Town of Chatham Community Resilience Building Workshop Summary of Findings Final Report

June, 2019






Prepared by Applied Coastal Research and Engineering
For the Town of Chatham, MA

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Overview

This report summarizes efforts by the Town of Chatham to prepare for the future and build resiliency towards a changing climate. As a coastal community, the Town of Chatham and its residents have a high awareness of the need for addressing vulnerabilities and risks associated with natural hazards and climate change. With an apparent ever-shifting Chatham shoreline, exemplified by recent new inlet formations, it is important for the Town to undertake proper steps to plan for vulnerabilities and increase coastal resiliency. Participation in the Massachusetts Municipal Vulnerability Preparedness (MVP) Program is the latest example of an undertaking the Town has made to plan for natural hazards, coastal and community resiliency, and climate change.

In 2017, the Commonwealth announced the MVP Planning Grant Program. The MVP Program is designed to provide support to cities and towns to complete community-based climate change vulnerability assessments, increase community awareness and by-in of these issues, and develop action-oriented resiliency plans. The program provides funding for communities to run Community Resiliency Building (CRB) workshops with local stakeholders. Municipalities who complete this process and develop a final report will be designated as an "MVP Community," which leads to increased standing in other state grant programs, including additional MVP Action grants.

This *Summary of Findings* report presents the results of the CRB workshop held on Chatham on May 1, 2019.

Community Resilience Building Workshop

A core team of key internal stakeholders was initially created to plan and establish goals for the MVP process. These individuals, along with Applied Coastal Research and Engineering (Applied Coastal) identified twenty-seven participants with a variety of experience and perspectives to attend the CRB workshop. Participants backgrounds ranged from local neighborhood associations, conservation groups, historical and cultural resource organizations, small businesses, and members of town departments/committees.

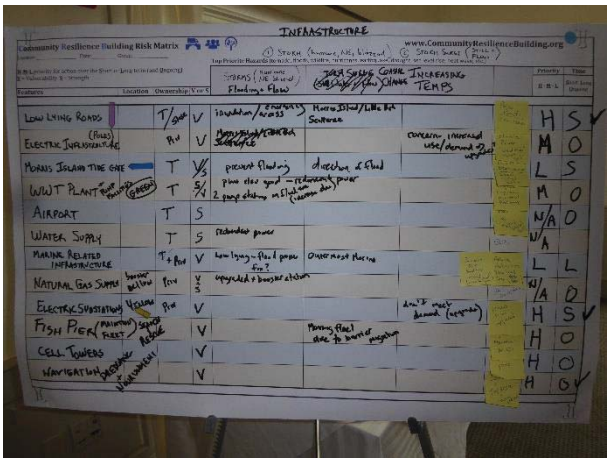
The Workshop's stated goals were to accomplish the following:

1. *Develop a mutual understanding and respect around natural hazard risks, vulnerabilities, and resilience options in Chatham using a consensus building process.*
2. *Define top hazards faced by the Chatham community.*
3. *Identify vulnerabilities and strengths with regards to Climate Change in Chatham.*
4. *Develop risk profiles for Chatham's assets including infrastructure, society (social environment), natural environment, economy and historic assets.*
5. *Develop actions that reduce vulnerabilities and reinforce strengths for the community.*

6. *Document the top priority actions to reduce the impact of hazards and increase resilience in the community.*

The workshop combined group interactions between all participants, in addition to small, breakout discussion groups. Before starting the small team breakout sessions, participants listened to a presentation about other related municipal initiatives currently underway, the types of hazards that can threaten the community, and the impacts that climate change is expected to have on those hazards. Following this presentation, participants were directed to three separate "small team" tables, of roughly 10 persons. Each group was intentionally comprised of individuals with different roles, responsibilities, and expertise to foster an exchange of ideas and opinions. The variety of experiences between participants promoted unique discussions for each group. Each small team, participants engaged in dialogue to identify the top hazards faced by Chatham, the key strengths and vulnerabilities of the Town, and actions that could be taken to support strengths or protect vulnerabilities associated with the top hazards listed. Following the small group discussions, all groups convened in a larger discussion to share their respective ideas.

Features



To begin, each small group completed the CRB matrices for infrastructural, environmental, and societal features of Chatham. Features were identified as specific locations or general systems that are relevant in the context of resiliency. These features were categorized as strengths, vulnerabilities, or both. Discussion groups had some unique responses, however, there were many common themes allowing further grouping and prioritizing later in the meeting. Features of the discussion are listed below for each team:

Table 1 Summary of the Features and Category and Concerns discussed by each Team.

Category	Feature	Discussion
	Infrastructural	
Beaches and Coastline	Southside Beaches	• **Low-lying and prone to flooding/erosion** • **Loss of recreational value** • **Few properties (mostly recreational)**
	Shifting Barrier Islands	• **Shifting navigational channel** • **Wave exposure through breaks** • Increased storm surge
	Little Beach	• **Low-lying properties and roadways, prone to flooding**
Energy and Communication	Electrical Infrastructure	• **Flooding of electrical systems could be problematic**
	Substations	• **Capacity issue, cannot meet demand** • **Need to consider upgrading**
	Cell Towers	• **Dependence on them**

	Natural Gas Supply	• **Moratorium Issued**
Tourism	Fish Pier and Commercial Fishermen	• **Prone to flooding** • **Needs improvements to safely support the public while properly servicing the commercial fishing industry**
	Downtown Infrastructure	• **All service industry is downtown**
Transportation	Low-lying Roads	• **Can isolate sections of town during storm events (e.g., Morris Island)**
	Airport	• **Important to maintain for local and regional response, search and rescue, and supplies in an emergency**
	Navigational Channels	• **Permitting issues as permits only allow for a short time window to dredge** • **Shifting shoals create ambiguity in terms of dredging location**
	Marinas and Other Marine Related Infrastructure	• **Town is spending millions on public waterfront infrastructure** • **Designed to be resilient to sea level rise of intermediate projections**
Water Supply and Wastewater	Fresh Water Wells	• **Locations of water tower and wells are in high elevation locations** • **Wells have their own generator** • **Water use/demand very high in summer** • **Need for additional wells in the future**
	Treatment Plants and Effluent Water Quality	• **Town is implementing its comprehensive plan to sewer throughout the Town** • **Phasing of installation based on priorities for water bodies most vulnerable to nitrogen loading**
	Septic	• **Most properties have septic tanks (85%)** • **Sea level rise impacts to septic**

		systems may modify priorities of sewer locations
Environmental		
Beaches	Barrier Beaches	• **Offer protection as a buffer from storm waves and surge** • **Even with sea level rise of 3 feet, some form of the barrier beaches are expected to remain in tact**
	Recreation	• **South-side beaches are popular for tourists in the summer** • **Important for town-wide economic viability & revenue generation**
	Nourishment	• **Dredged sand from navigation channels available for nourishment**
Fishing	Shellfish	• **Need to look at if/how ocean acidification might affect shellfish** • **Groundfish stocks changing due to warming ocean waters**
Terrestrial Resources	Conservation Land	• **Chatham has considerable conservation land with over 1,000 acres** • **Need to maintain**
	Sylvan Garden	• **Important green space for the town**
Water Bodies	Pleasant Bay	• **Important to keep clean as it is important provider of recreation, tourism, and shellfishing**
	Marshes	• **Storm protection capabilities when inundated**
	Muddy Creek	• **Provides wetland buffer, mitigation for nutrient loadings, and resource area**
	Mosquito Control	• **Increased breeding habitat with increased water levels**

	Pollution/Fuel (Marine)	• **Containment of fuel depots during storms**
Societal and Cultural		
Communities	Pleasant Bay Alliance	• **Steady agenda with watershed coordination of the towns** • **Continue to seek grants.** • **Current grant effort seeks funding for salt marsh study to preserve function under sea level rise scenarios**
Housing	Seasonal	• **Many residents renting in the off-season are unable to find affordable housing in the summer and must camp for the summer**
	Affordable Housing	• **Not much affordable housing available year-round** • **Potential for accessory unit expansion in Town**
Populations	Young Families	• **Young families are moving out** • **Chatham 365 program is dealing with the issue**
	Elderly/Retired	• **Active senior center to expand services** • **Variety of private elderly housing options within Town**
	Seasonal Workers	• **Difficult to find staff with expensive housing**
	Winter Population	• **Less resources necessary to cover fewer people**
School Enrollment	Cape Tech, Monomoy Regional	• **Tough maintaining sufficient enrollment to fill programs with the loss of young families**

***Appendix XX includes photos of the matrices completed by each team.**

Top Hazards

Discussions regarding the top hazards faced by Chatham showed a large degree of agreement

between different teams. Participants identified a range of hazards, including flooding, high winds, sea level rise, coastal storms, barrier island movement, inlet formation extreme high temperatures, extreme low temperatures, drought, and wildfire. Human-related "hazards" such as pollution and overdevelopment were also noted. Ultimately, each small team arrived at four to five top hazards as follows.

As many of the top hazards were common between small teams and similar in character, the list of top-priority hazards identified in the workshop can be condensed to the following:

- Coastal Flooding
- Erosion
- Shifting Shoals
- Sea Level Rise

The specific concerns related to the top hazards are laid out in Table 1:

Table 2 Top Concerns Related to Hazards

Concern	Feature of Concern
Shoreline Management and Resiliency	1. **Little Beach** 2. **Barrier Islands** 3. **South Side Beaches** 4. **Pleasant Bay** 5. **Cedar Swamp**
Access to Water and Navigation	1. **Shifting Shoals** 2. **Dredging** 3. **Public Beaches** 4. **Marinas**
Housing and Sustaining Populations	1. **Seasonal Workers** 2. **Young Families** 3. **School Enrollment** 4. **Elderly Population** 5. **Affordable Housing**
Flooding and Sea Level Rise	1. **Low Roads/Neighborhoods** 2. **Pleasant Bay** 3. **Fish Pier** 4. **Water Supply** 5. **Morris Island** 6. **Wastewater Treatment**

Once the features and top hazards of Chatham were discussed, workshop participants then categorized each one as a strength or vulnerability, in addition to assigning a priority (i.e., high, medium, or low). These include features that are vulnerable to climate hazards, those that are strengths with regards to community resilience, and those features that are both vulnerabilities and strengths.

Infrastructure

Elevation (S)

Most of Chatham's residential areas were built in elevated parts of town, the natural elevation ensures that most properties are protected from flooding events (nor'easters and hurricanes). Homes built at a lower elevation may need to be raised, an action discussed in the next section. Other important infrastructure (municipal, private, public utilities) were also built at elevations above the floodplain, including wastewater treatment plants and most of the town's wells.

Zoning (V)

Some groups discussed their opinion on current zoning regulations. Groups were mostly in agreement that homeowners should be allowed to raise their home, but limits on elevation which were put in place to protect the character and feel of the Town, are in question regarding the need to raise houses further above the flood plain. Current MassDEP Wetland Protection Act regulations prohibit coastal engineering structures (e.g. revetments) to protect homes from erosion built after 1978. It is anticipated that most properties eligible for revetments will choose to harden their shoreline in lieu of other more natural "soft" alternatives which may exacerbate erosion issues elsewhere and result in a net loss of wetland resources. These were important considerations when discussing limitations of personal home protection.

Low-Lying Road (V)

Several important roads are low lying and flood during storm events. For example, Morris Island is only accessible from one low-lying road and can become isolated and inaccessible during high storm tides. Participants discussed the decision of whether it is appropriate to fund projects to raise non-major roads, the Town's ability to respond to emergencies during floods serviced by the low-lying roads, and if the length of time flooding occurs mitigate for the occurrence.

Wells & Water Supply (S)

The Town's seasonal population expands greatly during the summer and water usage and demand can outpace water supply. The Town's fresh water extraction wells and water towers are built at elevations well above the flood plain and have backup generators. Two additional wells are soon to become operational expanding the Town's ability to supply fresh water. Additional regulations on sprinkler systems have been implemented which should help control the future water demand at a rate the system can absorb.

Navigation Channels (V)

Navigation channels behind the barrier islands within Chatham Harbor are constantly shoaling and changing position due to the dynamic morphological movement of sediment as the harbor adjusts to evolving multi-inlet configurations. Dredging and maintaining these channels is difficult from a regulatory standpoint as the best location for a navigation channel rapidly shifts and moves and the regulatory process does not adjust at the same rate of change. Therefore, dredging within the Harbor requires adaptive management as the dredging is costly and technically challenging regarding availability and use of proper dredge equipment and dredged material disposal options. Choosing the most effective time for dredging is further complicated by fisheries Time of Year (TOY) work restrictions. Chatham will continue to investigate further adaptive management permitting strategies with regulatory agencies to allow flexible dredging and disposal methodologies.

