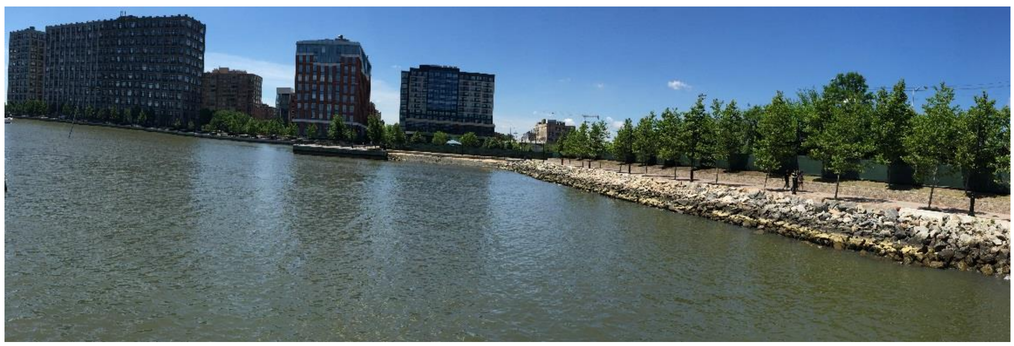

Rebuild by Design - Hudson River Project

Hydrology and Flood Risk Assessment Report

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SUBMITTED BY:

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State of New Jersey Department of Environmental Protection

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1 Executive Summary

The Rebuild by Design- Hudson River feasibility assessment and Environmental Impact Statement (EIS) study involves the development and evaluation of flood risk reduction measures to reduce flood risk from coastal storm surge and rainfall events within the entire City of Hoboken and adjoining portions of Weehawken and Jersey City (also referred to as study area). A coastal hydrodynamic and stormwater management model is required to understand the flooding effects of coastal storm surge and rainfall events and evaluate the effectiveness of proposed flood risk reduction measures. The main objectives of modeling is to aid in the development of potential flood risk reduction measures, evaluate flood risk reduction benefits and potential residual flooding impacts from the proposed alternatives.

A two-dimensional (2D) coastal hydrodynamics model was developed using the Danish Hydraulic Institute's (DHI) MIKE 21 software to evaluate the coastal storm surge conditions. Additionally, a combined stormwater and coastal conditions model was developed using DHI's MIKE FLOOD program to assess flooding within the study area from rainfall events.

The best available data was utilized as inputs for the development of the MIKE 21 coastal hydrodynamic model including Post Sandy Light Detection and Ranging (LiDAR) overland topography, recent topographic surveys developed as part of this effort, bathymetry from NOAA and Stevens Institute of Technology and others. The MIKE 21 model captures street-level flooding in the study area and has a minimum horizontal resolution of approximately 3 meters (10 feet) with a total of approximately 1 million computation nodes in the entire MIKE 21 model domain. The MIKE 21 model mesh also includes building footprints located within the study area that are modeled as blocked obstructions to replicate flow volume for the coastal storm surge through the streets of the project area. In reality it is likely that a volume of surge floodwater would enter some buildings, but given the difficulty of simulating flow volume into buildings, the approach used results in a somewhat conservative coastal hydrodynamic model.

A hindcast of Superstorm Sandy was conducted to validate the MIKE 21 coastal hydrodynamics model. Measured high water mark (HWM) data obtained from USGS (Unites States Geological Survey) and Stevens Institute of Technology allowed for the MIKE 21 coastal model results to be evaluated and verified against observed data for Sandy. An overall comparison of water depth between the model and the observed HWM data showed Root Mean Square Error (RMSE) of less than 6 inches (0.5ft). Overall these minor differences in water depths are within the uncertainty of the measured height and time of the HWM data and thus indicates that the MIKE 21 coastal model performs well to predict the hydrodynamics within the study area. The model results and comparisons with measured water depths are also in good agreement with other past modeling efforts of Superstorm Sandy in the study area (Blumberg et al., 2015).

