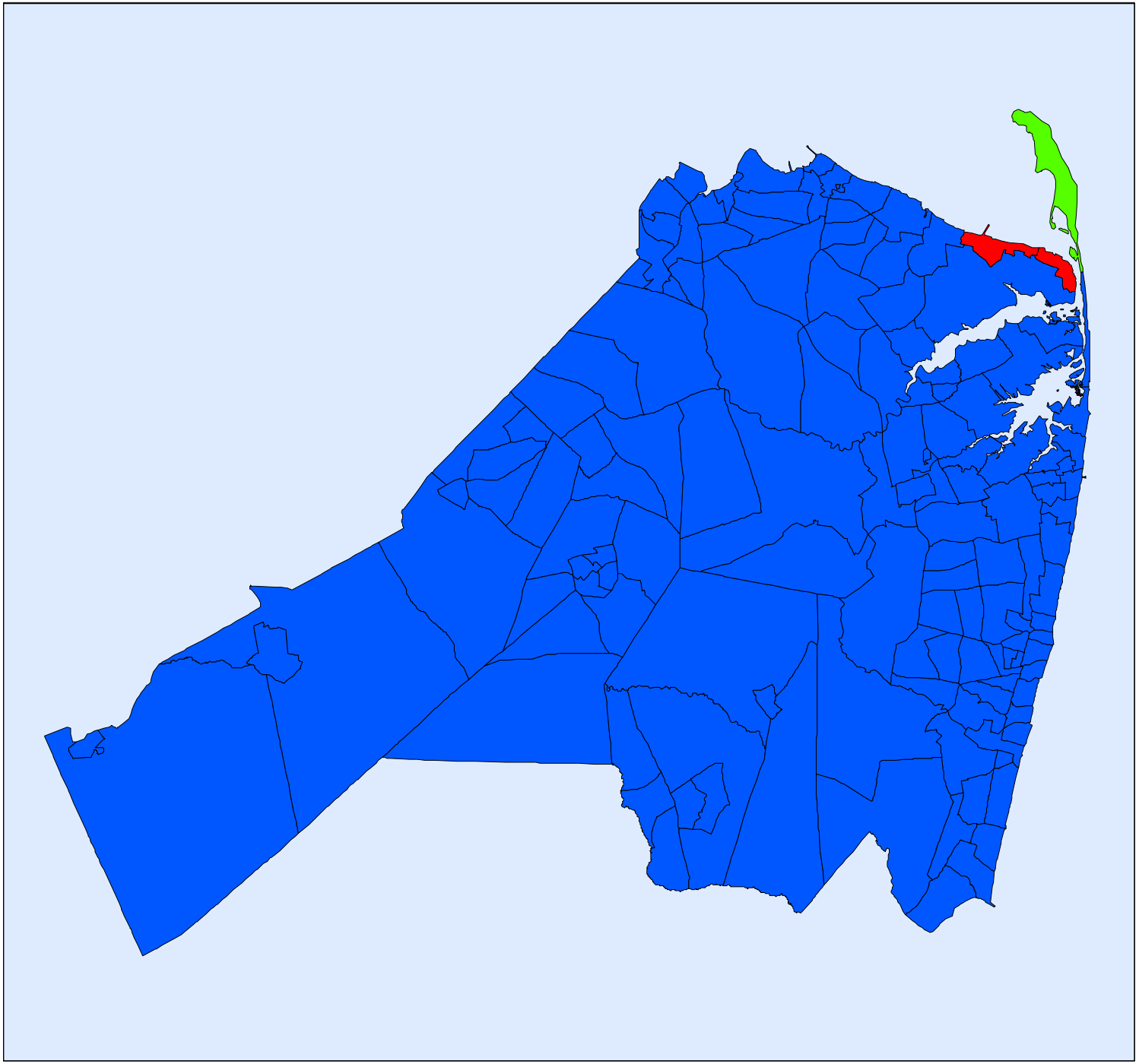
State: 600 - 2,000

Counties :
- Monmouth,NJ

Major Metro Area :

APPENDIX P

1000-year return period with upgraded geology (M6.5)



5 2.5 0 5 Miles

Study Region:
Monmouth County

Scenario Description:
6.5 Probabilistic 1000 Year Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 20, 2008

Building Damage by Count by General Occupancy

October 16, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*142*	*25*	*11*	*3*	*1*	*182*
Commercial	*3,509*	*589*	*337*	*84*	*15*	*4,534*
Education	*116*	*18*	*10*	*3*	*1*	*148*
Government	*203*	*32*	*19*	*6*	*2*	*261*
Industrial	*640*	*101*	*64*	*15*	*3*	*823*
Religion	*250*	*34*	*19*	*7*	*2*	*313*
Other Residential	*9,788*	*1,479*	*851*	*360*	*159*	*12,637*
Single Family	*158,075*	*15,737*	*4,670*	*1,960*	*770*	*181,212*
Total	**172,722**	**18,015**	**5,982**	**2,438**	**953**	**200,110**
Region Total	**172,722**	**18,015**	**5,982**	**2,438**	**953**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.50 - 1.80
	Building Contents	0.00 - 0.10
	Business Interruption	0.10 - 0.30
Infrastructure	Lifelines Damage	
	Total	0.70 - 2.70

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	11 - 50	0 - 1	< 1.0	12 - 50
Major	1 - 6	< 1.0	< 1.0	1 - 6
Total	13 - 50	0 - 2	< 1.0	13 - 50

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	190 - 800
Level 2	Hospital Care	40 - 150
Level 3	Life-threatening	< 20
Level 4	Fatalities	10 - 30

Estimated Shelter Needs

Type	Households	People
Displaced Households	1,200 - 5,000	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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

Earthquake Information

Location :

Origin Time:

Magnitude : 6.50

Epicenter Latitude/Longitude :

