Greenwich Coastal Resilience Planning Study
Report of Methodology and Findings
October 18, 2012

Introduction

The Town of Greenwich, Connecticut is located at the western end of Long Island Sound. With many miles of developed shoreline, the town is vulnerable to coastal flooding from storm surges associated with nor'easters and hurricanes.

The Town obtained a grant for evaluating vulnerabilities and resilience relative to coastal flooding. The town's approach was to compile and analyze elevation certificates to determine how many structures have floors that are lower or higher than coastal flood elevations based on the recent DFIRM and Flood Insurance Study for Fairfield County for the purpose of gauging coastal resiliency.

Grant:

The Town of Greenwich was awarded a grant of $7,500 provided by the Climate Program Office of the National Oceanic and Atmospheric Administration (NOAA) to the Association of U.S. Delegates to the Gulf of Maine Council on the Marine Environment (USGOMA). The grant was open to coastal communities in New England to advance local efforts to adapt land use, infrastructure, policies, and programs to reduce the vulnerability of the built and natural environment to changing environmental conditions.

About Greenwich:

Greenwich is a town of 50 square miles in the southwest corner of Connecticut, 30 miles from New York City. It is a coastal community with 32 miles of coastline on Long Island Sound and approximately 11,000 residents live in or near coastal flood zones. Increased flooding has occurred because of two significant factors: development in the flood plains and increased impervious surfaces created by new development. Coastal flooding is also an increasingly important issue, as concerns about global warming and sea level rise draw additional attention to this topic. Areas within the Old Greenwich coastal zone are particularly affected due to it low lying topography.

A Coastal Overlay Zone was established in 1987, accordance with the authorization of Sections 22a-90 to 22a-96 of the General Statutes as amended by Public Act 79-535, The Connecticut Coastal Management Act. The purposes of the zone are:

(1) To insure that the development, preservation or use of the land and water resources of the coastal area proceeds in a manner consistent with the capability of the land and water resources to support such development, preservation or use without significantly disrupting the natural environment;
(2) To preserve and enhance coastal resources;
(3) To give high priority and preferences to uses and facilities which are dependent upon proximity to the water or the shorelands immediately adjacent to marine and tidal waters;

(4) To limit the immediate shorefront properties to the following principal uses: Residential, water dependent and Use Group 7 uses (Waterfront Business Uses);
(5) To limit the potential impact of coastal flooding and erosion patterns on coastal development so as to minimize damage to and destruction of life and property and to reduce the necessity of public expenditure to protect future development from such hazards;
(6) To encourage public access to the waters of Long Island Sound in both a physical and visual manner;
(7) To encourage the development of recreational facilities in the coastal area as outlined in the Plan of Development/Land Use Plan of the Town;
(8) To encourage fishing and recreational boating harbor space, and the related uses and facilities which support those activities.

The boundaries of the Coastal Overlay Zone can be seen in Map #1 (attached).

Pursuant to the Town of Greenwich Building Zone Regulations, any new construction within the Coastal Overlay Zone must submit a site plan application to the Planning and Zoning Office. Furthermore, any new construction with the a coastal flood zone must have the first floor at least one foot above the base flood elevation, as verified by an elevation certificate during the site plan process.

Research Methodology

The method used in this study to gauge the coastal resiliency of Greenwich was to collect and analyze elevation data for the first floor of structures located on properties that lay within an AE or VE flood zone and in the Coastal Overlay Zone. This study relies on the premise that the more structures with first floor elevations at least one foot above the base flood elevations the more resilient the community. Elevation data was collected from elevation certificates prepared by surveyors licensed in the State of Connecticut, and the data was organized in a database. The source of the elevation certificates were from both local engineering firms and also from a search of site plan applications. The data could then be analyzed to determine the "resiliency" of our coastal area by determining how many properties are located within the Coastal Overlay Zone, how many properties are in flood zones, how many structures are in flood zones, and how many of those structures have first floor elevations below the base flood elevations.

Binders containing Elevation Certificates

Our consultant was provided a collection of elevation certificates that were provided by local engineer firms. The database of parcels located in the Coastal Overlay Zone was used as a starting point for building the coastal resilience worksheet. Thus, many records represent parcels that are not located in AE and VE flood zones.

The elevation certificate binders were reviewed and properties not located in Greenwich were removed from the binders. Elevation certificates for properties located in FEMA "X" zones

were not selected for data entry. Likewise, elevation certificates for properties located in inland (non-coastal) flood zones were not selected. This was largely a straightforward task, as flood zones with elevations exceeding 20 feet were automatically not considered further.

If flood elevations were noted on the certificate as lower than 20 feet and there was a question regarding location of the structure (inland vs. coastal), additional research was conducted using the maps provided by the Town (with some manual corrections for missing AE zones) and a list of streets that was generated for structures addressed in AE and VE zones. This list was compiled by merging AE and VE zones with the structures database, and applying a 15-foot buffer around structures to "capture" any buildings that are very near (but not in) AE and VE zones.

