Connecticut Coastal Design Project

Current Opportunities and Constraints for Connecticut's Coast
Non-Structural/Natural Infrastructure

Workshop Summary of Findings

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Acknowledgements:

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Purpose of Project

In order to identify and eventually demonstrate the effectiveness of non-structural and/or natural infrastructural alternatives (natural infrastructure here after) in addition to typical shoreline armoring measures (i.e., seawalls, bulkheads, etc.), a constructive dialogue needs to be fostered across the state of Connecticut. As a first step to advancing this critical dialogue, The Nature Conservancy's Coastal Resilience Program embarked on the Connecticut Coastal Design Project. The intent is to bring together coastal engineers, regulatory agents, coastal geomorphologists, landscape design professionals, and natural resource managers to define more environmentally-friendly shoreline protection approaches; the "what", "where", and "how" for the Connecticut coast.

The Conservancy's Connecticut Coastal Design Project had two phases; the first phase provided for the first time an interview series with coastal engineers and designers as well as regulatory agents engaged in coastal projects in the state of Connecticut. The finding as captured in the "Interview Series Summary Report" (Appendix B) revealed obstacles and opportunity for creating the right conditions necessary to increase acceptance and implementation of natural infrastructure projects. The project's first phase effectively provided a current situational analysis as well as a constructive frame and focus for the project's second phase: the first Connecticut Coastal Design Workshop. The summary of findings from this workshop is reported herein.

It is the sincere hope of the Conservancy's Coastal Resilience Program that this final report and the process (i.e., interviews coupled to the workshop) used to generate this unique dialogue between coastal engineers, regulatory agencies, academia, and natural resource managers will assist with the advancement of natural infrastructure projects that help to improve the resilience of communities, residents, and ecosystems in Connecticut and beyond.

Purpose of Report

The purpose of this report is to accurately capture and present the constructive dialogue and agreements reached by participants at the first Connecticut Coastal Design Project Workshop held on June 11, 2014 in Guilford, Connecticut.

The summary of finding transcribed in this report, like any that concern the evolving nature of risk management are proffered for comments, corrections and updates from workshop participants and additional stakeholders alike. The leadership presented by the workshop participants on this important component of coastal resilience will benefit from the continuous and expanding participation of all those concerned.

Workshop Objectives

As mentioned above, the second phase workshop was designed to directly respond to the obstacles and opportunities surfaced during the first phase interviews. To that end, the workshop's objectives were as follows:

- Understand and describe the current knowledge and comprehension of what natural infrastructure alternatives and approaches are possible in Connecticut.

- Understand where installation of natural infrastructure is most feasible and preferred along the Connecticut coast.

- Articulate potential obstacles to implementation of natural infrastructure projects and key recommendations for successfully overcoming obstacles.

- Identify and develop an opportunity for workshop participants to collaboratively define criteria and design elements for pilot projects that test natural infrastructure adaptation strategies.

- Identify specific recommendations and next steps for action to further advance discovery and collaborations around natural infrastructure efforts.

Workshop Process Summary

To achieve these objectives, the workshop participants were presented with a suite of introductory presentation followed by a series of small teams and large group exercises. The introductory presentations focused on the design and engineering of natural infrastructure projects gathered from real world situations along the coasts of New England and beyond. The presentations were followed be a facilitated large group discussion that helped to initiate the dialogue on the current state of understanding on natural infrastructure obstacles and opportunities along Connecticut's coast.

Participants then divided into pre-selected smaller teams that included regulatory agents, coastal engineers, natural resource managers, and other expertise and proceeded with a series of reinforcing exercises. The first exercise focused on defining natural infrastructure projects by discussing and prioritizing the key characteristics and criteria ("The What"). The second exercise required the small teams to determine which locational characteristics are critical for successful natural infrastructure projects along Connecticut's coast ("The Where" – Part 1). The exercise was paired with a participatory mapping process that further required the small teams to rank the

suitability of shoreline districts and identify specific places within those districts that are "most possible, "possible", and "least possible" for natural infrastructure projects ("The Where" – Part 2).

With a firm understanding of the "what" and "where" for natural infrastructure projects in Connecticut, the final segment of the workshop focused on surfacing obstacles to advancement and the subsequent development of top-priority, consensus initiatives to overcome the current obstacles ("The How"). To ensure a broad and robust dialogue which incorporated the information gathered in the Interview Series Summary Report (Appendix B), the obstacles discussion was professionally facilitated with accurate dialogue capture by designated scribes. The participants then returned to their respective small teams and identified several top priority actions that could be advanced to overcome those obstacles. The small teams identified potential team members, specific tasks, responsibilities, and time lines towards a stated outcome. Once completed each team presented on top priorities and from that, a common list of action items was compiled on behalf of the larger group for understanding and agreement. For a final activity, the workshop participants were engaged by a group from the Town of Guilford on a tour of a potential natural infrastructure project in the West River, Guilford.

Workshop Exercises

Exercise 1: What are the key characteristics of a successful natural infrastructure project in Connecticut?

Individually, the three small teams discussed and captured the key characteristics of a successful natural infrastructure project with an eye towards generating criteria that could be used to scope locations along Connecticut's coastline. The following is a summary of characteristics and criteria synthesized from all three small teams.

Appropriate Location

- ✓ One of the most important features of a successful natural infrastructure project is its location. The site must meet suitable physical environmental criteria such as amount of exposure, wave slope, and be able to handle environmental processes and loads of varying magnitudes and duration.

- ✓ A project's success also depends upon these physical characteristics and those of adjoining land uses. Ideally, neighboring properties will have natural, undeveloped coasts and will not deflect wave energy towards the natural infrastructure project site under consideration. Neighboring properties should have minimal human use (for example: adjoining a marine may not be appropriate – higher impacts from frequent boat traffic/wakes; open space versus power plant; upland context important).

Sustainable Design

- ✓ A well-designed natural infrastructure project must be durable and able to weather the wide range of storm events that occur in Connecticut from winter Nor'easters (higher frequency – lower energy) to hurricanes (lower frequency – higher energy). The design must provide a setting where shoreline plants can colonize and thrive. While it may be unrealistic for all natural infrastructure projects to be perpetually self-sustaining, successful projects have a longer than anticipated lifespan (15–25 years). To maximize a project's lifespan, maintenance and monitoring programs should be incorporated into their designs and approved plans.

    i. Functional life span – requires durability from event to event or during a sequence of changing events (i.e., thunderstorms, waves and high tide; enhanced resilience where dunes are stabilized with grasses; winter nor'easters).
    ii. Longevity – natural infrastructrue project rarely have a 25-year life span; 10-15 years is more typical.

- ✓ To ensure sustainability, the project design may need to integrate hard infrastructure elements (i.e., hybrid approaches – "green with gray"). This type of application could extend the project's longevity from 15 to 25 years in some cases.

- ✓ Sustainable design also requires an accounting of changing conditions such as increases in sea level rise and/or storm intensity over the projects intended life span (i.e., consideration 10 years – 1" to 4" of static sea level rise). This may require identifying and modeling for a more impactful design storm as well.

Multiple Beneficiaries

- ✓ Unlike most hardened shoreline projects, natural infrastructure projects provide co-benefits to multiple stakeholders and focus issues. With so much current development along Connecticut's coast, successful natural infrastructure projects should look to achieve multiple objectives if possible such as native habitat and erosion prevention for immediate and nearby infrastructure and homes.

- ✓ Natural infrastructure projects can provide not only critical habitat but also current/future migratory corridors for coastal wildlife and fisheries.

i. Projects can support ecological improvement for shorelines (and adjoining uplands) and improve resilience of that shoreline to episodic and gradual changes.

- ✓ Finally, an ideal natural infrastructrue project also benefits most coastal users by maintaining a scenic shoreline. As an emerging opportunity in Connecticut, a natural infrastructure project can offer educational benefits to coastal visitors about the alternative choices for protecting the shoreline. For example, project champions could connect with individuals that can help to involve local citizens/schools when possible to assist with plantings of native plant species.

Cost Effectiveness

- ✓ The workshop participants agreed that a successful natural infrastructure project will be similar in overall cost to a hard, structural approach. The initial costs such as design and construction should be less as compared to a structurally engineered project. However, monitoring and maintenance costs may be greater for natural infrastructure projects over time. In addition, permitting costs may be less (COP vs. Individual permit). For design engineers, another cost/benefit consideration of using natural infrastructure solutions is a reduced liability for potential adverse impacts the project has on adjoining properties compared to hard structures which are notorious for redirecting destructive wave energy to another part of the coast.

Stakeholder Understanding and Agreement

- ✓ An ideal natural infrastructure project will have agreements in place on the goals and vision of project success among stakeholders. Stakeholders in a typical natural infrastructure project include property owners, state and local regulators, consultants, and adjacent/nearby property owners. Project stakeholders should all be in agreement in terms of the project's regulatory approvability, proper design guidance/standards, and expectations of risk reduction afforded by the project prior to breaking ground.

- ✓ One of the more challenging characteristics is the public perception of viability of natural infrastructure projects. Ideal projects will have a good way to limit public access and control as well as realistically manage the clients expectation of risk reduction and needs for adaptive management interventions over time

- ✓ In addition, there are considerations regarding the replicable or transferability of project elements and approaches due to site specificity. Undoubtedly, a successful

natural infrastructure project will be specifically tailored for individual site conditions and environmental forces.

Exercise 2: What are the characteristics of ideal locations for successful natural infrastructure projects in Connecticut?

Individually, the three teams discussed and captured the key characteristics of an ideal location for natural infrastructure that could be used to scope projects along Connecticut's coast. The following is a summary of characteristics synthesized from all three teams. Fundamentally, the three teams agreed that the answer to this question ultimately resides in how living shorelines and other natural infrastructure approaches are defined in Connecticut; this need remains largely undetermined at this point in time. The group also fundamentally agreed that it would be useful to consider where natural infrastructure projects cannot be implemented and for what site specific reasons.

