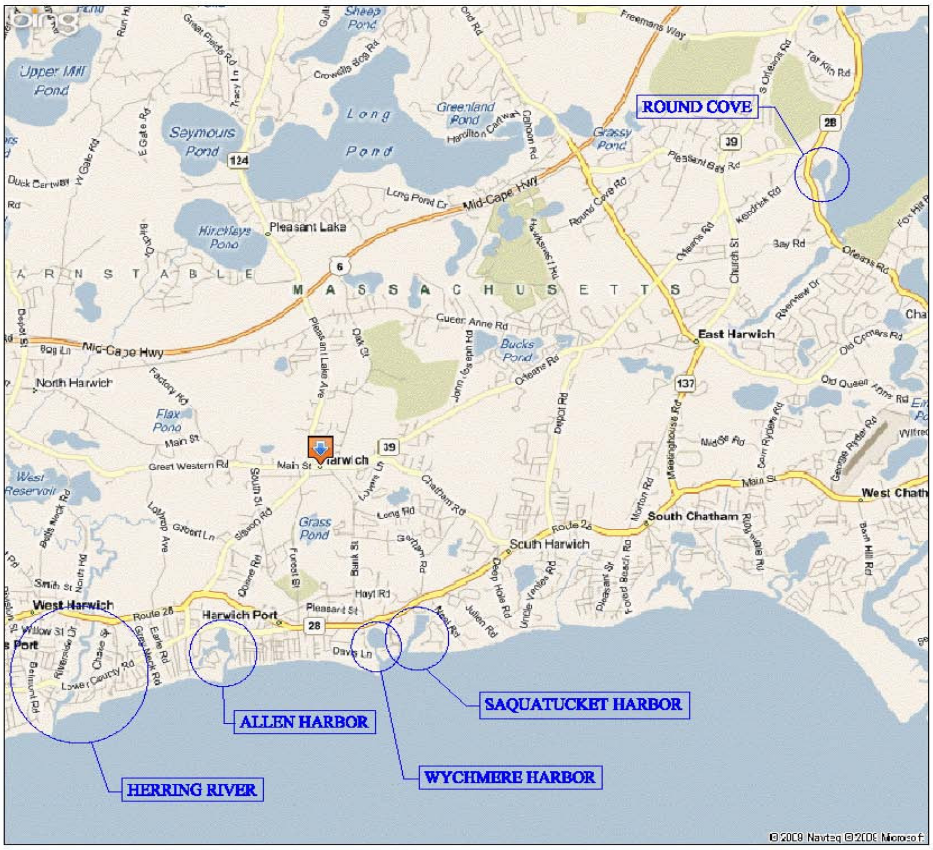
Project No. C17209.00

TOWN OF HARWICH
HARBORS & MARINE FACILITIES
ANALYSIS REPORT

August 19, 2009



Prepared for:
TOWN OF HARWICH
c/o Joe Borgesi, Town Engineer
732 Main St.
Harwich, MA 02645

Prepared by:
COASTAL ENGINEERING CO., INC.
260 Cranberry Highway
Orleans, MA 02653
(508) 255-6511

John A. Bologna P.E.

Roy E. Okurowski P.E.

TABLE OF CONTENTS

LIST OF FIGURES

PROJECT PHOTOGRAPHS (see inspection reports for descriptions)

APPENDICES

Executive Summary

CEC performed in depth inspections for an existing conditions assessment on the majority of the marina components at town owned and operated facilities located at Saquatucket Harbor, Wychmere Harbor, Allen Harbor, Round Cove, and Herring River. The objective of this project was to evaluate each site for performance and stability, then systematically analyzed for repair or replacement options, and cost out for capital budget planning purposes. The intent is to provide the Town of Harwich with a well thought out road map in place for the efficient up-grades and utilization of these facilities. This will also be a useful tool for the Town to determine long term strategic planning objectives for the management of these important town resources.

Our approach was to inventory and inspect all municipal facilities included in the RFP scope of services and to provide an existing conditions assessment of major components at each facility and to prepare a prioritized list of repairs with life cycle cost . This included initial meetings with Town officials and local stakeholders, as well as a basic engineering reconnaissance, including structural and civil investigation and evaluation of the existing facilities, materials testing, and related aspects of the inspection. Field crews were utilized to inspect structural items in the project areas required. Level I, II, and III inspections were made on bulkheads, piers, floats, boat ramps, site parking and drainage, and several building structures

These inspections lead CEC to formulate this report to provide guidance to the town in maintaining an budget for planning and cost estimating until year 2018 and beyond. The following summary clearly reiterates and condenses the inspections, and any observations that were made during the inspection process.

Saquatucket Harbor

The following facilities were inspected in Saquatucket Harbor: concrete bulkhead, floating docks, parking and drainage, and buildings. Out of these facilities, the concrete bulkhead to the east requires the most attention at this time. This area of the bulkhead wall with tie back anchors at the access road/loading area between the ramp and fuel dock is showing significant deflection at the top of the wall toward the harbor basin. The rotation has progressed to a point that the concrete cap beam is leaning against the wood bumper piles in this area. Heavy truck traffic in close proximity to the bulkhead wall has likely caused the wall to deflect and rotate. Please refer to the inspection reports and cost estimate spreadsheet for an in depth description of the condition and predicted cost of replacing the bulkhead. Other predicted costs for the harbor include replacing the remaining portion of the concrete bulkhead in 2016, replacing the floating docks in 2017 and maintenance costs associated with the boat ramp and buildings in 2018 and beyond.

Wychmere Harbor

The following facilities were inspected in Wychmere Harbor: steel and timber bulkhead, concrete pier, buildings, and parking and drainage. From in depth inspections, including physical pretrographic analysis, CEC has determined that the concrete pier is in need of repair or replacement due to the deterioration that is present. It is our opinion that the existing pier has reached the end of its service life, due to the extensive deterioration of the concrete pile cap beams throughout the structure. In particular the condition of the beam concrete is poor and has limited internal aggregate bond with extensive micro-cracking. Repair attempts with protective systems applied to concrete of this quality, in our opinion, are not feasible and will not achieve reasonable extension of the structure's serviceable life. The current condition of the pier is therefore, in our opinion, considered to be beyond reasonable repair capability and the entire pier structure should be replaced within the next 3 years. In addition, the remaining predicted costs for the harbor include replacing the comfort station in 2012, replacing the timber and steel bulkhead in 2013 (recommended to occur with pier reconstruction), and refurbishing the parking and drainage in year 2018 and beyond.

Allen Harbor

The following facilities were inspected in Allen Harbor: timber bulkhead, floating docks, timber pier, concrete boat ramp, and parking and drainage. From CEC inspections, it was found that the timber bulkhead requires the majority of the attention at this time due to the presence of voids in the timber planks that retain the parking lot adjacent to the wall. To further extend the serviceable life of the bulkhead, CEC recommends installing an accessory wale to protect sheeting from continued deterioration and substrate washout in areas below the bottom wale (in intertidal zone) as a cursory fix. This will extend the life of the wall for a few more years until a complete replacement is needed in the year 2014. Other concerns for the harbor involve replacing the comfort station in 2011, upgrades to the timber pier in 2015 (providing cross bracing and replacing any deteriorated pilings), replacing the concrete boat ramp and reconstructing the parking lot and drainage in year 2018 and beyond.

Herring River

The following facilities were inspected in Herring River: two (2) timber piers, concrete boat ramp, and parking and drainage. CEC has found that the timber pier at the mouth of the river at the end of Riverside drive is in deplorable condition and poses a major risk in regard to public safety. There are substantial shifts in horizontal and vertical alignment of the pier, as well as major deterioration of the bearing piles. The stringers, headers, and decking have endured substantial biological and functional damage over the years. The sizing of the members is also unsuitable for current design loads. In addition, rusted and missing components, and corrosion are hindering the piers ability to function, as it should. CEC has recommended that the pier be replaced in year 2011. Other components of the area slated for repair or replacement include replacing the concrete boat ramp and upgrading the parking and drainage for the area adjacent to route 28 in the year 2018 and beyond.

Round Cove

The following facilities were inspected in Round Cove: concrete bulkhead, concrete boat ramp, floating dock and ramp, and parking and drainage. From the inspections, CEC did not find an immediate need to replace or repair any component of the area. However, the components that will require continued monitoring to ensure structural stability are the boat ramp and concrete bulkhead. The bulkhead is experiencing spalling of concrete due to freeze/thaw conditions as well as expansion cracking. There are voids in the wall that is creating a susceptible area for substrate washout from the parking lot. The boat ramp, concrete bulkhead, and parking and drainage are slated to be reconstructed or upgraded in the year 2018 and beyond.

In concluding, please note that these predictions are based on assessing the structure or component in regard to protecting the well being of the public. CEC recommends that a majority of these structures be formulated into a yearly monitoring program to assess if the structure can be remedied to prolong its serviceable life. This will be a crucial tool in providing an accurate assessment of the structure, and to accurately determine if the structure will need to replaced or repaired immediately. Also, all service life expectancy assumptions are based on normal weather and use conditions, not including extreme single events, such as high winds, storm events, or seismic occurrences that may result in reducing the remaining service life of building components.

Finally, we note that we understand the town waterways committee is considering improvements to several of the marine facilities, particularly at Saquatucket Harbor, where a new fixed pier, docking system and Harbormaster/comfort station building is desired. The analysis of any new harbor system or major facility improvements were not a requirement of the RFP, and therefore beyond the scope of this report. Nonetheless, we believe a Harbor Management Report would be a useful tool to study long-term harbor management needs and should be considered as a supplement to this report.

1. INTRODUCTION

1.1 Project Scope and Objectives

The scope of the project is to serve the Town of Harwich's interest in obtaining an accurate assessment of current conditions at town-owned marine facilities along with a prioritized list of recommendations for construction/rehabilitation work required at each facility. This, in turn, will provide the Town with a well thought out road map in place for the efficient up-grades and utilization of the facilities. This will also be a useful tool for the Town to determine long term strategic planning objectives for the management of these important town resources.

The marine facilities at the following sites were investigated for an assessment of current conditions: Saquatucket Harbor, Wychmere Harbor, Allen Harbor, Herring River, and Round Cove. Each site was then evaluated for performance and stability, then systematically analyzed for repair or replacement options, and cost out for capital budget planning purposes.

The major components evaluated at each of these areas included the following items, as applicable:

1. Bulkheads
2. Boat Ramps
3. Town Docks
4. Buildings
5. Parking Areas and Drainage

Existing record plans and documentation provided by the town were collected and reviewed along with any available data and resource information for each area (refer to section 2.1 for background and licensing information for each facility). Site investigations and various materials testing for components of the marine facilities listed were also performed (refer to Appendix C for inspection reports for the designated areas). These inspections created the foundation for the assembly of prioritized lists of recommendations, and were the basis for the creation of both short and long term planning needs. The results are summarized in a spreadsheet (Appendix F) that includes projected time frames, annual maintenance, repair and replacement costs.

Technical Approach and Methodology

The approach to this project was to inventory and inspect each designated municipal facility included in the project scope up front. This included initial meetings with Town officials and local stakeholders, as well as a basic engineering reconnaissance, including structural and civil engineering investigation and evaluation of the existing facilities, materials testing, and related aspects of the inspection. Field crews were utilized to inspect structural items in the project areas required, including bulkheads, docks, parking areas, and boat ramps.

Inspection Protocol

Coastal Engineering Co., Inc. (herein referred to as CEC) performed the required inspections and conditional assessments of the five(5) major component structure items in accordance with the following protocol.

Items 1 – 4, Bulkheads, Boat Ramps, Town Docks and Buildings:

At deteriorated concrete bulkhead, wall, and foundation sections, concrete soundings were taken at various locations via hammer tapping and other similar audible procedures at accessible areas of the

sections. Based upon these field audible tests, along with minor chipping of loosened concrete spalls and delamination, determination of the extent of concrete deterioration was ascertained. Visual evaluations were performed on all visible, exposed portions of concrete to determine the probable cause and extent of spalling, cracking or other detrimental qualities of the concrete.

Concrete sections that indicated evidence of extensive deterioration were sampled using a hand coring drill in order to secure test cores for laboratory analysis. Core samples, where required, were obtained where concrete wall or bulkhead structures exist. The cores were subjected to laboratory analysis for petrographic examination and additional testing in order to determine the overall quality of concrete, durability, extent of microcracking, chloride ion content, carbonation, sulfate attack, etc. Laboratory testing results are included in Appendix D.

Bulkhead, wall, soldier piles, fiberglass and timber piles and building foundation systems were measured for horizontal and vertical deviations where possible in order to determine the extent of deformations and deflections. Methods and tools including plumb-bob with tape measure, inclinometers, or magnetic polycast protractors were used in order to determine the extent of structure or section offsets.

Timber piles, dimensional lumber, decking, and other wood materials were probed or slightly shave cut (where accessible) to determine the extent or depth of deterioration and/or sectional loss. At timber piles, a portion of the pile was shaven to a smooth surface in order to gain an accurate circumference reading with a loose tape measure.

Structural steel sections including soldier piles in bulkhead systems, connectors, brackets, hardware, etc. were evaluated visually, and where accessible, coatings and oxidation was removed at various test locations to expose bare clean metal substrate, in order to determine the section loss. Extent of exfoliation, approximate percentage of steel section loss, condition of existing coatings, functionality of connections, etc. is included with the evaluation.

Site buildings, guardrails, railings, floats and similar site appurtenances were visually evaluated for general load capacity, lateral stability, conditional assessment via decay, deterioration and weathering, wear and tear, and expected structural life expectancy. In addition to structural conditional and strength assessments, feasibility for repair and replacement options is included.

Site buildings, appurtenances, wharf, dock, bulkhead, pile, float, elevated walks, etc. were reviewed for building technologies conditional assessments where appropriate. Items such as roofing, cladding, sealants, bumpers, signage, functionality of doors, windows, gates, latches, hardware, etc. are included with our evaluations of these systems.

Overall, a rating system, which included present condition, structural capacities, life expectancy, life/safety issues, and similar qualifications, was used in order to establish the severity of the present harbor system conditions. Options toward repair of these systems in order to extend their serviceable life, or assign partial or complete replacement, were also considered for each of these systems.

Item 5, Parking Areas and Drainage:

The existing parking lot grading and storm water management systems in the Herring River, Wychmere Harbor, Allen Harbor and Saquatucket Harbor parking areas was evaluated. Items including catch basins, man holes, pipes, and outfalls were reviewed to see if they are functioning. The overall system was evaluated to determine improvements that may be necessary to upgrade the systems to comply with the DEP Storm Water Management Policy.

1.2 Limits of Investigation

This report is limited to a general overview of the existing structures identified in the RFP and is intended to provide a broad overview of general conditions and assessment of existing facilities with probable life cycle and approximate cost estimates. The intent of this report is to provide a road map for long term project budget planning purposes, and as such is limited for use as a planning tool for the town's future capital budget needs.

1.3 Additional Studies

Detailed engineering studies, for the implementation of the recommendations contained in this report will be required for the various sites. Typical scope of services would include detailed engineering studies, field surveys, engineering design plans, environmental permitting and administration for public bid procurement.

Furthermore, we understand the town waterways committee is considering improvements to several of the marine facilities, particularly at Saquatucket Harbor, where a new fixed pier, docking system and Harbormaster/comfort station building is desired. The analysis of any new harbor system or major facility improvements were not a requirement of the RFP, and therefore beyond the scope of this report. Nonetheless, we believe a Harbor Management Report would be a useful tool to study long-term harbor management needs and should be considered as a supplement to this report.

2. ACTIVITY DESCRIPTION

2.1 Locations and Background

2.1.1 Saquatucket Harbor

Saquatucket Harbor is Harwich's main full service municipal marina located on Nantucket Sound. It is the largest of the three harbors, and serves a substantial number of recreational and commercial boating slips. The facility has an expansive parking area, that features a two lane, paved boat ramp and multiple bulkhead retaining walls. The site also serves as the location of the Harbormaster's office. The marina hosts over 190 vessels including sailing boats and charter fishing boats. In addition to the, there are numerous slips dedicated for transient boat users that can be rented during the summer season. The marina is generally in full service from May 1st to November 15th.

The channel is a designated federal channel that is supposed to be maintained by the Army Corps of Engineers and is dredged to maintain a depth of six feet at low tide. Other amenities of the facility include: 20 or 30 amp electrical power at various slips, water connection at each slip, a self-service pump out station, handicap accessible bathrooms, showers, and laundry services. Along with recreational boating, there is also commercial ferry service provided that transports passengers seasonally from Harwich to Nantucket daily.

Based on research conducted at the Barnstable County Registry of Deeds, and at the Town of Harwich engineering department and Harbormaster's office, the following Chapter 91 licenses were documented at Saquatucket Harbor:

-License #1019 "…to construct and maintain floating docks and piles in Saquatucket Harbor for the Town of Harwich." issued October 6, 1983; license in perpetuity
-License #5710 "…to install and maintain a fender piles and tie-off piles…" issued July 5, 1996; license in perpetuity

It has been found that piles were replaced under local permits after Hurricane Bob in the early 1990's to class B wooden piles. Also, the steel pilings on the outer east dock were replaced in 2006/2008 with fiberglass pilings.

2.1.2 Wychmere Harbor

The Town of Harwich maintains the Wychmere Harbor Pier at Harbor Road, Harwich Port, MA as a landing area for commercial fishing vessels. This is a controlled off-loading area and requires a special permit from the town for the associated fishing vessels and passenger vessels conducting business to use this area. The pier serves as an important point for a fleet of more than 60 vessels in four categories that use Harwich Port for most or part of the year. Commercial fishing vessels depend on the facility to unload fish, take on ice, fresh water and most importantly, diesel fuel.

In 1978, the original town dock and the adjacent Pogie's Wharf were removed and replaced with a single concrete pier that currently exists today. The pier is managed by the Harbormaster's office out of Saquatucket Harbor. Also located at this facility are a steel bulkhead, timber bulkhead, concrete bulkhead, parking and drainage structures, comfort station, and a shellfish laboratory. The original concrete and wooden bulkhead were constructed in the 1930's. All batter piles along the south facing bulkhead were replaced in 2003. Other fender pilings for the main pier were replaced in 1996. The latest update to the facility was in 2006, where steel pilings were replaced by fiberglass pilings in the vicinity of the fishing vessels.

Based on research conducted at the Barnstable County Registry of Deeds, and at the Town of Harwich engineering department and Harbormaster's office, the following Chapter 91 were documented at Wychmere Harbor:

-License #2660 "…place and maintain two piles…" issued June 7, 1991; expires June 7, 2021
-DEQE License #596 for existing pier and tie off piles, issued September 12, 1979
-DPW License #1418 for existing pier and tie off piles, issued June 28, 1932

2.1.3 Allen Harbor

Allen Harbor is one of Harwich's top priority marinas. Located on Lower County Road in Harwich Port, the town owned portion of the harbor consists of a small marina, boat ramp and parking area. The marina is comprised of multiple transient floats, timber bulkhead, concrete boat ramp, wooden pier, boat launching/ ramp with courtesy float, and a small area for parking and drainage. The majority of the facility is weathered and in need of repair. The pier, bulkheads, and the original boat ramp were constructed in the early 1950's. The existing float system was installed before 1985. The original pilings are still present and in fairly good condition, given their age. The bulkhead has collapsed in the past, requiring the deadmen system to be repaired on two occasions in the last twenty years. The comfort station was constructed in the late 60's and does not currently meet handicap accessibility requirements.