Coastal Site Plan Review Spreadsheets (1999-2007 and 2007-Present)

Coastal Site Plan Review (CSPR) records represent individual CSPR permit applications or administrative decisions for projects in the Coastal Management area. Most of the parcels in the Coastal Management area are not located in AE or VE flood zones. Therefore, the spreadsheets were reviewed line by line to determine (1) which records could represent projects in AE or VE zones, and (2) which records represent "new" or "substantial improvements," either of which should have triggered the completion of an elevation certificate.

To screen the entries for AE and VE zones, the list of streets with structures addressed in AE and VE zones (described above) was consulted. The map provided by the Town was also consulted, with corrections for the four areas where AE mapping appeared to be incomplete. When necessary, locations of addresses were checked using google maps. Through this process, a number of records were selected that may not be located in AE zones, but may be very close to AE zones. Examples include records for projects on South Water Street, Sachem Lane, Strickland Road, River Road, and Edgewater Drive. This level of uncertainty was not an issue for the review of the elevation certificate binders, because the information provided on the certificates (AE, VE, X, an/or flood elevation exceeding 20 feet) was sufficient for screening properties in the binders.

For selecting which CSPR projects could have triggered the completion of an elevation certificate, several factors were considered. New structures, demolition/reconstructions, and additions of one or more rooms were initially selected. Conversions of porches or garages to living spaces were also selected. The following were not selected: docks, shoreline stabilization or repairs, pools, pool houses, fences, sheds, driveways, landscaping, decks, replacements or repairs of porches, and interior projects such as remodeling.

Building Permits

The DPW-Division of Buildings provided a PDF (dated June 4, 2012) of building permit records. Building permit records represent individual permit applications or administrative decisions for projects regulated by the Division of Buildings. Many of the projects listed are not located in AE

or VE flood zones. Therefore, the PDF was reviewed line by line to determine (1) which records could represent projects in AE or VE zones, and (2) which records represent "new" or "substantial improvements," either of which could have triggered the completion of an elevation certificate.

To screen the entries for AE and VE zones, the list of streets with structures addressed in AE and VE zones (described above) was consulted. The map provided by the Town was also consulted, with corrections for the four areas where AE mapping appeared to be incomplete. When necessary, locations of addresses were checked using google maps. Through this process, a number of records were selected that may not be located in AE zones, but may be very close to AE zones. As noted above, this level of uncertainty was not an issue for the review of the elevation certificate binders, because the information provided on the certificates (AE, VE, X, an/or flood elevation exceeding 20 feet) was sufficient for screening properties in the binders.

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Additional Screening

Four PDFs were generated by the DPW-Division of Buildings (compiled July 25, 2012):

- Floodzonelivedatabase.pdf (111 pages)
- Floodzoneitshistory.pdf (190 pages)
- Floodzone.pdf (112 pages)
- Floodzonearchivedatabase.pdf (801 pages)

Recall that the initial DPW-Division of Buildings PDF dated June 4, 2012 was reviewed page-by-page for activities that could have resulted in an elevation certificate. Given the number of additional records listed on the four new PDFs, an abbreviated process was employed to review the records. Each PDF was searched for the words "elevation," "certificate," and "BUI NEW RES." Moderate overlap was found among the four files (and likewise with the original PDF prepared by the Division of Buildings) but 37 new properties were identified that could have elevation certificates. Many of these were flagged due to the comment "proof of elevation required" but many were identified simply as a result of the new construction in a coastal flood zone.

Cornerstone was used to verify and check permit numbers. In the vast majority of the cases, additional information was not available. In limited instances, additional permit numbers were found. For example, 1 Tomac Lane (permit W-5862 in the PDFs) was listed for a new structure

per permit number 07-2849. One interesting piece of information available from cornerstone is the log of emergency management department inspections after storms such as the March 2010 nor'easter and T.S. Irene. The availability of this information implies that one could query the cornerstone database for coastal storm responses.

Permit Review

A comprehensive list of potential building projects that could have resulted in elevation certificates was compiled from the CSPR spreadsheets and the five PDFs provided by the Division of Buildings. A total of 105 permit files were reviewed at the Building Division on August 23 and 29, 2012. Approximately 40 files contained elevation certificates, site plans with elevations specified or other correspondence with elevation data.

Results

Subsequent to the review of elevation certificates and Building Division files, 190 unique records[1] were identified. In other words, 190 coastal structures were found with elevation certificates, site plans, or other correspondence that provided at least limited elevation data. Of these 190 records, several properties contained multiple buildings. For example, certificates were available for three structures at 92 Harbor Drive (maintenance building, residential home, and pool/guest house.

To evaluate coastal flood resilience, it was necessary to focus on only one structure per property. For residential properties, the home was selected. For non-residential properties, the structure with the best available elevation data was selected.