/

Depth & Type :/P

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

State: 600 - 2,000

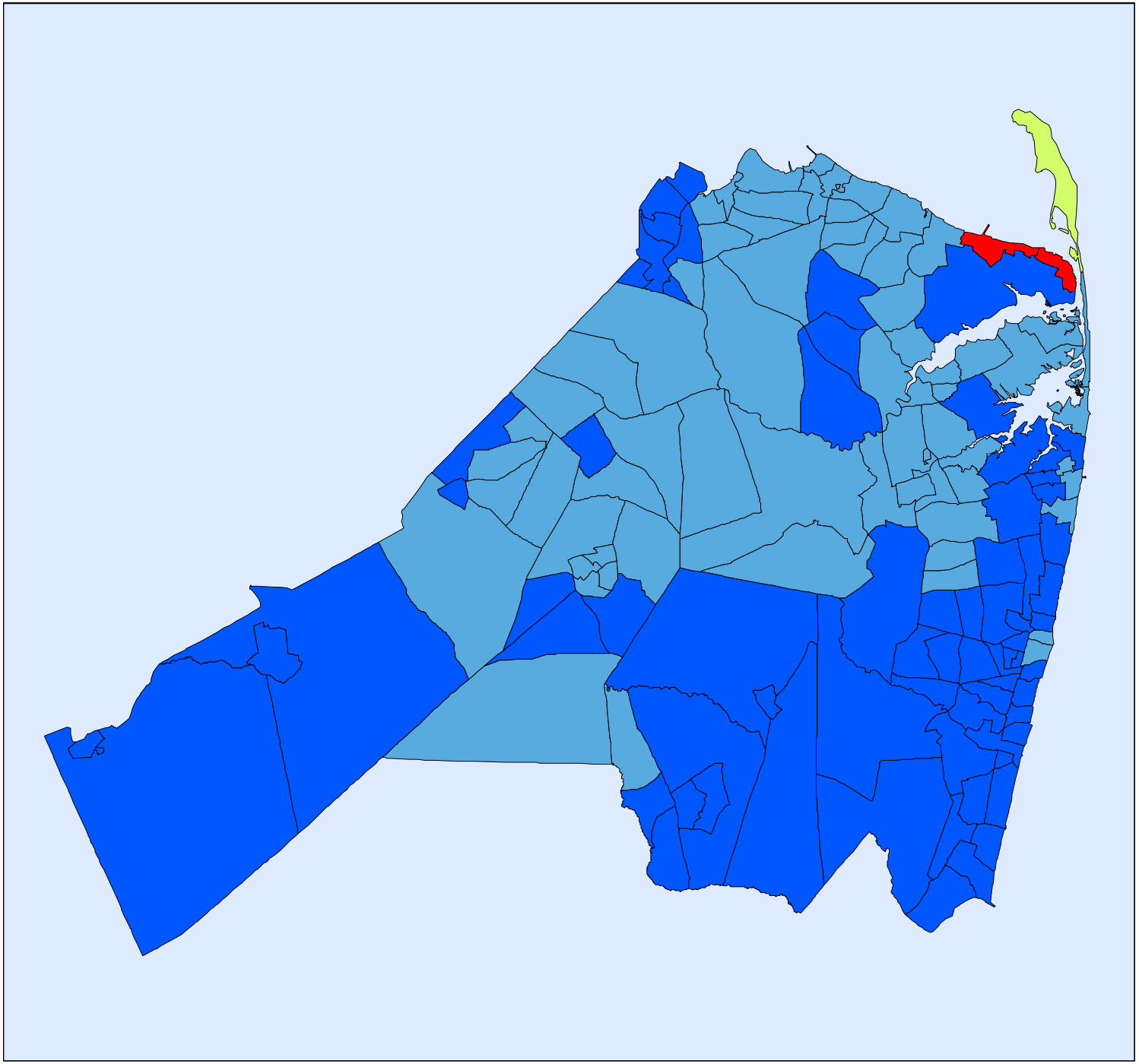
Counties :
- Monmouth,NJ

Major Metro Area :

Time of report: October 16, 2008 2:02 pm

APPENDIX Q

2500-year return period with upgraded geology (M5.5)



Study Region:
Monmouth County

Scenario Description:
5.5 Probabilistic 2500 Year Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

5 2.5 0 5 Miles

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 20, 2008

Building Damage by Count by General Occupancy

October 16, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*97*	*44*	*30*	*9*	*3*	*182*
Commercial	*2,360*	*969*	*832*	*295*	*78*	*4,534*
Education	*79*	*30*	*26*	*9*	*3*	*148*
Government	*137*	*52*	*49*	*17*	*6*	*261*
Industrial	*433*	*164*	*155*	*56*	*15*	*823*
Religion	*182*	*60*	*44*	*20*	*7*	*313*
Other Residential	*7,238*	*2,479*	*1,828*	*732*	*360*	*12,637*
Single Family	*128,453*	*34,191*	*11,530*	*4,335*	*2,702*	*181,212*
Total	**138,980**	**37,989**	**14,493**	**5,474**	**3,174**	**200,110**
Region Total	**138,980**	**37,989**	**14,493**	**5,474**	**3,174**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	1.40 - 5.40
	Building Contents	0.10 - 0.30
	Business Interruption	0.20 - 0.90
Infrastructure	Lifelines Damage	
	Total	2.00 - 8.10

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	30 - 100	0 - 3	0 - 1	30 - 100
Major	4 - 16	< 1.0	< 1.0	4 - 17
Total	30 - 120	1 - 4	0 - 1	30 - 120

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	600 - 2,000
Level 2	Hospital Care	130 - 500
Level 3	Life-threatening	10 - 60
Level 4	Fatalities	30 - 110

Estimated Shelter Needs

Type	Households	People
Displaced Households	3,000 - 12,000	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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

Earthquake Information

Location :

Origin Time:

Magnitude : 5.50

Epicenter Latitude/Longitude :
/

Depth & Type :/P

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

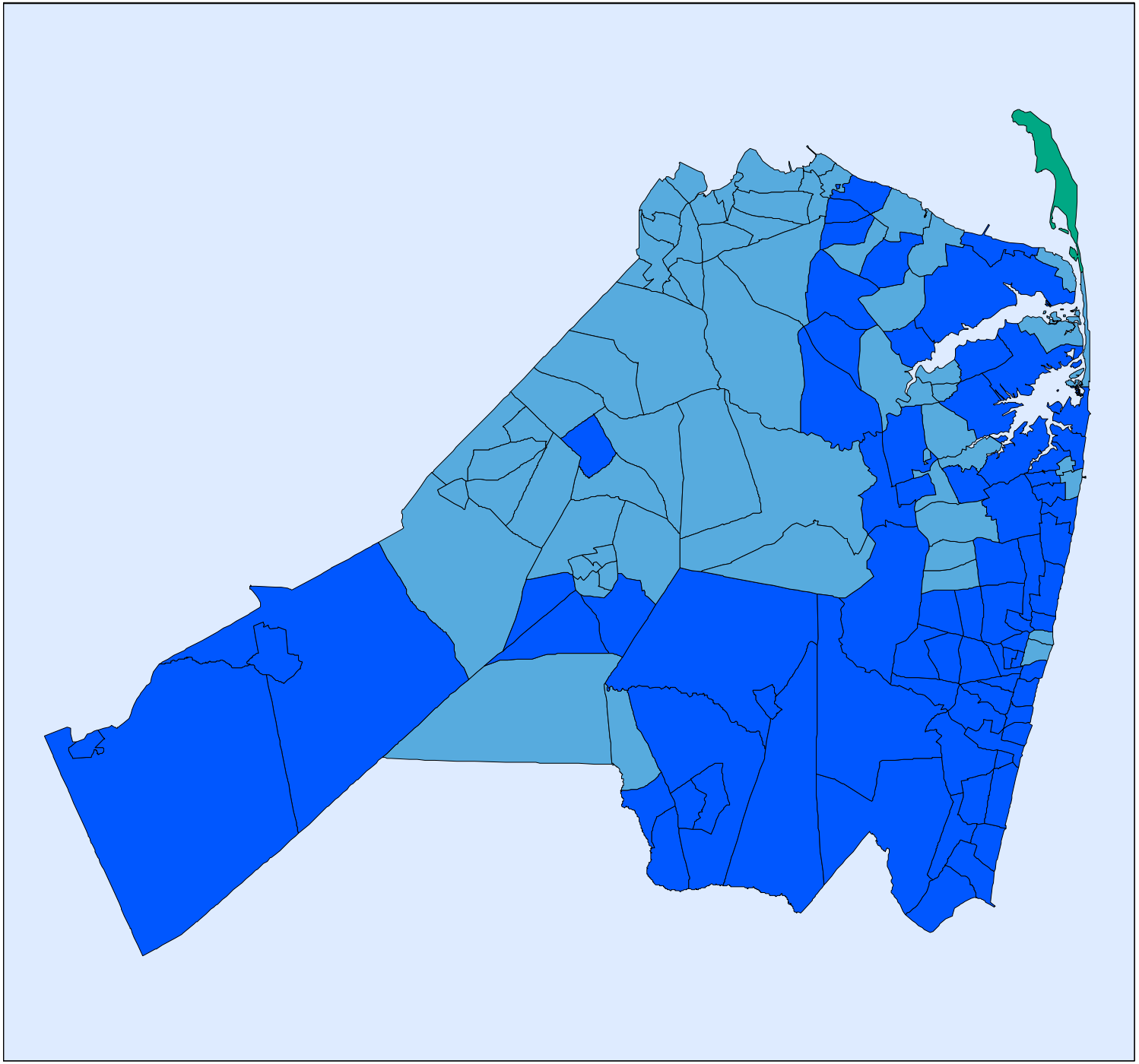
State: 1,800 - 7,000

Counties :
- Monmouth,NJ

Major Metro Area :