Environmental

Coastal Resources Department (S)

Chatham's position of Coastal Resources Director employs is unique to most coastal towns. The appointment provides the town with a full-time position to evaluate and plan for coastal challenges and decisions faced by the Town and better manage coastal resources. Continued support of this position is important to keeping Chatham on-track with its resiliency goals.

Fish Pier (S/V)

The Chatham Fish Pier is the largest commercial fishing port on Cape Cod and is an important asset of the Town. The Fish Pier is also a major tourist attraction and the most-visited tourist destination in town. The building itself is low-lying and at risk of flooding during storms.

Maintaining and protecting the Fish Pier from future storm events will require significant costs from the Town.

Figure 1 Chatham Fish Pier during a northeast storm event.

South Side Beaches (S/V)

The south side beaches are important as they are a draw for summer tourists, help support a robust summer rental industry, and serve the Town as a buffer for storms with winds out of the southern quadrants. However, many of these beaches have sediment deficits and experience increased erosion rates requiring sustained nourishment. The erosion of south-side beach shorelines results in less tourism and resulting revenue generation for the town. Fortunately, neighboring navigation channels provide a source of sand for the beneficial use of dredged material to combat erosion along these shorelines. Chatham's Board of Selectmen has endorsed implementation of a beach nourishment program and supports routine funding for the program in the Town's budget as needed.

Pleasant Bay (S)

The 9,000-acre estuary of Pleasant Bay is a state-designated Area of Critical Environmental

Concern (ACEC) and represents a central asset to Chatham and the neighboring communities of Harwich, Orleans and Brewster. Pleasant Bay provides important water access and serves as nursery area and habitat for a wide variety of fish, shellfish, and other aquatic animals and wetland resources. The shorelines and marshes provide important food and habitat for shorebirds and other waterfowl. The fringing marsh systems provide wave attenuation and erosion protection to upland property. Continued support and preservation of Pleasant Bay by the Town, the Pleasant Bay Alliance, and other non-profit organizations are important for the well-being of the Bay.

Shellfish (S)

Chatham has some of the largest wild shellfish landings in Massachusetts which are vital to the Town both recreationally and commercially. Of the numerous species of shellfish found along the Chatham coastline quahogs, soft-shell clams, blue mussels, razor clams and scallops (when available) are the most popular for fishermen. The Town has a substantial shellfish propagation program that includes a shellfish upwelling system in Stage Harbor to facilitate the grow-out of seed quahogs, scallops and oysters. This program is critical for a stable and sustainable shellfishery for the Town's commercial and recreational fishermen. The Town is developing plans for a new shellfish upwelling facility to further augment its propagation program. Mosquito Control (V)

Warming temperatures and higher water elevations provide more opportunities for mosquito borne diseases as breeding areas are expanded. Varying degrees of control in other towns will have an impact on Chatham. Partnership with other towns to combine forces and improve control efforts is important moving forward.

Social and Cultural

Committees and Public Involvement (S)

Numerous committees in town allow for public involvement. One small group recommended that term limits for committee members would allow a more diverse set of residents and perspectives which might benefit the Town. This may be difficult to implement since it is often difficult to get qualified volunteer applicants for various committees.

Town Government (S)

Chatham has been proactive in addressing the challenges that face not only the local community but other Town's across the Cape. This approach has let the Town take the lead in

addressing wastewater issues, begin to restore and enhance natural resources, maintain the character of the Town, and address critical issues as they arise.

Elderly Population (S/V)

The Town has an active and growing elderly population. The Town's senior center has plans to continue to expand its services, but is dependent on funding coming through Town Meeting. The Town has a reassurance list call program to check-in with residents on the list. If there is not response, a police officer will stop by the residency to check-in. Elderly residents not on the list are often the ones most at risk during storms, and therefore should be advised.

Regional Shelter (S/V)

The number of individuals that make use of the warming/cooling center should be monitored in emergency scenarios to develop plans. Warming and cooling centers are being established and the Town is investing in backup generators for these facilities. Currently there is a lack of volunteers to open and staff these stations and consistent or dependable transportation to the shelters is an issue.

Wealth/Affordable Housing (S/V)

The strong housing market and generally affluent population in Chatham provides a strong tax base, allowing the Town to provide a wide range of services for its residents. However, due to the large percentage of non-resident second homeowners and high median value of homes, living in Chatham is not affordable for many mid to low income families and workforce. Families are sometimes forced to camp at Nickerson State Park and other local camping sites during the summer, as they are unable to pay rent during summer months. Construction of affordable housing units was an important topic discussed among all the CRB groups.

Top Recommendations to Improve Resilience

After identifying top hazards, challenges, and strengths, each small team discussed possible actions that could be taken by the community to mitigate hazards, protect vulnerable assets, and support existing strengths. Actions were then prioritized. All high-priority actions from each working group are summarized in Appendix A.

Following the individual group discussions, all workshop participants were brought together to decide on the full group's top recommendations. Each small team shared their top three or four actions with the full group. Similar actions were consolidated with a resulting list of 9 high-priority recommendations. The results of this discussion are presented in the table below.

High Priority Recommendations

1. *Shoreline Management and Resiliency*

Chatham must continue to plan for a resilient future with climate change in mind, especially in terms of shoreline management strategies. Some examples of actions the town can take are:

- Review and improve local zoning bylaws and development/building regulations. For example, assess if low lying property owners should be permitted to raise their home further than currently allowed with sea level rise in mind.
- On Pleasant Bay, encourage other towns (i.e., Orleans, Brewster, and Harwich) to collaborate to create consistency across communities with respect to the standards, interpretation and enforcement of the local bylaws and regulations (zoning and wetlands protection).
- The existing FEMA flood elevations should be reconsidered as several powerful storms have recently inundated the coast.
- Dune nourishment, planting, management, access, stabilization, continued measurement of accretion and erosion, and innovative restoration and stabilization approaches.

2. *Access to Water and Navigation*

Participants believed that all residents in town should have access to water, and it is important for the Town to maintain those access points. It is also important to undertake dredging where necessary to maintain navigational access. Some methods to ensure everyone has access to Chatham's waterways include:

- Existing permitting methods should be flexible to allow for a rolling dredging periods and variable dredging areas depending on the location of shoal features. The Town needs to continue working with state and federal regulators on this adaptive approach.
- Continue use of dredged material as beach nourishment for erosion and flood protection and to widen south-side recreational beaches.
- Continue to maintain marinas and public access points to water.

3. *Housing and Sustaining Populations*

Housing prices in Chatham are high, forcing many families to move elsewhere. Each group

prioritized the importance of making Chatham more accessible to moderate/low income and young families. Vulnerable and elderly populations must be taken care of in a storm event. Some actions the Town can take include:

- Construction of apartment style housing to increase the availability of affordable housing.
- Support work done by Chatham 365.
- Develop a database or registry of vulnerable populations, and a comprehensive plan for emergencies and power outages.
- Looking to expanding housing opportunities within town by supporting a greater use of accessory dwelling units.
- Seek ways to retain younger year-round families within town.

4. *Flooding and Sea Level Rise*

Flooding events will increase in extent and frequency as a result of sea level rise. Chatham should develop a plan for vulnerable or isolated sections of town during flooding events by:

- Consider alternative means of power generation and supply in emergencies, including green energy, generators at private service stations, and large generators to support services during storm events. Many of the Town facilities have installed or plan to install the necessary generator equipment.
- Prepare plans to reduce flooding and improve access on emergency evacuation routes and key access roads, including the causeway out to Morris Island and other similar roadways. Raising these roads to provide safe dry emergency access is one possible solution.
- Address private septic systems likely impacted by sea-level rise in the future.
- Evaluate alternatives and implement measures to enhance coastal resiliency along Chatham's eastern mainland shoreline associated with predicted changes to the outer beach and inlets.

Medium and Lower Priority Recommendations

In addition to the high-priority actions chosen by the above, the working groups developed additional recommended actions through the process, which were prioritized "medium" and "low" priority actions:

Medium Priority Actions:

- Address the risk of contamination from waterfront sites (docks, marines, marine sheds, etc.) that have fuel depots at and are subject to coastal storms and erosion. The groups expressed concern about containing contamination at fuel storage areas during storm events. Ensure the Town and facilities have spill response plans and conduct regular prevention inspection to assess for corrosion, vulnerability, and upgraded to best practices if necessary.
- Evaluate areas and homes that have regular repetitive loss claims and determine the causes and possible solutions to reduce the frequency of damage. Potential solutions include relocations, elevating, changes in zone or building codes to assist with relocating or raising structures.
- Educate the public and real estate professionals so residents and prospective buyers understand

the risks and responsibilities of owning coastal property.

- Identify vulnerable areas and inventory private septic systems likely to be impacted by sea-level rise in the future. Local regulations may need to be developed to address/manage this issue. Phasing and build-out of the sewer system may need to be modified or extended to replace abandoned/failed septic systems and those expected to be impacted in the future. Consider ways individual neighborhoods could pay for construction of extended sewer systems. Need to consider long-term planning.
- Local regulations (zoning, planning, building, and conservation) may need to be revised or further developed to address/manage sea level rise and increased storm damage. Consider existing regulatory guidelines to analyze 10- to 20-year vulnerabilities and plan how regulations may need to evolve and change over time. Potentially limit future development in high risk areas.
- With regards to bridges and culverts, there should be more public outreach for stormwater management, and culverts should be assessed to determine the proper size for maintaining adequate tidal range and a healthy ecosystem, as well as for preventing flooding. Various funding opportunities to provide on the ground assessments of bridges and culverts necessary for this evaluation should be sought.

Low Priority Actions:

- With increasing temperatures and flooding there was concern about mosquito control and potential increase in breeding habitat as sea level rise expands their natural habitat. The increase in mosquito populations could result in large public health issues by transmitting deceases. The groups concurred this should be addressed within the existing framework of Barnstable County Mosquito Control as opposed to individual Town's seeking solutions independently.
- Morris Island tide gate was originally designed specifically for southern flooding events related to hurricanes. The gate is antiquated and should be re-evaluated to determine its function, benefit, proper operation and then upgraded as appropriate. The assessment should include an evaluation to determine if it can also function to accelerate release of floodwaters from eastern flood events.
- To help maintain the water quality with the Town's estuaries, continue to address low lying septic systems that will likely be impacted by sea-level rise in the future as part of the Town wide Waster Water Management Plan. The Town already has a plan and is implementing it over a phased rollout system.

Conclusions

The Chatham CRB Workshop demonstrated the Town's commitment to implement resilient adaptations to prepare for future climate change. The significant agreement between the different stakeholder groups regarding strengths, vulnerabilities, and potential resiliency for Chatham is a promising sign moving forward. An important outcome of the process was identification of many existing *strengths* the community has available to combat climate-related hazards. Chatham has made great strides in implementing resilient strategies to their future planning initiatives.

The MVP Core Group will continue to meet regularly to pursue actionable recommendations stated in this report and to develop additional pursuits as a result of the data collected in the Community Resilience Building Workshops. The Core Group will focus on high priority and policy recommendations as a first step. Having completed the MVP program, Chatham will become certified by the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) as an MVP community and therefore eligible for MVP Action Grant funding. The MVP Action Grant provides funding to pursue priority climate resilience actions as identified through the MVP Planning Grant program. MVP certification also increases Chatham's standing for other grant opportunities from the State.

Acknowledgements

May CRB Workshop Participants

Table 3 Workshop Participants

Name	Affiliation
Jack Farrell	**Realtor; Land Bank/Open Space Committee**
Ted Keon	**Coastal Resources, Town of Chatham**
Robert Duncanson, Ph.D.	**Health and Natural Resources, Town of Chatham**
Bob Ryder	**Citizen, former Fisherman**
Stephen Daniel	**Finance Committee**
Aly Sabatini	**Principal Planner, Town of Chatham**
Jay Briggs	**Building Commissioner, Town of Chatham**
Paul Chamberlin	**Chatham Conservation Foundation**
David Clark	**Clark Engineering**
Renee Gagne	**Shellfish Constable, Town of Chatham**
Dick Hosmer	**Waterways Advisory Committee**
Michael Westgate	**South Coastal Harbor Plan Committee**
Jane Harris	**Pleasant Bay Alliance**
Jeff Dill	**Little Beach Association**
Chuck Bartlett	**Water & Sewer Advisory Committee**
Tom Temple	**DPW Director, Town of Chatham**
Susan Ladue	**Eastward Companies**
Terry Whalen	**Special Project Admin, Town of Chatham**
Jill Goldsmith	**Town Manager, Town of Chatham**
John Beckley	**Board of Health**
Mandi Speakman	**Council on Aging Director**
Alan Cohen	**Ryder's Cove Boat Yard**
Joel Rottner	**Aunt Lydia's Cove Committee; Summer Residents Advisory Committee**
Don Poyant	**Eastward Companies**
Matt Hillman	**USFWS, Monomoy National Wildlife Refuge**
Cally Harper	**Conservation Agent, Town of Chatham**
Kristen Andres	**Association for Preservation of Cape Cod**

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CRP Workshop Project Team

Contributors from within the Town and across the community helped make this project a success and there are far too many to recognize everyone by name. The core team consisted of Robert Duncanson, Ted Keon, Aly Sabatino, John Papalardo, and Jack Farrell. Workshop Scribes were Liz Hunt, Morgan Simms, and Matthew Doelp. The facilitation team from Applied Coastal was comprised of John Ramsey and Trey Ruthven, with Adam Whelchel from the Nature Conservancy.