Subsequent to this filtering, a total of 168 structures on 168 individual properties were analyzed. Findings were as follows:

- Two of the structures had elevation certificates or plans that did not provide the lowest floor or next floor, and therefore could not be characterized any further.

- A total of 33 structures were not located within DFIRM boundaries according to GIS analysis. However, given the availability of elevation certificates, many of these structures were believed to be in flood zones in the past, or at least nearby. Some of the elevation certificates include comments such as "building lies in flood zone AE" and "house built on piers with breakaway walls" (which implies VE status). Perhaps more informative, ten of these properties have their lowest floor below the lowest BFE in Greenwich (11'), four have their lowest floor below between 11' and 12', three have their lowest floor below between 12

[1] More than 220 elevation certificates were located, but many pertained to older structures on properties that were later renovated or replaced, resulting in new elevation certificates; and some pertained to older certificates that were simply replaced for other reasons.

and 13,' three have their lowest floor below between 13' and 14', and two have their lowest floor below between 14' and 15'. A total of 11 structures have the lowest floor above 15', and eight have the lowest floor above 19' (note that 19' is the highest coastal BFE in Greenwich). These eight structures with lowest floor above 19' are truly believed located outside of a flood zone. ***However, the 25 structures that were not located within DFIRM boundaries according to GIS analysis may nevertheless possess varying degrees of flood risk.*** Two of these are non-residential but most are residential.

- A total of 133 structures therefore were associated with reported elevation and were found by the GIS to be located within DFIRM boundaries. A summary of the elevation data is provided in the following table:

Structures in AE and VE Flood Zones	
With lowest floor below base flood elevation	107
With lowest floor above the base flood elevation	26
With *next-highest* floor below base flood elevation	26
With *next-highest* floor above the base flood elevation	87
With *next-highest* floor unknown relative to base flood	20

The 107 structures with their lowest floor below the BFE represent 80% of the total. ***These structures are vulnerable to flood damage to buildings, contents, and building utilities such as hot water heaters and furnaces.*** In contrast, 26 structures have their lowest floor above the BFE, and are considered more resilient to coastal flood damage.

In many cases, the lowest floor does not represent living space. Therefore, a more appropriate metric for evaluating risk to people is the number of structures that have the *next* floor below the BFE. This analysis found that of the 107 structures with their lowest floor below the BFE, 26 had the next floor also below the base flood elevation. These structures (20% of the total of 133) represent the highest risk because they are vulnerable to flood damage to buildings, contents, and building utilities; ***and also pose significant risk to inhabitants who do not evacuate.*** While it is possible that inhabitants could move to rooftops or higher floors (if present) during floods, this is an unsafe scenario.

The elevation of the floor above the lowest floor was not reported for a total of 20 structures. The risk is therefore unknown.

Next Steps:

The next step to further gauge coastal resiliency using the methods employed is to link the data contained in the database of elevation certificates with the property and/or building layers of the Town of Greenwich Geographic Information System (GIS). This will generate a layer showing first floor elevations of structures within the AE and VE flood zones. When this layer is used together with existing topographic and flood zone information, it will effectively identify the vulnerability of the built environment within the coastal flood zones. The vulnerable structures are those that have first floor elevations below the base flood elevation, meaning flooding will

occur in the living space of the structure. This information can be used by Planners to ensure that the Zoning Regulations are meeting the intended purpose of promoting the public health, safety and general welfare and to minimize public and private losses due to flood conditions in specific areas. It can also be used by Emergency Responders who will be able to more accurately target areas of vulnerability during storm events.

Applicability to Other Communities:

Coastal resiliency planning involves studying how a community fares against threats as well as planning for adaptive land use and infrastructure, developing policies and programs to reduce the vulnerability of the built and natural environment to changing environmental conditions. Other coastal communities interested in evaluating coastal vulnerabilities and resilience can undertake the same methodology used here to generate data. The next steps that Greenwich intends to take with further highlight the power of this data but even as flat data, it has proven to be very effective at revealing vulnerabilities characterizing our coastal resilience.

Conclusions

This study employed the best available methods for locating elevation certificates and evaluating the information on elevation certificates. In a limited number of cases, site plans and other correspondence provided more limited elevation data. Despite these efforts, only 190 unique elevation records were found.

If the results of this analysis can be translated throughout coastal Greenwich, an appropriate assumption for building officials and emergency managers might be the following:

- 80% of coastal structures may suffer damage to structure, contents, and building utilities during a coastal base flood (100-year flood, or flood with 1% chance); and
- 20% of coastal structures pose significant risk to inhabitants who do not evacuate because the two lowest floors are below the base flood elevation.

This data will continue to be refined as additional data become available. Converting the flat data into a GIS layer will allow the Town Of Greenwich to better plan for public and private losses due to flood conditions in specific areas and more accurately target areas of vulnerability during storm events.