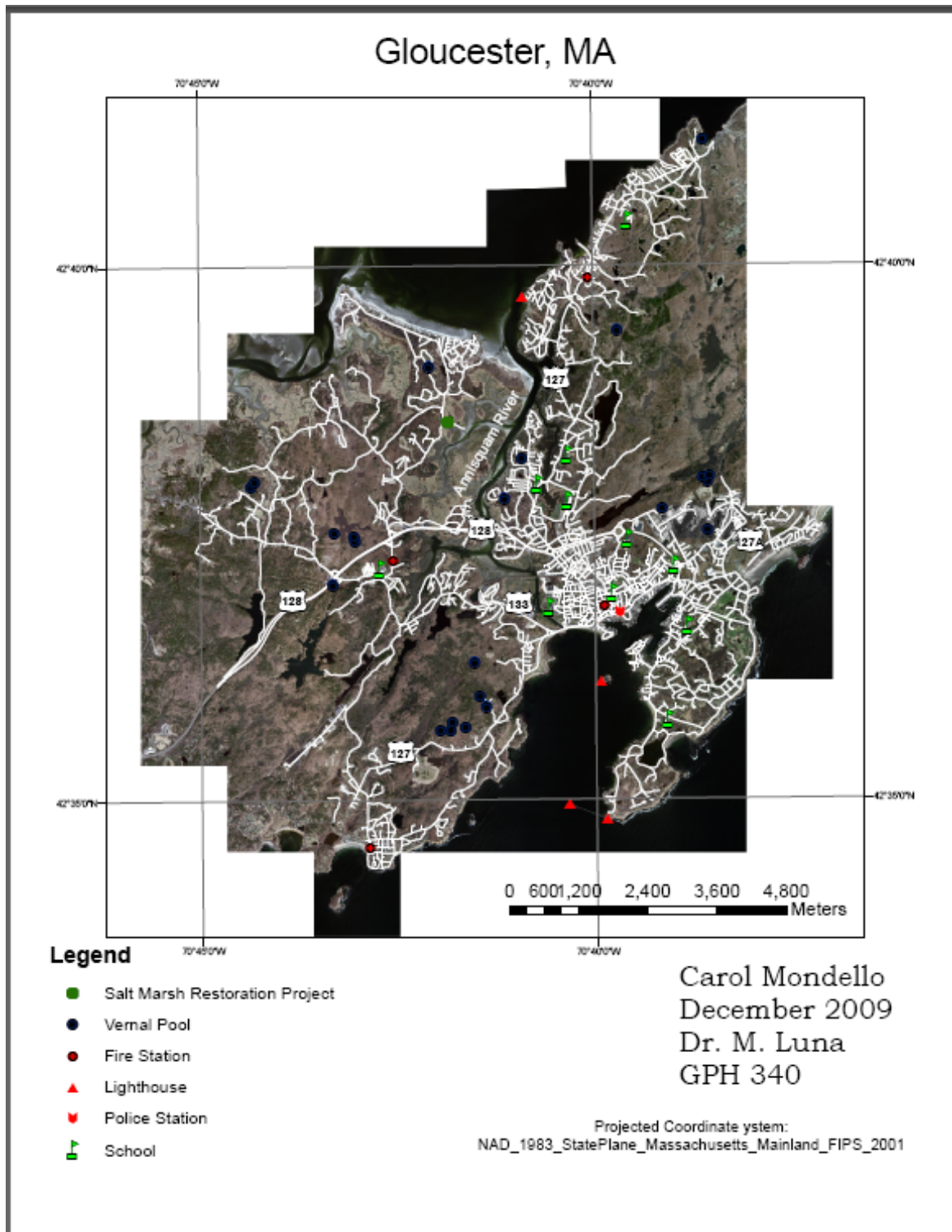


# Gloucester, MA

Carol Mondello  
GIS Final Project  
December 2009

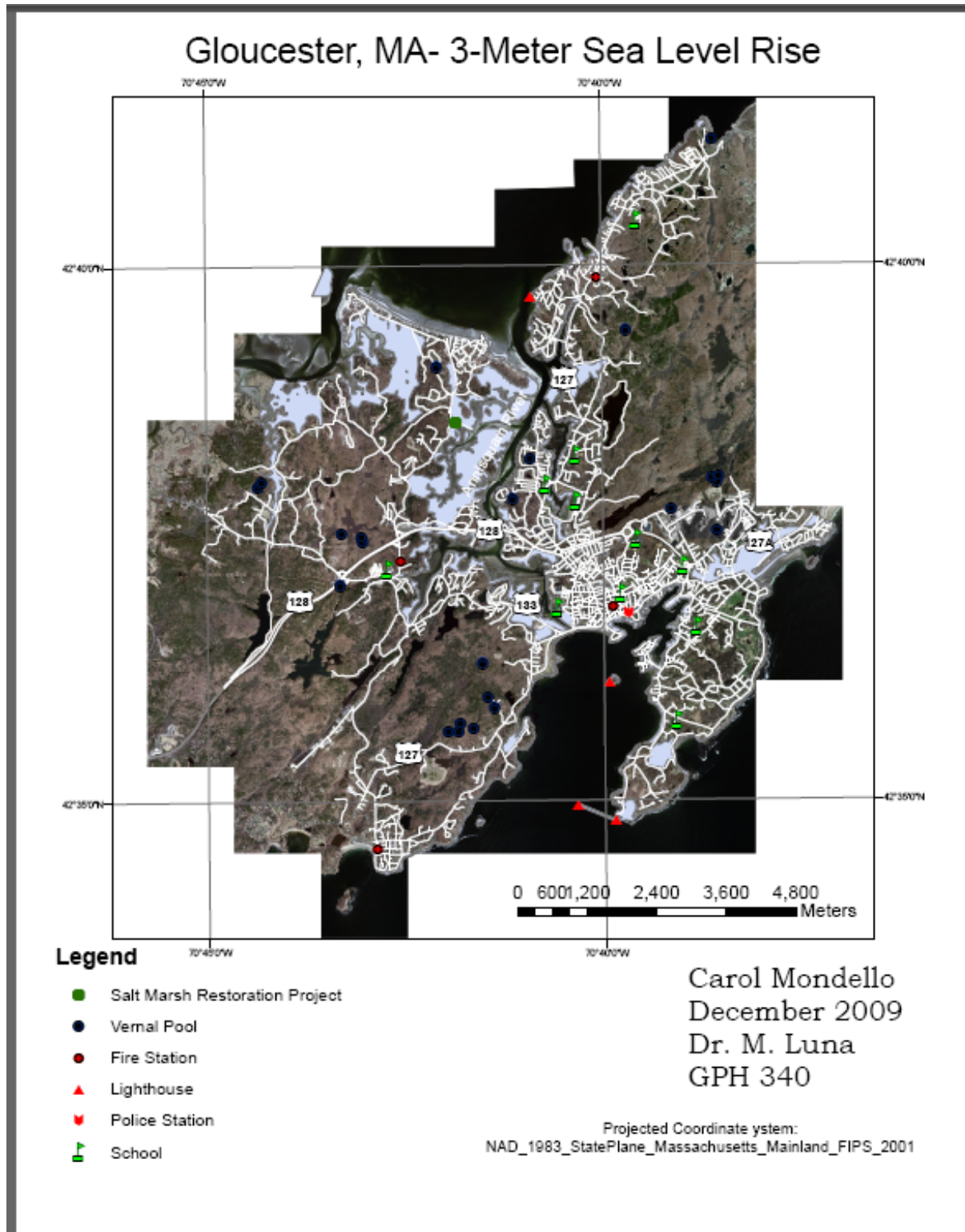


### 3-Meter Sea Level Rise

At a 3 meter rise there are quite a few areas that flood. Gloucester already has a couple points that are below sea level, so that doesn't help. Firstly, I noticed Eastern Point, which is the piece of land jutting out on the right, that street has many of the most expensive and largest homes in Gloucester. It is also home to two lighthouses and the Dogbar Breakwater, all help to keep the harbor safe. Immediately the lighthouse is cut off from its only access road. Niles Pond, also on this piece of land, being so close to the ocean has also flooded. Gloucester has also lost 3 beaches, Good Harbor, Wingaersheek and Niles, of those, Good Harbor and Wingaersheek are huge money makers for the city, upwards of \$1.5 million annually. The map does not show them flooded, but looking at them and the dark sand suggests that the orthoimages were taken at a lower tide and thus wouldn't show up when the map was flooded using the raster calculator. Much of the land behind Good Harbor beach (on the right of the map) has also flooded, that area has hotels/motels, a few restaurants and many homes. Homes and docks along East Main Street have begun to be compromised, however it is not very severe and looks as though it hasn't come up high enough. Moving west a part of the Jodrey State Fish Pier has flooded, though it's made up of piled rocks, so it seems that the pier itself has not flooded yet, though it may have compromised dockage at that site. Moving further west to Rogers Street, a large commercial area has begun to flood similarly to East Main Street, though there also may be some damage to dockage there as well. The High School, though it's football field started below sea level, has also flooded. Across the canal from the High School is some marshland and some very large homes, it looks like most would flood at this time, and the water from the Annisquam River would cover that section of Rte. 133 at this time making passage through here impossible, and one would have to go around to Rte. 128 to get into town. A portion of that area contains a motel, two restaurants, a boatyard, movie theater and gas station, any one of these things flooding would not only cause an economic impact but may cause a water pollution issue. There is also a water treatment plant on that section of road, would not be good if that flooded, not only for the pollutants, but where would the wastewater be treated. The banks of the Annisquam River are mostly wetlands and any home along this area is very high up off the river and thus at this level there is not a lot of damage to property. A lot of the area that floods further down Rte. 133 is wetlands. Continuing along, the areas around Little River, and extension of the Annisquam River, would come close but not cover another portion of Rte. 133, which, in a very large storm surge has also been known to flood. Much of the flooded area on the Western bank of the Annisquam River is mostly all marshland and wetland and thus

## Gloucester, MA

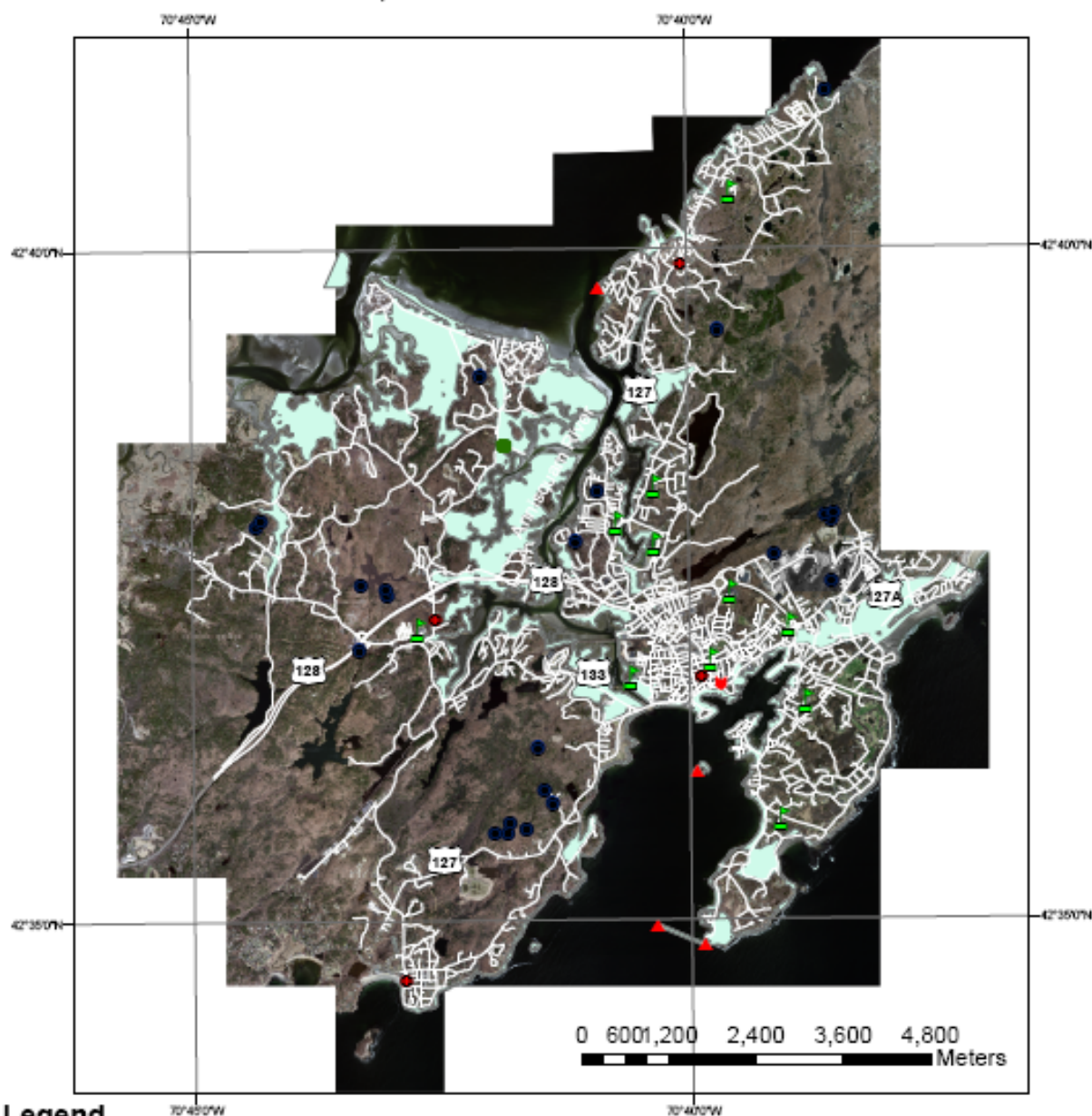
will not cause a large effect on residential or commercial areas, although the clamming industry could be hurt, and wildlife that lives in those areas would no longer be there. All-in-all about 11% of Gloucester will be covered in water with a 3-meter sea level rise or 7,633,059 square meters.



