Description of storm damage

The combination of high tide, a full moon, and Superstorm Sandy's size and wind dynamics created a massive surge of water that funneled up through the Narrows at the entrance to Upper New York Harbor. The tide gauge at the Battery measured a flooding height of 14 feet above Mean Lower Low Water,[11] surpassing the previous high water mark (set by Hurricane Donna in 1960) by four feet.[12] This large influx of water led to still water (as opposed to wave-driven) flooding of many of the shoreline areas of Lower Manhattan, with significant salt water flooding and sewer backup of building first floors, basements, and underground infrastructure—including transportation, electrical power, and telecommunications equipment. The damage to physical assets was eclipsed by the impact on human life, including two lives lost in the Area and far more across the City and region.

The flooding in Lower Manhattan was intensified by the fact that high tide at the Battery occurred at roughly the peak of the Superstorm Sandy storm surge, meaning that the surge was building on top of the highest base water levels. Had the storm surge arrived six hours earlier or six hours later, flooding likely still would have occurred, but would have been significantly less extreme in this location.[14]In addition, the prevailing winds shifted to a direction that pushed more water directly through the Narrows and into the Upper Harbor, increasing the volume of water entering into the constrained topography, leading to yet higher levels of storm surge coming over the various seawalls and bulkheads at the waterfront edge. Because the Upper Harbor is relatively sheltered and the shoreline is generally guarded by those seawalls, the buildings within Lower Manhattan experienced water flowing in and around them, but did not experience the direct wave action that severely impacted the waterfront neighborhoods of Queens, Brooklyn, and Staten Island that suffered the most structural damage to buildings.

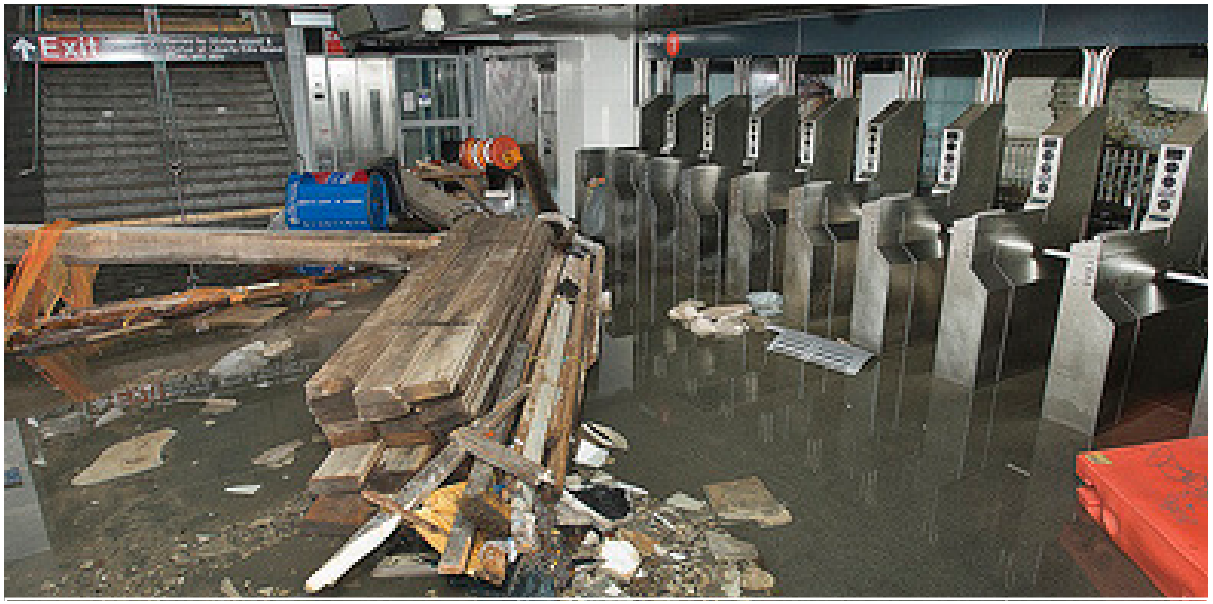
Flooding in the area principally affected the low-lying areas adjacent to the shoreline, typically within two to three blocks from the shore. In certain cases, particularly in the lower-lying areas adjacent to Canal Street on the west side, flooding extended farther inland once water overtopped the bulkheads, covering adjacent areas based on local topography. Flooding in Battery Park City was more limited because the neighborhood was constructed at a higher elevation, but water entered from both the north and south of Battery Park City along West Street (Route 9A), which led to significant flooding of the World Trade Center site, including the Port Authority Trans-Hudson (PATH) tunnels into New

Superstorm Sandy rattled the west side, seen at top at Christopher Street Pier. Damage was extensive to retail businesses throughout the Focus Area, including in the South Street Seaport Historic District (bottom). Sources: courtesy of Robert Woodworth (top); courtesy of Pasanella & Son Vintners (bottom).

