EARTHQUAKE LOSS ESTIMATION STUDY
FOR
ESSEX COUNTY, NEW JERSEY:

GEOLOGIC COMPONENT

Prepared for the
New Jersey State Police
Office of Emergency Management

by the
New Jersey Geological Survey

November 2001

CONTENTS

FINAL REPORT

GEOLOGIC COMPONENT OF THE EARTHQUAKE LOSS ESTIMATION STUDY FOR ESSEX COUNTY, NEW JERSEY

Prepared for the New Jersey State Police, Office of Emergency Management

by
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Summary: Geologic and topographic data were acquired and analyzed in order to compile maps of seismic soil class, liquefaction susceptibility, and landslide susceptibility for Essex County (folded in pocket). The soil class, liquefaction susceptibility, and landslide susceptibility data were entered into the HAZUS model for each census tract in the county. The HAZUS model was run with the full upgraded geologic data and with the default geologic data for earthquake magnitudes of 5.5 and 6. To assess the effect of liquefaction, runs were also made with full upgraded geology and with upgrade without liquefaction for magnitudes 5, 5.5, 6, 6.5, and 7. Selected outputs from these runs are attached in Appendices B through M. The upgraded geology produced significant changes in both the spatial distribution of damage and the total damage estimates compared to default geology. The upgraded geology produced greater building damage in the Newark Meadows and Great Piece Meadows areas of the county (Figure 1), where soils are softer and more liquefiable than the default, and less building damage on most upland areas, where soils are stronger than the default. Because uplands comprise most of the area of Essex County, the total economic loss is between 10 and 20% less with the upgraded geologic data than with the default data at all magnitudes. Adding liquefaction increases building damage about 10% in susceptible census tracts, especially at magnitudes 6 and 6.5, but results in less than a 1.5% increase in total loss for the entire county.

In addition to the HAZUS data upgrades and runs, shear-wave velocity was measured on two soil types (alluvium and till) at a total of 14 locations. The results of these measurements are provided in Table 3 and Appendix N. 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. Weathered till yielded slower velocities than predicted by the penetration data in unweathered till, an effect previously observed for till in Bergen County.

Geologic Data Acquired: Six surficial materials were identified and mapped in Essex County. These include glacial till, glacial-lake and glacial-river sand and gravel deposits, glacial-lake silt and clay deposits, postglacial river deposits, peat and organic silt and clay deposited in wetlands, and outcropping bedrock. The distribution and thickness of these materials were mapped at

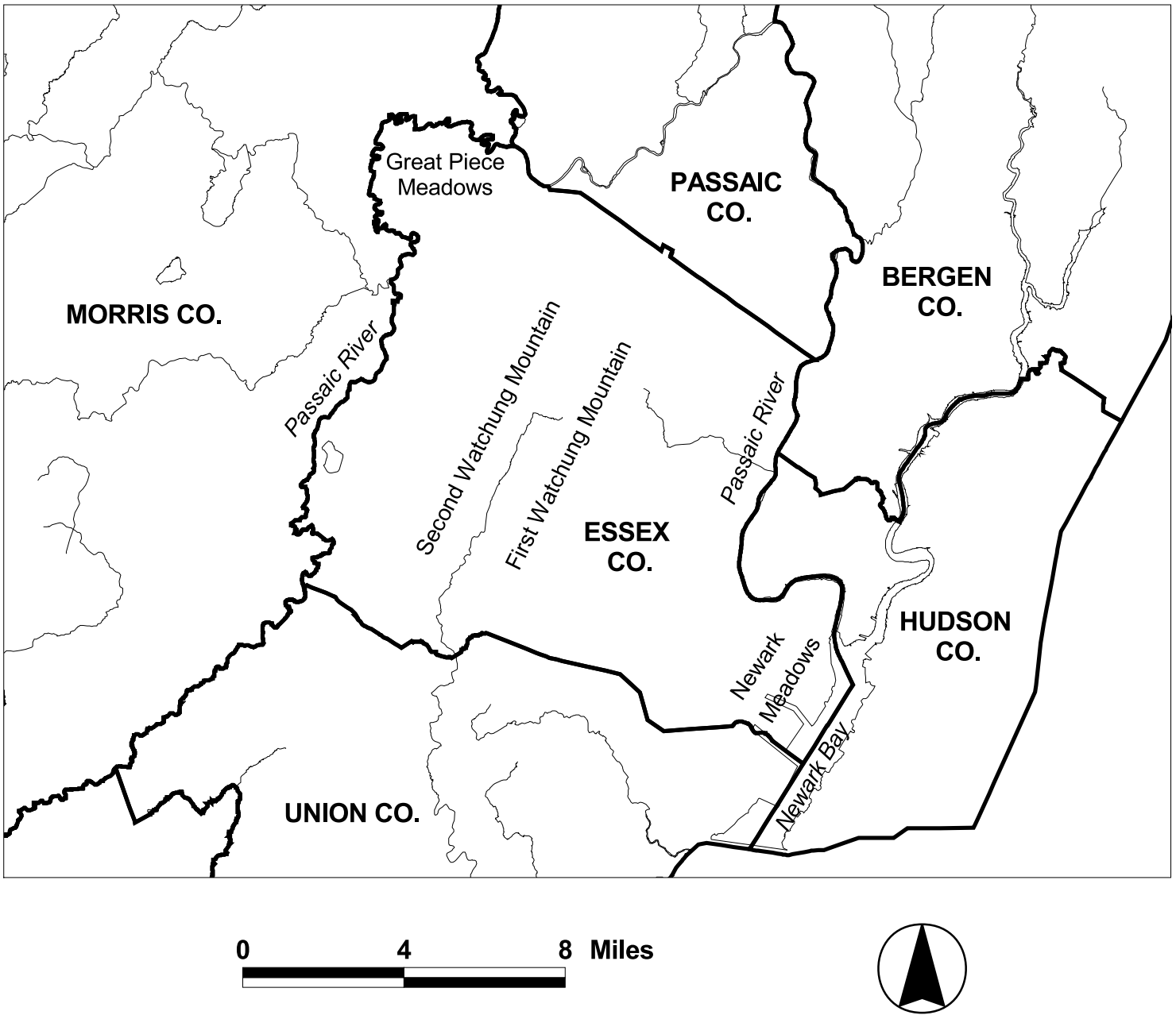


Figure 1. Essex County, showing features named in text.

1:24,000 scale using stereo-airphoto interpretation, field observations, archival geologic map data on file at the NJGS, and logs of about 1000 test borings. Till is a compact pebbly, cobbly, and, in places, bouldery silty sand to sandy silt sediment deposited directly beneath glacial ice. It veneers the bedrock surface and is as much as 170 feet thick in the county. On parts of the Watchung Mountains, till is thin or absent and bedrock is exposed or is at depths of less than 10 feet. Glacial-lake deposits overlie the till in the lowlands along the Passaic River, in the valley between First and Second Watchung Mountain, in some valleys east of First Watchung Mountain, and in the Newark Bay-Newark Meadows area. These deposits include sand and gravel as much as 150 feet thick and silt and clay as much as 250 feet thick. Glacial-river sand and gravel forms terraces in some valleys east of First Watchung Mountain. Alluvial sediment was deposited in floodplains along all the main streams after the glacier retreated and the glacial lakes drained. It is as much as 20 feet thick and overlies glacial-lake deposits in places. In the Newark Meadows and Newark Bay, alluvial sand laid down before sea-level rise underlies salt-marsh and estuarine deposits. The salt-marsh and estuarine deposits are generally less than 20 feet thick. The extent of these deposits is important because they are loose, saturated soils that are especially susceptible to seismic shaking. Archival maps at the NJGS dating back to 1880 were used to delineate the original limit of the marshes, which are now covered by fill over much of their former extent.

Data Analysis: 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. In addition to the approximately 300 borings in the Hudson County-Newark area, with a total of 4,777 SPT tests, that were used to define soil classes for the Newark and Hudson County HAZUS studies in 1998 and 1999 (Table 1), an additional 60 borings, with a total of 688 SPT tests, were acquired for Essex County (Table 2). These borings were chiefly in the Passaic Valley along the western border of the county.

SPT data from the additional borings show the effect of varying depositional settings across the county. Alluvium along the Passaic River in western Essex is younger in age and more clay- and silt-rich than the sandy alluvium in the Newark area, and so has a lower mean penetration value. Glacial-lake silt and clay in western Essex was more widely exposed to oxidation and desiccation after glacial lakes drained than lake clays in the Newark area, so the dried upper portions of the deposits in western Essex have higher penetration resistance. In Table 2 these data are subsetted as “dried glacial-lake silt and clay” while the lower, unexposed deposits are subsetted as “wet glacial-lake silt and clay”, which have a mean SPT that is similar to the Newark-area lake clay (Table 1). Till is of high resistance in both areas, with the variation in mean likely due to the low sample number in western Essex.

For each surficial unit, a mean SPT value, and standard deviation, were calculated. This mean value is then applied to the mapped extent of the surficial unit to prepare the soil class map. Fill includes a variety of materials ranging from demolition debris and excavated bedrock to trash and dredged silt and sand. Because of the variable composition of fill it is inappropriate

to apply a mean SPT value, and fill was not included in the soil classification determinations. The behavior of fill under seismic shaking should be assessed on a site-specific basis. HAZUS soil classes were assigned according to the procedures described in sections 4.1.2.1, 4.1.2.2, and 4.1.2.3 of the 1997 National Earthquake Hazards Reduction Program (NEHRP) Provisions. These procedures assign a soil class by using a weighting formula to sum the soil and rock layers to a depth of 100 feet.

Table 1.--Standard Penetration Test (SPT) data for surficial materials in the Hudson County-Newark area, from the 1998 and 1999 HAZUS studies.

Material	Number of Borings	Number of Tests	Range of SPT Values	Mean ± Standard Deviation	Percentage of Zero Values
fill	223	737	0-191	17.8±19.2	1.2%
salt-marsh deposits	218	647	0-38	2.8±4.5	45.9%
alluvial sand	67	221	0-89	24.0±13.9	1.8%
glacial-lake sand	79	573	2-139	27.3±17.3	0%
glacial-lake silt and clay	224	1559	0-157	13.7±13.9	11.4%
till	247	723	3-330	67.4±57.8	0%

Table 2.--Additional SPT data for Essex County.

Material	Number of Borings	Number of Tests	Range of SPT Values	Mean± Standard Deviation	Percentage of Zero Values
alluvial silt, sand, and clay	54	332	0-104	14±16	0.6%
glacial-lake silt and clay, all	37	327	0-64	19±12	0.6%
glacial-lake silt and clay, wet	19	128	0-36	11±6	1.6%
glacial-lake silt and clay, dried	18	199	3-64	24±12	0%
till	11	29	17-279	102±66	0%

The boring logs also report the depth of the water table, which marks the upper limit of saturation. This information, along with the grain size and compaction of the soil, is used to map liquefaction susceptibility. Liquefaction susceptibility was assigned based on Table 9.1 of the

HAZUS Users Manual, with some modifications to the classification scheme based on local penetration-test data. For example, low penetration resistance of some saturated glacial-lake deposits of Pleistocene age indicate a moderate-to-high liquefaction susceptibility, rather than the low susceptibility for Pleistocene lake deposits provided in Table 9.1. The resulting maps are attached (folded in pocket).

Landslide susceptibility depends on slope angle and the geologic material underlying the slope. Slope angles for Essex County were calculated from 1:24,000 topographic maps with 10-foot contour interval and slope materials were determined in the field, and from archival geologic maps. Landslide susceptibility was assigned according to the classification in Table 9.2 of the HAZUS User's Manual (refer to map folded in pocket). Areas of potential landsliding include steep slopes on till and basalt bedrock on the east sides of First and Second Watchung Mountain, cliffs on basalt in quarries and roadcuts in the Watchungs, and a few steep slopes on till, sandstone bedrock, and sand and gravel elsewhere in the county.

Shear-wave Velocity Measurements: To test the accuracy of using SPT data as a proxy for shear-wave velocity, seismic data were collected at fourteen sites in Essex County. The tested soil types include alluvium (8 sites) and till (6 sites) (Table 3). The measurements were made at sites where the natural deposit was undisturbed and not covered or mixed with man-made fill. At each site, hand-auger holes were drilled 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 wave (horizontal component) and compression (P) wave data were acquired (Appendix N). P-waves are much faster than shear waves and help in isolating the shear-wave signal in the seismic record. P-wave data generally show two velocity layers. The uppermost layer is unsaturated sediment and the lower layer is saturated sediment. The boundary between the two layers is the water table. The water table is not detectable in shear wave data because liquids do not transmit shear waves.

Table 3. Shear-wave velocity measurements. Complete data provided in Appendix N.

Site	Location (latitude; longitude)	Material	Measured shear-wave velocity (feet/second)	Shear-wave velocity range predicted from SPT data (feet/second)	Comments
Interstate 80 Fairfield	40E53'48"; 74E17'07"	peaty alluvium	429	<600	agrees
South Orange Ave. #1	40E46'36"; 74E22'14"	clayey alluvium	815	600-1200	agrees

South Orange Ave. #2	40E46'30"; 74E22'15"	clayey alluvium	752	600-1200	agrees
Peckman	40E51'02"; 74E13'58"	sandy alluvium	605	600-1200	agrees
Livingston Well Site	40E48'37"; 74E20'44"	clayey alluvium	765	600-1200	agrees
Painters Point	40E44'24": 74E18'09"	gravelly alluvium	966	600-1200	agrees
Horseneck Rd. #1	40E52'52"; 74E20'20"	sandy alluvium	820	600-1200	agrees
Horseneck Rd. #2	40E52'54"; 74E20'24"	clayey alluvium	514	600-1200	lower than predicted due to high organic content?
East Hill	40E47'15"; 74E17'52"	till	1101	1200-2500	lower than predicted due to weathering
South Orange till	40E46'43"; 74E21'57"	till	1700	1200-2500	agrees
Locust Grove	40E43'38"; 74E18'17"	till	1007	1200-2500	lower than predicted due to weathering
Becker Park #1	40E48'53"; 74E19'17"	till	1235	1200-2500	agrees
Becker Park #2	40E48'49"; 74E19'17"	till	1912	1200-2500	agrees
Eagle Rock	40E49'02"; 74E14'23"	till	1089	1200-2500	lower than predicted due to weathering

Twelve shear geophones were used with a 6-foot spacing. The source was located 6 feet from the first geophone. Each geophone was oriented with its axis of movement parallel to the generating source. The 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 while it is being hit to improve ground coupling.

Compressional (P-wave) data were collected using the standard seismic refraction line type setup. Twelve 8-hertz geophones were used in-line at 6-foot spacing. A 10-pound sledgehammer and a strike plate are used as a source.

The first seismic break on the raw records from both the shear and compressional data is picked on the records much like picking first breaks for seismic refraction data. 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. 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 inhomogeneities within the soil; however, the regression velocity is statistically more accurate as a bulk soil property.

Table 3 shows that 9 of the 14 tests yield velocities that fall within the range predicted from the county-wide SPT data. One alluvium site (Horseneck Rd. #2) yielded a slower velocity than predicted from the penetration-test data. This site was next to an abandoned-channel pond along the Passaic River and it is possible that organic matter accumulated in the pond slowed the shear waves. Also, the clay at this site was a recent flood deposit and so is less compact than most floodplain clay.

Three of the six till measurements yielded lower-than-predicted velocities. Most till is deposited beneath glacial ice, and so is overconsolidated by the weight of the ice. Once exposed, however, the compact matrix of the till is broken apart and loosened by weathering and soil processes, so that the upper several feet of outcropping till is decompacted. Also, as the glacier margin retreats, material on the surface of the ice is deposited on top of the till laid down at the base of the glacier. This surface till is noncompact because it was never compressed by the ice. The loose surface till is recorded by SPT data from borings drilled into till outcrops. Typically, the upper several feet yield low blow counts, which increase significantly below the weathered zone. The tests at the East Hill, Locust Grove, and Eagle Rock sites may have sampled weathered or noncompressed till.

Soil classes were adjusted based on the above observations. Peaty alluvium was placed into class E rather than the D class indicated by the SPT data from nonpeaty deposits. Till was maintained as class C because the boring data indicate that compact till everywhere underlies the loose till, which is generally less than 5 feet thick.

HAZUS Simulations: To evaluate the effect of upgraded geology and liquefaction, a total of twelve simulations were run. Earthquake magnitudes of 5.5 and 6, with an epicenter at the county centroid (Appendix A) and a focal depth of 10 km, were simulated for both the default and the upgraded geology. Earthquake magnitudes of 5, 5.5, 6, 6.5, and 7, with the same epicenter and focal depth, were simulated for full upgraded geology and for upgraded geology without liquefaction. 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 event 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 the Boston area, southern Quebec, and the St. Lawrence Valley.

To upgrade the geologic data, soil type, liquefaction susceptibility, and landslide susceptibility were modified for each census tract using the seismic soil class, liquefaction

susceptibility, and landslide susceptibility maps (folded in pocket). Many census tracts, particularly in the western parts of the county, spanned two or more soil types. In these cases, the dominant soil under the most densely built part of the census tract was selected. Also, areas subject to landsliding cover only a small part of the census tracts that were assigned a landslide hazard. 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. It was determined that building damage was the output parameter that would most directly illustrate the effect of geology on the simulations, because it does not directly incorporate economic and demographic patterns. Appendices B through M provide tables showing the number of the buildings (classed by use) in various states of damage, and the probability of a given damage state for a given use class. 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 "Quick Assessment Report" 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.