Appropriate Physical and Environmental Conditions

- ✓ An ideal location for natural infrastructure project must meet several environmental condition thresholds. First, the site should consistently have relatively minimal exposure to environmental forces such as wind, waves, and currents. An ideal "low energy" site has a fetch of less than 1.5 miles (wind frequency and wave height). Typical low energy sites along Connecticut's coast include rivers, coves, and estuaries. In addition, human impacts such as boat wakes should be minimal.

    i. For example: rivers have short fetch and low wave energy, although there is boat wake and potential for ice damage. These sites may also provide the co-benefit of mitigating stormwater runoff and habitat provisioning.

- ✓ The consideration of tidal range or amplitude at the site location can be a critical determinant. This is particularly important in Long Island Sound where the diurnal tidal amplitudes can be significantly different from east (Greenwich) to west (Stonington).

- ✓ Sites located in high sediment transport zones should be carefully considered and if possible monitored prior to implementation. Areas with low sediment movement are preferred. Sites free of ice are also preferred given the significant damage to shorelines from ice sheets and blocks during the winter months.

- ✓ Sites which are "not high energy" have been suggested to be more suitable but there is no agreed upon methods or standards to define "high" and "low" energy specific to the unique conditions of Connecticut's coast. There is a need to define wave energy as determined by wind, wakes, fetch, depth, and currents.

- ✓ A gradual slope was identified as a critical characteristic to allow for the horizontal movement of sand, habitat, and wildlife.

- ✓ Onsite soil condition and properties are also critical to consider (sandy versus clay).

- ✓ Width of buffer onsite and adjoining an immediate project site is critical. A buffer of at least 200ft is needed in order to successfully create dunes – anything less tends to become sacrificial.

Surrounding Land Use

- ✓ The proximity to other structures (e.g. walls, bridges, etc.) is an important consideration.

    i. Project should not be implemented in known high impact areas.
        1. For example: areas with high boat traffic and frequent boat wakes experience increased wave energy.
    ii. An important issue is how to tailor the project to a site knowing that some seawalls will remain along with other proximate hardened structures.
    iii. The implications or influence of adjoining structures may change with increased sea level rise and/or storm intensity.

- ✓ Projects should be located in areas with no critical infrastructure in the upland portion of the property.

- ✓ Projects should not cause unacceptable impact or risk to existing resources and adjacent properties (consideration on CAM; No Adverse Impact).

- ✓ The conversion of one coastal resource for another (e.g., mudflat to salt marsh to stabilize toe) may be a necessary tradeoff as long as the overall coastal resource is protected, maintained, or enhanced by the project.

- ✓ A critical issue is the site access for construction of the project or the "constructability".

i. This impacts the cost of installing a natural infrastructure project. For example, lack of access to the base of a bluff can greatly hinder and prevent the installation of a project.

Adequate Frontage and Scale

- ✓ Areas where natural processes can take over (dune, tidal marsh, behind barriers, tidal creek) and be self-sustaining should be favored during the selection process.

    i. Key areas where you can promote natural processes – near tidal marsh.
        1. Trying to set it up so the natural processes can take over.
        2. Take advantage of natural features (woody debris).
        3. Design to foster natural processes onsite – self restoring after events.
    ii. These projects require enough space to allow the application of techniques that enable natural processes to eventually dictate.

- ✓ Take into account the length of frontage and property size - densely populated coastal areas with numerous coastal structures are typically not good areas for a natural infrastructure project.

- ✓ To get to a bigger scale it may be best to work with groups of property owners with shared problems and commitments to alternative approaches (i.e., Special Areas Management Plans, Integrated Sediment Management Plans).

Strategic Opportunities for Initial Projects

- ✓ State/municipal parks are often large properties with agreeable land uses (recreational fields, agricultural land, conserved land) that would be appropriate for natural infrastructure project implementation and monitoring. These properties offer low risk opportunities to build knowledge about natural infrastructure projects in Connecticut.

- ✓ Work with private landowners who understand the risks and rewards or natural infrastructure projects.

- ✓ Pilot projects may also include experiments via federal and state funding sources.

Exercise 3: Rank the seven shoreline districts in Connecticut from most (1) to least (7) ideal locations for successful natural infrastructure projects. For those highest ranked districts, apply characteristics from previous exercises to identify which areas are "least possible" (Red), "possible" (Yellow), and "most possible" (Green) for successful natural infrastructure projects.

The collective outcomes from Exercise #2 on the locational characteristics critical for successful natural infrastructure projects were brought into Exercise #3; a small team-driven, participatory mapping process. Each of the three teams was presented with a large (3'x5') map of the Connecticut coast segmented into seven distinct Shoreline Districts (Bloom 1967 – CAM Planning Report 29) and asked to rank these Shoreline Districts based on the characteristics defined in Exercise #2 (Appendix A). The individual and cumulative rankings of the Shoreline Districts are presented in Table 1.

Table 1: Individual and cumulative ranking of seven Shoreline Districts* on Connecticut's coast from most (1) to least (7) ideal for natural infrastructure projects by three individual teams of workshop participants.

Shoreline District	A	B	C	D	E	F	G
Team Red	7	3	5	6	1	4	2
Team Green	5	2	6	7	1	3	4
Team Blue	7	3	4	5	1	2	6
Total**	6.3	2.7	5	6	1	3	4

*Source: Arthur Bloom (1967) via CAM Planning Report 29 – "Shoreline Erosion and Recommended Planning Process" 1979.
**Cumulative team scores for each Shoreline District divided by 3. Lower number = more ideal Districts

By far the greatest unanimity amongst the three teams as the most ideal area for natural infrastructure projects was Shoreline District E which runs east to west from Guilford to Old Lyme. Shoreline Districts B (Norwich to Milford) and F (Old Lyme to Groton) represented the areas with the second highest potential after Shoreline District E for natural infrastructure projects. Shoreline District G (Groton and Stonington), C (Milford to New Haven), and D (New Haven to Guilford) were deemed less ideal. Shoreline District A (Greenwich to Norwalk) was recognized by most teams as being the least ideal of all for natural infrastructure projects.

Once completed the individual small teams worked across their top ranked shoreline districts to identify specific places that are "most possible, "possible", and "least possible" for natural infrastructure projects. While this part of the exercise was not designed to be definitive, it

did foster the required step of integrating "the what" (Exercise #1) with "the where" (Exercise #2) into specific parts of the coast as a team of regulatory, engineering, design, and resource management professionals. The annotated shoreline district maps generated by each of the three teams are provided in Appendix A.

Exercise 4: What are current obstacles to advancing natural infrastructure approaches and projects along the Connecticut coast?

A. There is a lack of clarity regarding the definition of "Living Shoreline" other than a need to have a natural resource benefit as defined by recent state statute. There is currently no regulatory translation, definitions, or even guidance on non-structural, erosion control approaches for the state of Connecticut. There is also discontinuity between permitting agencies (DEEP and USACOE) which needs to be rectified around natural infrastructure projects.

B. To ensure there are sufficient native vegetation plantings for natural infrastructure project installments, there must be a reliable supply. The United States Department of Agriculture is well-suited to champion this effort and provide incentives to growers around the region to secure a ready supply for natural infrastructure projects.

C. Currently, there is no natural infrastructure project design guidance developed specifically for Connecticut's coastal environment (generally: rocky shoreline, low energy, sediment starved). When official design guidance is made available, Connecticut's coastal engineer professionals and natural resource managers can develop a greater understanding of non-structural options and installation strategies. The design guidance should include specific criteria (e.g. 1.5' wave, slope, fetch, etc.) for siting natural infrastructure projects. The guidance should also include a regulatory mechanism to increase the incorporation of natural infrastructure features in standard hard infrastructure projects (e.g., New Haven harbor). The guidance document(s) need to come from CT DEEP which will require education, training, and workshops for CT DEEP staff. The coastal engineering community is well suited, if willing, to support this type of collaborative education effort.

D. There is currently no catalogue of completed or proposed projects for Connecticut that could be used to provide supporting evidence of the effectiveness (or non-effectiveness) and potential performance of these projects (i.e., Milford – outfall). There should be a prerequisite for reporting and monitoring of projects (i.e., as-built descriptions; 1, 5, 10 year post-project monitoring, etc.).

E. There are different types of engineers (coastal versus civil) with varying levels of expertise and training on coastal design and implementation. Municipal engineers often defer to consulting coastal engineers when asked by municipal Planning and Zoning Commissions about the merits of a project. There should be training program for natural infrastructure engineering projects – including CT DEEP staff. In some cases, there is no PE stamp needed for landscape design for vegetative shorelines (Landscape Architect stamp is required); there is a need to clarify the role of engineer.

F. Current lack of "leadership" from state coastal zone management agents. There needs to be consistency and commitment to compiling data, developing design standards, guidance documents, fact sheets, etc. The states of Rhode Island, New York, and Massachusetts can serve as programmatic models to emulate in Connecticut.

G. The level and extent of coastal armoring and adjoining development along the Connecticut coast is such that there are challenges with scale – percentages of undisturbed versus armored shoreline is low. Alternative approaches such as Special Area Management should be utilized as in other neighboring states (i.e., Rhode Island).

H. Municipalities need comfort level and support from state coastal zone management agents to foster and increase willingness to advance natural infrastructure projects and ensure consistency in proposals from consulting engineers.

I. Need further clarity in permitting process – more guidance and information for clients will help manage expectations and improve the quality and quantity of natural infrastructure projects. There is some history of soft or hybrid structures that have been successful; Woodmont, Milford (blue mussel project), Stratford Reef Ball Project (structural components included and permitted), and New Haven Long Wharf sewer system erosion control project (rock sill as the erosion control measure).

J. The current regulatory process is counterproductive and confusing. Regulators don't have guidance or standards; consulting engineers submit projects to see what will make it through despite the inconsistency in permit review process.

