CONNECTICUT

Leslie Katz Genova
Andrew Hickok
Daniel Hudgens
Casey Roberts

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Chapter 2: CONNECTICUT

By

Leslie Katz Genova
Andrew Hickok
Daniel Hudgens
Casey Roberts

TABLE OF CONTENTS

INTRODUCTION

The Long Island Sound shoreline is densely developed on both the Connecticut and New York sides, with five million people living within 15 miles of the coast. The coastal beaches of Long Island Sound attract approximately six million visitors a year. Long Island Sound commercial and sport fisheries are estimated to be worth more than $70 million annually.[1] With a large population depending on the coastal zone for employment, recreation, and housing, planners in Connecticut have a strong interest in understanding and regulating activities in the coastal zone as well as understanding the implications of sea level rise for this area.

Connecticut's 618 miles of tidal shoreline are protected by Long Island from many strong ocean storms; coastal flooding, however, can be and is a problem in some areas.[2] According to Titus and Richman, approximately 111 square kilometers of the Connecticut coast is located below 3.5 meters in elevation (of which nearly 63 square kilometers are located below 1.5 meters in elevation).[3] The majority of these lands are in the eastern part of the state. As sea levels rise, much of this area will be inundated by water unless the state or private property owners armor or elevate the land. In this report, we examine the likelihood of such sea level rise protection by characterizing the likely response of Connecticut residents, the state, and local governments to threats of sea level rise.

Table 1 provides a preliminary estimates of the land that could potentially be inundated by rising sea level by county.

Table 1. Area of Land Close to Sea Level by County (square kilometers)

	Elevations (m) above spring high water				
County	1	2	3	4	5
Fairfield	14	19	24	31	39
Middlesex	21	27	37	42	48
New Haven	6	11	17	24	34
New London	31	40	48	56	65
Harford	6	6	9	11	13
Total	72	97	126	153	186

Source: Titus et al. 2009. State and local governments plan for development of most land vulnerable to rising sea level along the U.S. Atlantic Coast. Environ. Res. Lett. **4** (2009) 044008 (7pp), based on the procedures in Titus J.G., and J. Wang. 2008. Maps of Lands Close to Sea Level along the Middle Atlantic Coast of the United States: An Elevation Data Set to Use While Waiting for LIDAR. Section 1.1 in: *Background Documents Supporting Climate Change Science Program Synthesis and Assessment Product 4.1*, J.G. Titus and E.M. Strange (eds.). EPA 430R07004. U.S. EPA, Washington, DC.

[1]Conservation and Development Policies Plan, 1998–2003, Office of Policy and Management, Connecticut Department of Environmental Management, 1998.

[2]Bernd-Cohen, Tina, and Melissa Gordon. "State Coastal Management Effectiveness in Protecting Beaches, Dunes, Bluffs, Rocky Shores: A National Overview," Sea Grant National CZM Effectiveness Study, Office of Ocean and Coastal Resource Management, NOAA. March 1998 (Table 1).

[3]Titus J.G. and C. Richman, "Maps of Lands Vulnerable to Sea level Rise: Modeled Elevations along the U.S. Atlantic and Gulf Coasts," *Climate Research*, 2001.

Purpose of this Study

This study develops maps that distinguish coastal areas likely to be protected as the sea rises from areas where shores will likely retreat naturally, either because the cost of holding back the sea is greater than the value of the land or because there is a current policy of allowing the shore to retreat.[4] This report is part of a national effort by the U.S. Environmental Protection Agency to encourage the long-term thinking required to deal with the impacts of sea level rise issues. The nature of rising sea level prevents the issue from being a top priority; but it also gives us time to reflect on how to address the impacts. Maps that illustrate the areas that might ultimately be submerged convey a sense of what is at stake, but they also leave people with the impression that submergence is beyond their control. Maps that illustrate alternative visions of the future may promote a more constructive dialogue.

For each state, EPA is evaluating potential state and local responses to sea level rise, with attention focused on developing maps that indicate the lands that would probably be protected from erosion and inundation as the sea rises. These maps are intended for two very different audiences:

- *State and local planners and others concerned about long-term consequences.* Whether one is trying to ensure that a small town survives, that coastal wetlands are able to migrate inland, or some mix of both, the most cost-effective means of preparing for sea level rise often requires implementation several decades before developed areas are threatened.[5] EPA seeks to accelerate the process by which coastal governments and private organizations plan for sea level rise. The first step in preparing for sea level rise is to decide which areas will be elevated or protected with dikes, and which areas will be abandoned to the sea.

- *National and international policy makers.* National and international policies regarding the possible need to reduce greenhouse gas emissions require assessments of the possible impacts of sea level rise, and such assessments depend to a large degree on the extent to which local coastal area governments will permit or undertake sea level rise protection efforts.[6] Moreover, the United Nations Framework Convention on Climate Change, signed by President Bush in 1992, commits the United States to taking appropriate measures to adapt to the consequences of global warming.

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[4]For purposes of this study "protect" generally means some form of human intervention that prevents dry land from being inundated or eroded. The most common measures include beach nourishment and elevating land with fill, stone revetments, bulkheads, seawalls, and dikes. Shore protection does not include activities that protect structures but allow lands to erode or become inundated.

[5]Titus, J.G., "Rising Seas, Coastal Erosion and the Takings Clause: How to Save Wetlands and Beaches Without Hurting Property Owners," *Maryland Law Review*, 57:1279–1399, 1998.

[6]Titus, J.G., et al., "Greenhouse Effect and Sea Level Rise: The Cost of Holding Back the Sea," *Coastal Management,* 19:171–204, 1991; and Yohe, G., "The Cost of Not Holding Back the Sea. Toward a National Sample of Economic Vulnerability," *Coastal Management* 18:403–431, 1990.

This study analyzes state and local coastal management and development patterns to the extent that they are foreseeable. The maps that accompany this study illustrate the areas that local planning officials expect will be protected from erosion and inundation by rising sea level. Those judgments incorporate state policies and regulations, local concerns, land use data, and general planning judgment. We hope that this report can be used as a tool to help estimate the cumulative impacts of shoreline armoring. This analysis does not, however, analyze whether hard structures, soft engineering, or some hybrid of the two approaches is most likely. Those decisions will depend on a variety of factors, including both economics and the evolution of shore protection methods in Connecticut.

Current and Future Trends in Sea Level

Sea level has risen 6 to 8 inches in the last century, according to tide gauge records. The observed rate, however, varies geographically. In northern portions of Europe and North America, the land is uplifting in response to the ice sheet melting after the last glacial period; so sea level is falling relative to those coasts. Along the mid-Atlantic coast of the United States, the land is sinking in response to the uplift to the north, and so the sea has risen 12 to 16 inches in the last century. In deltas and areas with substantial groundwater extraction, the land is sinking and as a result sea level appears to be rising by an inch every three years!

The rate of sea level rise in the last century has been more than twice the average rate over the last few thousand years. One possible explanation is global warming: The 1^{o}F warming of the last century has expanded the upper layers of the ocean enough to raise the sea 1–2 inches, and the retreat of mountain glaciers and small ice caps around the world has contributed enough water to the oceans to raise the sea another 1–2 inches. Nevertheless, the rise in sea level has not accelerated during the last century.

How much will the sea rise during the next century? The Intergovernmental Panel on Climate Change estimates that global warming is likely to contribute 3/4 to 3 feet over the next century, which would be in addition to the rise caused by other factors. Therefore, it is reasonable for US planners to assume a 1 to 4 foot rise in the next 100 years, with 2 feet most likely. Those calculations assume that no major loss of ice occurs in Antarctica. Over the next 200 to 300 years, the ice sheets in Greenland and Antarctica could contribute enough water to raise sea level 5 to 10 feet.

Report Outline

In the sections that follow, we describe the:

- methods by which we assess the likely sea level rise responses;
- state policies that affect the management of coastal lands; and
- municipal policies that affect the management of coastal lands, particularly land-use planning decisions.

METHODS

Approach

This study had five components:

1. Background research and literature review.

2. Initial meetings with state and local officials to explain the study and learn about those policies and trends most likely to have an impact on whether particular lands will be protected, and clarify our understanding.

3. Definition of the case study area.

4. Specification of general mapping decision and creation of draft maps, based on what we learned from the meetings with state and local officials.

5. Stakeholder review meetings in which the same governmental organizations review the map general statewide assumptions and the maps and make categorical or site-specific corrections.

Background Research. To understand Connecticut's likely sea level rise responses, we first researched state and local policies and development plans to determine the policies that affect sea level rise responses.

Initial Meetings with State and Local Officials. Next, we conducted interviews with state regulators as well as regional and municipal planners to investigate existing and anticipated coastal policies and land uses. We interviewed officials in the Connecticut Department of Environmental Protection's Long Island Sound Program to gain a perspective on statewide coastal policy. We also interviewed planners of the regional planning agencies or councils of government (COGs) in the coastal area of the state.[7] Their knowledge about local priorities and goals allowed us to model future scenarios based on current and projected land uses. The procedure in the interviews was to discuss areas of importance in each region that may merit some protection from a change in sea level. We also discussed public access to the water, economic conditions, areas of cultural or historical importance, and flood-prone areas. Typically, the likelihood of protecting specific land-use categories was discussed, and then specific areas within regions were examined to determine if the general policy directions apply. During this phase of the study, we also collected GIS data layers for integration into the draft map (see Table 2).

Case Study Area. The general approach developed by EPA is to examine all land that is either below 20 feet (NGVD) or within 1,000 feet of the shore. Most of these lands will not be

[7]Connecticut is a "home-rule" state, and so counties have very limited regulatory authority. Therefore, we interviewed town officials in the South Central Region towns of Guilford, New Haven, Westbrook, and West Haven to obtain a local perspective on shoreline protection.

threatened by sea level rise during the next century. The EPA project manager reasoned, however, that any study area that could be easily defined would either be over- or under-inclusive, and that the maps would be more useful if they included areas that are not at risk, than if they omitted areas that are threatened. Defining the areas at risk is difficult for several reasons: Current digital elevation models are frequently inaccurate, and hence areas shown at a particular elevation may actually be significantly lower (or higher) in elevation than depicted. Moreover, the best available elevation data are often a USGS map with a 10-foot contour interval. Because USGS map standards state that the 10-foot contour may be as high as 15 feet or as low as 5 feet, we would have to be certain that no land above the 5-foot contour is vulnerable to sea level rise to be satisfied with a study area based on the 10-foot contour. Because both the design flood and most coastal elevations are above 5 feet, such a study area would exclude areas that ought to be included. EPA includes land within 1,000 feet of the shore to account for possible erosion of sandy bluffs with elevation sufficient to avoid direct inundation.

When we started this study, we could not find a readily available digital map of the 20-foot contour at the scale we needed.[8] To provide an approximate basis for evaluating the lands at highest risk of inundation, we used floodplain data to define an initial study area.[9] We were able to obtain a dataset that defined areas throughout the state that are within the 500-year floodplain, as defined by the Federal Emergency Management Agency using hydrological models.[10] Recognizing that the floodplain does not include all of the low lands below the 20-foot contour, our data and the maps reviewed by local officials depicted classifications well inland of the 500-year floodplain. The maps in this report show only the land within the floodplain, but the data we make available extend farther inland. As a result, one can, for example, use Connecticut's LIDAR data to define a 20-foot contour and create a map comparable to the maps of other states. We also include all lands that are within 1,000 feet of the shoreline as defined by town boundaries.[11]

Creation of Draft Maps. Based on the background research and meetings with officials, we defined a set of general mapping assumptions using the data we collected. The general statewide

[8]The USGS DEM at the 1:24,000 scale, for example, was not based on the printed USGS map but rather a less precise set of profile data.

[9]As discussed in the stakeholder review section below, we also later created separate response maps using a larger study area to provide a review of lands potentially under twenty feet in elevation.

[10]We obtained FEMA Flood Zone data for the entire state of Connecticut from the state Environmental and Geographic Information Center. The study authors are not certain of the elevation within the 500-year floodplain. Along the coastline and the tidally affected portions of the state's rivers, however, we anticipate that the floodplain is entirely below the 20-foot (NGVD) contour. Until recently, most topographic maps provided contours that measured elevation above the National Geodetic Vertical Datum of 1929. That datum represented mean sea level for the tidal epoch that included 1929, at approximately 20 stations around the United States. The mean water level varied at other locations relative to NGVD, and inland tidal waters are often 3–6 inches above mean sea level from water draining toward the ocean through these rivers and bays. Because sea level has been rising, mean sea level is above NGVD29 almost everywhere along the U.S. Atlantic Coast

[11]Town boundary data developed by the state Environmental and Geographic Information Center provide accurate detail of the Connecticut shoreline.

assumptions assign all land in a particular category as shore protection almost certain, shore protection likely, shore protection unlikely, or no shore protection.[12]

Stakeholder Review. We visited or telephoned each of the six regional planning organizations in the study area to ensure that the maps and general statewide assumptions correctly reflected their expectations.[13] We obtained numerous corrections and revised the maps accordingly. After making the corrections, we sent the revised maps back to these stakeholders for confirmation.

Based on comments from stakeholders, we revised shoreline protection designations on a site-specific level. We also changed the shoreline protection status of certain areas so that the maps were in accordance with the original general statewide assumptions that we developed for this study. To confirm that the resulting changes made sense, we then consulted high-resolution satellite imagery to verify existing land uses and confirm the existence of shoreline armoring structures.[14] Where appropriate we made additional site-specific changes.

Caveats and Uncertainties

As with any effort to predict future societal actions, this report and the responses we develop are subject to a number of uncertainties. One must consider the following caveats when reading this report or applying the information and maps in future efforts:

- The future political context could alter development and coastal management regulations that affect property owners' decisions to abandon or protect their property. For example, technological advances or improvements in construction techniques may reduce design limitations and allow for greater development of the coastal area; or, societal values and interests may affect the response in unknown ways, ranging from an exodus from the coastal area to much higher development demands. Because it is impossible to predict how policies may change in the future,

[12]In this regard, our approach was different from most of the sea level planning studies, which have either (a) used general statewide assumptions developed during the meetings with state and local officials or (b) used general statewide assumptions developed by the researcher before the meeting but endorsed by the state and local officials during the initial meeting. The approach we followed here has also been employed by four regional planning councils along the Atlantic Coast of Florida and the assessment of the Georgia coast (for all but one county). As a general rule, it is preferable to obtain map general statewide assumptions during the initial meeting, so that the stakeholder review involves refinement of a map that is already close to representing the County's expectations. In this case, however, we scheduled the meetings before we were able to develop a draft set of maps. As it turned out, without such a set of maps, we were unable to focus the meetings on general statewide assumptions or a site-specific assessment of which areas will be protected. Therefore, we used the meetings to exchange information and deferred until the stakeholder review a meeting to review the draft maps and discuss what the maps ought to show.

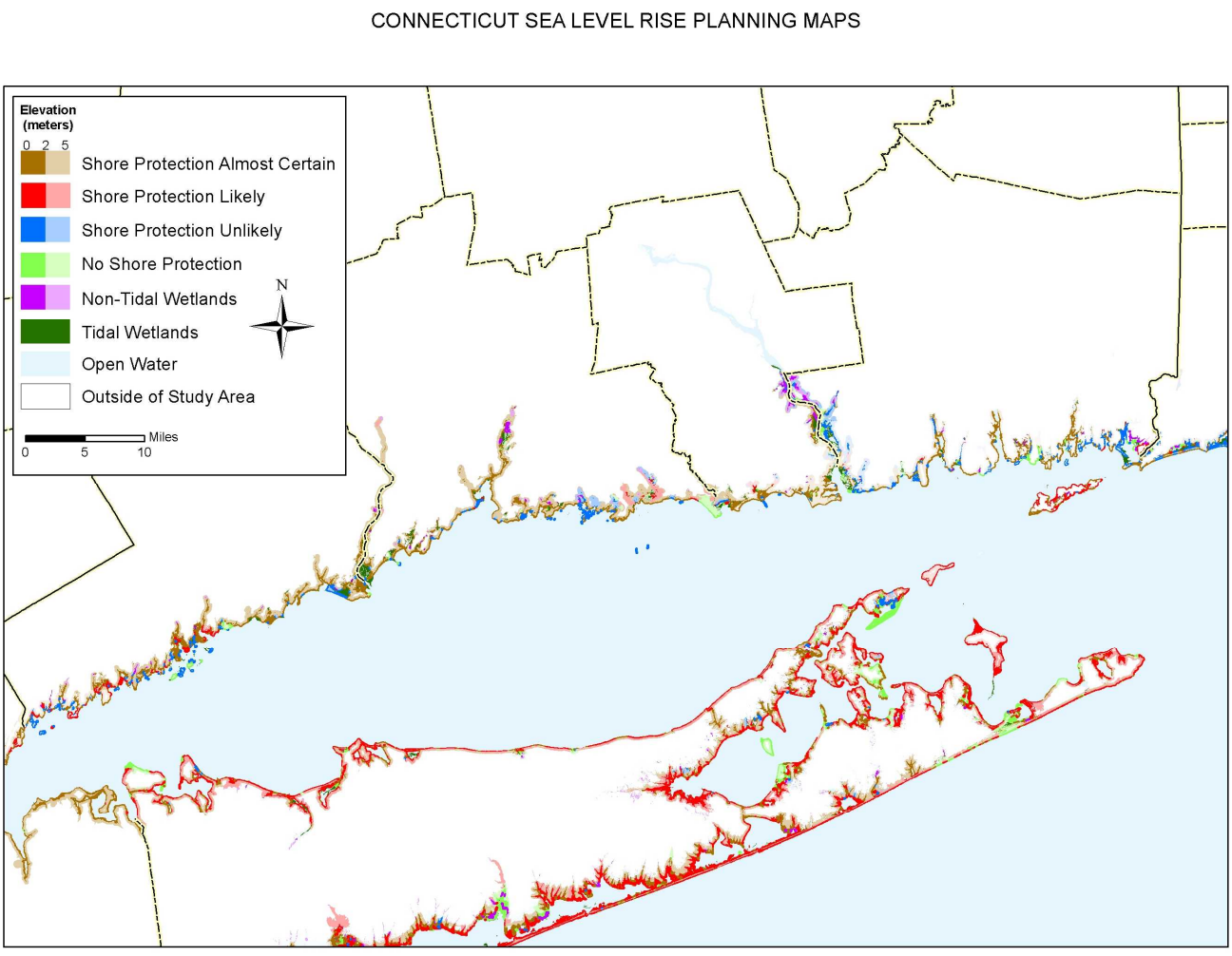
[13]Leslie Katz Genova and Casey Roberts attempted to conduct an initial stakeholder review of the draft report and maps between February and April 2004. The following regional planning organizations responded with brief comments: Southeastern, Connecticut River Estuary, and South Central regions. Because this initial attempt did not yield any substantive changes to the report or maps, stakeholder review efforts were restarted in June 2005.