Evaluation of Simulations: The upgraded geologic data produced increased damage estimates in the Great Piece Meadows, Newark Meadows, and downtown Newark, and generally decreased damage estimates elsewhere, compared to the default data.. This pattern reflects the softer wetland and glacial-lake soils beneath the Great Piece Meadows and eastern half of Newark, which are of less stable soil class and are more liquefiable than the default conditions, and the compact glacial till soil on most of the upland areas of the county, which is of stronger soil class than the default. Census tracts underlain by the vulnerable soils (classes D and E, with medium and high liquefaction susceptibility) show as much as 30% more buildings damaged to a moderate or greater state than the default (class D with no liquefaction susceptibility) damage. Census tracts underlain by till (class C) show as much as 20% fewer buildings damaged than the default.

Because the area of the county underlain by till is more extensive than the area underlain by vulnerable soils, the total number of buildings with moderate or greater damage is less with the upgraded geologic data than with the default data, and the total economic and property loss is between 10 and 20% less with the upgraded geologic data. Note, however, that important transportation facilities are located in eastern Newark, including Newark Airport, Port Newark, the New Jersey Turnpike, Interstate 78, Routes 1-9, 22, and 21, and the Northeast Corridor rail line. Many of the highways are on viaducts in this area, and the HAZUS results indicate significantly increased bridge damage for the upgrade runs. At magnitude 5.5 the default run shows 14 bridge segments with moderate damage and 0 with complete damage. The 5.5 upgrade run shows 31 bridge segments with moderate damage and 4 with complete damage. At magnitude 6 the default run shows 209 bridge segments with moderate damage and 19 with complete damage. The 6 upgrade run shows 249 segments with moderate damage and 46 with complete damage.

Liquefaction accounts for less than 1.5% of countywide economic loss, with the greatest impact at magnitudes 5 (1.4%) and 5.5 (0.9%). However, census tracts with a moderate and high liquefaction susceptibility show as much as a 10% increase in the percentage of buildings damaged to a moderate or greater state, compared to no-liquefaction runs. This increase is most strongly expressed at magnitudes 6 and 6.5. It is likely that the true impact of liquefaction is greater than indicated in these runs. Liquefaction causes permanent ground displacements (PGD), which is the principal cause of damage to gas, water, and sewer mains and other underground utilities, as well as damage to roads, railroads, and runways. HAZUS did not calculate this damage for these runs because there is no default data for utility system lifelines. Upgrading the utility data would provide a more complete picture of the impact of liquefaction. An indication of the effect is provided by damage to oil pipelines, for which there is default data. At magnitude 5.5, HAZUS calculates 4 leaks and 10 breaks for 17 km of pipeline with liquefaction, compared to 2 leaks and 0 breaks without liquefaction. At magnitude 6 there are 10 leaks and 16 breaks with liquefaction, and 8 leaks and 2 breaks without. So liquefaction appears to increase pipeline breaks by a factor of 8-10.

APPENDIX A

Maps of Essex 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

2 1 0 2 4 6 8 10 Miles

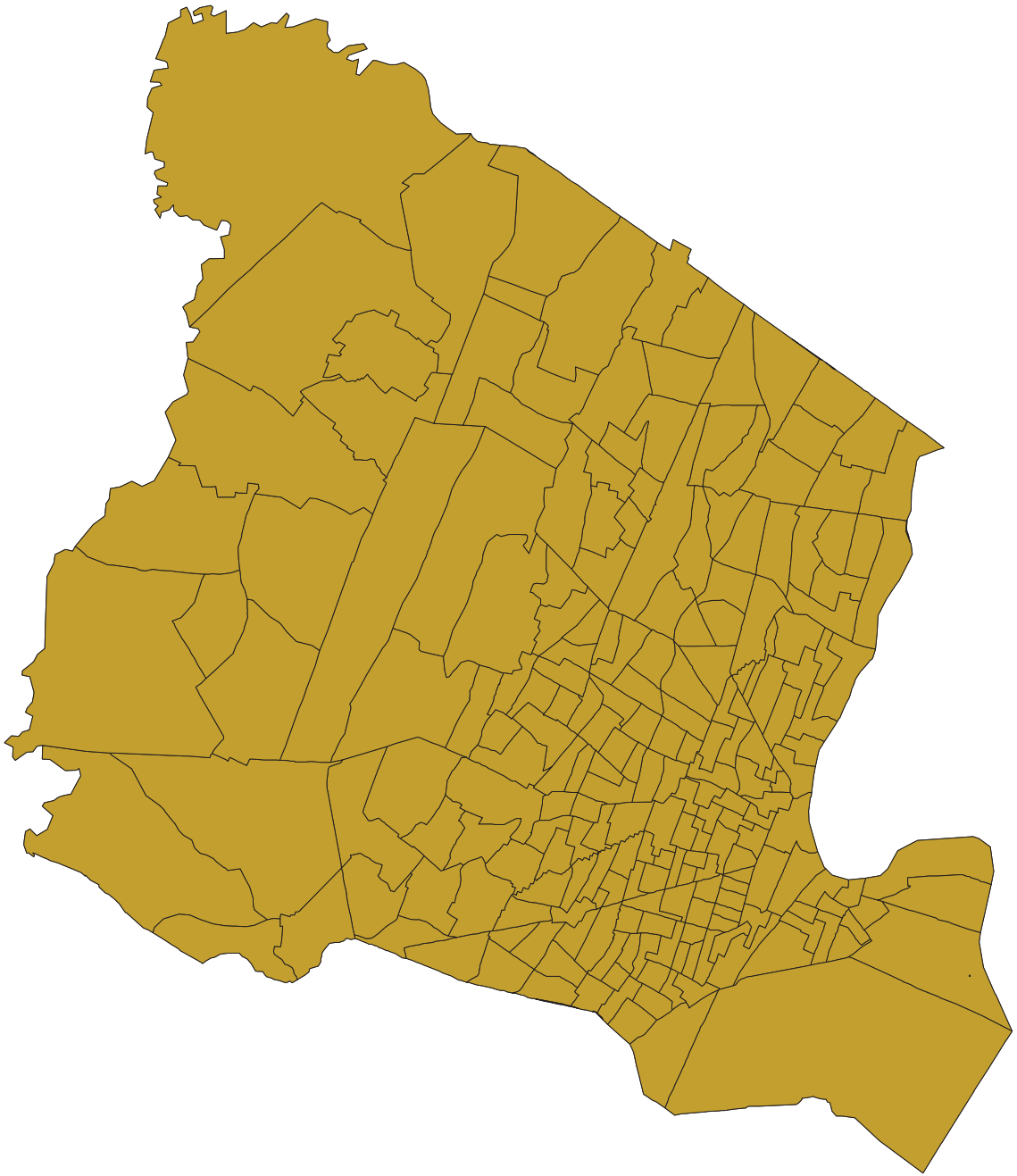
Study Region:
Essex County

Table Description:
Study Region Epicenter

Epicenter (Arbitrary)
74.246 degrees longitude
40.806 degrees latitude

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software
October 11, 2001



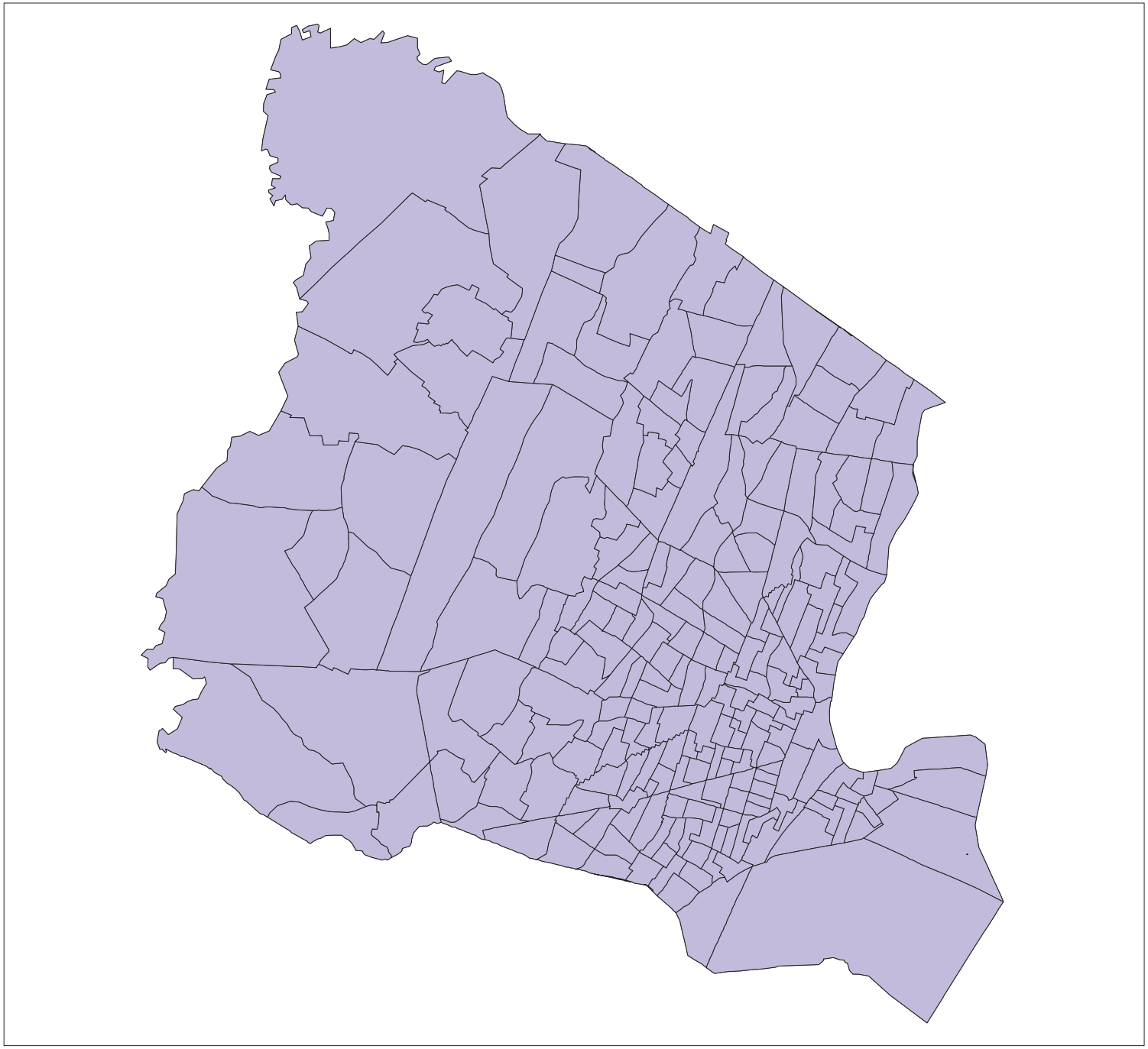
2 1 0 2 4 6 8 10 Miles

Study Region:
Essex County

Table Description:
Default Soil Map

Soil Type
Class D

Data from the HAZUS GIS software.
October 11, 2001



2 1 0 2 4 6 8 10 Miles

Study Region:
Essex County

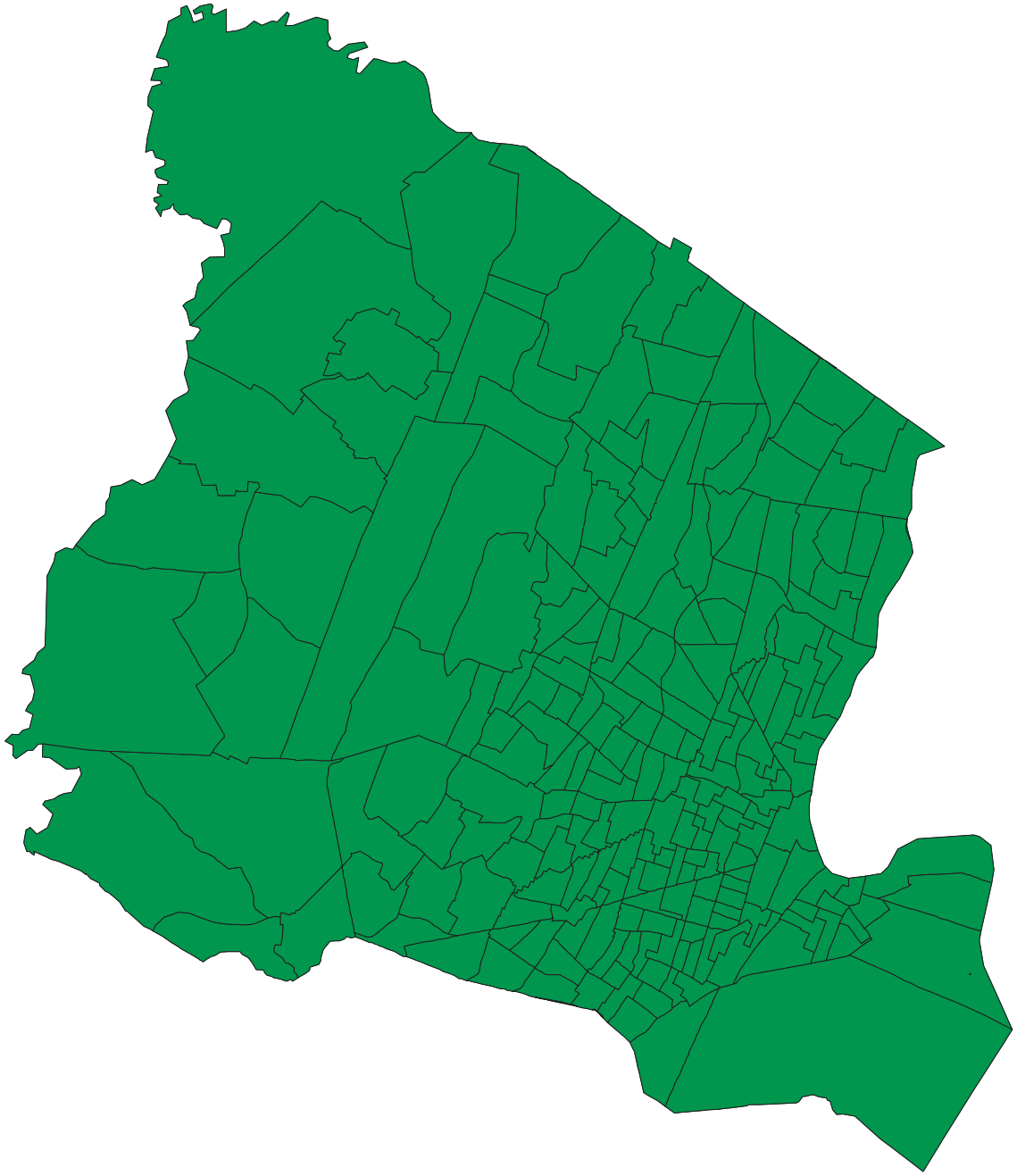
Table Description:
Default Liquefaction Map

Liquefaction Susceptibility

None

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software.
October 11, 2001



2 1 0 2 4 6 8 10 Miles

Study Region:
Essex County

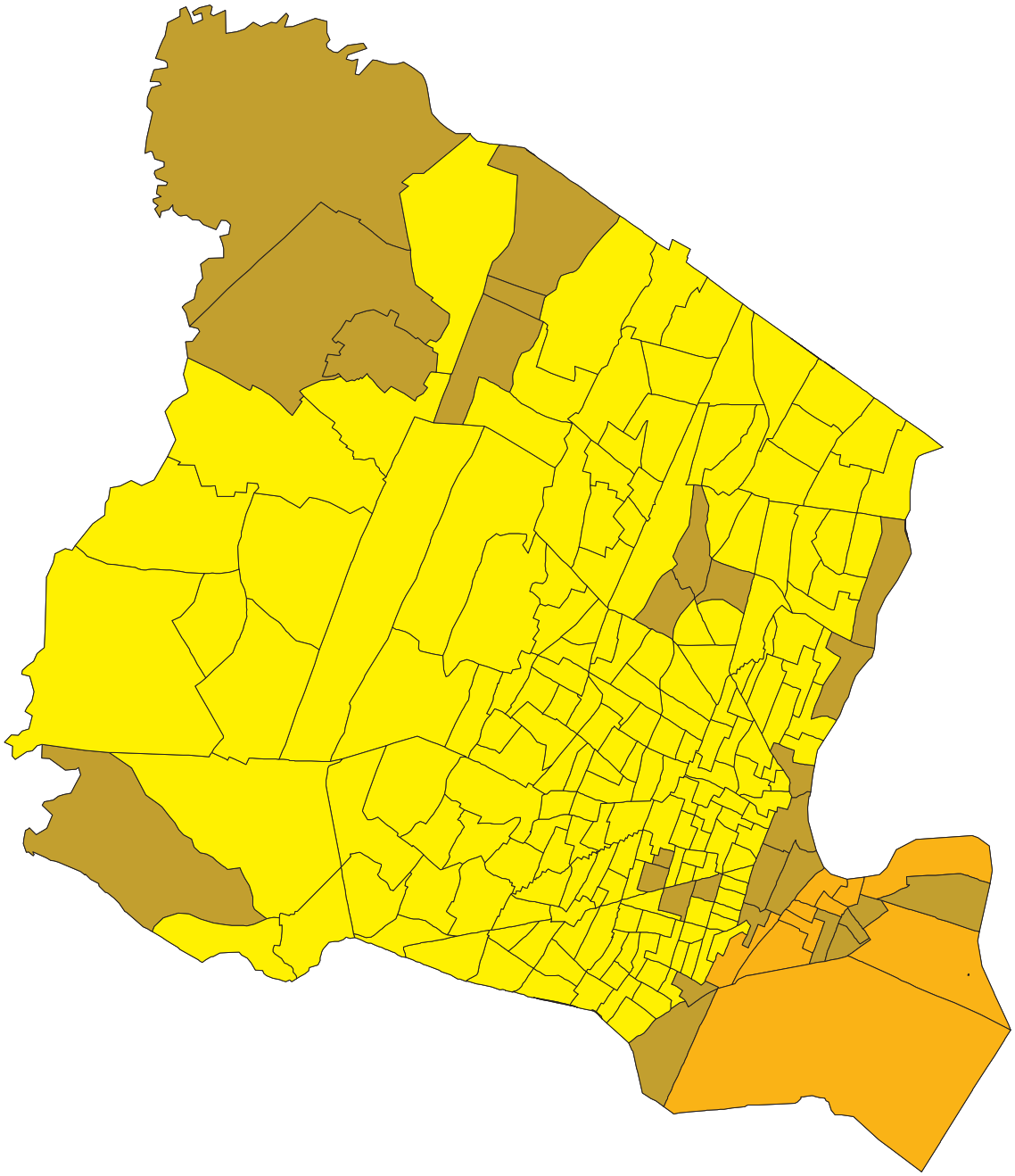
Table Description:
Default Landslide Map