K. There is disconnects between owners, designers, and regulators. Different audiences have different informational needs. The expectations of designers, homeowners and regulators are different – need to all be speaking the same language.

Exercise 5: Next Steps

As a final exercise of the workshop, the participants, within their small teams, developed three top priority actions that could be advanced to overcome obstacles for natural infrastructure projects. The small teams identified potential members, specific tasks, responsibilities, and time lines towards a stated outcome. Once completed, each team presented on their top priorities. A common list of priority actions was compiled on behalf of the larger group for understanding and agreement. A summary of the priority actions is provided in Table 2.

Table 2: Collectively compiled and priority action items by workshop participants that are specifically designed to overcome identified obstacles and help advance natural infrastructure projects in Connecticut.

Overall Activity	Actions	Who	Timeframe
Develop Leadership – Build Confidence	• Take Lead • Public Outreach	CIRCA Advisory Group	Continuous - Now
Develop Technical-Design Document	• Create Document • Public input • Publish final document	CIRCA/DEEP	July 2015
Best Management Practices/ Project Catalogue	• Collaborative work group develops guidance document of best management practices including case studies (AMCE database)	TBD	Initiate within in 3 months/ Completion in 2 years
'How-to' Permitting Guidance	• Publish online permitting guidance and pre-application process	CT DEEP	Draft completed by July 2015
Availability of Native Plantings	• Ensure reliable sources for plant materials of local ecotypes	USDA	2 -5 years
Public Outreach and Education	• Statewide workshop for municipal officials & practitioners • Living shoreline information on state website or database	Hosted by CIRCA DEEP/UCONN	Winter 2015 2016
Pilot Project on Public Property	• Fully carry out process of executing a project and report results	CIRCA, DEEP	No date – TBD
Towns - Meeting with Building Officials	• Create handouts for building officials	CIRCA, DEEP	No date – TBD

Workshop Participants: Organizations, Companies, Agencies

Coastline Consulting. Inc.
Coastal Ocean Analystics
DeStefano and Chamberlain, Inc.
Docko, Inc.
GEI Consultants, Inc.
Gerwick Merren, LLC.
Harbor Engineering, LLC.
New England Environmental, Inc.
Ocean and Coastal Consulting, Inc.
Roberge Associates Coastal Engineers, LLC.

CT Department of Energy and Environmental Protection, Office of Long island Sound Programs
The Nature Conservancy, Coastal Resilience Program
University of Connecticut, Connecticut Sea Grant College Program
University of Connecticut, Center for Land Use Education and Research
Yale University, Urban Ecology and Design Laboratory

Guest Presenters

Laura Schwanof, RLA – GEI Consultants, Inc.: "*Designing Living Shorelines: Connecticut Coastal Design Workshop*".

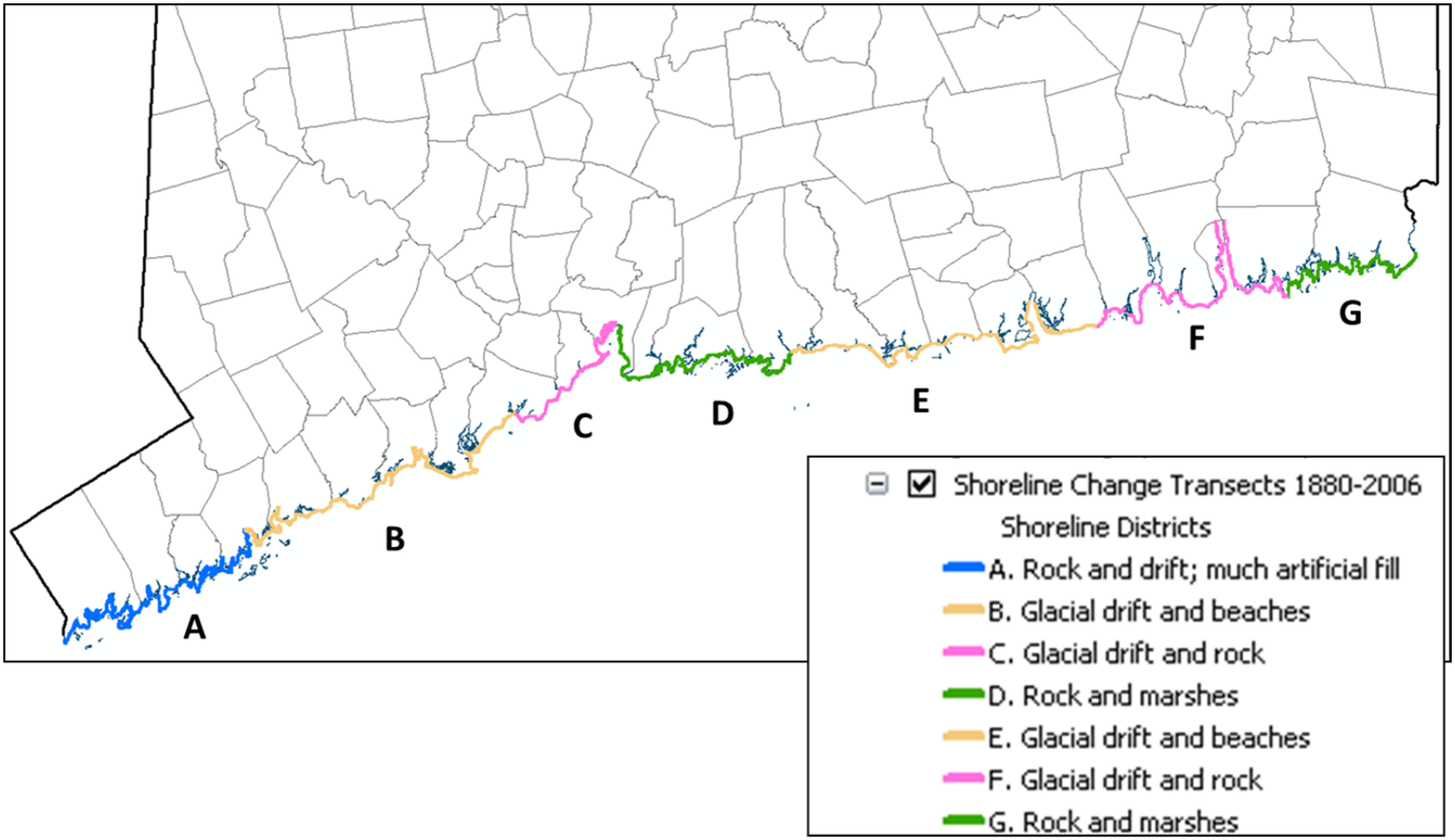
Mickey Marcus – New England Environmental, Inc.: "*Coastal Case Studies: Lessons Learned*".

Kevin O'Brien – Connecticut Department of Energy and Environmental Protection: "*Analysis of Shoreline Change in Connecticut: 100 Years of Erosion and Accretion*".

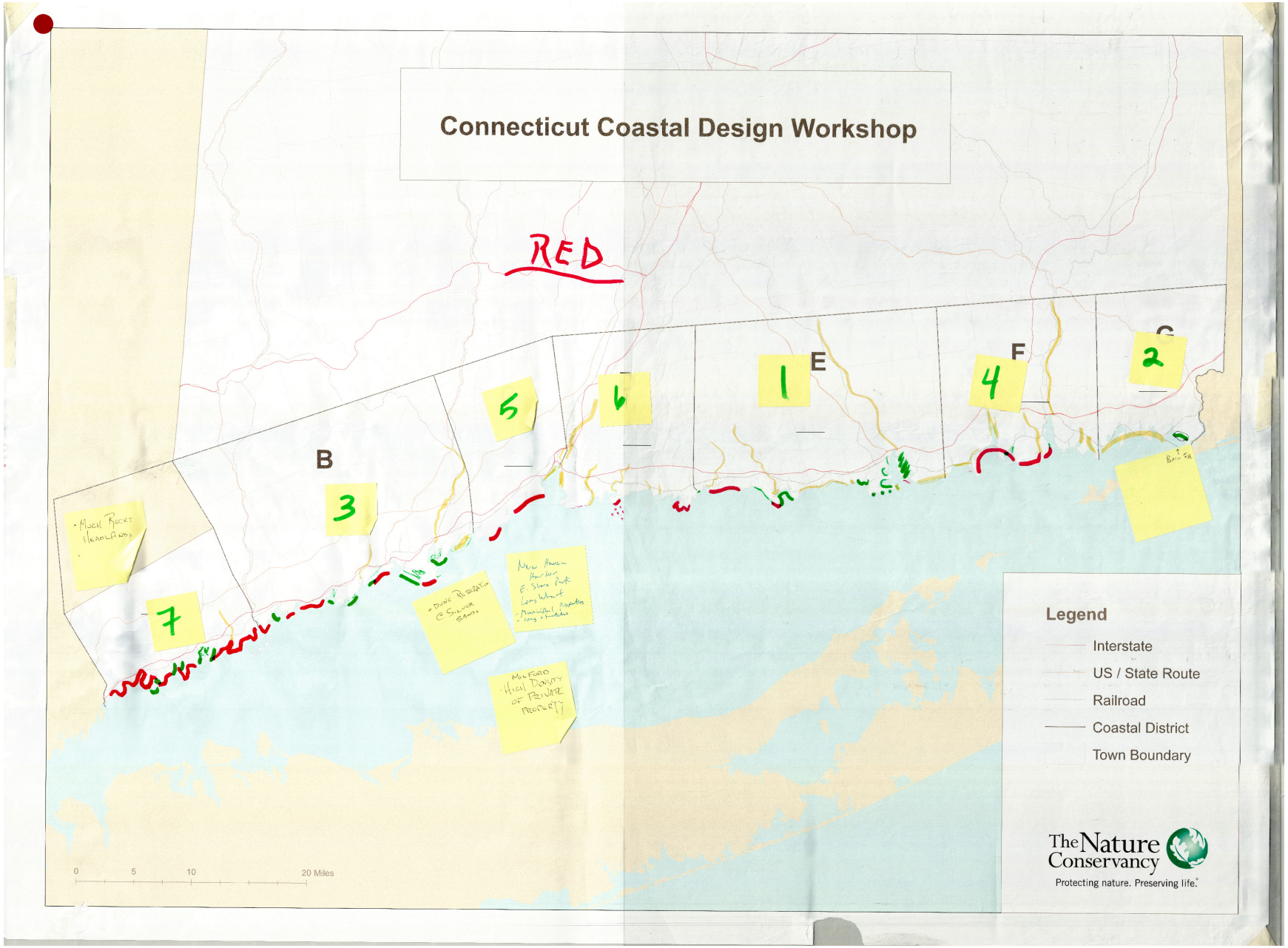
Facilitation Services

Mark Amaral – Lighthouse Consulting Group (http://lighthousecg.com/)