Special Acknowledgements

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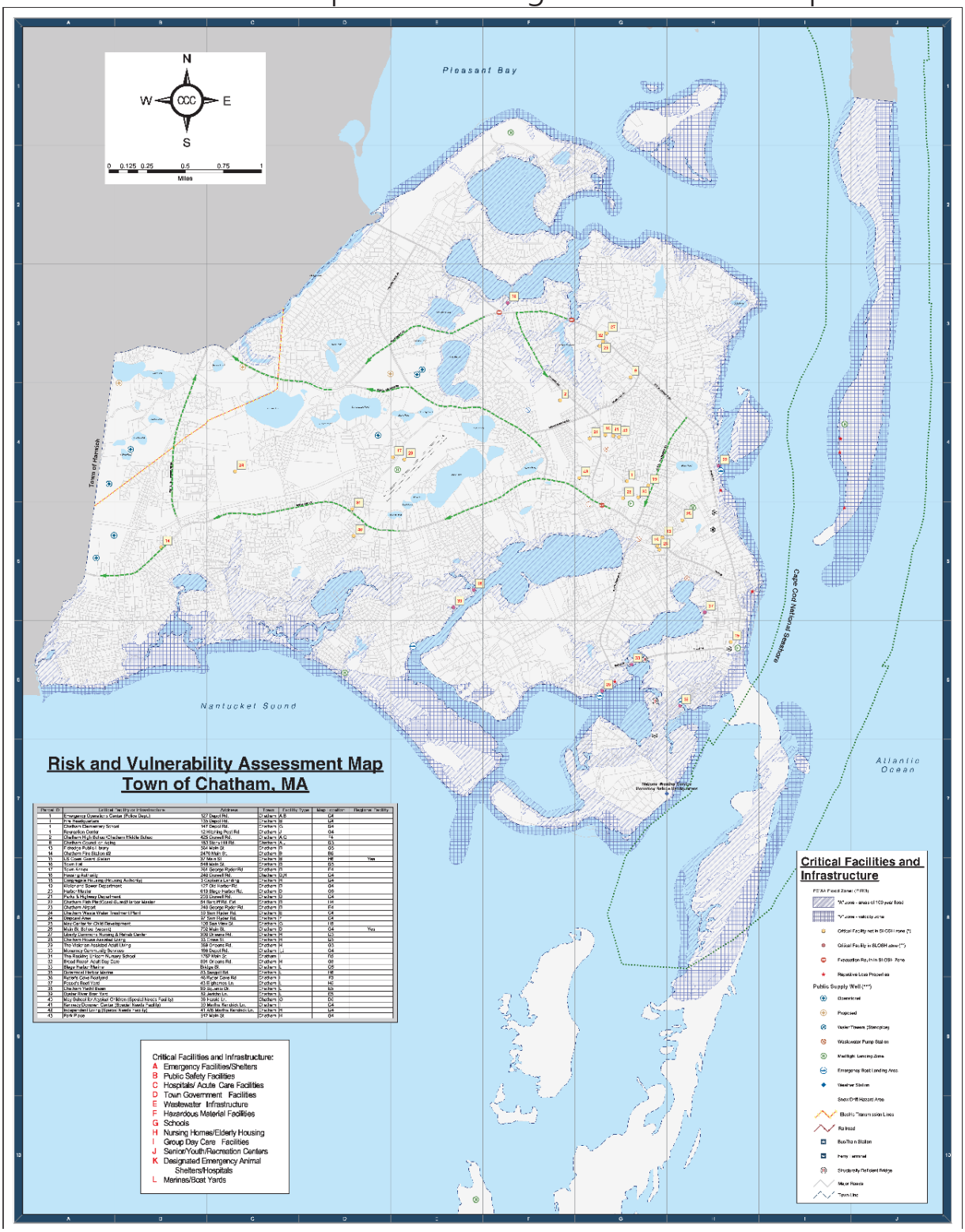
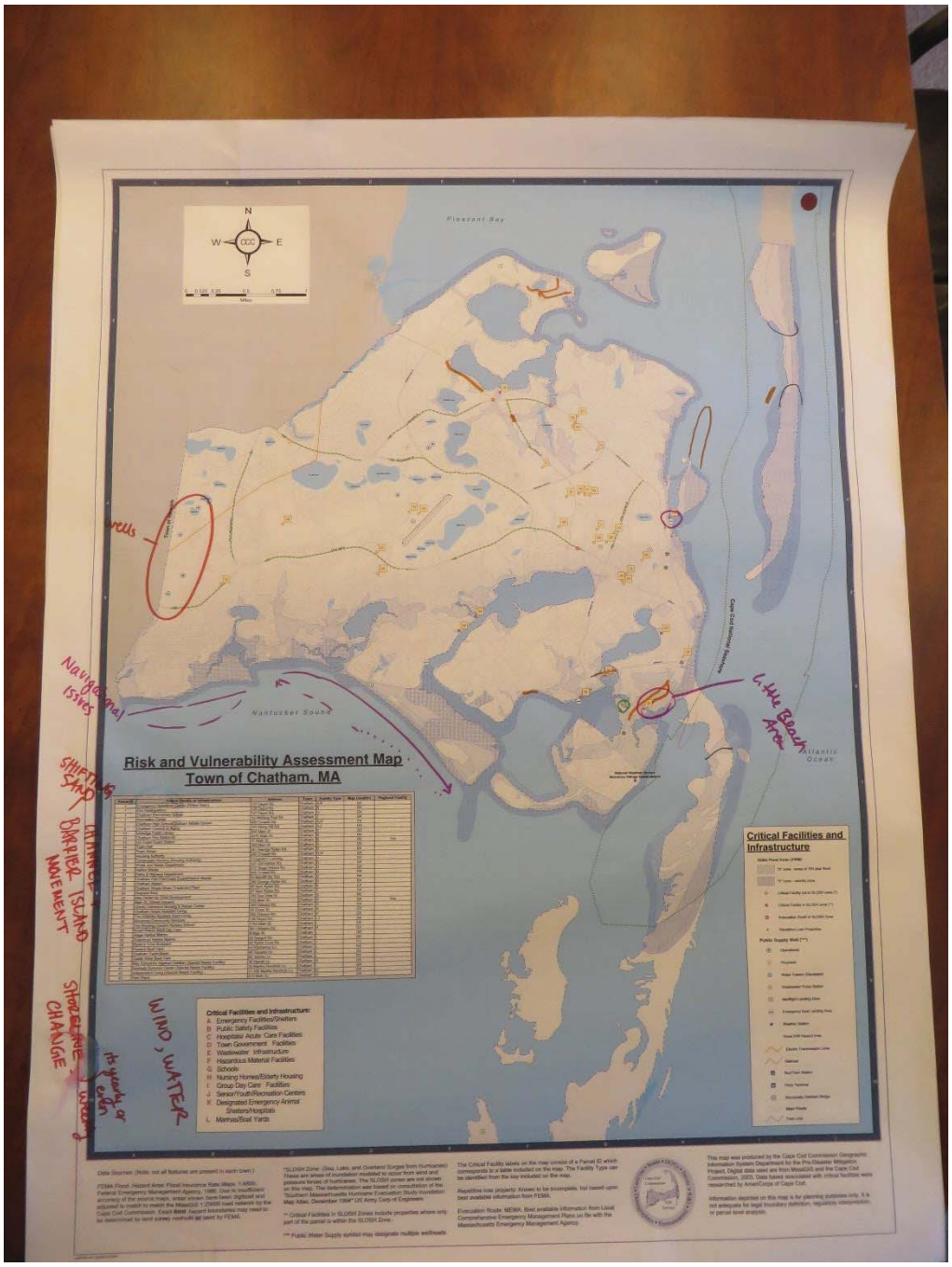
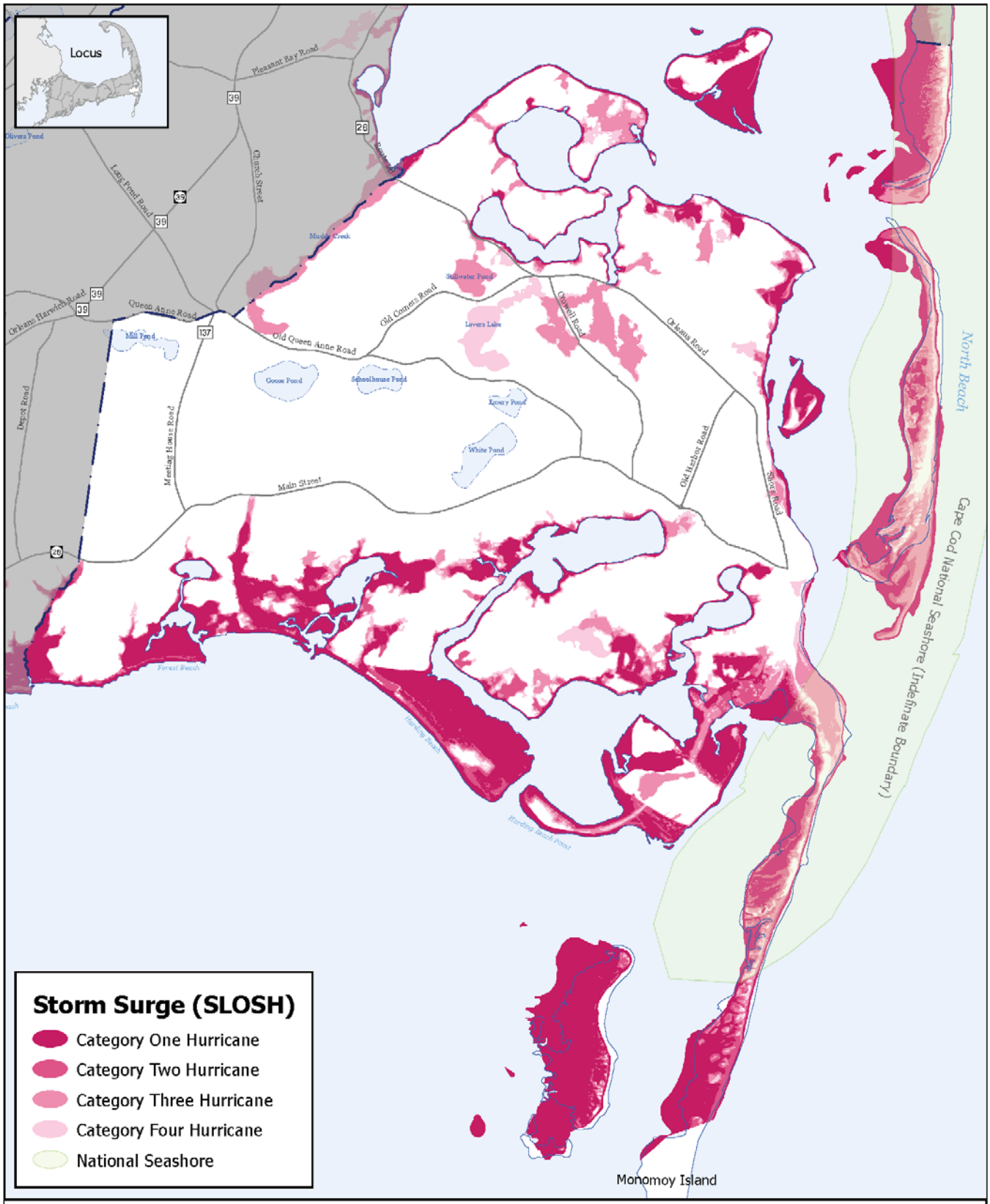
Appendix A
Resource Maps used during the CRB Workshop