## 4-Meter Sea Level Rise

Gloucester is now a true island. Both Rte. 128 and Rte. 133 have flooded with now, no way out of the city. Starting again at Eastern Point, this has now been cut off completely from the rest of the city, thus some of the most expensive homes, and a museum are flooded. Looking again to the area behind Good Harbor Beach, the flooding has continued further inland, and has now almost cut off the connection between Gloucester and Rockport in the east, and has also put the Stop & Shop plaza underwater. Still in East Gloucester, the entrance to Rocky Neck, the oldest working art colony, has been flooded, this type of flooding can cause a major economic and cultural impact to the area. The flooding seen at 3-meters along East Main Street has extended and seems to be hitting homes at this point, and also would be affecting dockage in that area. Going west, the Jodrey State Fish Pier has now completely flooded, almost certainly destroying any dockage that was once there. Rogers Street, the center for much economic activity has now completely flooded in many areas, including the area off of Rogers St, Harbor Loop that is the home to the U.S. Coast Guard station Gloucester. Commercial Street, known for its commercial properties, also has many homes and apartment buildings, many of which would be inaccessible at this time, although they would not be under water. The flooding around the high school has extended to the homes just outside of it, as well as extending into the street. Across the river the flooding around Rte. 133 continued to spread, however has not affected any more homes. Further down flooding has spread, but still has not extended to many more homes or roads. The area around what was once Wingaersheek Beach (which disappeared at 3 meters) has received the most amount of flooding, and although much of this is wetlands there are also a lot of homes and as seen at 3-meters the economic impact of the lack of beach parking lingers. In this same area there is a salt marsh restoration project that will have undoubtedly been abandoned as all efforts would have been ruined. At this level about 13.48% of the city will be underwater or 9,358,614 square meters.

## Gloucester, MA- 4-Meter Sea Level Rise



### Legend

- Salt Marsh Restoration Project
- Vernal Pool
- Fire Station
- ▲ Lighthouse
- Police Station
- School