[14]We obtained recent satellite imagery for the entire Connecticut coast through the web service Google Earth. In most cases, this imagery allowed us to clearly identify buildings and shoreline armoring structures.

we base response scenarios on the existing circumstances in the state and changes anticipated by state and local officials.

- Certain economic impacts of sea level rise are beyond the scope of this investigation. Salt water intrusion into drinking water aquifers is one example. Changes to salinity structures, flushing times, and ecological distributions in estuaries are others. Additionally, we do not consider the economic and environmental effects of wetland loss in this report. This investigation examines only changing land uses and the possible adoption of shore protection measures.

Map 1 shows the statewide results of our analysis.



Map 1: Likelihood of Shore Protection in Connecticut.

STATE POLICIES RELEVANT TO SEA LEVEL RISE

In this section, we identify state regulations and policies that affect land use and the likelihood of shoreline armoring and nourishment along the Connecticut coastline. Based on these policies, regional policies, and state planner input, we then outline anticipated statewide sea level rise responses in the following sections.

Connecticut Coastal Management Act

Enacted in 1980, the Connecticut Coastal Management Act [C.G.S. Sec 22a-90 to 112] defines a "coastal area" for Connecticut and establishes the fundamental state policies for activities conducted therein. The primary goal of the act is to ensure that the use of the coastal area "proceeds in a manner consistent with the capability of the land and water resources to support development, preservation, or use without significantly disrupting either the natural environment or sound economic growth." The act sets out other goals of preserving and enhancing coastal resources, and gives high priority and preference to water-dependent uses and facilities, including public access. The act states that all major state plans as well as municipal planning documents should be consistent with the goals set out in the act. The state exercises direct regulatory authority over activities that occur below the high tide line and in wetlands. [15] Property landward of the mean high water line is under municipal jurisdiction.

Under the act, the majority of the responsibility for regulating activities in the coastal area remains with coastal municipalities (or delegated special districts). Specific Coastal Management Act policies apply within a narrower "coastal boundary" within the coastal area. [16] Municipalities must undertake "coastal site plan reviews" for proposed buildings, uses, structures, or shoreline flood and erosion control structures located fully or partially within the coastal boundary. [17] No building permit or certificate of occupancy is to be granted within the coastal boundary without certification in writing (generally by municipalities rather than districts) that it has been approved as being in accordance with the act. The board or commission that reviews a site plan must approve, modify, condition, or deny each proposed activity. The Connecticut Department of Environmental Protection (DEP) may comment and make recommendations on individual coastal site plans. [18]

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[15]The mean high water mark is the average of all high tide elevations based on a 19-year series of tide observations by the National Ocean Survey. Connecticut Coastal Management Manual, September 2000. The high tide line is defined by CGS §22a-359(c).

[16]Counties in Connecticut exist for the purposes of the court system, but have no other governmental significance. Interviews with David Blatt, George Wisker, and Ron Rozsa, Office of Long Island Sound Programs, Connecticut DEP, Hartford, January 9, 2003.

[17]The CMA specifies the coastal boundary, but allows municipalities to establish a customized boundary as long as it does not diminish the statutory boundary. This zone is typically 1,000 feet from coastal features such as rivers. CGS §22a-94. Richard Serra, Southeastern Connecticut Council of Governments, Norwich, February 27, 2003.

[18]DEP can make recommendations for revisions, but does not have veto power to deny a coastal site plan application outright. The State does have the authority to make an appeal in cases where it feels the statutes are being misinterpreted, but the statute allows for considerable discretion on the part of the municipal decisionmakers.

Municipalities must submit coastal site plans for any shoreline flood and erosion control structures to the DEP for review. municipalities may, however, formally exempt certain activities from the coastal site plan review process. These exemptions can include construction of individual single-family residences and minor additions, modifications, or accessory buildings on a property, but exemptions vary by municipality.[19] A shoreline flood and erosion control structure may be considered to be consistent with the CCMA if 1) it is protecting a pre-January 1, 1980, structure that is "in danger or located perilously close" to water, a water-dependent use (e.g. marina, commercial fishing facility, public access walkway), or infrastructure (e.g. roads, water lines, sewer lines); 2) there is clear need (e.g., evidence of significant erosion, qualified structure in peril, infrastructure that cannot be moved, etc.); and 3) there is a clear reason why nonstructural alternatives are not possible. Thus, any shoreline flood and erosion control structure should be "unavoidable and necessary to protect water-dependent use, infrastructural facilities, or an inhabited structure(s) that predates January 1, 1980, the effective date of the CCMA."[20] Nonstructural protection of most properties is permissible. DEP staff state that although the CCMA allows protection of imperiled pre-1980 flood and erosion control structures, a permit may also be granted for structural armoring to new structures, or structures in sensitive areas, if those structures support public access, support another water-dependent use, or affect public infrastructure facilities such as bridges.[21]

Municipalities can also adopt a municipal coastal program that includes revising a municipality's plan of conservation and development, zoning regulations, port development plan, open space plan, municipal water pollution control plan, and more.

Tidal Wetlands Act

Enacted in 1969, the Tidal Wetlands Act was passed to stop the loss of tidal wetlands in Connecticut. The law essentially disallows activities that destroy or degrade tidal wetlands, particularly dredging and filling activities, without a state permit. The State reports that, at present, authorized wetland losses average less than one-half acre per year and that restoration activities are increasing wetland acreage.

Therefore, appeals occur only in rare cases, and DEP believes that local coastal site plan review (CSPR) decisions are unlikely to be overturned on appeal. For the most part, the towns take the state's comments seriously and do their best to address them. Based on interviews with David Blatt, George Wisker, and Ron Rozsa, Office of Long Island Sound Programs, Connecticut DEP, Hartford, January 9, 2003.

[19]"Office of Long Island Sound Fact Sheet for Coastal Site Plan Review Exemptions," Connecticut Coastal Management Manual, September 2000.

[20]"Office of Long Island Sound Fact Sheet for Mandatory Municipal Referrals," Connecticut Coastal Management Manual, September 2000.

[21]Interviews with David Blatt, George Wisker, and Ron Rozsa, Office of Long Island Sound Programs, Connecticut DEP, Hartford, January 9, 2003; Interview with David Blatt, March 13, 2003.

Inland Wetlands and Watercourses Act

Enacted in 1972, and amended in 1973, 1987, and 1996 [C.G.S. Sec 22a-28], this act was created to set up a protection strategy for state wetlands. The act is currently implemented through approximately 1,470 appointed or elected volunteers in 170 municipal agencies. The act establishes state and municipal authority to adopt programs regulating activities that may affect inland wetlands and watercourses. The act now requires that municipalities establish an agency to regulate activities in their wetlands and watercourses. DEP oversees the implementation of the act and reviews all wetland agency regulations and amendments. Note that inland wetlands and state-regulated tidal wetlands are mutually exclusive according to statute.

Conservation and Development Policies Plan for Connecticut

In 1971, House Joint Resolution No. 40 [C.G.S. Sec 16a-28] called for the creation of a state plan of conservation and development. In 1976, the General Assembly set out a procedure for creation of a conservation and development plan for the state of Connecticut every five years. The resulting plan guides the planning and decision making process for state government relative to, among other things, "balancing economic growth with environmental protection and resource conservation concerns" through mandatory review processes. In addition, regional planning organizations and municipalities are encouraged to use the plan and municipalities must note any inconsistencies with it in their local plans of conservation and development.[22] Connecticut's Office of Policy and Management writes and oversees implementation of this plan, which was last updated in June 2005 for the period 2005 through 2010.[23] The 1998–2003 Plan states that:

> The overall Plan strategy is to reinforce and conserve existing urban areas, to promote staged, appropriate, sustainable development, and to preserve areas of significant environmental value. State actions that influence the form and location of development or conservation because of investments in infrastructure, real property, physical facilities, and human services should conform to this strategy. Regions and municipalities also need to consider this strategy when updating their plans of conservation and development. (p. 113)

[22]Connecticut's Office of Policy Management coordinates with each regional planning organization and municipality to produce a mutually agreed on conservation and development policies plan map for the entire state. In addition to this statewide planning effort, Section 8-35a of the C.G.S. states that "each regional planning agency shall make a plan of development for its areas of operation, showing its recommendations for the general use of the area and shall be designed to promote with the greatest efficiency and economy the coordinated development of its areas of operation and the general welfare and prosperity of its people." These regional plans are developed in coordination with member towns for each regional area, and guide development and conservation priorities for activities that occur therein. Although region and municipality plans may differ from the state-level conservation and development plan, we relied on the latter source in this study because all parties contributed to this product.

[23]We incorporated geographic data from the 2005–2010 Conservation and Development Policies Plan into the sea level rise response maps.

A section of the plan is devoted to a geographic map of Connecticut that categorizes areas by their suitability for future development actions or conservation actions. For example, the plan identifies "Regional Centers" as significantly developed areas that have the "highest priority for affirmatively supporting rehabilitation and further development toward revitalization of the economic, social, and physical environment." "Neighborhood Conservation Areas" have a high density of residential and commercial uses, but are not major centers of development. "Rural Community Centers" are existing areas with "relatively higher intensity land uses of residential, shopping, employment, and public facilities and services occurring in rural communities," and with policies to promote clustering in the future as feasible. Because this map is intended primarily to inform state capital investment decisions, it is a helpful indicator of potential future areas that are likely to have infrastructure, and those which will not. Areas with future infrastructure, such as Regional Centers, Neighborhood Conservation Areas, and Rural Community Centers, are more likely to be protected from sea level rise damage because of their large sunk costs and likelihood of nearby built structures.

Connecticut River Gateway Zone and Commission

In 1973, the Connecticut General Assembly established the Lower Connecticut River Conservation Zone [C.G.S. Sec 25-102e], which allowed for the creation of the Connecticut River Gateway Commission, with state and local support. In addition, the commission is authorized to establish minimum zoning standards for height, setback, lot coverage, etc., within the Gateway Zone. The commission, however, has had no state funding since 1992.

The commission has a geographic focus on 30 miles on the Connecticut River, and has eight member towns: Chester, Deep River, East Haddam, Essex, Haddam, Lyme, Old Lyme, and Old Saybrook. The commission has focused on securing the protection of key upland tracts in this region that "contribute to the valley's scenic qualities," and has overseen the protection of more than 1,000 acres of land since its creation.[24] A key land use standard established by the commission is that "no building shall be constructed, reconstructed, enlarged, extended, moved, or structurally altered within fifty feet of the Connecticut River or any of its tributaries or associated wetlands," unless a special permit is approved by the town having jurisdiction. Another standard requires that site plans for development have erosion and sedimentation control plans.

Niantic River Gateway Commission was also created by the state General Assembly, with member towns East Lyme and Waterford. This commission does not, however, appear to be as active as the Connecticut River Gateway Commission.

[24]Connecticut River Gateway Commission website, accessed February 12, 2003. http://www.connecticutrivergateway.org/

Beach Nourishment Practices

In general, only a few regular beach nourishment projects exist in Connecticut, although there is great potential for expansion. The Connecticut River is dredged regularly by the Army Corps of Engineers (ACOE), and the dredged sand is acceptable nourishment material. The sand is somewhat more fine in texture than is typical for beaches, but because the shores of Connecticut are not exposed to the wave energy of the open ocean it is acceptable for nourishment. Currently the ACOE dumps the sand inland or offshore. DEP staff have suggested on numerous occasions that ACOE consider the possibility of bringing the sand to appropriate beaches for use as a nourishment material, but the ACOE has been reluctant to execute this option. There is no state-funded nourishment program.[25]

Examples of recent dredging projects include:

- Savin Rock Beach/West Haven Beach Nourishment/Revegetation/Rock Armoring Project. This state and locally funded project (2/3 state, 1/3 local) restored sand to 0.25 miles of beach using 71,500 cubic yards of sand and 700 tons of armoring stones.[26] The primary purpose was to protect sewers and properties, but the project had a side effect of creating a public beach. Sand was placed in the 1980 and has been maintained since then.
- Sherwood Island State Park was nourished in the last few years but the sand is washing away.
- Hammonassett State Park was nourished in 1955 and the beach has remained stable since that time.

[25]Interviews with David Blatt, George Wisker, and Ron Rozsa, Office of Long Island Sound Programs, Connecticut DEP, Hartford, January 9, 2003.

[26]Hedrick, Casey. "State, Territory and Commonwealth Beach Nourishment Programs", OCRM Program Policy Series, Technical Document No. 00-01, Office of Ocean and Coastal Resource Management, National Ocean Service, NOAA, March 2000.

STATEWIDE RESPONSE TO SEA LEVEL RISE

Generalized Categorical Mapping Rules

Table 2 summarizes the geographic data sources that we obtained and used to create the maps. Table 3 identifies the likelihood of future shore protection for various categories of land use within the Connecticut coastal area, based on the policies discussed above and input from state and county planners. These general trends reflect the likelihood of both structural and nonstructural protection.[27] Specific areas within towns may be more or less likely to be protected given site-specific factors. Some trends are more important than others and one must define their priorities to know what to do when assumptions conflict. Table 4 explains our general statewide priorities in deciding which land use classifications take precedence in our analysis of the likelihood of shore protection. Tables showing the region-specific order of land use classification are included in the individual regional sections that follow. Table 5 provides examples of specific land uses within the land use categories that played the most important role in this study.

We used two distinct approaches for classifying land, corresponding to the two ways the state classifies land use. First, the Conservation and Development Policies Plan categorizes most areas into one of six uses based on the suitability for future development actions or conservation actions.[28] Second, the statewide 1995 Land Use Land Cover dataset classifies all areas in the state into 21 different land use types based on LANDSAT satellite imagery.[29] Together, these two data sources provide a clear baseline picture of current and projected land use over the entire state.

[27]Nonstructural shoreline protection includes beach nourishment activity, vegetation and other temporary materials such as sandbags, snow fencing for dune restoration, or coconut logs. Structural shoreline protection includes facilities such as bulkheads, revetments, groins, jetties, and seawalls.

[28]Refer to section discussing Conservation and Development Policies Plan.

[29]This study also uses the 2002 Land Use dataset, which categorizes land use into 11 types. We only use the "Developed" land use type from this dataset in the study maps.

Table 2

SUMMARY OF GIS DATA APPLIED IN STUDY*

Data Name	Application in Study	Source, Year Published (Scale)
Coastal Area	Used to identify the boundary within which activities and actions conducted by federal agencies and state agencies (i.e., DEP regulatory programs, and state plans and actions) must be consistent with all of the applicable standards and criteria contained in the Connecticut Coastal Management Act.	CT DEP, Office of Long Island Sound Programs, 1995 (1:24,000)
Connecticut Towns	Used to identify small islands off the Connecticut coast that are not visible in the state land use land cover data. The boundaries of towns along the coast are also used to approximate the extent of the study area.	CT DEP, Environmental and Geographic Information Center, 1995 (1:24,000)
Development Priority Areas	Used to identify lands within the entire study area designated for various categories of development (e.g., Regional Center), according to the 2005–2010 Conservation and Development Policies Plan for Connecticut.	Connecticut DEP, Office of Policy and Management, Central Connecticut State University, 2005 (1:24,000)
Federally Owned Land	Federally owned lands include National Park Service property, U.S. Fish and Wildlife Service National Wildlife Refuge lands, and U.S. Army Corps of Engineers holdings.	CT DEP Environmental and Geographic Information Center, 1997 (1:24,000)
Federal/Indian Land Areas	Used to identify federally owned military lands.	National Atlas of the US/ USGS/ ESRI, 2004 (1:2,000,000)
Flood Zone	The 500-year floodplain boundary was used in early phases of the study to approximate the study area.	Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps/ obtained in 2003 (1:24,000)
Hydrography	Used to identify wetlands and open water within the entire study area. It includes perennial and intermittent lakes, ponds, reservoirs, rivers, streams, marshes, dams, and drainage ditches.	CT DEP Environmental and Geographic Information Center/ 1995 (1:24,000)

Land Use in Southeastern Region	Used to identify developed (i.e., residential, commercial, industrial) and undeveloped lands within Southeastern Region.	Southeastern Connecticut Council of Government (SCCOG), 2000 (1:50,000)
1995 Land Use Land Cover	Used to identify developed (i.e., residential and commercial) and undeveloped lands within entire study area.	University of Connecticut Department of Natural Resources Management Engineering/ CT DEP, 1997 (1:50,000)
2002 Land Cover	Used to identify developed (i.e. residential and commercial) lands within the entire study area.	University of Connecticut Department of Agriculture and Natural Resources, Center for Land Use Education and Research (CLEAR), 2003 (1:50,000)
Municipal and Private Open Space	Identifies property owned by Connecticut municipalities and private organizations for the purpose of preserving open space. Lands include conservation trust property, town open space, parks, school playgrounds, campgrounds, golf courses, club and association recreational property, and cemeteries.	CT Office of Policy and Management/ CT DEP Environmental and Geographic Information Center, 2005 (1:24,000)
National Wetlands Inventory	Used to identify tidal and nontidal wetlands in the Connecticut River Estuary Regional Planning Area.	U.S. Fish and Wildlife (obtained from CRERPA in 2003), 1981 to 2000 (scale ranges from 1:20,000 to 1:132,000)
Regional Planning Organizations	Used to identify the boundaries of regional planning organizations located within the Coastal Area.	CT DEP Environmental and Geographic Information Center, 1995 (1:125,000)
Sewer Service Areas	Used in Connecticut River Estuary Regional Planning Area to identify lands where sewer service is provided.	CT Bureau of Waste Management/ CT DEP Environmental and Geographic Information Center, 1998 (1:24,000)
State-Owned Land	Land owned by Connecticut DEP, including State parks, State forests, Wildlife Areas or Sanctuaries, Natural Area Preserves, Water Access properties, and Flood Control properties.	CT DEP Environmental and Geographic Information Center, 2002 (1:24,000)

Tribal Settlement Areas	Used to identify tribally owned lands in the Southeastern Region.	Connecticut DEP, Office of Policy and Management/ Central Connecticut State University, 2005 (1:24,000)
Shoreline Armoring	As part of the stakeholder review, used to identify lands where shoreline armoring is not present.	Environmental Sensitivity Index (ESI) / NOAA 1991-2001 (1:24,000)
* Refer to the Appendix for a full summary of data sources.		