Landslide Susceptibility

None

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software.
October 11, 2001



2 1 0 2 4 6 8 10 Miles

Study Region:
Essex County

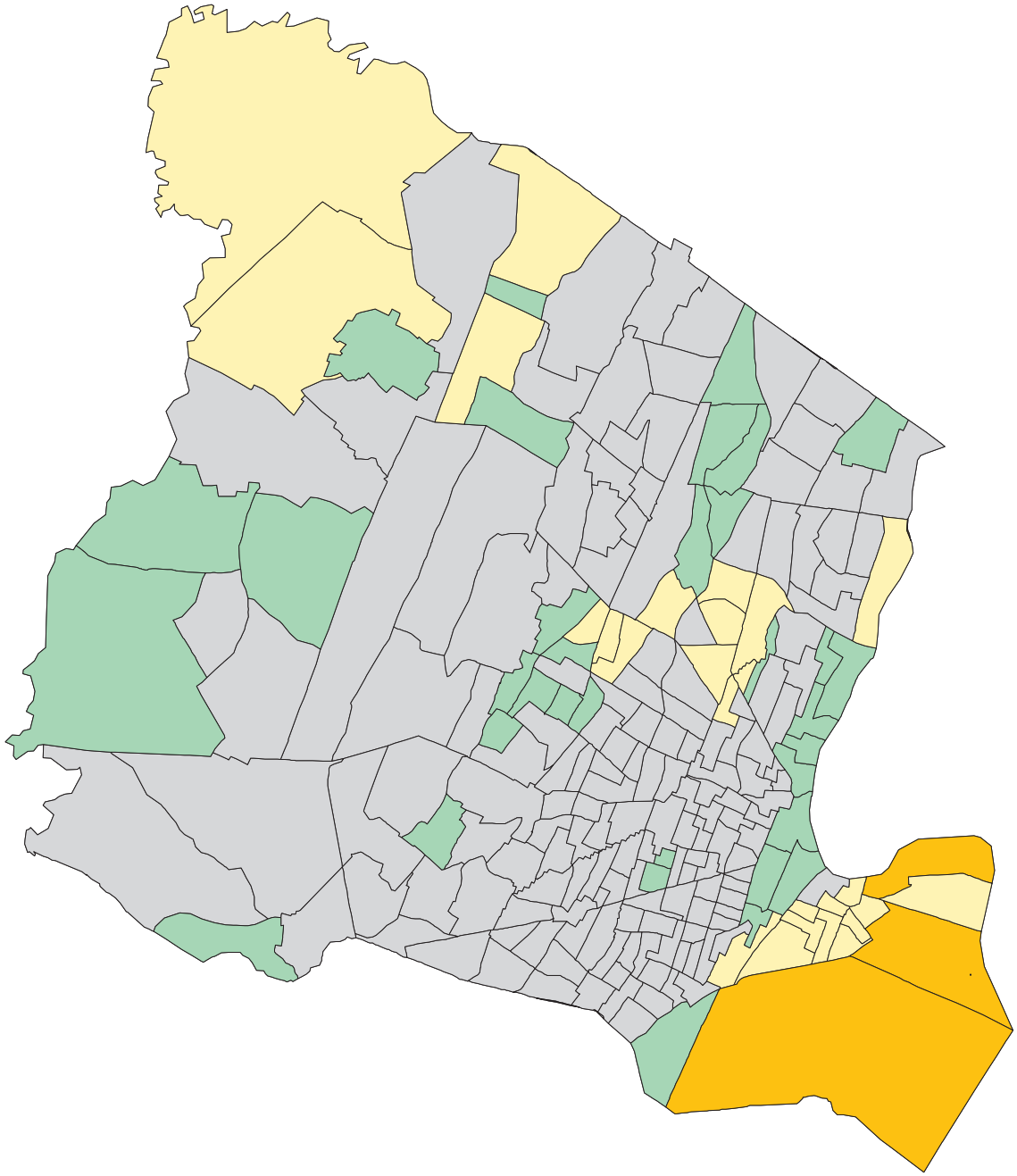
Table Description:
New Jersey Geological Survey Soils Map

Soil Type

- Class C
- Class D
- Class E

NEW JERSEY GEOLOGICAL SURVEY 1835

Data generated by the New Jersey Geological Survey.
October 16, 2001



2 1 0 2 4 6 8 10 Miles

Study Region:

Essex County

Table Description:

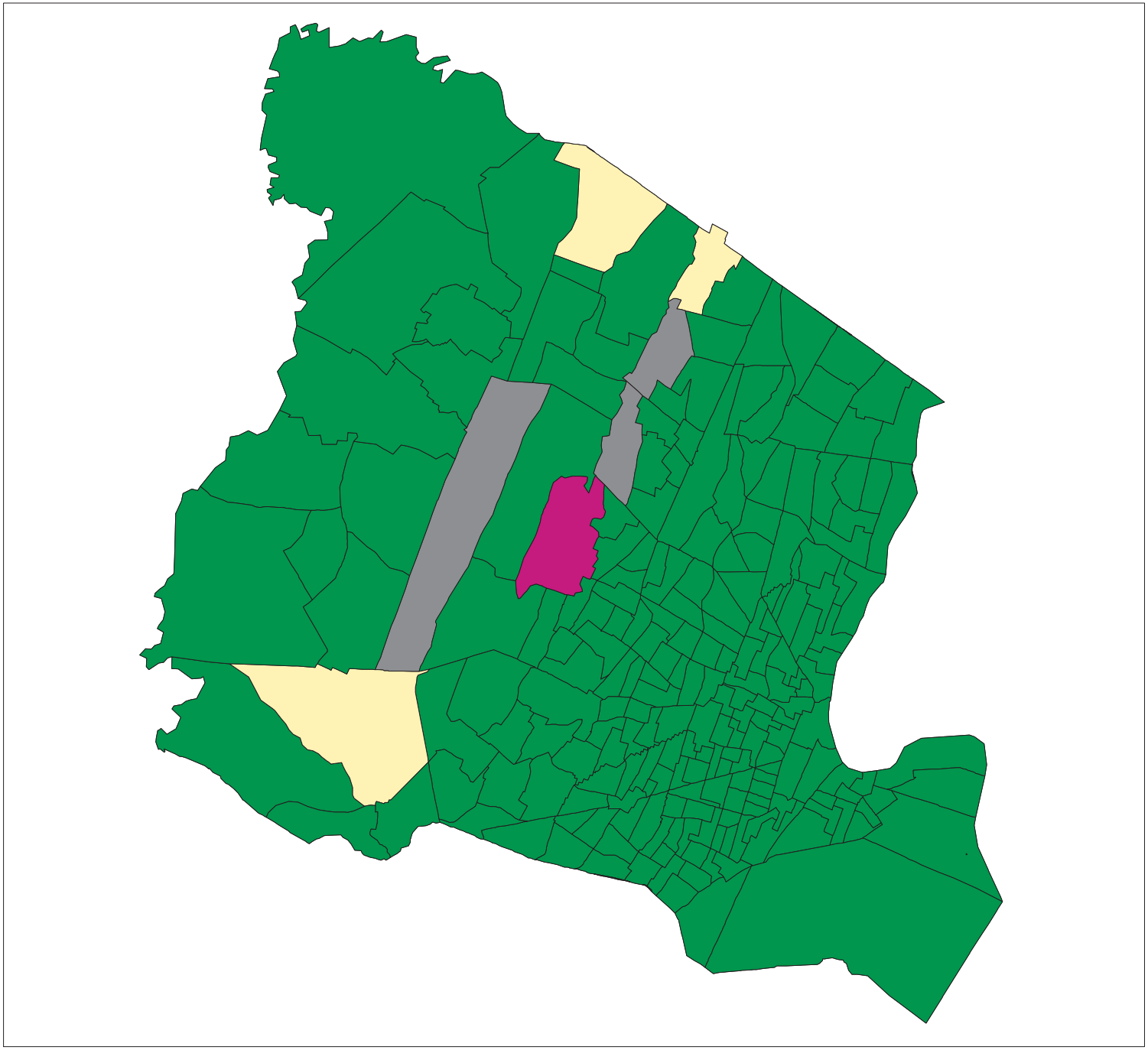
New Jersey Geological Survey Liquefaction Map

Liquefaction Susceptibility

- Very low
- Low
- Medium
- High

NEW JERSEY GEOLOGICAL SURVEY 1835

Data generated by the New Jersey Geological Survey.
October 16, 2001



2 1 0 2 4 6 8 10 Miles

Study Region:

Essex County

Table Description:

New Jersey Geological Survey Landslide Map

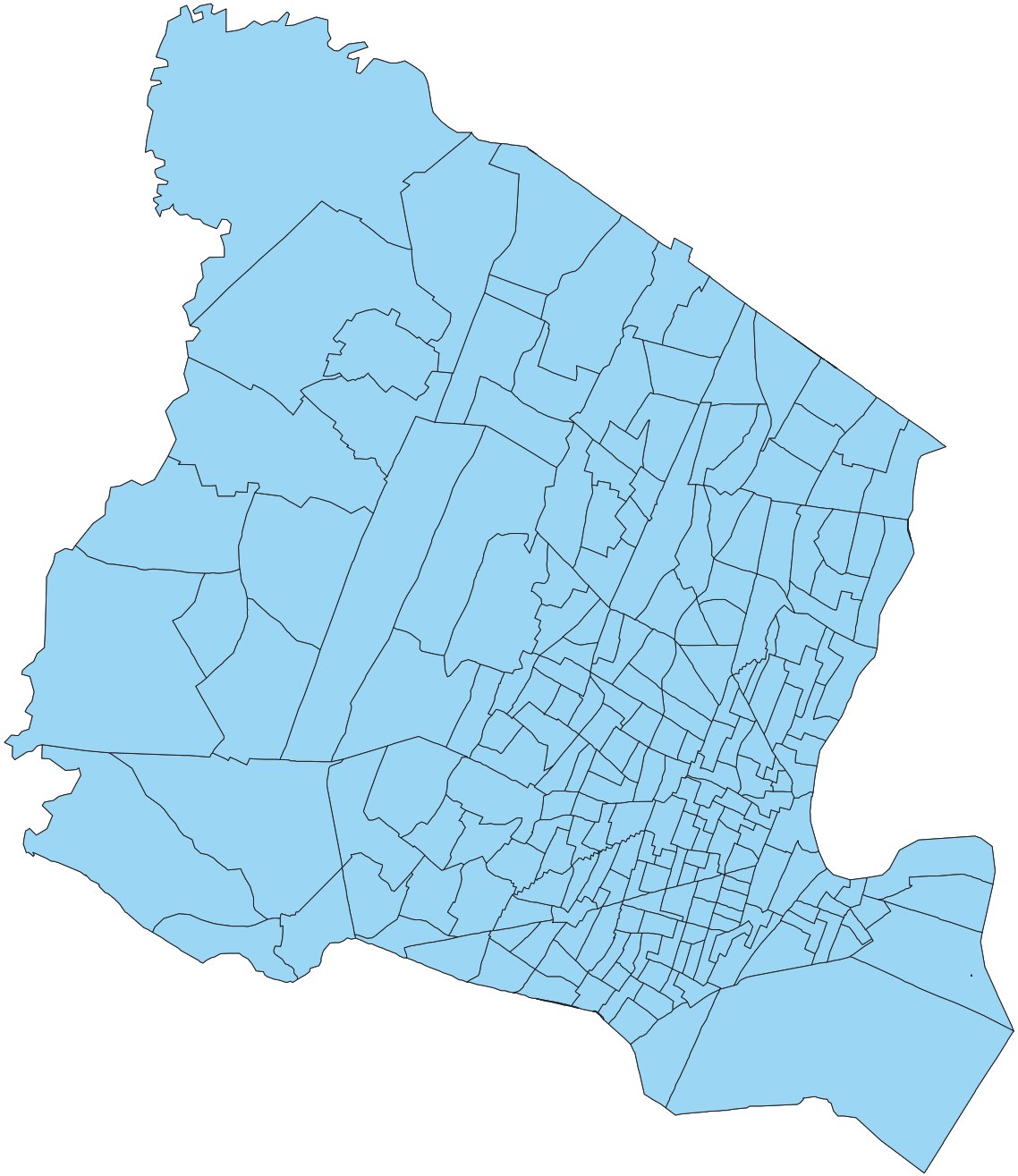
Landslide Susceptibility

- None
- Susceptibility II
- Susceptibility III
- Susceptibility V

Data generated by the New Jersey Geological Survey.
October 16, 2001

APPENDIX B

Magnitude 5 with full upgrade geology



2 1 0 2 4 6 8 10 Miles

Study Region:
Essex County

Scenario Description:
5.0 Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

0 to 10

Data from the HAZUS GIS software and the New Jersey Geological Survey. October 30, 2001

Building Damage By General Occupancy

October 17, 2001

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Essex						
Agriculture	662	35.28	3.37	1.22	0.11	0.00
Commercial	130,243	84.97	7.83	3.42	0.40	0.00
Education	7,246	65.65	5.60	2.47	0.29	0.00
Government	1,616	86.37	7.21	3.23	0.27	0.00
Industrial	44,446	78.64	6.86	3.21	0.40	0.00
Religion	5,431	76.15	6.78	3.04	0.39	0.00
Residential	362,823	88.77	6.48	1.93	0.16	0.00
State Average	552,467	73.69	6.30	2.64	0.29	0.00
Study Region Average	552,467	73.69	6.30	2.64	0.29	0.00

Study Region : Essexnj
Scenario : njess5

Building Damage by Count by General Occupancy

October 17, 2001

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Essex						
Agriculture	35	0	0	0	0	35
Commercial	5,289	341	135	14	0	5,779
Education	332	8	1	0	0	341
Government	17	0	0	0	0	17
Industrial	1,638	109	43	3	0	1,793
Religion	361	8	0	0	0	369
Residential	110,306	6,752	1,453	178	13	118,702
Total State	117,978	7,218	1,632	195	13	127,036
Study region	117,978	7,218	1,632	195	13	127,036

Study Region : Essexnj

Scenario : njess5

Quick Assessment Report

October 17, 2001

Regional Statistics

Area (Square Miles)	130
Number of Census Tracts	225
Number of Buildings	
Residential (x 1000)	119
Total (x 1000)	127
Number of People in the Region (x 1000)	778
Building Exposure ($ Millions)	
Residential	29,600
Total	43,000

Scenario Results

Maximum PGA (g) 0.36

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	6,800	7,200
Moderate	1,500	1,600
Extensive	200	200
Complete	0	0
Total	8,400	9,100

Casualties

Severity 1 (Medical treatment without hospitalization)	92
Severity 2 (Hospitalization but not life threatening)	11
Severity 3 (Hospitalization and life threatening)	1
Severity 4 (Fatalities)	1

Shelter

Displaced Households (# households)	270
Short Term Shelter (# people)	230

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	1,410
Business Interruption (Income) Losses ($ Millions)	90
Total ($ Millions)	1,500

Disclaimer:

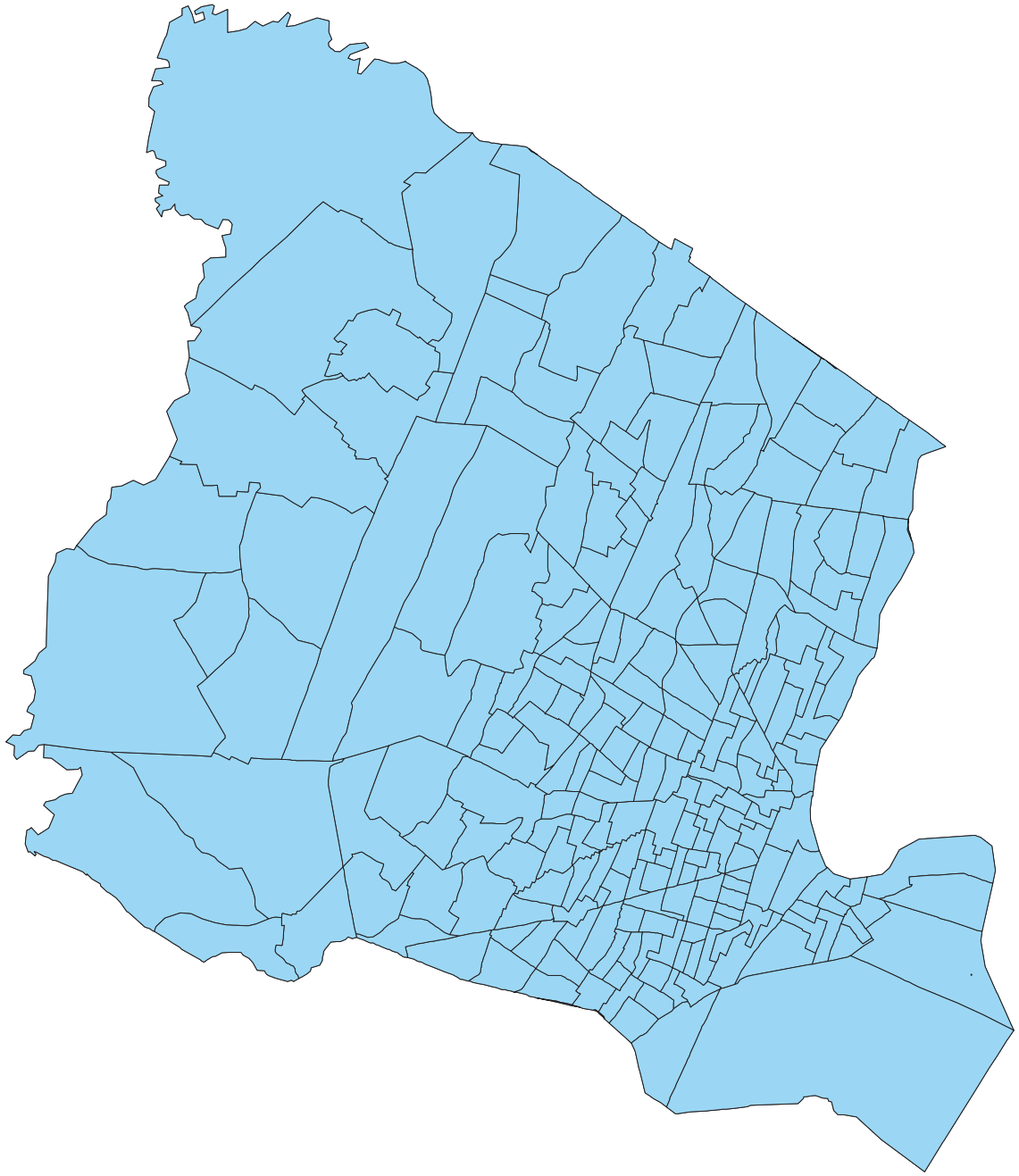
The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences 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.