Based on research conducted at the Barnstable County Registry of Deeds, and at the Town of Harwich engineering department and Harbormaster's office, the following Chapter 91 licenses were documented at Allen Harbor:

-License #1191 "…to reconstruct and maintain a boat launching ramp…" issued January 28, 1985; license in perpetuity
-License #2490 "…to extend and maintain a boat ramp and maintain an existing ramp, pier,

and float…" issued November 30, 1990; license in perpetuity
-License #5288 "… to place floating docks, ramp and platform in Allen Harbor, at its property in the town of Harwich…" issued October 25, 1967

2.1.4 Herring River

Herring River is the one the largest river estuary on Cape Cod and a vitally important natural resource in the town of Harwich. The river provides navigational access to Nantucket Sound via multiple docks and ramps. The town owns two small piers on the river: one is located at the mouth of the river near Nantucket Sound, and the other is located next to the Route 28 bridge overpass. The town facility at the mouth of the river consists of a small pier and launch area, but there is no parking or ramp at this location. At the Route 28 site, the town owned facility consists of a small pier, a boat launching ramp, and a gravel parking area with drive access directly off Route 28. The pier adjacent to Route 28 has recently been renovated. The other pier, located at the mouth of the river, is in need of replacement.

Based on research conducted at the Barnstable County Registry of Deeds, and at the Town of Harwich engineering department and Harbormaster's office, the following Chapter 91 licenses were documented at Herring River:

-License #1328 "…to remove an existing bridge and construct and maintain a new pile-supported timber pedestrian bridge…" issued November 18, 1985; license in perpetuity
-License #2279 "…to maintain a bridge and rip-rap…" issued March 16, 1990; license in perpetuity
-License #2715 "…to reconstruct and maintain a pier, ramp, and float and maintain a boat ramp…" issued October 8, 1991; license in perpetuity
-License #3062 "…to amend License #2715 by extending the pier nine feet into the waterway and narrowing its width…" issued July 22, 1992; license in perpetuity
-License #4344 "…to maintain an existing pier and construct and maintain a ramp and pile-held float…" issued January 26, 1995; license in perpetuity

2.1.5 Round Cove

Round cove is located off of Route 28 in East Harwich. The facility contains a concrete boat ramp, concrete bulkhead retaining wall, parking area, dinghy storage area, aluminum ramp and floating dock. The facility provides boaters with access to nearby Pleasant Bay. The natural barrier from the bay creates a very calm and protected atmosphere for boaters, as well as, alleviates the severity of waves induced from extreme storm events.

Based on research conducted at the Barnstable County Registry of Deeds, and at the Town of Harwich engineering department and Harbormaster's office, no Chapter 91 licenses were documented for Round Cove.

3. SAQUATUCKET HARBOR

3.1 Saquatucket Concrete Bulkhead

3.1.1 Description of Facility

The concrete bulkhead is a crucial component of the Saquatucket Harbor Marina. It defines the boundaries of the inner harbor and provides earth retainage for upland land improvements and site features; it provides storm damage protection to upland structures and protects area improvements from overwash during ordinary strorm events. It also acts as a stabilizing element for the adjacent travelway, parking area, and Harbormaster's building. The bulkhead runs a total approximate length of 875 feet. The bulkehead runs predominately east-west, with terminations on the boundary line to the west and at the concrete boat ramp to the east. From the boat ramp, the bulkhead continues east for another 30 feet and turns a 90 degree angle south, where it runs for the remaining portion of its length (adjacent to the fuel dock).

The wall is vertically supported by H-piles that are spaced approximately 8' O.C. The vertical sheeting of the bulkhead consists of 8" thick precast concrete panels that are retained by compression plates at every H-Pile. The H-piles are supported by 12" diameter batter piles, angled at 45 degrees, attached mechanically through bracket connections and fasteners. The concrete cap is approximately 12"x12" and runs the whole length of the bulkhead wall.

3.1.2 Observed Conditions

CEC has reviewed the condition of the existing bulkhead wall and made the following observations:

The original H-pile construction shows evidence of prior augmentation with cover plates and a stiffened compression plate detail added on top of the batter piles on the waterside of the bulkhead wall. This occurs along the entire length of the wall, with exception being at the walls at the boat ramp, where no batter piles were provided. It appears that the original bracket plates and fasteners at the batter piles have corroded to such extent that minimal load transfer capacity remains at these connections. The compression plates appear to be in adequate condition to provide sufficient connection strength in transferring loads from the bulkhead wall supporting H-piles to the batter piles. Some corrosion has been observed on the compression plates, which in our opinion, does not compromise the structural capacity significantly.

Corrosion levels of H-piles showed ranges from mid level to considerable, depending on the particular pile and location on the pile. Most piles appear to have less than 1/8 inch section loss due to corrosion within the top 10 to 12 inches, which is outside of the high stress zone of the piles. The corrosion appears to be most significant at the ends of the flanges and less extensive towards the center of each flange and at cover plates.

Individual H-piles in a few locations typically at the side walls of the ramp and at a corner post at the end of the fuel dock wall, showed more significant deterioration of the exposed flanges with surface loss to approximately 50 to 75% of the flange section.

Due to the strongest corrosion being located at the top of the H-piles, the existing concrete cap beam has spalled off in front of many pile flanges or shows signs of a cracked break-out cone, which has not fully separated in all areas. The volume increase of rust, water intrusion into the cracks, and freeze-thaw damage are the main cause for concrete spalling. The H-piles are not needed to laterally restrain these areas of the concrete cap beam; therefore, the spalls are not of particular structural

concern at this time. However, water is more likely to enter into the space behind the H-pile flange, which may lead to accelerated freeze-thaw damage and steel corrosion in these areas.

All observed bulkhead walls were generally plumb, and did not show significant signs of buckling or rotation, except for the bulkhead wall with tie back anchors at the access road/loading area between ramp and fuel dock. The tied back wall at this location showed significant deflection at the top toward the harbor basin. The rotation has progressed to a point that the concrete cap beam is leaning against the wood bumper piles in this area. Heavy truck traffic in close proximity to the bulkhead wall has likely caused the wall to deflect and rotate.

CEC observed settled grade and sinkholes behind the bulkhead, which allow water to infiltrate, further and increase the settling rate. Fill materials may be washed out through cracks and penetrations of the bulkhead.

Concrete bulkhead panels, which serve as soil retaining elements between the steel H-piles are typically in structurally sound condition. Some panels show larger, usually horizontally oriented, single cracks, which may allow retained soils from behind the wall to be washed out, which may result in settling of soils behind the wall. Some panels showed crazing, and some spalled concrete at panel edges. It is CEC's opinion that the current cracking and spalling of existing concrete panels is not of structural concern at this time. We recommend, however, that larger cracks and spalls be filled in with suitable repair mortar to prevent settling of soils on the retained side of the wall.

The concrete surfaces of the cap beam typically shows exposed aggregate, which is largely caused by erosion and mild sulfate attack. The current state is not of structural concern. However, if the erosion continues, and aggregate begins to roll out of the concrete matrix, freeze-thaw damage and cracking will occur at a faster rate.

3.1.3 Structural Condition Assessment

CEC rated the overall condition of the above-described structure as acceptable, in fair to good condition, with some exceptions as follows:

We are of the opinion that the bulkhead wall (with the exclusion of the ramp area and tied back wall north of the fuel dock) is in a acceptably sound structural condition. We estimate the remaining service life of the bulkhead to be approximately 5 to 10 years, providing the structure is properly maintained with the recommended repairs made within the next year.

The tied back wall north of the fuel dock can be stabilized with an appropriately designed support system of the wall within the next 1 to 2 years, which would extend the remaining service life to approximately 5 to 10 years. Please note that the current deflection is likely not reversible and would remain after a stabilization system has been implemented.

It is our understanding that renovation plans for the ramp area have been prepared, including a newly designed bulkhead system for the ramp side walls. We therefore excluded this area from our recommendations in this evaluation.

Please note, that all service life expectancy assumptions are based on normal weather and use conditions, not including extreme single events, such as high winds, storm events, or seismic occurrences that may result in reducing the remaining service life of building components.

3.1.4 Recommendations

The repairs to the bulkhead wall (with the exclusion of the ramp area and tied back wall north of the fuel dock) include: 1) infilling cracks and spalls of concrete wall panels; 2)light surface cleaning and sealing of the top of the H-pile at spalled concrete cap beams to prevent rain water from penetrating between piles and cap and cause further freeze-thaw damage; and 3) infill of sinkholes and installation of sufficient drainage weep ports to prevent water accumulation on the land side of the cap beam.

In regard to the tied back wall north of the fuel dock, if no stabilization is installed, CEC estimates that this portion of the bulkhead will likely require full replacement in 3 to 5 years.

3.2 Saquatucket Boat Ramp

The boat ramp at Saquatucket Harbor is not included with the scope of this project. The boat ramp is a component of the state and is run by the Office of Fishing and Boating Access. The state has allocated monies for this ramp to be refurbished, as well as completed a design and obtains all the necessary permits in hand to start the project. According to an article published in the *Cape Cod Chronicle,* the construction is to begin in the fall of 2009, with bids due by August 20, 2009. Also, if a given contractor cannot complete the work before November 30, 2009, then the contract will not be awarded to that contractor.

3.3 Saquatucket Marina (East and West floating dock)

3.3.1 Description of Facility

Saquatucket Harbor currently contains a total of 217 floats and approximately 244 pilings. are typically dimensioned either 4x10, 4x20, or 6x20. The floats are constructed with 2x4 pressure treated decking, with 2x6 sideboards and 4x4 timber cleats. The actual float is comprised of foam board floatation and fiberglass shells. The piles range from 12”-15” in diameter and consist of both timber and fiberglass material. Each slip provides boaters with 20 or 30 amp electrical service, water service, and lighting.

The majority of the slips are used by fishing vessels for either commercial or recreational use. There are multiple charter fishing boats, sightseeing tour vessels, and a commercial ferry that takes passengers to Nantucket (Freedom Ferry). In addition to the commercial use, there is still an abundance of slips for recreational boating for members of the marina, as well as various transient floats for temporary boaters. These slips are rented for a minimum of 3 nights, with a a maximum allotment of 2 weeks in the summer season.

3.3.2 Observed Conditions

A level II inspection was performed for the 217 floats and 244 pilings for the marina. CEC performed in depth walk-around inspections, as well as detailed close up inspections of the pilings, wood decking, hardware & connections, cleats, and overall general condition of the components. The majority of piles inspected were scraped and measured by circumference at two locations per pile. Please see field reports and photographs for an in depth analysis of the observations. The inspection was broken down into 10 sections to enhance the clarity of the data acquisition process. The sections are as follows:

-Section A: West Dock

Pilings: A total of 12 pilings were inspected in this area. There were no major concerns associated with the integrity of the piles. Piles 5, 7, 11 & 12 are showing signs of minor to moderate wear due to abrasions from the rectangular brackets on the adjacent attached floats.

Floats: A total of 22 floats were inspected in this area. The majority of the floats are in good to fair condition with no floats in poor condition. All floatation appears to be in adequate working condition with no hazard in regard to public safety apparent at this time. Notable deficiencies are areas of rust, or loose hardware on float A21.

-Section B: West Dock

Pilings: A total of 10 piles were viewed and inspected in this area. Piles 3, 9, & 10 are showing signs of major wear and sectional loss due to functionality problem with connector brackets from floats. Remaining piles are in good condition, with minor wear and sectional loss. Abrasion is clearly evident on piles due to float connections.

Floats: A total of 22 floats were inspected and viewed in this area. Floats B3 & B18 are found to be in poor condition due to the number of loose boards. The remaining majority of floats are in fair to good condition. Various floats have loose or rusted connections, with rusted nails being a major concern. Please refer to Section B Float Inspection Report for more detailed analysis of the floats.

-Section C: West Dock

Pilings: A total of 22 piles were inspected in Section C, with 6 out of the 22 being Pearson fiberglass pilings that have been recently installed. Pile C2, C7, & C14 are showing signs of major wear due to abrasions from float brackets. All remaining piles are in fair to good condition, with minor signs of wear and sectional loss.

Floats: A total of 24 floats were inspected in this section, with 7 out of the 24 being in poor condition. Loose decking, loose hardware, and corrosion is the major concern in this area. No functionality issues in regards to floatation. Cleats are visible and remain in good condition. (Refer to attached Section C Float inspection report for further inspection data).

-Section D: West Dock

Pilings: A total of 31 piles were observed in section D, with 12 out of the 31 piles being Pearson fiberglass pilings. The fiberglass pilings are in fair condition, with only minor peeling of the outer shell on a few pilings caused from boat anchoring. Bent A was found to need the most attention due to the amount of wear present on the timber piles. Again, this wear is caused by the abrasion from the constant motion of the brackets rubbing against the pile during storm events and from low to high tide cycles.

Floats: A total of 11 floats were inspected in this area. Approximately 80 percent of the decking on the floats has been recently replaced and is in excellent condition. Floatation, hardware, connections, and overall condition are substantially functional.

-Section E: East Dock

Pilings: A total of 20 piles were inspected in this area. Pile E8 is very loose and will require

attention in the near future. 50% of piles are damaged due to the bracket connection to adjacent floats. In addition, there is splitting at the top of various piles due to the absence of pile caps. A total of 7 pile caps were noted missing.

Floats: Section E has a total of 30 floats, 5 of which are in poor condition (E3, E25, E27, E29, & E39). The remaining floats are in fair condition. Major rusting and a few warped or loose connections are present.

-Section F: East Dock

Pilings: In section F, a total of 34 pilings were inspected, ranging from Pearson fiberglass to treated timber. Visually, the majority of the piles were in good to excellent condition with a few exceptions due to abrasions or peeling. Many of the fiberglass pilings had minimal abrasion from ropes and boat disturbance. Also, moderate splitting is occurring at piles that do not contain pile caps.

Floats: Out of the 18 floats inspected, 1/3 of them are in need of repair. Loose decking and hardware, or warped hardware is occurring in this location. Nails are rusting, causing the connections to become loose. The disassociation of the nails with the wood is causing the end sections of the decking to split as well. Overall floatation is in good condition, with a few floats in fair condition.

-Run 1: East and West Dock

Pilings: A total of 38 piles were inspected in this vicinity. The conditions range from no damage, to severe damage (pile 33). This pile has endured major sectional loss due to extreme friction between brackets and pile. Other problems encountered consist of minor sectional loss, damage at top where pile cap is missing, or peeling of the outer shell.

Floats: Out of the 47 floats inspected, there were no major problems found. Any damage found is from rusted nails or warped bars that connect the floats together. Worn decking is present, but not causing any functionality or safety issues.

Please see attached Saquatucket Harbor plan for a location key for the designated areas. Also, for an in depth analysis for the inspections, refer to attached pile and float inspection reports for the given areas.

3.3.3 Overall Condition Assessment

Overall, the floating docks and piles of Saquatucket Harbor were found to be in fair condition and in generally good repair, with no immediate need for substantial replacement of any pile or float system. However, regular maintenance will be required to address hardware deterioration and normal repair issues , particularly in regard to the bracket connections to the existing piles. These brackets protrude out in the vicinity of the pile. During a storm event, tidal fluctuation, or float movement caused from boat dockage, these brackets rub against the outer diameter of the piles, causing moderate to major sectional loss. If these brackets are not replaced in the near future, the abrasions will continue, ultimately hindering each pile's ability to function properly.

Other concerns are associated with loose decking, warped/loose connecting hardware, or rusting components. Rusting is an issue that is present at all marinas; however, in some areas of the marina, it has caused the decking to become loose. This creates a safety hazard for individuals walking on the docks and should be addressed as appropriate. Moderate weathering of decking is present in over 50% of the marina, and a large majority of these floats are unbalanced in regard to floatation. This is

another component of the float system that could pose a safety risk. Also, this instability is causing bends in the metal axle that holds the floats together.

From CEC's field observations and research, it is evident that the float and pile system in Saquatucket Harbor has withstood several major storms, including Hurricane Bob in 1991, which did not significantly destroy or damage beyond repair the facility. Although pilings needed to be replaced after Hurricane Bob, the remaining components generally stood strong. From our visual observations and inspection of the marina, it is clear that the facility is well maintained with regular repairs made to the pier on a yearly basis to maintain the integrity of the facility. These repairs are crucial to avoid long term major costs associated with replacing substantial components of the marina and the practice should continue into the future.

3.3.4 Recommendations

CEC makes the following recommendations regarding the float and pile facility at Saquatucket Marina. These recommendations should be incorporated into a maintenance plan that addresses the following issues:

1. Replacing float brackets with Schedule 40 PVC pile rings.
2. Installing pile caps on missing piles.
3. Reinstalling various float drums with stronger, durable polyethylene encased float drums.
4. Continued replacement of worn decking and hardware. Utilizing stainless steel screws and hardware to attach boards to the floats.

Utilizing PVC pile guides in replacement of the existing metal brackets will substantially minimize the disturbance to the piles of the marina. These are easy to install and are comprised of 1½" Schedule 40 PVC pipe, a ¼" thick structural steel plate, and ½" carriage bolts for mounting to the float. CEC recommends that all hardware be hot dipped galvanized. Please see attached cut sheet for a general description of the product.

Next, installing pile caps on missing piles will protect the pile from weathering, checking, water penetration, and will also discourage any birds from perching or nesting on the pile. There are several options for pile caps; however, CEC recommends polyethylene marine heavy duty pile caps. This is a practicable fix in regard to price, availability, longevity, and overall superior quality. A small fix of installing pile caps could potentially increase the life span of the piles by at least 5-10 years.

To alleviate unbalanced floats, CEC recommends polyethylene float drums to replace the existing foam core floats in problem areas. Please see attached cut sheet for SUPERFLOAT float drums. These units are made from linear virgin polyethylene resin containing UV inhibitors and carbon black pigment to protect against UV deterioration, ultimately increasing the longevity of the product. These floats show resilience against freeze-thaw conditions, bumps from watercraft, and contact deterioration from petroleum products. Also, the product is a food grade material that will not contaminate the marina.

Lastly, to maintain the integrity of the floats, new decking planks must be installed on an on-going basis. These are as-needed repairs and from CEC's observations, only a few areas require immediate action due to loose boards. CEC expects that a majority of the decking will need to be fully replaced within 2-3 years based on the extent of checking in most of the members.

The attached cost maintenance plan summarizes cost estimates for the recommended repairs. With the implementation of the above recommendations, CEC believes that the floats and piles of Saquatucket Harbor can continue to function properly for many years to come.

3.4 Saquatucket Parking and Drainage

3.4.1 Description of Facility

Due to Saquatucket Harbor's immense popularity among vacationers and residents, the parking area is quite expansive. The parking boasts compact spaces, full size spaces, handicap spaces, & spaces to accommodate large trailers for boaters.

3.4.2 Observed Conditions

Level II inspections were performed for the parking and drainage of the marina. CEC and Town of Harwich officials worked in conjunction to assess the form and function of the existing drainage components. The drainage in the parking lot consists of 26 catch and leaching basins with two drain manholes. Please see attached data sheet to gain a better understanding of the condition of each individual component. The majority of the leaching basins were installed within the past 5 years. A portion of the basins are connected via 12" HDPE pipes that are goosenecked to provide some moderate treatment. There are three shallow leaching basins adjacent to the waterfront that contain untreated outfalls leading directly into the waterway of the marina.