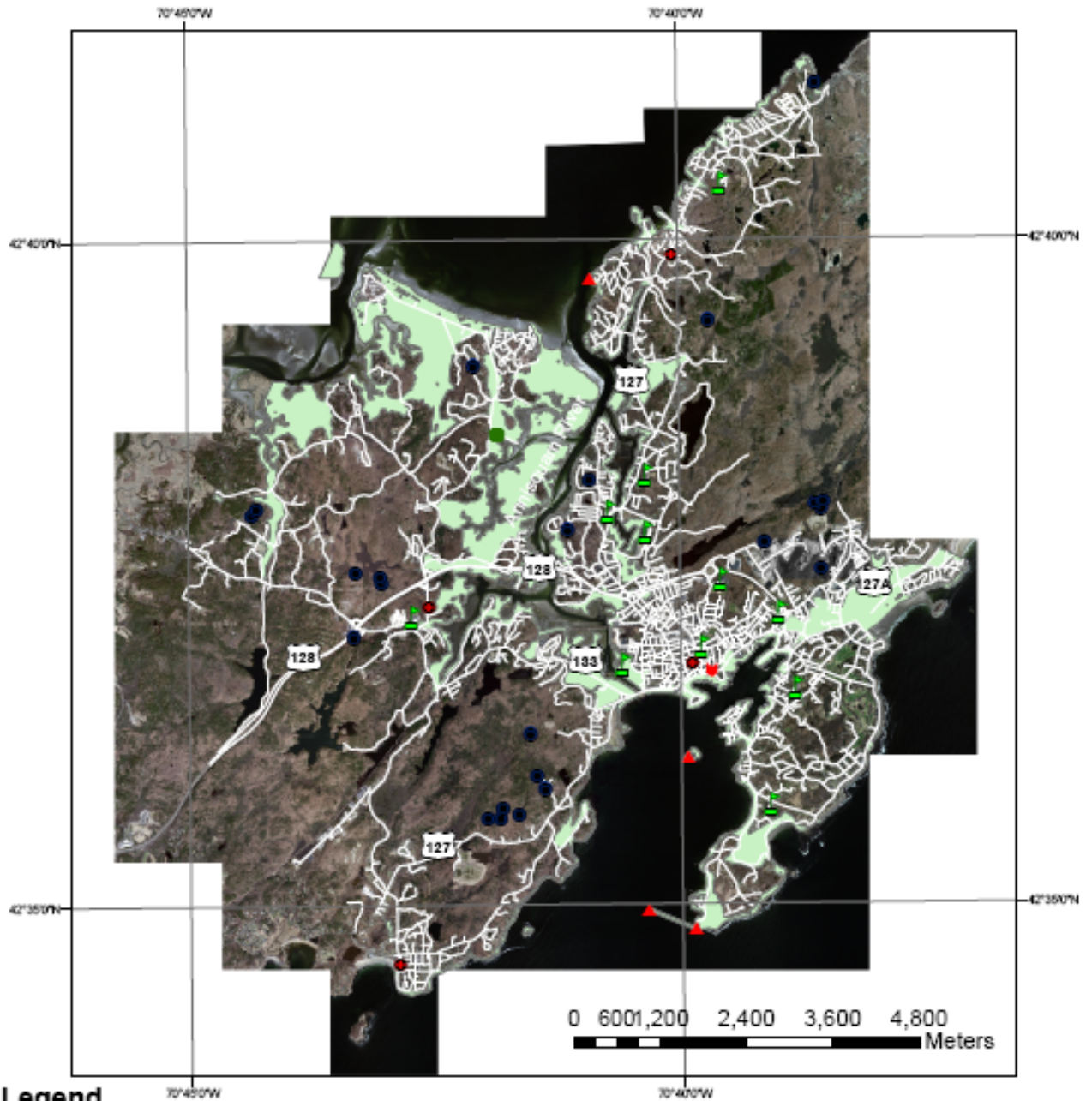
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GPH 340

Projected Coordinate system:  
NAD\_1983\_StatePlane\_Massachusetts\_Mainland\_FIPS\_2001