Study Region : Essexnj

Scenario : njess5

APPENDIX C

Magnitude 5 with upgraded geology, no liquefaction



2 1 0 2 4 6 8 10 Miles

Study Region:

Essex County

Scenario Description:

5.0 Scenario With Upgraded Soils And Landslide Data And Default Liquefaction Data.

Percentage Of Buildings With Moderate and Greater Damage

0 to 10

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software and theNew Jersey Geological Survey. October 31, 2001

Building Damage By General Occupancy

October 30, 2001

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Essex						
Agriculture	662	35.28	3.37	1.22	0.10	0.00
Commercial	130,243	84.98	7.83	3.42	0.38	0.00
Education	7,246	65.66	5.60	2.47	0.28	0.00
Government	1,616	86.40	7.21	3.23	0.22	0.00
Industrial	44,446	78.66	6.86	3.21	0.37	0.00
Religion	5,431	76.16	6.79	3.04	0.37	0.00
Residential	362,823	88.80	6.48	1.93	0.14	0.00
State Average	552,467	73.71	6.31	2.65	0.27	0.00
Study Region Average	552,467	73.71	6.31	2.65	0.27	0.00

Building Damage by Count by General Occupancy

October 30, 2001

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Tota
New Jersey						
Essex						
Agriculture	35	0	0	0	0	35
Commercial	5,292	341	135	11	0	5,779
Education	332	8	1	0	0	341
Government	17	0	0	0	0	17
Industrial	1,639	110	43	1	0	1,793
Religion	361	8	0	0	0	369
Residential	110,310	6,753	1,454	170	13	118,700
Total State	117,986	7,220	1,633	182	13	127,034
Study region	117,986	7,220	1,633	182	13	127,034

Study Region : Essexnj

Scenario : dl5

Quick Assessment Report

October 30, 2001

Regional Statistics

Area (Square Miles)	130
Number of Census Tracts	225
Number of Buildings	
Residential (x 1000)	119
Total (x 1000)	127
Number of People in the Region (x 1000)	778
Building Exposure ($ Millions)	
Residential	29,600
Total	43,000

Scenario Results

Maximum PGA (g)	0.36

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	6,800	7,200
Moderate	1,500	1,600
Extensive	200	200
Complete	0	0
Total	8,400	9,000

Casualties

Severity 1 (Medical treatment without hospitalization)	90
Severity 2 (Hospitalization but not life threatening)	11
Severity 3 (Hospitalization and life threatening)	1
Severity 4 (Fatalities)	1

Shelter

Displaced Households (# households)	250
Short Term Shelter (# people)	210

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	1,390
Business Interruption (Income) Losses ($ Millions)	90
Total ($ Millions)	1,480

Disclaimer:

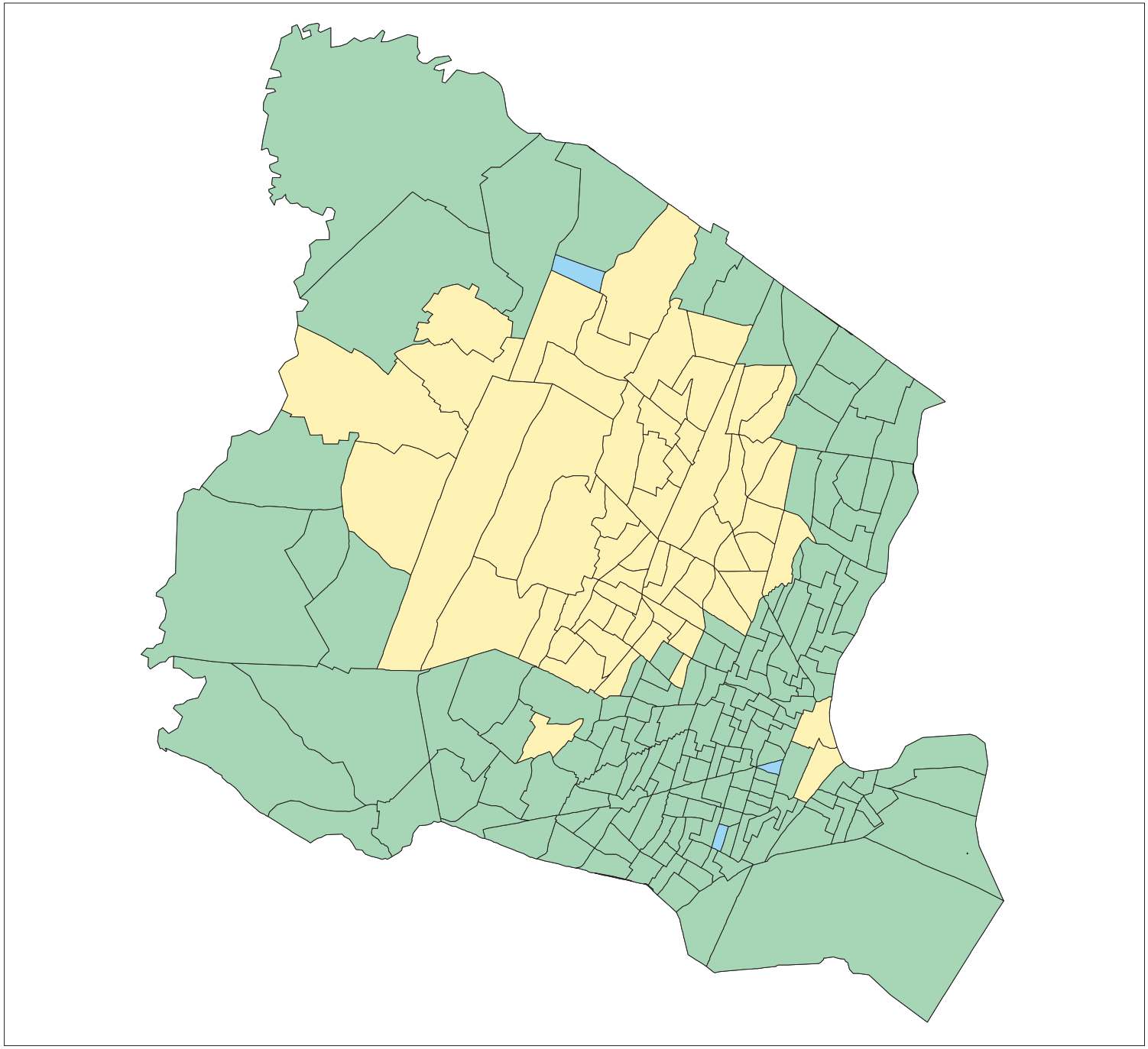
The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences 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.

Study Region : Essexnj

Scenario : dl5

APPENDIX D

Magnitude 5.5 with default geology



2 1 0 2 4 6 8 10 Miles

Study Region:
Essex County

Scenario Description:
5.5 Default Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software and the New Jersey Geological Survey. October 30, 2001

Building Damage By General Occupancy

October 17, 2001

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Essex						
Agriculture	662	20.70	9.94	7.06	1.96	0.35
Commercial	130,243	50.89	21.12	18.01	5.61	0.95
Education	7,246	40.04	15.67	13.62	4.11	0.78
Government	1,616	53.35	19.76	18.13	5.25	0.89
Industrial	44,446	47.60	18.19	17.20	5.37	0.84
Religion	5,431	42.36	21.49	16.26	5.46	1.21
Residential	362,823	49.63	27.51	15.64	3.94	0.73
State Average	552,467	43.51	19.10	15.13	4.53	0.82
Study Region Average	552,467	43.51	19.10	15.13	4.53	0.82

Study Region : Essexnj
Scenario : defess552

Building Damage by Count by General Occupancy

October 17, 2001

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Tota
New Jersey						
Essex						
Agriculture	24	4	1	0	0	29
Commercial	3,409	1,101	898	148	6	5,562
Education	225	40	35	3	0	303
Government	14	0	0	0	0	14
Industrial	1,093	294	271	46	1	1,705
Religion	211	58	38	3	0	310
Residential	59,480	36,960	18,472	3,767	433	119,112
Total State	64,456	38,457	19,715	3,967	440	127,035
Study region	64,456	38,457	19,715	3,967	440	127,035

Study Region : Essexnj

Scenario : defess552

Quick Assessment Report

October 17, 2001

Regional Statistics

Area (Square Miles)	130
Number of Census Tracts	225
Number of Buildings	
Residential (x 1000)	119
Total (x 1000)	127
Number of People in the Region (x 1000)	778
Building Exposure ($ Millions)	
Residential	29,600
Total	43,000

Scenario Results

Maximum PGA (g)	0.49

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	37,000	38,500
Moderate	18,500	19,700
Extensive	3,800	4,000
Complete	400	400
Total	59,600	62,600

Casualties	
Severity 1 (Medical treatment without hospitalization)	1,225
Severity 2 (Hospitalization but not life threatening)	184
Severity 3 (Hospitalization and life threatening)	16
Severity 4 (Fatalities)	16
Shelter	
Displaced Households (# households)	8,910
Short Term Shelter (# people)	7,680
Economic Loss	
Property Damage (Capital Stock) Losses ($ Millions)	4,080
Business Interruption (Income) Losses ($ Millions)	860
Total ($ Millions)	4,930

Disclaimer:

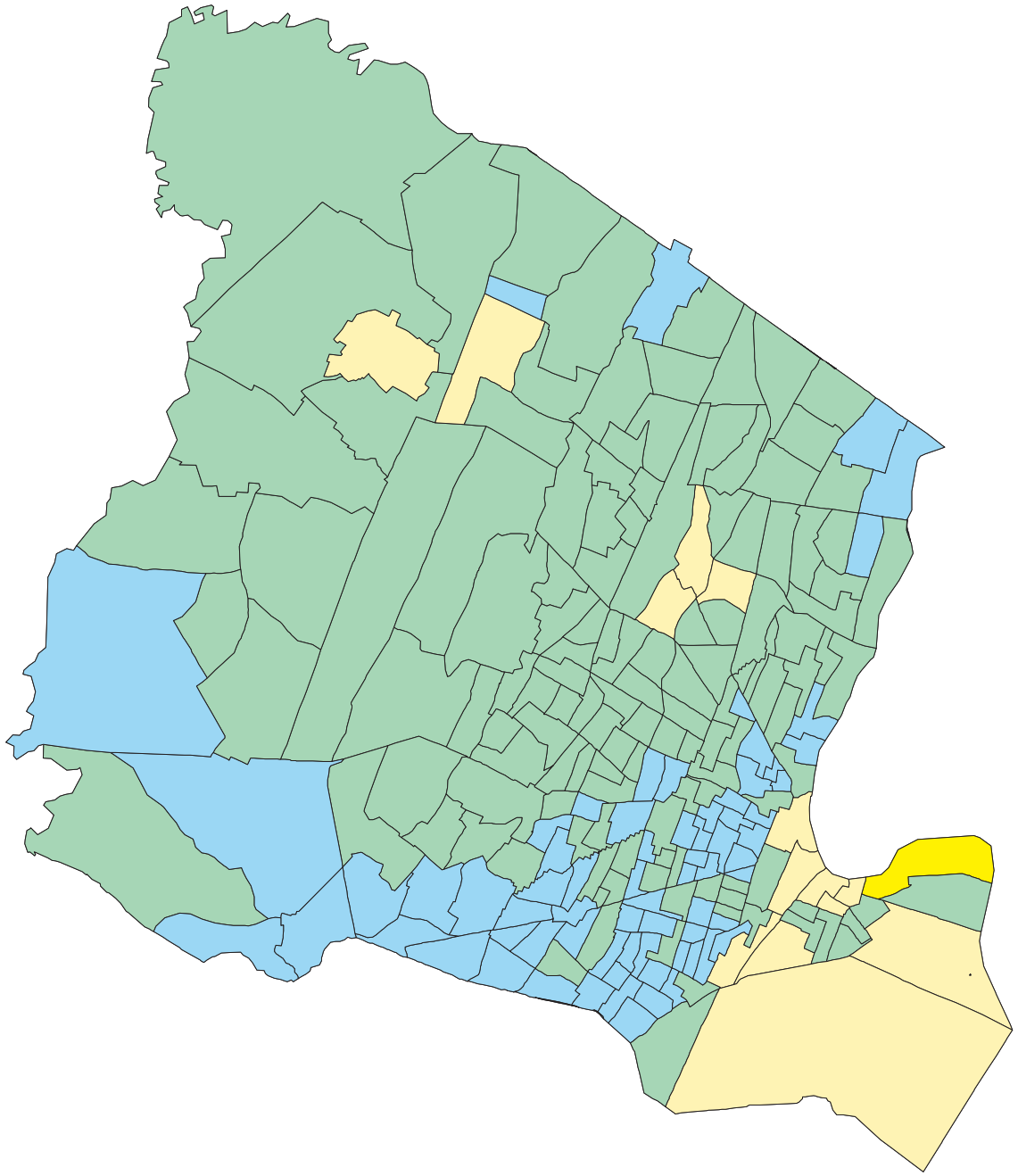
The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences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

Study Region : Essexnj

Scenario : defess552

APPENDIX E

Magnitude 5.5 with full upgrade geology



Study Region:
Essex County

Scenario Description:
5.5 Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30
- 30 to 40

2 1 0 2 4 6 8 10 Miles

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software and the New Jersey Geological Survey. October 30, 2001

Building Damage By General Occupancy

October 17, 2001

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Essex						
Agriculture	662	25.21	8.44	4.99	1.19	0.05
Commercial	130,243	60.83	18.43	13.26	3.62	0.38
Education	7,246	47.75	13.48	9.89	2.60	0.34
Government	1,616	63.47	17.06	13.04	3.23	0.18
Industrial	44,446	56.92	15.85	12.67	3.37	0.19
Religion	5,431	52.13	18.23	12.00	3.63	0.93
Residential	362,823	61.63	22.22	10.56	2.64	0.31
State Average	552,467	52.56	16.24	10.92	2.90	0.34
Study Region Average	552,467	52.56	16.24	10.92	2.90	0.34

Study Region : Essexnj
Scenario : njess552

Building Damage by Count by General Occupancy

October 17, 2001

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Tota
New Jersey						
Essex						
Agriculture	28	3	2	0	0	33
Commercial	3,808	972	693	146	11	5,630
Education	264	34	18	1	0	317
Government	15	0	0	0	0	15
Industrial	1,165	260	233	49	1	1,708
Religion	248	47	17	2	0	314
Residential	75,882	29,139	11,479	2,244	277	119,021
Total State	81,410	30,455	12,442	2,442	289	127,038
Study region	81,410	30,455	12,442	2,442	289	127,038

Study Region : Essexnj

Scenario : njess552

Quick Assessment Report

October 17, 2001

Regional Statistics

Area (Square Miles)	130
Number of Census Tracts	225
Number of Buildings	
Residential (x 1000)	119
Total (x 1000)	127
Number of People in the Region (x 1000)	778
Building Exposure ($ Millions)	
Residential	29,600
Total	43,000

Scenario Results

Maximum PGA (g)	0.47

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	29,100	30,500
Moderate	11,500	12,400
Extensive	2,200	2,400
Complete	300	300
Total	43,100	45,600

Casualties

Severity 1 (Medical treatment without hospitalization)	804
Severity 2 (Hospitalization but not life threatening)	120
Severity 3 (Hospitalization and life threatening)	11
Severity 4 (Fatalities)	11

Shelter

Displaced Households (# households)	5,460
Short Term Shelter (# people)	4,630

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	3,380
Business Interruption (Income) Losses ($ Millions)	610
Total ($ Millions)	3,980

Disclaimer:

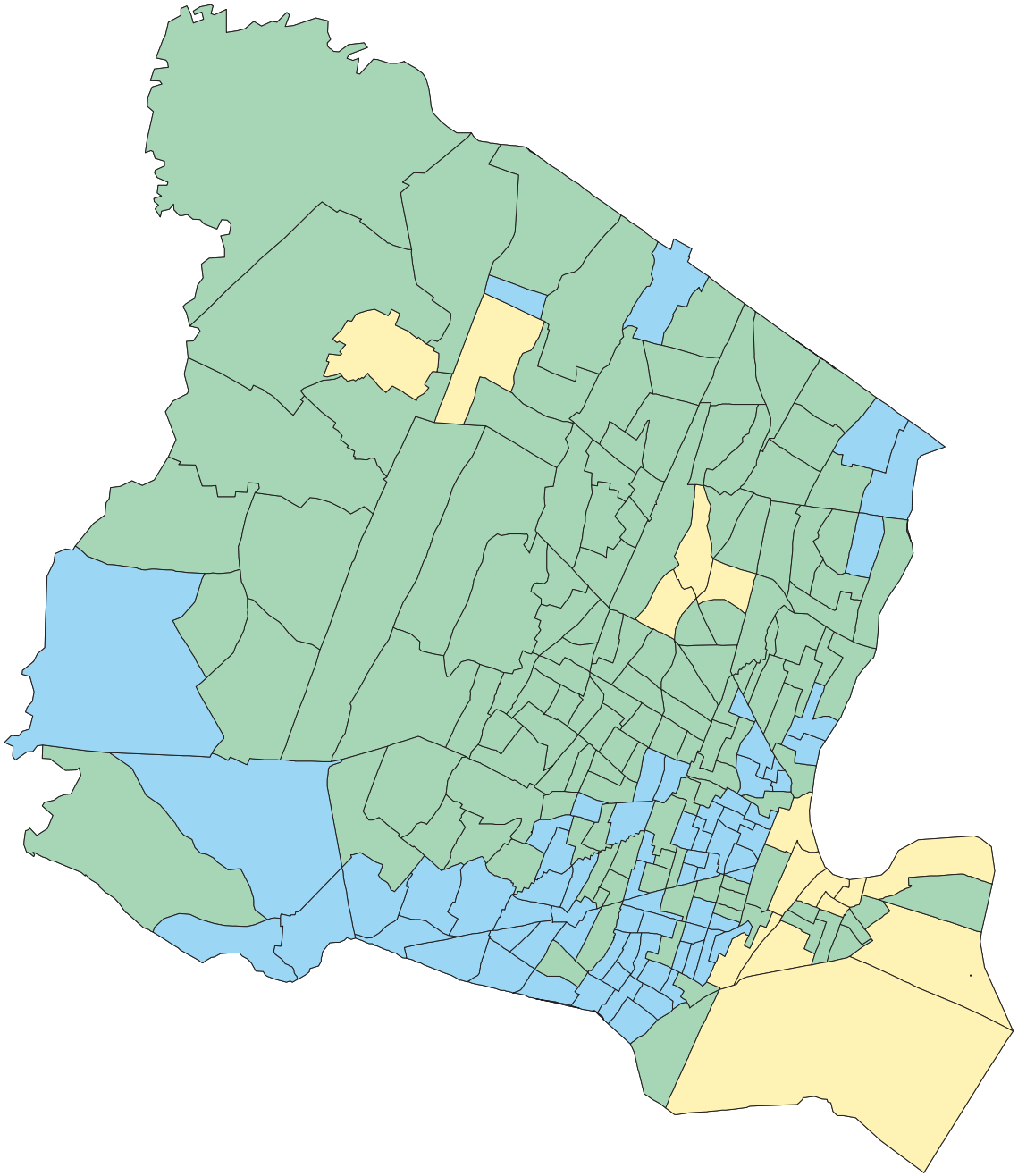
The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences 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.

Study Region : Essexnj

Scenario : njess552

APPENDIX F

Magnitude 5.5 with upgraded geology, no liquefaction



2 1 0 2 4 6 8 10 Miles

Study Region:

Essex County

Scenario Description:

5.5 Scenario With Upgraded Soils And Landslide Data And Default Liquefaction Data.

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30

Data from the HAZUS GIS software and the New Jersey Geological Survey.
October 31, 2001

Building Damage By General Occupancy

October 30, 2001

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Essex						
Agriculture	662	25.21	8.44	4.99	1.18	0.05
Commercial	130,243	60.84	18.44	13.26	3.60	0.37
Education	7,246	47.76	13.48	9.89	2.60	0.34
Government	1,616	63.48	17.07	13.05	3.20	0.17
Industrial	44,446	56.93	15.87	12.68	3.35	0.19
Religion	5,431	52.13	18.23	12.00	3.61	0.93
Residential	362,823	61.65	22.22	10.56	2.61	0.30
State Average	552,467	52.57	16.25	10.92	2.88	0.34
Study Region Average	552,467	52.57	16.25	10.92	2.88	0.34

Building Damage by Count by General Occupancy

October 30, 2001

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Tota
New Jersey						
Essex						
Agriculture	28	3	2	0	0	33
Commercial	3,811	972	695	142	10	5,630
Education	264	34	18	1	0	317
Government	15	0	0	0	0	15
Industrial	1,163	263	235	48	1	1,710
Religion	248	47	17	2	0	314
Residential	75,891	29,139	11,478	2,235	276	119,019
Total State	81,420	30,458	12,445	2,428	287	127,038
Study region	81,420	30,458	12,445	2,428	287	127,038

Study Region : Essexnj

Scenario : dl55

Quick Assessment Report

October 30, 2001

Regional Statistics

Area (Square Miles)	130
Number of Census Tracts	225
Number of Buildings	
Residential (x 1000)	119
Total (x 1000)	127
Number of People in the Region (x 1000)	778
Building Exposure ($ Millions)	
Residential	29,600
Total	43,000

Scenario Results

Maximum PGA (g)	0.47

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	29,100	30,500
Moderate	11,500	12,400
Extensive	2,200	2,400
Complete	300	300
Total	43,100	45,600

Casualties

Severity 1 (Medical treatment without hospitalization)	803
Severity 2 (Hospitalization but not life threatening)	120
Severity 3 (Hospitalization and life threatening)	10
Severity 4 (Fatalities)	10

Shelter

Displaced Households (# households)	5,430
Short Term Shelter (# people)	4,590

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	3,350
Business Interruption (Income) Losses ($ Millions)	600
Total ($ Millions)	3,950

Disclaimer:

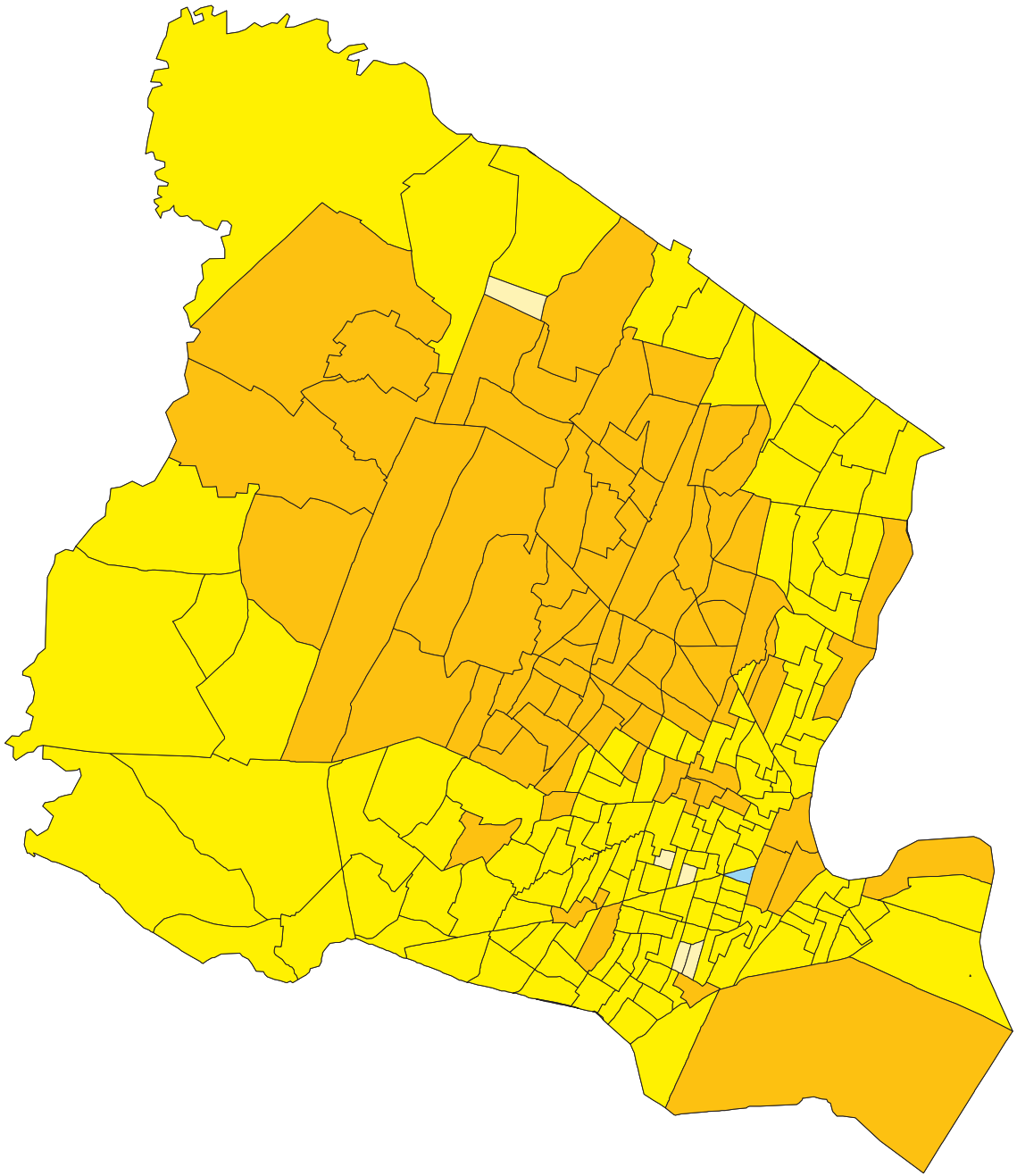
The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences 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.

Study Region : Essexnj

Scenario : dl55

APPENDIX G

Magnitude 6 with default geology



Study Region:
Essex County

Scenario Description:
6.0 Default Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30
- 30 to 40
- 40 to 50

2 1 0 2 4 6 8 10 Miles

Data from the HAZUS GIS software and the New Jersey Geological Survey. October 30, 2001

Building Damage By General Occupancy

October 17, 2001

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Essex						
Agriculture	662	9.77	10.11	12.90	5.48	1.72
Commercial	130,243	24.54	21.07	30.66	15.53	5.11
Education	7,246	19.71	15.69	23.35	11.57	3.96
Government	1,616	25.91	19.66	31.12	15.86	4.84
Industrial	44,446	22.95	17.77	28.52	15.30	4.70
Religion	5,431	21.32	21.98	25.63	13.08	4.94
Residential	362,823	26.17	30.81	27.47	9.84	3.14
State Average	552,467	21.48	19.59	25.66	12.38	4.06
Study Region Average	552,467	21.48	19.59	25.66	12.38	4.06

Study Region : Essexnj
Scenario : defess6

Building Damage by Count by General Occupancy

October 17, 2001

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Tota
New Jersey						
Essex						
Agriculture	3	4	4	0	0	11
Commercial	1,696	1,093	1,777	725	111	5,402
Education	89	37	82	30	3	241
Government	1	0	1	0	0	2
Industrial	488	295	518	227	36	1,564
Religion	92	66	97	24	2	281
Residential	32,290	41,203	33,454	9,913	2,712	119,572
Total State	34,659	42,698	35,933	10,919	2,864	127,073
Study region	34,659	42,698	35,933	10,919	2,864	127,073

Study Region : Essexnj

Scenario : defess6

Quick Assessment Report

October 17, 2001

Regional Statistics

Area (Square Miles)	130
Number of Census Tracts	225
Number of Buildings	
Residential (x 1000)	119
Total (x 1000)	127
Number of People in the Region (x 1000)	778
Building Exposure ($ Millions)	
Residential	29,600
Total	43,000

Scenario Results

Maximum PGA (g) 0.69

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	41,200	42,700
Moderate	33,500	35,900
Extensive	9,900	10,900
Complete	2,700	2,900
Total	87,300	92,400

Casualties

Severity 1 (Medical treatment without hospitalization)	3,915
Severity 2 (Hospitalization but not life threatening)	666
Severity 3 (Hospitalization and life threatening)	69
Severity 4 (Fatalities)	68

Shelter

Displaced Households (# households)	26,530
Short Term Shelter (# people)	22,560

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	7,850
Business Interruption (Income) Losses ($ Millions)	2,290
Total ($ Millions)	10,140

Disclaimer:

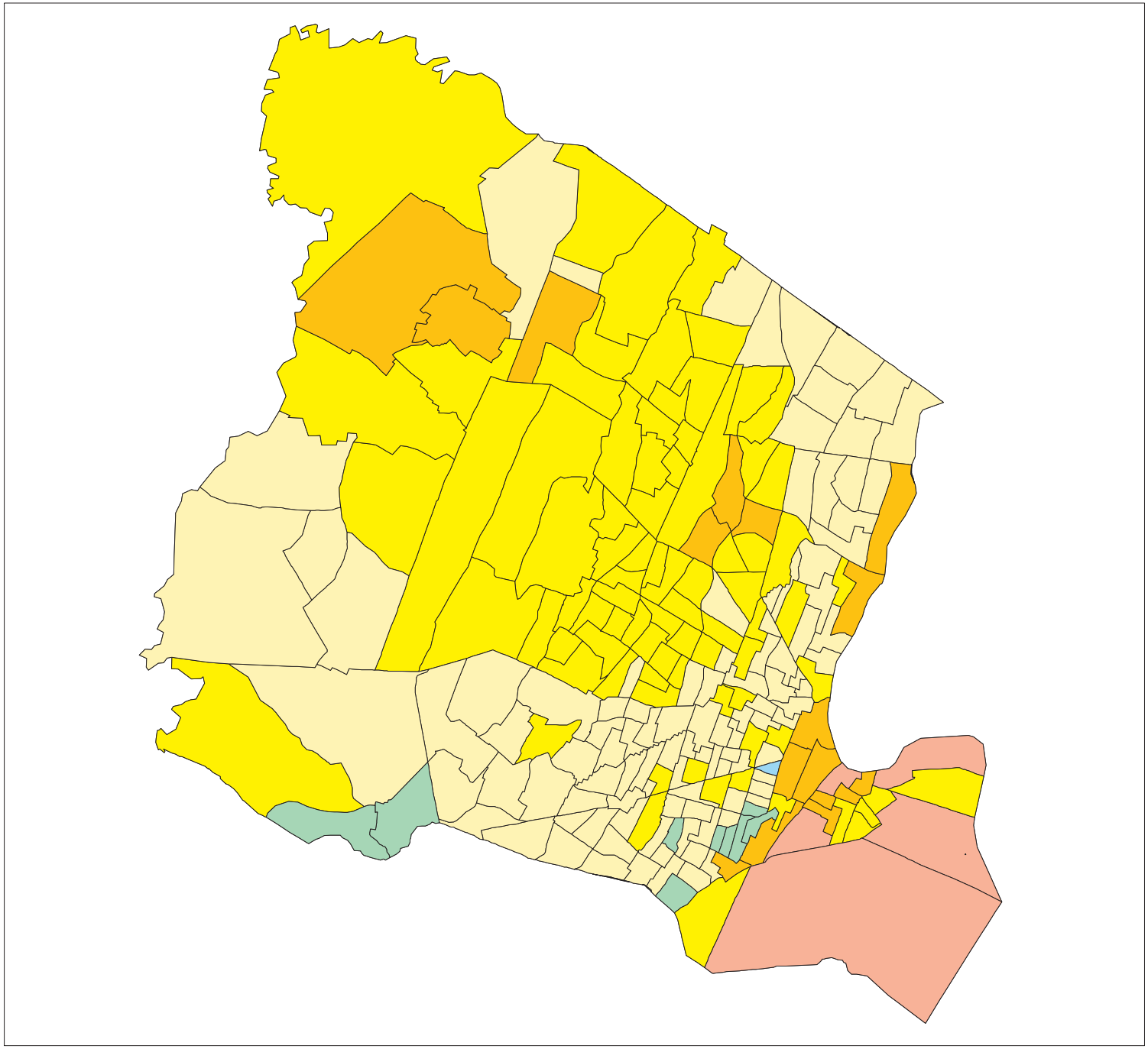
The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences 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.