APPENDIX R

2500-year return period with default geology (M6)



Study Region:
Monmouth County

Scenario Description:
6.0 Probabilistic 2500 Year Default Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

5 2.5 0 5 Miles

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey.
October 20, 2008

Building Damage by Count by General Occupancy

October 15, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*97*	*45*	*31*	*8*	*1*	*182*
Commercial	*2,371*	*995*	*860*	*267*	*41*	*4,534*
Education	*80*	*31*	*27*	*8*	*1*	*148*
Government	*139*	*54*	*51*	*15*	*2*	*261*
Industrial	*437*	*169*	*161*	*49*	*7*	*823*
Religion	*185*	*63*	*46*	*16*	*3*	*313*
Other Residential	*7,511*	*2,628*	*1,944*	*488*	*67*	*12,637*
Single Family	*130,868*	*35,571*	*11,978*	*2,288*	*506*	*181,212*
Total	**141,688**	**39,556**	**15,098**	**3,138**	**629**	**200,110**
Region Total	**141,688**	**39,556**	**15,098**	**3,138**	**629**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	0.90 - 3.70
	Building Contents	0.10 - 0.20
	Business Interruption	0.20 - 0.80
Infrastructure	Lifelines Damage	
	Total	1.50 - 5.80

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	30 - 100	0 - 3	0 - 1	30 - 110
Major	1 - 6	< 1.0	< 1.0	1 - 7
Total	30 - 110	1 - 4	0 - 1	30 - 120

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	300 - 1,200
Level 2	Hospital Care	60 - 200
Level 3	Life-threatening	10 - 30
Level 4	Fatalities	10 - 60

Estimated Shelter Needs

Type	Households	People
Displaced Households	1,100 - 5,000	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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

Earthquake Information

Location :

Origin Time:

Magnitude : 6.00

Epicenter Latitude/Longitude :

/

Depth & Type :/P

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

State: 700 - 3,000

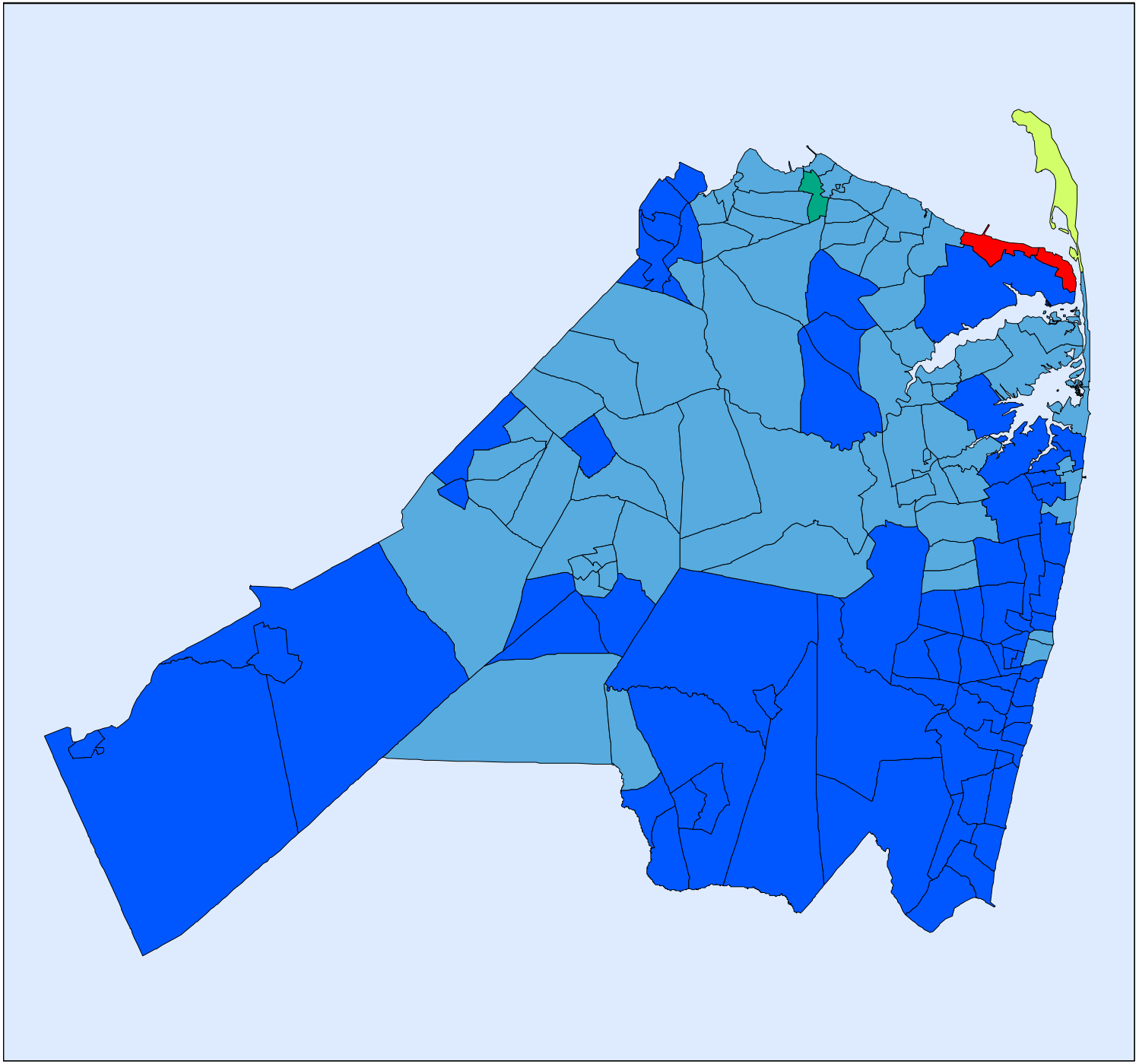
Counties :
- Monmouth,NJ

Major Metro Area :

Time of report: October 15, 2008 4:01 pm

APPENDIX S

2500-year return period with upgraded geology (M6)



Study Region:
Monmouth County

Scenario Description:
6.0 Probabilistic 2500 Year Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

5 2.5 0 5 Miles

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey. October 20, 2008

Building Damage by Count by General Occupancy

October 16, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*97*	*44*	*30*	*9*	*3*	*182*
Commercial	*2,359*	*969*	*831*	*288*	*88*	*4,534*
Education	*79*	*30*	*26*	*9*	*4*	*148*
Government	*137*	*52*	*49*	*17*	*7*	*261*
Industrial	*432*	*164*	*154*	*54*	*18*	*823*
Religion	*182*	*60*	*44*	*19*	*8*	*313*
Other Residential	*7,232*	*2,476*	*1,824*	*664*	*442*	*12,637*
Single Family	*128,348*	*34,152*	*11,499*	*3,897*	*3,318*	*181,212*
Total	**138,865**	**37,945**	**14,456**	**4,956**	**3,888**	**200,110**
Region Total	**138,865**	**37,945**	**14,456**	**4,956**	**3,888**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	1.40 - 5.70
	Building Contents	0.10 - 0.30
	Business Interruption	0.20 - 0.90
Infrastructure	Lifelines Damage	
	Total	2.10 - 8.40

