

SEA LEVEL RISE MAPPING
NEW HAMPSHIRE OPEN COAST, PISCATAQUA RIVER, AND
GREAT BAY

for

The University of New Hampshire

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1. Task Summary

INTRODUCTION

This report presents the sea level rise mapping data development for the New Hampshire open coast, Piscataqua River, and Great Bay. AECOM prepared this document in accordance with Amendment Number 01 to Subcontract Number 12-074 between the University of New Hampshire (UNH) and AECOM.

SCOPE

AECOM developed basic sea level rise extent of inundation GIS layers for four sea level rise horizons along the open coast of New Hampshire, the Piscataqua River, and Great Bay. The four sea level rise horizons and mapping scenarios are described as follows:

- Mean high-high water (MHHW) + 1.7' (2050 high emissions scenario estimate)
- MHHW + 6.3' (2100 high emissions scenario estimate)
- 100-year present plus 1.7' which represents the 2050 high emissions scenario estimate concurrent with a 100-year event
- 100-year present plus 6.3' which represents the 2100 high emissions scenario estimate concurrent with a 100-year event

For the 100-year scenarios, the recently updated 100-year flood extents were used as the reference case upon which sea level rise was projected. The elevations of the MHHW along the Atlantic Ocean, the Piscataqua River, and Great Bay were provided to AECOM by UNH.

DELIVERIBLES

AECOM delivered the following items for this task:

- GIS layers showing the extent of flooding on the open coast, the NH side of the Piscataqua River, and Great Bay for:
 - Mean high-high water (MHHW) + 1.7' (2050 high emissions scenario estimate)
 - MHHW + 6.3' (2100 high emissions scenario estimate)
- GIS layers showing the extent of flooding on the open coast, the NH side of the Piscataqua River, and Great Bay for:
 - 100-year present plus 1.7' which is the 2050 high emissions scenario estimate)
 - 100-year present plus 6.3' which is the 2100 high emissions scenario estimate
- Depth grids for these same four scenarios
- Metadata in FGDC format

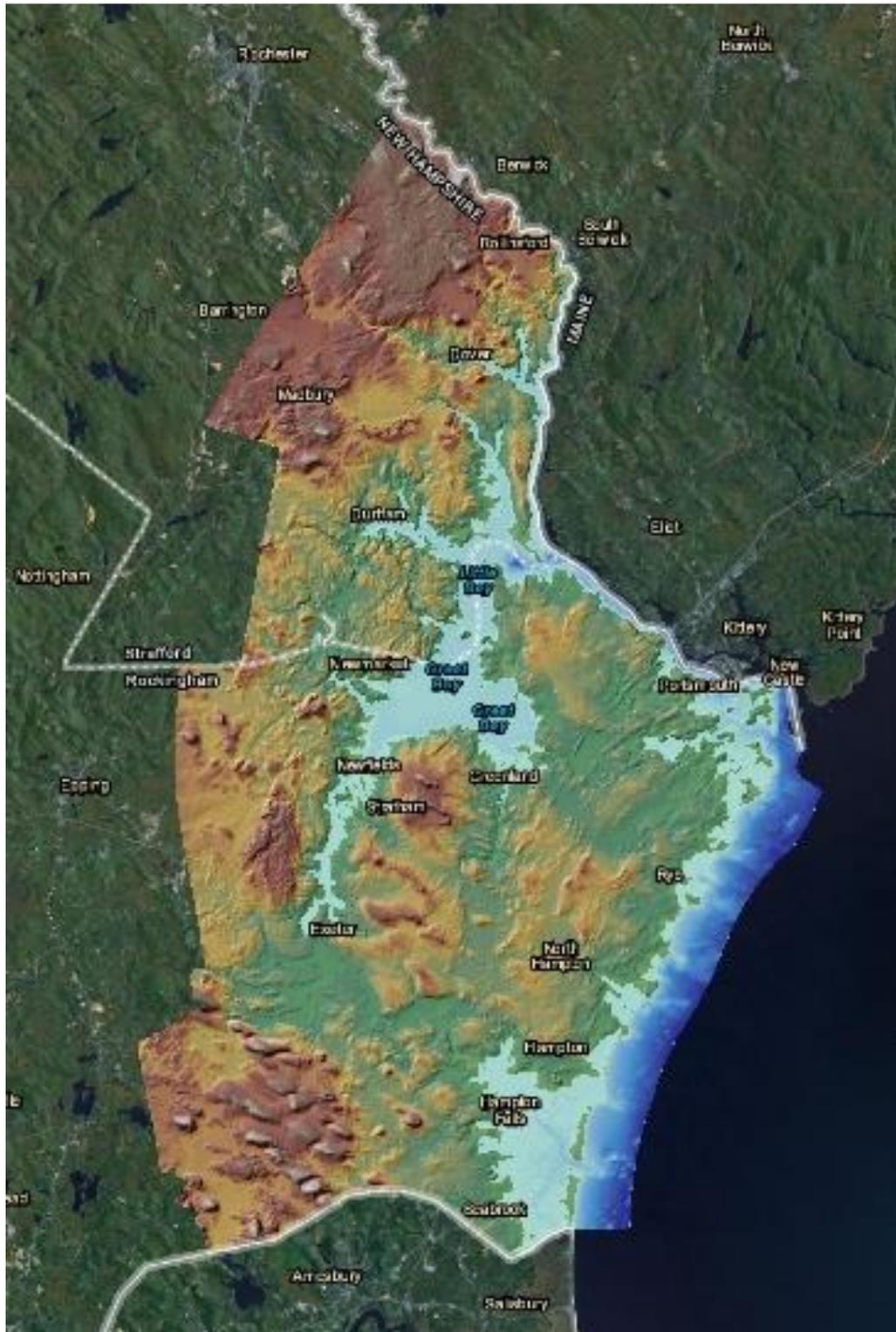
- This memorandum.
- One meeting to discuss results