Table 3

GENERAL STATEWIDE ASSUMPTIONS FOR LIKELIHOOD OF SHORELINE PROTECTION

Likelihood of Protection	Map Color	Land-Use Category	Data Source*
Protection Almost Certain	Brown	Regional Centers in C&D Plan	1
		Neighborhood Conservation Areas in C&D Plan Rural Community Center in C&D Plan	1
		Residential and Commercial Land Use	2, 3, 4
		Commercial and Industrial Areas (excluding extraction)	2, 3, 4
		Institutional	4
		Transportation, Communications, and Utilities	2, 3, 5
		Mixed Urban Uses	2, 3, 4
		Native American Tribal Reservations	6
Protection Likely	Red	Growth Areas in C&D Plan	1
		Military Installations	7
		Cemeteries, Low Density Residential Land Use	4
Protection Unlikely	Blue	Forest and Agricultural Lands	2, 4
		Barren Lands and Bare Soil	2, 4
		Reservoir Areas/ Public Water Supply Watershed	2, 4
		Active Recreation	2, 4
		Easements	8
		Town Open Space	8
No Protection	Light Green	DEP-Owned Lands	9
		Federally Owned Lands	10
		Existing Preserved Open Space, Land Trust, Wildlife Refuges, Conservation Lands	8
	Dark Green	Wetlands	11, 12

*Key to data name:

1. Development Priority Areas
2. 1995 Land Use/Land Cover
3. 2002 Land Cover
4. Land Use in Southeastern Region
5. Sewer Service Areas
6. Tribal Settlement Areas
7. Federal and Indian Lands
8. Municipal and Private Open Space data
9. State-Owned Lands
10. Federally Owned Lands
11. Hydrography
12. National Wetlands Inventory

Table 4

STATEWIDE ASSUMPTIONS FOR SHORE PROTECTION MAP

Land Area Type	Protection Status	Source
Refuges, WMAs, Preserves	No Protection	State-owned lands, federally wwned lands
Military Installations	Uncertain	Federal and Indian lands
Private Conservation Lands, Preserves, Refuges and Open Space	No Protection	Municipal and Private Open Space
Town Open Space and Easements	Unlikely	
Developed Lands[a]	Almost Certain	1995 Land Use Land Cover, 2002 Land Cover
Neighborhood Conservation Area, Rural Community Center, and Regional Center	Almost Certain	Development Priority Areas
Growth Areas	Likely	
Undeveloped and Open Lands[b]	Unlikely	1995 Land Use Land Cover

[a]Developed lands include commercial, industrial, and residential areas that hold significant built infrastructure.

[b]Undeveloped lands include forest and agriculture lands, barren lands and bare soils, and reservoir lands.

Note: Where land areas overlap, classifications higher in the table take precedence.

Table 5

SPECIFIC LAND USE EXAMPLES IN COASTAL CONNECTICUT

Land Use	Example
Transportation, Communication and Utilities	• Millstone Nuclear Power Station at mouth of Niantic River (shoreline already armored with a seawall, almost certain to be protected) • Interstate 95 and other major routes in proximity to shoreline (almost certain to be protected) • Bridgeport Municipal Airport lies below the 20-foot contour near Stratford Point (almost certain to be protected).
Residential	• Low-density development dominates residential land use in the SWRPA region (almost certain to be protected) • Medium-density in Rogers Lake section of Lyme, Westbrook and Clinton centers (almost certain to be protected)
Institutional	• Navy base in Ledyard along Thames River (likely to be protected) • Household Hazardous Waste in Essex (almost certain to be protected)
Committed Open Space and DEP-owned lands	• Tidally influenced committed open space: Barn Island Wildlife Management Area, Bluff Point State Park, Reserve, Rocky Neck State Park (no protection) • The Nature Conservancy, Public Land Trust, Gateway Commission, and CT-DEP all manage committed open space on the east side of Connecticut River (no protection) • The Connecticut Audubon Coastal Center in Milford is an 8.4 acre preserve (no protection).
Commercial and Industrial	• The Mohegan Native American Tribe's casino property as well as purchased state land along the Thames River, which the tribe indicated may be used for housing development (almost certain to be protected) • Captain's Cove Seaport in Black Rock Harbor, Bridgeport, is a cultural/tourist attraction with dense commercial development (almost certain to be protected). • Harbor Yard Ball Park and Arena in Bridgeport are major event centers located within 1,000 feet of Long Island Sound (almost certain to be protected) • The Port of Bridgeport and the Port of New Haven (almost certain to be protected) • The densely developed commercial/industrial centers in Stamford, Norwalk, New Haven , Bridgeport, and New London (almost certain to be protected)
Historic and Cultural Value	• The Maritime Aquarium at Norwalk, located directly on the harbor, is one of Connecticut's largest tourist attractions (almost certain to be protected)

Data source: Interviews with regional planners.

Change in General Statewide Assumptions Based on Stakeholder Review [h2]

During stakeholder review, each regional planning organization had the opportunity to view two separate maps of their region. The first map showed sea level rise response scenarios for only defined lowland areas (land within the 500-year floodplain or within a 1,000-foot buffer of the shoreline). The second map, labeled "Expanded Study Area", depicted all lands within the state Coastal Area.[30] We included the second map because the delineation of areas vulnerable to sea level rise might be adjusted in the future as improved elevation data become available. This approach ensured that planners could comment on all lands that might be considered within a modified study area.

Recommendations by various reviewers led us to modify the general statewide assumptions and mapping methods. First, based on recommendations from several regional planners, we added newly available 2002 Land Cover data developed by the Center for Land Use Education and Research (CLEAR) to the study maps to include more recent development as almost certain to be protected. Second, our GIS decision rules had originally treated lands that are both currently developed (land use data sources, protection almost certain) and within a designated Growth Area (protection likely, Conservation and Development Policies Plan data) as likely to be protected. We corrected that decision rule so that such developed lands are treated as protection almost certain.

Third, based on reviewer comments, we also modified the general statewide assumptions in the Connecticut study due to limitations we encountered with two data sources. Regional planners pointed out that certain land uses (e.g., yacht clubs) were incorrectly depicted as open space lands (no protection) on our map. These comments prompted us to review our use of two statewide data sources, the Municipal and Private Open Space (MPOS) areas and the Conservation and Development (C & D) Plan areas. The sections that follow describe the problems with our initial general statewide assumptions and explain our solution for addressing these issues.

Municipal and Private Open Space Areas

According to the Connecticut DEP, the MPOS data layer "identifies property owned by Connecticut municipalities and private organizations for the purpose of preserving open space. Lands include conservation trust property, town open space, parks, school playgrounds, campgrounds, golf courses, club and association recreational property, and cemeteries." The initial draft maps IEc produced in 2003 showed all polygons within this layer as light green (no protection).

Before the stakeholder review process in June 2005, we realized that the MPOS data layer included both conservation and nonconservation lands, and thus we chose to differentiate among

[30]The Coastal Area is the boundary within which activities and actions conducted by federal agencies and state agencies (i.e., DEP regulatory programs, and state plans and actions) must be consistent with all applicable standards and criteria contained in the Connecticut Coastal Management Act.

varying levels of protection. It seemed most sensible to classify properties based on the "Category" field, which provides a general description of the type of open space. Table 6 indicates the methodology we used to match land types to protection categories, which was in accordance with the initial general statewide assumptions.

Table 6. Designations for Municipal and Private Open Space Areas on Stakeholder Review Maps

Property Category	Initial Response Category
Cemetery	Likely
School	
General Recreation	Unlikely
Recreation	
Uncategorized	
Preservation	No Protection
Conservation	
Existing Preserved Open Space	

Problems encountered with MPOS data

Through comments obtained during stakeholder review meetings, the EPA project manager's review, and follow-up research, we found that many of the individual land areas were identified by categories that do not follow from the "Property Name" entries. In particular, we found the "Existing Preserved Open Space" category to be a mixed group of properties, including high schools, playgrounds, town open space, homeowners' association lands, golf courses, and conservation easements. Planners noted that many lands designated in this category are likely to be protected in the future. Such properties include Seaside Park, Lordship Beach, and Short Beach in the Greater Bridgeport Region, and Greenwich Point Park and Cummings Park in the South Western Region. Several of these lands already have hard armoring structures. The other classifications, particularly "Uncategorized" properties, also have diverse entries.

To resolve these problems, we contacted Howard Sternberg, a GIS specialist in the state DEP who fields questions about the MPOS data layer. He indicated that this layer was developed in 1997 and that no new open space lands have been added to the dataset since that time. He also confirmed our observation that the categorization of open space lands is not highly accurate. A contractor will soon release a new statewide Dedicated Open Space layer available, and Howard recommended we integrate this into our map. Unfortunately, he could not provide us with a clear time frame for the release of this new dataset.

Approach for addressing MPOS layer concerns

We developed a strategy for using the existing MPOS data layer to isolate properties that are most likely to be set aside for open space conservation. We used the following keyword search on the "Property Name" field to identify areas most likely to be held for land conservation:

[Like "*preserv*" Or Like "*conserv*" Or Like "*open space*" Or Like "*refuge*" Or Like "*audubon*" Or Like "*trust*" Or Like "*sanctuary*"]

In general, these names imply land conservation and can be shown as light green. Based on a review of the identified lands, we found that a portion of these are town- or city-owned open space. Additionally, many of these identified lands are conservation easements. We then identified these properties by using the following keyword search on the "Property Name" field:

[(Like "*open space*" And "city") Or (Like "*open space*" And "*town*") Or (Like "*open space*" And "*village*") Or (Like "*easement*")]

We then showed this group of properties as protection unlikely (blue).

Conservation and Development Data

The C & D dataset was integrated into the original draft map for Connecticut.[31] Before conducting stakeholder review in June 2005, we added layers to our map from the 2005–2010 C & D Plan to replace layers from the 1998–2003 C & D Plan. We did not change our mapping methodology for the layers within the C & D dataset between the drafting of the original maps and stakeholder review in 2005. Table 7 indicates the response categories that we assigned to these layers. The statewide C & D dataset contains three separate conservation layers (Existing Preserved Open Space, Preservation Areas, and Conservation Areas), which we showed as blue (protection unlikely). Other layers in the C & D dataset that we depicted in the map include Growth Areas (protection likely) and currently developed areas (Neighborhood Conservation, Rural Community Center, and Regional Center), which we showed as shore protection almost certain.

Table 7. Designations for Conservation and Development Plan Areas on Stakeholder Review Maps

Conservation and Development Designation	Initial Response Category
Neighborhood Conservation	Almost Certain
Rural Community Center	
Regional Center	
Growth Area	Likely
Existing Preserved Open Space	Unlikely
Preservation Areas	
Conservation Areas	

Lands with the highest priority for conservation are depicted in the "Existing Preserved Open Space" data layer. Prompted by stakeholder and EPA comments, we found that this designation

[31] The Conservation and Development dataset is composed of multiple data layers that separately depict areas of conservation and areas of development.

is overly broad because it applies to thousands of properties, including state parks, land trusts, schools, yacht clubs, and others. Similar to the issue we encountered with the MPOS data layer, we found that many of the individual land areas were identified by categories that do not follow from the "Name" entries. The properties in this layer appear to have the exact same degree of spatial accuracy as the MPOS data. The naming of properties in this layer seems to be more irregular, however, because there are far more unnamed properties.

The "Preservation Areas" data layer depicts water supply watershed lands, wetlands, agricultural or forest lands for which development rights have been acquired, and existing water bodies. The "Conservation Areas" data layer includes public water supply watershed lands, Aquifer Protection Areas, scenic areas, prime agricultural lands, historic areas, and "natural areas of local significance." Clearly, these layers encompass a highly mixed group of lands. These two layers also have the distinct disadvantage of not providing any name or other attribute distinction. For example, it is impossible to differentiate scenic areas from public water supply watershed lands in the "Conservation Areas" layer.

Solution for using C & D data [h4]

Given the difficulty of distinguishing among the land use types in the three conservation data layers (Existing Preserved Open Space, Preservation Areas, and Conservation Areas), we revised the maps by excluding these components of the C & D data. We instead rely on the MPOS data (as described above) to identify conservation lands. All other undeveloped properties default to the underlying Land Use/Land Cover category.

Review of Modified Methodology

After implementing the above methodology changes, we compared the resulting maps to the post-stakeholder review version. For each region, we identified all areas where the revised map differed from the earlier version. The following summarizes our findings:

- Several privately held lands (e.g., yacht club, golf course) changed from blue to brown.
- Several municipal parks, including town beaches, changed from light green to brown.
- A few schools and cemeteries changed from red to brown.
- Narrow undeveloped stretches along the shoreline changed from blue to brown.[32]

The reason these properties change to a designation of protection almost certain is that the underlying development designations Regional Center and Neighborhood Conservation cover

[32]These areas, which are designated as "Conservation Areas" or "Preservation Areas" in the C & D Plan, were originally depicted as shore protection unlikely prior to the methodology change. While making these revisions, we examined whether these lands were undeveloped and unarmored.

broad areas of the Connecticut coastline. The majority of map changes appear in the South Western and South Central Regions of the state. These regions include some of the most densely developed and wealthy communities in the state, so we would already expect a high level of commitment to shore protection. This revised methodology produces relatively few changes in the other regions.

Although we agree with most of the map changes, we reviewed each of the resulting map changes to ensure that all areas matched any specific protection designations identified by planners. For example, the review changes initially switched several offshore, privately held islands to protection almost certain (brown); given that planners previously indicated that these lands are unlikely to be protected, we changed the areas back to blue. In addition, given concerns that some lands changed to brown as part of the review changes may not be developed currently and therefore less likely to be protected, we referenced imagery and shoreline armoring data. Lands that are not developed currently and are also not currently developed where changed to shore protection likely to acknowledge the lower level of certainty.

Because these additional changes were made in response to comments made by the planners, we did not provide revised maps and report to planners after making the changes.

Overview of the Anticipated Likelihood of Shoreline Protection by Land Type [h2]

Commercial, Industrial, and Residential Lands

Most of these areas are certain to be protected, but a few areas are likely, but not certain, to be protected.

Protection Almost Certain [h4]

The Connecticut shoreline is primarily developed for residential use, but also includes pockets of highly developed industrial and commercial land uses. Generally, there is a trend of decreasing development as one moves eastward along the Connecticut shoreline. In the Greater Bridgeport Regional Planning Area, a western region with significant industrial development, residential uses currently occupy more than 52 percent of lands, and commercial and industrial uses occupy 5 percent of lands combined. To the east, in the Connecticut River Estuary Region, residential development currently accounts for close to 20 percent of the total land area, and commercial and industrial lands together occupy just over 2 percent of the area (1995 data). In Southeastern Connecticut, the easternmost region, residential land uses comprise roughly 15 percent of the land area, and commercial and industrial uses account for about 1 percent each.

To obtain a permit to construct structural armoring waterward of the high tide line in Connecticut, a property owner must submit a coastal permit application to the state DEP. As stated above, the flood and erosion control structure should be "unavoidable and necessary to protect water-dependent use, infrastructural facilities, or an inhabited structure(s) that predates

January 1, 1980, the effective date of the CCMA."[33] As part of the application, the applicant must evaluate the beneficial and adverse impacts of the project on coastal resources, and show that alternatives such as beach nourishment and vegetation would not work. This could mean actually attempting other remedies or simply analyzing other possibilities. The burden of proof is also on the applicant to show that the property is actually in peril. DEP staff state that although the CCMA allows protection of imperiled pre-1980 flood and erosion control structures, a permit may also be granted for structural armoring to new structures, or structures in sensitive areas, if those structures support public access, another water-dependent use, or affect public infrastructure facilities such as bridges.[34] In addition, nonstructural protection is permitted in most circumstances.

Thus planners assume that private landowners will protect existing developed lands (e.g., through armoring or elevation/beach nourishment). In particular, heavily developed areas, such as Stamford, Norwalk, and Bridgeport, will almost certainly be protected with structural armoring. This includes designated Regional Centers in the State Plan of Conservation and Development, and areas shown as commercial, industrial, mixed urban uses, or medium/high density residential in recent land use data.[35] Designated Rural Community Centers have a higher density of residential and commercial uses than other rural areas and are almost certain to be protected.[36]

A number of relatively densely populated areas in the eastern portion of the state are serviced by septic systems.[37] The DEP would like to move these areas to sewer systems; however, towns are often opposed to such a change because of the fear that sewers will encourage further development. Examples of densely developed areas that rely on septic systems are Groton Long Point and Lord's Point in Eastern Connecticut. With sea level rise, rising water tables could create septic system failures in these areas. Because these areas are highly developed with private homes, however, this analysis assumes that private funding would allow these areas to be maintained and protected when faced with sea level rise.[38]

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[33] "Office of Long Island Sound Fact Sheet for Mandatory Municipal Referrals," Connecticut Coastal Management Manual, September 2000.