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	20 - 100	0 - 3	0 - 1	30 - 100
Major	4 - 16	< 1.0	< 1.0	4 - 17
Total	30 - 120	1 - 4	0 - 1	30 - 120

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	700 - 3,000
Level 2	Hospital Care	150 - 600
Level 3	Life-threatening	20 - 60
Level 4	Fatalities	30 - 120

Estimated Shelter Needs

Type	Households	People
Displaced Households	3,000 - 14,000	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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

Earthquake Information

Location :

Origin Time:

Magnitude : 6.00

Epicenter Latitude/Longitude :

/

Depth & Type :/P

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

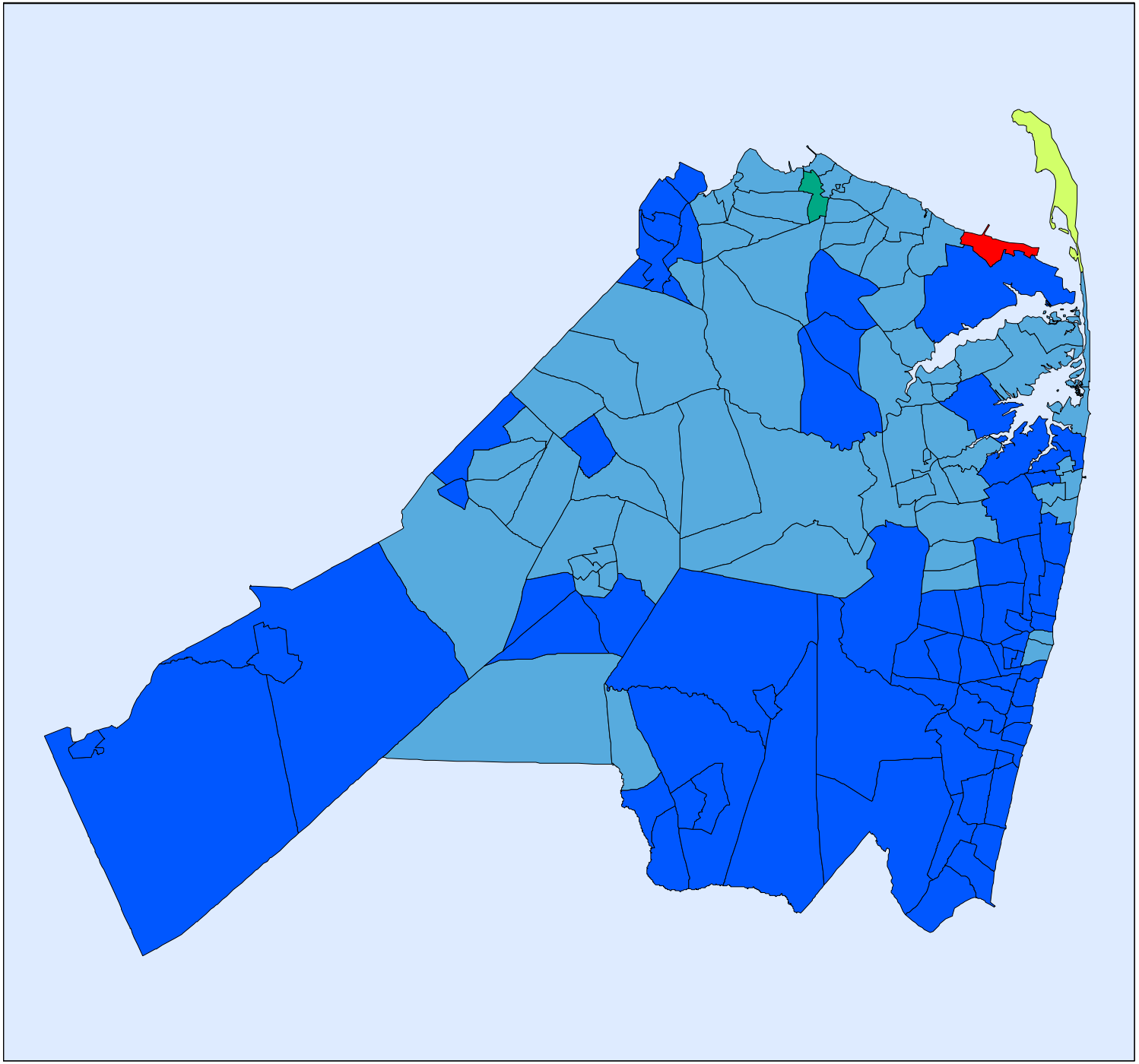
State: 1,900 - 8,000

Counties :
- Monmouth,NJ

Major Metro Area :

APPENDIX T

2500-year return period with upgraded geology (M6.5)



Study Region:
Monmouth County

Scenario Description:
6.5 Probabilistic 2500 Year Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 90 to 100
- 80 to 90
- 70 to 80
- 60 to 70
- 50 to 60
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10

5 2.5 0 5 Miles

Data from the HAZUS-MH GIS software and the New Jersey Geological Survey. October 20, 2008

Building Damage by Count by General Occupancy

October 16, 2008

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Monmouth						
Agriculture	*97*	*43*	*30*	*9*	*4*	*182*
Commercial	*2,357*	*967*	*829*	*279*	*101*	*4,534*
Education	*79*	*30*	*26*	*8*	*4*	*148*
Government	*137*	*52*	*48*	*16*	*8*	*261*
Industrial	*432*	*164*	*154*	*52*	*21*	*823*
Religion	*182*	*60*	*44*	*18*	*10*	*313*
Other Residential	*7,224*	*2,472*	*1,819*	*587*	*535*	*12,637*
Single Family	*128,228*	*34,107*	*11,458*	*3,421*	*3,998*	*181,212*
Total	**138,735**	**37,895**	**14,409**	**4,391**	**4,680**	**200,110**
Region Total	**138,735**	**37,895**	**14,409**	**4,391**	**4,680**	**200,110**

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/states were selected at the time of study region creation.

HAZUS-MH Loss Estimation

Estimated Economic Loss ($ Billions)

Category	Description	Range
General Building Stock	Building Damage	1.50 - 5.90
	Building Contents	0.10 - 0.30
	Business Interruption	0.20 - 1.00
Infrastructure	Lifelines Damage	
	Total	2.20 - 8.80

Estimated Building Damage(Thousands of Buildings)

Description	Residential	Commercial	Other	Total
Minor	20 - 100	0 - 3	0 - 1	30 - 100
Major	4 - 17	< 1.0	< 1.0	4 - 18
Total	30 - 120	1 - 4	0 - 1	30 - 120

Estimated Casualties : Night Time

Severity Level	Description	# Persons
Level 1	Medical Aid	700 - 3,000
Level 2	Hospital Care	170 - 700
Level 3	Life-threatening	20 - 70
Level 4	Fatalities	30 - 140

Estimated Shelter Needs

Type	Households	People
Displaced Households	4,000 - 15,000	
Public Shelter		

Comments :

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:

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

Earthquake Information

Location :

Origin Time:

Magnitude : 6.50

Epicenter Latitude/Longitude :

/

Depth & Type :/P

Fault Name :
NA

Maximum PGA : 0.00

Ground Motion /Attenuation :

Information Sources:

Comments :

Population and Building Exposure (2002 D&B) (2000 Census)

Population: 615,301

Building Exposure : ($ Millions)

Residential	44,379
Commerical	10,164
Other	4,019
Total	58,562

State: 2,000 - 9,000

Counties :
- Monmouth,NJ

Major Metro Area :