The parking is more than sufficient to accommodate the amount of seasonal boaters, tourists, and residents that utilize the facility. There are a total of approximately 230 parking spaces: 7 handicap, 160 full size, 61 trailer spaces, and 2 handicap trailer spaces.

3.4.3 Recommendations

Overall, the parking and drainage of Saquatucket Harbor was found to be in substantially good condition, with the exception of the standing water in some of the leaching basins. CEC recommends that the basins with noted standing water should be pumped, cleaned and any impervious material at the base of the pit be removed.

3.5 Saquatucket Buildings

3.5.1 Description of Facility

Saquatucket Harbor Master Building:

The Harbor Master's building is approximately 35 ft long and 20 ft wide with an attached wing of 10 ft long by 14 ft wide on the northeastern side of the structure. A separate oil storage building located in direct proximity to the northeastern corner of the Harbor Master's building is approximately 8 ft wide and 16 ft long.

The Harbor Master's building consists of a 1 1/2 story portion with office space on the first and second floor levels as well as a single story portion with cathedral ceilings, which are used as bathrooms. The attached wing is a one story office space at first floor level with unused attic space above. The main portion of the building consists of cast-in-place concrete foundations and common wood framed construction. The wing portion has CMU block foundations and common wood frame construction. The building is surrounded with an exterior wood framed deck and walk way on three

sides (partially southern, eastern and partially northern sides of the building). All parts of the building have a gabled roof with asphalt shingles and wood shingle cladding on all exterior walls.

The single story oil storage building is constructed with cast-in-place concrete foundation and common wood framed construction. The roof is gabled with asphalt shingles and wood shingle cladding on all exterior walls.

3.5.2 Observed Conditions

The cast-in-place foundations of the main building and oil storage building are in generally good condition. No signs of structural concern were observed during our visual evaluation of exposed areas, such as extensive cracking, settling, or other damage.

The CMU block foundation at the office wing of the main building appeared to be in generally good condition with some minor separation at mortar joints.

In general, the wood framed structure did not show any signs of structural concern. However, CEC observed some unconventional framing on the eastern side of the roof. This includes a structural ridge beam that appears to be added at a later time to the tied roof system. A knee brace support at the gable end has been cut, which results in some reduction of carrying capacity of the ridge beam. Missing collar ties were observed in the western side of the attic space.

The oil storage building appears to be in generally good condition. CEC observed that uplift ties for the roof structure were not present. Further, only the bottom sill plate is connected via anchor bolts to the structure, while a single sill supporting the wall studs has been notched at the anchor bolt locations. The proper connection of the wood framed structure to the foundations is questionable.

CEC observed some warping and missing asphalt shingles at the main building. Lifted and warped ends of asphalt shingles were mainly observed at steps in the roof plane and around skylights.

Some of he exterior trim and wooden gutters (northern side only) showed minor signs of weathering and beginning deterioration, such as peeling paint, some moss growth and soft spots near gutter drains.

The exterior deck framing appeared to be in good structural condition with some signs of normal weathering of the wooden decking and railings. Metal connectors appeared to be in good condition at the accessible areas on the western side of the building.

CEC did not observe any signs of cracking or other structural concerns within the interior of the buildings. The main building showed evidence of missing or inconsistent insulation in the attic level.

3.5.3 Structural Condition Assessment & Recommendations

CEC rated the overall condition of the above described buildings as good and suggests the following upgrades and maintenance repairs.

- Roof shingles appear to have a remaining service life of approximately 5 years. All missing, warped or otherwise damaged shingles should be replaced and repaired immediately in order to prevent water intrusion and future damage to the structure.
- In general, the exterior shingle cladding of walls is expected to have a remaining service life of approximately 5 to 7 years. Some shingled areas on the northern side of the main building

may need to be cleaned or replaced sooner (within the next 3 years) due to higher moisture exposure and beginning moss growth.

- Some minor rot, splitting and deterioration should be repaired at exterior wooden trim and gutters. Re-coating with a weather resistant paint system is recommended at periodical service intervals, in order to prevent future damage to these elements.
- The exterior wooden decks show some signs of weathering from sun and moisture exposure and appear to have a remaining service life of 4 to 6 years. CEC recommends periodic monitoring and replacement of deck components as necessary.
- CEC recommends to secure the added "structural ridge member" in place with adequate supports and add collar ties at all roof rafter framing as soon as possible, in order to maintain the continuity and stiffness of the existing framing systems.
- Some re-pointing of cracked and separating grout joints at the CMU block foundations is recommended as soon as possible in order to maintain the integrity of these foundation elements.
- CEC further recommends adding proper insulation at attic areas in order to reduce energy cost for heating or cooling of the building.

Please note, that all service life expectancy assumptions are based on normal weather and use conditions, not including extreme single events, such as high winds, storm events, or seismic occurrences that may result in reducing the remaining service life of building components.

4. WYCHMERE HARBOR

4.1 Wychmere Timber & Steel Bulkhead

4.1.1 Description of Facility

The timber and steel bulkheads of Wychmere Harbor are primarily used for retaining the parking area and travelway for boaters utilizing the existing concrete pier. The steel bulkhead is located in the southeast portion of the marina and is comprised of steel sheeting, a 10"x10" top wale and cap, multiple sets of fender piles, and a steel anchoring system. A duckbill outfall is located at the northern end of the wall that releases stormwater from the adjacent catch basins located in the parking lot. The wall was constructed approximately 30 years ago. The total length of the steel bulkhead is approximately 39 feet.

In addition to the steel bulkhead, the majority of the marina is also comprised of a timber bulkhead, which encompasses the southern limit of the parking lot, as well as the western portion where the parking lot meets the concrete pier. This system is comprised of 8" wide by 2" depth tongue and groove timber sheeting; (2) 10"x12" timber wales that are spaced 5' vertically from one another; 1.5" diameter steel tiebacks, spaced at 8' O.C.; a 12"x12" timber cap; and approximately 9 sets of fender piles that are located in front of the wall. The total wall length is approximately 91 feet.

4.1.2 Observed Conditions

A level II inspection was performed for the entire length of both the timber and steel bulkheads. CEC utilized the low tide to perform the majority of the inspection to ascertain that a full visual of the condition of the structures could be attained. The inspection involved utilizing a motor boat, waders, camera, ice pick, pile scraper, and tape measures. The majority of the piles inspected were scraped and measured by circumference at two locations per pile to acquire an accurate reading as to how the pile has weathered. CEC utilized ice picks and hammers to lightly tap any areas of the wall

that appeared to be fatigued. Extreme care was taken when performing these tasks to maintain the integrity of the wall and its components.

Steel Bulkhead

Beginning at low tide, CEC performed an analysis of the steel sheeting at and below the mud line. There appeared to be no voids at the mud line, and no wale was found. The majority of the wall was exposed during low tide, with only the northern portion of the wall submerged one to two feet, making it advantageous for the inspection process. From visual and physical inspection, the steel sheeting appears to be experiencing major decomposition due to rust and corrosion. Although there were no major voids found in the face of the wall, the outer surface of the steel has endured substantial peeling and spalling. The wale and cap has endured much weathering with moderate signs of horizontal checking and splitting. While inspecting the wale, no evidence was found indicating any type of anchoring system was installed in the original construction. In addition, it appears that the existing fender piles have recently been supplemented with newer piles to provide additional load capacity for the wall. The previous piles are in deplorable condition and have no load bearing capacity. The newer piles are in moderate condition, although the hardware is a critical concern, due to corrosion. When the most recent fender piles were installed, it appears that the hardware used to attach the pile to the wall was only attached to the existing pile. This is a major concern considering the previous piles have virtually no bearing capacity.

The parking area adjacent to the wall is experiencing major depressions and voids due to wash out of substrate under the sheeting. This is a evidence that the subgrade sheeting contains voids that needs to be assessed.

Timber Bulkhead

A total of 91 linear feet of wall was inspected using a motorboat and waders starting at the eastern end of the marina. At low tide, the bottom wale was exposed, therefore providing an accurate assessment of the majority of the timber bulkhead. The 8" wide timber sheeting appears to be in fair condition with only a few voided areas noted. These voids appear to be caused by rot as a result of marine growth that is causing the wood to become soft. The mold that is present on the wood is most likely creating a favorable environment for decaying organisms to flourish. Marine borers and marine fouling animals could also cause some disturbance in the wall. The largest void was located between pile 5 & 6. Please refer to attached plan depicting pile locations.

The steel anchoring system has endured extreme corrosion and rusting. In their current state, it is assumed that their ability to act in tension and support the wall is extremely limited. The majority of the newer fender piles are in excellent condition, with the exception to their connections to the bulkhead. As previously mentioned for the steel bulkhead, the newer piles single connection to the existing deteriorated pilings is insufficient. Over half of the older piles are in deplorable condition and serve no structural purpose for the bulkhead.

When observing the parking area above the bulkhead, there appears to be moderate slumping occurring that leads to puddling and sediment outwash. This outwash could be occurring due to voids in the wall that were noticed during visual inspection.

4.1.3 Structural Condition Assessment

In summing up the inspections for the timber and steel bulkheads, it was found that the steel bulkhead requires the most attention at this current time. The steel appears to have outlasted its serviceable life and will be in need of replacement soon. At minimum, surfical repairs would be

needed to maintain the existing bulkhead while long term replacement plans are developed. It's clearly evident that the wall is not functioning as designed due to the presence of slumping in the parking lot. Along with the steel, the piles are not functional due to the insufficient connections. These connections would need to be independent of the existing failed fender piles. Currently, this is not the case, and in the event of a major storm, these piles are dependent on the existing deteriorated piles and will not function to the best of their ability to maintain the stability of the wall.

The timber bulkhead is in fair condition. There is no immediate need for substantial replacement of the wall. The anchoring system and hardware connection from the existing piles are the major problems associated with the wall. The minor slumping of the parking lot is also a condition that should be continually monitored.

4.1.4 Recommendations

CEC makes the following recommendations regarding the Wychmere Harbor timber and steel bulkheads. These recommendations should be incorporated into a maintenance plan that addresses the following issues:

- Re-establish connection from recent fender piles to existing timber bulkhead
- Replace, as necessary, any failed steel tie backs for timber wall
- Replace, as needed, timber planks that are rotted or deteriorated
- Vibrate or drive new vinyl sheeting to replace existing steel to a depth to be determined by a licensed professional engineer.
- Install new timber wale and cap for new vinyl wall

Establishing a solid connection for the existing piles is extremely important for the long term life of the timber bulkhead. It will increase the walls ability to withstand major storm events and will provide more support for the parking area.

The attached cost maintenance plan summarizes cost estimates for the recommended repairs.

4.2 Wychmere Harbor Pier

4.2.1 Description of Facility

The original town pier was constructed in the early 1930s. The pier has been updated with a number of repairs and improvements, such as the replacement of the south facing batter piles along the south facing bulkhead in 2003, and the remaining fender piles of the main pier were replaced in 1996. The latest update to the marina was replacing the corroded steel pilings with Pearson fiberglass pilings in 2006. The existing pier is approximately 122 ft long and 22 ft wide. The pier is constructed of twenty five, 24 ft long, 4 ft wide and 8 inch thick, pre-stressed concrete deck planks. Five planks are placed parallel and span as a two-span-continuous system to 28 inch by 18 inch, pre-cast concrete pile caps, which are supported by three 12 to 14 inch diameter wooden timber piles each. A total number of 11 pile caps, typically spaced at 12 ft on center are in place, and are framed by a wooden fender pile on each end.

The pier serves as a homeport and loading dock for the local fishing fleet. Reportedly the entire pier is regularly submerged at extreme high tides or storm flooding events.

4.2.2 Observed Conditions

The following observations were made:

The pre-stressed concrete planks appear to be in adequate structural condition with only minor signs of cracking, spalling or other concrete deterioration. CEC extracted test core samples for petrographic examination or lab testing in two locations of the existing pier planks (refer to petrography section for discussion of test results). The existing pile cap beams are in structurally poor condition. Substantial spalling of concrete has occurred at all pile caps, apparently caused by freeze-thaw damage and expansion of corroding reinforcing bars. Extensive chloride ion contamination of the concrete due to the ocean environment and regular submersion serves as an accelerator for corrosion of the reinforcing, embedded in the concrete sections. Efflorescence and moss growth is a sign of regular moisture presence at these members. The ends of the cap beams, bearing pockets for timber piles and grouted connections between planks and pile caps are typically showing the most significant deterioration, cracking, and section loss. CEC extracted test core samples for petrographic examination and lab testing in two locations of pile caps (refer to petrography section for discussion of test results).

Bearing piles that sustain load for concrete pile cap beams are in fair to poor condition. Majority of piles are deteriorating (outer shell peeling). Large presence of water being contained within the pile causing accelerated rot and deterioration. Timber piles appear to be used as system lateral restraints, which is not the typical function of these members.

Evidence of corroded connection pins at plank to cap beam connections was observed. In some areas the original grouted joint between planks and beam has fallen out and corroded pins were visible, other areas showed rust staining and cracking in this area.

4.2.3 Structural Condition Assessment

In order to obtain a representative and accurate conditional assessment of the pier structure and the present state of the materials, CEC used the following evaluation and testing methods:

- Visual evaluation of concrete surfaces, due to noted sulfate attack, physical damage or deterioration, cracking, vertical settlement, surrounding earth scour, and lateral displacement or deformation.
- Hand tool tapping, probing and chipping to determine the extent of visible spalling, depth of cracking, and degree of additional concrete substrate delamination that is not evident from the material surfaces.
- Four 4-inch diameter cores were obtained from the concrete pre-cast plank and cast-in-place concrete beams to perform petrographic examination. Core No.1 was obtained from the top horizontal surface of the concrete plank at the west end of the pier. Core No.2 was obtained from the vertical face of the concrete beam at the western end of the pier, where the concrete appeared to be “leached”, pitted, porous, with an exposed aggregate condition. Core No.3 was obtained from the vertical face of the concrete beam at the eastern side of the pier. Core No.4 was obtained as a full depth sample of a concrete pre-cast plank on the eastern side of the pier. (A copy of the complete petrographic examination report is included in Appendix D)
- Three (3) obtained concrete cores (C2, C3 and C4) were evaluated via complete, certified, petrographic examination, conforming to ASTM C856. The following parameters were evaluated and are included with the petrographic analysis:
  - Water/cement ratio, air content,
  - durability and hardness evaluation,

- presence of sulfate attack,
- depth of carbonation,
- general make-up of the concrete mix including type, size, and distribution of aggregate,
- cement to aggregate bond,
- presence of micro-cracking,
- analysis for alkali silica reactivity,
- alkali carbonate reactivity
- presence of ettringite
- evidence of retempering and original placed slump

- All four (4) obtained concrete cores were sampled in the lab, ground to a powder, and tested for chloride ion content at 1 inch to 2 inch depths and 3 inch to 4 inch depths.
- Photographic documentation of some pier deterioration was recorded.

The above testing procedures, field work, and methods of evaluation have been used in order to determine if the pier is repairable, and if so, what materials and procedures will be needed in order to obtain an appreciable extension of the structures' serviceable life.

Summary of Petrographic Examination and Lab Testing for Concrete Samples:

The complete petrographic and lab testing report with microscopic photography is attached in Appendix D. The following general summary of concerns regarding the condition of the concrete are important parameters which CEC uses in order to determine if the concrete sections should be repaired, or if replacement of these structural components are now required:

- The concrete is carbonated to an approximate depth of 5/16 inch. The depth of carbonated concrete has not yet reached the primary flexural reinforcing steel at this time, based upon this test area.
- The cement paste to aggregate bond is fair.
- The water to cement ratio is estimated between 0.42 and 0.48, which is adequate for severely exposed concrete.
- The chloride ion content up to 4 inches depth is very high at 3.2 to 12.2 lbs/cy, which greatly exceeds the recommended threshold of 1.5 lbs/cy. This equates to the concrete acting as a corrosive environment to any reinforcing steel located within these depths.
- The concrete air void content of pier support beams is not consistent with current technology for durability. Although some of the air void content was 4%, which is appreciable in durability performance, the spacing factor of these air voids is too great and therefore voids are not spaced tightly enough.
- Some cement paste clinkers (non-hydrated cement particles) were found in the concrete. This phenomenon likely indicates that the concrete was not mixed thoroughly or the concrete set too quickly during construction, with evidence of retempering with water.
- Considerable micro-cracking has been observed, which is likely the result of poor concrete durability, freeze-thaw damage and fair cement paste-to-aggregate bond.

4.2.4 Recommendations

CEC rated the overall condition of the above-described structure as poor and suggests the following:

It is our opinion that the existing pier has reached the end of its service life, due to the extensive deterioration of the concrete pile cap beams throughout the structure. In particular the condition of the beam concrete is poor, segregating, and has limited internal aggregate bond with extensive micro-cracking. Repair attempts with protective systems applied to concrete of this quality, in our opinion,

are not feasible and will not achieve reasonable extension of the structures serviceable life. The current condition of the pier is therefore, in our opinion, considered to be beyond reasonable repair capability and the entire pier structure should be replaced within the next 1 to 2 years.

Please note, that all service life expectancy assumptions are based on normal weather and use conditions, not including extreme single events, such as high winds, storm events, or seismic occurrences that may result in reducing the remaining service life of building components.

4.3 Wychmere Parking and Drainage

4.3.1 Description of Facility

Wychmere Harbor parking area accommodates boaters utilizing the pier, comfort station, and shellfish facility. The facility holds 30 parking spaces (five parallel spaces, eight angled spaces, 15 typical spaces, and two handicapped spaces). The drainage is composed of treatment tanks, catch basins, and an outfall that releases untreated stormwater into the harbor.

4.3.2 Observed Conditions

CEC performed a Level II inspection for the parking and drainage at Wychmere Harbor. A walk through was performed for the parking and condition of the pavement. In addition, CEC coordinated with the Town of Harwich highway department to assist in accessing the existing drainage structures. Each drain manhole and catch basin grate was lifted to expose the inside of each component. Visual inspection, pictures, and an overall assessment of the drainage structure was performed. These observations of each component are as follows:

Pavement

The pavement has endured some weathering by showing signs of bumps, cracks, and sags. There were no major potholes or voids in the pavement. Minor linear cracking was present, most likely caused from settling over the years. The major faults in the pavement were due to sediment outwash from the adjacent timber and steel bulkheads. This has caused the pavement to create major depressions and voids in the areas behind the walls.

Parking

Parking found to be substantially adequate for this location. During the time of inspections, there were open parking spaces remaining during mid day, which proves true that there is ample parking at the facility. The egress and traffic flow of the area is functional for trucks to maneuver at times of high traffic. The space is somewhat limited to rearrangement; however, the availability of larger spaces dedicated for trailers should be addressed.

Drainage

Treatment of storm water and drainage is one of the main concerns for Wychmere Harbor in regard to any proposed site development. The current treatment units are quite substantial and take up prime space that could be used for parking. According to Coastal Zone Management, the facility does not operate as designed and should be replaced with a working system. The remaining drainage structures in the parking lot are made of either concrete block construction, or precast concrete. The majority of them need to be pumped and cleaned to facilitate proper functionality in controlling stormwater. The structures are connected via concrete culverts that ultimately outfall into the harbor via duckbill piping. The pipe penetrates through the western facing steel bulkhead.