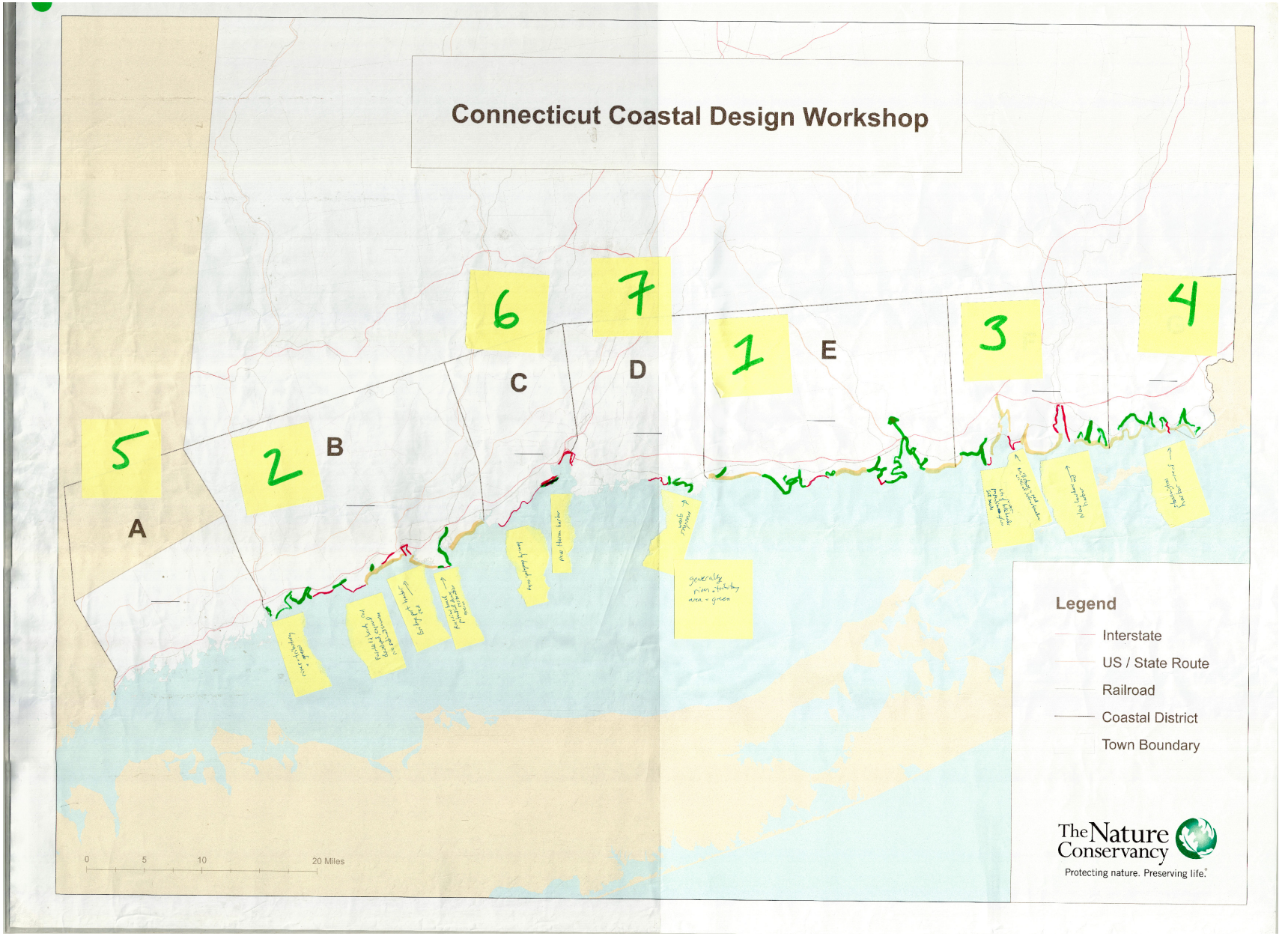
Appendix A
Shoreline District Maps



Source: Arthur Bloom (1967) via CAM Planning Report 29: "Shoreline Erosion & Recommended Planning Process" 1979



The Nature Conservancy's Coastal Resilience Program – Connecticut Coastal Design Project



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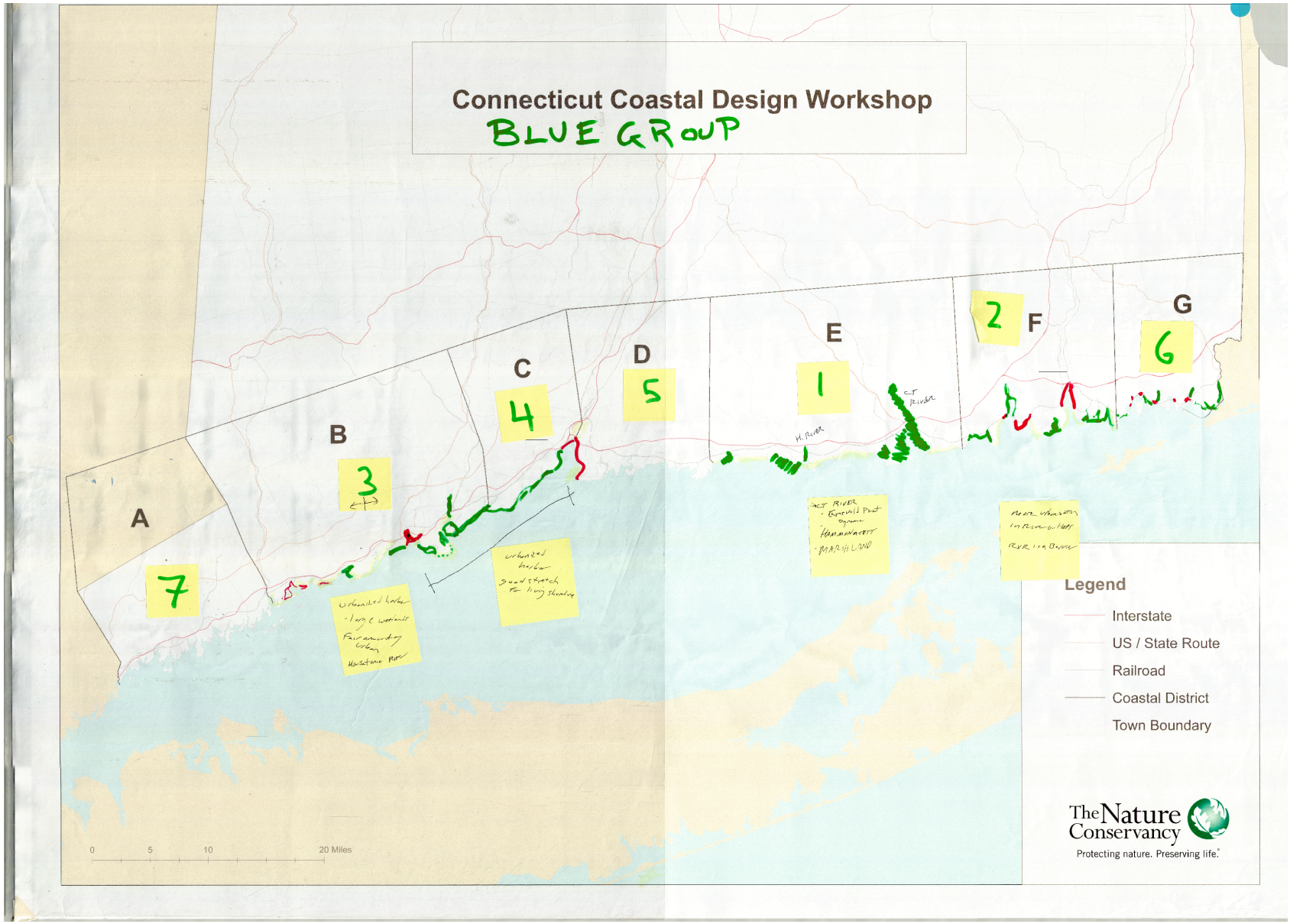
Connecticut Coastal Design Workshop
BLUE GROUP
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Legend
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US / State Route
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Coastal District
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20 Miles
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Appendix B
Interview Series Summary Report

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Current Opportunities and Constraints for Connecticut's Coast
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The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends. Our vision is to leave a sustainable world for future generations.

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This effort was made possible through partial funding by the Phillip Henry Kraft Family Memorial Fund and the McCance Foundation Trust.

Introduction:

In order to identify and eventually demonstrate effective shoreline treatment alternatives to typical shoreline armoring measures (i.e., seawalls, bulkheads, etc…), a constructive dialogue needs to be fostered and advanced within Connecticut. As a first step to advance this important dialogue, The Nature Conservancy has embarked on a two-phase process as part of our Connecticut Coastal Design Project intended to bring together coastal engineers, regulatory agents, coastal geomorphologists and natural resource managers to define more environmentally-friendly shoreline protection approaches (otherwise referred to as non-structural and/or natural infrastructure). Reported herein is the first phase in the process: interview responses from coastal engineers and designers as well as regulatory agents engaged in coastal projects in the state of Connecticut. The intent is that the following responses will help to elucidate both the opportunities and constraints for alternative shoreline approaches and treatments in Connecticut.