Time of report: October 16, 2008 2:56 pm

APPENDIX U

Seismic velocity data

Abbreviations are:

P-Wave=compressional wave
S-Wave=shear wave
gp spc = distance of geophone from source (feet)
pick = arrival time of wave at geophone (milliseconds)
int time = interval travel time between geophones (milliseconds)
int velocity = interval velocity--wave velocity between geophones (feet/second)
avg velocity = wave velocity calculated by averaging the interval velocities
regression velocity = wave velocity calculated from best-fit line to first arrivals

ALLAIRE

P WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	9.1					
6	19.2	10.1	594			
12	22.9	3.7	1622			
18	26.6	3.7	1622			
24	29.5	2.9	2069			
30	32	2.5	2400			
36	35.5	3.5	1714	1885	1961	layer 1
42	37.1	1.6	3750	3663	3315	layer 2
48	38.6	1.5	4000			
54	41	2.4	2500			
60	42.1	1.1	5454			
66	44.4	2.3	2609			

S WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	25.9					
6	35.1	9.2	652			
12	39.7	4.6	1304			
18	44.1	4.4	1364			
24	48.5	4.4	1364	1344	1364	layer 1
30	51	2.5	2400	2024	1818	layer 2
36	54.4	3.4	1765			
42	58.8	4.4	1364			
48	62	3.2	1875			
54	63.6	1.6	3750			
60	67.3	3.7	1622			
66	71.6	4.3	1395			

BOUNDARY

P WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	10					
6	14.8	4.8	1250			
12	22.6	7.8	769			
18	26.2	3.6	1667			
24	30	3.8	1579	1316	1219	layer 1
30	31.4	1.4	4286	5082	4693	layer 2
36	32.4	1	6000			
42	34	1.6	3750			
48	35.4	1.4	4286			
54	36.4	1	6000			
60	38	1.6	3750			
66	38.8	0.8	7500			

S WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	13.4					
6	25.8	12.4	484			
12	34.2	8.4	714			
18	41.8	7.6	789	662	641	layer 1
24	46.8	5	1200	1176	1120	layer 2
30	51.8	5	1200			
36	58.2	6.4	937			
42	63.4	5.2	1154			
48	68	4.6	1304			
54	74.8	6.8	882			
60	79.4	4.6	1304			
66	83.6	4.2	1429			

BURKE

P WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	8.3					
6	1.8	2.5	2400			
12	11.9	1.1	5454			
18	13.8	1.9	3158	3671	4000	layer 1
24	15.2	1.4	4286	6545	6324	layer 2
30	16.1	0.9	6667			
36	17.5	1.4	4286			
42	18.3	0.8	7500			
48	19.4	1.1	5454			
54	20.2	0.8	7500			
60	21.1	0.9	6667			
66	21.7	0.6	10000			

S WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	14.3					
6	22.7	8.4	714			
12	29.3	6.6	909			
18	36.4	7.1	845			
24	42.4	6	1000	918	916	layer 1
30	44.5	2.1	2857	2608	2295	layer 2
36	48.8	4.3	1395			
42	53.4	4.6	1304			
48	55.2	1.8	3333			
54	57	1.8	3333			
60	58.7	1.7	3529			
66	61.1	2.4	2500			

ELTON

P WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	4.1					
6	7.4	3.3	1818			
12	9.5	2.1	2857			
18	11.4	1.9	3158			
24	13.7	2.3	2609	2611	3000	layer 1
30	14.9	1.2	5000	5195	5234	layer 2
36	16.4	1.5	4000			
42	17.5	1.1	5454			
48	18.7	1.2	5000			
54	19.8	1.1	5454			
60	20.8	1	6000			
66	21.9	1.1	5454			

S WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	8.2					
6	14	5.8	1034			
12	18.7	4.7	1277			
18	22.2	3.5	1714			
24	26.5	4.3	1395	1355	1463	layer 1
30	29.3	2.8	2142	2841	2979	layer 2
36	31.3	2	3000			
42	33.1	1.8	3333			
48	34.9	1.8	3000			
54	36.9	2	3000			
60	39	2.1	2857			
66	41.7	2.7	2222			

FRANCIS MILL

P WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	6.4					
6	12.8	6.4	937			
12	17.6	4.8	1250			
18	22	4.4	1364			
24	27.2	5.2	1154	1334	1374	
30	30.6	3.4	1765			
36	34.4	3.8	1579			
42	39	4.6	1304			
48	43	4	1500			
54	48.2	5.2	1154			
60	51.8	3.6	1667			
66	57.8	6	1000			

S WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	29.6					
6	40.8	11.2	536			
12	47.6	6.8	882			
18	57.8	10.2	588			
24	65.6	7.8	769	739	752	
30	74	8.4	714			
36	81.8	7.8	769			
42	89	7.2	833			
48	95.8	6.8	882			
54	103.6	7.8	769			
60	113.4	9.8	612			
66	121.2	7.8	769			

IRON ORE

P WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	12.6					
6	16.6	4	1500			
12	19.3	2.7	2222	1861	2222	layer 1
18	20	0.7	8571	5594	5056	layer 2
24	21	1	6000			
30	22.3	1.3	4615			
36	23.2	0.9	6667			
42	24.2	1	6000			
48	25.3	1.1	5454			
54	26.9	1.6	3750			
60	28.3	1.4	4286			
66	29.5	1.2	5000			

S WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	16.1					
6	24.7	8.6	698			
12	33.4	8.7	690	694	690	layer 1
18	37.8	4.4	1364	1270	1227	layer 2
24	42.4	4.6	1304			
30	46.9	4.5	1333			
36	52.5	5.6	1071			
42	57.2	4.7	1277			
48	59.4	2.2	2727	3396	3125	layer 3
54	62.3	2.9	2069			
60	64.1	1.8	3333			
66	65.2	1.1	5454			

MANASQUAN

P WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	7.5					
6	12.3	4.8	1250	1786	1708	
12	17.7	5.4	1111			
18	22.9	5.2	1154			
24	27.5	4.6	1304			
30	29.8	2.3	1609			
36	33.5	3.7	1622			
42	36.6	3.1	1935			
48	39.7	3.1	1935			
54	43.7	4	1500			
60	45.9	2.2	2727			
66	48.3	2.4	2500			

S WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	13.6					
6	22.2	8.6	698			
12	28.1	5.9	1017	1231	1282	
18	34.4	6.3	952			
24	39.3	4.9	1224			
30	43.9	4.6	1304			
36	47.1	3.2	1875			
42	51.3	4.2	1429			
48	55.3	4	1500			
54	61.6	6.3	952			
60	66	4.4	1364			

MONMOUTH PARK

P WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	9.1					
6	12.8	3.7	1622			
12	15.7	2.9	2069			
18	18.1	2.4	2500			
24	20.2	2.1	2857	2262	2439	layer 1
30	21.6	1.4	4286	4918	4800	layer 2
36	22.6	1	6000			
42	23.9	1.3	4615			
48	25.3	1.4	4286			
54	26.7	1.4	4286			
60	27.6	0.9	6667			
66	29	1.4	4286			

S WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	21.2					
6	31.6	10.4	577			
12	43.4	11.8	508	646	636	
18	59	15.6	385			
24	72	13	461			
30	80.8	8.8	682			
36	91	10.2	588			
42	97.8	6.8	882			
48	106	8.2	732			
54	114.2	8.2	732			
60	120.8	6.6	909			
66	127	6.2	968			