Risk and Vulnerability Assessment Map
Town of Chatham, MA
Nantucket Sound
Atlantic Ocean
Critical Facilities and Infrastructure:
A Emergency Facilities/Shelters
B Public Safety Facilities
C Hospitals/ Acute Care Facilities
D Town Government Facilities
E Wastewater Infrastructure
F Hazardous Material Facilities
G Schools
H Nursing Homes/Elderly Housing
I Group Day Care Facilities
J Senior/Youth/Recreation Centers
K Designated Emergency Animal Shelters/Hospitals
L Marinas/Boat Yards
Critical Facilities and Infrastructure
Public Supply Well (***)
Operational
Proposed
Water Towers (Standpipe)
Wastewater Pump Station
MedFlight Landing Zone
Emergency Boat Landing Area
Weather Station
Snow Drift Hazard Area
Electric Transmission Lines
Railroad
Bus/Train Station
Ferry Terminal
Structurally Deficient
Major Roads
Town Line
*SLOSH Zone: (Sea, Lake, and Overland Surges from Hurricanes) These are areas of inundation modeled to occur from wind and pressure forces of hurricanes. The SLOSH zones are not shown on this map. The determination was based on consultation of the "Southern Massachusetts Hurricane Evacuation Study Inundation Map Atlas, December 1994" US Army Corp of Engineers.
** Critical Facilities in SLOSH Zones include properties where only part of the parcel is within the SLOSH Zone.
*** Public Water Supply symbol may designate multiple wellheads.
The Critical Facility labels on the map consist of a Parcel ID which corresponds to a table included on the map. The Facility Type can be identified from the key included on the map.
Repetitive loss property: Known to be incomplete, but based upon best available information from FEMA.
Evacuation Route: MEMA. Best available information from Local Comprehensive Emergency Management Plans on file with the Massachusetts Emergency Management Agency.
Cape Cod Commission
GIS Services
Land Use • Roads • DCPCs • Parcels • Demographics • Environmental • Data
This map was produced by the Cape Cod Commission GIS (CCGIS) Department for the Regional Project. Digital data used are from Massachusetts GIS, Cape Cod Commission, 2003. Data bases associated researched by AmeriCorps of Cape Cod.
Information depicted on this map is for planning purposes only and is not adequate for legal boundary definitions or parcel level analysis.


Risk and Vulnerability Assessment Map
Town of Chatham, MA
Pleasant Bay
Nantucket Sound
Atlantic Ocean
Critical Facilities and Infrastructure:
A Emergency Facilities/Shelters
B Public Safety Facilities
C Hospital/ Acute Care Facilities
D Town Government Facilities
E Wastewater Infrastructure
F Hazardous Material Facilities
G Schools
H Nursing Homes/Elderly Housing
I Group Day Care Facilities
J Senior/Youth/Recreation Centers
K Designated Emergency Animal Shelters/Hospitals
L Marinas/Boat Yards
Critical Facilities and Infrastructure
Public Supply Well (***)
Navigational Issues
Little Beach Area
Barrier Island Movement
Shoreline Change
Wind, Water

Risk and Vulnerability Assessment Map
Town of Chatham, MA
Critical Facilities and Infrastructure
Cape Cod National Seashore
Atlantic Ocean
Pleasant Bay
Nantucket Sound
Critical Facilities and Infrastructure:
A Emergency Facilities
B Public Assembly Facilities
C Hospitals/ Acute Care Facilities
D Elderly Assisted Living Facilities
E Non-Water Infrastructure
F Hazardous Material Facilities
G Schools
H Nursing Homes/Elderly Housing
I Group Day Care, Pre-School Centers
J Designated Emergency Shelters
K Designated Emergency Arrival Sites/Helipads
L Marinas/Boat Ramps



Storm Surge (SLOSH)

Chatham

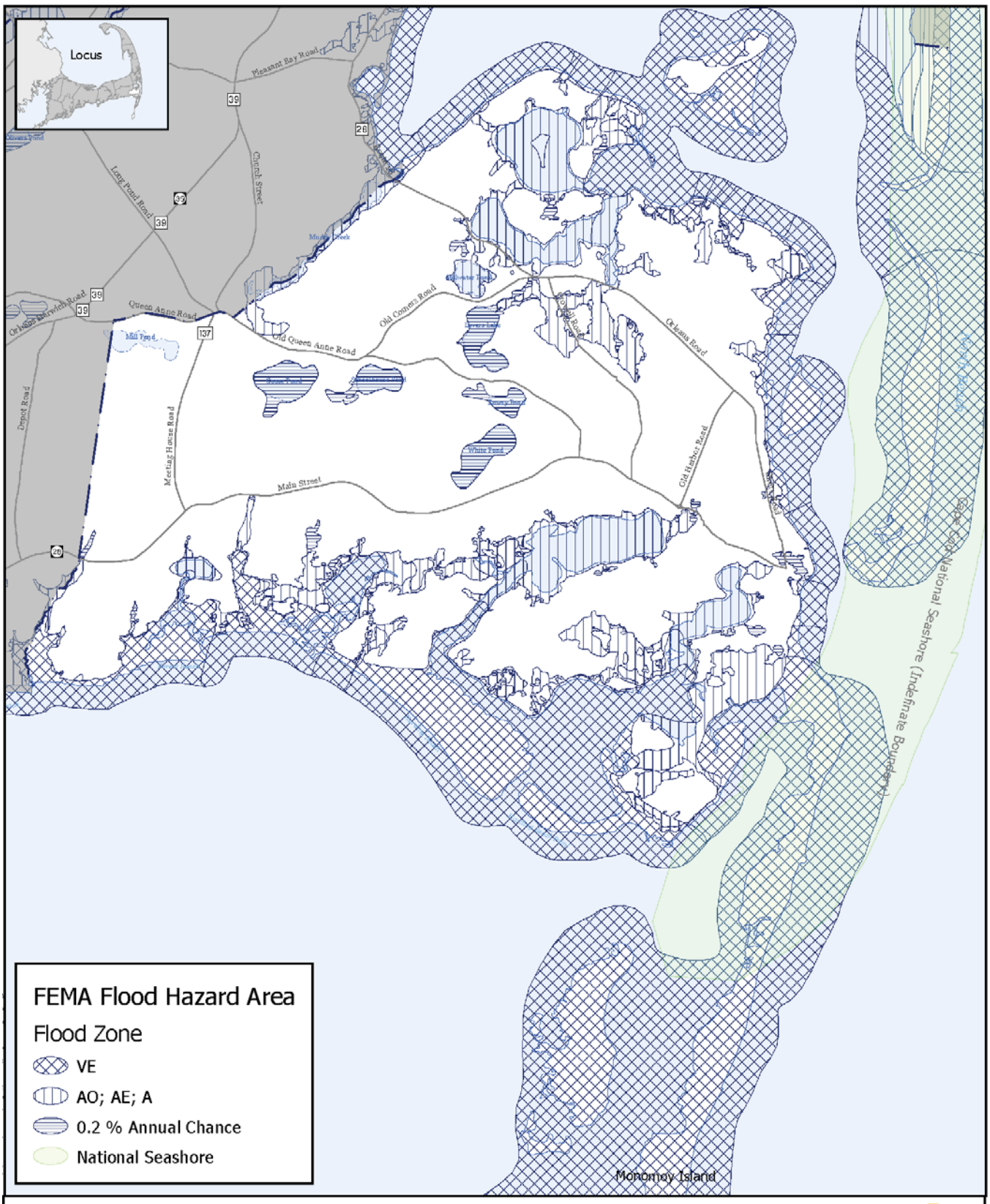
Sources:
Storm Surge (Sea, Lake, and Overland Surges from Hurricanes): Army Corps of Engineers, 2013.
Base map features: MassGIS and Cape Cod Commission.
This map is produced by the GIS Department of the Cape Cod Commission, a division of Barnstable County, 2017.

The information depicted on these maps is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel level analysis. It should not substitute for actual on-site survey, or super-safe deed research.

User: grahm Date: 12/7/2017

0.1 0 0.1 0.2 0.3 0.4 0.5
Miles

CAPE COD COMMISSION



FEMA Flood Zones

Chatham

Sources:
Flood Zones: FEMA Flood Insurance Rate Maps, 2014.
Base map features: MassGIS and Cape Cod Commission.
This map is produced by the GIS Department of the Cape Cod Commission, a division of Barnstable County, 2017.

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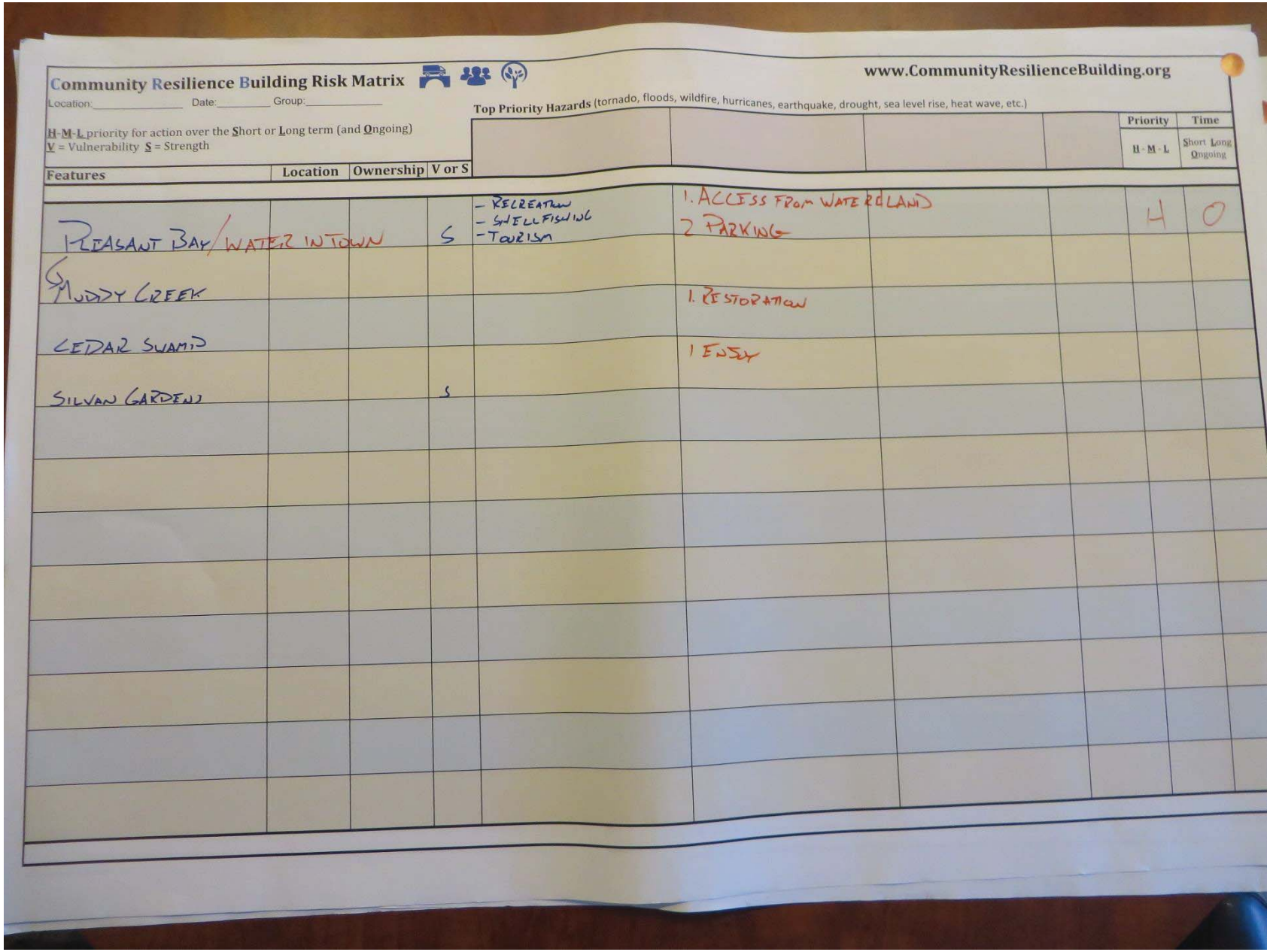
0.1 0 0.1 0.2 0.3 0.4 0.5
Miles