This document provides a summary of the interviews conducted by The Nature Conservancy with coastal engineers and designers as well as regulatory agencies in advance of the second phase of this process - Coastal Design Workshop. This summary of interviews report is being used to design the agenda for the upcoming Workshop.

Summary of Interviews

Coastal Engineers and Designers:

The Connecticut Coastal Design Project survey questions were designed to help develop a comprehensive understanding of the principal opportunities and challenges to advancing non-structural/natural infrastructure projects along Connecticut's coast as well as inland waterways. Interviews were conducted in-person or by telephone with ten firms experienced in coastal engineering, design, permitting and/or construction for Connecticut coastal projects. Most firms interviewed are familiar with or have direct experience with coastal design and permitting in New York, Massachusetts and Rhode Island. Each firm was represented by one to three employees specializing in coastal engineering, landscape architecture, wildlife biology, restoration and/or project installation. Participants responded to the following series of ten questions. In addition, the interviewees were asked to add any additional information they felt would be relevant or helpful to the discussion. All information was collected and coalesced by question across all respondents.

Question #1: What types of projects or designs come to mind when you think of "soft armoring" or "non-structural" shoreline alternatives for Connecticut? Are there other ways or phrases you would use to describe these projects?

All respondents explained that while a variety of non-structural alternatives exist, application is very site specific due to geophysical shoreline differences in Connecticut (e.g. low gradual salt marsh vs. exposed beachfront). All ten coastal engineering firms referred to vegetation when describing soft armoring or non-structural alternatives. Eight respondents specifically highlighted biodegradable shoreline stabilization products (e.g., coir logs and mats) when discussing soft techniques that include vegetation (Figure 1). Several participants gave detailed descriptions of non-structural techniques that are included in the breakdown of responses below.

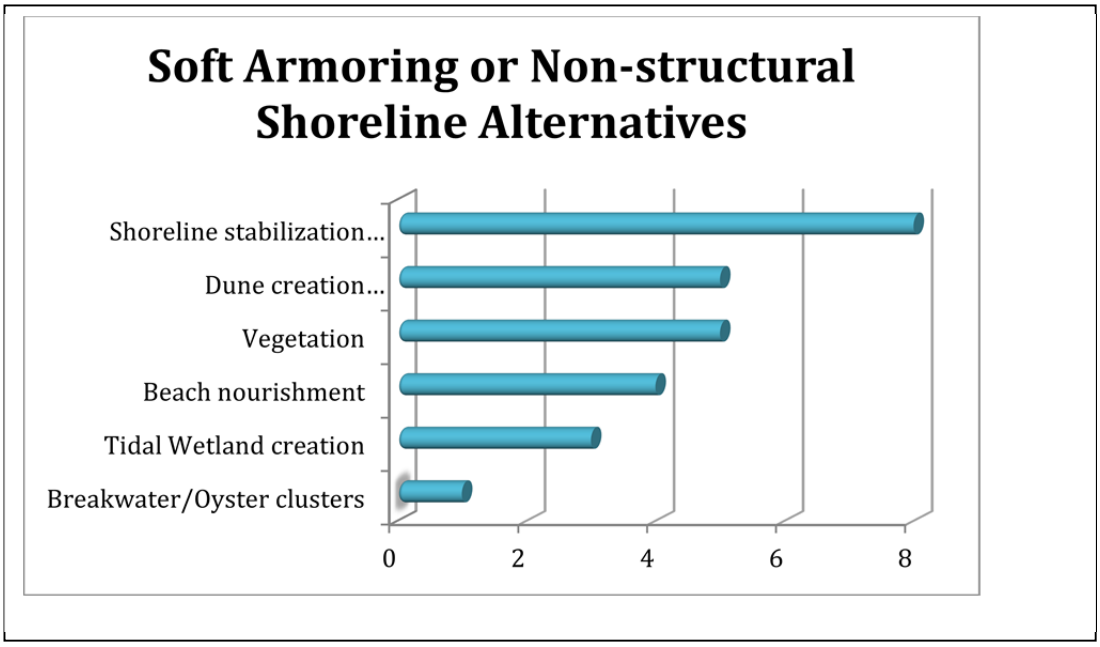

Figure 1: Number of responses for each type of non-structural shoreline alternative from ten coastal engineering and design firms.

Soft Armoring or Non-structural Alternatives:

1. Shoreline stabilization with vegetation (8 responses) - techniques discussed included:

    a. Coir log and mats - reinforced shoreline improvements combined with vegetation;
    b. Geolifts - stabilize bank with fabric and plant (also bio-degradable "pillows" material (sand) wrapped with fabric works horizontally rather than vertically;
    c. Geogirds – hybrid to soft solution – used more commonly along river fronts than coastal. Plastic cells interlocked together creates web on slope – filled with material (sand and gravel for weight) and vegetated – does not require equipment/machine installation.

2. Tidal wetland creation (5 responses): Plant-based stabilized soil, intertidal zone, especially in low wave energy area. Usually recommended by CT DEEP as an alternative to riprap or bulkhead or as mitigation for wetland disturbance caused elsewhere.

3. Dune recreation (5 responses): Hard to do in Connecticut due to limited setbacks and the compressed nature of the coast (i.e., "lack of room") between the erosion zone and inland extent of tides. (Example East Shore Park, New Haven 2009). Approach often utilizes beach/dune fencing to capitalize of wind born deposition of sand.

4. Beach nourishment (4 responses): Beach nourishment is a major component of projects in Long Island, New York and New Jersey.

5. Breakwaters to reduce wave velocity/wave action in inlet – utilization of oyster clusters (1 response).

Are there other ways or phrases you would use to describe these projects?

The most common answer to this question was "living shorelines", and as one coastal practitioner stated (inset) the term meant different things to almost every respondent. Most referred to living shorelines as a hybrid of structural and non-structural techniques. Additionally, some respondents suggested there are differing perspectives about these descriptions among engineers and regulators.

- Regulators and engineer versions of "soft" differ – CT DEEP's perspective of soft is habitat creation
- "Soft" is taken too literally – "non-structural" resonates better
- "Soft" can also mean minimal construction – very site specific ratio of structural to natural (e.g. gabion filled with soil, erosion control matting)
- "Soft-structures" and "soft armoring" have been brought into the vernacular – in literature and has gained knowledge over the years
- Coastal resiliency becoming a buzzword but can't always say what it means – something that can withstand storms?
- Permanent vs. non-permanent
- Green, living shorelines = soft; Engineered controls, bulkheads, seawalls = hard; Varied stone toe planted with vegetation = hybrid

"…the term living shoreline means different things to different people. Need to be clear."

"Living shorelines are a "softer" or hybrid approach involving structural stabilization at toe of slope to enable vegetation establishment."

"Living shorelines, a balance of structure and plants - something that will survive the climate and climate induced hydrodynamic forces by coastal waters, would seem suitable."

"Living shoreline is a vegetated buffer - not always erosion control application but can serve a water quality filter function."

Question #2: Can you describe some different designs and where they might be appropriate in Connecticut?

When discussing where non-structural designs might be appropriate, coastal engineers and designers stressed the importance of avoiding the assumption that one solution will work everywhere. Among the many variables taken into account alongside erosion they cited: fetch, directionality, sediment transport, wave action, slope, settling, ice damage, surrounding conditions and public usage.

Low energy areas:

- Reestablishing tidal wetland growth or vegetative cover only works where wave energy is not a factor that constantly eats away at the toe. Occasional boat wake is okay.
- Coir log method works in tidal rivers without exposure to Long Island Sound wave action and significant boat wake.
- Can work in harbors like Guilford Harbor – extensive marsh systems, functioning dune systems, set back far enough and not pounded by winds and wind-driven waves.
- Start with wave intensity and work backward – Long Island Sound's harsh wave conditions preclude living shorelines as a long-term viable solution. The regulatory process is so difficult that even if you get the client onboard they will need to go through the arduous process again after a storm – how many times will it be rebuilt?
- Sites that are less exposed to direct power of large storm events - open Long Island Sound exposure is so great under normal conditions toe can't establish.
- Estuaries where peak wave height doesn't exceed 1.5 feet - Perhaps in upriver places like in CT River – quiet areas that might be appropriate.

Adequate buffer area or setback:

- Sand dunes okay on direct Long Island Sound exposure if they are set far enough back from constant wave action – best chance to stabilize in place only subjected to storm energy – but that is not a typical condition in CT.
- Not much room for dunes in CT - dunes and beach nourishment are major projects on Long Island, New York and New Jersey.
- More effective for coastline yes but not for individual property. Where ever you have the room it is a good idea.

Appropriate land use and conditions:

- Best to look at nearby area to see what is working and why (e.g. dunes, tidal marsh, etc.) and try to mimic the local conditions.
- No critical infrastructure.

- It is important to consider the use – try to work with everybody to understand what is needed.
- Beach community versus I-95 corridor: different mix for different areas.

Question #3: Do any specific examples from the State or elsewhere standout in your mind as exemplary and worth gathering more information on?

Connecticut State Parks:

- Sherwood Island to Hammonasset - shows what soft structures might do in certain spots within the park. State can't fix the erosion issues they are having there.
- Rock Neck State Park: dune creation and alewife project, removed tide gate and culvert – created new dune, however project was blown out during Storm Sandy and creek closed.

Dunes and Beach Nourishment:

- East Shore Park: Dunes failed because they were not properly located and allowed to establish. New Haven wanted to armor – CT DEEP approved small isolated strips of riprap and erosion continued between the structures (Figure 2). A public park does not meet the criteria for structural erosion control and can continue to erode. Engineer modeled wave action and identified lowest energy areas but predicted dune establishment would fail.