4.3.3 Recommendations

CEC recommends that the existing drainage structures be pumped, cleaned, and removed of any sediment that will interfere with proper drainage practices. Consideration of removing the existing treatment units should be addressed, due to their size and function. Also, the parking lot will need to be replaced and regraded in 10 years. At this time, CEC recommends that the treatment units be removed, to gain additional parking/drainage for the harbor.

4.4 Wychmere Buildings

4.4.1 Description of Facility

Wychmere Harbor Shellfish Lab Building:

The Shellfish Lab building is an approximately 28 ft long by 18 ft wide wood framed structure supported on timber piles. The ocean water level typically rises above the beach elevation under the entire building during high tide and during moon tides or storm events. The level of ocean water elevates above the building sill height. The building is a one-story structure with an open ceiling for approximately two thirds of its length and a loft floor used for office space for one third. Water filled tanks and trough systems, for raising shellfish, occupy the first floor level. Reportedly, the building is used seasonally during the summer months.

Wychmere Harbor Comfort Station Building:

The Comfort Station building is an approximately 12 ft long by 12 ft wide wood framed structure supported on CMU block foundations with a concrete floor slab on grade. The building is a single story structure with a gabled roof and roof overhang on the entrance side to the enclosed portion. Roof and walls are wood shingled. Trim consists of painted wood members.

4.4.2 Observed Conditions

Wychmere Harbor Shellfish Lab Building:

The wood framed building structure of the shellfish lab appears to be insufficiently tied to its supporting timber piles. A mechanical connection between girder beams and timber piles was not observed. The floor joists appear to be without appropriate mechanical connection to the primary girder beams, and blocking between floor joists at supports is not installed.

Some of the first floor main support beams and floor boards showed extensive decay and appear to be in immediate need of repair and replacement (especially at the perimeter on the eastern side of the structure). Due to substantial water leaking from the shellfish tanks onto the wood framed floor, mold and mildew growth are accelerated, which leads to decay and destruction of the wooden members. Constantly wet floors appear to be saturated and deflect considerably when stepped upon. Multiple layers of floor sheathing have been placed in the past in some areas in an effort to lessen floor deflections. The floor joists appear undersized for the current loading from water tanks.

It appears that generally high levels of air humidity and sea mist inside of the building have led to corrosion of all exposed metal surfaces, such as fasteners, metal connectors, outlet boxes, etc.

The wood framed structure consists of a tied roof rafter system. In the loft area, the original rafter ties have been removed and a 2nd floor level has been framed instead. Some face mount hangers supporting the 2nd floor joists at the loft area are extensively corroded and need to be replaced.

It appears that the overall structure has not shifted significantly there is no evidence of considerable deflections, even though general framing members appear undersized and some connections are of questionable structural capacity.

The exterior wall cladding consists of wood shingles, which are in fair condition. It appears that shingles on the northern building façade have been replaced in the recent past. The bottom perimeter of all walls shows signs of moisture saturation to about 1 ft, which appears to be the result of overflowing tank water

Wychmere Harbor Comfort Station Building:

The overall structure of the building appears to be in good condition. The wooden wall shingles at the back side (viewed from the parking lot) are considerably warped and are separating from the wall plane. The wooden roof shingles show beginning signs of deformation, and separation, as well as surface moss growth. Some trim shows signs of rot and insect damage at the bottom corners of the building. Interior structural members appeared to be in good overall condition.

4.4.3 Structural Condition Assessment & Recommendations

Wychmere Harbor Shellfish Lab Building:

CEC rated the overall condition of the above-described building as mid level to failing in some components and suggests the following upgrades and maintenance repairs.

- Some timber framing members and connections of the first floor system are in need of immediate replacement or repair due to extensive deterioration.
- The connections of the entire structure to its supporting timber piles should be evaluated prior to the winter season and augmented with mechanical connectors as required to properly secure the structure in place.
- Water leaking from shellfish tanks is likely one of the main causes for deterioration and damage to the first floor framing and lower walls. We recommend making all tanks and pipe systems watertight, in order to protect the building structure from further damage after this year's raising season, when tanks can be emptied and refurbished. All soft, decaying and otherwise damaged floor framing members, floor boards and sheathing should be removed and replaced with new properly designed, deterioration and corrosion resistant members to provide adequate support for water tanks and floor loads.
- CEC recommends a general structural evaluation of all framing members and connections of the building, which will likely lead to augmentation of framing members and the addition of mechanical connectors, such as hurricane ties and replacement of face-mount hangers at the loft floor.
- The access stairway to the loft level and the interior side of the loft floor do not meet adequate fall protection requirements, and should be upgraded prior to the end of this year.
- Building envelope components appear to be in generally adequate condition. The asphalt shingle roofing appears to be recently renewed and is expected to have a remaining life expectancy of approximately 10 years. Wood shingles on three exterior walls (eastern, western and southern sides) appear to have reached the end of their service life and replacement is recommended within the next year. Wood shingles on the northern side of the

building are currently in good condition, except for the saturation of the approximately bottom 1 ft due to water leaking from the tanks. If constant exposure to water leaking from the inside of the building is eliminated, the remaining life can be estimated to be approximately 10 years.

Please note, that all service life expectancy assumptions are based on normal weather and use conditions, not including extreme single events, such as high winds, storm events, or seismic occurrences that may result in reducing the remaining service life of building components.

Wychmere Harbor Comfort Station Building:

Please note that all service life expectancy assumptions are based on normal weather and use conditions, not including extreme single events, such as high winds, other weather conditions, or seismic events that may result in a shorter remaining service life of building components. CEC rated the overall condition of the above-described building as good and suggests the following upgrades and maintenance repairs:

- The exterior wood shingle wall cladding at the back side of the building has exceeded its service life. CEC recommends replacement with new shingles prior to the winter of 2010. The other three building sides appear to be in adequate condition and a remaining service life of the wooden wall shingles is estimated at 7 to 10 years.
- Roof shingles are approaching the end of their service life and we recommend replacement within the next 2 years.
- The wooden trim should be repaired or replaced at all deteriorated and damaged areas (typically at the lower building corners). Regular maintenance and inspection will allow continuous service life.

5. ALLEN HARBOR

5.1 Allen Harbor Timber Bulkhead

5.1.1 Description of Facility

The bulkhead at Allen Harbor is a crucial element of the overall function of the marina. The bulkhead functions as a retaining structure for the parking area and travel way for the adjacent ramp. The ramp and parking area are utilized to a great extent during the peak season. In addition, during the off season, the wall must endure major point loads from boats that are stored in the parking area during the winter months. The overall length of the bulkhead is approximately 174 feet and runs north to south on the eastern side of the parking lot. It is composed of timber sheeting, fender/bearing piles, 2 timber wales, anchoring system, and top cap.

To further describe the components of the bulkhead, the timber sheeting was found to be 12” wide timber planking with tongue and groove construction. The wales are measured at 10”x10”, are spaced 6 feet vertically, and are of timber grade. The steel anchor rods are 1.5” in diameter and are spaced at 6’ on center. Their assumed depth is 20+/- based on the record plan. These anchors are attached and secured to a deadman system that is located below grade in the parking area. The fender piles, as indicated on the record plans, are 12” in diameter and are pressure treated creosole piles that are connected to each wale.

5.1.2 Observed Conditions

A level II inspection was performed for the entire length of the timber bulkhead. As previously stated, CEC utilized the low tide to perform the majority of the inspection to ascertain that a full visual of the condition of the structure could be attained. The inspection involved utilizing a motor boat, waders, camera, ice pick, pile scraper, and tape measures. The majority of the piles inspected were scraped and measured by circumference at two locations per pile to acquire an accurate reading as to how the pile has weathered. CEC utilized ice picks and hammers to lightly tap any areas of the wall that appeared to be fatigued. Extreme care was taken when performing such tasks to maintain the integrity of the wall and its components.

From the inspection, it was found that the timber sheeting has endured moderate weathering from insect damage to wave damage. The majority of this detrimental action is located in the intertidal zone, below the bottom wale. There are substantial voids (100% penetration) that are located all throughout the wall. These voids measure in width from 8" to ½" and are extremely susceptible to substrate washout. This bottom scouring and substrate washout is clearly evident in the parking area, as there are substantial depressions indicating sediment is escaping from behind the bulkhead and through the voids in the intertidal zone of the wall. Remaining sections of the bulkhead are in fair condition with no substantial weathering. The piles are in excellent condition, with only a few minor inconsistencies associated with their surficial appearance. The extent of the damage is located within the intertidal zone and could be caused by fungi, marine borers, or abrasion. When taking into consideration that the piles contain a creosote based preservative, it brings about the argument that the creosote is easily attacked by the marine borer Limnoria tripunctata. This could be one of the problems that the pile is enduring in the intertidal area, where the limnoria marine borers flourish.

The remaining components of the bulkhead were found to be in adequate condition. The cap, anchoring system, and wales are all in good condition and do not require any immediate maintenance.

5.1.3 Structural Condition Assessment

CEC has determined that the wall is in fair to poor condition in regard to the sheeting, which is a crucial component to maintain the integrity of retaining the structure of the parking lot. This component is recommended to be remedied within 1-2 years. The shift in horizontal and vertical alignment of sheets is minimal and does not require attention at this time. However, damage or deterioration of the sheeting, wash-out of substrate under the sheeting at the toe, and signs of detrimental wave action and scouring is moderately present. These areas need to be addressed in the near future.

The 2x4 side railings on the indicated piles in the inspection report should be removed. These are rotted and do not appear to serve a function. In addition, the rotted float guides are recommended for removal at pile 16 & 25 due to the safety risk that is posed due to their presence. Furthermore, the wales and anchoring system appear to be in good condition and are predicted to last for another 10 years.

5.1.4 Recommendations

CEC makes the following recommendations regarding the Allen Harbor timber bulkhead in a timeline format. These recommendations should be incorporated into a maintenance plan that addresses the following issues:

1. Install accessory wale to protect sheeting from continued deterioration and substrate

washout in areas below the bottom wale (in intertidal zone) as a cursory fix
2. Remove existing deteriorated railings and pile guides from all fender piles adjacent to the bulkhead.
3. Completely rebuild the timber bulkhead.

CEC recommends that a cursory upgrade be applied to the wall in the first year of the maintenance plan to extend the bulkhead's serviceable life. This fix is predicted to last for about four years and will cost approximately $20,000 including miscellaneous maintenance. This will include removing all unnecessary components attached to the bulkhead/piles. In addition, the plan calls for a complete re-build of the bulkhead in year 2014. This will involve driving new sheeting in front of the old sheeting and is predicted to cost approximately $211,000.

5.2 Allen Harbor Boat Ramp

5.2.1 Description of Facility

The Allen Harbor boat ramp is located adjacent (parallel) to the timber pier and runs from north to south. The ramp is approximately 12' wide by 74' long (888 SF) and is constructed by poured in place concrete. The ramp is retained partially by the timber bulkhead to the north and is retained by sand on the south. Vehicles are protected by means of a 6"x6" timber curb on both sides of the ramp, with an additional 3"x5" back wale that provides further protection against damage. The slope of the ramp is 10% approximately.

5.2.2 Observed Conditions

Overall, the ramp is in adequate condition. The concrete is not showing any signs of linear cracking, shrinking or depressions. The calculated slope and pitch of the ramp provides enough drop for boaters to release their vessels from a trailer with ease. The curbing, however, has indications of fatigue from cyclic loads, or from trailers traversing over the edge.

5.2.3 Structural Condition Assessment

When performing the level II inspection of the ramp, there were no substantial problems found with the ramp at this time. CEC recommends that the ramp be continually monitored throughout the years to ensure the stability and integrity of the pavement. Curbing should be maintained and replaced as appropriate when it has reached its serviceable life.

5.2.4 Recommendations

CEC makes the following recommendations regarding the Allen Harbor boat ramp. These recommendations should be incorporated into a maintenance plan that addresses the following:

- Replace and/or repair timber curbing as necessary. (0-2 years)
- Continually monitor stability and integrity of concrete and provide maintenance repairs as necessary. (0-10 years)
- Full replacement of ramp. (10-15 years)

To replace and maintain the curbing and other miscellaneous elements of the ramp is predicted to cost approximately $10,000 dollars over the span of 10-15 years. CEC predicts that after these yearly repairs, the ramp will need full replacement in year 2020. At this time, the predicted cost of ramp

replacement will be approximately $282,000. Please refer to attached cost estimate listed in the appendix section.

5.3 Allen Harbor Pier

5.3.1 Description of Facility

The Allen Harbor pier is a typical wooden pile-supported structure with a wood deck and an aluminum ramp leading to a wooden float. Piles are constructed with bents with a combination of stringers 4" x 10" every one to two feet on center along the pier. There are (2) 2" x 10" headers located at each pile bent. Headers and stringers appear to be treated with creosote, similar to the pilings. The decking consists of 2"x12" plank decking with ½" spacing. Piles are 12" in diameter and are typically used telephone poles or creosote treated timber pilings.

There are no attached railing systems built on the pier. Also, utility and water conduits are not present under the pier. The attached floating dock is approximately 300 SF (10'x30') and the aluminum ramp is 14.5'x.2.5'. The ramp is connected to the pier by means of roller connection.

5.3.2 Observed Conditions

A modified level III inspection was done on the pier. A walk-around was done to inspect piles, wood deck, cleats, float, ramp and overall general condition. All piles tested were scraped and measured by circumference at two locations per test. Please see field reports and photographs for a detail of the actual inspection results. CEC also utilized a small motor boat to assess the underside of the pier at low tide.

The variety of headers, stringers, and wood decking appear to be in fair condition. The cross bracing on each bent needs to be replaced due to inadequate connections or lack thereof. The treated timber stringers and headers are leaking their preservative and are enduring moderate weathering due to fungi and/or extended exposure to moisture. Minor to moderate checking is present in the majority of the members at exposed ends, and at the surface of the decking. The piles are in fair condition with minor to moderate striations present due to marine borers or fungi. The presence of the creosote preservative could be hindering the woods ability to deter harmful marine borers such as limnoria tripunctata. Piles at Bents 3 and 4 are particularly in need of repair or replacement within the next 5 years. It has been shown that piles typically last 10-15 years until they need to be replaced. This pier was constructed in the early 1950's.

The ramp and float are in excellent condition and are not in need of replacement at this time. The header at the end of the pier that the connecting ramp hardware is attached to is in need of replacement. The wood is severely deteriorating with major horizontal checking occuring through the wood. This poses a concern in regards to the stability of the connection to the ramp, and ultimately leads to a safety hazard. This should be addressed as soon as possible. The piles attached to the floating dock are in poor condition. It is evident that they have endured major marine borer damage and/or damage caused from float abrasion during storm events. Since these piles are not dependent on any structure, it is recommended that they be continually monitored rather than be replaced. They still serve their current function of controlling the floating dock and are predicted to serve in this fashion for at least 5-7 more years.

The hardware seems to be at various stages of corrosion and has signs of corrosion related failure. The top of the pier is approximately at elevation 7.85' above Mean Low Water. The general observation of the pier's condition is that it has been repaired on an as-needed basis. The quality of the timber was not always marine grade in some instances and shows signs of age and cracking.

5.3.3 Structural Condition Assessment

Overall, Allen Harbor Pier was found to be in fair condition. The classification of a structurally sound pier for withstanding storm events includes the following features:

- Designed to resist 100 mile per hour winds from any direction.
- Can withstand 10 foot tidal surge at high tide=14' MLW.
- The pier is regularly maintained and is inspected on an annual basis.
- Wave heights with 5 foot breaking waves do not destroy the structure.
- The current does not exceed 2.5 knots.
- Piles were driven to refusal or 10' minimum below the mud-line.
- Piles are mechanically attached to the superstructure of the pier.

From field observations and inspections, the Allen Harbor Pier is in fair condition at the present time, but will need continued maintenance and monitoring before it is completely renovated and rebuilt. The main components that need immediate attention are the cross bracing, end header connecting to the aluminum ramp, and the eastern stringer. The piles for the floating dock shall be monitored, but are not in need of replacement at this time. It is recommended that the pier be totally replaced in year 2025.

5.3.4 Recommendations

CEC makes the following recommendations regarding the Allen Harbor Pier. These recommendations should be incorporated into a maintenance plan that addresses the following issues:

- Replace and repair stringers, cross bracing and hardware with new treated lumber and hot dipped galvanized hardware on an as needed basis.
- Implement a cost based maintenance plan that uses available funds to make upgrades to the pier on a prioritized basis.
- Consider rebuilding the pier to significantly reduce yearly maintenance and long-term repair costs.

The attached cost maintenance plan summarizes cost estimates for the recommended repairs. With the implementation of the above recommendations, CEC believes that the Allen Harbor Pier can remain a useful waterfront facility.

5.4 Allen Harbor Float System

5.4.1 Description of Facility

The floating docks of Allen Harbor are located on the eastern side of the marina, adjacent to the existing timber bulkhead. These floats run perpendicular and parallel with the bulkhead. The floats are composed of metal cleats, 2x6 decking, 2x6 sideboards, and a styrofoam like material for the floating mechanism. There are a total of 30 floats (not including the floating dock attached to the pier), ranging in size from 3.3'x16' to 4.3'x16'. The floats are all connected to one another by means of roller and pin connection and are connected to accompanied pile by chains and PVC rollers (various piles).

5.4.2 Observed Conditions

A level II inspection was performed for the 30 floats and 12 pilings for the floating dock facility. CEC performed in depth walk-around inspections, as well as detailed close up inspections of the pilings, wood decking, hardware & connections, cleats, and overall general condition of the components. The majority of piles inspected were scraped and measured by circumference at two locations per pile. Please see field reports and photographs for an in depth analysis of the observations.

The majority of the decking on the floats is extremely weathered with rusted connections. This has caused the nails to become disassociated from the wood, leaving loose boards. There are a few locations where the brackets for the rod and pin connection are loose and/or warped. The styrofoam floating mechanism for the floats is in fair to poor condition, their ability to function is still present; however, there are signs of extreme deterioration on the bottom and side of the float. In addition to rusted decking connections, it is evident that there is substantial rust in the side board connections as well. (Please see attached inspection report to gain a further understanding of the observations).

Furthermore, the pilings that help support the floats ability to remain stagnant are in need of repair or replacement. The majority of the piles are experiencing serious deterioration from weather, insect/fungi penetration, and abrasion damage from the bracket system connecting the float to the pile. The chain link connection to the pile is causing a detriment to the pile. As previously mentioned in the Saquatucket Harbor float system, the L brackets that attach the chain to the pile is rubbing against the circumference of the pile, creating major sectional loss and splitting of the pile. All pile connections are rusted, and in some instances, the chain has become disassembled.

5.4.3 Structural Condition Assessment

CEC has determined that the condition of the floating docks is in fair to poor condition. The docks are near the end of the serviceable life, as they have been functioning for close to 30 years. The deck planking has endured extreme weathering and is not predicted to last much longer. CEC predicts that the deck boards will need to be replaced within 2-3 years. However, in some instances, boards should be removed and replaced on an as needed basis to ensure public safety. The floating mechanisms are also recommended for replacement within 2-3 years.