[34] Interviews with David Blatt, George Wisker, and Ron Rozsa, Office of Long Island Sound Programs, Connecticut DEP, Hartford, January 9, 2003; Interview with David Blatt, March 13, 2003.

[35] The State Conservation and Development Plan defines Regional Centers as areas that should have the "highest priority for affirmatively supporting rehabilitation and further development toward revitalization of the economic, social, and physical environment." These areas are generally already significantly developed. Examples include New Haven, New London, and Norwich.

[36] The State Conservation and Development Plan defines Rural Community Centers as areas with "relatively higher intensity land uses of residential, shopping, employment, and public facilities and services occurring in rural communities," and with policies to promote clustering in the future as feasible. Few of these areas exist in southeastern Connecticut's coastal region, with one small area designated in Old Lyme.

[37] Refer to section discussing the Connecticut River Estuary Region.

[38]There may be exceptions, however, where towns or the state decides that such protection is not worthy of infrastructure investment. For example, Beach Drive in Stratford loses some cottages in every major storm. The

Affluent lower density residential areas are also assumed to be almost certainly protected because of residents' ability to personally finance protection and also to influence local and state authorities to allow or fund the necessary structures. For example, most of the coastline in the South Western Region, with a median family income of $93,000 (nearly twice the state average) and several coastal towns with median family incomes of more than $120,000, is almost certain to be protected.

Protection Likely [h4]

The State Conservation and Development Plan identifies some Growth Areas, where growth is to be encouraged and is considered to be "capable of supporting large-scale, mixed uses and densities in close relationship to the Regional Centers." Because much of the ocean coast is already developed, Growth Areas in southern Connecticut lie predominantly inland or along river corridors. Because of existing development along the coast, very few Growth Areas have been identified west of New Haven. To the east, however, Branford, Guilford, Madison, Clinton, and Westbrook have each identified growth areas within about a mile of the coast. Other growth areas are found along the Housatonic River in Milford, the Quinnipiac River in Wallingford, and the Thames River in Montville and Preston. Currently undeveloped lands located within Growth Areas are shown as protection likely (red).

Infrastructure

Most of the state's public facilities are certain to be protected, but a few areas are likely, but not certain, to be protected.[39]

Protection Almost Certain [h4]

Projects that occur waterward of the high water mark that may require structural armoring are likely to receive protection under the CCMA. Structural armoring needed to protect infrastructural facilities may be deemed to be consistent with the CCMA.[40] State planners further

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development is a condo group, so the town has the option, if someone is applying for a permit to protect their house or to develop something new, to tell the applicant to develop somewhere else on the property.

[39] In the initial draft maps, we depicted areas within 300 feet of all shoreline armoring structures (including riprap) as protection almost certain. Most armoring, however, was (and continues to be) adjacent to lands designated as shore protection almost certain. In addition, this approach fails to adequately illustrate the area that would be protected by armoring. We therefore removed this general statewide assumption from our maps. During the stakeholder review of this study, along shore areas designated as protection unlikely, we reviewed shoreline armoring data to identify existing armored areas. We did not find any existing armoring, however, that warranted additional changes.

[40] Refer to section discussing Connecticut Coastal Management Act, page 8.

indicate that installing riprap to protect bridge supports is a commonly approved activity under present regulations.[41] Thus, bridges, roads, rail lines, communication facilities, and other major infrastructure already are shown as almost certain to be protected by structural armoring (brown). For example, structural armoring is virtually guaranteed for the Millstone Nuclear Power Facility at the mouth of the Niantic River.

Protection Likely [h4]

In response to findings in other states, EPA decided the most appropriate approach would be to classify all military lands as protection uncertain (red), except for those lands that are within urban areas where protection would be certain even if the land were held by the private sector.

Agricultural Lands and Forests

Undeveloped lands that are currently used for agriculture or are covered by forest and are not currently designated as Neighborhood Conservation Areas, Rural Community Centers, or Growth Areas by the state Plan of Conservation and Development are assumed unlikely to be developed for commercial or residential purposes in the foreseeable future. Thus, these areas are shown as protection unlikely (blue).

Open Space

No Protection

Most undeveloped land in southern Connecticut is located east of New Haven. In Southeastern Connecticut, committed open space accounts for 13 percent of the land area. In the Connecticut River Estuary planning area, this figure is slightly higher, at 17 percent.[42] As a general statewide assumption also applied in this study for other states, we assume that lands set aside as permanent open space will not be armored against rising sea level. Thus all property types that meet this criterion are shown as no protection (light green). Our definition of permanent open space includes preservation lands, land trusts, private open space, refuges, sanctuaries, and Audubon lands.

[41]Interview with David Blatt, Office of Long Island Sound Programs, Connecticut DEP, Hartford, March 13, 2003.

[42]Cited in CRERPA's 1995 Plan of Development on page 9.

Protection Unlikely

Municipally owned open space lands are less likely to be permanently set aside for conservation. In some cases, cities may elect to sell valuable open space land to developers to increase the tax base. Thus, we depict city and town open space areas as protection unlikely (blue) rather than no protection. Similarly, lands held in conservation easement are not likely to be armored, but property owners do typically maintain the right to armor. Therefore, we also show lands held in conservation easements as protection unlikely.

Areas that are currently barren and are not designated as Neighborhood Conservation Areas, Rural Community Centers, or Growth Areas are also assumed to be unlikely to be protected from sea level rise (blue).

Other Public Lands

Protection Unlikely

Many of the smaller islands off the coast of Connecticut are owned by the state. Following the methodology used in other states, state-owned offshore lands that are not parks are depicted as unlikely to be protected from sea level rise (blue).

No Protection

In general, the state and towns do not have mandatory policies preserving current open lands as natural areas. State planners, however, told us that areas currently designated as state or federal parks will not be protected from sea level rise (light green).[43] This includes DEP-owned lands such as state forests, state parks or preserves, and wildlife areas or sanctuaries. Planners also anticipate that lands in Connecticut owned by the federal government, such as National Wildlife Refuges, will not be protected from sea level rise (light green).[44] Two National Wildlife Refuges lie within Connecticut's coastal area: Stewart B. McKinney and Salt Meadow.

[43]Interview with David Blatt, Office of Long Island Sound Programs, Connecticut DEP, Hartford, March 13, 2003.

[44] There was, in the past, a controversial decision made to apply riprap to part of one of the refuges to stop further erosion. Faulkner's Island is home to a historic lighthouse that was being threatened by erosion. The island is also a habitat for terns. A local group was concerned about preserving the lighthouse and was able to procure political backing on the matter, including the blessing of the state Fish and Wildlife Agency, to armor the entire island with rip rap. The feeling was that the habitat would not be put in much danger from armoring and that, in fact, the rip rap might provide good nesting sites. The situation has not played out as well for the terns as these people had hoped.

Nontidal Wetlands

Connecticut has 450,000 acres of inland wetlands, 85,000 acres of freshwater watercourses, and 17,500 acres of tidal wetlands.[45] As stated above, the Tidal Wetlands Act requires a permit for all activities within tidal wetlands. Wetlands are unlikely to be altered in any way to address sea level rise, and are dark green on the map.[46]

Tribal Lands

The Mohegan Sun Hotel and Casino along the west bank of the Thames River in Uncasville is the only tribal area located within the study area.[47] Tribal governments have considerable autonomy when determining how their lands will be used. Because of the large investment in this facility, this analysis assumes that this tribal area is almost certain to be protected with structural armoring from sea level rise (brown).

[45] Conservation and Development Policies Plan, 1998–2003, Office of Policy and Management, Connecticut Department of Environmental Management, 1998.

[46]Refer to section discussing Tidal Wetlands Act. Current maps do not differentiate between tidal and nontidal wetlands because of the lack of available statewide data from the National Wetlands Inventory. Future maps will show this distinction.

[47]Outside of the study area, the Golden Hill Paugussett, Mashantucket Pequot, Paucatuck Eastern Pequot, and Mohegan Tribal reservations cover approximately 3,150 acres in Southeastern Connecticut. Areas run by the Mohegan and Mashantucket Pequot have developed gaming and resort facilities. Land Use 2000: Southeastern Connecticut Region, Southeastern Connecticut Council of Governments, March 2002.

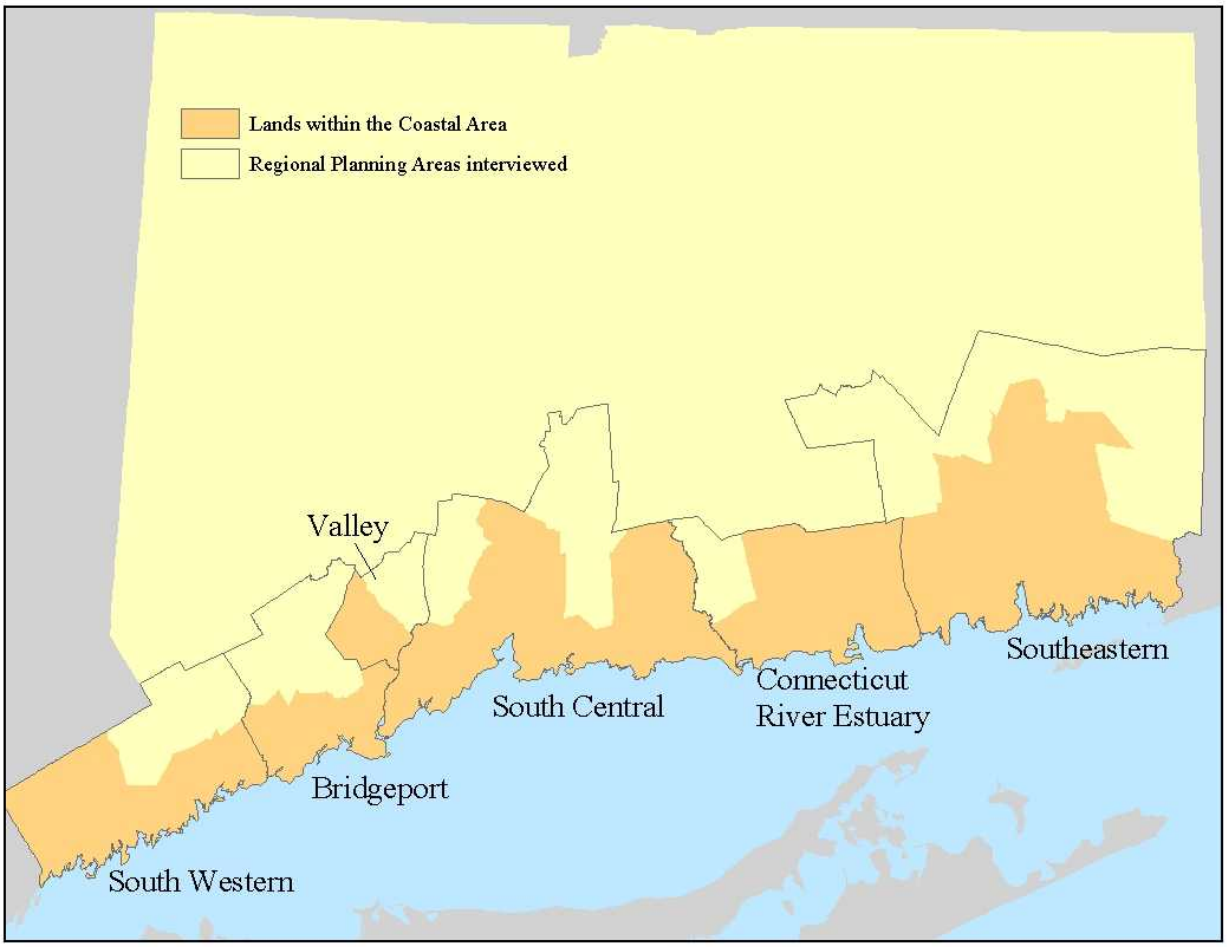
RESPONSES TO SEA LEVEL RISE BY REGION

Mapping the likely response to sea level rise requires a consideration of site-specific factors. Although towns generally have land use authority in Connecticut, it was not practical for us to meet with every coastal town, many of which do not have planners anyway. Instead, we met with representatives from the regional planning agencies. Figure 1 illustrates the areas represented by the coastal agencies we contacted.

We now examine each of these six regions. We first describe the policies and trends that we considered in defining the general state-wide assumptions. We then discuss the map changes suggested during the stakeholder review, and the policies and trends that formed the basis of those suggested changes.[48]

[48]We discuss map changes in each region in a west-to-east direction.

Figure 1: Connecticut Regional Planning Organizations Interviewed



SOUTH WESTERN CONNECTICUT

Regional Policies

We initially contacted the staff of the South Western Regional Planning Agency (SWRPA) in February 2003 to explain the study and collect their thoughts concerning trends and policies that might have a bearing on the region's ultimate response to sea level rise.[49] We briefly describe what we learned from our research.

The South Western Region of Connecticut occupies the 225 square-mile panhandle at the western tip of the state and is part of the New York City metropolitan area. The region is the most urbanized in all of Connecticut, and serves as a conduit between New York City and the rest of New England. As a result, the South Western Region's development patterns, transportation system, and economy have significant bearing on surrounding regions as well as the eight cities and towns that constitute the region served by the SWRPA. Overall, the population growth rates for SWRPA communities between 1990 and 2000 exceeded projections, and the SWRPA region includes three communities (Stamford, Norwalk, and Greenwich) that rank in the top ten in the state in terms of total population.[50] In fact, the City of Stamford was the only major urban center in Connecticut to show a growth in population from 1990 to 2000—growing by 8.6 percent. The town of Westport reversed earlier decade losses in population to exceed 25,000, exhibiting a 5.5 percent growth in population over the last 10 years.

The South Western Region is much more densely populated than Connecticut as a whole. The 2000 Census measured 1,682 persons per square mile in the South Western Region, compared to 703 per square mile for the state as a whole. Most of this density occurs in the coastal towns, and the inland towns of New Canaan, Wilton, and Weston are less than, or equally dense as, the state. Development is concentrated along the I-95 corridor, which runs along the coast of Long Island Sound. As a result of this dense population, there is relatively little open space in the coastal South Western Region compared to the rest of coastal Connecticut. Greenwich and Norwalk have designated some large conservation areas. Sherwood Island State Park in Westport, covering approximately 250 acres, is the only coastal state park. Many of the small islands off the region's coast, whether publicly or privately owned, are designated as conservation areas in the state Conservation and Development Plan, limiting their use to low-density residential and recreational purposes. The majority of coastal South Western Connecticut is designated by the state's Conservation and Development Plan as Neighborhood Conservation Areas, reflecting the high density of residential and commercial uses. Because of the proximity of I-95 to the Long

[49]Leslie Katz Genova placed several phone calls to Robert Wilson in February 2003, but was unable to interview him before developing the mapping methodology. The Regional section is based on research of Census data and the state Conservational and Development Policies Plan.

[50]The 1998–2003 Conservation and Development Policies Plan for Connecticut provided town population projections for 2000. We obtained actual population data from the 2000 US Census.

Island Sound coastline, it is likely that development will continue along the coast. For example, Stamford's plan of development allows for major commercial development south of 95 along the waterfront.[51]

Stakeholder Review

We sent the draft report and draft maps to the South Western Regional Planning Agency, and then arranged a conference call with planning staff. [52] We initially explained the purpose of the study and then outlined the guidelines for stakeholder review. We were interested in soliciting feedback on the map to ensure that we accurately captured trends in development and conservation. During the conference call, we marked up the map based on the planners' comments.

Planners' General Comments

The planners emphasized that given the "astronomically" high value of real estate and the population density in the South Western Region, the majority of coastal lands are almost certain to be protected. As evidence of this high property value, the median home price in the Region in 2004 was $925,000. Although residential property and critical public facilities are areas with the highest priority for shore protection, the staff indicated that members of privately owned clubs (i.e., golf, yacht, and beach clubs) are likely to pool resources to fund shoreline protection measures. Marinas, in particular, have a dense concentration of valuable facilities that members are likely to protect.

Communities in the South Western Region place a high premium on public coastal recreation facilities. Municipal parks are important for providing public access to the shoreline in an area with otherwise limited public access. The planners confirmed that many of these shorefront parks already are heavily armored and are likely to continue to be armored in the future. Additionally, many of the public beaches in the towns of Greenwich and Stamford are regularly nourished.

Towns in the South Western Region have a limited amount of public open space dedicated to preserving tidal wetlands. Because these lands are not active recreation areas, it is unlikely that shoreline protection will be pursued.

The South Western Regional Planning Agency recently completed its Pre-Disaster Mitigation Plan for FEMA. These studies are conducted for the purpose of identifying the coastal areas most vulnerable to erosion and flooding. The cost of protecting the most vulnerable lands might be so

[51]Stamford 2002 Master Plan.

[52]Andrew Hickok and Daniel Hudgens spoke with Robert Wilson, executive director; Daryl Scott, staff planner; and Michael Wellington, intern, on June 29, 2005. Before the phone call, the staff received both paper and electronic versions of the draft sea level rise response maps.

prohibitive that shoreline armoring will not be pursued in some areas. The planners noted that sea level rise could be incorporated into future iterations of the Pre-Disaster Mitigation Plan.

New structural modifications to shorefront properties are relatively uncommon in the region, because the communities actively attempt to regulate this activity and encourage nonstructural options. The city of Stamford requires the first floor of new homes to be a minimum of 1 foot above the median high tide point. The planners indicated that it was reasonable to assume that shoreline protection will be permitted in Stamford in all areas located at least 1 foot above median high tide. Some properties in the low-lying Saugatuck Shores area of Westport have been raised and others have been bought out by the city. The staff is aware of only one property in Greenwich that has been significantly fortified in recent years. Although it is currently difficult for property owners to obtain permits for armoring structures, the planners predict that permitting will become less stringent as inundation problems increase.