## 5-Meter Sea Level Rise

Eastern Point has been flooded even further with the run over of Niles Pond and its connection to both the Atlantic Ocean and Gloucester's harbor, the tip has also been swallowed by the Atlantic, undoubtedly the lighthouse and much of this tip of land has been abandoned. Much more of Rocky Neck has been flooded, including the Marine Railways at the end which could cause both economic and environmental issues. The flooding around East Main Street has not extended, however East Gloucester is now an island, so I don't think the flooding of that particular street is much cause for concern. Ten Pound Island, in the middle of the harbor, I would imagine only shows a portion of a lighthouse sticking out of the water, crumbling from erosion. A small piece of land behind the Jodrey State Fish pier has now been surrounded on all 4 sides forming a small diamond shaped island. Rogers Street flooding has extended to meet the East Main Street flooded areas. That flooding has also extended across the street up to Main Street, where multiples businesses and apartments are. All fishery industry related businesses at this point are gone. At this point the only police station has flooded. The center of town where the highest density of population lives is now almost completely surrounded by water. Much of this area is at a higher elevation and thus will not flood, but in a short time will be inaccessible. Other sections of Rte 128 are now impassible. A vernal pool on the east side of the Annisquam has also been compromised at this point, turning much needed spring water into salt water undrinkable for local wildlife. Continuing down the river into Annisquam and Lanesville there has been minimal flooding because of its high elevation. Jumping across the river into West Gloucester, most of this area is now inhabitable, because of either flooding or inaccessibility. At 5-meters 15.67% of the area is covered by water or 10,871,974 square meters.