Study Region : Essexnj

Scenario : defess6

APPENDIX H

Magnitude 6 with full upgrade geology



2 1 0 2 4 6 8 10 Miles

Study Region:
Essex County

Scenario Description:
6.0 Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30
- 30 to 40
- 40 to 50
- 50 to 60

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software and the New Jersey Geological Survey. October 30 2001

Building Damage By General Occupancy

October 18, 2001

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Essex						
Agriculture	662	13.07	10.68	11.10	4.14	1.14
Commercial	130,243	31.84	21.98	27.38	12.18	3.52
Education	7,246	25.59	16.53	20.72	8.91	2.57
Government	1,616	33.53	20.73	27.84	12.13	3.26
Industrial	44,446	29.69	18.73	25.76	11.96	3.22
Religion	5,431	28.08	22.27	22.58	10.35	3.31
Residential	362,823	34.52	30.33	23.08	7.53	2.06
State Average	552,467	28.05	20.18	22.64	9.60	2.73
Study Region Average	552,467	28.05	20.18	22.64	9.60	2.73

Study Region : Essexnj
Scenario : njess2

Building Damage by Count by General Occupancy

October 18, 2001

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Essex						
Agriculture	4	4	4	1	0	13
Commercial	1,939	1,106	1,613	635	131	5,424
Education	119	41	78	18	1	257
Government	1	0	1	0	0	2
Industrial	540	288	507	211	42	1,588
Religion	109	64	79	14	0	266
Residential	42,784	40,632	27,367	7,252	1,479	119,514
Total State	45,496	42,135	29,649	8,131	1,653	127,064
Study region	45,496	42,135	29,649	8,131	1,653	127,064

Study Region : Essexnj

Scenario : njess2

Quick Assessment Report

October 18, 2001

Regional Statistics

Area (Square Miles)	130
Number of Census Tracts	225
Number of Buildings	
Residential (x 1000)	119
Total (x 1000)	127
Number of People in the Region (x 1000)	778
Building Exposure ($ Millions)	
Residential	29,600
Total	43,000

Scenario Results

Maximum PGA (g)	0.69

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	40,600	42,100
Moderate	27,400	29,600
Extensive	7,300	8,100
Complete	1,500	1,700
Total	76,700	81,600

Casualties

Severity 1 (Medical treatment without hospitalization)	2,742
Severity 2 (Hospitalization but not life threatening)	454
Severity 3 (Hospitalization and life threatening)	52
Severity 4 (Fatalities)	48

Shelter

Displaced Households (# households)	19,270
Short Term Shelter (# people)	16,310

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	6,970
Business Interruption (Income) Losses ($ Millions)	1,890
Total ($ Millions)	8,860

Disclaimer:

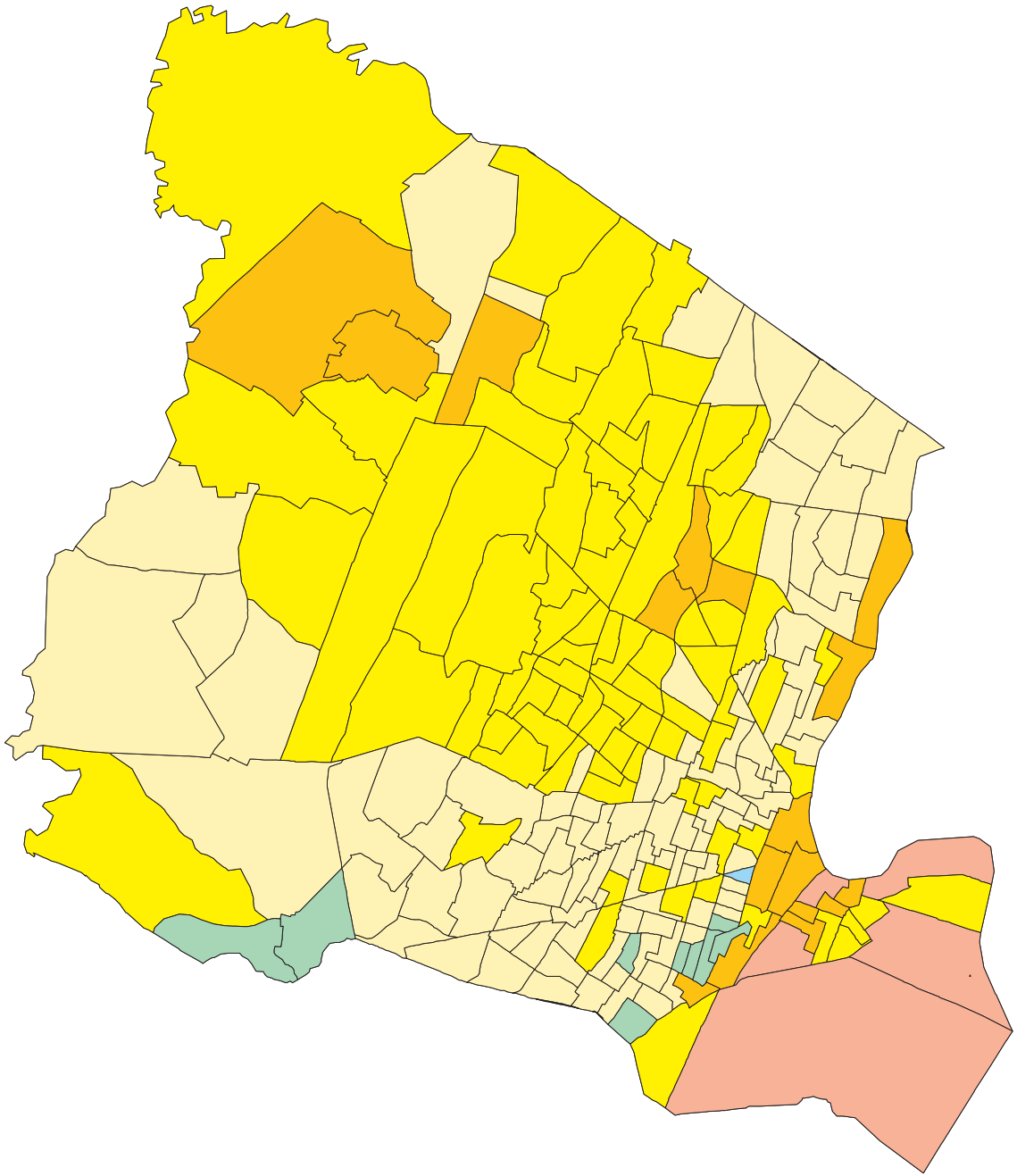
The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences 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.

Study Region : Essexnj

Scenario : njess2

APPENDIX I

Magnitude 6 with upgraded geology, no liquefaction



2 1 0 2 4 6 8 10 Miles

Study Region:

Essex County

Scenario Description:

6.0 Scenario With Upgraded Soils And Landslide Data And Default Liquefaction Data.

Percentage Of Buildings With Moderate and Greater Damage

- 0 to 10
- 10 to 20
- 20 to 30
- 30 to 40
- 40 to 50
- 50 to 60

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software and theNew Jersey Geological Survey. October 31, 2001

Building Damage By General Occupancy

October 30, 2001

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Essex						
Agriculture	662	13.08	10.68	11.11	4.13	1.14
Commercial	130,243	31.86	22.00	27.40	12.13	3.51
Education	7,246	25.60	16.55	20.74	8.90	2.56
Government	1,616	33.54	20.74	27.86	12.10	3.24
Industrial	44,446	29.70	18.74	25.78	11.93	3.21
Religion	5,431	28.09	22.28	22.60	10.32	3.30
Residential	362,823	34.53	30.35	23.09	7.50	2.02
State Average	552,467	28.06	20.19	22.65	9.57	2.71
Study Region Average	552,467	28.06	20.19	22.65	9.57	2.71

Study Region : Essexnj
Scenario : dl6

Building Damage by Count by General Occupancy

October 30, 2001

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Tota
New Jersey						
Essex						
Agriculture	4	4	4	1	0	13
Commercial	1,941	1,107	1,620	630	128	5,426
Education	119	41	78	18	1	257
Government	1	0	1	0	0	2
Industrial	540	289	510	210	42	1,591
Religion	109	64	78	14	0	265
Residential	42,794	40,709	27,374	7,176	1,457	119,510
Total State	45,508	42,214	29,665	8,049	1,628	127,064
Study region	45,508	42,214	29,665	8,049	1,628	127,064

Study Region : Essexnj

Scenario : dl6

Quick Assessment Report

October 30, 2001

Regional Statistics

Area (Square Miles)	130
Number of Census Tracts	225
Number of Buildings	
Residential (x 1000)	119
Total (x 1000)	127
Number of People in the Region (x 1000)	778
Building Exposure ($ Millions)	
Residential	29,600
Total	43,000

Scenario Results

Maximum PGA (g)	0.69

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	40,700	42,200
Moderate	27,400	29,700
Extensive	7,200	8,000
Complete	1,500	1,600
Total	76,700	81,600

Casualties

Severity 1 (Medical treatment without hospitalization)	2,727
Severity 2 (Hospitalization but not life threatening)	451
Severity 3 (Hospitalization and life threatening)	51
Severity 4 (Fatalities)	47

Shelter

Displaced Households (# households)	19,170
Short Term Shelter (# people)	16,230

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	6,940
Business Interruption (Income) Losses ($ Millions)	1,880
Total ($ Millions)	8,820

Disclaimer:

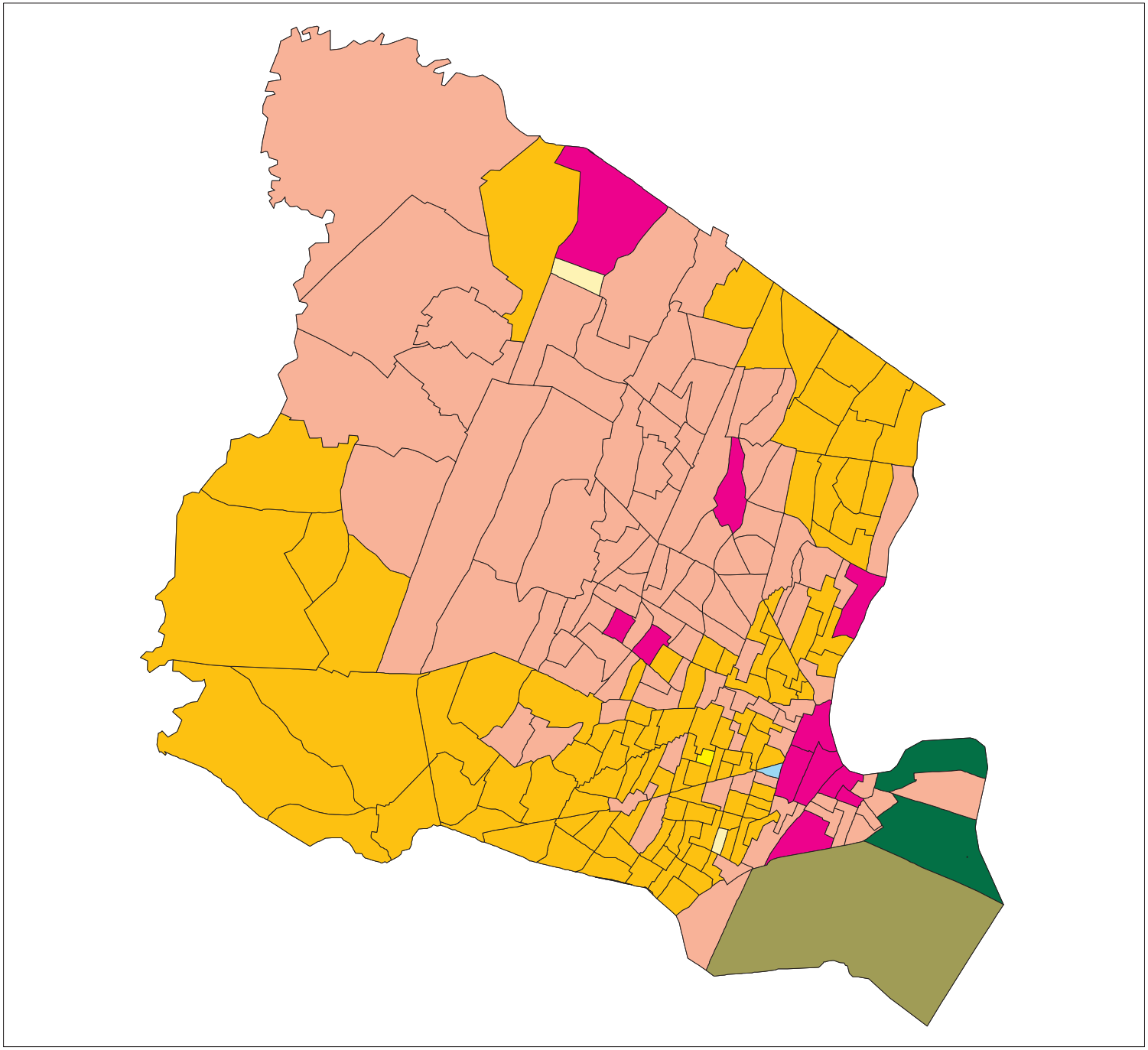
The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences 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.

Study Region : Essexnj

Scenario : dl6

APPENDIX J

Magnitude 6.5 with full upgrade geology



Study Region:
Essex County

Scenario Description:
6.5 Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

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

2 1 0 2 4 6 8 10 Miles

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software and the New Jersey Geological Survey. October 30, 2001

Building Damage By General Occupancy

October 18, 2001

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Essex						
Agriculture	662	6.00	8.48	14.20	7.72	3.65
Commercial	130,243	14.74	16.98	32.42	22.03	10.79
Education	7,246	12.01	12.80	24.84	16.71	8.01
Government	1,616	15.31	15.49	32.48	23.31	10.90
Industrial	44,446	13.53	14.02	29.52	21.97	10.48
Religion	5,431	13.48	19.14	27.53	17.50	8.80
Residential	362,823	17.19	28.10	31.85	14.14	5.65
State Average	552,467	13.18	16.43	27.55	17.62	8.33
Study Region Average	552,467	13.18	16.43	27.55	17.62	8.33

Study Region : Essexnj
Scenario : njess65
Scenario : njess65

Building Damage by Count by General Occupancy

October 18, 2001

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Tota
New Jersey						
Essex						
Agriculture	1	1	4	2	1	
Commercial	905	802	1,891	1,241	552	5,391
Education	44	28	92	54	13	231
Government	0	0	1	0	0	
Industrial	227	200	526	415	206	1,574
Religion	47	48	105	44	11	255
Residential	21,506	38,501	40,167	14,549	4,887	119,610
Total State	22,730	39,580	42,786	16,305	5,670	127,071
Study region	22,730	39,580	42,786	16,305	5,670	127,071

Study Region : Essexnj

Scenario : njess65

Quick Assessment Report

October 18, 2001

Regional Statistics

Area (Square Miles)	130
Number of Census Tracts	225
Number of Buildings	
Residential (x 1000)	119
Total (x 1000)	127
Number of People in the Region (x 1000)	778
Building Exposure ($ Millions)	
Residential	29,600
Total	43,000

Scenario Results

Maximum PGA (g)	0.96

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	38,500	39,600
Moderate	40,200	42,800
Extensive	14,500	16,300
Complete	4,900	5,700
Total	98,100	104,300

Casualties

Severity 1 (Medical treatment without hospitalization)	6,226
Severity 2 (Hospitalization but not life threatening)	1,108
Severity 3 (Hospitalization and life threatening)	177
Severity 4 (Fatalities)	135

Shelter

Displaced Households (# households)	40,760
Short Term Shelter (# people)	34,350

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	11,910
Business Interruption (Income) Losses ($ Millions)	3,760
Total ($ Millions)	15,670

Disclaimer:

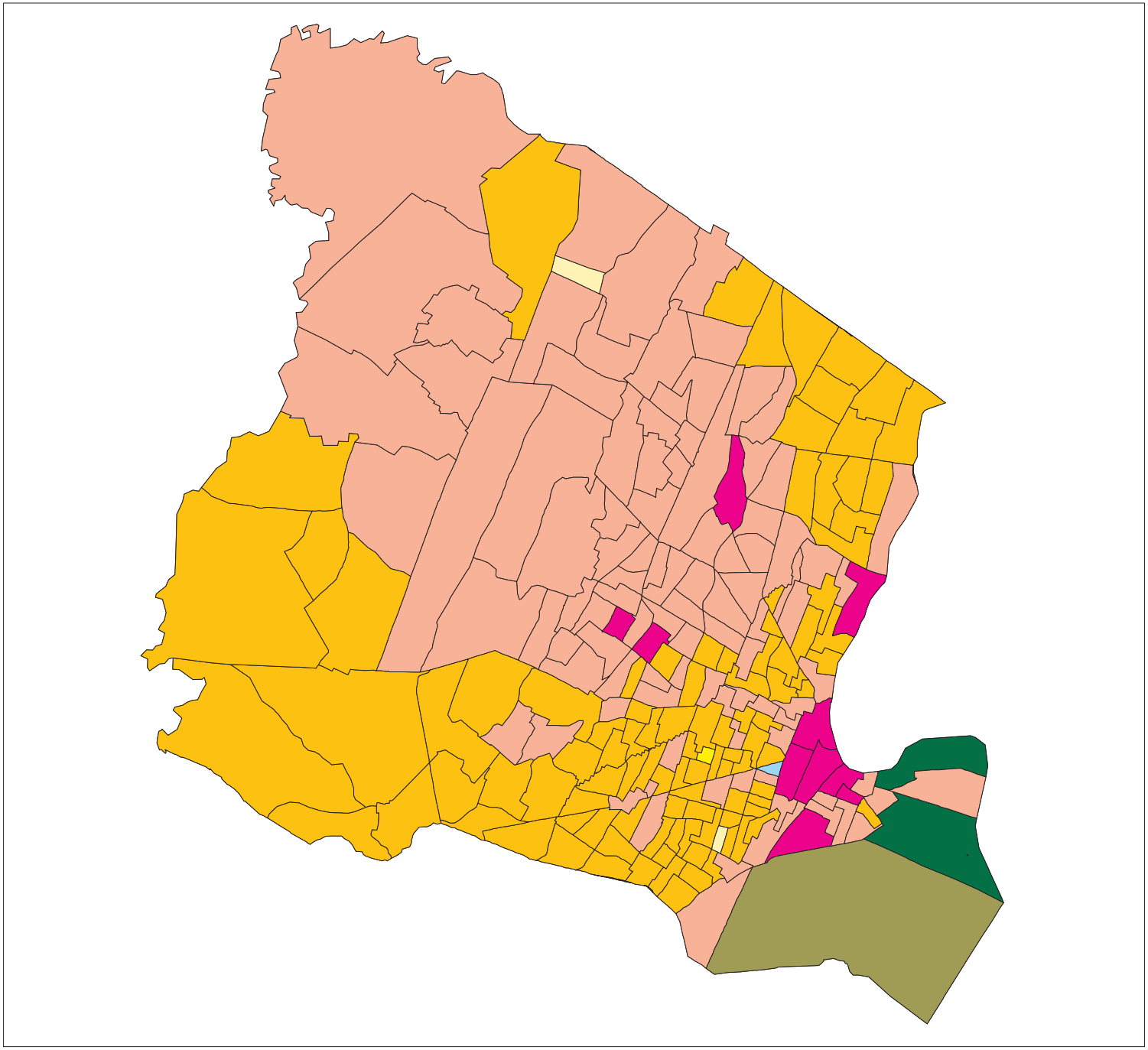
The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences 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.