Summary of Map Comments

The map changes in the South Western Region are as follows:

1. *Change public recreation areas in Greenwich from light green to red* (protection likely). The planners commented that cities in the region are committed to protecting public recreation areas. Many of these parks, such as Greenwich Point Park, already are significantly armored. The planners recommended we display all public active recreation areas located along the shorefront in the South Western Region as protection likely to reflect the desire of communities to protect these public spaces. Additional areas affected by this map change include the following (moving west to east; see #1 on Figure SHR-1)[53]:
    - Greenwich Point Park: The most popular beach in Greenwich, the city has spent substantial funds to maintain access to this area. For instance, the city has rebuilt the land bridge to Greenwich Point after hurricanes. Before being owned by the city, Greenwich Point was an estate on which seawalls were constructed.
    - Island Beach (also known as Little Captain Island): The second most popular beach in Greenwich, Island Beach is located two miles offshore of the Bellhaven area. The staff indicates that this 4-acre island has a seawall around its entire circumference. Ferries serve Island Beach throughout the summer.
    - Byram Park (Greenwich)
    - Grass Island (Greenwich)
    - Southfield Park (Stamford)
    - Kosciuszko Park (Stamford)
    - Cummings Park (Stamford)
    - Cove Island Park (Stamford)

[53]Figures SHR-1 to SHR-5 are included as an annex at the end of this report.

- Czecsik Park (Stamford)[54]
- West Beach (Stamford)
- Pear Tree Point Beach (Darien)
- Bayley Beach (Norwalk)
- Village Creek Open Space (Norwalk)
- Veterans Memorial Park (Norwalk)
- Westport Longshore Club Park (Norwalk)
- Compo Beach and Yacht Club (Norwalk)

2. *Change private clubs in Greenwich from blue to red* (protection likely). The planners commented that members of private beach, yacht, and golf clubs will probably likely seek to protect these properties from inundation. Properties affected by this map change include the following see #2 on Figure SHR-1):
    - Hawthorne Beach (Greenwich)
    - Belle Haven Yacht Club (Greenwich)
    - Milbrook Country Club (Greenwich)
    - Riverside Yacht Club (Greenwich)
    - Yacht Haven Marina (Stamford)
    - Stamford Yacht Club (Stamford)
    - Woodway Beach Club (Stamford)
    - Soundview Association Beach (Stamford)
    - Weed Beach (Darien)[55]
    - Tokeneke Beach Club (Norwalk)
    - Wee Burn Beach (Norwalk)
    - Roton Point Club (Norwalk)
    - Shore and Country Club (Norwalk)
    - Cove Marina (Norwalk)
    - Ascension Beach (Norwalk)
    - Shorehaven Country Club (Norwalk)
    - Cedar Point Yacht Club (Westport)
    - Saugatuck Harbor Yacht Club (Westport)

3. *Change residential areas in the town of Darien from blue to brown* (protection almost certain). The planners remarked that low density residential areas throughout the South Western Region, with the exception of the most vulnerable areas as identified in the FEMA Disaster Mitigation Study, are almost certain to be protected. Based on this comment, the staff recommended we change the following residential areas from blue to brown see #3 on Figure SHR-1):
    - Noroton Neck and Long Neck, as well as inland areas in Darien

[54] Robert Stein, the Land Use Bureau Chief for the City of Stamford, indicated in an email on November 18, 2005, to Andrew Hickok at Industrial Economics, Inc. that Czecsik Park and West Beach are likely to be protected from sea level rise. These two parks form a barrier between the peninsula of Shippan Point and the city.

[55] Weed Beach is a municipal park, though it appeared as blue (protection unlikely) on the original draft map.

- South Norwalk near Wilson Point
- East Norwalk near Sasqua Hill
- East Westport in the Green Farms area

4. *Add small off-shore islands to the map as lands unlikely to be protected*. Planners noted that the draft maps did not display several small islands off the coast of the South Western Region (see #4 on Figure SHR-1).

5. *Change areas inland of Route 1 or Interstate 95 to brown*. Planners commented that high property values and the importance of this transportation infrastructure would make protection of these areas almost certain (see #5 on Figure SHR-1).

Areas that are Correctly Depicted. The SWRPA staff noted that shorefront lands in the Harborview area of Norwalk and the Saugutuck Shores area in Westport are the areas in the Region most vulnerable to the effects of sea level rise. On further review, planning staff in Westport indicated that protection in these two areas is almost certain for three reasons: 1) the value of property is very high, 2) there has been a great deal of investment in the area with many new constructions and renovations, and 3) the town of Westport is in the process of designing a plan to extend the sanitary sewer to Saugutuck Shores.[56] Therefore, these areas continue to be shown as brown (see #6 on Figure SHR-1).

General Data Changes based on Stakeholder Review Comments

Several areas in the South Western Region were initially shown as blue on the stakeholder review maps, but changed to brown when we modified our general statewide assumptions. These were primarily lands along a narrow stretch of shoreline that were designated as either Preservation Areas or Conservation Areas in the state Conservation and Development Plan.[57] Given concerns that some of these lands that were changed to brown may not be developed and therefore may be less likely to be protected, we reviewed high resolution satellite imagery to identify lands that are not currently developed or have armoring structures. Based on this analysis we changed the following lands, which lie adjacent to highly developed areas, from brown to red, which was consistent with the edits we made during stakeholder review.

- Land along Byram Harbor in Greenwich (see #7 on Figure SHR-1)
- Lands along Greenwich Harbor in Greenwich (see #8 on Figure SHR-1)
- Unarmored shoreline along east coast of Shippan Point in Stamford (see #9 on Figure SHR-1)
- Calf Pasture Beach in Norwalk (see #10 on Figure SHR-1).

[56]SWRPA Executive Director Robert Wilson elicited email comment from Michelle Frye, planning assistant for Westport, on November 28, 2005.

[57]As noted in the discussion of changes in the statewide assumptions, these two designations in the Conservation and Development Plan dataset indicate general types of land use, but do not provide specific information about properties, such as ownership or land use type.

Planning Judgments

Table 8 summarizes the data used to implement these planning judgments.[58]

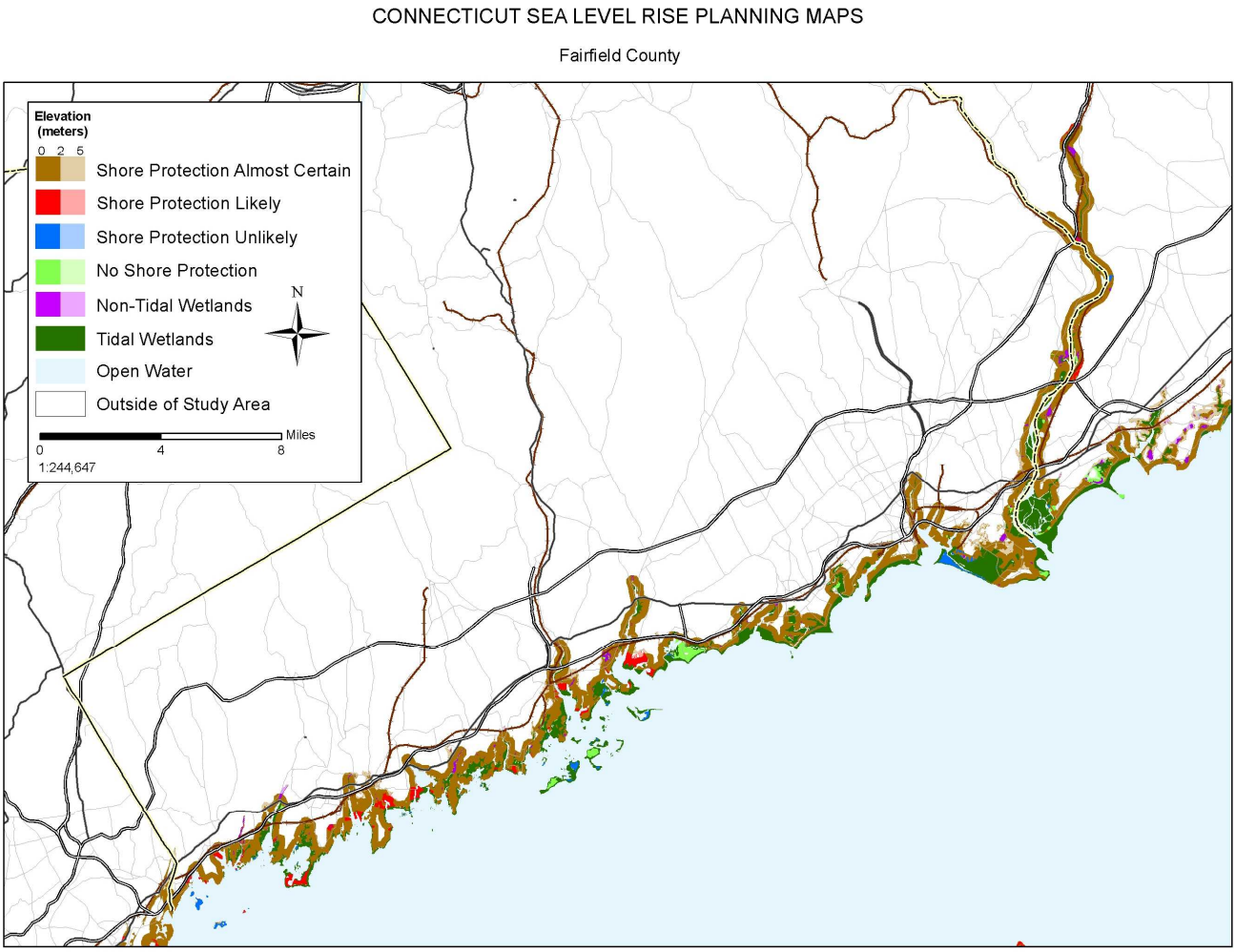
Table 8

GIS Data Employed to Map for South Western, Greater Bridgeport, Valley, and South Central Regions

Land Area Type	Protection Status	Source
Stakeholder review changes	As Specified	See text
Refuges, WMAs, Preserves	No Protection	State-owned lands, federally owned lands
Private Conservation Lands, Preserves, Refuges, and Open Space	No Protection	Municipal and Private Open Space
Town Open Space and Easements	Unlikely	
Developed Lands	Almost Certain	1995 Land Use Land Cover, 2002 Land Cover
Neighborhood Conservation Area, Rural Community Center, and Regional Center	Almost Certain	Development Priority Areas
Growth Areas	Likely	
Undeveloped or open lands	Unlikely	1995 Land Use Land Cover
Note: Where land areas overlap, classifications higher in the table take precedence.		

Map 2 of Fairfield County shows study results for the South Western Region

[58]The planning assumptions were the same across the South Western Greater Bridgeport, and Valley regions, although map changes requested by stakeholders varied.



Map 2: Fairfield County: Likelihood of Shore Protection. The darker shades represent land that is either within 2 meters above spring high water or within 300 meters of the shoreline.

GREATER BRIDGEPORT

Regional Policies

We initially contacted the staff of the Greater Bridgeport Regional Planning Agency (GBRPA) in February 2003 to explain the study and collect their thoughts concerning trends and policies that might have a bearing on the region's ultimate response to sea level rise.[59] We briefly describe what we learned.

The Greater Bridgeport Planning Region, as its name suggests, is dominated by the city of Bridgeport, the most populous city in the state. The region consists of six municipalities: Bridgeport, Easton, Fairfield, Monroe, Stratford, and Trumbull. With nearly 300,000 residents, the region is also one of the most populated in the state. Highly developed for commercial and industrial land uses along the coast, at least 52 percent of GBRPA lands are used for residential purposes, which are primarily single-family homes.[60]

The region's three largest communities, Stratford, Bridgeport, and Fairfield, are coastal, and are cut by I-95, the Merritt Parkway, and Route 1, the main thoroughfares through the region. Bridgeport sits at the mouth of the Paquonnock River, and the large downtown is developed primarily for commercial and industrial uses. The Port of Bridgeport serves Connecticut and Massachusetts markets with petroleum, lumber, metal, and tropical fruit trades. Bridgeport maintains its role as the industrial and commercial center of the region, though many industries have declined in recent years. After reaching a peak population of 160,000 in 1950, Bridgeport's population fell to 139,529 in 2000.[61] Recently, some redevelopment of declining urban manufacturing areas has occurred for residential or other uses. For example, the $19 million Harbor Yard Ballpark and Area at Harbor Yard was recently redeveloped by the City of Bridgeport for sporting events, concerts, and trade shows. Bridgeport's barrier spit, Pleasure Beach, is accessed by boat or through Stratford and discussions are ongoing about whether to allow rebuilding of the cottage homes in that area.

Stratford serves as a regional subcenter and is home to the region's largest employer, Sikorsky, a military helicopter manufacturer. The city is highly developed along the ocean coast, Housatonic River, and inland. Stratford's Short Beach and Long Beach are popular summer attractions. Fairfield is slightly larger than Stratford in population (53,890 in 2000), but is more dominated by dense residential development and small commercial centers. Coastal areas in Fairfield are in demand for high-end residential use, and coastal land uses include many small marinas as well as the Fairfield County Club. Easton, Monroe, and Trumbull (the inland, northern towns) are predominantly residential and hold most of the region's undeveloped land and open space.

[59]Leslie Katz Genova interviewed staff planner Pat Hare by phone on May 27, 2003.

[60]Cited in Greater Bridgeport Regional Profile, March 2003.

[61]Ibid.

Stakeholder Review

We sent the draft report and draft maps to the Greater Bridgeport Regional Planning Agency, and then arranged a conference call with planning staff.[62] We initially explained the purpose of the study and then outlined the guidelines for stakeholder review. We were interested in soliciting feedback on the map to ensure that we accurately captured trends in development and conservation. During the conference call, we marked up the map based on the planners' comments. Figure SHR-2 shows the changes made to the stakeholder review map.

Summary of Map Comments

The map changes in the Greater Bridgeport Region are as follows:

1. *Change private shoreline properties in Fairfield to brown* (protection almost certain). GBRPA contacted the city of Fairfield about this study. City planning staff commented that the Country Club of Fairfield, as well as other private ocean-fronting properties will almost certainly be protected by the city or property owners. Based on this comment, the following properties should be changed from blue to brown (see #1 on Figure SHR-2).

    - Country Club of Fairfield
    - Par 3 Golf Course
    - Fairfield Beach Club

2. *Change public shoreline properties in Fairfield to red* (protection likely). The planner for the City of Fairfield noted that these areas are likely to be armored in the future. Ocean-fronting properties affected by this map change include: Jennings Beach, Penfield Beach, and Capozzi Park (see #2 on Figure SHR-2).

3. *Change inland areas of Fairfield to brown*. Based on the city's commitment to shoreline protection, inland areas of Fairfield not bordering wetlands or waterways should be depicted as almost certain to be protected. We define "inland" as areas completely surrounded by brown or lands in Fairfield located on the north side of Route 1 and I-95. (see #3 on Figure SHR-2).

4. *Change the municipal park in Bridgeport from light green to brown*. According to the planner, portions of the area shown as light green on the map in the Seaside Park area are actually part of the University of Bridgeport campus. Additionally, the planner noted that the city is committed to protecting Seaside Park as a public recreation area (protection almost certain) (see #4 on Figure SHR-2).

[62] Andrew Hickok and Daniel Hudgens spoke with James Wang, Executive Director on June 29, 2005. Before the phone call, Mr. Wang received both paper and electronic versions of the draft sea level rise response maps.

5. *Change the southern tip of Seaside Park from light green to blue*. The city is unlikely to armor near the lighthouse at the southern tip of Seaside Park; however, given some uncertainty, the planners suggested showing this area as protection unlikely rather than as no protection (see #5 on Figure SHR-2).

6. *Change the entire Bridgeport barrier spit (including the portion in Stratford) from light green and brown to red* (protection likely). The state and city of Bridgeport seek to provide public access to this land, though construction of a bridge is not certain[63] (see #6 on Figure SHR-2).

7. *Change beaches in Stratford from light green to brown*. The planner indicated that Lordship Beach Park and Short Beach are adjacent to a densely populated residential area and are considered to be valuable recreational assets that would almost certainly be protected[64] (see #7 on Figure SHR-2).

8. *Change portion of Short Beach from light green to red*. The planner noted that the portion of Short Beach Park on the seaward side of wetlands is less than certain to be protected (see #8 on Figure SHR-2).

9. *Change golf club lands in Stratford from blue to brown*. The planner indicated that Mill River Country Club, which is adjacent to the Housatonic River, is almost certain to be protected by its members from future inundation (see #9 on Figure SHR-2).

[63]The State General Assembly is currently in the process of trying to approve funding to reestablish a public access road to Pleasure Beach on Bridgeport's barrier spit. Although Bridgeport would like to reestablish access to this public recreation area, Stratford opposes filling of wetlands to build a bridge. Currently, there is no way to travel to the barrier spit by car. Access to Pleasure Beach would also be possible through Stratford, though this alternative is unlikely to be seriously considered. The new bridge, which would likely cost at least $30 million to build, would connect the city to the northwest tip of the spit in the location of the former bridge. Since the General Assembly is likely to approve only $14 million for the project, funding is a major obstacle to its construction. The cities are considering ferry service to Pleasure Beach. Currently, several older cottages exist in the area shown as brown on the barrier spit. Some of the owners still use these cottages, though these are not accessible by road. The cottages were built on public land and have little value. While Bridgeport and Stratford disagree on the issue of the bridge, neither city is interested in developing the area for residential use. The planner notes that it might not be politically feasible to protect Pleasure Beach.

[64]The Lordship Peninsula in Stratford, much of which is 10–15 feet above sea level, is at high risk of inundation and flooding from severe storms. The planner indicated that waterfront areas on the peninsula have been developed in recent years. Currently no armoring structures exist on Lordship Beach or Short Beach. The planner also noted that the Stratford Zoning Commission currently discourages structural modification to properties and does not permit shoreline armoring.

The change in general statewide assumptions based on stakeholder review comments did not result in any changes within Greater Bridgeport.

Planning Judgments

Table 8 summarizes the data used to implement these planning judgments.

The Greater Bridgeport Region results are included in Map 2 of Fairfield County.

VALLEY REGION

Regional Policies

We did not contact staff from this agency during the initial stage of this study At the time we did not realize that the Valley Region was located within the Coastal Area defined by the Department of Environmental Protection.[65] Before the stakeholder review, we developed the Valley Region map using the general statewide assumptions applied to the other coastal regions.

