

# New Jersey



## Geologic Map Guides Earthquake Damage Prediction

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### Defining the Problem

The density and value of its buildings place **New Jersey** tenth among all states for **potential** economic loss from earthquakes (Fig. 1). Soft soils amplify the motion of earthquake waves, producing greater ground shaking and increasing the stresses on structures. Loose, wet, sandy soils may lose strength and flow as a fluid when shaken (a process known as *liquefaction*), causing foundations and underground structures to shift and break. Understanding the shaking and liquefaction potential of soils is an essential component in predicting earthquake **damage**.

### The Geologic Map

Newark, New Jersey's largest city, is built on glacial and postglacial deposits that overlie sandstone bedrock (Fig. 2). **Geologic** data acquired during the **mapping** of these deposits include soil observations, records of more than 800 borings and wells, and archival maps of the extent of swamps and salt marshes prior to land filling in the early 20<sup>th</sup> century. These **data** permit mapping of the bedrock surface, the thickness and layering of the glacial deposits, and the extent of swamp and salt-marsh peats that are now completely covered by fill.

### Applying the Geologic Map

The soft, saturated soils that underlie much of the eastern half of the city are highly susceptible to **shaking** and liquefaction (Fig. 3). The narrow belt of sand and gravel deposits through the center of the city is of intermediate compaction and has medium shaking and **liquefaction** potential. A simulation for a magnitude 5.5 earthquake centered about 5 miles northwest of the city center was run with these data (Fig. 4). Earthquakes of similar magnitude occurred in this area in 1737 and 1884. Less than 10% of buildings underlain by till (unsorted glacial deposits) were significantly damaged, whereas between 20 and 30% of those underlain by wetland and glacial-lake deposits were significantly damaged. The **vulnerable** eastern section of the city includes vital transportation links, including Newark Airport, the New Jersey Turnpike, Interstate 78, the Amtrak **Northeast Corridor** rail line, and the Port Newark marine terminal. The mapping and simulations indicate that this is a priority area for strengthening vulnerable structures.

### Conclusion

Similar soil **mapping** and earthquake **simulations** have been completed for four counties, and are planned for eight others in northern New Jersey. Geologic mapping provides the data foundation that makes these simulations possible. This approach also can be used to **predict damage** in areas where the historical record indicates a risk of potential earthquakes.

Fig. 1. Densely built urban areas on soft soils are prone to earthquake damage. Geologic maps provide vital information on the extent of these soils.

Newark, NJ



### Earthquake Damage Factors

- Location, depth, and magnitude
- Thickness and composition of soil and bedrock
- Types of structures

# geologic map

of the Newark, NJ area



## GEOLOGIC MAP

- floodplain deposits
- stream-terrace deposits
- salt-marsh deposits
- swamp deposits
- glacial-lake sand and gravel
- glacial-lake silt and clay
- glacial-river sand and gravel
- thick till
- thin till
- moraine deposits
- bedrock outcrop
- wells and borings
- contours on bedrock surface

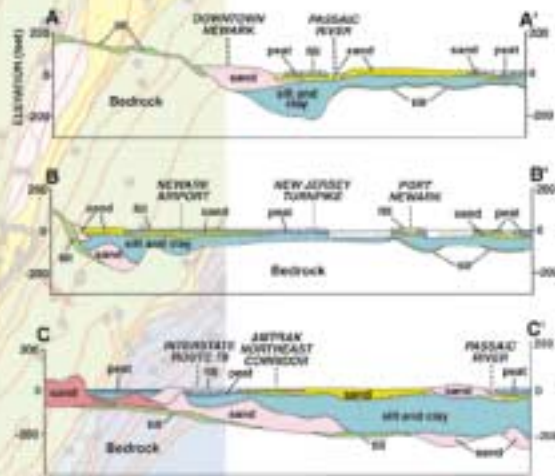
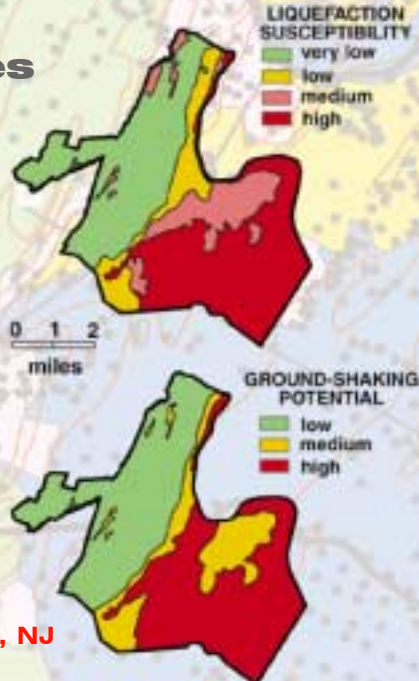


Fig. 2. Unsorted glacial deposits, till, (light green) has low liquefaction and ground-shaking potential. The soft, saturated soils (blue and gold) under much of the eastern half of the city are highly susceptible to shaking and flowing as a fluid. The narrow belt of sand and gravel deposits (pink) through the city center has medium shaking and liquefaction potential.

## seismic soil properties

Fig. 3. Soft soils amplify the motion of earthquake waves, producing greater ground shaking and increasing the stresses on structures. Loose, wet, sandy soils may lose strength and flow as a fluid when shaken (a process known as liquefaction), causing foundations and underground structures to shift and break.



## simulated building damage from a magnitude 5.5 earthquake

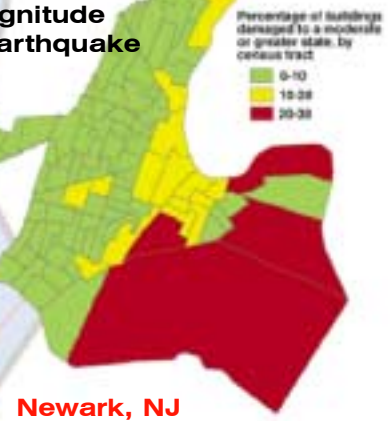


Fig. 4. A computer model commissioned by the Federal Emergency Management Agency and now used as a nationwide standard analyzes earthquake factors on a census-tract basis to generate damage estimates.