The pilings still function properly and are not loose, therefore their serviceable life is somewhat longer than the floats. CEC recommends that the piles be removed and replaced in increments of every 2 years. Since these piles are not for bearing purposes, it is economically feasible to maintain the floats as long as they are sound and firm in the ground. CEC predicts that the life span of the pile will become prolonged once the destructive brackets are replaced.

5.4.4 Recommendations

CEC makes the following recommendations regarding the Allen Harbor floating dock system. These recommendations should be incorporated into a maintenance plan that addresses the following issues:

- Replace deck planking and hardware with new treated lumber and hot dipped galvanized hardware on an as needed basis.
- Replace all float brackets connecting to the piles with PVC float guides
- Implement a cost based maintenance plan that uses available funds to make upgrades to the pier on a prioritized basis.

- Consider rebuilding the floats to significantly reduce yearly maintenance and long-term repair costs.

5.5 Allen Harbor Parking and Drainage

5.5.1 Description of Facility

Allen Harbor parking area accommodates boaters utilizing the pier, comfort station, boat ramp, and floating docks. The facility holds approximately 30 spaces. The drainage is composed of catch basins, drain manholes, leaching basins and an outfall that releases untreated stormwater into the harbor.

5.5.2 Observed Conditions

CEC performed a level II inspection for the parking and drainage at Allen Harbor. A walk through was performed for the parking and condition of the pavement. In addition, CEC coordinated with the Town of Harwich highway department to assist in accessing the existing drainage structures. Each drain manhole and catch basin grate was lifted to expose the inside of each component. Visual inspection, pictures, and an overall assessment of the drainage structure was performed. These observations of each component are as follows.

The pavement has endured some weathering by showing signs of bumps, cracks, and sags. There were no major potholes or voids in the pavement. Minor linear cracking was present, most likely caused from settling over the years. The major faults in the pavement were due to sediment outwash from the adjacent timber bulkhead. This has caused the pavement to create major depressions and voids in the areas behind the walls.

The stormwater system at Allen harbor has endured a considerable amount of wear and tear. The drainage structures in the parking lot are made of either concrete block construction, or precast concrete. The majority of them need to be pumped and cleaned to facilitate proper functionality in controlling stormwater. According to the marina workers, the parking lot endures considerable flooding during storm events. In addition, it was noted that the majority of the structures had standing water inside, with the liquid level located above the invert of the piping. The structures are connected via culverts that ultimately outfall into the harbor via 8” PVC piping. The pipe penetrates through the eastern facing timber bulkhead.

1.5.3 Recommendations

CEC recommends that, as a temporary fix, the drainage structures be completely pumped, cleaned, and removed of any excess sediment that is interfering with drainage. Also, any catch basins that are releasing stormwater into the waterway should be upgraded with a stormcepter unit to comply with current stormwater pollution prevention regulations. In 10+ years, CEC recommends a complete refurbishment of the parking lot, including replacement all of the drainage structures in the marina.

5.6 Allen Harbor Buildings

Allen Harbor Comfort Station Building:

5.6.1 Description of Facility

The Comfort Station building is an approximately 12 ft long by 12 ft wide wood framed structure supported on a concrete floor slab on grade. The building is a single story structure with a gabled

roof and roof overhang on the entrance side to the enclosed portion. Roof and walls are wood shingled. The trim consists of painted wood members.

5.6.2 Observed Conditions

The overall structure of the building appears to be in fair-to-good condition with some failing building envelope components. Some grated closures for building penetrations are corroded or damaged. Floor drains are clogged and do not allow proper drainage in both units. The wooden wall shingles show significant signs of weathering and are warped and have separated from the wall plane. The bottom sill plate was observed to be soft and deteriorated on the southern building side. It is likely that all sill plates are deteriorated and will require replacement. The current exterior grade elevation around the perimeter of the building allows moisture to be in close proximity to the wood frame structure. Wooden trim at eaves, soffits, and post bases show minor to medium level rot and deterioration especially at ends of members. The uplift connections at the roof overhang between support beam and wooden posts, and between posts and foundation slab are questionable. Mechanical connectors are missing at these framing transitions, and members appear to be currently connected via toenails only.

5.6.3 Structural Condition Assessment & Recommendations

CEC rated the overall condition of the above-described building as fair-to-good and suggests the following upgrades and maintenance repairs:

- Replacement of all rotted sill plates with new, pressure treated, double 2x plates properly anchored to the concrete foundations and re-nailing of wall sheathing to new sills prior to the winter of 2010.
- Re-grading around the perimeter of the building to achieve positive pitch away from the building, and prevent moisture from contacting the building.
- All wooden wall shingles have reached the end of their service life and CEC recommends replacement as soon as possible with new shingles. (Shingle replacement should be coordinated with sill replacement previously mentioned)
- The roof shingles remaining service life is estimated at 3 to 5 years.
- All building penetration covers (metal grating) and attic access cover should be replaced with new covers as soon as possible. The penetrations at floor level serve as flood vents to relieve hydrostatic pressures on the structure during a flood event. Damaged grates should be replaced with new appropriately sized flood vents to allow water pressure release and protect the interior from rodent infestation and damage.
- All deteriorated wooden trim should be replaced or repaired and receive regularly maintained coating for weather protection.
- CEC recommends installing uplift ties at the top and post bases at the bottom of roof supporting posts in the porch area prior to the end of 2009. We suggest stainless steel connectors of sufficient capacity (e.g. Simpson Strong Tie Connectors), in order to protect the overhanging roof area from damage during high winds.

Please note, that all service life expectancy assumptions are based on normal weather and use conditions, not including extreme single events, such as high winds, storm events, or seismic occurrences that may result in reducing the remaining service life of building components.

6. HERRING RIVER

6.1 Herring River Wixon Pier and Float

6.1.1 Description of Facility

The Herring River Wixon Pier is a typical wooden pile-supported structure with a wood deck and an aluminum ramp leading to a wooden float and is located adjacent to Route 28. The pier has a total length of approximately 56 feet and a width of 4.3 feet (241 SF). Piles are constructed with 6 bents with 3 rows of 3" x 8" stringers every two feet on center along the pier. There are (2) 3" x 10" headers located at each pile bent. All lumber for structural components appear to be pressure treated southern yellow pine. The decking consists of 2"x6" plank decking with ½" spacing. Piles are 12" in diameter (12 total) and are pressure treated greenheart grade.

The side railings are measured at 2"x4" members. Also, utility and water conduits are not present under the pier. The attached floating dock is approximately 200 SF (10'x20') and the aluminum ramp is 15'x3'. The ramp is connected to the pier by means of roller connection.

6.1.2 Observed Conditions

A modified level III inspection was done on the pier. A walk-around was done to inspect piles, wood deck, cleats, float, ramp and overall general condition. All piles tested were scraped and measured by circumference at two locations per test. Please see field reports and photographs for a detail of the actual inspection results.

When inspecting the headers, stringers and wood decking of the recently constructed pier, CEC did not find any discrepancies in terms of structural instability. All members are sound and show minimal to no signs of beginning stages of disease. All structural members such as the headers and stringers appear to be designed in accordance with general marine construction. The size of the members is appropriate for the application of sustaining the loads of the pier and from storm events. However, the side railings are inadequate for the use of the pier. Additional railings need to be installed in order to bring the pier to current Massachusetts State Building code regulations. This is a safety risk and should be addressed as soon as possible. The piles are all in excellent condition, with the exception of the lack of pile caps present. In order to maintain the health of the pile, it is crucial to install pile caps to avoid water penetration

The ramp and float are in excellent condition and are not in need of replacement at this time. The piles and connections are all sound and remain to be in good condition. All hardware of the pier and float system are in good condition and are not showing signs of corrosion as of yet. The pier should be monitored every year to assess any maintenance or safety issues that need to be addressed.

6.1.3 Structural Condition Assessment

At this time, the pier is structurally sound and remains in excellent condition. With the exception of the railings and the pile caps, no maintenance needs to be performed at this time.

6.1.4 Recommendations

CEC makes the following recommendations regarding the Herring River Wixon Pier. These recommendations should be incorporated into a maintenance plan that addresses the following issues:

- Upgrade side railings to match current building code regulations.

- Provide pile caps for existing pier and float piles to maintain their serviceable life.
- Implement a cost based maintenance plan that uses available funds to make upgrades to the pier on a prioritized basis.

6.2 Herring River Pier and Float at Mouth, Riverside Drive

6.2.1 Description of Facility

The Herring River Pier is a typical wooden pile-supported structure with a wood deck and an aluminum ramp leading to a wooden float and is located at the end of Riverside Drive. The pier has a total length of approximately 45 feet and a varied width of 4.75 feet to 11.5 feet (327 SF). Piles are constructed with 8 bents with 3-5rows of 2" x 8" stringers every two feet on center along the pier. There are (2) 2" x 8" headers located at each pile bent. All lumber for structural components appear to be pressure treated southern yellow pine. The decking consists of 2"x8" plank decking with ½" spacing. Piles range from 10"-12" in diameter (approx. 18 total) and are pressure treated.

The side railings are measured at 2"x4" members. Also, utility and water conduits are not present under the pier. The attached floating dock is approximately 200 SF (10'x20') and the aluminum ramp is 12'x3'. The ramp is connected to the pier by means of roller connection.

6.2.2 Observed Conditions

A modified level III inspection was done on the pier. A walk-around was done to inspect piles, wood deck, cleats, float, ramp and overall general condition. All piles tested were scraped and measured by circumference at two locations per test. Please see field reports and photographs for a detail of the actual inspection results.

The stringers, headers, and main structural members of the pier are in deplorable condition and are unsuitable for their specific function. The majority of the piles are deteriorating to the point where they are breaking apart. The piles are disease stricken, weathered, and infested with marine borer organisms. CEC has presumed that the main reason for this breakdown is due to biological deterioration. Various piles have an "hour-glass" shape, which clearly indicates the presence of the crustacean family of marine borers. These wood borer organisms such as Limnoria, Sphaeroma, and Chelura form networks of interlacing tunnels that easily erode the inner cavity of the pile. Once the pile becomes eroded, it creates a susceptible environment for waves to eat away at the pile. Not all of the piles of the pier are showing such grim deterioration; however, they are still experiencing biological infestation and continue to erode and lose crucial pile circumference that is required to withstand waves and pier generated loading.

The size of the members is also another concern in regard to current building code requirements that relate to dead and live loads. A 2"x8" header is not sufficient for a town pier of this magnitude and should at least be upgraded to a 3"x10". Existing connective hardware is not sufficient, as some through bolting is inappropriately placed.

Lastly, the ramp and float are in good condition and are not in need of replacement at this time. The piles and connections are all sound and remain to be in good condition. All hardware of the float system is in good condition and does not show signs of corrosion as of yet. The pier should be monitored every year to assess any maintenance or safety issues that need to be addressed.

6.2.3 Structural Condition Assessment

When considering the amount of time and effort required to provide maintenance to this pier on an as needed basis, it is economically unfeasible to provide surficial or maintenance repairs to the pier at this time. The pier has endured a great deal of deterioration and weathering. CEC recommends that the pier be removed and replaced in kind as soon as possible. The pier, as it stands, is extremely vulnerable to wave or wind action. Also, if a large group of individuals congregate on the pier, it could potentially collapse at any time. There is a major safety risk posed with this pier and it should be addressed as soon as time permits.

There are substantial shifts in horizontal and vertical alignment of the pier, as well as major deterioration of the bearing piles. The stringers, headers, and decking have endured substantial biological and functional damage over the years. The sizing of the members is also unsuitable for current design loads. In addition, rusted and missing components, and corrosion are hindering the piers ability to function as it should.

6.2.4 Recommendations

CEC makes the following recommendations regarding the Herring River Wixon Pier. These recommendations should be incorporated into a maintenance plan that addresses the following issues:

- Consider removing and reconstructing the pier to meet current building code requirements.

6.3 Herring River Boat Ramp

6.3.1 Description of Facility

The Herring River boat ramp is located adjacent to Route 28 and provides public access to upper Herring River. The ramp is located parallel to the existing pier and has dimensions of 50’ in length by 12’ in width (600 S.F.). The ramp has a slope of approximately 12%, with an elevation drop of 6 feet. The material components of the ramp consist of poured concrete, with no curbing present.

6.3.2 Observed Conditions

From CEC inspections and observations, the boat ramp at Herring River remains in poor condition. The concrete is showing signs of weathering, rutting, linear cracking and it contains major depressions. There is a substantial scour hole at the base of the ramp that drops off approximately 3 feet. In addition to this scour hole, there is no curb stop to protect boaters from falling into the river. This poses a major risk for individuals dropping their trailer in the water. If the trailer goes behind the end of the ramp, it would be very difficult to extract it from the water. Not only is this a problem, but the lack of a curb creates another risk for trailer users. On the other hand, CEC did not find signs of any exposed reinforcement, or pop-outs from freeze-thaw conditions.

6.3.3 Structural Condition Assessment

Based on the inspection, CEC has found the ramp to be in structurally poor condition. The concrete is spalling and cracking in over 85% of the overall area. The end scouring poses a safety hazard for boaters accessing the river. Overall, the ramp could remain functional if some surficial repairs were performed. However, CEC recommends full replacement in the near future to avoid ongoing maintenance costs.

6.3.4 Recommendations

CEC makes the following recommendations regarding the Herring River Boat ramp. These recommendations should be incorporated into a maintenance plan that addresses the following issues:

- Fill in scour hole at the base of the ramp to provide a shallow entrance into the river
- Install curbing at the sides of the ramp to provide protection for trailers.
- Consider plans to completely rebuild the ramp in the near future.
- Implement a cost based maintenance plan that uses available funds to make upgrades to the pier on a prioritized basis.

6.4 Herring River Wixon Parking and Drainage

6.4.1 Description of Facility

The parking area is located to the south of Route 28, adjacent to the Herring River bridge. It is of gravel construction, with no drainage structures present. There is no striping, or any delineation of where boaters are to park their trailers or vehicles.

6.4.2 Observed Conditions

From observation, the parking lot is not clearly delineated as to where to park. There is a distinct entrance and exit that is divided by some grass, however, no striping or indication for parking. It was found that boaters leave their trailers on the eastern face of the parking lot, while various vehicles park on the western side facing the river. There is no stormwater prevention control, and it is quite obvious that the stormwater runs directly into the wetland and marsh area of the river. This is evident based on the extreme sloping grade retreating from Route 28.

CEC has found this drainage to become an important item due to the sensitivity of the adjacent wetland. Sediment from the parking lot and Route 28 travel with the stormwater and enter directly to the wetland, causing pollution and disturbance to the wildlife and vegetation of the wetland.

6.4.3 Recommendations

After inspecting the parking area and drainage patterns, CEC believes that the parking organization and drainage should be evaluated further. The most beneficial option would be to pave the parking lot, create a curb or berm on the southern face of the lot and install multiple catch basins with stormceptors to treat and trap any sediment entering the basin. This would greatly reduce the amount of pollution and sediment that is currently entering the wetland and polluting the Herring River. This will also allow for a more organized area for parking and travel patterns. These recommendations should be incorporated into a maintenance plan associated with the boat ramp renovation as it would be beneficial to upgrade all of the components at the same time for economic and environmental reasons.

7. ROUND COVE

7.1 Round Cove Boat Ramp

7.1.1 Description of Facility

Round cove boat ramp is located off of Route 28 and provides public access to Pleasant Bay and Round Cove. The total length of the boat ramp is approximately 95' and the total width is approximately 12'. The ramp runs directly adjacent and parallel to the existing concrete bulkhead to the south. The ramp has a slope of less than 10%, with an elevation drop of 4 feet. The material components of the ramp consist of poured concrete, with 4x4 timber curbing on the northern face.

7.1.2 Observed Conditions

Overall, the Round Cove boat ramp is in poor condition. CEC has determined this state based on a visual in depth inspection of the structural state, as well as inspection of the functional state. The concrete is crumbling in multiple areas and is experiencing some major shifting and linear cracking that is causing the ramp to become uneven. The adjacent beach is eroding, causing substantial amounts of sand to build up at the bottom of the ramp, decreasing the slope of the ramp. This hardship has caused the already shallow slope of the ramp to become less steep, hindering a boaters' ability to release his/her boat into the water with ease. Boaters do not have adequate water depth at low tide to launch their boats into the water.

7.1.3 Recommendations

CEC recommends that the boat ramp be regraded and/or removed and replaced to create a more pronounced slope for boaters to utilize.

7.2 Round Cove Concrete Bulkhead

7.2.1 Description of Facility

The concrete bulkhead at Round Cove is one of the major components of the facility. It maintains the overall structure and stability of the parking area for public use in gaining access to the adjacent floating dock and ramp. The wall is composed of a monolithic concrete structure that measures out to be approximately 12" in width. The overall length of the bulkhead wall is approximately 168 feet. CEC found various discoveries of footings from a 8"x4" concrete footing, as well as a 6"x6" timber footing. A ramp and floating dock are connected to the eastern side of the bulkhead by means of pin and roller connection. There are 2 tie off piles that are attached to the existing floating dock by means of rigid piping. The floating dock is measured at 14'x20' (280 SF) and the aluminum ramp is measured at 13'x2.5'.

7.2.2 Observed Conditions

Portions of the wall have endured some damage due to stress, lack of expansion joints, and settling. The southern façade of the concrete bulkhead adjacent to the marsh is in good condition with very minor horizontal and surficial cracking. The section of the bulkhead in the vicinity of the aluminum ramp on the eastern façade is in extremely poor condition. It is apparent that the wall has gone through multiple surficial repairs in the past, due to the elemental difference compared to the other sections of the wall. In this area, the wall is enduring major spalling and loss of concrete at the end sections, allowing for sediment outwash from the parking lot above. It is clearly evident in the parking lot, as there are major depressions and holes in areas where the wall is deteriorating.

7.2.3 Structural Condition Assessment

Overall, the structural condition of the wall is fair, with some portions needing more attention than others. The eastern portion of the wall that is attached to the floating dock is in need of replacement or remediation. There is a minimal amount of horizontal and vertical shifting of the wall, with minimal signs of detrimental wave action. On the other hand, there is a substantial amount of deteriorated concrete and a moderate amount of substrate wash-out due to this deterioration.

7.2.4 Recommendations

Coming from the most practicable standpoint, CEC recommends installing vinyl sheeting in front of the existing bulkhead wall. This method proves to be the most cost efficient in terms of concrete repair. On-going repairs will be more costly than replacing the entire structure in itself. The addition of sheeting will allow for a more unified structure and will eliminate the need for costly surficial concrete repairs that will not last nearly as long as a new bulkhead wall. The estimated cost for a vinyl wall of this magnitude would be approximately $200,000. CEC does not foresee this to be an immediate fix, as we believe that the wall can endure 10-15 more years until full replacement. However, the deteriorated wall sections should be monitored yearly to assure the structure is stable.

7.3 Round Cove Parking and Drainage

7.3.1 Description of Facility

The parking area is located at the bottom of a steep road that leads to the boat ramp and bulkhead for access to round cove. The lot is comprised of gravel, with some mix of concrete adjacent to the boat ramp. There is no designation for vehicle or trailer parking.