The 58.5 square-mile Valley Region encompasses four towns, three of which border tidally affected portions of the Housatonic River (Ansonia, Derby, and Shelton). The Census measured a 5 percent increase in the region's population between 1990 and 2000, where it stood at 84,500. The South Western Regional Planning Area's Congestion Mitigation Study provides information on land use trends in the Valley Region:

> The Valley Region generally encompasses a former manufacturing region that is undergoing very gradual transition to more suburban residential land use with associated regional retail activity. Older industrial areas are concentrated in Ansonia and Derby. Open spaces and rural areas are scattered throughout the northwestern side of Shelton and eastern and western edges of Seymour. There are no urban centers, although the downtowns in Ansonia and Derby form a regional subcenter…. For the Valley Region as a whole, most residential use occurs in broad areas of low density, single-family homes.[66]

Stakeholder Review

We sent the draft report and draft maps to the Valley Council of Governments, and then arranged a conference call with planning staff.[67] We initially explained the purpose of the study and then outlined the guidelines for stakeholder review. We were interested in soliciting feedback on the map to ensure that we accurately captured trends in development and conservation. During the conference call, we marked up the map based on the planner's comments. Figure SHR-3 shows the changes made to the draft map.

[65]The state Coastal Area is the boundary within which activities and actions conducted by federal agencies and state agencies (i.e., DEP regulatory programs, and state plans and actions) must be consistent with all of the applicable standards and criteria contained in the Connecticut Coastal Management Act.

[66]Cited in SWRPA's January 2002 report, "Vision 2020 Congestion Mitigation Study", on page 2-5 of the Existing Conditions Technical Memorandum.

[67]Andrew Hickok and Daniel Hudgens spoke with David Elder, staff planner, July 5, 2005. The planner had worked in the region for less than one year, before which he was a graduate student at Central Connecticut State University, where he contributed to the development of the 2005–2010 state Conservation and Development GIS data.

Planner's General Comments

The planner was not aware of any recent efforts to armor the shoreline in the Valley Region. He pointed out that dikes had recently been constructed in Ansonia, a town on the northern border of Derby, to prepare for a greenway trail to run along the Naugatuck River.

Summary of Map Comments

The planner recommended the following modification to the Valley Region map[68]:

1. *Change currently developed lands in Shelton from red to brown* (protection almost certain). A large portion of land in the town of Shelton is classified as a Growth Area in the 2005–2010 state Conservation and Development Policies Plan. This area is zoned as residential and commercial land and is already considered part of the downtown area. Properties on this piece of land are developed and the owners all contribute taxes to the town (see #1 on Figure SHR-3).

2. *Change the brownfield site in Derby from blue to red*. The former industrial site at the confluence of the Housatonic and Naugatuck rivers is being redeveloped. A portion of this site will be set aside as a greenway. Given the likelihood of future development for the remaining portion, however, we should depict this area as likely to be protected (see #2 on Figure SHR-3).

Other comments: Dams along the Housatonic and Naugatuck rivers mark the tidal boundaries. Lands upriver of these points should be considered outside the study area. A 15.4-acre island on the Housatonic River in Shelton is a valuable residential property (approximately $900,000) on which four buildings are situated. The planner commented that this land was accurately shown as shoreline protection almost certain (brown) on the map. The change in general statewide assumptions based on stakeholder review comments did not result in any changes within the Valley Region.

Planning Judgments

Table 8 summarizes the data used to implement these planning judgments.

Map 2 includes our results for the Valley Region.

[68] The planner made several other map comments about lands located outside of the study area. We have not included these notes in the report.

SOUTH CENTRAL REGION

Regional Policies

We initially contacted the staff of the South Central Regional Council of Governments (SCRCOG) in February 2003 to explain the study and collect their thoughts concerning trends and policies that might have a bearing on the region's ultimate response to sea level rise.[69] We briefly describe what we learned from our research.

The South Central Region of Connecticut consists of 15 towns, 8 of which border Long Island Sound. The South Western Regional Planning Area's Congestion Mitigation Study provides information on land use trends in the South Central Region:

> Open space, rural lands, and very low-density residential uses are concentrated in the eastern and western edges of the region in Bethany, Guilford, and Madison. The two easternmost coastal towns, Guilford and Madison, are relatively undeveloped compared to the western coastal areas, which include New Haven and its inner suburbs. The suburban corridor between Meriden and New Haven and the coastline of the region have a mix of typical suburban uses including some regional malls and large areas of single-family residential use. New Haven is the region's urban center with a mix of older manufacturing sites, office and institutional uses downtown (including Yale University and Yale/New Haven Hospital), cultural attractions, and dispersed neighborhood commercial uses amongst high-density residential areas. Areas of concentrated commercial and industrial activity also occur in Meriden, Wallingford, and along major highway and arterial roadway corridors, including Interstate 95, which runs along the coastline.[70]

This same report also describes demographic trends in the region:

> The South Central Region had a three percent overall drop in population between 1990 and 2000, from 536,853 to 521,282. While nine of the region's 15 municipalities had some growth, the urban center and regional subcenters all experienced population declines. New Haven's population fell by five percent. West Haven had a three percent population loss. Meriden and Wallingford each had a two percent population decline. As in all of Southern Connecticut, population and housing density remain concentrated along the Connecticut coastline.[71]

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[69] Casey Roberts contacted staff planner Herbert Burstein by phone in February 2003. SCRCOG participated in this study by providing planning documents to Industrial Economics and by initiating the involvement of the region's coastal municipalities. We did not however, receive any comments from the municipalities that necessitated editing the report or the maps.

[70] Cited in SWRPA's January 2002 report, "Vision 2020 Congestion Mitigation Study", on page 2-5 of the Existing Conditions Technical Memorandum.

[71] Ibid., page 3-3.

South Central Connecticut is experiencing a sprawling pattern of growth similar to that in eastern coastal Connecticut. Population growth in the outer suburbs of the South Central Region has outpaced growth in the inner suburbs and city centers for the past 30 years.[72] About one-quarter of the region's housing is relatively low density—fewer than 1,000 persons per square mile.[73] As suburban areas grow, basic transportation, water, and sewer systems are being strained, and the region's remaining open space is under pressure for development. Regional Water Authority holdings (36 square miles) comprise 40 percent of the region's open space.[74] Overall, about one-eighth of the region's open space is not permanent, and could be sold or developed at any time.[75] The state is in the process of acquiring permanent open space for several areas along the coast, including Silver Sands State Park in Milford and New Haven's east shore park system.[76] Hammonassett Beach State Park in Madison is Connecticut's largest public beach park. In addition to preserving open space, the region is focused on restoring waterfront and harbor areas, both in recognition of their maritime historic value and to provide opportunities for development and economic growth in these areas.[77]

Stakeholder Review

We sent the draft report and draft maps to the SCRCOG, and then visited planning staff in their offices.[78] We initially explained the purpose of the study and then outlined the guidelines for stakeholder review. We were interested in soliciting feedback on the map to ensure that we accurately captured trends in development and conservation. While we conducted the interview, we marked up the map based on the planners' comments. Figure SHR-4 shows the changes made to the draft map after stakeholder review.

Summary of Map Comments

The map changes in the South Central Region are as follows:

1. *Change areas along the east bank of Housatonic River and west of Highway 121 in the town of Orange to brown*. This area is being rapidly developed, which satellite imagery available on Google confirms. The planner also indicated that the adjacent Great River

[72] Cited in SCRCOG's 2000 report, "Vision for the Future: Regional Plan of Development", on page 2.

[73] Ibid.

[74] Ibid., page 10.

[75] Ibid., page 11.

[76] Ibid., page 10.

[77] Ibid., page 16.

[78] Andrew Hickok and Daniel Hudgens met with Emmeline Harrigan, SCRCOG planner, on June 16, 2005, at the SCRCOG Offices in North Haven.

Golf Course in Milford was also certain to be protected from inundation. The planning staff suggested we change this area to shore protection almost certain (originally shown as blue and red) (see #1 on Figure SHR-4).

2. *Change area on the New Haven–North Haven border west of Lake Saltonstall from red to brown*. Though this land is designated as a Growth Area in the Conservation and Development Policies Plan, much of it is already developed. Additionally, this area is surrounded almost entirely by brown areas (see #2 on Figure SHR-4).

3. *The County suggested we add more recent land cover data to depict recent development as protection almost certain on the maps*. As a result, we incorporated the CLEAR (Center for Land Use Education and Research) Land Cover dataset, which is based on 2002 LANDSAT imagery.

Summary of Changes Based On Modified Statewide Assumptions

Following the same general rule we have applied in this study for other states, we assume that all areas in the South Central Region that not brown, are located inland from the shore (i.e., not abutting coastal waterways or tidally affected wetlands), and are surrounded by lands where protection is almost certain are also almost certain to be protected. These lands would inherently be protected by efforts to protect the surrounding lands.

Several areas in the South Central Region were initially shown as blue on the stakeholder review maps, but changed to brown when we modified our general statewide assumptions (see the discussion above). These were primarily lands along a narrow stretch of shoreline that were designated as either Preservation Areas or Conservation Areas in the state Conservation and Development Plan.[79] Given concerns that some of these lands that were changed to brown may not be developed and therefore may be less likely to be protected, we reviewed high resolution satellite imagery to identify lands that are not currently developed or have armoring structures. Based on this analysis we changed the following lands, which are undeveloped and lie adjacent to highly developed lands, from brown to red.

- The spit of land at the entrance to New Haven Harbor in West Haven currently lacks any armoring structures and is not immediately adjacent to residential or commercial areas (see #3 on Figure SHR-4).

- A strip of land along the ocean side of Sea View Avenue in Madison does not contain buildings and is not currently structurally armored. The shoreline could potentially retreat in this area (see #4 on Figure SHR-4).

[79]As noted in the discussion of changes in the statewide assumptions, these two designations in the Conservation and Development dataset indicate general types of land use, but do not provide specific information about properties, such as ownership or land use type.

We also changed the following lands, which are undeveloped and are not adjacent to highly developed lands, from brown to blue.

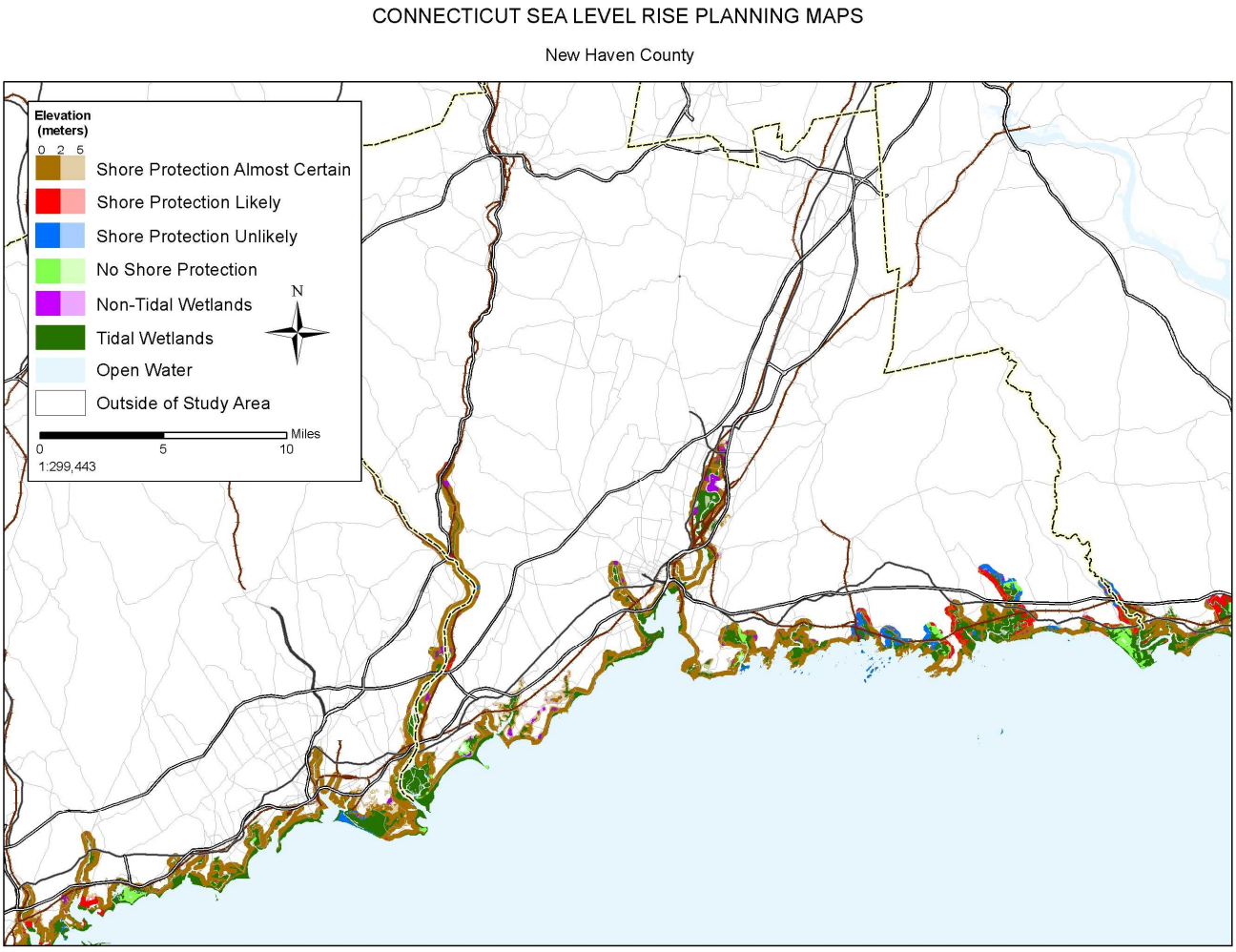
- An island immediately off the coast in Branford near the mouth of the East Haven River lacks roads and structures (see #5 on Figure SHR-4).

- An area near Jacobs Beach in Guilford is marshy, lacks structures, and is not adjacent to any development (see #6 on Figure SHR-4).

Planning Judgments

Table 8 summarizes the data used to implement these planning judgments.

Map 3 of New Haven County shows study results for the South Central Region



Map 3: New Haven County: Likelihood of Shore Protection. The darker shades represent land that is either within 2 meters above spring high water or within 300 meters of the shoreline.

CONNECTICUT RIVER ESTUARY

Regional Policies

We visited the staff of the Connecticut River Estuary Regional Planning Agency (CRERPA) to explain the study and collect their thoughts concerning trends and policies that might have a bearing on the region's ultimate response to sea level rise.[80] We briefly describe what we learned.

The CRERPA area occupies 177 square miles, centered on the Connecticut River. Because the river is tidal from its southern mouth north to the Massachusetts border, the area of the region designated as coastal is large relative to its ocean coast area. The region experienced a nearly 10 percent increase in its population during the 1980s, though this has slowed recently. As of 1990, 35 percent of the region's committed land area was open space.[81] Several towns in the region, including Clinton, Old Lyme, and Lyme, are particularly opposed to further development that would disrupt the natural and rural heritage of the community. Many towns are hesitant about economic growth because of the extra cost of municipal services and their desire to preserve the rural character of their towns. At the same time, because municipal budgets are drawn almost entirely from property taxes, some towns encourage economic development as a means to increase the local tax base.

Most of the developed land in the region is low-density residential, a growth pattern reinforced by health standards for septic systems that require setbacks from buildings. The lack of sewers discourages dense development and can create problems when a town grows larger than its septic systems can accommodate. For example, the Connecticut Department of Environmental Protection is concerned about groundwater contaminated with septic discharge in the rapidly growing town of Old Saybrook. Only the town of Deep River has on-site sewer and water treatment; the remainder of the region is supported by septic systems.

Low-density development has also resulted from developers' preferences for upscale, single-family homes. Most of the upscale residential development has occurred along the west bank of the Connecticut River and along the Long Island Sound coastline. Towns on the west side of the river, such as Deep River and Chester, have river embankments of 15–35 feet, in contrast with the eastern bank, which is of a lower elevation and contains several protected areas, including extensive tidal marsh holdings by the State of Connecticut. According to regional planners, very little land remains available for development along the Long Island Sound coastline, but growth continues along the Connecticut River as large plots of land are subdivided. Because the elevation rise along the coast is very gradual, towns built along Long Island Sound, including Old Saybrook, Westbrook, and Clinton, are likely to be more vulnerable to sea level rise than those built along the banks of the Lower Connecticut River, where the elevation increases

[80] Leslie Katz Genova met with Torrence Downs, staff planner for CRERPA on February 27, 2003, in Old Saybrook.

[81] Cited in CRERPA's 1995 Plan of Development, page 9.

steeply.[82] Local residents and landowners in Westbrook are already grappling with beach erosion that decreases the aesthetic value of their property and increases vulnerability to flooding during storms. For example, landowners on Chapman Beach have formed a beach association to investigate the causes of and potential solutions to the dramatic beach erosion they have experienced over the past 30 years. This organization has also expressed concern that structural modifications by adjacent beaches have contributed to the erosion on Chapman Beach. The development of this beach association and others suggests that policies toward structural armoring and beach nourishment are sometimes addressed on the sub-municipality level.

Stakeholder Review

We sent the draft report and draft maps to CRERPA, and then visited planning staff in their offices.[83] We initially explained the purpose of the study and then outlined the guidelines for stakeholder review. We were interested in soliciting feedback on the map to ensure that we accurately captured trends in development and conservation. During the meeting, we further marked up the map based on the planners' comments.

Planners' General Comments

A large effort to preserve open space is under way, although there is generally not enough money for lands to be purchased outright as conservation areas. One exception is Griswold Point, which is owned by The Nature Conservancy. Land trusts are very active, especially in the Lyme area.

The 2005–2010 Conservation and Development Policies Plan, which emphasizes preservation of rural areas and smart growth, has a significant role in directing development in the region. The map accurately shows areas surrounding the village centers as brown. The region is committed to focusing development to stay within the brown areas. The net density in outlying areas is unlikely to increase.