NOMOCO

P WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	9.5					
6	13.7	4.2	1429			
12	16.5	2.8	2143			
18	18.6	2.1	2857			
24	20.3	1.7	3529	2489	2740	layer 1
30	21.4	1.1	5454	5766	5490	layer 2
36	22.3	0.9	6667			
42	23.2	0.9	6667			
48	24.3	1.1	5454			
54	25.4	1.1	5454			
60	26.9	1.5	4000			
66	27.8	0.9	6667			

S WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	20.5					
6	29.8	9.3	645			
12	37.5	7.7	779			
18	42.2	4.7	1277			
24	46.5	4.3	1395			
30	52.7	6.2	968			
36	58.2	5.5	1091	1026	1094	layer 1
42	60.7	2.5	2400	2931	2927	layer 2
48	63.7	3	2000			
54	65.2	1.5	4000			
60	67.4	2.2	2727			
66	69.1	1.7	3529			

PALAIA PARK

P WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	15.2					
6	21.6	6.4	937			
12	23.8	2.2	2727			
18	26.2	2.4	2500	2055	2609	layer 1
24	27.4	1.2	5000	5372	4701	layer 2
30	28.2	0.8	7500			
36	29	0.8	7500			
42	30.1	1.1	5454			
48	32	1.9	3158			
54	33.6	1.6	3750			
60	34.6	1	6000			
66	35.9	1.3	4615			

S WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	20.4					
6	28.2	7.8	769			
12	34.7	6.5	923			
18	40.4	5.7	1053			
24	45.4	5	1200			
30	49.2	3.8	1579			
36	55.6	6.4	937			
42	60.4	4.8	1250	1102	1141	layer 1
48	62.5	2.1	2857	2805	3158	layer 2
54	64.6	2.1	2857			
60	66.3	1.7	3529			
66	68	1.7	3529			

PESKIN

P WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	8.8					
6	15	6.2	968			
12	20	5	1200			
18	23	3	2000			
24	26.8	3.8	1579			
30	28.9	2.1	2857	1721	1734	layer 1
36	29.8	0.9	6667	6159	6461	layer 2
42	30.7	0.9	6667			
48	31.2	0.5	12000			
54	32	0.8	7500			
60	33	1	6000			
66	34	1	6000			

S WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	19.3					
6	30.7	11.4	526			
12	38.2	7.5	800			
18	46.5	8.3	723	683	759	layer 1
24	50.7	4.2	1429	2102	2123	layer 2
30	54.5	3.8	1579			
36	56.8	2.3	2609			
42	58.9	2.1	2857			
48	61.7	2.8	2143			
54	65.2	3.5	1714			
60	66.6	1.4	4286			
66	70.4	3.8	1579			

RISING SUN

P WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	4.2					
6	8.2	4	1500			
12	10.8	2.6	2308			
18	15	4.2	1429			
24	17.7	2.7	2222			
30	20.9	3.2	1875	1921	1837	
36	24.1	3.2	1875			
42	27.6	3.5	1714			
48	31.5	3.9	1538			
54	34	2.5	2400			
60	37.9	3.9	1538			
66	40.1	2.2	2727			

S WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	14.4					
6	21	6.6	909			
12	26.6	5.6	1071			
18	32.8	6.2	968	935	928	
24	39.3	6.5	923			
30	45.6	6.3	952			
36	53.1	7.5	800			
42	58.6	5.5	1091			
48	64.8	6.2	968			
54	73	8.2	732			

ROUTE 537

P WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	14.8					
6	19.6	4.8	1250			
12	23.6	4	1500			
18	33.2	9.6	625			
24	39.6	6.4	937			
30	45.8	6.2	968	1090	915	layer 1
36	56	10.2	588			
42	63	7	857			
48	68.8	5.8	1034			
54	73	4.2	1429			
60	77.6	4.6	1304			
66	81.6	4	1500			

S WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	21.6					
6	31.8	10.2	588			
12	41.2	9.4	638			
18	49.4	8.2	732	625	624	
24	59	9.6	625			
30	69	10	600			
36	78.4	9.4	638			
42	87.4	9	667			
48	98.4	11	545			
54	106.4	8	750			
60	117.6	11.2	536			
66	128.4	10.8	556			

WITCHES HOLLOW

P WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	4.8					
6	8.5	3.7	1622			
12	10.7	2.2	2727			
18	14.3	3.6	1667			
24	16.3	2	3000			
30	19.3	3	2000	2550	2579	
36	21	1.7	3529			
42	23.2	2.2	2727			
48	25.5	2.3	2609			
54	27.3	1.8	3333			
60	29.6	2.3	2609			
66	32.3	2.7	2222			

S WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	6.4					
6	11.3	4.9	1224			
12	14.5	3.2	1875			
18	21.3	6.8	882	1375	1279	
24	26.1	4.8	1250			
30	30.6	4.5	1333			
36	35.6	5	1200			
42	40.3	4.7	1277			
48	45.7	5.4	1111			
54	49.1	3.4	1765			
60	53.6	4.5	1333			
66	56.8	3.2	1875			

WRECK POND

P WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	4.4					
6	10.4	6	1000			
12	15.8	5.4	1111			
18	22.6	6.8	882			
24	28.2	5.6	1071			
30	32.4	4.2	1429	1099	1064	layer 1
36	34.3	1.9	3158	3336	3153	layer 2
42	37	2.7	2222			
48	38.3	1.3	4615			
54	40.8	2.5	2400			
60	42.2	1.4	4286			
66	44	1.8	3333			

S WAVE

gp spc	pick	int time	int velocity	avg velocity	regression velocity	comments
0	12					
6	20.4	8.4	714			
12	30.4	10	600			
18	38.3	7.9	759	744	729	
24	48.6	10.3	582			
30	55	6.4	937			
36	63.6	8.6	698			
42	71.6	8	750			
48	80.2	8.6	698			
54	88.2	8	750			
60	94.5	6.3	952			

SEISMIC SOIL CLASS MAP
FOR
MONMOUTH COUNTY, NEW JERSEY

Prepared by Scott D. Stanford, New Jersey Geological Survey
for the
New Jersey State Police, Office of Emergency Management
2009

Soil Class C--very dense soil and soft rock. Shear-wave velocity between 1200 and 2500 ft/s (360 and 760 m/s) (HAZUS number 3).

Soil Class D--stiff soil. Shear-wave velocity between 600 and 1200 ft/s (180 and 360 m/s) (HAZUS number 4).

Soil Class E--soft soil. Shear-wave velocity less than 600 ft/s (180 m/s) (HAZUS number 5).

The soil class designations are defined in the 1997 National Earthquake Hazards Reduction Program (NEHRP) Provisions. Soil classes were assigned using Standard Penetration Test data, shear-wave velocity measurements, and geologic map data (listed below), according to the procedures described in sections 4.1.2.1, 4.1.2.2, and 4.1.2.3 of the NEHRP Provisions (Federal Emergency Management Agency, 1998). Equation 4.1.2.3-2 was used to assign soil class in layered cases.

This map shows the extent of natural soils. Man-made fill overlies these soils in parts of the county. This fill includes a wide range of materials. The behavior of fill during seismic shaking should be assessed on a site-specific basis.

SCALE 1:50,000

1 0 1 2 3 4 MILES

3000 0 3000 6000 9000 12000 15000 18000 21000 FEET

1 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 10 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

BASE FROM U. S. GEOLOGICAL SURVEY LONG BRANCH (1983) AND TRENTON (1986) 1:100,000 METRIC TOPOGRAPHIC MAPS

12° TRUE NORTH MAGNETIC NORTH

APPROXIMATE MEAN
DECLINATION, 1989

REFERENCES

Federal Emergency Management Agency, 1998, NEHRP recommended provisions for seismic regulations for new buildings and other structures, part 1--provisions: prepared by the National Institute of Building Sciences, FEMA 302, p. 33-41.