CAPE COD COMMISSION

User: graham Date: 12/7/2017

Appendix B
CRB Risk Matrixes populated during Workshop



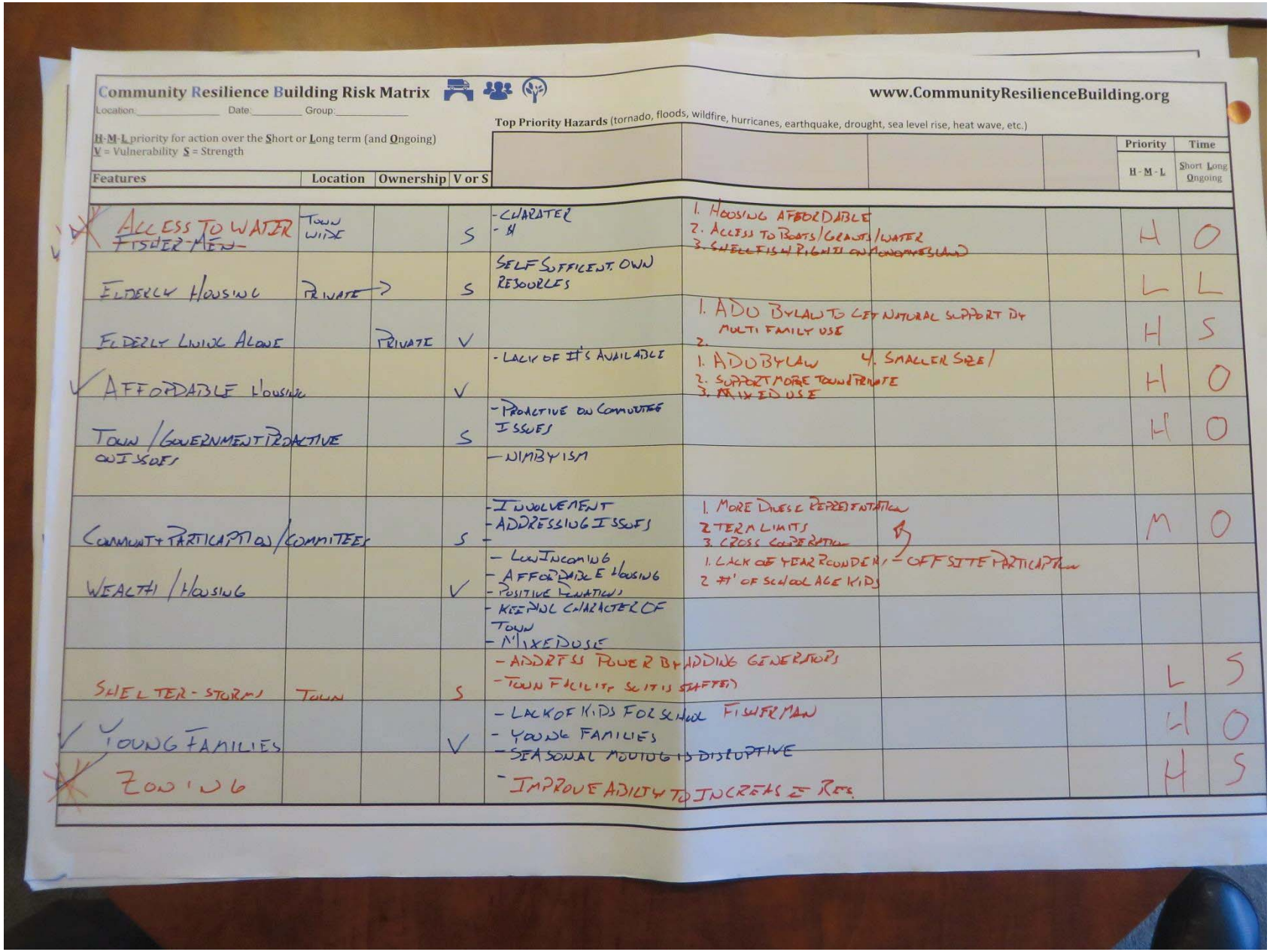
Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

Location:_____ Date:_____ Group:_____

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S			Priority H-M-L	Time Short Long Ongoing
PLEASANT BAY/WATER IN TOWN			S	- RECREATION - SHELLFISHING - TOURISM	1. ACCESS FROM WATER/LAND 2 PARKING	H	O
MUDDY CREEK					1. RESTORATION		
CEDAR SWAMP					1 ENJOY		
SILVAN GARDENS			S				



Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

Location:_____ Date:_____ Group:_____

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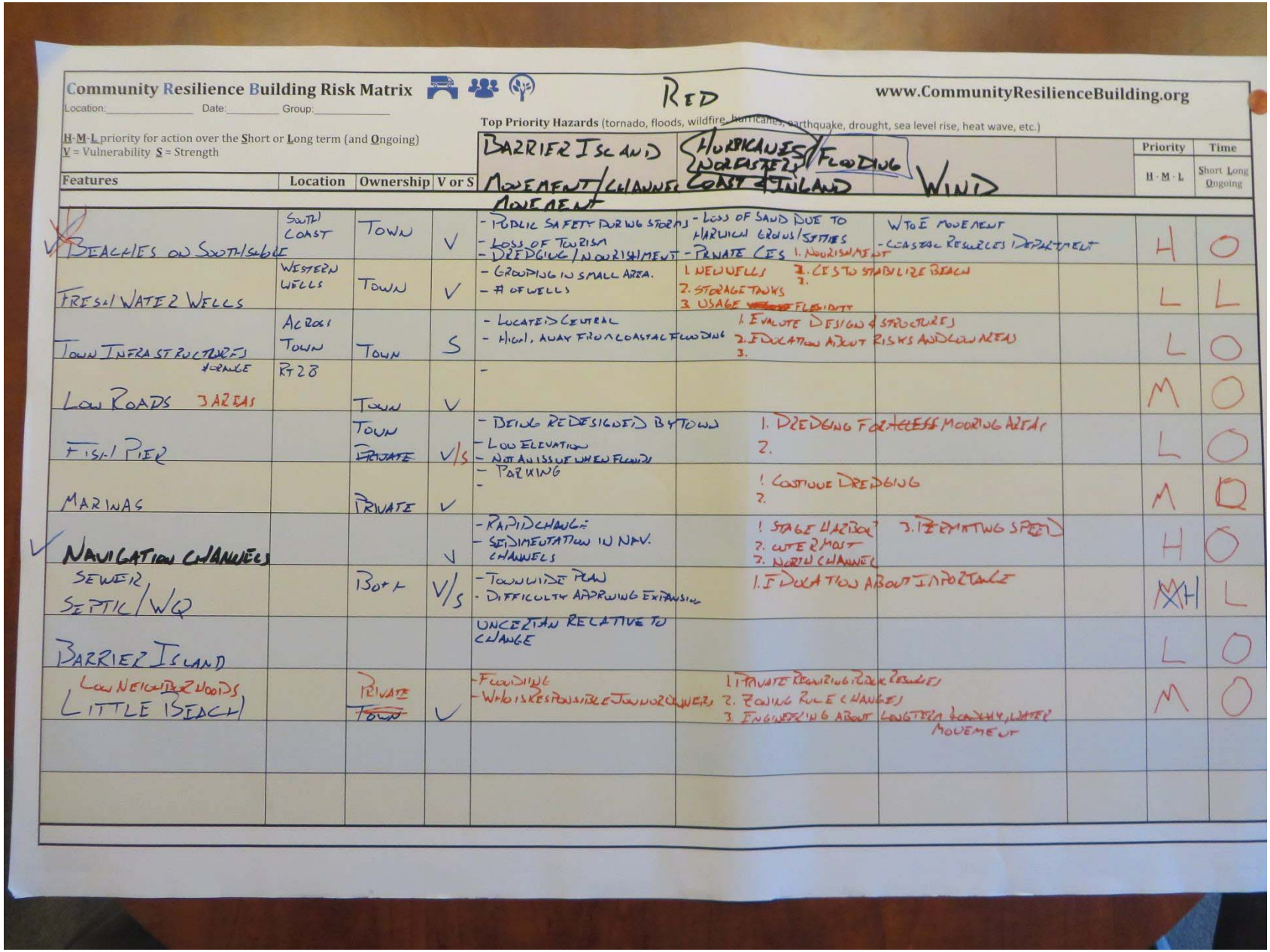
V = Vulnerability S = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S					Priority H-M-L	Time Short Long Ongoing
ACCESS TO WATER FISHER-MEN	TOWN WIDE		S	- CHARATER - $$	1. HOUSING AFFORDABLE 2. ACCESS TO BOATS/GRANTS/WATER 3. SHELLFISH RIGHTS ON MOORINGS/LAND			H	O
ELDERLY HOUSING	PRIVATE →		S	SELF SUFFICENT. OWN RESOURCES				L	L
ELDERLY LIVING ALONE		PRIVATE	V		1. ADU BYLAW TO GET NATURAL SUPPORT BY MULTI FAMILY USE 2.			H	S
AFFORDABLE HOUSING			V	- LACK OF IT'S AVAILABLE	1. ADU BYLAW 4. SMALLER SIZE/ 2. SUPPORT MORE TOWN/PRIVATE 3. MIXED USE			H	O
TOWN/GOVERNMENT PROACTIVE ON ISSUES			S	- PROACTIVE ON COMMUTER ISSUES - NIMBYISM				H	O
COMMUNITY PARTICAPTION/COMMITEES			S	- INVOLVEMENT - ADDRESSING ISSUES -	1. MORE DIVERSE REPRESENTATION 2 TERM LIMITS 3. CROSS COOPERATION			M	O
WEALTH/HOUSING			V	- LOW INCOMING - AFFORDABLE HOUSING - POSITIVE DONATIONS	1. LACK OF YEAR ROUNDERS - OFF SITE PARTICIPATION 2 #1 OF SCHOOL AGE KIDS				
				- KEEPING CHARACTER OF TOWN - MIXED USE					
SHELTER - STORMS	TOWN		S	- ADDRESS POWER BY ADDING GENERATORS - TOWN FACILITY SCITUATION SHIFTED				L	S
YOUNG FAMILIES			V	- LACK OF KIDS FOR SCHOOL FISHERMAN - YOUNG FAMILIES - SEASONAL MOVING IS DISRUPTIVE				H	O
ZONING				- IMPROVE ABILITY TO INCREASE REV.				H	S



Community Resilience Building Risk Matrix — RED — www.CommunityResilienceBuilding.org