Towns within the Connecticut River Estuary Region follow the Connecticut Coastal Management Act and enforce the limitations on the construction of shoreline coastal structures. Where the shoreline is not currently hardened (or at least was not hardened in the past), it is unlikely to become so in the future. The DEP is restrictive in allowing structural modification; they tend to block new structures from being built. [84] For example, a permit for a swimming pool in the town of Fenwick was denied because it abutted wetlands. Currently, a Riparian Buffer

[82] Statement made by Torrence Downs, regional planner, to Leslie Katz Genova, February 27, 2003.

[83] Andrew Hickok and Daniel Hudgens met with Torrance Downs, planner; Margot Burns, GIS specialist; and Linda Krause, executive director, on June 16, 2005 at the CRERPA offices in North Haven.

[84] Refer to the section discussing the Connecticut Coastal Management Act.

Study of the Connecticut River is ongoing. Saybrook is mostly built out. Hamburg Cove is another area where development is likely. The area south of I-95 is fully developed.

The four towns in the Lyme area are examining alternatives to sewer systems. The town of Chester is planning to hook into the Deep River system. The service area will not extend beyond the town boundary currently shown in brown.

The rail corridor that passes through the region connects the historic commercial centers of the towns. I-95 was originally constructed to bypass more urban areas. The DOT has long-range plans to widen I-95. A railroad line owned by the DEP runs along the west side of the river and is currently used for tourist trains and the transportation of coal.

Summary of Map Comments

The map changes in the Connecticut River Estuary Region were as follows:

1. *Change commercially developed areas between Route 1 and I-95 in the towns of Westbrook and Old Saybrook from red to brown* (see #1 on Figure SHR-5).

2. *Change lands in Clinton south of I-95 from blue to red*. This area, which is currently mostly undeveloped, borders a designated Neighborhood Conservation Area, which is characterized by medium density commercial and residential land uses (see #2 on Figure SHR-5).

3. *Change golf course in Old Saybrook from blue to brown*. (see #3 on Figure SHR-5).

4. *Change the historic cemetery in Old Saybrook, which is included in our data, from light green to brown* (see #4 on Figure SHR-5).

5. *Change areas along west bank of the Connecticut River in the towns of Deep River and Essex from blue to brown*. Properties along the river tend to be either 1–2 acre parcels or larger properties that could be subdivided. The map should show areas along the river as "pockmarked" red and brown areas (protection almost certain and protection likely) because of the rapid pace of development. The staff provided a paper map showing dock usage in parcels along the banks of the Connecticut River. Although the 1995 land use data show these areas as undeveloped, planners indicate that these areas are mostly developed, in low-density land use patterns (see #5 on Figure SHR-5).

6. *Change sewer treatment plant along Connecticut River in the town of Deep River from blue to brown* (see #6 on Figure SHR-5).

7. *Change several polygons seaward of State Highway 156 in Old Lyme to brown*. These areas, which were shown as either blue or brown on the initial map, are currently developed (see #7 on Figure SHR-5).

8. *The County suggested we add more recent land cover data to depict recent development as protection almost certain*. As a result, we incorporated the CLEAR (Center for Land

Use Education and Research) Land Cover dataset, which is based on 2002 LANDSAT imagery.

9. *Remove CRERPA Open Space layer from analysis*. This dataset, which IEc used in the map, was never verified or ground-truthed. The statewide Municipal and Private Open Space Property data should sufficiently show open space lands in the Connecticut River Estuary Region.

Summary of Changes Based on Modified Statewide Assumptions

Following the same general rule we applied in this study for other states, we assume that all areas in the Connecticut River Estuary Region that are not brown, that are inland from the shore (i.e., not abutting coastal waterways or tidally affected wetlands), and that are surrounded by lands where protection is almost certain are also almost certain to be protected. These lands would inherently be protected by efforts to protect the surrounding lands.

Several areas in the Connecticut River Estuary Region were initially shown as blue on the stakeholder review maps, but changed to brown when we modified our general statewide assumptions (see the discussion above). These were primarily lands along a narrow stretch of shoreline that were designated as either Preservation Areas or Conservation Areas in the state Conservation and Development Plan.[85] Given concerns that some of these lands that were changed to brown may not be developed and therefore may be less likely to be protected, we reviewed high resolution satellite imagery to identify lands that are not currently developed or have armoring structures. Based on this analysis we changed the following lands, which either contain structures or are adjacent to current development, from brown to red (protection uncertain).

- Cedar Island, a peninsula that extends from Hammonasset Beach State Park in Clinton into Clinton Harbor, has a few dozen seasonal homes on a sandy piece of land that has no road link to the mainland. Currently no armoring structures exist on Cedar Island (see #8 on Figure SHR-5).

- Land adjacent to a large marina in Clinton currently is marshy and contains no structures (see #9 on Figure SHR-5).

Additionally, we changed Menunketesuck Island, a narrow and uninhabited island off the coast of Westbrook, from brown to blue (protection unlikely) (see #10 on Figure SHR-5).

[85]As noted in the discussion of changes in the general statewide assumptions, these two designations in the Conservation and Development dataset indicate general types of land use, but do not provide specific information about properties, such as ownership or land use type.

Planning Judgments

Table 9 summarizes the data used to implement these planning judgments.

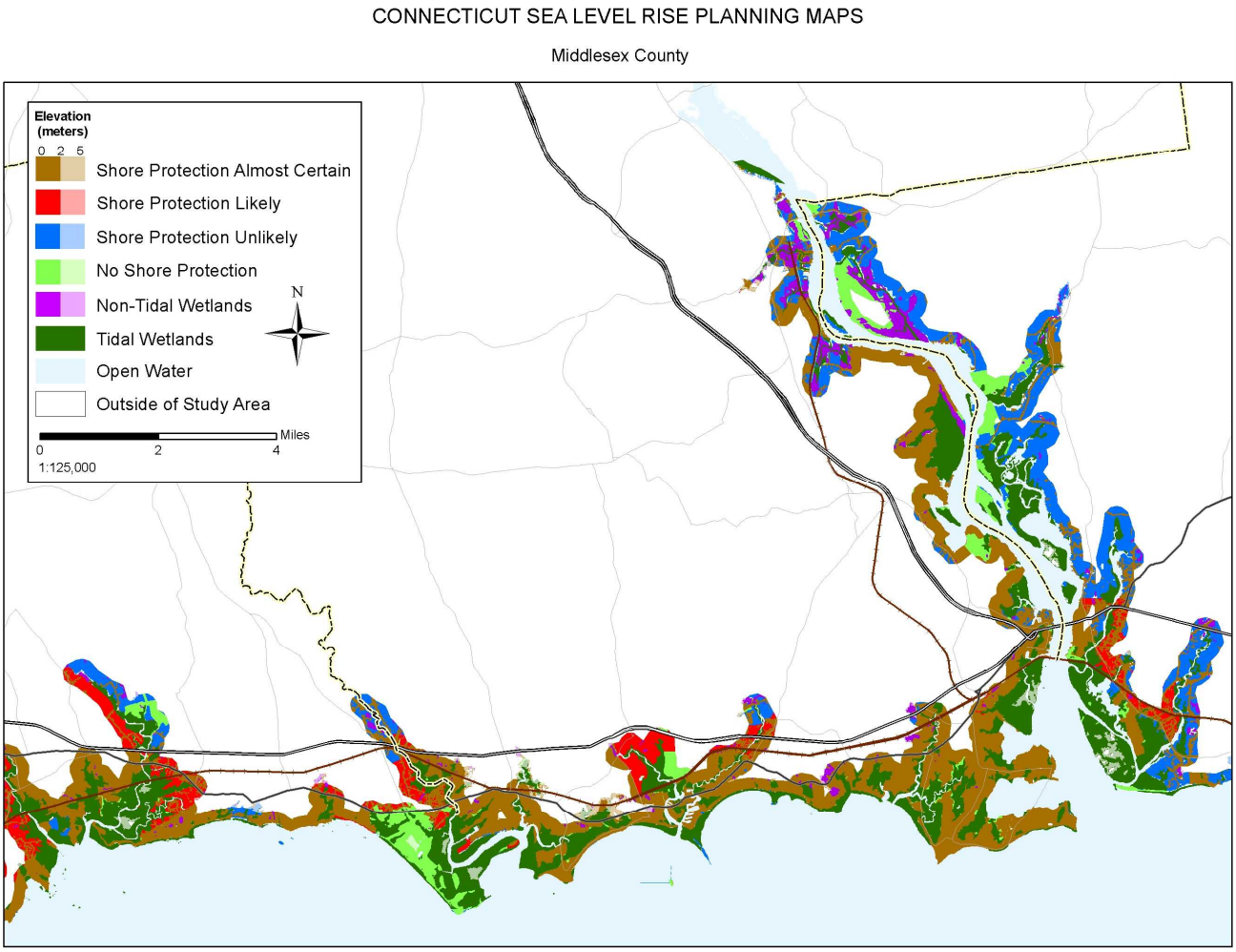
Table 9

GIS Data Employed to Map for Connecticut River Estuary Region

Land Area Type	Protection Status	Source
Stakeholder review changes	As Specified	See text
Refuges, WMAs, Preserves	No Protection	State-owned lands, federally owned lands
Private Conservation Lands, Preserves, Refuges, and Open Space	No Protection	Municipal and Private Open Space
Town Open Space and Easements	Unlikely	
Conn. River Estuary Region: Lands served by sewers	Almost Certain	Sewer Service Areas; planner input from initial study
Developed Lands	Almost Certain	1995 Land Use Land Cover, 2002 Land Cover
Neighborhood Conservation Area, Rural Community Center, and Regional Center	Almost Certain	Development Priority Areas
Growth Areas	Likely	
Undeveloped or open lands	Unlikely	1995 Land Use Land Cover

Note: Where land areas overlap, classifications higher in the table take precedence.

Maps 4 and 5 show study results for the portions of the Connecticut River Estuary Region in Middlesex and New London Counties, respectively.



Map 4: Middlesex County: Likelihood of Shore Protection. The darker shades represent land that is either within 2 meters above spring high water or within 300 meters of the shoreline.

SOUTHEASTERN CONNECTICUT

Regional Policies

We first visited the staff of the Southeastern Connecticut Council of Governments (SCCOG) to explain the study and collect their thoughts concerning trends and policies that might have a bearing on the region's ultimate response to sea level rise.[86] We briefly describe what we learned.

[86] Leslie Katz Genova met with Richard Serra, staff planner for SCCOG, on February 27, 2003 in Norwich. Subsequently, she and Casey Roberts corresponded with Richard Serra and Planning Director Dick Guggenheim by phone and email between May 6, 2003, and June 2, 2004.

The SCCOG's Planning Region comprises roughly 560 square miles and 18 towns, stretching along the Long Island Sound coastline from the Rhode Island border to East Lyme. The region contains both the Thames and Niantic rivers and numerous bays, inlets, and populated islands. In contrast with the western parts of the state, southeastern Connecticut remains largely undeveloped. In 2000, forests, wetlands, and water bodies constituted 55.5 percent of the regional land area, and urban areas only 11.3 percent.[87] Agricultural and recreational lands and committed open space accounted for another 19.5 percent of the land area.[88] Since 1990, when 61 percent of the regional land area was undeveloped, about 1 percent of the region has been developed every two years.[89]

The SCCOG region has seen substantial growth in low-density residential development since 1990. Rural communities that cover large areas of open land in proximity to I-95, such as Lisbon, are experiencing major residential and commercial growth while urban centers like Norwich and New London are not growing at all. Until recently, the region received large amounts of defense funding for submarine manufacturing at Electric Boat, located in Groton. With the end of the Cold War, the demand for submarines has decreased, and gaming, tourism, and pharmaceuticals have become the principal employers in the region. The very large Foxwoods Casino is located roughly 6 miles from the Thames River, and the slightly smaller Mohegan Sun gaming facility is closer to the river. The 115 square miles of Southeastern Connecticut that are intensely developed are primarily concentrated along the Long Island Sound coastline and the Thames River. Several of these areas, including Mason's Island in Stonington, Waterford, and Groton, have very high property values. The population with homes immediately along the coast is far wealthier than the population of the region living farther inland from the shore.[90]

The absence of public water and sewer systems is a major factor in the dispersed development patterns seen in the region. East of the Thames River, only Pawcatuck (Stonington), Groton, and Mystic have sewage treatment facilities. Several municipalities west of the Thames, including New London, Montville, and Griswold, are also served by sewer, but on-site subsurface septic systems remain the primary disposal system in the region. On Black Point in East Lyme and Mason's Island in Stonington, where traditionally seasonal residences are now being occupied year-round, septic systems are becoming overwhelmed more often than before.

As in the Connecticut River Estuary Region, septic systems that serve most of the low-density, seasonal residences on the coast discourage further development. Thus, the presence of sewers and water systems can serve as a predictor of growth patterns in rural and suburban areas along the coast; where sewers are built, development follows.

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[87] Cited in report titled Land Use—2000 Southeastern Connecticut Region, on page 2.

[88] Ibid.

[89] Ibid., page 13.

[90] Statement made by Chuck Boster, freelance planner, to Dan Hudgens and Andrew Hickok, June 16, 2005.

Although sewer construction is a local decision, it is sometimes opposed by residents who want to maintain the rural character of their communities. The lack of sewer systems was cited as a reason for the East Lyme Zoning Commission's denial of the application to build 894 housing units on the 220-acre Oswegatchie Hills area bordering the Niantic River and the Inner Niantic Bay. This June 2002 decision is under appeal by the development group who originally applied for the permit, and some local community groups are encouraging the DEP to purchase the area to prevent its development. This single development would result in a more than 12 percent increase in homes and population in the town of East Lyme. Some community interests, however, favor economic growth because of the associated increase in the property tax base. Once a municipality has constructed a sewage treatment facility and other development infrastructure, they will define outlying areas to which services are likely to be expanded in the future. These decisions can reveal the policy of a municipality toward growth. According to regional planners at SCCOG, the town of Montville may have plans to expand sewer lines as a means to spur development along the Route 32 corridor.[91]

Stakeholder Review

We sent the draft report and draft maps to the SCCOG, and then visited planning staff in their offices.[92] We initially explained the purpose of the study and then outlined the guidelines for stakeholder review. We were interested in soliciting feedback on the map to ensure that we accurately captured trends in development and conservation. Richard Serra provided a map that he had marked up before our meeting. During the meeting, we further marked up the map based on the planners' comments. Figure SHR-6 shows the changes made to the draft map after stakeholder review.

Summary of Map Comments

The map changes in the Southeastern Region were as follows:

1. *Change areas interior of the major roadways in East Lyme and Waterford to brown*. Development pressure, which is already significant, is likely to proceed in these areas over the long term. The two casinos, which employ about 10,000 people each, have been a large reason for the continued residential development patterns in the region. *Additional areas inland of Interstate 95 and Route 1 in Groton and Lyme were also changed to brown*[93] (see #1 on Figure SHR-6).

[91] Statement made by Richard Serra, SCCOG planner, to Leslie Katz Genova on February 27, 2003.

[92] Andrew Hickok and Daniel Hudgens met with Richard Serra, SCCOG planner, and Chuck Boster, freelance planner, on June 16, 2005, at the SCCOG offices in Norwich.

[93]Most of the interior areas described here are not visible beneath the elevation mask. Planners commented on the "Expanded Study Area" version of the map.

2. *Change Naval Submarine Base lands from brown to red*. This follows the general procedure in other states in which we have conducted this study to show military installations as shore protection likely.[94] The base, located on about 285 acres in Groton, was slated to be closed at the time of the stakeholder interview but has since been removed from this list. If the base were to be closed at some point in the future, the region would most likely seek to convert it to some water-based use. Although some retired bases in the Northeast have quickly been redeveloped for other uses, others have taken 20 or more years to be utilized. Environmental problems at the Groton site would most likely require significant remediation efforts. Given the long-term uncertainty of the site's use, the region suggested we continue to show these lands as protection uncertain (red) (see #2 on Figure SHR-6).

3. *Change areas in Pawcatuck from blue to red*. Given the uncertainty of future development in this area and the high property value of coastal lands, planning staff suggested we depict it as protection likely (see #3 on Figure SHR-6).

4. *The County suggested we add more recent land cover data to depict recent development as protection almost certain*. As a result, we incorporated the CLEAR (Center for Land Use Education and Research) Land Cover dataset, which is based on 2002 LANDSAT imagery.

<u>Areas that are Correctly Depicted.</u>

- The planners thought that land where the New London/Groton Airport exists did not appear on the map as shore protection almost certain (brown). We added a statewide data layer "Airports" to the map and found that the map had correctly shown the extent of runways and facilities (see #4 on Figure SHR-6).

- The Oswegatchie Hills area in East Lyme has not been developed. It is appearing more likely that this land will be put into preserve. Therefore, staff suggested we continue to depict this area as protection unlikely (blue).

- As the only residential area built on sand in the Southeastern Region, lands in Groton Long Point are most vulnerable to sea level rise. Given the existing development in this area and the high property value, staff suggested we leave this area as shore protection almost certain (brown).

- Land on the east bank of the Thames River in Preston might be purchased by the state to turn into low cost housing and is currently depicted on the map as shore protection likely. Given this uncertainty, staff suggested we continue to show this area as red.

- The small off-shore islands near Stonington are state-owned and uninhabited. These are currently shown as blue.

[94]Refer to section discussing of General Categorical Mapping Rules.

- Since most tidal wetlands are hemmed in by existing development, it is unlikely that any tidal wetlands in the Stonington area would remain if there were a rise in sea level of the magnitude of 3.5 feet or more (e.g., on Barnes Island).

Summary of Changes Based On Modified Statewide Assumptions

Following the same general rule we have applied in this study for other states, we assume that all non-brown areas in the Southeastern Region that are inland from the shore (i.e., not abutting coastal waterways or tidally affected wetlands) and that are surrounded by lands where protection is almost certain are also almost certain to be protected. These lands would inherently be protected by efforts to protect the surrounding lands.