Figure 2 East Shore Park, New Haven Harbor

- Walnut Beach, Milford: dunes successful about 15 years – set back is right, good slope and vegetation. Survived Irene and other storms but Sandy got it. Reestablished itself after Sandy, elevation is a little less but re-vegetated well.
- Waterford Town Beach: thriving dune system, just enough protection to work well.
- Some good results on RI coastal bluffs (Little Compton) – stabilized toe, used baffles and silt fence made of coir fabric – very high bluffs difficult to stabilize. Pleased with results because the client hasn't lost any land (good result) but integrity is still in question – one big storm can take out any of these options.

Salt Marsh:

- Salt marsh restoration behind IMAX in Norwalk - mitigation projects are more flexible and a hybrid approach was allowed at the site.
- Milford Head of Harbor behind Coast Guard auxiliary building.
- Wetland restoration in Los Angeles, Long Beach Inner Harbors.

Hybrid Alternatives:

- One firm is in development phase for a residential site in Fairfield County – working closely with CT DEEP on a hybrid application in a relatively high energy area. Proposing lower section stone revetment, pinning toe stone into ledge, reconstructing slope, strengthening with geotech reinforcement and planting – the firm used this application at a private beach club with success because the club is committed to maintenance but there is no regulatory obligation to continue.

Comments on identifying "exemplary projects":

- Monitoring is a big issue for consulting work in general – there is no money to go back over an extensive time period. The consultants do try to monitor their own projects but are not quick to jump on exemplary examples because everything is site specific and there are so many variables.
- Dynamic shorelines move and need to be adjusted in certain ways – some erosion is supposed to happen – need to help clients understand there will be a need to update and maintain.
- Town of Chester development moratorium to protect submerged aquatic vegetation is an example in Connecticut.

Question #4: What concerns do you have about the effectiveness of non-structural designs? Concerns about their durability with respect to coastal storms and to sea level rise? Costs – short and long term?

Effectiveness:

- Because these non-structural approaches/products are under continued development, there are no real standards and their performance under storm-related duress is not well proven. Manufacturers and contractors can often say anything to sell their solution but are not typically reliable.
- No idea how they will work?!? Seawalls are predictable – engineers can figure out the safety factor and longevity. "I can simply build one like your neighbor and people are good with that." "If you tell them we can simply plant some grass but I can't tell you how well it will work." Research and review perspective – review design.

- 50/50 chance of successful vegetation establishment in the best of situations

Durability:

- Contractors have a good understanding of vegetation and stone combinations necessary for stabilizing re-graded banks. Every case requires some adaptation to site specifics. Contractors will tell you what won't work. Any solution which does not include soil retention/confinement and wave attenuation up to "Sandy" waves/wave height will probably have to be rebuilt. Stone seems most suitable because it is natural, resilient, porous and deformable, without failure. Wave energy can be absorbed to an extent.
- Lack of durability – short or long term in more exposed environment – fighting the tides.
- Must communicate with clients – everything requires maintenance and nothing is a perfect solution.
- Increase in sea level rise – biggest threat to any non-structural success of wetland restoration project. CT DEEP needs to change their delineation of wetlands or other regulations to adjust to sea level rise.

Cost:

- Clients are receptive to these lines of design from a cost perspective.
- Client will need to rebuild [non-structural solution] every 5-10 years at about 75% of the cost of revetment that, if done properly, would last up to 100 years. The most practical/ideal solution is stone in many places.
- Clients and contractors are concerned that the design required by CT DEEP won't survive – contractors don't want their names on a project that will fail. Land owners do not want to pay for something that will fail. Liability is a number one concern.

Design Standards:

- No standard design guidance is available, yet engineers are required to certify to 1% recurrence interval storm.
- Need to address design standards and provide guidance/tools before the professional community will be comfortable working in this gray area (e.g. reasonable slope, operating depth, etc.).
- Need to construct to V zone standards in coastal A zones along with free board. Need to go above and beyond FEMA FIRMs – "FEMA doesn't account where Mother Nature will go in the future – rearview mirror on past risk".

Question #5: What hurdles stand in the way of implementing these types of shorelines?

Permitting:

- The CT DEEP permit review process is just too long, inefficient and uncertain with non-engineers reviewing and rendering decisions on permits submitted by certified coastal

engineers with years of on-the-ground experience and training in this specific field. Lack of skilled, professional engineers within CT DEEP is a major hurdle to implementing alternative approaches for Connecticut's coast. Non-engineers at CT DEEP are reviewing permits submitted by Professional Engineers.

- CT DEEP's perception of the statute stands in the way of a lot of things – they seem to be receptive to new ideas but really aren't making changes - historically looking at Chesapeake Bay success but not willing to think outside the box.
- It is easier in NYS – they don't have a policy regarding coastal erosion. CT does have flood and coastal erosion policy and makes poorly based decisions without scientific support (e.g. Gulf Beach Milford project – breakwater would reduce erosion but state denied it. Doing sediment testing with sacrificial sand which is being washed into navigation channel and requires dredging.
- Regulators need to accept that to get 80% of the "oft armoring" they want they should accept 20% of what the client wants for minor structure and toe stabilization (e.g. rubber gabions) but CT DEEP won't budge.
- Most rules and regulations are there for a purpose – sometimes a knee-jerk reaction to a situation in the past.
- Regulatory/permitting process gets down to individuals - can make process difficult and expensive if individual wants to be a pain.

Design and Permitting Guidance:

- Lack of proper design guidance accepted by regulatory, building and engineering communities.
- Some clients just want it to look nice and don't understand how permitting works. Client-friendly guidance on the permitting process (e.g. process flow chart – CT DEEP, Town, CZMA; What/where is the line between soft and hard solutions?)
- CT DEEP will not or is not able to provide standard design guidelines. CT DEEP needs an in-house staff authority on these designs. Engineering community is very willing to assist with this task (e.g. Mickey Marcus, New England Environmental (NEE) to help formulate reasonable specific solutions).
- Rationality – decisions not made with sound science and cohesive plan for how coast should look; Coastal Zone Management Act largely forgotten. Direct impacts often considered from a habitat perspective; indirect impacts sometimes address; cumulative impacts rarely if ever considered resulting in haphazard and fragmented approach to coastal zone management by CT DEEP.
- Coastal analysis of sediment transport changes due to structural approaches (i.e., seawall, bulkheads, etc…) is not often done or required for coastal engineers.

Maintenance/Repetitive loss:

- Lack of regulatory obligation for maintenance in projects that require attention.
- The consultants try to write maintenance into permits to fix as needed and avoid going through the permitting process again (this has not been tested).
- Engineer has suggested a gabion basket mattress with vegetation as part of a 10 year erosion control plan in hopes that CT DEEP will come around to more progressive permitting.
- Engineer would recommend more often if there were assurances from CT DEEP that the client would not be tied to repeating the application if it fails. Suggest setting a threshold for success.
- Performance of non-structural solutions not really issues since even structural solutions fail to work.
- Confidence is lacking from engineers, land owners and contractors regarding site feature protection and restoration. Permitting agencies are not accountable.

Client Acceptance:

- In most locations clients don't want to lose an inch of ground – they want something they know will work and don't see the larger perspective.
- Clients are not happy about the requirements but "non-structural" projects establish a baseline to support hard structures in the future if soft structures fail.
- Consultants have developed their own internal case studies but need client-friendly guidance on permitting process (e.g. what/where is the line between soft and hard solutions?).
- Some clients receptive but there is a mindset of people who want to control (wealthy, used to being in charge and making decisions) and don't listen to advice from other people; only listen when you say what they want to do will not be permitted.
- Public perception and lack of willingness to take a chance with non-structural solutions – not a lot of guarantee that they will work.

Cost:

- Proper solutions usually less costly.
- Exposure and cost – labor is more expensive than materials.
- Cost prohibitive and ineffective to introduce plants at elevations where they will disappear – sea level rise is a new dynamic. For example *Spartina* will migrate but depends on upland.

Question #6: Have you or would you recommend a non-structural shoreline solution to a client? What concerns do you anticipate your client would have?

Three of the firms interviewed stated they have or would recommend a non-structural shoreline solution to a client when the regulatory hurdles are removed with a more progressive, efficient and simpler permitting process. Additionally, five firms stated that it depends on the site, the needs of the client and the confidence of the engineer or designer that the proposed solution will work. One engineer stated that he would only develop for a client who insisted on a non-structural solution and then with caveats and a release of liability.

With respect to client concerns, most firms felt that clients really want a guarantee that the project will successfully protect their property.

- There is a natural inclination to protect an investment in expensive property and they are not willing to accept that the state doesn't care they are having erosion issues. It is an emotional issue - need to be honest that it won't solve every problem.
- The client wants to protect his/her/their property and the consultant has to tell them that most of what they want won't be permitted in Connecticut. The USACOE, New York DEC and RI CRMC are much more progressive and accommodating then CT DEEP.
- Getting client to understand it is not a permanent solution – the tide will still come up and there will still be erosion – this will slow erosion vs. arrest it.
- They are concerned about costs and how money is spent, performance and likelihood of success – it is hard to communicate to clients that there is no guarantee the project is going to work.

Question #7: What information do you have on non-structural regarding the following?

Cost effectiveness compared to common structured shoreline treatments?

- Cost information is developed internally and not readily available. It would be great to have a standard approach to cost comparison and determining effectiveness but it may be difficult to standardize since every project is so site specific.
- Haven't researched cost effectiveness – at the mercy of CT DEEP (what is or isn't permitted) and client (budget).
- Cost is easier to quantify but short and long term performance has not been generated so driven by site characteristics.

Performance compared to common structured shoreline treatments?