This validated MIKE 21 coastal hydrodynamics model was utilized to evaluate flooding effects of coastal storm surge during a 10-year (10% annual chance), 50-year (2% annual chance) and 100-year (1% annual chance) storms in the No-Action Alternative (NAA) and the three build alternatives (see Figure 5- 1 and 6-11 for map showing NAA and three "Resist" alternatives, respectively). To accurately reflect future project area conditions the NAA scenario considers completion of two existing independent projects underway: the filling-in of the Long Slip canal located on NJ Transit's property and the development of Newport property in Jersey City. Each of the three build alternatives include "Resist" alignments has potential to reduce the area subject to flood risk from coastal storm surge at varying levels. The maximum flood water depths in NAA and each of the three build alternatives within the study area were compared to evaluate the flood risk reduction benefits and any potential residual flooding. Alternative 1 which includes "Resist" alignment primarily along the waterfront provides the maximum flood risk reduction benefits with 98% percent of the population currently living within the 2013 preliminary Federal Emergency Management Agency (FEMA) 100-year floodplain. Similarly, Alternative 2 which includes a "Resist" alignment along 15th street in Hoboken and Alternative 3 which includes a "Resist" alignment along the pedestrian alleyway between Garden Street and Washington Street provides flood risk reduction benefits for 86% and 85% of the population currently living within the 2013 preliminary FEMA 100-year floodplain, respectively. Residual flooding risk as per NJAC 7:13 rules is defined as an adverse effect or impact with the proposed Resist structure that results in a potential increase of greater than 0.04 feet of flood depths as shown by the coastal model to an existing area that is located within FEMA's 1-percent-annual-chance Special Flood Hazard Area (SFHA). The coastal model results indicate that Alternative 1 has the least residual flooding impacts whereas Alternative 2 and 3 has potential residual flooding impacts at 5 properties within the entire study area.

Storm-sewer data was provided by North Hudson Sewerage Authority (NHSA) in order to develop a stormwater model using DHI's MIKE URBAN and MIKE FLOOD program. The stormwater model primarily covers the City of Hoboken sewersheds, but it takes into account rainfall runoff flow coming into the NHSA sewer system within the City of Hoboken from portions of Jersey City and Union City. DHI's MIKE FLOOD program was utilized to integrate the storm-sewer data with the two-dimensional (2-D) overland topographic flow model developed with DHI's MIKE 21 model. The stormwater model results were validated with the best available data on inland rainfall flood depths from Hurricane Irene. Additionally, NHSA officials confirmed the flooding extents and water depths from the integrated model for Hurricane Irene based on their observations at the time of this hurricane.

Based on discussions with FEMA, the interior drainage in a coastal flood risk reduction project subject to impact from tidal action requires evaluation of the stormwater system in two conditions – with outfalls open (low tide) and with outfalls closed (high tide)– for various rainfall events. The No-Action Alternative (NAA) for stormwater management as well as the "Delay, Store, Discharge (DSD)" alternative for the 5-year (20% annual chance), 10-year (10% annual chance), 25-year (4% annual chance), 50-year (2% annual chance) and 100-year (1% annual chance) rainfall events was simulated under these two conditions. The NAA considers several on-going and completed projects undertaken by the City of Hoboken and NHSA which can be found in Figure 9-1. The DSD alternative includes the implementation of 61 Right-of-Way (ROW) green and grey infrastructure enhancements along with three parcel based stormwater management improvements (BASF, NJ Transit/Housing Authority and Block 10 sites). The extent of flooding demonstrated by the integrated model for various rainfall events in the NAA and DSD alternatives was compared. Model results indicates that the DSD alternative has a potential to reduce rainfall induced flooded area by 73% and 81% over the NAA flooded areas in a 5-year flood event in high tide and low tide conditions, respectively. As the rainfall return period increases, the flood risk reduction benefits provided by the DSD alternative over the NAA flooded areas decreases.

The main conclusions of this task report are as follows –

- Coastal storm surge modeling results shows that all the three "Resist" alternatives provides coastal flood risk reduction benefits within the study area
- Stormwater modeling results shows that the proposed "DSD" alternative provides significant flood risk reduction benefits especially for lower rainfall return period events such as the 5-year rainfall

For the final preferred alternative, we recommend the following major items should be considered during the design phase of this project –

- Perform Wave Height Analysis for Flood Insurance Study (WHAFIS) model analysis using the best available FEMA data to satisfy FEMA's Conditional Letter of Map Revision (CLOMR) requirements
- Perform interior drainage analysis by updating the integrated stormwater and coastal model developed for this project to satisfy the interior drainage requirements for the FEMA levee certification
- Conduct coordination meetings with FEMA Region II before the submittal of CLOMR documentation to ensure appropriate methodology was adopted and implemented

Additional recommendations for the design phase of the project is provided in Section 10 of this report.