Minard, J. P., and Owens, J. P., 1962, Pre-Quaternary geology of the New Egypt quadrangle, New Jersey: U. S. Geological Survey Geologic Quadrangle Map GQ 161, scale 1:24,000.

Minard, J. P., 1964, Geology of the Roosevelt quadrangle, New Jersey: U. S. Geological Survey Geologic Quadrangle Map GQ 340, scale 1:24,000.

Minard, J. P., 1969, Geology of the Sandy Hook quadrangle in Monmouth County, New Jersey: U. S. Geological Survey Bulletin 1276, 43 p.

Owens, J. P., and Minard, J. P., 1964, Pre-Quaternary geology of the Allentown quadrangle, New Jersey: U. S. Geological Survey Geologic Quadrangle Map GQ 340, scale 1:24,000.

Owens, J. P., and Minard, J. P., 1975, Geologic map of the surficial deposits in the Trenton area, New Jersey and Pennsylvania: U. S. Geological Survey Miscellaneous Investigations Series Map I-884, scale 1:48,000.

Stanford, S. D., 1992, Surficial geology of the Marlboro quadrangle, Monmouth County, New Jersey: N. J. Geological Survey Open File Map OFM 5, scale 1:24,000.

Stanford, S. D., 1995, Surficial geology of the South Amboy quadrangle, Middlesex and Monmouth counties, New Jersey: N. J. Geological Survey Open File Map OFM 18, scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Farmingdale quadrangle, Monmouth and Ocean counties, New Jersey: N. J. Geological Survey Open File Map OFM 35, scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Roosevelt quadrangle, Mercer, Monmouth and Ocean counties, New Jersey: N. J. Geological Survey Open File Map OFM 36, scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Adelphia quadrangle, Monmouth and Ocean counties, New Jersey: N. J. Geological Survey Open File Map OFM 37, scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Long Branch quadrangle, Monmouth county, New Jersey: N. J. Geological Survey Open File Map OFM 38, scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Sandy Hook quadrangle, Monmouth County, New Jersey: N. J. Geological Survey Open File Map OFM 39, scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Asbury Park quadrangle, Monmouth and Ocean counties, New Jersey: N. J. Geological Survey Open File Map OFM 40, scale 1:24,000.

Stanford, S. D., 2002, Surficial geology of the Freehold quadrangle, Middlesex and Monmouth counties, New Jersey: N. J. Geological Survey Open File Map OFM 43, scale 1:24,000.

Stanford, S. D., 2002, Surficial geology of the Jamesburg quadrangle, Middlesex and Monmouth counties, New Jersey: N. J. Geological Survey Open File Map OFM 45, scale 1:24,000.

Stanford, S. D., 2002, Surficial geology of the Keyport quadrangle, Middlesex and Monmouth counties, New Jersey: N. J. Geological Survey Open File Map OFM 46, scale 1:24,000.

Sugarman, P. J., Owens, J. P., and Bybell, L. M., 1991, Geologic map of the Adelphia and Farmingdale quadrangles, Monmouth and Ocean counties, New Jersey: N. J. Geological Survey Geologic Map Series GMS 91-1, scale 1:24,000.

Sugarman, P. J., and Owens, J. P., 1994, Geologic map of the Asbury Park quadrangle, Monmouth County, New Jersey: N. J. Geological Survey Geologic Map Series GMS 94-2, scale 1:24,000.

Sugarman, P. J., and Owens, J. P., 1996, Bedrock geologic map of the Freehold and Marlboro quadrangles, Middlesex and Monmouth counties, New Jersey: N. J. Geological Survey Geologic Map Series GMS 96-1, scale 1:24,000.

Sugarman, P. J., Stanford, S. D., Owens, J. P., and Brenner, G. J.,1996, Bedrock geologic map of the South Amboy quadrangle, Middlesex and Monmouth counties, New Jersey: N. J. Geological Survey Open File Map OFM 65, scale 1:24,000.

SOIL LIQUEFACTION SUSCEPTIBILITY FOR MONMOUTH COUNTY, NEW JERSEY

Prepared by Scott D. Stanford, New Jersey Geological Survey
for the
New Jersey State Police, Office of Emergency Management

2009

EXPLANATION

- Category 1--very low
- Category 2--low
- Category 3--moderate
- Category 4--high

Categories are from the HAZUS User's Manual, Table 9.1 (National Institute of Building Sciences, 1997), with modifications reflecting local geologic conditions. Geologic data are from the maps listed below.

This map shows the liquefaction susceptibility of natural soils. Man-made fill overlies these soils in parts of the county. This fill includes a wide range of materials. The behavior of fill during seismic shaking should be assessed on a site-specific basis.

SCALE 1:50,000

1 1/2 0 1 2 3 4 MILES
3000 0 3000 6000 9000 12000 15000 18000 21000 FEET
1 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 10 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

BASE FROM U. S. GEOLOGICAL SURVEY LONG BRANCH (1983) AND TRENTON (1986) 1:100,000 METRIC TOPOGRAPHIC MAPS

12°
APPROXIMATE MEAN DECLINATION, 1989

REFERENCES

Minard, J. P., and Owens, J. P., 1962, Pre-Quaternary geology of the New Egypt quadrangle, New Jersey: U. S. Geological Survey Geologic Quadrangle Map GQ 161, scale 1:24,000.

Minard, J. P., 1964, Geology of the Roosevelt quadrangle, New Jersey: U. S. Geological Survey Geologic Quadrangle Map GQ 340, scale 1:24,000.

Minard, J. P., 1969, Geology of the Sandy Hook quadrangle in Monmouth County, New Jersey: U. S. Geological Survey Bulletin 1276, 43 p.

National Institute of Building Sciences, 1997, HAZUS user's manual: Washington, D. C., National Institute of Building Sciences Publication 5200.

Owens, J. P., and Minard, J. P., 1964, Pre-Quaternary geology of the Allentown quadrangle, New Jersey: U. S. Geological Survey Geologic Quadrangle Map GQ 340, scale 1:24,000.

Owens, J. P., and Minard, J. P., 1975, Geologic map of the surficial deposits in the Trenton area, New Jersey and Pennsylvania: U. S. Geological Survey Miscellaneous Investigations Series Map I-884, scale 1:48,000.

Stanford, S. D., 1992, Surficial geology of the Marlboro quadrangle, Monmouth County, New Jersey: N. J. Geological Survey Open File Map OFM 5, scale 1:24,000.

Stanford, S. D., 1995, Surficial geology of the South Amboy quadrangle, Middlesex and Monmouth counties, New Jersey: N. J. Geological Survey Open File Map OFM 18, scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Farmingdale quadrangle, Monmouth and Ocean counties, New Jersey: N. J. Geological Survey Open File Map OFM 35, scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Roosevelt quadrangle, Mercer, Monmouth and Ocean counties, New Jersey: N. J. Geological Survey Open File Map OFM 36, scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Adelphia quadrangle, Monmouth and Ocean counties, New Jersey: N. J. Geological Survey Open File Map OFM 37, scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Long Branch quadrangle, Monmouth county, New Jersey: N. J. Geological Survey Open File Map OFM 38, scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Sandy Hook quadrangle, Monmouth County, New Jersey: N. J. Geological Survey Open File Map OFM 39, scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Asbury Park quadrangle, Monmouth and Ocean counties, New Jersey: N. J. Geological Survey Open File Map OFM 40, scale 1:24,000.