NOTES/ASSUMPTIONS

The coastal elevations and extents are an approximation, assuming the following:

- For the 100-year event along the open coast subject to waves, setup is considered but other wave impacts are not considered. An average setup value for the NH seacoast (3.32 feet) was added to the storm surge elevation (8.36 feet).
- There may be cases, because of the deeper water, where waves are able to regenerate and create V zones on inland embayments. No computations were performed to establish if this would happen.
- The mapping shows sea level rise under “present day” 100-year conditions – the characteristics of the 100-year storm event will not change.

Figure 1. Coverage Area Map



2. Methodology

ELEVATION DATA

A 10-foot resolution bare earth digital elevation model (DEM) was leveraged from the Piscataqua/Salmon Falls FEMA flood study developed by AECOM. The DEM was sampled from a TIN developed using topographic and bathymetric data detailed below. The DEM serves as the basis for determining depths associated with the sea level rise scenarios

Table 1. Summary of Elevation Data used to Develop the DEM

Data	Description	Source	Accuracy
Topographic LiDAR	2010 LiDAR for the Northeast. Collection includes approximately 8,200 square miles of coastal areas including parts of Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, and New York.	Complex Systems Research Center at the University of New Hampshire (UNH) via the United States Geological Survey	Vertical accuracy for 1-meter point spacing LiDAR is better than 9.25 cm RMSE. Vertical accuracy for 2-meter point spacing LiDAR is better than 15 cm RMSE
Bathymetry	National Ocean Service Hydrographic Survey Data	National Oceanic and Atmospheric Administration	For data acquired after 1965, meets accuracy requirements set forth in NOS Hydrographic Surveys Specifications and Deliverables
National Elevation Dataset	1/3 Arc Second Digital Elevation Model used to supplement void areas in the LiDAR.	United States Geological Survey	For 7.5- and 15-minute DEM's derived from vector or DLG hypsographic and hydrographic source data, accuracy is considered one-half the source contour interval.

INUNDATION DATA

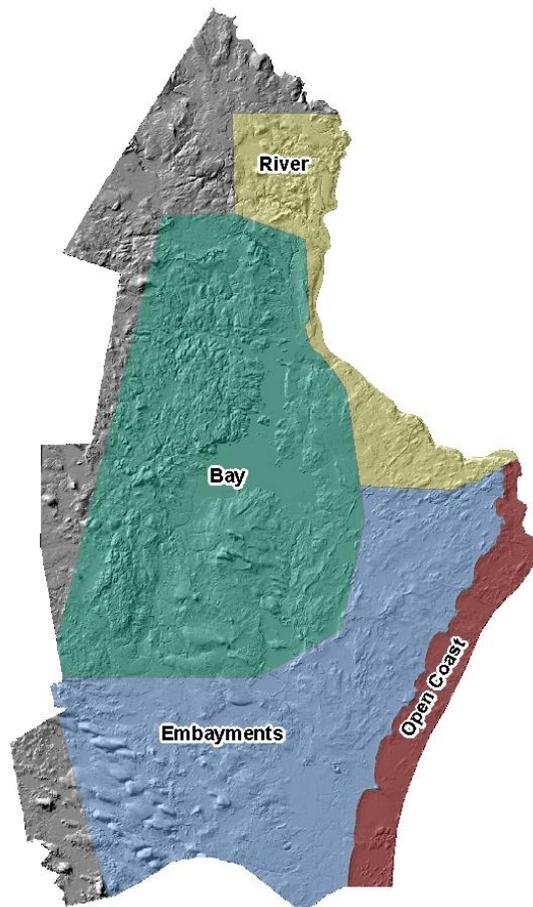
Grid data representing four inundation scenarios were developed to calculate depths against the bare earth DEM. For each of the four scenarios, the project area was divided into four zones to account for potential changes in inundation characteristics; open coast, embayment areas, river,

and bay. The embayment zone was separated from open coast with the assumption that the inundation would dissipate after making initial contact with the shore. The river zone, broken from the open coast at Fort Point in Newcastle, was created with the assumption that setup would not extend into the Pisacataqua River. The Bay zone, containing Little Bay and Great Bay, broken at the bridge crossing near the confluence of the Little Bay and the Pisacataqua River, was created with the assumption that this zone would be subject to different 100-year and MHHW elevations. Present day MHHW values were estimated from nearby tidal gage data, and are shown in Table 2. Figure 2 below displays the zone boundaries.