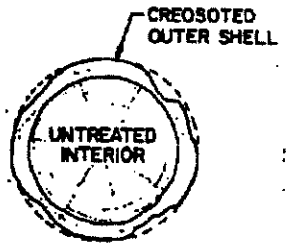
7.3.2 Observed Conditions

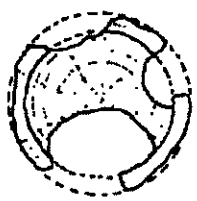
Overall, the parking lot is in fair condition, with few pot holes and depressions that trap stormwater. Also, in areas where the bulkhead is failing, large voids and depressions have formed, allowing sediment to pour into the waterway. This has created a safety hazard for individuals traversing over the parking lot next to the bulkhead. There is no stormwater prevention located on the site, so it is evident that all the drainage from upland on the property is running down and into the wetland. There is a grassy area that acts as a barrier in trapping this sediment, however; the water retreats toward the cove. Across from the boat ramp, it was noted that there is an immense amount of erosion occurring on the coastal bank adjacent to where individuals store their dinghies. This erosion from the bank is migrating to the boat ramp, causing a hindrance to boaters accessing the cove.

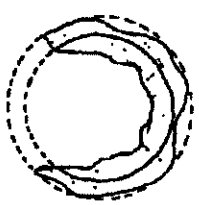
7.3.3 Recommendations

CEC recommends that the parking lot be continually monitored for structural stability for the next 10 years. There is no immediate need for renovations or upgrades at this time. However, the town should consider remodeling the area within the next ten years. Stormwater should be addressed and alleviated from entering the waterway. CEC believes that if a berm was introduced at the bottom of the slope accompanied with stormcepter catch basins, that the amount of sediment from entering the wetland would greatly be reduced.

Appendix C - Pile Condition Ratings for Timber Piles



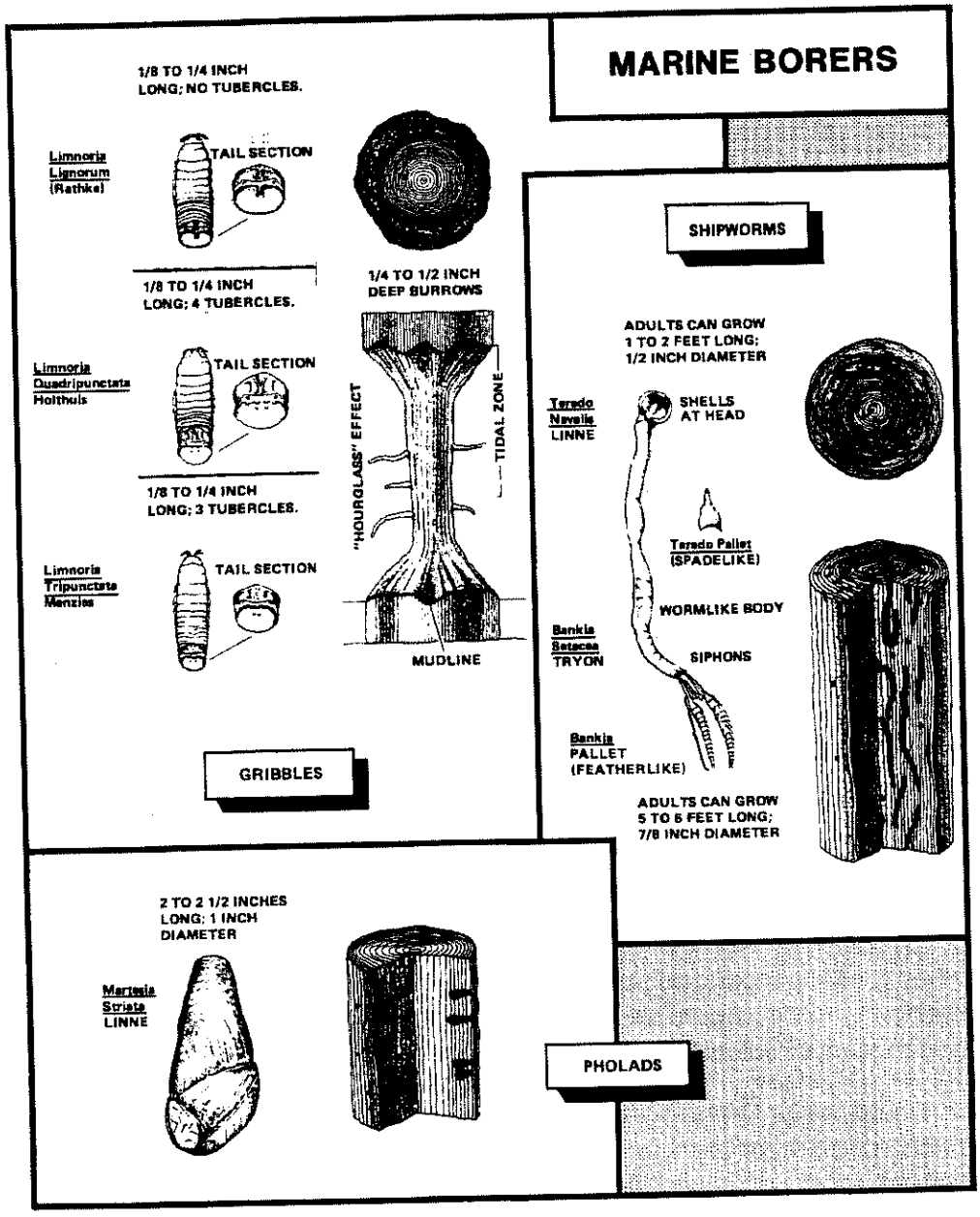




Timber Pile Condition Rating	Explanation
NI	Not inspected, inaccessible or passed by
ND	No defects: - less than 5% lost material - sound surface material - no evidence of borer damage
MN	Minor Defects: - 5 to 10% lost material - sound surface material - no evidence of borer damage - minor abrasion damage
MD	Moderate Defects: - 15 to 45% lost material - significant loss of outer shell material - evidence of borer damage - significant abrasion damage
MJ	Major Defects: - 45 to 75% lost material - significant loss of outer shell and interior material - evidence of severe borer damage - severe abrasion damage
SV	Severe Defects - more than 75% lost material - no remaining structural strength - severe borer damage

Figure 3-14.
Explanation of pile condition ratings for timber piles.

Figure 3-1. Three groups of Marine Borers.[1]



NOTE: Gribbles are 3mm to 6mm (1/8 to ¼ inch) in length; Shipworms are 30 to 60 cm (1 to 2 feet) in length, 12.7mm (1/2 inch) in diameter; and Pholads are 51mm to 63.5mm (2 to 21/2 inches) in length.

[1] From *Oregon State Research Bulletin 48*, October 1984.

APPENDIX A

GENERAL INSPECTION PROCEDURES

GENERAL INSPECTION PROCEDURES

The following is a summary of the general inspection protocol used during the field investigation phase of the project:

The inspection of the pier was carried out by a licensed professional engineer in the state of Massachusetts who is qualified to do these types of inspections. A second qualified person shall check the work of the engineer to ensure that all measurements were taken accurately. Below is a list of activities that took place during the inspection. A modified Level III inspection was performed on the structures with the exception of diving activities due to the shallow water. The following tasks were completed during the survey.

1. A baseline was set to reference all observations to the fixed structure.
2. One or two inspectors conducted the work on foot or in a skiff utilizing the following equipment.

    a. underwater camera
    b. ice pick
    c. measuring tape
    d. wire brush
    e. paint scraper
    f. small sledge hammer
    g. underwater light
    h. recording board & pencil

3. Still photos were taken of above water piles and stringers, deck, and hardware, focusing on the attachment points.
4. The inspector cleaned piles as necessary, spacing at two locations on each pile. The locations were at an elevation where the inspector determined the maximum degradation had occurred.
5. The inspector measured the circumference of the pile at all locations at the narrowest point in the inspection areas.
6. The inspector hard probed each of these test areas with an ice pick, and recorded depth of penetration from pile surface. The inspector checked for marine borer-holes, Shipworms, Gribbles, Pholads, and general pile degradation and gave the pile a rating. This information was recorded on the standard pile inspection report form.
7. The joists and stringers were also investigated in the same manner if applicable. Special attention was given to loose or broken hardware.
8. An inspection of all attachment points and fender piles was also be made in a similar manner.
9. The wood deck was inspected for cracking or dry rot. If either of these was present, further investigation was conducted.
10. The existing buildings were inspected in a general manner for structural integrity.

APPENDIX B

FIELD INSPECTION REPORTS

ALLEN HARBOR

Condition key for Inspection Reports

LS – loose
MS – missing
BW – bowed
SP – split
RT – rotted
RS – rust
CR – corrosion
BR – broken
SL – slippery
GD – good
FR – fair
NATT – needs attention

PR - poor
ME - mechanical
BIO - biological
FUNC - functional
ND – no damage (see pile condition rating chart)
MN – minor damage (see pile condition rating chart)
MD – moderate damage (see pile condition rating chart)
MJ – major damage (see pile condition rating chart)
SV – severe damage (see pile condition rating chart)

PILE INSPECTION REPORT

Location: Allen Harbor Bulkhead & Floats			Date: April 28th, 2009 Page 1 of 2
Pier Name/No. Bent 1	Pile Type __ Bearing __ Fender __	Pile Material _X_ Timber __ Steel __ Concrete	
Water Depth: 1-2'	Time of Day: 9:00 AM	Tide: Low (8:45 am)	Weather: Sunny 70

Bent	Pile	Dimension		Pile Condition					Type Damage			Gauge	Dimensions of Damage		
No.	No.	Low	Upp	ND	MN	MD	MJ	SV	ME	BIO	FUNC	Damage	HGT	WID	PENETR
1	1	-	-	X	-	-	-	-	-	-	-	-	-	-	-
1	2	39.5	39.5	X	-	-	-	-	-	-	-	-	-	-	-
1	3	38.75	39.5	X	-	-	-	-	-	-	-	-	-	-	-
1	4	38.5	39	-	X	-	-	-	-	-	X	abrasion	4'	5"	2"
1	5	35	36	-	X	-	-	-	-	X	-	splitting	3'	1"	1"
1	6	37	37.2	X	-	-	-	-	-	-	-	-	-	-	-
1	7	-	-	X	-	-	-	-	-	-	-	-	-	-	-
1	8	34.5	35	X	-	-	-	-	-	-	-	-	-	-	-
1	9	36.7	37	X	-	-	-	-	-	-	-	-	-	-	-
1	10	-	-	X	-	-	-	-	-	-	-	-	-	-	-
1	11	38	38.5	X	-	-	-	-	-	-	-	-	-	-	-
1	12	40	41	X	-	-	-	-	-	-	-	-	-	-	-
1	13	-	-	X	-	-	-	-	-	-	-	-	-	-	-
1	14	41	42	-	X	-	-	-	-	X	-	worm	1/8"	1/8"	0.5"
1	15	36	36.7	X	-	-	-	-	-	-	-	-	-	-	-
1	16	-	-	-	X	-	-	-	-	X	-	-	-	-	-
1	17	38.5	39	-	X	-	-	-	-	X	-	worm	-	-	-
1	18	39	40	X	-	-	-	-	-	-	-	-	-	-	-
1	19	-	-	X	-	-	-	-	-	-	-	-	-	-	-
1	20	37.2	37.5	X	-	-	-	-	-	-	-	-	-	-	-
1	21	-	-	-	X	-	-	-	-	X	-	rotting	-	-	-

Comments: Piles where dimensions were not obtained: 2x4 side railings should be removed, severe deterioration and rot present, does not appear to serve any function. Also, rotted float guides are recommended for removal @ pile 16 & 25. Overall piles are in good condition.

Picture 1


Picture 2

PILE INSPECTION REPORT

Location: Allen Harbor Bulkhead & Floats			Date: April 28th, 2009 Page 2 of 2
Pier Name/No. Bent 1& 2	Pile Type __ Bearing __ Fender __	Pile Material _X_ Timber __ Steel __ Concrete	
Water Depth: 1-2'	Time of Day: 9:00 AM	Tide: Low (8:45 am)	Weather: Sunny 70

Bent	Pile	Dimension		Pile Condition					Type Damage			Gauge	Dimensions of Damage		
No.	No.	Low	Upp	ND	MN	MD	MJ	SV	ME	BIO	FUNC	Damage	HGT	WID	PENETR
1	22	42.25	42.25	-	X	-	-	-	-	X	-	1 worm	-	-	-
1	23	-	-	X	-	-	-	-	-	-	-	-	-	-	-
1	24	40.5	40.7	X	-	-	-	-	-	-	-	-	-	-	-
1	25	-	-	X	-	-	-	-	-	-	-	-	-	-	-
1	26	41	41.25	-	X	-	-	-	-	X	-	worm	.5"	.5"	1"
1	27	-	-	X	-	-	-	-	-	-	-	-	-	-	-
1	28	40.7	41	-	X	-	-	-	-	X	-	worm	-	-	-
1	29	40.5	40.5	X	-	-	-	-	-	-	-	-	-	-	-
1	30/31	-	-	X	-	-	-	-	-	-	-	in riprap	-	-	-
2	1	33	33	-	X	-	-	-	X	-	-	wear	2'	3"	0.5"
2	2	30	30	X	-	-	-	-	-	-	-	-	-	-	-
2	3	31	31	X	-	-	-	-	-	-	-	-	-	-	-
2	4	33.2	32.2	X	-	-	-	-	-	-	-	-	-	-	-
2	5	36	34.7	-	X	-	-	-	-	X	-	worm	-	-	-
2	6	39	38	-	X	-	-	-	-	X	-	splitting	-	-	-
2	7	35.7	34	-	X	-	-	-	-	X	-	worm	-	-	-
2	8	38.5	39	-	X	-	-	-	-	X	-	worm	-	-	-
2	9	31	30	-	-	X	-	-	-	X	-	splitting	5'	1-2"	2"
2	10	33.5	32.5	-	-	X	-	-	-	X	-	splitting	4'	1-2"	2"
2	11	32	31	-	-	X	-	-	-	X	-	splitting	4'	1-2"	2"
2	12	33.25	32.25	-	X	-	-	-	-	X	-	rotting	-	-	-

Comments: Piles where dimensions were not obtained: 2x4 side railings should be removed, severe deterioration and rot present, does not appear to serve any function. Also, rotted float guides are recommended for removal @ pile 16 & 25. Overall piles are in good condition.

Picture 1

Picture 2

BULKHEAD INSPECTION REPORT

Location: Allen Harbor Bulkhead		Date: April 28, 2009	
Pier Name/No.: Allen Harbor	JRN/KES	Bulkhead Material _X_ Timber __ Steel __ Concrete	
Water Depth 1-2'	Time of Day: 9:00 AM	Tide: 9:00 AM low	Weather: Sunny 70

Structural Members						Condition		
Component	Size	Depth	Material	No./Length	Spacing	Good	Fair	Poor
Sheeting	12" W	ND	T&G Timb	174'	cont.		X	
Wale	10"	10"	Timber	2	6' vert	X		
Anchoring System	1.5"	-	Steel	30	6' O.C.	X		
Cap	10"	10"	Timber			X		
Fender Pilings	SEE PILE BENT 1 INSPECTION REPORT							

Additional Checklist Items	Extent of Damage			
	N/A	Minimal	Moderate	Substantial
Shifts in horizontal and vertical alignment of sheets		X		
Damage or deterioration of the sheet piling			X	
Wash-out of substrate under the sheeting at toe			X	
Signs of detrimental wave action, scouring sloughing			X	
Components of system missing		X		
Rust, corrosion, or bulging present			rust	

Comments: The following comments pertain to large striations and voids in the existing timber bulkhead wall. Majority of holes are caused from rot, as well as marine borers & insect damage. Parking lot above wall has allowed sediment out wash in some parts of wall. **19-21 FT:** 2" depth, serious rot @ -1 MLW, **35 FT:** 1/2" wide x 1/2" deep, **40 FT:** 8" wide x 4" deep, **46-52 FT:** substantial deep voids, **47 FT:** 100% penetration, **52-71 FT:** 3/4" wide x 2" deep marine borer holes uniformly for 19 ft, **72 & 101 FT:** 100% penetration, **106 FT:** 3"x2"depth, **112-120 FT:** major deterioration, washout of substrate due to parking lot slumping, **128 FT:** 3"x3" hole -Substantial rust/corrosion of hardware on lower wale (bolt and plate)

Picture 1

Picture 2

FLOAT INSPECTION REPORT

Location: **Allen Harbor**		Date: **April 28th, 2009**
Pier Name/No.: Floats		Float Material _**X**_ Timber __ Alum __ Concrete
Water Depth **1-2'**	Time of Day: **10:00 AM**	Tide: **Low @ 8:45 AM**	Weather: **Sunny 70**

Float No.	Dimensions	Float Condition					Connections			Cleats/ Guide	Floatation		
		PR	FR	GD	LS	RS	Type	GD	NATT		GD	FR	NATT
1a	3.3'x16'		X				RS					X	
1b	3.3'x16'		X				RS					X	
2a	3.3'x16'		X				RS					X	
2b	3.3'x16'		X				RS					X	
3a	3.3'x16'		X				RS					X	
3b	3.3'x16'		X				RS					X	
4a	3.3'x16'			X			RS					X	
4b	3.3'x16'			X			RS					X	
5a	3.3'x12.5'		X				rod		X			X	
5b	3.3'x16'		X				RS					X	
6a	3.3'x10'			X			RS				X		
6b	3.3'x16'						RS						
7a	3.3'x10'		X				RS					X	
7b	3.3'x16'		X				RS						
8	3.3'x16'		X				RS				X		
9	3.3'x16'		X				RS					X	
10	3.3'x16'		X				RS					X	
11	3.3'x16'		X				RS					X	
12	3.3'x16'		X				RS				X		
13	4.3'x16'		X				RS					X	
14	4.3'x16'		X				RS					X	

Comments: Overall, floats in fair working condition. Substantial sign of weathering, some loose boards due to disassociated rusted nails. Floatation in many floats is unequal and needs to be assessed. Predicted life of floats is 2-3 years until full replacement. Recommend continued monitoring of loose boards and replacement if safety risk is posed.

Picture 1

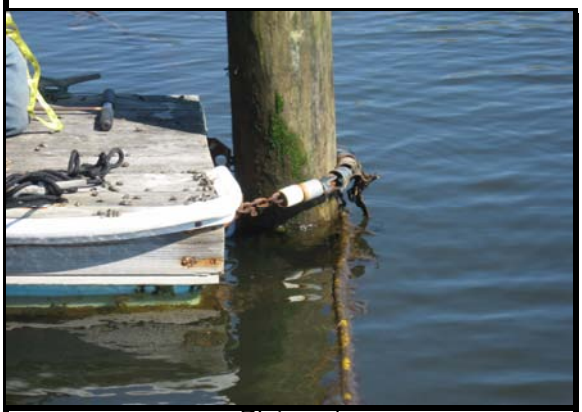
Picture 2

FLOAT INSPECTION REPORT

Location: **Allen Harbor**		Date: **April 28th, 2009**
Pier Name/No.: Floats		Float Material **X** Timber __ Alum __ Concrete
Water Depth **1-2'**	Time of Day: **10:00 AM**	Tide: **Low @ 8:45 AM**	Weather: **Sunny 70**

Float No.	Dimensions	Float Condition					Connections			Cleats/ Guide	Floatation		
		PR	FR	GD	LS	RS	Type	GD	NATT		GD	FR	NATT
15	4.3'x16'		X				RS					X	
16	4.3'x16'						RS				X		
17	4.3'x16'		X				RS					X	
18	4.3'x16'			X			RS					X	
19	4.3'x16'			X			RS					X	
20	4.3'x16'			X			RS					X	
21	4.3'x16'			X			RS					X	
22	4.3'x16'			X			RS					X	
23	4.3'x14'			X			RS					X	

Comments: Some connections to piles are in need of repair. Chains are 100% rusted and are in need of replacement. Floats are in fair condition with moderate to major weathering present. Actual floatation of floats are somewhat uneven due to damaged float drums. Overall in fair condition, no need of immediate action on structural stability of floats.