Stanford, S. D., 2002, Surficial geology of the Freehold quadrangle, Middlesex and Monmouth counties, New Jersey: N. J. Geological Survey Open File Map OFM 43, scale 1:24,000.

Stanford, S. D., 2002, Surficial geology of the Jamesburg quadrangle, Middlesex and Monmouth counties, New Jersey: N. J. Geological Survey Open File Map OFM 45, scale 1:24,000.

Stanford, S. D., 2002, Surficial geology of the Keyport quadrangle, Middlesex and Monmouth counties, New Jersey: N. J. Geological Survey Open File Map OFM 46, scale 1:24,000.

Sugarman, P. J., Owens, J. P., and Bybell, L. M., 1991, Geologic map of the Adelphia and Farmingdale quadrangles, Monmouth and Ocean counties, New Jersey: N. J. Geological Survey Geologic Map Series GMS 91-1, scale 1:24,000.

Sugarman, P. J., and Owens, J. P., 1994, Geologic map of the Asbury Park quadrangle, Monmouth County, New Jersey: N. J. Geological Survey Geologic Map Series GMS 94-2, scale 1:24,000.

Sugarman, P. J., and Owens, J. P., 1996, Bedrock geologic map of the Freehold and Marlboro quadrangles, Middlesex and Monmouth counties, New Jersey: N. J. Geological Survey Geologic Map Series GMS 96-1, scale 1:24,000.

Sugarman, P. J., Stanford, S. D., Owens, J. P., and Brenner, G. J.,1996, Bedrock geologic map of the South Amboy quadrangle, Middlesex and Monmouth counties, New Jersey: N. J. Geological Survey Open File Map OFM 65, scale 1:24,000.

LANDSLIDE SUSCEPTIBILITY FOR MONMOUTH COUNTY, NEW JERSEY

Prepared by Scott D. Stanford, New Jersey Geological Survey
for the
New Jersey State Police, Office of Emergency Management

2009

EXPLANATION

- None--HAZUS number 0
- BIII — Landslide Class BIII--dry sandy soil, slope angle 10-15 degrees (HAZUS number 3)
- BIV — Landslide Class BIV--dry sandy soil, slope angle 15-20 degrees (HAZUS number 4).
- BV — Landslide Class BV--dry sandy soil, slope angle 20-30 degrees (HAZUS number 7).
- CVI — Landslide Class CVI--dry clayey soil, slope angle 10-15 degrees (HAZUS number 8).
- CVII — Landslide Class CVII--dry clayey soil, slope angle 15-20 degrees (HAZUS number 9).
- CIX — Landslide Class CIX--dry clayey soil, slope angle 20-30 degrees (HAZUS number 9).
- CX — Landslide Class CX--wet clayey soil, slope angle greater than 15 degrees (HAZUS number 10).

Landslide classes are from the HAZUS User's Manual, Table 9.2 (National Institute of Building Sciences, 1997). Slope angles were measured from the following U. S. Geological Survey 7.5 minute quadrangles: Freehold, Jamesburg, Keyport, Long Branch, Marlboro, Sandy Hook (all with 20-foot contour interval); Allentown, Adelphia, Cassville, Roosevelt, South Amboy (10-foot contour interval); Asbury Park, Farmingdale, Lakewood, Point Pleasant (5-foot contour interval). Slope materials were determined from the geologic maps listed in the References.

SCALE 1:50,000

1 0 1 2 3 4 MILES
3000 0 3000 6000 9000 12000 15000 18000 21000 FEET
1 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 10 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

BASE FROM U. S. GEOLOGICAL SURVEY LONG BRANCH (1983) AND TRENTON (1986) 1:100,000 METRIC TOPOGRAPHIC MAPS

12°
TRUE NORTH
MAGNETIC NORTH

APPROXIMATE MEAN
DECLINATION, 1989

REFERENCES

Minard, J. P., and Owens, J. P., 1962, Pre-Quaternary geology of the New Egypt quadrangle, New Jersey: U. S. Geological Survey Geologic Quadrangle Map GQ 161, scale 1:24,000.

Minard, J. P., 1964, Geology of the Roosevelt quadrangle, New Jersey: U. S. Geological Survey Geologic Quadrangle Map GQ 340, scale 1:24,000.

Minard, J. P., 1969, Geology of the Sandy Hook quadrangle in Monmouth County, New Jersey: U. S. Geological Survey Bulletin 1276, 43 p.

National Institute of Building Sciences, 1997, HAZUS user's manual: Washington, D. C., National Institute of Building Sciences Publication 5200.

Owens, J. P., and Minard, J. P., 1964, Pre-Quaternary geology of the Allentown quadrangle, New Jersey: U. S. Geological Survey Geologic Quadrangle Map GQ 340, scale 1:24,000.

Stanford, S. D., 1992, Surficial geology of the Marlboro quadrangle, Monmouth County, New Jersey: N. J. Geological Survey Open File Map OFM 5, scale 1:24,000.

Stanford, S. D., 1995, Surficial geology of the South Amboy quadrangle, Middlesex and Monmouth counties, New Jersey: N. J. Geological Survey Open File Map OFM 18, scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Farmingdale quadrangle, Monmouth and Ocean counties, New Jersey: N. J. Geological Survey Open File Map OFM 35, scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Roosevelt quadrangle, Mercer, Monmouth and Ocean counties, New Jersey: N. J. Geological Survey Open File Map OFM 36, scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Adelphia quadrangle, Monmouth and Ocean counties, New Jersey: N. J. Geological Survey Open File Map OFM 37, scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Long Branch quadrangle, Monmouth county, New Jersey: N. J. Geological Survey Open File Map OFM 38, scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Sandy Hook quadrangle, Monmouth County, New Jersey: N. J. Geological Survey Open File Map OFM 39, scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Asbury Park quadrangle, Monmouth and Ocean counties, New Jersey: N. J. Geological Survey Open File Map OFM 40, scale 1:24,000.

Stanford, S. D., 2002, Surficial geology of the Freehold quadrangle, Middlesex and Monmouth counties, New Jersey: N. J. Geological Survey Open File Map OFM 43, scale 1:24,000.

Stanford, S. D., 2002, Surficial geology of the Jamesburg quadrangle, Middlesex and Monmouth counties, New Jersey: N. J. Geological Survey Open File Map OFM 45, scale 1:24,000.

Stanford, S. D., 2002, Surficial geology of the Keyport quadrangle, Middlesex and Monmouth counties, New Jersey: N. J. Geological Survey Open File Map OFM 46, scale 1:24,000.

Sugarman, P. J., Owens, J. P., and Bybell, L. M., 1991, Geologic map of the Adelphia and Farmingdale quadrangles, Monmouth and Ocean counties, New Jersey: N. J. Geological Survey Geologic Map Series GMS 91-1, scale 1:24,000.

Sugarman, P. J., and Owens, J. P., 1994, Geologic map of the Asbury Park quadrangle, Monmouth County, New Jersey: N. J. Geological Survey Geologic Map Series GMS 94-2, scale 1:24,000.

Sugarman, P. J., and Owens, J. P., 1996, Bedrock geologic map of the Freehold and Marlboro quadrangles, Middlesex and Monmouth counties, New Jersey: N. J. Geological Survey Geologic Map Series GMS 96-1, scale 1:24,000.

Sugarman, P. J., Stanford, S. D., Owens, J. P., and Brenner, G. J.,1996, Bedrock geologic map of the South Amboy quadrangle, Middlesex and Monmouth counties, New Jersey: N. J. Geological Survey Open File Map OFM 65, scale 1:24,000.