The draft maps reviewed by SCCOG staff during stakeholder review in June 2005 erroneously depicted a 150-foot buffer along the rail corridor that parallels the Thames River as almost certain to be protected. Before this phase, Casey Roberts communicated by email with SCCOG Planning Director Dick Guggenheim on April 13, 2004. He indicated that railroads in the Southeastern Region are vulnerable to sea level rise and that the ability to protect this infrastructure is an open question. Given that we do not typically examine transportation infrastructure (e.g., roads and railroads) in this study and the uncertainty of protection identified by the regional planning director, we opted to remove the original railroad buffer.

Several areas in the Southeastern Region were initially shown as blue on the stakeholder review maps, but changed to brown when we modified our general statewide assumptions (see the discussion above). These were primarily lands along a narrow stretch of shoreline that were designated as either Preservation Areas or Conservation Areas in the state Conservation and Development Plan.[95] Given concerns that some of these lands that were changed to brown may not be developed and therefore may be less likely to be protected, we reviewed high resolution satellite imagery to identify lands that are not currently developed or have armoring structures. Based on this analysis we changed the following lands from brown to blue, consistent with our methodology of depicting undeveloped or town open space lands as blue:

- Sections of the shoreline in Waterford are sparsely developed and are currently unarmored (see #5 on Figure SHR-6).

- Lands on the ocean side of Old Black Point Road in East Lyme are marshy and undeveloped (see #6 on Figure SHR-6).

- Griswold Island in East Lyme does not contain any structures (see #7 on Figure SHR-6).

- The Connecticut College Arboretum and Natural Area is a privately protected conservation area (see #8 on Figure SHR-6).

[95]As noted in the discussion of changes in the statewide assumptions, these two designations in the Conservation and Development dataset indicate general types of land use, but do not provide specific information about properties, such as ownership or land use type.

Planning Judgments

Table 10 summarizes the data used to implement these planning judgments.

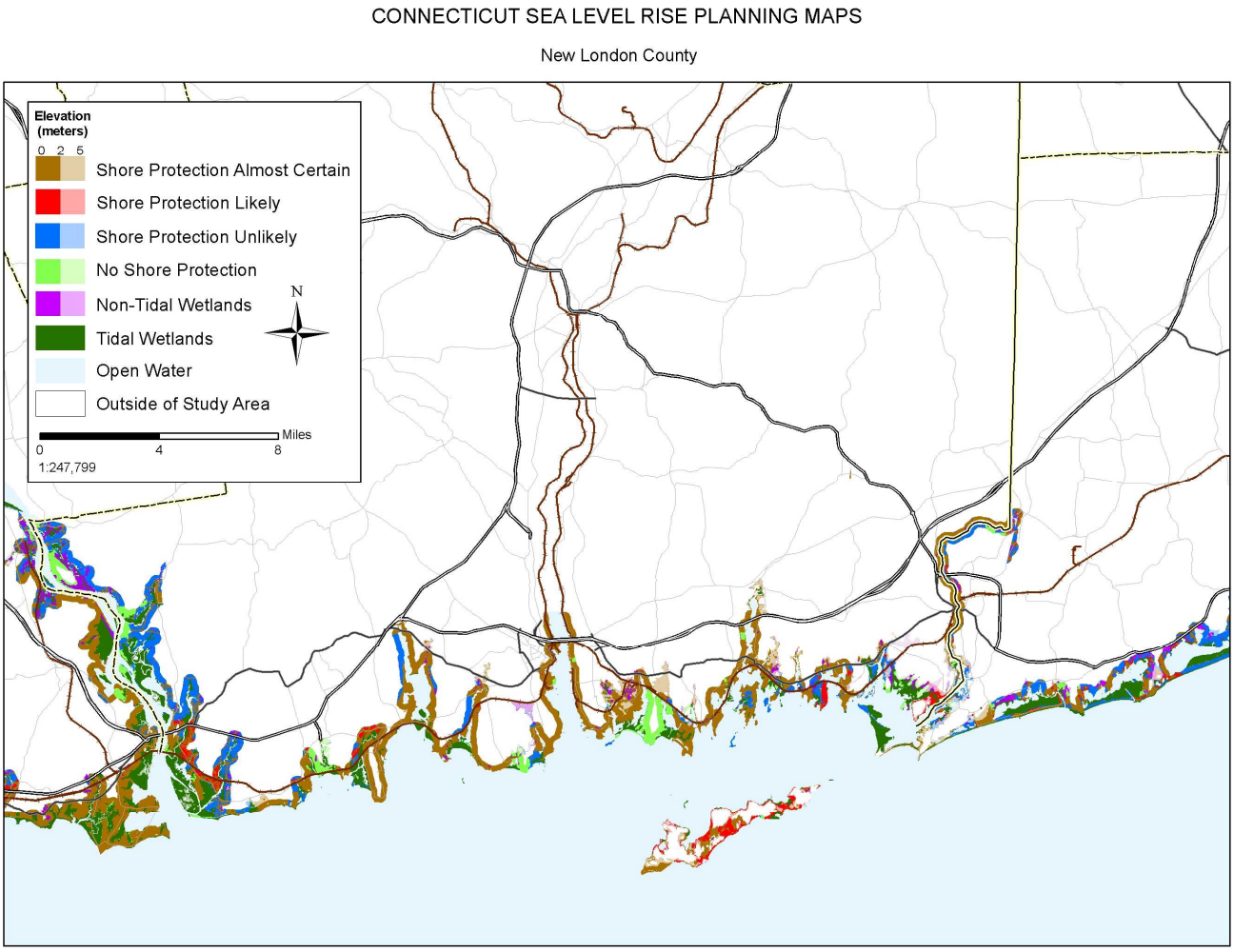
Table 10

GIS Data Employed to Map for Southeastern Region

Land Area Type	Protection Status	Source
Stakeholder Review Changes	As Specified	See text
Refuges, WMAs, Preserves	No Protection	State-owned lands, federally owned lands
Military Installations	Uncertain	Federal and Indian lands
Private Conservation Lands, Preserves, Refuges and Open Space	No Protection	Municipal and Private Open Space
Town Open Space and Easements	Unlikely	
Developed Lands	Almost Certain	2002 Land Cover, Land Use in SE Region, 1995 Land Use Land Cover
Neighborhood Conservation Area, Rural Community Center, and Regional Center	Almost Certain	Development Priority Areas
Growth Areas	Likely	
Undeveloped or open lands	Unlikely	1995 Land Use Land Cover, Land Use in SE Region

Note: Where land areas overlap, classifications higher in the table take precedence.

Map 5 of New London County shows study results for the Southeastern Region.



Map 5: New London County: Likelihood of Shore Protection. The darker shades represent land that is either within 2 meters above spring high water or within 300 meters of the shoreline.

APPENDIX

SUMMARY OF DATA SOURCES

This appendix describes data used to create the GIS-based maps accompanying this report. Data descriptions are organized by data source. Within each section we provide a brief summary of each layer obtained from that source. Summary information includes a description of how the data were developed, identifies the key elements of the data used in our analysis, and provides the date of publication.

Connecticut Department of environmental protection (Dep) environmental and geographic information center

1995 Land Use/Land Cover in Connecticut

Data organized in statewide layer identifying land use and land cover in Connecticut. Land use categories were identified using 30 meter by 30 meter satellite imagery collected in 1994 and 1995. Land uses were digitized into a vector format.

Key Data Elements: Each polygon is assigned a land use code according to a state-specific classification system. Exhibit A-1 lists the land use codes and descriptions used for these data.

Exhibit A-1

CONNECTICUT LAND USE CODES AND DESCRIPTIONS

Land Use Code	Description
1	Surface - Impervious
2	Residential/ Commercial - High Density
3	Residential - Medium Density
4	Surface - Roof
5	Road - Pavement
6	Turf/ Grass
7	Soil/Grass/Hay
8	Grass/Hay/Past
9	Soil/Corn
10	Grass/Corn
11	Soil/Tobacco
12	Grass/Tobacco
13	Forest - Deciduous
14	Forest - Coniferous
15	Water - Deep
16	Water - Shallow
17	Wetland - Non-forest
18	Wetland -Forest
19	Land -Barren
20	Soil -Bare
21	Marsh - Low Coast
22	Marsh - High Coast
25	Road -Major

Scale: 1:24,000; however, the data publisher recommends use at scale 1:50,000 or less.

Date of Publication: 1997.

State Owned Lands

The data consist of all lands owned and maintained by the Connecticut DEP. The DEP property information was originally compiled in 1994 by the Environmental and Geographic Information Center, DEP, using information from the Land Acquisition Division of DEP. The property boundaries were mapped on 7½ Minute U.S. Geological Survey topographic quadrangle maps and digitized at 1:24,000 scale.

Key Data Elements: Each parcel is identified according to the following DEP land use designations: state fish hatcheries, flood control areas, historic preserves, natural area preserves, state forests, state parks, state park scenic reserves, state park trails, state owned waterbody access, wildlife areas, and wildlife sanctuaries. Parcels are identified by their commonly used named and by more generalized land use designations. Parcel acreage is also included.

Scale: 1:24,000.

Date of Publication: 1994, updated in May 2002.

National Wetlands Inventory

These data are a reprojection of the U.S. Fish and Wildlife Service's (FWS) National Wetlands Inventory (NWI) data.

Key Data Elements: Each polygon is assigned a classification that identifies it according to the FWS hierarchical wetlands classification system. Connecticut's reprojection of the data stores these classification data in an "attribute" field. Wetlands are identified as tidal or nontidal based on the first two characters of the classification code. Tidal wetlands include those classification codes beginning with "M1" and "E2" and nontidal codes begin with "PS," "PF," "PE," "R1," "R2," "L2," and "PU" with the exception of any code that includes "OW", which indicates open water.

Scale: Ranges from 1:20,000 to 1:132,000.

Date of Publication: Ranges from February 1971 to December 1992.

Connecticut Hydrography

State developed data layer that includes all hydrography features in the state. We use this layer to depict wetlands throughout the state.

Key Data Elements: Each polygon is assigned a classification that identifies it according to water feature type. Wetlands are identified in the "Av_Legend" attribute field as "marsh". Other hydrography features

are classified as waterbodies, inundation areas, dams, aqueducts, canals, ditches, shorelines, tidal flats, shoals, rocks, channels, and islands.

Scale: 1:24,000.

Date of Publication: 1994, updated in 2005.

Town Boundaries

The data depict municipal boundaries within Connecticut.

Key Data Elements: The attribute field "Town" indicates the name of the municipality.

Scale: 1:24,000.

Date of Publication: 1994, updated in 2005.

Regional Planning Organizations

The data depict Regional Planning Organizations for Connecticut.

Key Data Elements: The attribute field "Plan_org" indicates the name of the Regional Planning Organization.

Scale: 1:125,000.

Date of Publication: 1994, updated in 2005.

CT DEP/ Bureau of Water Management

Sewer Service Areas

The data generally outline areas where sanitary waste water sewer service is provided in Connecticut.

Key Data Elements: The attribute field "Av_Legend" indicates whether a sewer service area is existent or proposed.

Scale: 1:24,000.

Date of Publication: 1985, updated in 1998.

CT DEP/ Office of Long Island Sound Programs

Coastal Area

The data show lands and waters of the state that lie within the Coastal Area. Activities and actions conducted by federal agencies and state agencies (i.e., DEP regulatory programs, and state plans and actions) within the Coastal Area must be consistent with all of the applicable standards and criteria contained in the Connecticut Coastal Management Act. The boundary of the Coastal Area is based on town boundaries from the Town Boundaries data layer.

Key Data Elements: All polygons in the data layer are within the Coastal Area.

Scale: 24,000.

Date of Publication: 1995.

CT DEP/ CT Office of Policy and Management (OPM)

Federally Owned Lands

The data identify lands uunder the jurisdiction of federal agencies such as the National Park Service, U.S. Fish and Wildlife Service, and U.S. Army Corps of Engineers. This layer includes holdings for the Appalachian Trail, National Wildlife Refuges, flood control areas, and Connecticut River Gateway Scenic Easements. This information was compiled in 1994 by the Environmental and Geographic Information Center, DEP using information from the federal agencies. The property boundaries were mapped on 7.5 minute U.S. Geological Survey topographic quadrangle maps and digitized at 1:24,000 scale.

Key Data Elements: Parcels are identified by their commonly used name. Additional elements include area and perimeter of the parcel.

Scale: 1:24,000.

Date of Publication: 1997.

Municipal and Private Open Space Areas

The data identify properties owned by Connecticut municipalities and private organizations for the purpose of preserving open space. Lands include conservation trust property, town open space, parks, school playgrounds, campgrounds, golf courses, club and association recreational property, and cemeteries. To create the data, DEP and OPM periodically collected and updated mapping information obtained from municipalities and land trust organizations. DEP and OPM mapped the open space property boundaries on 7.5 minute U.S. Geological Survey topographic quadrangle maps and digitized them at 1:24,000 scale.

Howard Sternberg of the Connecticut DEP commented to Andrew Hickok on October 17, 2005, that this dataset might be unreliable, since it has not been updated since 1997.

Key Data Elements: Each property is assigned a name in the "Name" attribute field. We queried this field to identify lands held for conservation and town open space lands.

Scale: 24,000.

Date of Publication: 1997.

Development Priority Areas

The data identify development priority areas for the state 2005–2010 Conservation and Development Policies Plan. This data layer was developed with data from the previous 1998–2003 Conservation and Development Policies Plan, which was updated with information from U.S. Census 2000 and negotiations with municipal and regional officials.

Key Data Elements: The attribute field "CONSDEV" assigns classifications to lands based on current or projected development trends. We use the following classifications in this study: Regional Center, Neighborhood Conservation, Growth Area, and Rural Community Center.[96] Regional Centers encompass land areas containing traditional core area commercial, industrial, transportation, specialized institutional services, and facilities of intertown significance. Neighborhood Conservation Areas are typically characterized by lands without the high incidence of the structural, occupancy, and income characteristics of Regional Centers yet are significantly built up and well populated. These areas generally reflect stable, developed neighborhoods and communities and are often contiguous to Regional Centers. Growth Areas are lands near Regional Centers or Neighborhood Conservation Areas that provide the opportunity for staged urban expansion generally in conformance with municipal or regional development plans. In the state's more rural communities, Rural Community Centers reflect existing mixed use areas or places that may be suitable for future clustering of the more intensive housing, shopping, employment, and public service needs of municipalities outside of urban development areas. Rural Community Centers are areas where small-scale community systems of water supply, waste disposal, and public services are appropriate but large-scale public service systems should be avoided.

Scale: 1:24,000.

Date of Publication: June 2005.

Tribal Settlement Areas

The data identify tribal settlement areas in Connecticut.

Key Data Elements: All polygons within this layer are tribal lands.

Scale: 1:24,000.

Date of Publication: June 2005.

University of connecticut department of agriculture and natural resources, center for land use education and research

[96]Areas not assigned to one of these classifications are considered by the 2005-2010 Conservation and Development Policies Plan to be Rural Lands.

2002 Land Cover in Connecticut

Data organized in statewide layer identifying land use and land cover in Connecticut. Land use categories were identified using 30 meter by 30 meter satellite imagery collected in 2002. Land uses were digitized into a vector format.

Key Data Elements: Each polygon is assigned a land use code according to a state-specific classification system by the Center for Land use Education And Research (CLEAR) in the College of Agriculture and Natural Resources at the University of Connecticut. Exhibit A-2 lists the land use codes and descriptions used for these data.

Exhibit A-2

CONNECTICUT LAND USE CODES AND DESCRIPTIONS

Land Use Code	Description
1	Developed
2	Turf and grass
3	Other grasses and agriculture
4	Deciduous forest
5	Coniferous forest
6	Water
7	Non-forested wetland
8	Forested wetland
9	Tidal Wetland
10	Barren
11	Utility right of way

Scale: 1:24,000; the publisher recommends use at scale of 1:50,000 or less.

Date of Publication: 2003.

southeastern connecticut council of governments (sccog)

Land Use in Southeastern Connecticut

Data organized in regional layer identifying land uses in Connecticut. Land use categories were identified from municipal land use plans for communities in the region in 2000.

Key Data Elements: Each polygon is assigned a land use category according to a region-specific classification system by the planning staff at the Southeastern Connecticut Council of Governments. Polygons generally represent land parcels in the Region. Exhibit A-3 lists the land use descriptions used for these data.

Exhibit A-3 SOUTHEASTERN CONNECTICUT REGION LAND USE DESCRIPTIONS
Description
Active recreation
Agriculture
Agriculture Reserve
cemetery
Commercial
High density residential
Industrial
Industrial - extraction
Institutional
Institutional - extensive
Low density residential
Medium density residential
Mixed Urban Uses
Open space
Reservoir area
Transportation, Communications, and Utilities

Scale: Regional planning staff were unable to identify the scale of this layer. A visual inspection showed that the density of vertices are similar to or better than 1:50,000 data. However, no information was available to document whether the maps are accurate to such a scale under National Mapping Standards.

Date of Publication: 2000.

Federal Emergency Management Agency (FEMA)

Flood Zones

FEMA created floodplain data that identify the boundaries of the 500-year floodplain. These data were obtained from the CT DEP Environmental and Geographic Information Center website. Used in this study to show the floodplain along the entire coastal portion of the state.

Key Data Elements: For this study, we identify land within the 500-year floodplain as polygons where the field "Zone" identifies the land area as "A," "AE," "AH," "AO," "V," "VE," "FW," "X-500," or "COBRA_IN".

Scale: 1:24,000.

Date Obtained: 2003.

ESRI National ATlas

Federal/Indian Land Areas

The National Atlas data identify federal land and are distributed as part of the ESRI data CDs. The data were used to identify the location of New London Naval Submarine Base.

Scale: 1:2,000,000.

Date of Publication: 2004.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)

Shoreline Armoring

NOAA developed the Connecticut Environmental Sensitivity Index (ESI) data to identify coastal areas vulnerable to oil pollution incidents. As part of this data, existing coastal armoring was identified.

Scale: 1:24,000.

Date of Publication: 2002.

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