## Gloucester, MA- 5-Meter Sea Level Rise



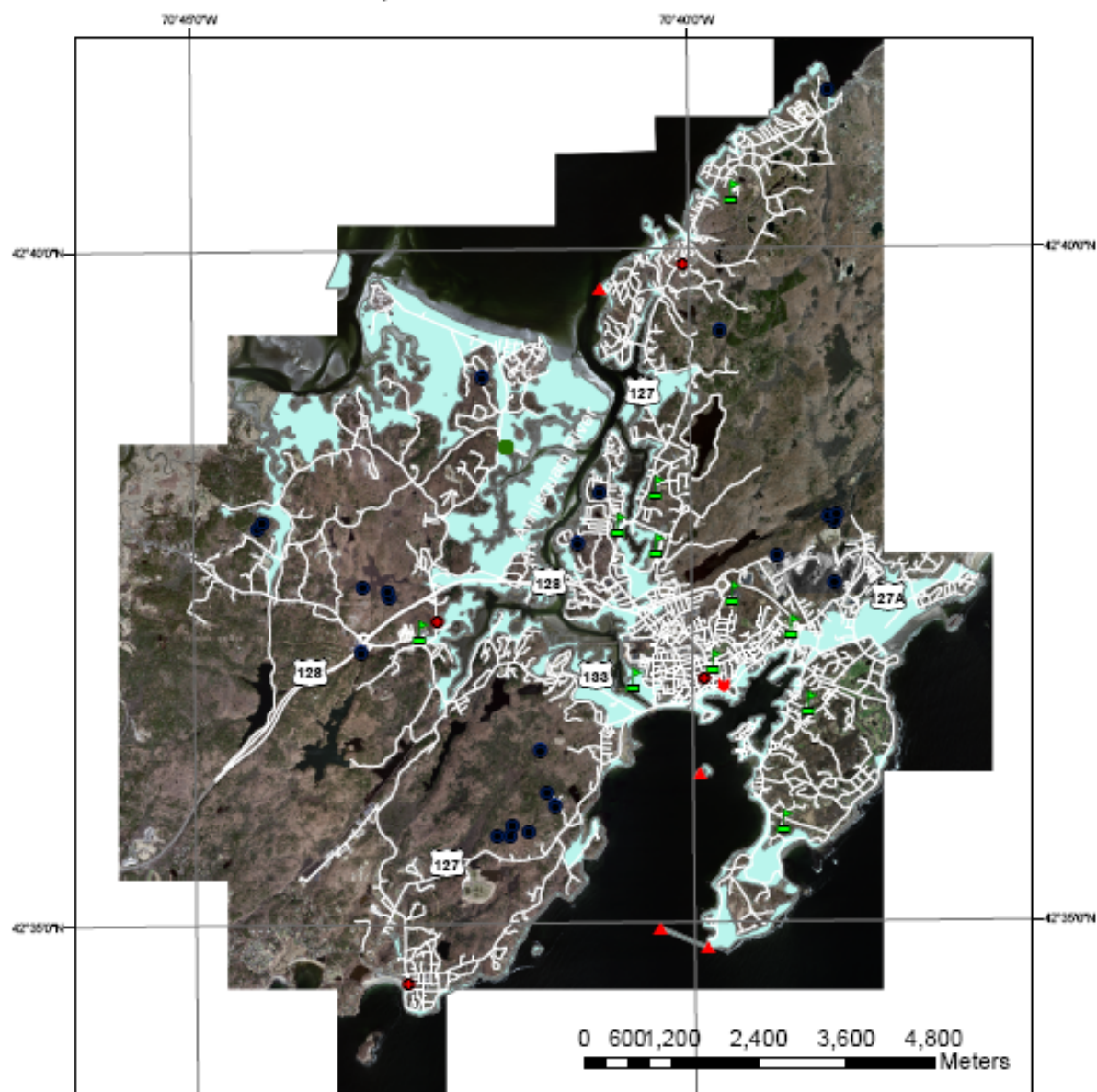
### Legend

- Salt Marsh Restoration Project
- Vernal Pool
- Fire Station
- ▲ Lighthouse
- ▼ Police Station
- 🏫 School

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Projected Coordinate system:  
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## Gloucester, MA- 6-Meter Sea Level Rise



### Legend

- Salt Marsh Restoration Project
- Vernal Pool
- Fire Station
- ▲ Lighthouse
- ▼ Police Station
- School

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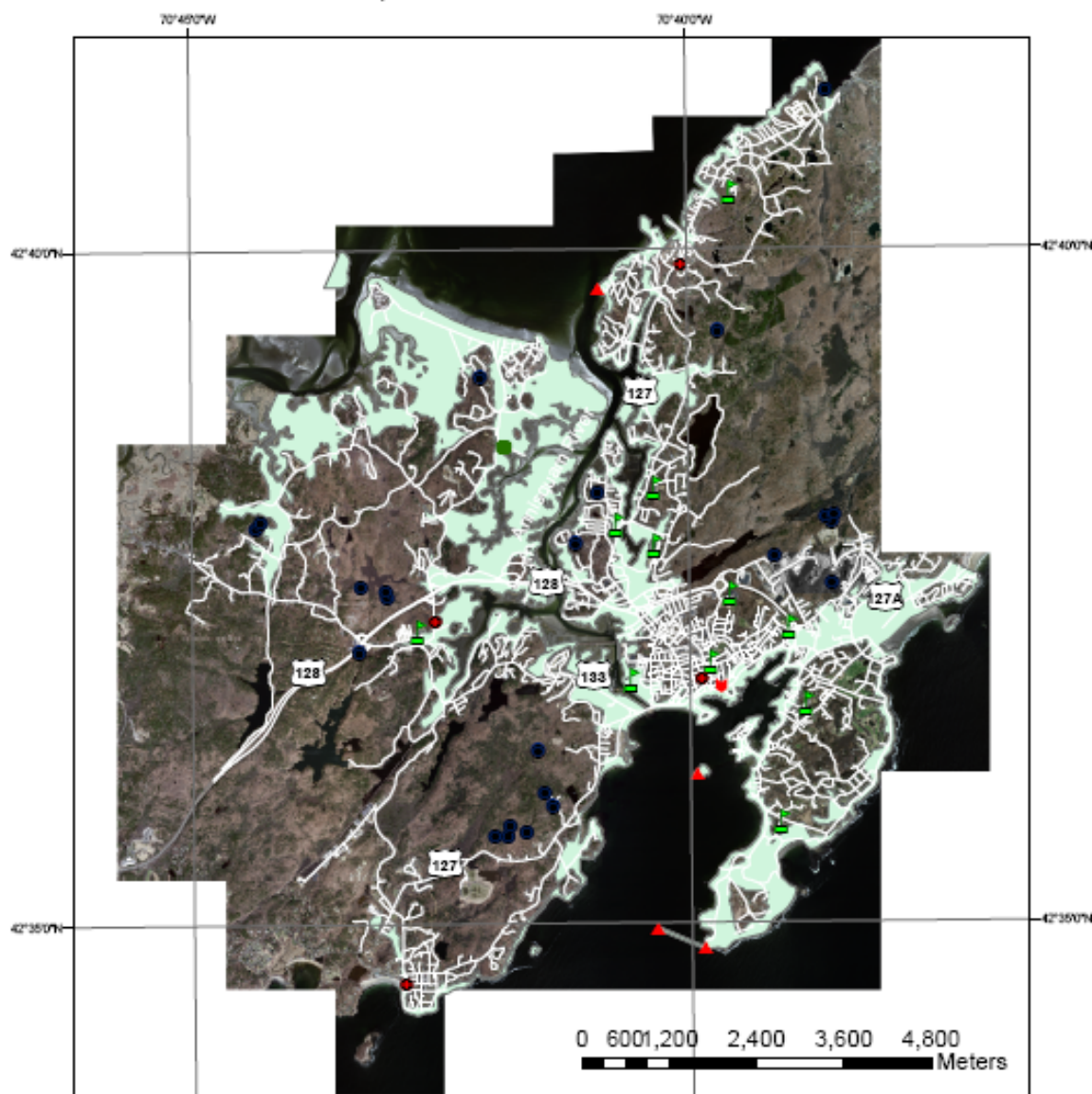
Projected Coordinate system:  
NAD\_1983\_StatePlane\_Massachusetts\_Mainland\_FIPS\_2001