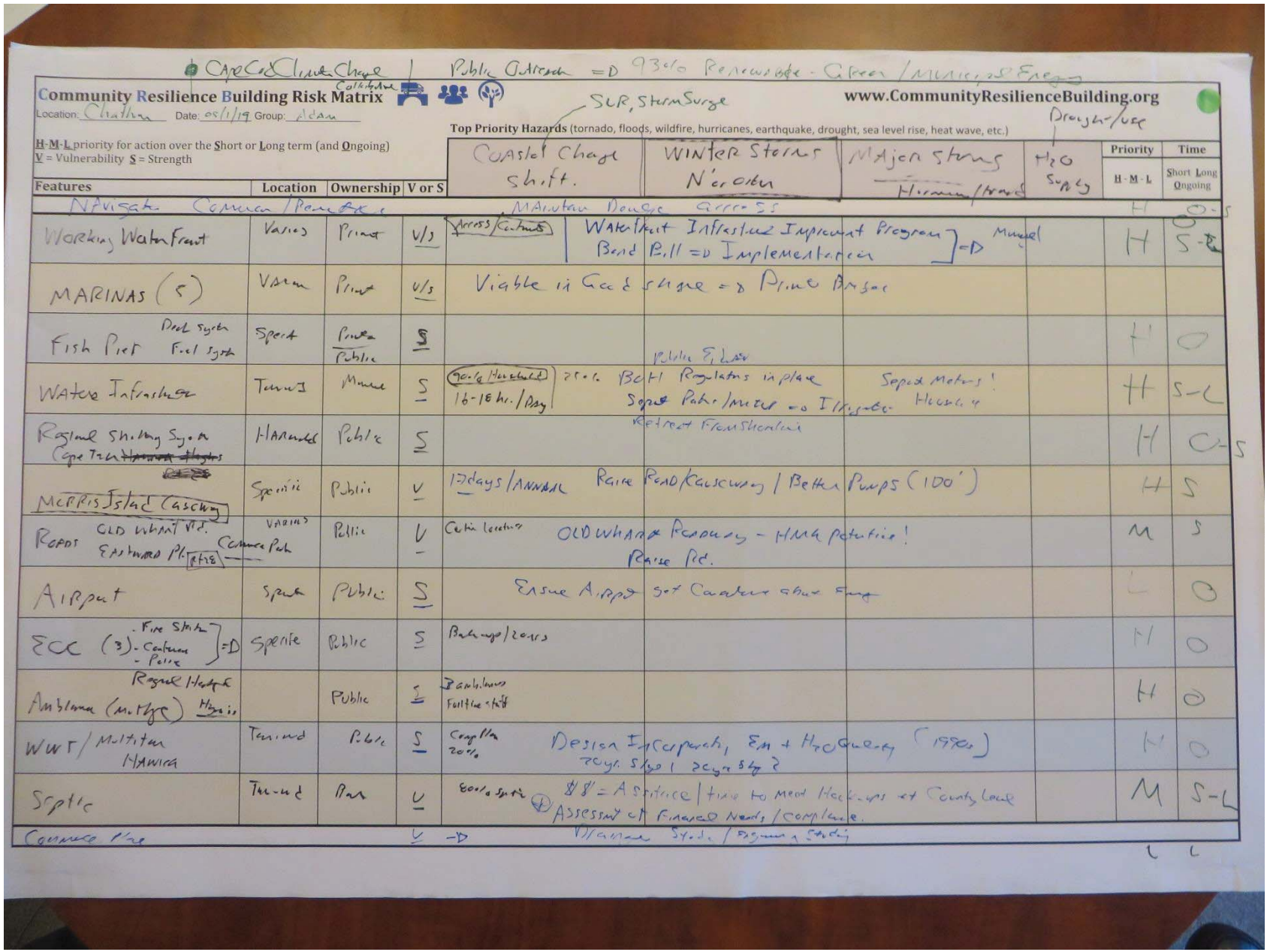
Location:_____ Date:_____ Group:_____

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

BARRIER ISLAND MOVEMENT/CHANNEL MOVEMENT | HURRICANES/NORTHEASTERLY COAST & INLAND FLOODING | WIND

Features	Location	Ownership	V or S				Priority H-M-L	Time Short Long Ongoing
V BEACHES ON SOUTH SIDE	SOUTH COAST	TOWN	V	- PUBLIC SAFETY DURING STORMS - LOSS OF TOURISM - DREDGING / NOURISHMENT	- LOSS OF SAND DUE TO HARDEN GRNDS/SETTIES - PRIVATE CES 1. NOURISHMENT	W TO E MOVEMENT - COASTAL RESOURCES DEPARTMENT	H	O
FRESH WATER WELLS	WESTERN WELLS	TOWN	V	- GROUPING IN SMALL AREA. - # OF WELLS	1. NEW WELLS 2. CES TO STABILIZE BEACH 2. STORAGE TANKS 3 USAGE FLEXIBILITY		L	L
TOWN INFRASTRUCTURES #ORANGE	ACROSS TOWN	TOWN	S	- LOCATED CENTRAL - HIGH, AWAY FROM COASTAL FLOODING	1. EVALUATE DESIGN & STRUCTURES 2. EDUCATION ABOUT RISKS AND LOW AREAS 3.		L	O
LOW ROADS 3 AREAS	RT 28	TOWN	V	-			M	O
FISH PIER		TOWN ~~PRIVATE~~	V/S	- BEING REDESIGNED BY TOWN - LOW ELEVATION - NOT AN ISSUE WHEN FLOODING	1. DREDGING FOR ACCESS MOORING AREA 2.		L	O
MARINAS		PRIVATE	V	- PARKING -	1. CONTINUE DREDGING 2.		M	O
V NAVIGATION CHANNELS			V	- RAPID CHANGE - SEDIMENTATION IN NAV. CHANNELS	1. STAGE HAZARD 3. PERMITTING SPEED 2. WATER MGMT 3. NORTH CHANNEL		H	O
SEWER, SEPTIC/WQ		BOTH	V/S	- TOWNWIDE PLAN - DIFFICULTY ADDRESSING EXPANSION	1. EDUCATION ABOUT IMPORTANCE		~~M~~ H	L
BARRIER ISLAND				UNCERTAIN RELATIVE TO CHANGE			L	O
LOW NEIGHBORHOODS LITTLE BEACH		PRIVATE ~~TOWN~~	V	- FLOODING - WHO IS RESPONSIBLE TO NOURISH	1. PRIVATE REQUIRING ROCK REVETMENTS 2. ZONING RULE CHANGES 3. ENGINEERING ABOUT LONGTERM HEALTHY WATER MOVEMENT		M	O



Cape Cod Climate Change Collaborative | Public Outreach => 93% Renewable - Green / Municipal Energy

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

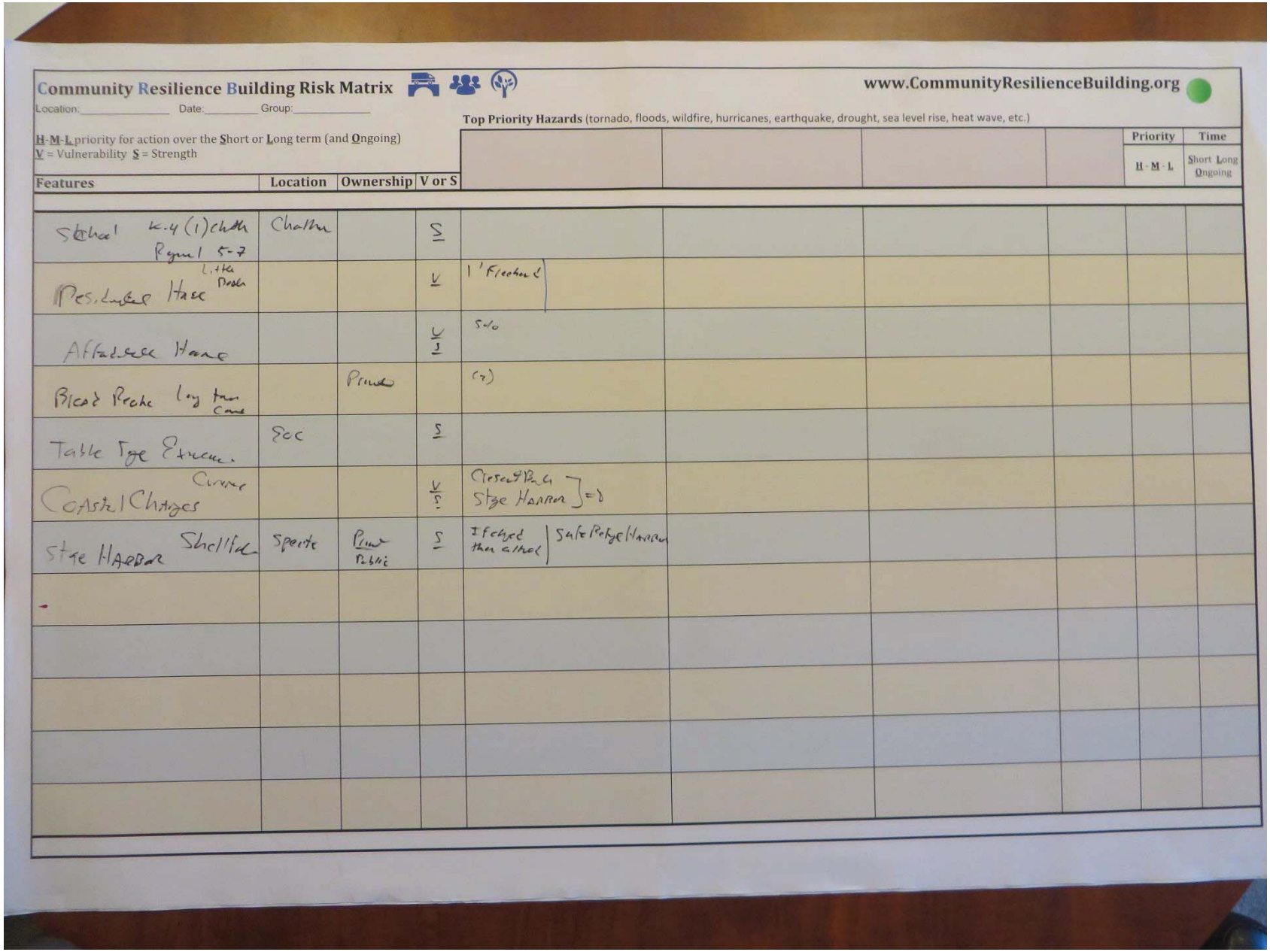
Location: Chatham Date: 05/1/19 Group: Adam

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

SLR, Storm Surge | Coastal Change Shift. | Winter Storms N'easters | Major Storms | Drought/use H2O Supply

Features	Location	Ownership	V or S		Priority H-M-L	Time Short Long Ongoing
Navigate Common / Pond Ent.				Maintain Dredge Access	H	O-S
Working Waterfront	Varies	Private	V/S	Access / Control; Waterfront Infrastructure Improvement Program Bond Bill => Implementation => Municipal	H	S-L
MARINAS (5)	Varies	Private	V/S	Viable in Good shape => Prime Basis		
Fish Pier Dock Systm Fuel Systm	Specific	Private / Public	S	Public Education	H	O
Water Infrastructure	Town	Municipal	S	Geo/Hydrological 16-18 hr./day; 20+% Both Regulations in place; Septic Pubs / Meter => Irrigation; Septic Meters! Hydrology; Retreat From Shoreline	H	S-L
Regional Shelter System Cape Tech ~~Hyannis Heights~~	Harwich	Public	S		H	O-S
~~Rt 28~~ Morris Island Causeway	Specific	Public	V	12 days/annual; Raise Road/Causeway / Better Pumps (100')	H	S
Roads Old Wharf Rd. Eastward Pl. Retire	Various Commerce Park	Public	V	Certain locations; Old Wharf Roadway - HMA Potential! Raise Rd.	M	S
Airport	Specific	Public	S	Ensure Airport Soil Contains Chem Emg	L	O
ECC (3) - Fire Station - Coastal - Police =>	Specific	Public	S	Backups / Towers	M	O
Ambulance (multiple) Regional Hospital Hyannis		Public	S	Ambulances; Fulltime staff	H	O
WWT / Military Harwich	Town	Public	S	Capacity 20%; Design Incorporate, EM + H2O Quality (1980s) 70yr. Study / 20yr Study 2	M	O
Septic	Town	Both	V	60% Septic; 88' = Assistance / time to meet Hackmatack at County Level; Assessment of Financial Needs / Compliance.	M	S-L
Commercial Fire		V	=>	Drainage Study / Engineering Studies	L	L



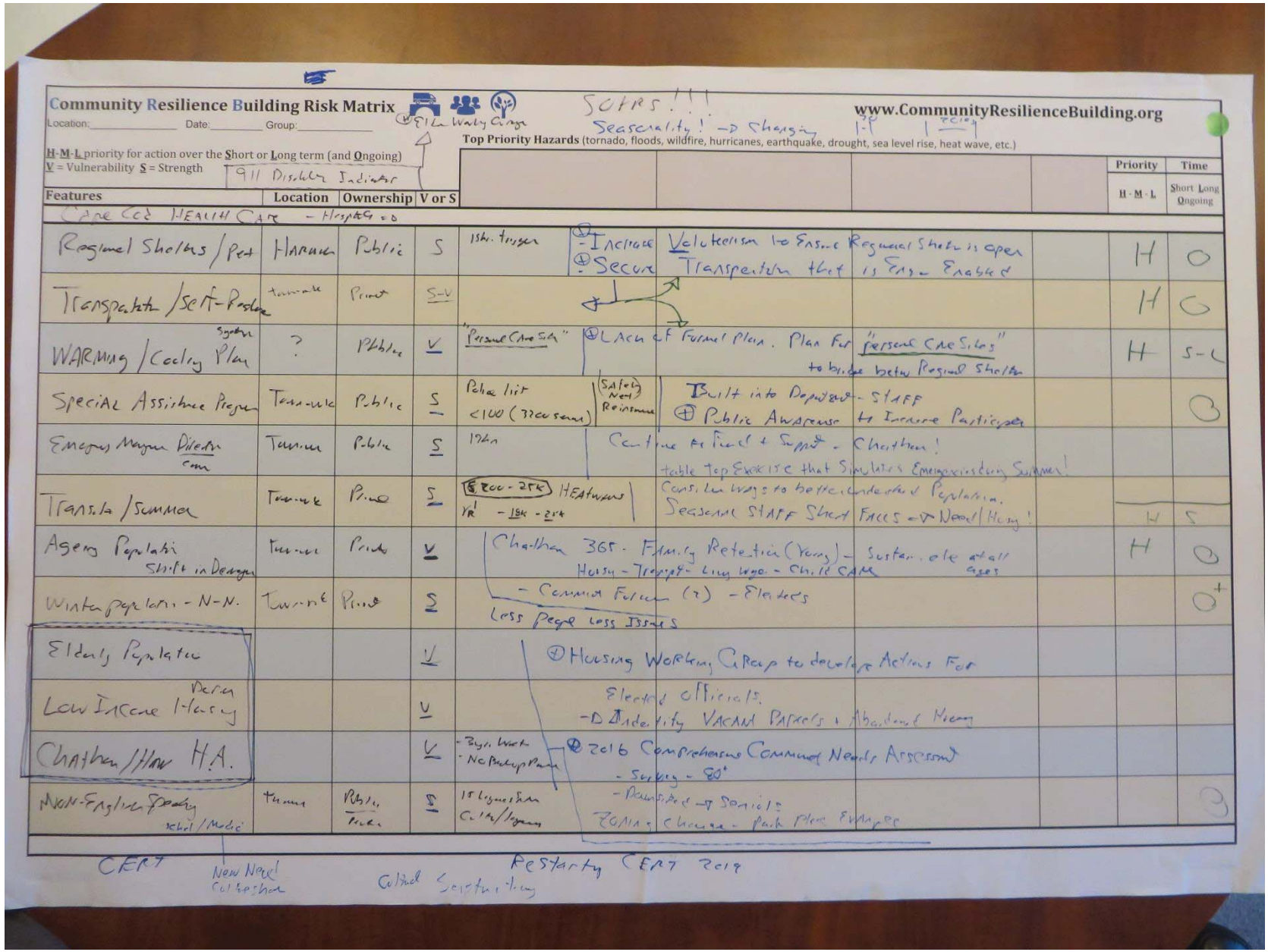
Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