Study Region : Essexnj

Scenario : njess65

APPENDIX K

Magnitude 6.5 with upgraded geology, no liquefaction



2 1 0 2 4 6 8 10 Miles

Study Region:

Essex County

Scenario Description:

6.5 Scenario With Upgraded Soils And Landslide Data And Default Liquefaction Data.

Percentage Of Buildings With Moderate and Greater Damage

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

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software and the New Jersey Geological Survey. October 31, 2001

Building Damage By General Occupancy

October 30, 2001

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Essex						
Agriculture	662	6.00	8.48	14.20	7.70	3.64
Commercial	130,243	14.75	17.01	32.44	22.00	10.76
Education	7,246	12.02	12.81	24.85	16.68	7.99
Government	1,616	15.32	15.50	32.51	23.28	10.90
Industrial	44,446	13.54	14.05	29.54	21.91	10.46
Religion	5,431	13.51	19.16	27.55	17.47	8.78
Residential	362,823	17.22	28.13	31.86	14.08	5.62
State Average	552,467	13.19	16.45	27.57	17.59	8.31
Study Region Average	552,467	13.19	16.45	27.57	17.59	8.31

Study Region : Essexnj
Scenario : dl65

Building Damage by Count by General Occupancy

October 30, 2001

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Total
New Jersey						
Essex						
Agriculture	1	1	4	2	1	9
Commercial	906	802	1,900	1,234	551	5,393
Education	44	28	92	53	13	230
Government	0	0	1	0	0	1
Industrial	228	201	530	414	206	1,579
Religion	47	48	105	44	11	255
Residential	21,533	38,578	40,203	14,461	4,829	119,604
Total State	22,759	39,658	42,835	16,208	5,611	127,071
Study region	22,759	39,658	42,835	16,208	5,611	127,071

Study Region : Essexnj

Scenario : dl65

Quick Assessment Report

October 30, 2001

Regional Statistics

Area (Square Miles)	130
Number of Census Tracts	225
Number of Buildings	
Residential (x 1000)	119
Total (x 1000)	127
Number of People in the Region (x 1000)	778
Building Exposure ($ Millions)	
Residential	29,600
Total	43,000

Scenario Results

Maximum PGA (g)	0.96

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	38,600	39,700
Moderate	40,200	42,800
Extensive	14,500	16,200
Complete	4,800	5,600
Total	98,100	104,300

Casualties

Severity 1 (Medical treatment without hospitalization)	6,210
Severity 2 (Hospitalization but not life threatening)	1,105
Severity 3 (Hospitalization and life threatening)	175
Severity 4 (Fatalities)	134

Shelter

Displaced Households (# households)	40,560
Short Term Shelter (# people)	34,230

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	11,870
Business Interruption (Income) Losses ($ Millions)	3,740
Total ($ Millions)	15,610

Disclaimer:

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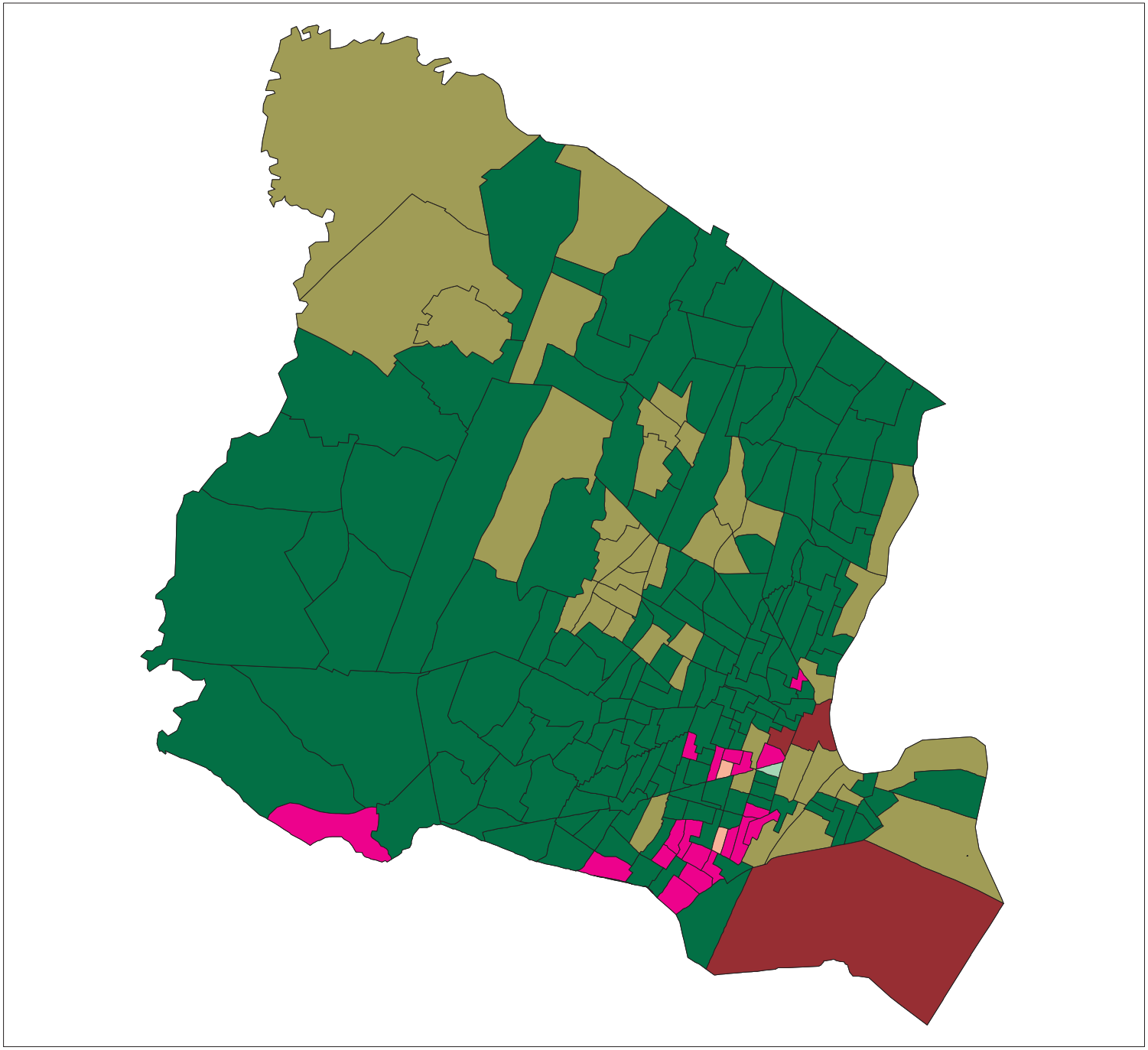
Study Region : Essexnj

Scenario : dl65

APPENDIX L

Magnitude 7 with full upgrade geology



Study Region:
Essex County

Scenario Description:
7.0 Upgrade Scenario

Percentage Of Buildings With Moderate and Greater Damage

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

2 1 0 2 4 6 8 10 Miles

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software and the New Jersey Geological Survey. October 30, 2001

Building Damage By General Occupancy

October 18, 2001

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Essex						
Agriculture	662	2.34	5.13	13.21	10.77	8.55
Commercial	130,243	5.71	10.05	27.87	29.14	24.20
Education	7,246	4.69	7.48	21.27	22.78	18.09
Government	1,616	5.51	8.42	26.25	31.31	25.80
Industrial	44,446	4.88	7.72	23.86	28.59	24.35
Religion	5,431	6.13	13.73	26.81	22.60	17.52
Residential	362,823	8.25	21.86	35.12	20.60	11.39
State Average	552,467	5.36	10.63	24.91	23.69	18.55
Study Region Average	552,467	5.36	10.63	24.91	23.69	18.55

Study Region : Essexnj
Scenario : njess7

Building Damage by Count by General Occupancy

October 18, 2001

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Tota
New Jersey						
Essex						
Agriculture	0	0	4	4	3	11
Commercial	332	339	1,536	1,668	1,445	5,320
Education	18	7	76	81	61	243
Government	0	0	1	1	0	2
Industrial	68	69	410	537	505	1,589
Religion	15	25	101	74	44	259
Residential	10,366	30,139	46,610	22,673	9,864	119,652
Total State	10,799	30,579	48,738	25,038	11,922	127,076
Study region	10,799	30,579	48,738	25,038	11,922	127,076

Study Region : Essexnj

Scenario : njess7

Quick Assessment Report

October 18, 2001

Regional Statistics

Area (Square Miles)	130
Number of Census Tracts	225
Number of Buildings	
Residential (x 1000)	119
Total (x 1000)	127
Number of People in the Region (x 1000)	778
Building Exposure ($ Millions)	
Residential	29,600
Total	43,000

Scenario Results

Maximum PGA (g)	1.21

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	30,100	30,600
Moderate	46,600	48,700
Extensive	22,700	25,000
Complete	9,900	11,900
Total	109,300	116,300

Casualties

Severity 1 (Medical treatment without hospitalization)	11,074
Severity 2 (Hospitalization but not life threatening)	2,135
Severity 3 (Hospitalization and life threatening)	426
Severity 4 (Fatalities)	273

Shelter

Displaced Households (# households)	66,260
Short Term Shelter (# people)	55,780

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	17,280
Business Interruption (Income) Losses ($ Millions)	6,110
Total ($ Millions)	23,390

Disclaimer:

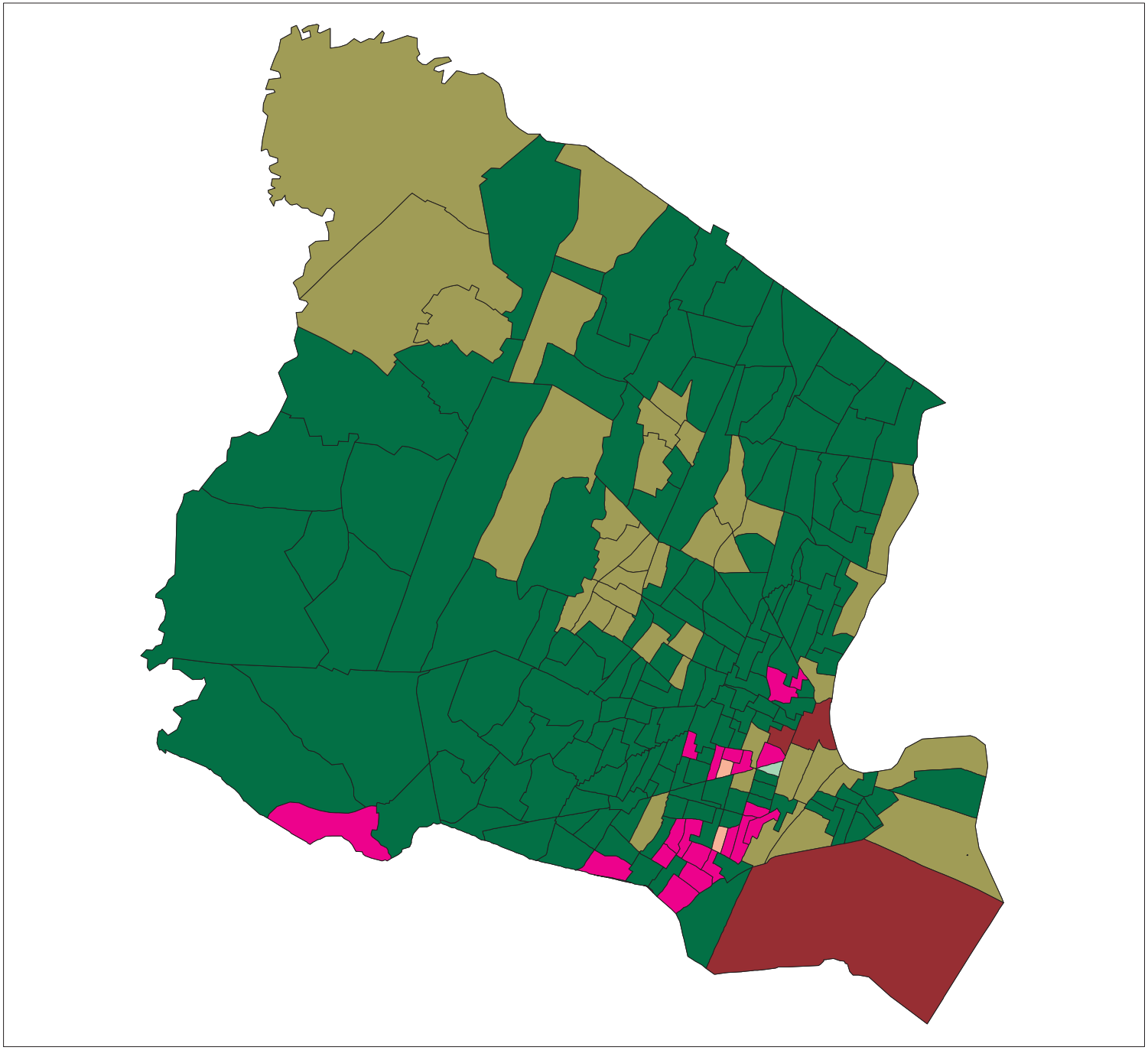
The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences 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.

Study Region : Essexnj

Scenario : njess7

APPENDIX M

Magnitude 7 with upgraded geology, no liquefaction



2 1 0 2 4 6 8 10 Miles

Study Region:

Essex County

Scenario Description:

7.0 Scenario With Upgraded Soils And Landslide Data And Default Liquefaction Data.

Percentage Of Buildings With Moderate and Greater Damage

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

NEW JERSEY GEOLOGICAL SURVEY 1835

Data from the HAZUS GIS software and the New Jersey Geological Survey. October 31, 2001

Building Damage By General Occupancy

November 05, 2001

	Square Footage (Thousand. sq.ft)	Damage State Probability (%)				
		None	Slight	Moderate	Extensive	Complete
New Jersey						
Essex						
Agriculture	662	2.34	5.13	13.24	10.76	8.55
Commercial	130,243	5.71	10.05	27.89	29.09	24.18
Education	7,246	4.69	7.49	21.29	22.76	18.08
Government	1,616	5.51	8.43	26.28	31.28	25.78
Industrial	44,446	4.88	7.72	23.90	28.56	24.35
Religion	5,431	6.14	13.75	26.84	22.59	17.52
Residential	362,823	8.28	21.88	35.18	20.58	11.36
State Average	552,467	5.36	10.64	24.94	23.66	18.54
Study Region Average	552,467	5.36	10.64	24.94	23.66	18.54

Study Region : Essexnj
Scenario : dl7

Building Damage by Count by General Occupancy

November 05, 2001

	# of Buildings					
	None	Slight	Moderate	Extensive	Complete	Tota
New Jersey						
Essex						
Agriculture	0	0	4	4	3	11
Commercial	332	341	1,539	1,664	1,441	5,317
Education	18	8	76	81	60	243
Government	0	0	1	1	0	2
Industrial	68	69	409	533	505	1,584
Religion	15	25	102	74	43	259
Residential	10,382	30,157	46,617	22,641	9,863	119,660
Total State	10,815	30,600	48,748	24,998	11,915	127,076
Study region	10,815	30,600	48,748	24,998	11,915	127,076

Study Region : Essexnj

Scenario : dl7

Quick Assessment Report

November 5, 200

Regional Statistics

Area (Square Miles)	130
Number of Census Tracts	225
Number of Buildings	
Residential (x 1000)	119
Total (x 1000)	127
Number of People in the Region (x 1000)	778
Building Exposure ($ Millions)	
Residential	29,600
Total	43,000

Scenario Results

Maximum PGA (g)	1.21

Number of Buildings Damaged

Damage Level	*Residential*	*Total*
Slight	30,200	30,600
Moderate	46,600	48,700
Extensive	22,600	25,000
Complete	9,900	11,900
Total	109,300	116,300

Casualties

Severity 1 (Medical treatment without hospitalization)	11,054
Severity 2 (Hospitalization but not life threatening)	2,130
Severity 3 (Hospitalization and life threatening)	423
Severity 4 (Fatalities)	273

Shelter

Displaced Households (# households)	66,180
Short Term Shelter (# people)	55,700

Economic Loss

Property Damage (Capital Stock) Losses ($ Millions)	17,230
Business Interruption (Income) Losses ($ Millions)	6,110
Total ($ Millions)	23,340

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.