- Good case studies and information on dune restoration are available – without armor in front of the treatment it won't survive; the money is wasted.
- FEMA documents that speak to performance are poorly written and fragmented.
- Coastal construction manual is very much needed for Connecticut.

- What conditions are non-structural solutions withstand; what thresholds exist beyond which non-structural solutions fail to function as designed; where are they appropriate or not. Structural solutions have been around a long time and there is a lot of information and experiences – design, shapes and configuration. Experiential learning and modeling has been done with structural solutions. Not true with non-structural to date in Connecticut.
- "Movable Shoreline" – very general discussion, not useful as non-structural design guidance. Would be a good start for CT DEEP OLISP to read this book as a prerequisite for all existing employees as a start.
- ACOE – shore protection manual no longer published (1977); now coastal engineering manual, which is too theoretical – the manual has mathematical equation for evaluating waver properties, instead of assistance on how to properly approach shoreline work.
- CT DEEP points to studies in Chesapeake Bay but these don't translate to CT shoreline well because tide ranges are so different and the unique geomorphology and sediment starved dynamics (i.e., rock dominated, sediment starved and relatively low energy).
- One firm develops information with help from consultants (i.e. soil scientists, botanists, etc.) Nothing they have seen is applicable to CT and they can't judge from their own work because it hasn't been long enough – need 10 years of data.

Additional comments on information:

- There is a gapping void of information, no good literature out there. We need useful, helpful publications that guide non-structural approaches here in Connecticut.
- Useful monitoring data would answer the question: does it work and why or why not? Rather than meeting the requirement of 85% grass after 3 years which is a common target or requirement.
- Damage patterns and extent in the last few years have changed (Lee, Irene and Sandy) – structural vs. nonstructural comparison has not been made.
- The State of Connecticut has just begun to expand thought process on state goals and objectives to include sea level rise – New York State has embraced sea level rise into the regulatory process.
- There may be professional engineering studies on efficacy but so much is effectively predetermined by statute. Engineering analysis (i.e., erosion rate, wind direction, wave energy) only done for a proposed structure that requires justification for the permit.
- Not aware of a Connecticut sources; soils and erosion controls – need that kind of manual for shoreline protection that integrates non-structural approaches like living shorelines ("workbook" approach).

Question #8: What sources do you use when seeking information on non-structural shoreline designs?

When discussing sources of information on non-structural solutions coastal engineers and designers had a varied response with no single clear preference for a particular resource (Figure 3). Based on adjoining comments during the interviews, this response indicates that there is no one clear source or reference resulting in a broad reach across multiple areas including talking with other engineers and personal project experiences.

Information Source		# Responses
Academic Research		3
Army Corp of Engineers		2
Case Studies/Manufacturers		3
Conferences		1
CT DEEP		2
Education or Training (Practitioner's)		2
Engineers/Peers		2
Experience or Eye Witness Accounts		3
Internet		2
Oceanographers		2
NOAA		1

Figure 3: Sources of information on non-structural approaches and design utilized by coastal engineers and designers in Connecticut.

Question #9: What is the state of research regarding non-structural shoreline treatments? What additional information would be helpful?

Natural science:

- There is a large amount natural science literature but not a lot on engineering. Biological data associated with marsh restoration projects is very helpful (e.g. Wipawog River, Milford)
- With Irene and Sandy, lulled into complacency on shore. Sandy was a dramatic high water event, but not sustained high winds or significant waves. People just raising houses up; was more shoreline damage in 1992 nor'easter – caught folks flat-footed.
- How do non-structural approaches perform in a cold weather region with northeast winter storm patterns?

Engineering:

- General lack of information regarding the use and viability of non-structural solutions in Connecticut. Unlike a few other places like Maryland where there are hundreds of examples with longer term monitoring.

- Need hard engineering documentation (e.g., what species are successful; elevation ranges; wave attenuation criteria; performance criteria).
- Need info on permitting implications – explain why dune vs. groins vs. other alternatives and why they should be used.
- In most cases, there is not a lot of information that can be universally applied. Each site has specific exposures, geological/geomorphic features and projects have financial constraints. Studies are frequently so limited that their range of applicability is generally restricted to an "idea" or range of possibilities of what might work at a particular site. Forensic engineering assessment would be helpful for projects already on the ground.
- Engineering information is available from ACOE shoreline protection manual (1984) and the Coastal Engineering Manual (2005) – has a lot of information, history and practical application to the field but is in need of updating. Also ASCE does research and publishes reports.

Economics:

- Economic analysis would be helpful for clients but haven't seen much out there related to non-structural, living shoreline types of projects. Can estimate costs in-house, but no real body of knowledge for Connecticut.

Social science/Education:

- Not necessarily a need for more research, scientific community understands – applying knowledge and educating decision makers.
- CT DEEP living shoreline facts sheets useful for explaining what has to be considered but doesn't help get client's buy-in.
- CT DEEP to be more focused on doing outreach to general public on non-structural solutions. Currently, no outreach on alternative approaches to shoreline management.
- People assume soft engineering options will offer the same amount of protection as hard but that really isn't the case.
- Social component – ACOE, NOAA or other federal agencies need to be connected to help disseminate information on non-structural projects and research.

Monitoring:

- All aspects come into play with monitoring – it would help to understand and monitor projects throughout their life cycle (i.e., what is installed, what techniques, what storms do to it, costs involved).
- Not fair to put the requirements/costs of monitoring on clients – this is a perfect grant opportunity (i.e., create a program to monitor every 1, 2, 3, 5 and 10 years).

- Engineers and designers have interest and desire to see projects over the long term – they revisit projects for visual inspections but would love to do full topographic survey to identify what changed and why over time.

Guidance Documents:

- Guidance in applications in specific situations only helpful to those with understanding – need guidance for layperson or homeowners.
- More research that is helpful in making decisions – could use case studies with all elements of a project available to help increase the comfort level in adapting to certain solutions.
- Would be great to have something like the erosion and sedimentation control and/or 2004 storm water quality manual specifically for non-structural, living shoreline types of applications. A state agency approved policy manual that has flexibility and science integrated into it would be a great advantage to engineers and help clients understand.

Question #10: What questions do you have for the permitting agency in the state regarding the implementation of non-structural shoreline designs?

Guidance:

- Would you please give us more accurate and concise guidelines? The engineers understand that this is currently rather qualitative and it may be difficult to provide clarity but the lack of guidance makes it difficult to minimize ambiguity for clients.
- What defines the need for engineering or hard structure? Outline from David Blatt (CT DEEP) at Coastal Erosion conference was a good start – changes to amend coastal jurisdiction line are helpful. Could use a good fact sheet for coastal property owners to describe regulations and permitting process (i.e., permitting flow chart).
- Can the State be more helpful in terms of implementation particularly on questions like "where and when can nonstructural solutions be successful?"
- What is the definition of living shoreline? Where and what are examples of this in Connecticut or elsewhere that are directly applicable here in Connecticut?
- What are the design criteria the State envisions related to projected success rate and/or recurrence survivability?
- Who is responsible for ensuring success when a non-structural design is required? Engineers want to see these solutions work but there is not enough experience and design criteria yet. Data needs to trickle down to states from larger projects through federal programs like ACOE. Mandating at the state level puts the burden of research on the client versus requiring State Agencies to step up.
- Is CT DEEP concerned about unintended consequences or short-term impacts of softer solutions (e.g., localized response of system, reduced sediment transport, regime

change flooding issues)? CT DEEP OLISP staffed predominantly by biologists – no engineers on staff. Generally, CT DEEP staff is learning as they go regarding engineering and coastal processes. Even softer solutions that are easier to permit have the potential to impact shoreline and coastal processes. There is still benefit to a review process to explain why a proposal would work.

Policy:

- Why are decisions made via blanket statements rather than on a site specific basis? Universal application of policy without looking at site factors. CT DEEP needs to be on-the-ground with projects to better inform the outcomes and build a relationship with coastal engineers and designers.
- How can the state agencies (particularly CT DEEP) quickly make it easier for people who want to try these designs to put them in place along the Connecticut coast? How will state agencies make it easier to try again if it doesn't work? If this takes too long (i.e. statutory change, long implementation) folks that want to try now will not be able to do it or not have interest in the future.
- Many in the engineering and design community have given feedback to CT DEEP in focused meeting when requested but nothing ever happens. CT DEEP is out of date and sometimes incorrect with their decisions on permits and projects that will advance a progress approach to coastal management on non-structural projects like living shorelines.
- Why is CT DEEP willing to forgo any beneficial project that meets the overall goal because of 10% of a project is not identified as appropriate – lack of flexibility results in stagnation? Statute doesn't provide definition of non-structural – just an interpretation.
- Why does any percentage of structural components cause the entire project to be considered structural? CT DEEP could satisfy their mandate more successfully and reduce the amount of hardened shoreline if there was greater flexibility during project review and permitting. (Consider up to 51% natural – if it is impairing natural function can't say it is natural)
- CT DEEP's inflexibility leads to unintended consequences (e.g., untreated stormwater runoff, erosion of upland sediments which aren't beneficial to accretion, etc…) that ultimately harm the environment and run counter to their mandate for the citizens of Connecticut.
- Why is CT DEEP so concerned about not armoring the shoreline? If property owners are not allowed to do it now they may lose properties and then the next line of properties or roads/infrastructure will be vulnerable. Where do you start to control the damage? When did property owners lose the right to protect their property? Statements about

depriving the public of the continued degeneration and degradation of coastal shorelines seem irrelevant in the face of more intense and frequent extreme weather.

- Has CT DEEP considered a more balanced approach in staffing? Rhode Island assigns a biologist and an engineer to each project for analysis. New York and Massachusetts are generally more science based on coastal issues. This gives consultants more leeway to drive the project design – including state engineers could help provide a balance perspective to softer solutions.
- Why doesn't Connecticut have a more transparent set of regulatory policies and requirements like Rhode Island Coastal Resource Management Council? Redbook provides soup-to-nuts information about what is allowed in different water types – it is not perfect but transparent. Connecticut is a moving smoke screen just based on experience with what has gone through in the past – only a very fundamental guideline documents available which is simply adequate. Better guidance and transparency would be beneficial for both parties (i.e., relieve stress amongst CT DEEP staff).