Table 2. Present Day Mean High High Water Elevations, NAVD88

	Bay	River	Embayment	Open Coast
MHHW	3.6'	4.2'	4.4'	4.4'

Figure 2. Zone Break Map



Each zone was assigned an inundation elevation, with consideration for its contributing factors, either derived from the MHHW or the 1% annual chance flood serving as the base value and adding 1.7' and 6.3' as reference from the 'Report on Emissions Scenarios' (Nakicenovic, N. et al. 2000). Because published values for the 1% flood along the Great Bay shoreline varied slightly between communities, an average 1% flood value of 6.7' NAVD was used as the basis for adding the 2050 and 2100 sea level rise values. The inundation values for each zone per scenario can be referenced in Table 3.

Table 3. Summary of Zone Inundation Elevations (rounded to nearest one-half foot)

	Bay	River	Embayment	Open Coast
MHHW + 1.7'	5'	6'	6'	6'
MHHW + 6.3'	10'	10.5'	10.5'	10.5'
1% + 1.7'	8.5'	10'	10'	13.5'
1% + 6.3'	13'	14.5'	14.5'	18'

With these values, four base sea level rise (SLR) scenario grids were created where each value was represented in its entire zone extent. To keep calculations between the SLR grids and the bare earth DEM one to one, the SLR grids were created using the same coordinate system, units, cell size, and origin as the bare earth DEM. The bare earth DEM was then subtracted, using ESRI Arc GIS raster calculator, from the SLR grids to create depth grids for each scenario. The resulting depth grids had positive and negative depths. The point where the positive depths reach the negative represents the inundation extent for a given scenario. All cells in the depth grids that had a positive depth were retained. Then, in an effort to remove miscellaneous low lying or extreme upper extent unconnected cells, a cluster operation was performed to count all cells that make up a connected cluster. Those clusters of cells that represented an acre of area or smaller were removed to clean up and homogenize the grids to better represent the effect of ocean inundation through the zones.

DELIVERABLE DESCRIPTIONS

All sea level rise data development files will be transmitted electronically to UNH for review and use. GIS spatial files, including bare earth DEM, SLR grids, and extent feature classes have been imported into an ArcGIS version 10 file geodatabase. The database structure below lists the files and a brief description:

- **NH_SLR_fgdb_v10.gdb**
 - **dem_10ft** – 10-foot resolution bare earth grid
 - **dem_10ft_poly** – spatial extent of dem_10ft
 - **dem_10ft_shd** – hillshade of dem_10ft

- **MHHW_2050_Connected** – MHHW + 1.7' with unconnected areas less than one acre removed
- **MHHW_2050_Connected_poly** – spatial extent of MHHW_2050_Connected
- **MHHW_2050_Raw** – MHHW + 1.7' with all unconnected areas
- **MHHW_2050_Raw_poly** – spatial extent of MHHW_2050_Raw
- **MHHW_2100_Connected** – MHHW + 6.3' with unconnected areas less than one acre removed
- **MHHW_2100_Connected_poly** – spatial extent of MHHW_2100_Connected
- **MHHW_2100_Raw** – MHHW + 6.3' with all unconnected areas
- **MHHW_2100_Raw_poly** – spatial extent of MHHW_2100_Raw
- **OnePercent_2050_Connected** – Preliminary 1% annual chance flood + 1.7' with unconnected areas less than one acre removed
- **OnePercent_2050_Connected_poly** – spatial extent of OnePercent_2050_Connected
- **OnePercent_2050_Raw** – Preliminary 1% annual chance flood + 1.7' with all unconnected areas
- **OnePercent_2050_Raw_poly** – spatial extent of OnePercent_2050_Raw
- **OnePercent_2100_Connected** – Preliminary 1% annual chance flood + 6.3' with unconnected areas less than one acre removed
- **OnePercent_2100_Connected_poly** – spatial extent of OnePercent_2100_Connected
- **OnePercent_2100_Raw** – Preliminary 1% annual chance flood + 6.3' with all unconnected areas
- **OnePercent_2100_Raw_poly** – spatial extent of OnePercent_2100_Raw
- **SLR_Zones** – Zones determined by impact to scenarios

3. CONCLUSIONS

To summarize, SLR zones were determined based on different sea level rise scenarios. SLR values were assigned to each zone for either the MHHW or 1% annual chance event using either the 2050 or 2100 high emissions projections. The resulting SLR grids were used to perform raster calculations to create depth and connected depth grids. The results were presented to UNH for review and use.