Study Region : Essexnj

Scenario : dl7

APPENDIX N

Shear-wave velocity data

Abbreviations are:

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

	EAST HILL						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	7.7			ft/sec		ft/sec
	6	10	2.3	2608.695652	**2993.815202**	0.4155	**2406.732118**
	12	13.2	3.2	1875			
	18	16.2	3	2000			
	24	18.4	2.2	2727.272727			
	30	22.7	4.3	1395.348837			
	36	24.9	2.2	2727.272727			
	42	26.6	1.7	3529.411765			
	48	28.1	1.5	4000			
	54	31	2.9	2068.965517			
	60	33.4	2.4	2500			
	66	34.2	0.8	7500			
	S-WAVE						
	0	18					
	6	24.7	6.7	895.5223881	**1170.31047**	0.90828	**1100.988066**
	12	30.5	5.8	1034.482759			
	18	37.8	7.3	821.9178082			
	24	41.9	4.1	1463.414634			
	30	47.9	6	1000			
	36	53.8	5.9	1016.949153			
	42	60.3	6.5	923.0769231			
	48	64.1	3.8	1578.947368			
	54	69.3	5.2	1153.846154			
	60	73.7	4.4	1363.636364			
	66	77.4	3.7	1621.621622			

	INTERSTATE 80 FAIRFIELD						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	12.6			ft/sec		ft/sec
	6	15.6	3	2000	**2743.351886**	0.32877	**3041.682313**
	12	18.4	2.8	2142.857143			
	24	21.4	3	4000			
	30	23.8	2.4	2500			
	36	26.2	2.4	2500			
	42	28	1.8	3333.333333			
	54	30.2	2.2	2727.272727			
	S-WAVE						
	0	22					
	6	33.6	11.6	517.2413793	**441.5475189**	2.33333	**428.5714286**
	12	50	16.4	365.8536585			

	SOUTH ORANGE AVE #1						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	12.2			ft/sec		ft/sec
	6	16	3.8	1578.947368	**1979.215998**	0.42906	**2330.692563**
	12	18.8	2.8	2142.857143			
	18	23.7	4.9	1224.489796			
	24	26.3	2.6	2307.692308			
	30	28.2	1.9	3157.894737			
	48	32.3	4.1	1463.414634			
	S-WAVE						
	0	35.4					
	6	41.2	5.8	1034.482759			
	12	50.2	9	666.6666667	**853.682469**	1.22679	**815.1382824**
	18	57.5	7.3	821.9178082			
	24	64.9	7.4	810.8108108			
	30	71.1	6.2	967.7419355			
	36	80	8.9	674.1573034			
	42	86	6	1000			

	LOCUST GROVE						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	6.6			ft/sec		ft/sec
	6	9.2	2.6	2307.692308	**1985.799009**	0.54312	**1841.201717**
	12	13.5	4.3	1395.348837			
	18	16.3	2.8	2142.857143			
	24	20.4	4.1	1463.414634			
	30	23.9	3.5	1714.285714			
	36	27.4	3.5	1714.285714			
	42	29.3	1.9	3157.894737			
	48	33.6	4.3	1395.348837			
	54	35.9	2.3	2608.695652			
	60	39.1	3.2	1875			
	66	42	2.9	2068.965517			
	S-WAVE						
	0	14.8					
	6	21.5	6.7	895.5223881	**981.4505439**	0.99347	**1006.570135**
	24	38	16.5	1090.909091			
	30	43.8	5.8	1034.482759			
	36	50	6.2	967.7419355			
	42	56.2	6.2	967.7419355			
	54	67.9	11.7	1025.641026			
	60	74.8	6.9	869.5652174			
	66	80.8	6	1000			

	PECKMAN						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	10.2			ft/sec		ft/sec
	6	13.6	3.4	1764.705882	**4605.13751**	0.28396	**3521.573604**
	12	16	2.4	2500			
	18	17.4	1.4	4285.714286			
	24	20.8	3.4	1764.705882			
	36	23	2.2	5454.545455			
	42	23.8	0.8	7500			
	48	25	1.2	5000			
	54	26.4	1.4	8571.428571			
	S-WAVE						
	0	12					
	6	21.8	9.8	612.244898	**651.8759938**	1.65303	**604.9495875**
	12	33.8	12	500			
	18	45.6	11.8	508.4745763			
	24	59.6	14	428.5714286			
	30	71	11.4	526.3157895			
	36	79	8	750			
	42	86.2	7.2	833.3333333			
	48	95.2	9	666.6666667			
	54	106	10.8	555.5555556			
	60	112	6	1000			
	66	119.6	7.6	789.4736842			

	SOUTH ORANGE AVE #2						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	12.2			ft/sec		ft/sec
	6	16	3.8	1578.947368	**3028.375925**	0.41528	**2408.026756**
	12	18.8	2.8	2142.857143			
	18	23.7	4.9	1224.489796			
	24	26.3	2.6	2307.692308			
	30	28.2	1.9	3157.894737			
	36	29.2	1	6000			
	42	30.6	1.4	4285.714286			
	48	32.3	1.7	3529.411765			
	S-WAVE						
	0	28					
	6	41.2	13.2	454.5454545	**770.8342827**	1.32956	**752.1265483**
	12	50.2	9	666.6666667			
	18	57.5	7.3	821.9178082			
	24	64.9	7.4	810.8108108			
	30	71.1	6.2	967.7419355			
	36	80	8.9	674.1573034			
	42	86	6	1000			

	SOUTH ORANGE TILL						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	8.7			ft/sec		ft/sec
	6	11.2	2.5	2400	**3594.210271**	0.30657	**3261.943987**
	12	15.5	4.3	1395.348837			
	18	18.7	3.2	1875			
	24	20.5	1.8	3333.333333			
	30	21.7	1.2	5000			
	36	22.3	0.6				
	42	23.3	1	6000			
	48	24.9	1.6	3750			
	54	26.1	1.2	5000			
	S-WAVE						
	0	14.2					
	6	22.5	8.3	722.8915663	**1850.023773**	0.58811	**1700.356718**
	12	27.5	5	1200			
	18	32.4	4.9	1224.489796			
	24	36.7	4.3	1395.348837			
	30	40.2	3.5	1714.285714			
	36	43	2.8	2142.857143			
	42	45.9	2.9	2068.965517			
	48	48.2	2.3	2608.695652			
	54	50.4	2.2	2727.272727			
	60	53.7	3.3	1818.181818			
	66	55.9	2.2	2727.272727			

	LIVINGSTON WELL SITE						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	5.6			ft/sec		ft/sec
	6	10.9	5.3	1132.075472	**4773.518077**	0.29604	**3377.952756**
	12	19.7	8.8	681.8181818			
	18	20.7	1	6000			
	24	21.8	1.1	5454.545455			
	30	22.6	0.8	7500			
	36	23.6	1	6000			
	42	24.8	1.2	5000			
	48	26	1.2	5000			
	54	27	1	6000			
	60	28.4	1.4	4285.714286			
	66	29.5	1.1	5454.545455			
	S-WAVE						
	0	29.5					
	6	39.6	10.1	594.0594059	**890.862402**	1.30721	**764.9896623**
	12	49.5	9.9	606.0606061			
	18	58	8.5	705.8823529			
	24	67.8	9.8	612.244898			
	36	83.9	16.1	745.3416149			
	42	89.8	5.9	1016.949153			
	48	95.1	5.3	1132.075472			
	54	98.6	3.5	1714.285714			

	PAINTERS POINT						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	5.6			ft/sec		ft/sec
	6	10.8	5.2	1153.846154	**1957.921055**	0.67806	**1474.794219**
	18	21.7	21.7	276.4976959			
	24	24.3	2.6	2307.692308			
	30	27.9	3.6	1666.666667			
	42	38.8	10.9	1100.917431			
	48	42.5	3.7	1621.621622			
	54	45.7	3.2	1875			
	60	47.1	1.4	4285.714286			
	66	48.9	1.8	3333.333333			
	S-WAVE						
	0	16.4					
	6	20.6	4.2	1428.571429	**1007.447246**	1.03494	**966.2438185**
	12	30.1	9.5	631.5789474			
	24	38.8	8.7	1379.310345			
	30	46	7.2	833.3333333			
	36	51.8	5.8	1034.482759			
	42	57.6	5.8	1034.482759			
	48	66.2	8.6	697.6744186			
	54	72.1	5.9	1016.949153			
	60	77.9	5.8	1034.482759			
	66	84	6.1	983.6065574			

	HORSENECK ROAD #2						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	11.9			ft/sec		ft/sec
	6	15.4	3.5	1714.285714	**4932.359307**	0.20688	**4833.802817**
	12	16.3	0.9	6666.666667			
	18	17.7	1.4	4285.714286			
	24	19.7	2	3000			
	30	20.7	1	6000			
	36	21.5	0.8	7500			
	42	23.1	1.6	3750			
	48	24.2	1.1	5454.545455			
	54	25.1	0.9	6666.666667			
	60	25.2	0.1				
	66	26.6	1.4	4285.714286			
	S-WAVE						
	0	35					
	6	49.4	14.4	416.6666667	**542.5053062**	1.94586	**513.9119601**
	12	65.4	16	375			
	18	81.8	16.4	365.8536585			
	24	90.8	9	666.6666667			
	30	100.6	9.8	612.244898			
	36	113	12.4	483.8709677			
	42	122.8	9.8	612.244898			
	48	132.8	10	600			
	54	140.8	8	750			

	HORSENECK ROAD #1						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	10.3			ft/sec		ft/sec
	6	15	4.7	1276.595745	**4198.400226**	0.22675	**4410.177332**
	12	17.8	2.8	2142.857143			
	18	20	2.2	2727.272727			
	24	21.8	1.8	3333.333333			
	30	22.1	0.3				
	36	23.7	1.6	3750			
	42	24.5	0.8	7500			
	48	24.9	0.4				
	54	26.3	1.4	4285.714286			
	60	26.8	0.5				
	66	27.5	0.7	8571.428571			
	S-WAVE						
	0	27.3					
	6	33.8	6.5	923.0769231	**849.7298034**	1.21905	**820.3125**
	12	43.1	9.3	645.1612903			
	18	49.5	6.4	937.5			
	24	56.9	7.4	810.8108108			
	30	65	8.1	740.7407407			
	36	71.5	6.5	923.0769231			
	42	77.7	6.2	967.7419355			

	Becker Park #1						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	4.6			ft/sec		ft/sec
	6	9.7	5.1	1176.470588	**2908.161377**	0.39959	**2502.552137**
	12	14.4	4.7	1276.595745			
	18	17	2.6	2307.692308			
	24	20	3	2000			
	30	22.3	2.3	2608.695652			
	36	24	1.7	3529.411765			
	42	26.2	2.2	2727.272727			
	48	27.3	1.1	5454.545455			
	54	29.5	2.2	2727.272727			
	60	31.7	2.2	2727.272727			
	66	32.8	1.1	5454.545455			
	S-WAVE						
	0	33.2					
	6	43.1	9.9	606.0606061	**1322.243319**	0.8095	**1235.33223**
	12	49.9	6.8	882.3529412			
	18	53.5	3.6	1666.666667			
	24	57.7	4.2	1428.571429			
	30	62.3	4.6	1304.347826			
	36	66.4	4.1	1463.414634			
	42	72.7	6.3	952.3809524			
	48	77.5	4.8	1250			
	54	82.2	4.7	1276.595745			
	60	85.7	3.5	1714.285714			
	66	88.7	3	2000			

	BECKER PARK #2						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	7.8			ft/sec		ft/sec
	6	8.5	0.7		**4251.120448**	0.24779	**4035.747883**
	12	10.1	1.6	3750			
	18	11.3	1.2	5000			
	24	13.1	1.8	3333.333333			
	30	14.8	1.7	3529.411765			
	36	16.2	1.4	4285.714286			
	42	17.8	1.6	3750			
	48	19.6	1.8	3333.333333			
	54	20.6	1	6000			
	60	22.3	1.7	3529.411765			
	66	23.3	1	6000			
	S-WAVE						
	0	14.7					
	6	18.1	3.4	1764.705882	**1978.2472**	0.52308	**1911.764706**
	12	22.1	4	1500			
	18	24.4	2.3	2608.695652			
	24	28.7	4.3	1395.348837			
	30	31.1	2.4	2500			
	36	33.7	2.6	2307.692308			
	42	37	3.3	1818.181818			
	48	40.3	3.3	1818.181818			
	54	43.2	2.9	2068.965517			
	60	47	3.8	1578.947368			
	66	49.5	2.5	2400			

	EAGLE ROCK PARK						
	P-WAVE						**REGRESSION**
	gp spc	pick	int time	int vel.	**AVG VEL**	SLOPE	**VELOCITY**
	0	3.8			ft/sec		ft/sec
	6	7.5	3.7	1621.621622	**4458.490215**	0.21894	**4567.474048**
	12	9.4	1.9	3157.894737			
	18	11.1	1.7	3529.411765			
	24	11.9	0.8	7500			
	30	13	1.1	5454.545455			
	36	14.4	1.4	4285.714286			
	42	15.6	1.2	5000			
	48	16.6	1	6000			
	54	18.2	1.6	3750			
	60	18.4	0.2				
	66	19.8	1.4	4285.714286			
	S-WAVE						
	0	10.8					
	6	14.2	3.4	1764.705882	**1288.362886**	0.91824	**1089.039792**
	12	19	4.8	1250			
	18	23.5	4.5	1333.333333			
	24	32.7	9.2	652.173913			
	30	37.6	4.9	1224.489796			
	36	42.2	4.6	1304.347826			
	42	50.6	8.4	714.2857143			
	48	54.7	4.1	1463.414634			
	54	58.1	3.4	1764.705882			
	60	64.9	6.8	882.3529412			
	66	68.2	3.3	1818.181818			

SEISMIC SOIL CLASS MAP FOR ESSEX COUNTY, NEW JERSEY

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

2001

- Soil Class A--hard rock with less than 10 feet of soil cover. Shear wave velocity greater than 1500 m/s (HAZUS number 1).
- Soil Class C--very dense soil and soft rock. Shear wave velocity between 360 and 760 m/s (HAZUS number 3).
- Soil Class D--stiff soil. Shear wave velocity between 180 and 360 m/s (HAZUS number 4).
- Soil Class E--soft soil. Shear wave velocity less than 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 and geologic map data from Salisbury (1895) and Stanford (1991, 1998, 2000) 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 (particularly soil class E) in many urban areas. This fill includes a wide range of materials. The behavior of fill during seismic shaking should be assessed on a site-specific basis.

REFERENCES CITED

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.

Salisbury, R. D., 1895, Surface geology: report of progress: N. J. Geological Survey Annual Report for 1894, p. 1-150.

Stanford, S. D., 1991, Surficial geology of the Roselle quadrangle, Essex, Union, and Morris counties, New Jersey: N. J. Geological Survey Open File Map 8, scale 1:24,000.

Stanford, S. D., 1998, Surficial geology of the Orange quadrangle, Essex, Passaic, Hudson, and Bergen counties, New Jersey: N. J. Geological Survey Open File Map (in press), scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Elizabeth quadrangle, Essex, Union, and Hudson counties, New Jersey: N. J. Geological Survey Open File Map (in press), scale 1:24,000.

0 1 2 3
MILES

SOIL LIQUEFACTION SUSCEPTIBILITY FOR ESSEX COUNTY, NEW JERSEY

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

2001

- Category 0--none
- 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). Geologic data are from Salisbury (1895) and Stanford (1991, 1998, 2000). Liquefaction susceptibility is based, in part, on soil-saturation and penetration-test data in Stanford (1997).

This map shows the liquefaction susceptiblity of natural soils. Man-made fill overlies these soils (particularly those in Category 4) over much of the county. While most fill has a low liquefaction susceptiblity, uncompacted sand and silt fill may liquefy. The behavior of fill during seismic shaking should be assessed on a site-specific basis.

0 1 2 3
MILES

REFERENCES CITED

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

Salisbury, R. D., 1895, Surface geology: report of progress: N. J. Geological Survey Annual Report for 1894, p. 1-150.

Stanford, S. D., 1991, Surficial geology of the *Roselle quadrangle, Essex*, Union, and Morris counties, New Jersey: N. J. Geological Survey Open File Map 8, scale 1:24,000.

Stanford, S. D., 1997, Distribution and thickness of surficial geologic *materials subject to potential* earthquake-induced ground-shaking amplification and liquefaction in the New Jersey part of the Weehawken and Jersey City quadrangles: report prepared for the U. S. Geological Survey, National Earthquake Hazards Reduction Program, by the N. J. Geological Survey, 8 p.

Stanford, S. D., 1998, Surficial geology of the Orange quadrangle, Essex, Passaic, Hudson, and Bergen counties, New Jersey: N. J. Geological Survey Open File Map (in press), scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Elizabeth quadrangle, Essex, Union, and Hudson counties, New Jersey: N. J. Geological Survey Open File Map (in press), scale 1:24,000.

LANDSLIDE SUSCEPTIBILITY FOR ESSEX COUNTY, NEW JERSEY

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

2001

- None--HAZUS number 0
- Landslide Class A I--strongly cemented rock, slope angle 15-20 degrees (HAZUS number 1)
- Landslide Class A II--strongly cemented rock, slope angle 20-30 degrees (HAZUS number 2)
- Landslide Class A IV--strongly cemented rock, slope angle 30-40 degrees (HAZUS number 5)
- Landslide Class A VI--strongly cemented rock, slope angle >40 degrees (HAZUS number 7)
- Landslide Class B III--weakly cemented rock and soil, slope angle 10-15 degrees (HAZUS number 3)
- Landslide Class B IV--weakly cemented rock and soil, slope angle 15-20 degrees (HAZUS number 4)
- Landslide Class B V--weakly cemented rock and soil, slope angle 20-30 degrees (HAZUS number 7)

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: Caldwell, Orange, Pompton Plains, and Roselle (all with 20-foot contour interval), and Paterson and Elizabeth (10-foot contour interval). Slope materials are from Salisbury (1895) and Stanford (1991, 1998, 2000).

0 1 2 3
MILES

REFERENCES CITED

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

Salisbury, R. D., 1895, Surface geology: report of progress: N. J. Geological Survey Annual Report for 1894, p. 1-150.

Stanford, S. D., 1991, Surficial geology of the Roselle quadrangle, Essex, Union, and Morris counties, New Jersey: N. J. Geological Survey Open File Map 8, scale 1:24,000.

Stanford, S. D., 1998, Surficial geology of the Orange quadrangle, Essex, Passaic, Hudson, and Bergen counties, New Jersey: N. J. Geological Survey Open File Map (in press), scale 1:24,000.

Stanford, S. D., 2000, Surficial geology of the Elizabeth quadrangle, Essex, Union, and Hudson counties, New Jersey: N. J. Geological Survey Open File Map (in press), scale 1:24,000