Picture 1

Picture 2

PIER INSPECTION REPORT

Location: Allen Harbor Pier		Date: April 30, 2009	
Pier Name/No. Allen Harbor	JRN/KES	Pier Material _X_ Timber __ Steel __ Concrete	
Water Depth 1-2'	Time of Day: 9:30 AM	Tide: Low: 9:45 am	Weather: Sunny 65

Good	Fair	NATT	Deck Area Above Water
	X		Check for cracked, rotted, loose or worn decking or string pieces, loose hardware, soft spots in decking, and termite or pest infestations.
	X		Check the tops of fender piles and visible chocks and wales for physical damage, dry rot and termite or pest infestations
X			Check horizontal and vertical alignment
X			Check for missing, broken, or loose connections; obstructions; and other hazardous conditions of curbing, handrails, and catwalks.
X			Check bollards, bits, cleats and capstans for wear, breaks, rough or sharp surfaces or edges and missing or loose bolts.
X			Check deck drains and scuppers for loose, missing or broken screws, standing water, and other deficiencies
	X		Check manhole covers and grating for rust, corrosion, bent or worn hinge pins
-	-	-	Inspect asphalt deck coverings (if applicable) for cracks, holes, other damage
	X		Check ladders for rust and corrosion, broken, bent or missing rungs, rot, pest
X			Check grounding connections for tightness
Good	Fair	NATT	Exposed Area Under Pier or Along Wharf or Dolphin Assembly
	X		Check wood stringers, pile caps, bearing, batter and fender piles, for missing or broken members and evidence of fungal decay and insect damage. Check for loose, fractured, or missing wales and chocks.
			Check dolphins for broken, worn or corroded cables and cable connectors; and corroded, loose, broken or missing wedge block, chafing strips, chock bolt hang
			Check dolphins for poor vertical pile alignment
	X		Visually examine piling and wood in the tidal and splash zone for borer damage
X			Check for pile shrinkage, overloading damage, connector corrosion, abrasion, and ice heaving damage

Comments:

Picture 1

Picture 2

APPENDIX B

FIELD INSPECTION REPORTS

HERRING RIVER

Condition key for Inspection Reports

LS – loose
MS – missing
BW – bowed
SP – split
RT – rotted
RS – rust
CR – corrosion
BR – broken
SL – slippery
GD – good
FR – fair
NATT – needs attention

PR - poor
ME - mechanical
BIO - biological
FUNC - functional
ND – no damage (see pile condition rating chart)
MN – minor damage (see pile condition rating chart)
MD – moderate damage (see pile condition rating chart)
MJ – major damage (see pile condition rating chart)
SV – severe damage (see pile condition rating chart)

PIER INSPECTION REPORT

Location: Herring River Lower		Date: April 30, 2009 Page 1 of 2
Pier Name/No.: Herring River	JRN/KFS	Pier Material X Timber Steel Concrete
Water Depth 1-2'	Time of Day: 9:00 AM	Tide: 9:00 AM low	Weather: Sunny 70

Structural Members						Condition		
Component	Size	Depth/L	Material	No./Length	Spacing	Good	Fair	Poor
Stringers	2x8	varies	PT Y. Pine	3-5 rows	24" O.C.			X
Headers	2x8	varies	PT Y. Pine	14	11' O.C.			X
Decking	2x8	varies	PT Y. Pine	-	1"		X	
Railings	2x4	varies	PT Y. Pine	105' total L	-		X	
Piles	varies		Timber	18 total	11' O.C.			X
Floats	10'x20'		Timber	1	-		X	
Ramps	3'x12'		Aluminum	1	-		X	

Additional Checklist Items	Extent of Damage			
	N/A	Minimal	Moderate	Substantial
Shifts in horizontal and vertical alignment of pier				X
Damage or deterioration of the bearing piles				X
Deterioration of stringers, headers, decking, railings				X
Sign of biological, mechanical, or functional damage				X
Components of system missing				X
Rusted components, corrosion, or bulging present				X

Comments: Overall, pier is in poor condition. Piles have endured major sectional loss from weathering, intertidal wave action, insect and marine borer damage. Connections are not sufficient for structural stability of pier. Majority of structural members are in poor condition, extreme checking and weathering is present. Float and ramp are in fair condition. Recommend that pier be removed and replaced within 1-2 years.

Picture 1

Picture 2

PIER INSPECTION REPORT

Location: Herring River Lower Pier		Date: April 30, 2009 Page 2 of 2	
Pier Name/No. Herring River	JRN/KFS	Pier Material X Timber Steel Concrete	
Water Depth 1-2'	Time of Day:	Tide:	Weather: Sunny 65

Good	Fair	NATT	Deck Area Above Water
		X	Check for cracked, rotted, loose or worn decking or string pieces, loose hardware, soft spots in decking, and termite or pest infestations.
		X	Check the tops of fender piles and visible chocks and wales for physical damage, dry rot and termite or pest infestations
		X	Check horizontal and vertical alignment
		X	Check for missing, broken, or loose connections; obstructions; and other hazardous conditions of curbing, handrails, and catwalks.
-	-	-	Check bollards, bits, cleats and capstans for wear, breaks, rough or sharp surfaces or edges and missing or loose bolts.
-	-	-	Check deck drains and scuppers for loose, missing or broken screws, standing water, and other deficiencies
-	-	-	Check manhole covers and grating for rust, corrosion, bent or worn hinge pins
-	-	-	Inspect asphalt deck coverings (if applicable) for cracks, holes, other damage
X			Check ramps for rust and corrosion, broken, bent or missing rungs, rot, pest
-	-	-	Check grounding connections for tightness
Good	Fair	NATT	Exposed Area Under Pier or Along Wharf or Dolphin Assembly
		X	Check wood stringers, pile caps, bearing, batter and fender piles, for missing or broken members and evidence of fungal decay and insect damage. Check for loose, fractured, or missing wales and chocks.
-	-	-	Check dolphins for broken, worn or corroded cables and cable connectors; and corroded, loose, broken or missing wedge block, chafing strips, chock bolt hang
-	-	-	Check dolphins for poor vertical pile alignment
		X	Visually examine piling and wood in the tidal and splash zone for borer damage
		X	Check for pile shrinkage, overloading damage, connector corrosion, abrasion, and ice heaving damage

Comments: Pier is in deplorable condition and should be replaced within the next year. Some decking can be salvaged, however, all piles need to be removed and replaced. Connections are not sufficient for load stability, major sectional loss occuring in tidal/splash zone of existing piles. Overall in poor condition.

Picture 1

Picture 2

PIER INSPECTION REPORT

Location: Herring River Upper		Date: April 30, 2009 Page 1 of 2	
Pier Name/No.: Herring River	JRN/KES	Pier Material X Timber Steel Concrete	
Water Depth 1-2'	Time of Day: 9:00 AM	Tide: 9:00 AM low	Weather: Sunny 70

Structural Members						Condition		
Component	Size	Depth/L	Material	No./Length	Spacing	Good	Fair	Poor
Stringers	3x8	56'L	PT Y. Pine	3 Rows	2' O.C.	X		
Headers	3x10	4.3'L	PT Y. Pine	12 Rows	7.5' O.C.	X		
Decking	2x6	4.3'L	PT Y. Pine	-	1"	X		
Railings	2x4	-	PT Y. Pine	2 rows	-	Not adequate		
Piles	12" diameter		greenheart	12 total	7.5' O.C.	X		
Floats	10'x20'		PT Y. Pine	1	-	X		
Ramps	3'x15'		Aluminum	1	-	X		

Additional Checklist Items	Extent of Damage			
	N/A	Minimal	Moderate	Substantial
Shifts in horizontal and vertical alignment of pier	X			
Damage or deterioration of the bearing piles	X			
Deterioration of stringers, headers, decking, railings	X			
Sign of biological, mechanical, or functional damage	X			
Components of system missing		X		
Rusted components, corrosion, or bulging present	X			

Comments: Pier is in excellent condition. Piles, pier components, and hardware are all in excellent condition and do not require any immediate attention. However, pile caps should be provided for the existing piles. This will ensure adequate protection for the piles in terms of moisture and weathering. Railings are not sufficient for this type of pier, should be installed in accordance with the Massachusetts State Building Code. Float and ramp are in good condition. Float has fabric bumps and 4 cleats that are maintained properly. 3'x3' metal plate at bottom of ramp is in good condition as well.

Picture 1

Picture 2

PIER INSPECTION REPORT

Location: Herring River Upper Pier		Date: April 30, 2009 Page 2 of 2
Pier Name/No. Herring River	JRN/KES	Pier Material X Timber Steel Concrete
Water Depth 1-2'	Time of Day:	Tide: Weather: Sunny 65

Good	Fair	NATT	Deck Area Above Water
X			Check for cracked, rotted, loose or worn decking or string pieces, loose hardware, soft spots in decking, and termite or pest infestations.
X			Check the tops of fender piles and visible chocks and wales for physical damage, dry rot and termite or pest infestations
X			Check horizontal and vertical alignment
		X	Check for missing, broken, or loose connections; obstructions; and other hazardous conditions of curbing, handrails, and catwalks.
-	-	-	Check bollards, bits, cleats and capstans for wear, breaks, rough or sharp surfaces or edges and missing or loose bolts.
-	-	-	Check deck drains and scuppers for loose, missing or broken screws, standing water, and other deficiencies
-	-	-	Check manhole covers and grating for rust, corrosion, bent or worn hinge pins
-	-	-	Inspect asphalt deck coverings (if applicable) for cracks, holes, other damage
X			Check ramps for rust and corrosion, broken, bent or missing rungs, rot, pest
-	-	-	Check grounding connections for tightness
Good	Fair	NATT	Exposed Area Under Pier or Along Wharf or Dolphin Assembly
		X	Check wood stringers, pile caps, bearing, batter and fender piles, for missing or broken members and evidence of fungal decay and insect damage. Check for loose, fractured, or missing wales and chocks.
-	-	-	Check dolphins for broken, worn or corroded cables and cable connectors; and corroded, loose, broken or missing wedge block, chafing strips, chock bolt hang
-	-	-	Check dolphins for poor vertical pile alignment
X			Visually examine piling and wood in the tidal and splash zone for borer damage
X			Check for pile shrinkage, overloading damage, connector corrosion, abrasion, and ice heaving damage

Comments: Pile caps need to be provided to protect pile from accelerated weathering and to prolong its serviceable life. Railings are not sufficient for this type of pier. Need to be installed to code. Otherwise, pier is in excellent condition.

Picture 1

Picture 2

APPENDIX B

FIELD INSPECTION REPORTS

ROUND COVE

Condition key for Inspection Reports

LS – loose
MS – missing
BW – bowed
SP – split
RT – rotted
RS – rust
CR – corrosion
BR – broken
SL – slippery
GD – good
FR – fair
NATT – needs attention

PR - poor
ME - mechanical
BIO - biological
FUNC - functional
ND – no damage (see pile condition rating chart)
MN – minor damage (see pile condition rating chart)
MD – moderate damage (see pile condition rating chart)
MJ – major damage (see pile condition rating chart)
SV – severe damage (see pile condition rating chart)

BULKHEAD INSPECTION REPORT

Location: Round Cove Bulkhead		Date: May 21, 2009	
Pier Name/No.: Round Cove	JRN/KES	Bulkhead Material __ Timber __ Steel _X_ Concrete	
Water Depth 0 - 1'	Time of Day: 2:00 PM	Tide: 3:00 PM low	Weather: Sunny 70

Structural Members						Condition		
Component	Size	Depth	Material	No./Length	Spacing	Good	Fair	Poor
Bulkhead	12" W	ND	Concrete	168'	cont.		X	
Footing	8"	4"	Concrete	115'	cont.	X		
Footing #2	6" W	6"D	Timber	115'	cont.	X		
Anchors	-	-	-	-	-	-	-	-
Fender Pilings	Not Applicable							

Additional Checklist Items	Extent of Damage			
	N/A	Minimal	Moderate	Substantial
Shifts in horizontal and vertical alignment of wall		X		
Damage or deterioration of the concrete wall				X
Wash-out of substrate under the concrete wall			X	
Signs of detrimental wave action, scouring sloughing		X		
Components of system missing		X		
Rust, corrosion, or bulging present, cracking			X	

Comments: Original sections of wall adjacent to boat ramp and marsh are in good condition with few sections containing large vertical cracking that penetrates 100% of the wall. Weepholes are present and no evidence of anchors. Area around the float and ramp are in need of repair. Substantial voids in concrete wall along with spalling and horizontal/vertical cracking are present. Voids are causing sediment outfall from parking lot into waterway. Cracking/splitting seems to be caused by lack of expansion joints in concrete.

Picture 1

Picture 2

APPENDIX B

FIELD INSPECTION REPORTS

SAQUATUCKET HARBOR

Condition key for Inspection Reports

LS – loose
MS – missing
BW – bowed
SP – split
RT – rotted
RS – rust
CR – corrosion
BR – broken
SL – slippery
GD – good
FR – fair
NATT – needs attention

PR - poor
ME - mechanical
BIO - biological
FUNC - functional
ND – no damage (see pile condition rating chart)
MN – minor damage (see pile condition rating chart)
MD – moderate damage (see pile condition rating chart)
MJ – major damage (see pile condition rating chart)
SV – severe damage (see pile condition rating chart)

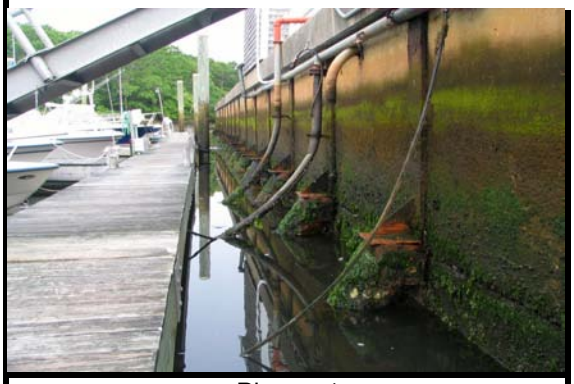
BULKHEAD INSPECTION REPORT

Location: Saquatucket Bulkhead		Date: June 25, 2009	Page 1 of 1
Pier Name/No.: Saquatucket	JRN	Bulkhead Material __ Timber __ Steel _X_ Concrete	
Water Depth 1-2'	Time of Day: 8:00 AM	Tide: 8:00 AM low	Weather: Sunny 70

Structural Members						Condition		
Component	Size	Depth	Material	No./Length	Spacing	Good	Fair	Poor
Bulkhead		8"	Concrete	875' appx	cont.		X	X
Wale	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Anchors	10" Strapping		Steel	105 apprx	8' O.C.			X
Cap	1.1'	1.1'	Concrete	875' apprx	cont.		X	X
H-Pile	8"		Steel	105 apprx	8' O.C.			X
Batter Piles	12" Diameter		Timber	105 apprx	8' O.C.		X	X

Additional Checklist Items	Extent of Damage			
	N/A	Minimal	Moderate	Substantial
Shifts in horizontal and vertical alignment of wall		X (north)		X (east)
Damage or deterioration of the concrete wall			X	
Wash-out of substrate under the concrete wall			X	
Signs of detrimental wave action, scouring sloughing			X	
Components of system missing			X	
Rust, corrosion, bulging, cracking, spalling present				X

Comments: Piles and compression plates are approx. 8' O.C., two weep holes between all piles, and a few outfalls from adjacent catch basins in the parking lot. All metal compression plates are rusted and corroded, piles in fair to poor condition. Efflorescence present with moderate sediment loss from the above parking lot. H-Piles exposed on parking lot side through cap in various locations. Majority of bracket connections and fasteners have no remaining load transfer capacity. Compression plate still functional with moderate corrosion. Corrosion level of H-piles range from moderate to high levels. Some exterior flanges at approx. 80-90% section loss. Signs of spalled concrete and section loss at cap beam at embedded heads of corroded H-piles. Bulkhead at east side of marina adjacent to fuel dock has deadmen tieback (one anchor per H-pile) and has started to rotate toward harbor likely due to overloading by live load traffic behind wall. Concrete bulkhead panels generally in good condition, some with larger single cracks, some with multiple smaller crack patterns.



Picture 1

Picture 2

PILE INSPECTION REPORT

Location: Saquatucket Harbor	Date: June 16, 2009 Page 1 of 5	
Pier Name/No. Run 1	Pile Type __ Bearing __ Fender __	Pile Material _X_ Timber __ Steel __ Concrete
Water Depth: 1-2'	Time of Day: 9:00 AM	Tide: Low (8:45 am)	Weather: Sunny 70

Bent	Pile	Dimension		Pile Condition					Type Damage			Cap	Comment
No.	No.	Low	Upp	ND	MN	MD	MJ	SV	ME	BIO	FUNC		
1	1	45	46	X								no	
1	2	37	36	X								no	
1	3	41	42		X				X				intertidal zone damage
1	4	50	51.5		X				X				intertidal zone damage
1	5	42	43		X				X				
1	6	42.5	43		X				X				
1	7	44.5	44	X									damage at top
1	8	47	47.5		X				X				
1	10	44	44		X				X				
1	11	38.5	38	X									
1	12	42	42	X									
1	13	46	45.5										
1	14	44.5	44	X									
1	15	39.5	40			X			X				mod. Sectional loss
1	16	37.5	38.3		X				X				
1	17	42	41.5		X				X				
1	18	46	46	X									
1	19	41	41.3			X			X			no	peeling outer shell
1	20	42	42.5	X									
1	21	42.5	42	X									
1	22	41	41.5	X									

Comments: Brackets are major concern for pile condition. Design/functionality problem - causing major sectional loss in majority of piles. Recommend alternative design/replacement of brackets. Roller configuration seems appropriate.

Picture 1

Picture 2

PILE INSPECTION REPORT

Location: Saquatucket Harbor	Date: June 16, 2009 Page 2 of 5

Pier Name/No. Run 1 (cont.)	Pile Type __ Bearing __ Fender __	Pile Material _X_ Timber __ Steel __ Concrete

Water Depth: 1-2'	Time of Day: 9:00 AM	Tide: Low (8:45 am)	Weather: Sunny 70

Bent	Pile	Dimension		Pile Condition					Type Damage			Cap	Comment
No.	No.	Low	Upp	ND	MN	MD	MJ	SV	ME	BIO	FUNC		
1	23	44.5	44	X									
1	24	45.5	45		X				X				
1	25	42	41.5		X				X				
1	26	40.5	41	X								no	
1	27	39	41		X				X				
1	28	41.5	41			X			X				sectional loss
1	29	43.5	44	X									
1	30	-	-									no	
1	31	39	40	X									
1	32	42	41	X									
1	33	49.5	40.5				X		X				major sectional loss
1	34	41.5	40	X								no	
1	35	41.5	41	X									
1	36	38.5	38.5	X									fiberglass
1	37	-	-	X									
1	38	-	-	X									fiberglass

Comments: Brackets are major concern for pile condition. Design/functionality problem - causing major sectional loss in majority of piles. Recommend alternative design/replacement of brackets. Roller configuration seems appropriate.