New Design and Technology:

- How can we define what is allowable, while integrating flexibility to "push the envelope" for improved designs and concepts in Connecticut?
- Can you consider a "Research and Development Permit" that allows new technology and incorporates reporting and monitoring without permanently tying applicants in the event of multiple failures? Must be flexible – a precedent exists with saltmarsh restoration work (Paul Cap) developing testing applications through a peer group of professionals and overseeing work.
- What does the state think should and can be done to encourage the use of these projects that require permitting? Need to build up a history and case study of how these non-structural living shoreline type projects work in Connecticut over time.
- What is the future for non-structural designs in Connecticut?
- What are the implications to adjoining properties from a "no adverse impact" perspective on structural and non-structural approaches? How is this be better addressed in the application/permit review process?
- Has CT DEEP considered state grant funding for special projects to build case studies in Connecticut? State or federal funding could help cover additional costs for project monitoring – requirements could include additional steps for consultant (monitoring component – 1, 2, 3, 5, 10 years, reporting, post-event monitoring) and added benefit to client (slightly easier review process).

Summary of Interviews

State Regulators:

The Connecticut Coastal Design Project survey questions were designed to help develop a comprehensive understanding of the principal opportunities and challenges to advancing non-structural/natural infrastructure projects along Connecticut's coast as well as inland waterways. An interview was conducted in-person with a team of CT DEEP staff from the Office of Long Island Sound Programs. Participants responded to the following series of questions. In addition, the interviewees were asked to add any additional information they felt would be relevant or helpful to the discussion. All information was collected and coalesced by question across all respondents.

Question #1: What types of projects or designs come to mind when you think of "soft armoring" or "non-structural" shoreline alternatives for Connecticut? Are there other ways or phrases you would use to describe these projects?

This question prompted a variety of responses as follows:

- The Coastal Zone Management Act discourages the hardening of shorelines here in Connecticut. Vegetating slopes and creating dunes and/or salt marsh as alternatives to wall and revetment are valid approaches but there needs to be a coastal process analysis to better integrate these more natural infrastructure into site plans.
- "Living shorelines" is a term used frequently and is now in state statute as an example of non-structural alternatives. This often requires adding materials in the water (sills) which have impacts on intertidal habitat. While these approaches can protect resources and property there has to be a natural resource component in the design.
- There is a recognized need with coastal resilience – existing natural infrastructure act as natural buffers and there is a need to incentivize natural solutions.
- While approaches may meet technical definitions of living shorelines or the statute these approaches need to be functional.
- Often the paradigm used to define natural infrastructure alternatives in that of Chesapeake Bay where projects typically use sills and back filling over time.
- In some cases living shoreline is being coupled with hard armoring versus the default hybird approach. (example Old Lyme).
- There is a perceived need for seawall versus real need amongst residents here in Connecticut – walls provided protection from the public's view.

Question #2: How has Irene, Sandy, or other recent storms informed or changed CT DEEP's review of or regulatory context around non-structural designs and implementation?

- Hard structures can in some cases increase the impacts of storm events particularly through increased erosion of adjoining processes. Amongst the public the recent storm events have increased the perceived needs that walls are more needed.
- The recent events highlight the need for documents to educate the public and guide engineers.
- A key question that has surfaced is how much collective confidence is there in non-structural approaches amongst the public and professionals? First step is that the regulators need to be educated or have the information to make suggestions. Need to have confidence that it will be around for 5-plus years. Need higher sense of confidence via case history that have worked or failed and why. Documentation that highlights the impacts that hard structures can have on amenities and public/private structure. Need to work on increasing the comfort level.
- Coastal zone is complicated – anything you do is starving sand?
- The recent events require broader considerations – shift from single property focus versus multiple property.
- CT DEEP doing shoreline erosion study to better understand dynamic system.
- Heightened the pressure political and otherwise to help private property owners to protect property – hard structures are the principal method to do this. Again there is the perception that walls are more effective versus living shoreline. Private property – is a small minority – reframing issue to appear like special interest (coastal private property owners) are taking away from us.
- Flooding will happen regardless of what you do as SLR rises.
- Flooding versus erosion – coastal communities are getting hit from both ends. We are already having a big change in rainfall patterns and acceleration from SLR.
- Public is focused on rebuilding and raising wall and creating uniform heights across adjoining properties – makes you feel safer.
- CT DEEP is not interested in permitting the raising of walls without new flood/erosion control structures – re-grading behind wall is required to trigger new review.
- CT DEEP has allowed the low wall in the middle to be raised to match the adjoining property heights.

Question #3: Do any specific examples from the State or elsewhere standout in your mind as exemplary and worth gathering more information on?

- The state of Maryland is a good example – incredible program – living shoreline program has implemented between 700-800 projects to date.
- Within the state Connecticut there are a few projects to consider:
    - Lordship Point - Stratford
    - Old Lyme (not so good)
    - East shore park – New Haven
- There need to be a stronger recognition with these types of projects and structural approaches that there is no such thing as a "zero risk solution".
- Public access requirements and needs to be incorporated.
- Public access is important coupled with healthy natural resources (which can improve real estate value).
- There is a suggestion that the cost/benefit of living along shoreline will be impacted with more armoring.
- Across much of Connecticut's coast there is limited space in low energy places – need to have room for living shorelines.
- Structure (sill) is possible but not a flood and erosion control structure.
- Living shorelines are not designed to protect you completely – slows erosion and provide a natural barrier – long-term results in slower changes.
- Healthy dunes/marshes are existing shorelines and serve as better buffers. Any specific projects that focus on restoration should be considered as a non-structural project.
- Geo-tubes at Fenwick – deflated after Sandy but they retained more sand then other places.
- Question regarding what is non-structural? Beach community's berming up sand and pushing it in front of private homes? Is this living shoreline kind of efforts or is this adaptation?

Question #4: What concerns do you have about the effectiveness of non-structural designs? Concerns about their durability with respect to coastal storms and to sea level rise? Legal recourse in the event of failure as compared to structural design?

- Permitting does not mean or provide assurance that a specific project will work or not – property owner want to sue because their living shoreline failed they would go after consultant and then in very remote circumstances the state.
- Consultants need to take a very conservative route – lowest risk solution to a client's property – given the potential liability.

- CT DEEP is concerned about having to believe what the coastal engineers and designers tell them – if they say it is so they we have to accept it.
- One of the concerns involves the minimal structural integrity an engineer can certify to – withstand x amount of velocity – comfort and discomfort with structural versus non-structural from the engineers and designers.
- Natural systems and natural protection along Connecticut's coast are limited due to previous development.

Question #5: What hurdles stand in the way of permitting non-structural shoreline treatments? What information is needed to assuage potential hurdles to enable permitting these alternatives?

- CT DEEP sees no hurdles to permitting non-structural projects given the new legislation.
- Conversion of resource – sills in intertidal structure – requires consideration of tradeoffs by CT DEEP. Living shorelines – intersection of many tradeoffs.
- The emphasis currently is on the actual impacts of a proposed project and not so much the longer term integrity or function of the project.
- Core logs versus seawall – core logs with maintenance plan? No to seawalls but okay with core log even if it needs to be replaced every 2 years.
- Long term cost/benefit is not currently examined or reviewed.
- Short-term private perspective – works against the public trust in some cases.
- Applicants are not looking at the public trust when considering responses on their property.

Question #6: What information do you have or need about non-structural alternatives?

- Successes in other areas – resiliency over several years
- Long Island Sound is different than other systems like Chesapeake Bay
- Precedent setting – consider the use elsewhere.

Question #7: What sources do you use when seeking information on non-structural shoreline designs?

- Long Island Sound Study - sentinel monitoring program
- Connecticut Sea Grant - Riparian/landscape coastal planting guide
    - Designed to appeal to home owners

Question #8: What questions do you have for coastal engineers or coastal scientists regarding the siting and implementation of non-structural shoreline designs?

- What do they need to become more comfortable with living shorelines? How can they sign off of structural/nonstructural components?
- What training do they need to better understand the design of living shoreline?
- Agency does not have the resources to pull together folks.
- Design manuals – state/federal documents?
- What design standards do you use or need?
- Coastal design process like this workshop that pull together diverse stakeholder to have discussion.

Additional Comments

The following are general comments secured during the interview once the specific interview questions had been addressed.

- There is a need to come up with a more reasonable plan to do armor stone (nature's way). Need to give people a reason to hope and permitting agencies must be more realistic about the approaches to be condoned.
- Should we collectively use FEMA flood elevations as armoring limit? Why reinvent the wheel, otherwise each agency will have its own (arbitrary) limit. If FEMA can set an elevation that a structure must be protected to then the same elevation should be used for upland owners to protect their land.
- Permitting in NY and RI is much more straight forward than CT (doesn't always result in a better product but the permitting is more uniform and transparent in both states). NY DEC recognized the need to do a better job with balance because land owners otherwise could just lose everything. RI CRMC Red Book is an appropriate guideline for lower energy shorelines. The Red Book should be replicated here in Connecticut.
- Other state's agencies seem more receptive to gaining engineering understanding through education. Without proper engineering and design education the state agencies naturally take a defensive approach to shoreline armoring.
- CT DEEP permitting approach is too limiting. Connecticut's approach is tough on private landowners and almost non-existent on CT DOT or Town/City projects because they are dealing with "critical" infrastructure or regarded as water dependent.
- There is a perception that national shorelines are going to erode. Storm armored shorelines are also going to erode but hopefully at a dramatically reduced rate. We collectively simply don't know enough to say either way.

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