Location:_____ Date:_____ Group:_____

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S					Priority H-M-L	Time Short Long Ongoing
School K-4 (1) church Regnl 5-7	Chatham		S						
Residential Hses Lt Hse Beach			V	1' Freeboard					
Affordable Hsng			V J	Solo					
Bread Roche Long term Care		Private		(2)					
Table Rge Entrance	Soc		S						
Coastal Changes Erosion			V S	Closed Back Stge Harbor					
Stge Harbor Shellfish	Sports	Prim Public	S	If closed then affect	Safe Refuge Harbor				



Community Resilience Building Risk Matrix — www.CommunityResilienceBuilding.org

Location: _____ Date: _____ Group: _____

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

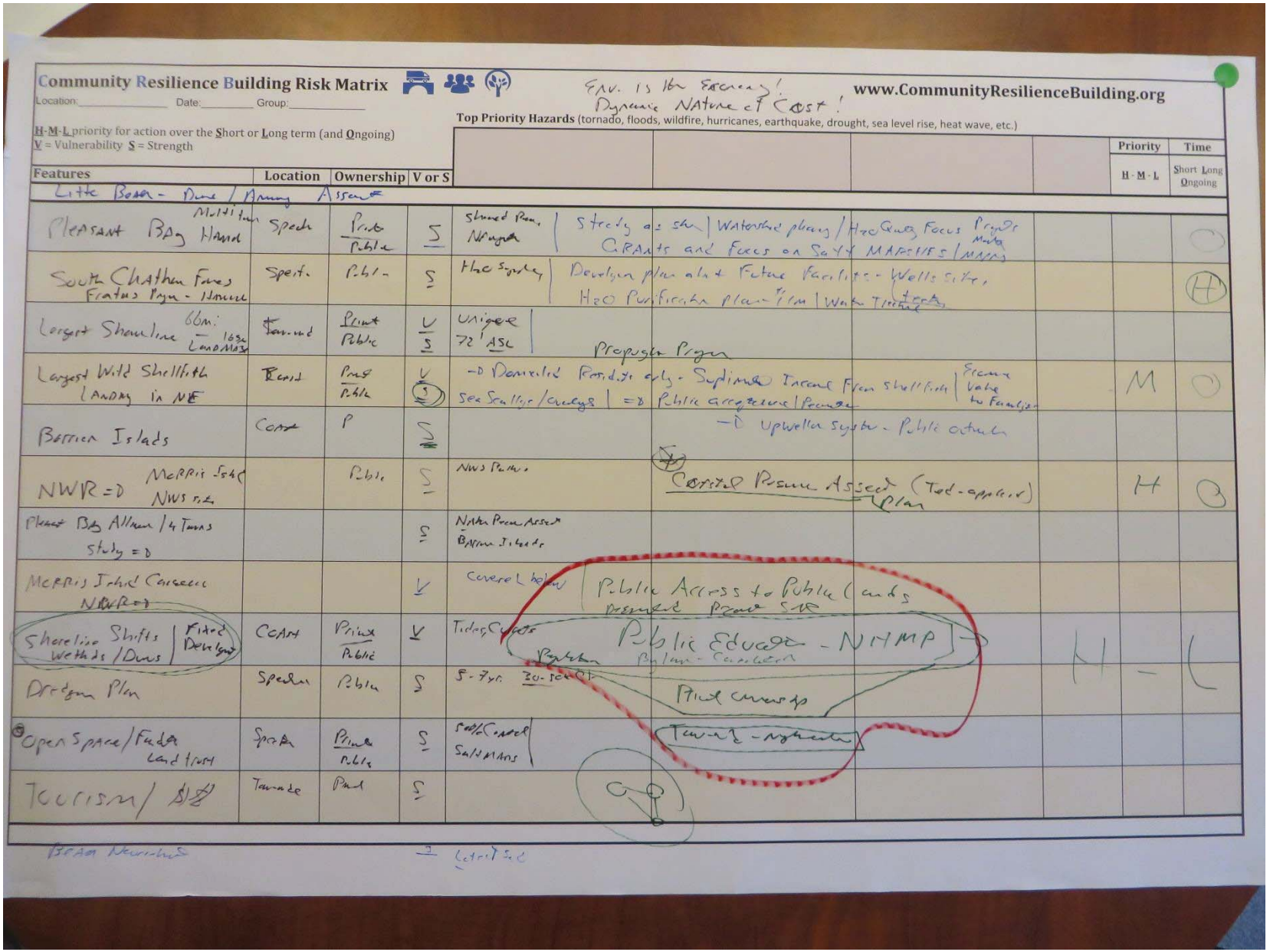
911 Disaster Indicator

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

SOTRS!!! Seasonality! -> Change

Features	Location	Ownership	V or S					Priority H-M-L	Time Short Long Ongoing
Cape Cod HEALTH CARE - Hospital = O									
Regional Shelters / Pet	Harwich	Public	S	15hr. trigger	⊕ - Increase ⊕ - Secure	Volunteerism to Ensure Regional Shelter is open Transportation that is Easy + Enabled		H	O
Transportation / Self-Evac	Townwide	Private	S-V					H	O
WARMing / Cooling Centers	?	Public	V	"Personal Care Sites"	⊕ Lack of Formal Plans. Plan For "Personal Care Sites" to bridge betw Regional Shelter			H	S-L
Special Assistance Program	Townwide	Public	S	Police list <100 (32 currently)	(Safety Net) Reinstate	Built into Department - STAFF ⊕ Public Awareness to Increase Participation			O
Emergency Management Director Comm	Townwide	Public	S	1924		Continue to Fund + Support - Chairman! table top Exercise that Simulates Emergency/Long Outages!			
Transportation / Summer	Townwide	Private	S	$200 - 25K HEAT waves Yr - 15K - 20K		Consider ways to better understand Population. Seasonal STAFF Short FALLS -> Need/Help!		H	S
Aging Population Shift in Demographics	Townwide	Private	V		Chatham 365 - Family Retention (Young) - Sustainable at all ages Housing - Transport - Living wage - Child CARE - Commercial Tax Base (2) - Elected Officials Less People Less Issues			H	O
Winter Population - N-N.	Townwide	Private	S						O+
Elderly Population			V			⊕ Housing Working Group to develop Actions For Elected officials. -> Address VACANT Parcels + Abandoned Homes			
Low Income Housing			V						
Chatham / Harwich H.A.			V	- Byr. Work - No Backup Power		⊕ 2016 Comprehensive Community Needs Assessment - Survey - 80+			
Non-English Speaking School / Medical	Townwide	Public Private	S	15 Languages Spoken Cable/Internet		- Downsized -> Seniors ZONING Changes - Park Plan Evacuees			O

CERT — New Next Generation — Critical Infrastructure — Restarting CERT 2019



Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

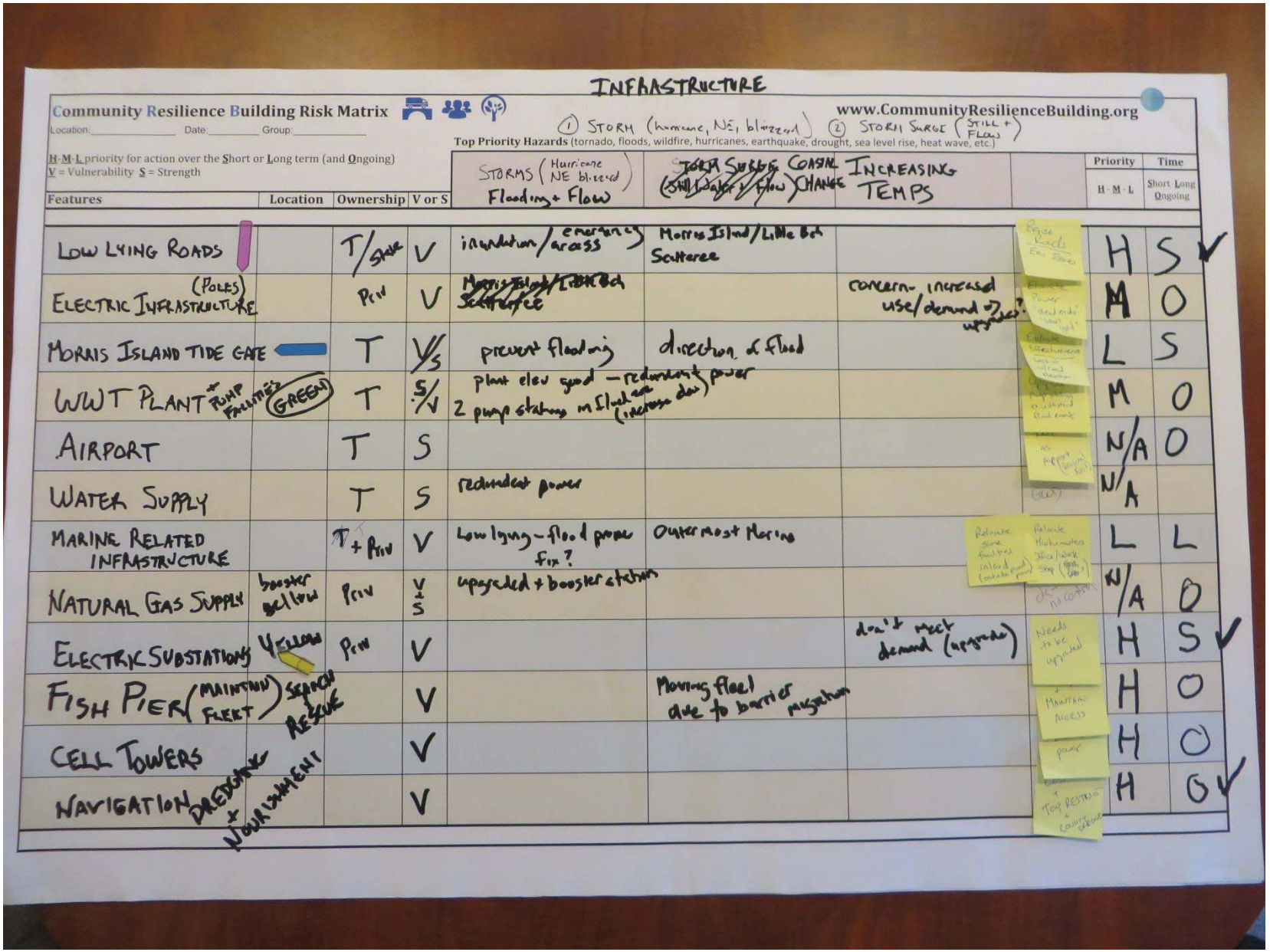
Location:_____ Date:_____ Group:_____

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S			Priority H-M-L	Time Short Long Ongoing
Little Bogue - Dune / Marsh Assess							
Pleasant Bay Herd	Speck	Private Public	S	Shared Res. Mngmt	Study as shr / Watershed planning / H2O Quality Focus Priority Mgmt CPAAts and Focus on Salt MARSHES / MAPPS		
South Chatham Fires Erratus Prgm - Nauset	Spect.	Publ-	S	H2O Supply	Develop plan about Future Facilities - Wells Site, H2O Purification Plant Trm / Water Treatment tests		H
Largest Shoreline 66mi: — less Landmass	Forested	Private Public	V S	Unique 72' ASL	Propagule Prgm		
Largest Wild Shellfish (Aquaculture) in NE	Coast	Pvt Public	V S	-D Densities Predators only - Supplies Income From shellfish / Sea Scallops / Quahogs / =D	Economic Value to Families / Public awareness / Permits	M	
Barrier Islands	Coast	P	S		-D Upwelling System - Public outreach		
NWR =D McMillis Est NWS Rds		Public	S	NWS Permits	Coastal Process Assess (Tod - approved) Plan	H	
Pleasant Bay Alliance / 4 Towns Study = D			S	Natural Process Assess Barrier Islands			
McMillis Island Causeway NWR=D			V	Covered below	Public Access to Public Lands Increased Permit SAR		
Shoreline Shifts Wetlands / Dunes Fixed Development	COAST	Private Public	V	Tides, Currents	Public Educate - NHMP Bylaw - Consistency Position	H	L
Dredging Plan	Species	Public	S	5-7yrs 30-50 CY	Plant coverage		
Open Space / Federal Land Trust	Space	Private Public	S	Salt Coastal Salt Marshes	Town - Agriculture		
Tourism / $$	Tornado	Pvt	S				