Jersey. Some other areas hit hardest by flooding include Alphabet City, portions of the Lower East Side, the South Street Seaport, Water Street, and high-density housing, including public and subsidized housing, adjacent to the East River between the Brooklyn Bridge and the Manhattan Bridge.

In addition to the direct damage caused by flooding, which was concentrated at the shoreline, the entire area lost electrical power and steam, due to both preventative shutdowns of certain portions of the electrical grid and the failure of other portions of the grid, due to flooding of critical facilities. One exception to this was Battery Park City, which, as noted above, was spared significant flooding due to its higher elevation and maintained power because it receives its electrical supply from an area transmission substation in Brooklyn that was not impacted by Sandy.

In addition to impacts on electrical systems, Sandy led to major damage to, and shutdown of the area's steam system and telecommunications systems. The shutdown of the steam system led to a loss of heat and hot water to many buildings, posing a danger to residents and business owners as cooler weather approached. The loss of steam required many property owners to install portable boilers and generators mounted on trailers around Lower Manhattan as commercial and residential buildings were reoccupied leading to quality of life issues for residents. The loss of communications had varying impacts on both residential and commercial buildings, particularly as many businesses could not move back into their offices until they had phone and internet access, and critical community-based organizations (CBOs)



Subway stations suffered serious damage from Sandy, including South Ferry station. A blackout engulfed Lower Manhattan (below). Sources: Flickr user MTAPhotos (Metropolitan Transportation Authority/Patrick Cashin) (top); Flickr user Dan Nguyen (bottom). Both licensed under Creative Commons.

found it difficult to coordinate relief efforts without reliable communications.

High-rise buildings lost water pressure, elevator service, and security systems, though this did not result in any major fires or other public safety hazards. In high- and mid-rise buildings, many residents found themselves trapped during and after Sandy due to power outages that caused the failure of electrical and mechanical systems. This disproportionately affected vulnerable populations, including seniors and tenants of public housing, who were stranded with limited access to vital services. These outages also forced many people to leave their homes for extended periods of time after the storm.

Damage to transportation infrastructure was great. Estimates of damage to the City's overall transportation infrastructure exceed $8 billion, with most of that damage concentrated in Lower Manhattan due to the density of transportation assets.

In advance of Sandy, the Metropolitan Transportation Authority (MTA) shut down the City subway system due to the risk of flooding and possible loss of electricity and damage to mechanicals. After Sandy made landfall, salt water damaged important electrical and communications equipment, including signal relays that prevent train collisions. Among the most severely damaged subway assets was the South Ferry 1 train Station—a loss that will require multiple years to repair. Other damaged assets include the World Trade Center PATH station and the Montague Tunnel, which connects the R train to Brooklyn. The Holland Tunnel to New Jersey, the Battery Park Underpass of the Franklin D. Roosevelt (FDR) Drive, and the Hugh L. Carey Tunnel to Brooklyn were fully flooded, the latter taking over three weeks to fully reopen.

Sandy also resulted in temporary shutdowns of the Staten Island Ferry and private ferry services, and damaged the surface—and in certain cases, the underground structure—of many streets in the inundation area, including Water Street, West Street and the FDR Drive.

Storm damage from Superstorm Sandy was more pervasive and long-lasting in the Planning Area than during Hurricane Irene and Tropical Storm Lee. During Hurricane Irene, a mandatory evacuation order was issued for significant coastal portions of New York City, including portions of the Planning Area, and the entire MTA bus, subway, and commuter rail system was shut down preemptively. Hospitals and other medical facilities were also evacuated and a state of emergency was declared. While portions of the Meatpacking District suffered flooding, most of the Planning Area experienced minimal damage, with the World Trade Center site escaping flooding damage due to efforts by construction workers to install temporary floodproofing structures. Because Tropical Storm Lee followed a path that brought it significantly to the west (inland) of New York City, the Planning Area was spared from any major impacts, as compared to locations such as Binghamton and the Susquehanna River Valley.

Figure I-6: Superstorm Sandy inundation map