## 9-Meter Sea Level Rise

At this extreme sea level rise 6 of the city's schools are flooded, 2 of the 4 fire stations flooded, police station is gone as well as the entire downtown economic center, the fishing industry has disappeared. Eastern Point and its super expensive homes are gone. My house is underwater and so are both my workplaces. The majority of Rte. 128 is flooded. At this point even the backshore which was partially destroyed in October 1991 in the "No Name Storm" from storm damage is underwater. All the lighthouses are gone and are no longer protecting the harbor, though with no more fishing industry there won't be many boats coming in and out.

I've done maps for 6 meters (extreme) and 9 meters (super extreme) pretty much because it was interesting to see how much of my city would disappear. At 6-meters 17.61% of Gloucester would be underwater, while at 9-meters a whopping 22.97% would be covered by salt water or 15,937,895 square meters. Though I can't see that anyone would be living there at that point.

## Gloucester, MA- 9-Meter Sea Level Rise



### Legend

- Salt Marsh Restoration Project
- Vernal Pool
- Fire Station
- ▲ Lighthouse
- ♥ Police Station
- 🚓 School

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Projected Coordinate system:  
NAD\_1983\_StatePlane\_Massachusetts\_Mainland\_FIPS\_2001

## In each scenario...

The most amount of land underwater is in the West Gloucester area, around the Annisquam River and Wingaersheek Beach. Though the highest level of economic and population impact is in the downtown and East Gloucester areas. Each shows flooding of Lighthouses, this is not only a safety issue but from a tourism perspective could be harmful to the area.

## Methods

Firstly, I acquired the DTMs for my city, 12 total. Then formatted them in excel, deleted unnecessary information and correctly labeling the columns (x, y, z). Then added each one to ArcMap and told it to show x-y data creating a dotted map. All of these then needed to be merged. After merging I interpolated them to raster form using inverse distance weighted method, and then saved this as a grid in order to make it permanent. Then using the raster calculator I flooded the area and reclassified each scenario to only show the locations below the meters specified. Then clipped each flood scenario to the Gloucester polygon. I then downloaded the 52 orthoimagery files and spatially joined each to the town polygon. This however, because Gloucester is an island, cut out much of the features I desired, and would not even allow me to put labels in the dead space. Which is why the maps are jagged. Then I chose various interesting layers of infrastructure or points-and selecting out ones located in Gloucester.

Calculating the total area flooded took a few steps. First, I had to find the total area of Gloucester. Then, I had to add a new field in each clipped flood layer and calculate the geometry. Using the statistic feature I found the total area of the flood, then divided it by the total area, multiplied it by 100 and got the percentage.

Fortunately, I picked Gloucester, where I've lived all my life. I used my knowledge of the area to analyze my maps. I also compared each map to the one before it which allowed me to better see the impact between each level of flooding. Issues with analysis is in the orthoimages, these pictures were taken at low tide, and thus the beaches, with the raster calculator do not show up as flooded although the area behind them does, thus I assumed that the beaches would be as well.

Gloucester, MA

## Bibliography

*Datalayers/GIS Gatabase*. Retrieved November 2009, from Mass GIS:  
<http://www.mass.gov/mgis/database.htm>