BEACH Nourishment — Retreat Sea



INFRASTRUCTURE

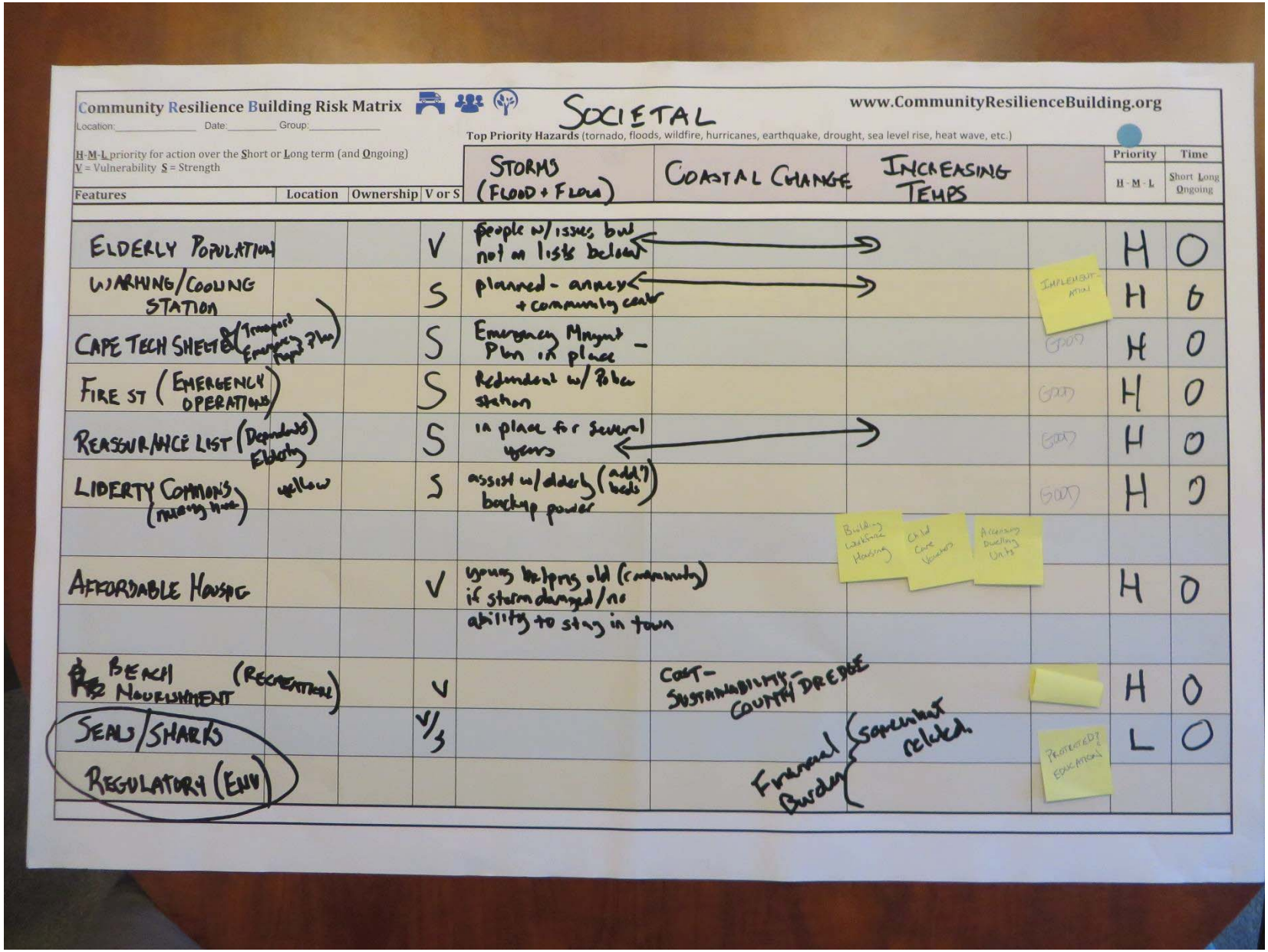
Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

Location:_____ Date:_____ Group:_____

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.) ① STORM (hurricane, NE, blizzard) ② STORM SURGE (STILL + FLOW)

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Features	Location	Ownership	V or S	STORMS (Hurricane NE blizzard) Flooding + Flow	STORM SURGE COASTAL (STILL + FLOW) CHANGE	INCREASING TEMPS		Priority H-M-L	Time Short-Long Ongoing
LOW LYING ROADS		T/State	V	inundation / emergency access	Morris Island / Little Bay Scatteree			H	S ✓
ELECTRIC INFRASTRUCTURE (POLES)		Priv	V	~~Morris Island / Little Bay Scatteree~~		concern - increased use/demand → upgrades?		M	O
MORRIS ISLAND TIDE GATE		T	V/S	prevent flooding	direction of flood			L	S
WWT PLANT + PUMP FACILITIES (GREEN)		T	S/V	plant elev good – redundant power 2 pump stations in flood area (increase dev)				M	O
AIRPORT		T	S					N/A	O
WATER SUPPLY		T	S	redundant power				N/A	
MARINE RELATED INFRASTRUCTURE		T + Priv	V	Low lying – flood proof fix?	Outermost Marina			L	L
NATURAL GAS SUPPLY	booster below	Priv	V ± S	upgraded + booster station				N/A	O
ELECTRIC SUBSTATIONS	YELLOW	Priv	V			don't meet demand (upgrade)		H	S ✓
FISH PIER (MAINTAIN FLEET)	SEARCH RESCUE		V		Moving fleet due to barrier migration			H	O
CELL TOWERS			V					H	O
NAVIGATION DREDGING + NOURISHMENT			V					H	O ✓



Community Resilience Building Risk Matrix

Location:_____ Date:_____ Group:_____

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

SOCIETAL

www.CommunityResilienceBuilding.org

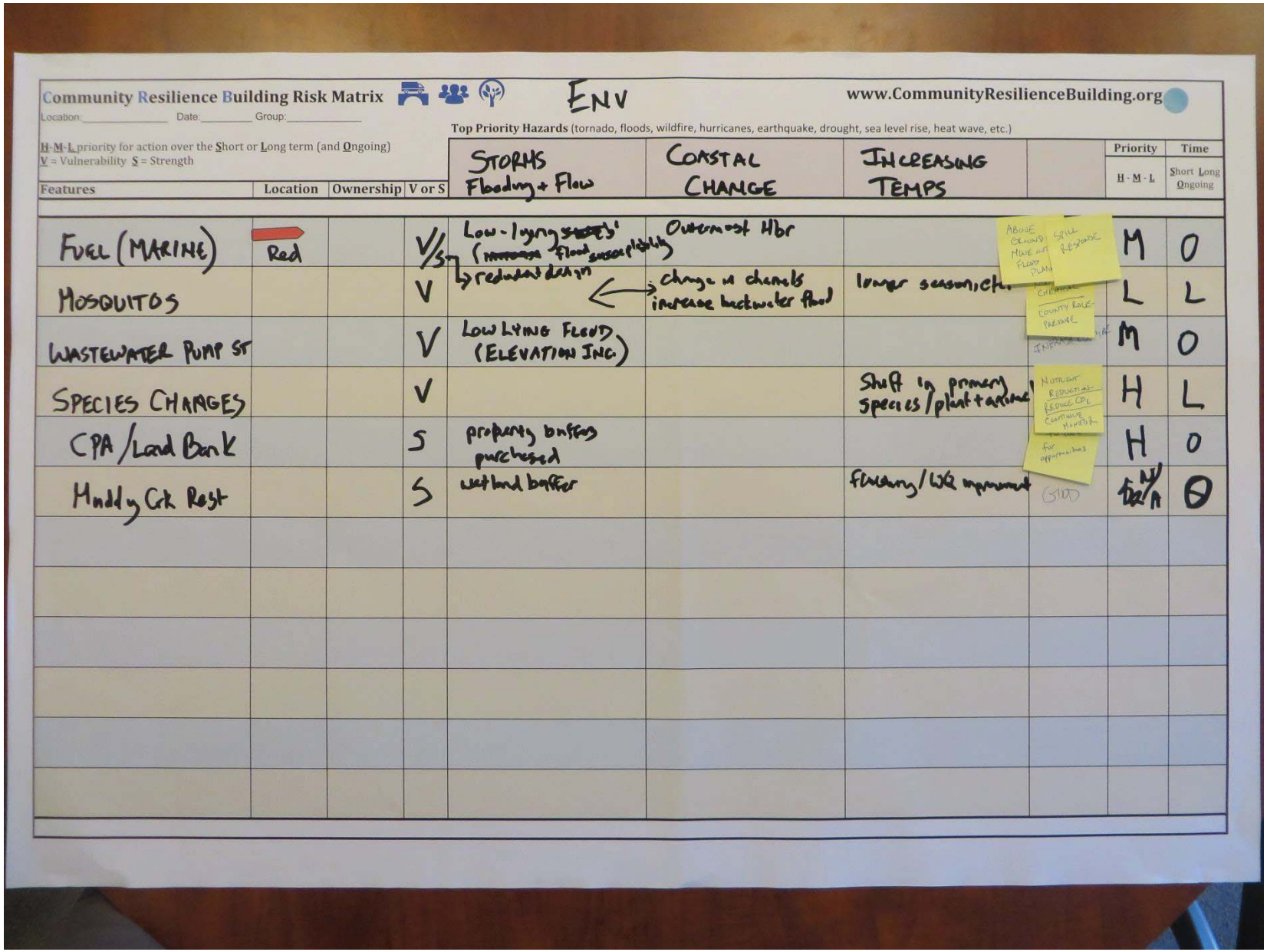
Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	STORMS (FLOOD + FLOOD)	COASTAL CHANGE	INCREASING TEMPS		Priority H-M-L	Time Short Long Ongoing
ELDERLY POPULATION			V	people w/ issues but not on lists below	←	→		H	O
WARMING/COOLING STATION			S	planned - annex + community center	←	→	IMPLEMENTATION	H	O
CAPE TECH SHELTER (Transport Emergency Trips Plan)			S	Emergency Mngmt Plan in place -			GOOD	H	O
FIRE ST (EMERGENCY OPERATIONS)			S	Redundant w/ Pole station			GOOD	H	O
REASSURANCE LIST (Dependents Elderly)			S	in place for several years	←	→	GOOD	H	O
LIBERTY COMMONS (nursing home)	yellow		S	assist w/ elderly (adult? beds) backup power			GOOD	H	O
AFFORDABLE HOUSING			V	young helping old (community) if storm damaged / no ability to stay in town				H	O
BEACH NOURISHMENT (RECREATION)			V		COST-SUSTAINABILITY-COUNTY/DREDGE			H	O
SEALS/SHARKS			V/S					L	O
REGULATORY (ENV)					Financial Burden (Sea level related)		PROTECTED? EDUCATION		

Building Workforce Housing

Child Care Vouchers

Accessory Dwelling Units



Community Resilience Building Risk Matrix — ENV — www.CommunityResilienceBuilding.org

Location:_____ Date:_____ Group:_____

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	STORMS Flooding + Flow	COASTAL CHANGE	INCREASING TEMPS		Priority H-M-L	Time Short Long Ongoing
FUEL (MARINE)	Red		V/S	Low-lying ~~streets~~ (~~increase~~ flood susceptibility → reduced design	Outermost Hbr			M	O
MOSQUITOS			V		← change in channels increase backwater flood	longer season/ch…		L	L
WASTEWATER PUMP ST			V	LOW LYING FLOOD (ELEVATION INC)				M	O
SPECIES CHANGES			V			Shift in primary species/plant+animal		H	L
CPA/Land Bank			S	property buffers purchased				H	O
Muddy Crk Rest			S	wetland buffer		flowing/WQ improvement	(SIDD)	N/A	O

ABUSE GROUNDS MOVE OUT FLOOD PLAN — SPILL RESPONSE — CHEMICAL — COUNTY ROLE PRESERVE — INFRASTRUCTURE — NUTRIENT REDUCTION — REDUCE CPL — CONTINUE MONITOR — for opportunities

Appendix C
Top Priority Action Cards from CRB Workshop