

**MMI Engineering applied advanced analytical methods to perform probabilistic flood hazard analysis for a major development in New York to assess flooding risk. The factors considered include tidal effects, riverine flooding, Nor'easter rainfall, hurricane storm surge and sea level rise.**

Fresh water discharges in nearby water bodies, astronomical tides, storm surge from tropical and extra-tropical storms (hurricanes and regional/tropical storms), sea level rise from global climate change and from wind surface waves are all effects that were taken into consideration in flooding predictions. An understanding of how each effect contributes to water elevation and its correlation with other effects was considered to appropriately combine them in a probabilistic framework. MMI used methods ranging from statistical analysis of empirical data to parametric studies using hydraulic and hydrodynamic analysis tools to quantify these effects.

To determine the storm surge from hurricanes, thousands of physically-behaved synthetic hurricanes relevant to the New York site were generated using importance sampling techniques and probabilistic extrapolation of historic storms. Storm surge analysis was then done on the synthetic tracks using SLOSH, a computer program developed by NOAA.

### Risk metrics generated:

- Robust estimates of storm surge based on 10,000+ hurricane simulations near the site
- Wind generated surface wave predictions
- Fresh water river flood contributions
- Sea level rise elevation for a variety of time periods
- Estimates of flooding for a range of return periods

The effect of sea level rise occurs on a multi-decadal or millennial scale and is incorporated with consideration of the project design life. New York sea level rise scenarios were incorporated for best estimates as well as rapid melting of ice sheets.

The hurricane-induced storm surge estimates are combined with astronomical tide, wind generated waves, regional storm induced surge, fresh water flow and sea level rise to create a comprehensive probabilistic flood model. With this model various outputs for

the client were generated such as inundation maps for flood elevation of various return periods.

The client gained insights in flood hazard assessment for different time periods and developed strategies for hazard mitigation.

### Flooding Factors

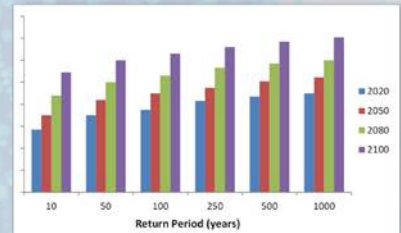
Hurricane storm surge, astronomical tides and sea level rising are just three possible flood contributors



Storm surge requires modeling the hurricane track from genesis to landfall

### Insightful Metrics

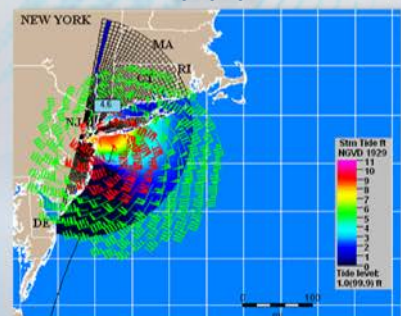
Linking data outputs together in informative visual aids.



Water elevation predictions for a range of return periods at different time points in the future

### Hurricane Simulations

Parameters including wind speed, central pressure deficit, forward velocity, radius to maximum winds and heading are all considered in the hazard



Time dependent hurricane storm surge modeling