Picture 1

Picture 2

PILE INSPECTION REPORT

Location: Saquatucket Harbor		Date: June 16, 2009 Page 3 of 5
Pier Name/No. Section E	Pile Type __ Bearing __ Fender __	Pile Material _X_ Timber __ Steel __ Concrete
Water Depth: 1-2'	Time of Day: 9:00 AM	Tide: Low (8:45 am)	Weather: Sunny 70

Bent	Pile	Dimension		Pile Condition					Type Damage			Cap	Comment
No.	No.	Low	Upp	ND	MN	MD	MJ	SV	ME	BIO	FUNC		
E	1	42	42	X									
E	2	38	37	X								no	
E	3	43	44	X									
E	4	40	39.5		X				X				
E	5	41	42		X				X			no	
E	6	42.5	43	X								no	
E	7	39	40		X								
E	8	32.5	-				X				X		very loose
E	9	44	44	X									
E	10	44	44		X				X			no	
E	11	38	36.5	X									
E	12	41	40.5		X				X				
E	13	43	44		X							no	
E	14	37.5	37			X						no	splitting at top
E	15	41	41.5	X									
E	16	43.5	42.5		X				X				
E	17	47.5	49	X									
E	18	30	-		X							no	sectional loss at top
E	19	41	42		X				X				
E	20	39	40.5		X				X				

Comments: Brackets are major concern for pile condition. Design/functionality problem - causing major sectional loss in majority of piles. Recommend alternative design/replacement of brackets. Roller configuration seems appropriate.

Picture 1

Picture 2

PILE INSPECTION REPORT

Location: Saquatucket Harbor			Date: June 16, 2009 Page 4 of 5
Pier Name/No. Section F	Pile Type __ Bearing __ Fender __		Pile Material _X_ Timber __ Steel __ Concrete
Water Depth: 1-2'	Time of Day: 9:00 AM	Tide: Low (8:45 am)	Weather: Sunny 70

Bent	Pile	Dimension		Pile Condition					Type Damage			Cap	Comment
No.	No.	Low	Upp	ND	MN	MD	MJ	SV	ME	BIO	FUNC		
F	1	33	33	X								no	
F	2	42	43	X									
F	3	39	-					X	X		FG		shell peeling
F	4	30	31	X								no	
F	5	39	-		X						FG		peeling around rope
F	6	37	-	X								no	
F	7	39	-		X						FG		abrasion from boat
F	8	39	-	X							FG		
F	9	39	40.5		X							no	splitting at top
F	10	39	-	X							FG		
F	11	39	-		X						FG		abrasion
F	12	39	-		X						FG		abrasion
F	13	39	41	X									
F	14	39	-	X							FG		
F	15	39	-		X						FG	no	minor abrasion
F	16	39	-		X						FG		minor abrasion
F	17	39	-		X						FG	no	
F	18	39	-		X						FG		
F	19	39	-		X						FG		
F	20	39	-	X							FG		
F	21	47	-		X							no	

Comments: Brackets are major concern for pile condition. Design/functionality problem - causing major sectional loss in majority of piles. Recommend alternative design/replacement of brackets. Roller configuration seems appropriate.

Picture 1

Picture 2

PILE INSPECTION REPORT

Location: Saquatucket Harbor		Date: June 16, 2009 Page 5 of 5
Pier Name/No. Section F	Pile Type __ Bearing __ Fender __	Pile Material _X_ Timber __ Steel __ Concrete
Water Depth: 1-2'	Time of Day: 9:00 AM	Tide: Low (8:45 am)	Weather: Sunny 70

Bent	Pile	Dimension		Pile Condition					Type Damage			Cap	Comment
No.	No.	Low	Upp	ND	MN	MD	MJ	SV	ME	BIO	FUNC		
F	22	39	-	X							FG		
F	23	39	-		X						FG		minimal wear
F	24	39	-			X					FG		moderate abrasion
F	25	39	-		X						FG		minimal abrasion
F	26	38	38		X							no	
F	27	39	-		X						FG		minimal abrasion
F	28	39	-	X							FG	no	minimal abrasion
F	29	39	-	X							FG		
F	30	-	-		X							no	2 additional tie off piles
F	31	-	-		X							no	2 additional tie off piles
F	32	39	-	X							FG		
F	33	39	39.5		X							no	
F	34	42.5	43.5			X						no	moderate abrasion

Comments: Brackets are major concern for pile condition. Design/functionality problem - causing major sectional loss in majority of piles. Recommend alternative design/replacement of brackets. Roller configuration seems appropriate.

Picture 1

Picture 2

FLOAT INSPECTION REPORT

Location: **Saquatucket Harbor**		Date: **June 9, 2009** **Page 1 of 8**
Pier Name/No.: **Section A**	JRN/KES	Float Material _**X**_ Timber __ Alum __ Concrete
Water Depth **3-8'**	Time of Day: **8:00 AM**	Tide: **Low @ 7:30 AM**	Weather: **Cloudy 60**

Float No.	Dimensions	Float Condition					Connections			Cleats/ Guide	Floatation		
		PR	FR	GD	LS	MS	Type	GD	NATT		GD	FR	NATT
A1	4'x20'			X				X		4		X	
A2	4'x20'			X				X		4	X		
A3	4'x20'			X			RS		X	4	X		
A4	4'x10'			X			RS		X	2		X	
A5	4'x20'			X				X		4	X		
A6	4'x20'		X					X		4	X		
A7	4'x20'			X				X		4	X		
A8	4'x20'			X				X		4	X		
A9	4'x10'		X					X		2	X		
A10	4'x20'			X				X		4		X	
A11	4'x20'			X				X		4	X		
A12	4'x20'		X					X		4	X		
A13	4'x20'		X					X		4	X		
A14	4'x20'			X				X		4		X	
A15	4'x20'			X				X		4	X		
A16	4'x10'			X				X		2	X		
A17	4'x20'			X				X		4	X		
A18	4'x20'			X				X		4	X		
A19	4'x20'			X				X		4	X		
A20	4'x10'			X				X		2	X		
A21	4'x20'		X		X		LS		X	4		X	
A22	4'x20'			X				X		4	X		

Comments: Majority of floats are in good condition, with a few exceptions that have loose or rusted members. No immediate need for maintenance. Life span approximately 5 years until full replacement

Picture 1

Picture 2

FLOAT INSPECTION REPORT

Location: **Saquatucket Harbor**	Date: **June 9, 2009**	**Page 2 of 8**
Pier Name/No.: **Section B**	JRN/KES	Float Material **X** Timber __ Alum __ Concrete
Water Depth **3-8'**	Time of Day: **8:00 AM**	Tide: **Low @ 7:30 AM**	Weather: **Cloudy 60**

Float No.	Dimensions	Float Condition					Connections			Cleats/ Guide	Floatation		
		PR	FR	GD	LS	MS	Type	GD	NATT		GD	FR	NATT
B1	4'x10'			X				X		2	X		
B2	4'x20'			X				X		4	X		
B3	4'x20'	X					LS			4	X		
B4	4'x20'		X				LS		X	4		X	
B5	4'x10'			X				X		2	X		
B6	4'x10'		X					X		2	X		
B7	4'x20'			X				X		4	X		
B8	4'x20'			X				X		4		X	
B9	4'x20'		X					X		4	X		
B10	4'x10'			X				X		2	X		
B11	4'x20'			X			LS		X	4	X		
B12	4'x20'		X					X		4		X	
B13	4'x10'		X					X		2	X		
B14	4'x20'			X				X		4	X		
B15	4'x20'			X				X		4		X	
B16	4'x20'			X				X		4		X	
B17	4'x10'			X				X		2	X		
B18	4'x10'	X					RS		X	2		X	
B19	4'x20'			X				X		4	X		
B20	4'x20'			X				X		4	X		
B21	4'x20'		X		X		LS		X	4	X		
B22	4'x10'			X				X		2	X		

Comments: Loose boards are in need of replacement or proper fastening. Remaining floats have adequate floatation. Life span of floats approximately 5 years.

Picture 1

Picture 2

FLOAT INSPECTION REPORT

Location: **Saquatucket Harbor**		Date: **June 9, 2009** **Page 3 of 8**
Pier Name/No.: **Section C**	JRN/KES	Float Material **X** Timber __ Alum __ Concrete
Water Depth **3-8'**	Time of Day: **8:00 AM**	Tide: **Low @ 7:30 AM**	Weather: **Cloudy 60**

Float No.	Dimensions	Float Condition					Connections			Cleats/ Guide	Floatation		
		PR	FR	GD	LS	MS	Type	GD	NATT		GD	FR	NATT
C1	4'x10'	X					LS/RS		X	2	X		
C2	4'x20'			X				X		4		X	
C3	4'x20'		X				LS		X	4		X	
C4	4'x10'	X					RS/LS		X	2	X		
C5	4'x20'			X				X		4	X		
C6	4'x10'			X				X		2	X		
C7	4'x20'			X				X		4	X		
C8	4'x20'			X				X		4		X	
C9	4'x10'		X					X		2	X		
C10	4'x10'		X					X		2	X		
C11	4'x20'			X				X		4		X	
C12	4'x20'		X				LS		X	4		X	
C13	4'x10'		X					X		2	X		
C14	4'x20'			X				X		4	X		
C15	4'x20'			X				X		4	X		
C16	4'x10'			X				X		2		X	
C17	4'x20'			X				X		4	X		
C18	4'x20'			X				X		4	X		
C19	4'x10'			X				X		2	X		
C20	4'x10'		X					RS	X	2		X	
C21	4'x20'	X					LS		X	4	X		
C22	4'x10'	X					LS		X	2		X	
C23	4'x20'		X					X		4	X		
C24	4'x10'		X					X		2	X		

Comments: Typical rust and loose connections, moderate. No extreme need of replacement of any float. Floats C21, C22 , C1 and C4 are in need of attention in regard to decking and hardware.

Picture 1

Picture 2

FLOAT INSPECTION REPORT

Location: **Saquatucket Harbor**		Date: **June 9, 2009** **Page 4 of 8**
Pier Name/No.: **Section D**	JRN/KES	Float Material **X** Timber __ Alum __ Concrete
Water Depth **3-8'**	Time of Day: **8:00 AM**	Tide: **Low @ 7:30 AM** Weather: **Cloudy 60**

Float No.	Dimensions	Float Condition					Connections			Cleats/ Guide	Floatation		
		PR	FR	GD	LS	MS	Type	GD	NATT		GD	FR	NATT
D1	6x20		X					X		4		X	
D2	6x20		X					X		4		X	
D3	6x20		X					X		4		X	
D4	6x20		X					X		4		X	
D5	6x20		X					X		4		X	
D6	6x20		X					X		4		X	
D7	6x20	X						X		4		X	
D8	6x20			X				X		4	X		
D9	6x12		X					X		2		X	
D10	6x12		X					X		2		X	
D11	6x12		X					X		2		X	

Comments: Majority of floats in fair condition. Decking will need to be replaced within the next 2 years. Sideboards and floating device are in good condition. Total replacement predicted to occur in 5-8 years.

Picture 1

Picture 2

FLOAT INSPECTION REPORT

Location: **Saquatucket Harbor**		Date: **June 16, 2009** **Page 5 of 8**
Pier Name/No.: **Section E**	JRN/KES	Float Material **X** Timber __ Alum __ Concrete
Water Depth **3-8'**	Time of Day: **2:30 PM**	Tide: **Low @ 12:30**	Weather: Sunny 70

Float No.	Dimensions	Float Condition					Connections			Cleats/ Guide	Floatation		
		PR	FR	GD	LS	RS	Type	GD	NATT		GD	FR	NATT
E1	4x10		X		X	X		X		2	X		
E2	4x20		X		X	X		X		4		X	
E3	4x20	X			X	X		X		4	X		
E4	4x20		X		X	X		X		4	X		
E5	4x20		X		X	X		X		4		X	
E6	4x20		X			X		X		6	X		
E7	4x20		X		X	X		X		4		X	
E8	4x20		X		X	X		X		4	X		
E9	4x20		X			X		X		4	X		
E10	4x10		X			X		X		2		X	
E11	4x20		X			X		X		4	X		
E12	4x20		X			X		X		4	X		
E13	4x20		X			X	WP		X	4	X		
E14	4x10		X			X	WP		X	2	X		
E15	4x20		X		X	X		X		4		X	
E16	4x20		X			X		X		4	X		
E17	4x20		X			X		X		4	X		
E18	4x20		X		X	X		X		4		X	
E19	4x20		X			X		X		4	X		
E20	4x10		X			X		X		2	X		
E21	4x20		X			X	LS		X	4	X		
E22	4x20		X			X		X		4		X	
E23	4x20		X		X	X	LS		X	4	X		
E24	4x10		X			X		X		2	X		

Comments: Floats are in fair shape, predict decking to be replaced within 3 years. Warped connecting bars will need to be replaced - causing floats to be off balace.

Picture 1

Picture 2

FLOAT INSPECTION REPORT

Location: **Saquatucket Harbor**		Date: **June 16, 2009**	**Page 6 of 8**
Pier Name/No.: **Section E**	JRN/KES	Float Material **_X_** Timber __ Alum __ Concrete	
Water Depth **3-8'**	Time of Day: **2:30 PM**	Tide: **Low @ 12:30**	Weather: Sunny 70

Float No.	Dimensions	Float Condition					Connections			Cleats/ Guide	Floatation		
		PR	FR	GD	LS	RS	Type	GD	NATT		GD	FR	NATT
E25	4x10	X			X	X		X		4	X		
E26	4x20		X			X		X		4	X		
E27	4x20	X			X	X		X		4	X		
E28	4x20		X			X		X		4	X		
E29	4x20	X			X	X		X		4		X	
E30	4x20	X			X	X		X		2		X	

Comments: Majority of floats are in poor condition. Loose and rusted decking that will need to replaced within 1-2 years. Floatation is adequate.

Picture 1

Picture 2

FLOAT INSPECTION REPORT

Location: **Saquatucket Harbor**		Date: **June 16, 2009** **Page 7 of 8**
Pier Name/No.: **Section F**	JRN/KES	Float Material _**X**_ Timber __ Alum __ Concrete
Water Depth **3-8'**	Time of Day: **2:30 PM**	Tide: **Low @ 12:30**	Weather: Sunny 70

Float No.	Dimensions	Float Condition					Connections			Cleats/ Guide	Floatation		
		PR	FR	GD	LS	RS	Type	GD	NATT		GD	FR	NATT
F1	4x10		X				LS		X	2		X	
F2	4x20		X					X		4	X		
F3	6x20	X	X		X	X	LS		X	4	X		
F4	6x20	X			X	X	WP		X	4	X		
F5	4x20	X			X	X		X		4	X		
F6	4x10		X					X		2		X	
F7	6x20		X			X				4	X		
F8	6x20	X	X		X	X		X		4	X		
F9	4x20		X			X				4	X		
F10	4x10		X			X				2	X		
F11	6x20		X			X		X		4	X		
F12	6x20	X	X					X		4	X		
F13	4x20		X					X		4	X		
F14	4x10		X						X	2	X		
F15	6x20	X			X	X		X		4	X		
F16	6x20		X			X		X		2	X		
F17	4x20		X		X	X		X		4		X	
F18	4x10		X					X		2		X	

Comments: Decking is splitting and rotting at end sections where nails are rusted. Many areas where decking is loose, no new decking has been installed. Majority of connections in fair shape, no sign of functionality problems. No indication of severe structural damage. Predicted lifespan of 2-3 years until replacement needed.

Picture 1

Picture 2

FLOAT INSPECTION REPORT

Location: **Saquatucket Harbor**		Date: **June 16, 2009** **Page 8 of 8**
Pier Name/No.: **Run 4**	JRN/KES	Float Material **X** Timber __ Alum __ Concrete
Water Depth **3-8'**	Time of Day: **2:30 PM**	Tide: **Low @ 12:30**	Weather: Sunny 70

Float No.	Dimensions	Float Condition					Connections			Cleats/ Guide	Floatation		
		PR	FR	GD	LS	RS	Type	GD	NATT		GD	FR	NATT
1	6x20		X			X		X		4	X		
2	6x20		X			X		X		4	X		
3	6x20		X			X		X		4	X		
4	6x20		X			X		X		4	X		
5	6x20		X			X		X		4	X		
6	6x20		X			X		X		4	X		
7	6x20		X			X		X		4	X		
8	6x20		X			X		X		4	X		
9	6x20		X		X	X	WP		X	4	X		
10	6x20		X		X	X		X		4	X		
11	6x20		X		X	X		X		4	X		

Comments: Rollers between floats warped in multiple locations. Remaining hardware is in good condition. Decking has endured extreme weathering, however side boards are in favorable condition. PT side boards, what about decking? When was decking, floats, sideboards installed?

Picture 1

Picture 2

APPENDIX B

FIELD INSPECTION REPORTS

WYCHMERE HARBOR

Condition key for Inspection Reports

LS – loose
MS – missing
BW – bowed
SP – split
RT – rotted
RS – rust
CR – corrosion
BR – broken
SL – slippery
GD – good
FR – fair
NATT – needs attention

PR - poor
ME - mechanical
BIO - biological
FUNC - functional
ND – no damage (see pile condition rating chart)
MN – minor damage (see pile condition rating chart)
MD – moderate damage (see pile condition rating chart)
MJ – major damage (see pile condition rating chart)
SV – severe damage (see pile condition rating chart)

BULKHEAD INSPECTION REPORT

Location: Wychmere Harbor Steel Bulkhead		Date: May 26, 2009	
Pier Name/No.: Wychmere Harbor	JRN/KES	Bulkhead Material __ Timber _X_ Steel __ Concrete	
Water Depth 1-2'	Time of Day: 9:00 AM	Tide: 9:00 AM low	Weather: Sunny 70

Structural Members						Condition		
Component	Size	Depth	Material	No./Length	Spacing	Good	Fair	Poor
Sheeting	-	-	Steel	39'	cont.			X
Wale	10"	10"	Timber	1	-		X	
Anchoring System	ND	ND	Steel	ND	ND		X	
Cap	10"	10"	Timber	39'	cont.		X	
Fender Pilings	SEE PILE BENT 1 INSPECTION REPORT							

Additional Checklist Items	Extent of Damage			
	N/A	Minimal	Moderate	Substantial
Shifts in horizontal and vertical alignment of sheets		X		
Damage or deterioration of the sheet piling				X
Wash-out of substrate under the sheeting at toe			X	
Signs of detrimental wave action, scouring sloughing				X
Components of system missing			X	
Rust, corrosion, or bulging present				rust

Comments: Overall, wall is in poor condition. Major steel decompostion due to rust and corrosion. Wale showing signs of horizontal checking/splitting due to weathering. Substrate wash out present due to parking lot slumping as seen in Picture 1. New fender piles are not properly secured to wall, recommend to be independent of previous failing fender pile.

Picture 1

Picture 2

PILE INSPECTION REPORT

Location: Wychmere Harbor		Date: May 26, 2009 Page 1 of 6
Pier Name/No. Bent A Steel Bulkhead	Pile Type __ Bearing _X_ Fender __	Pile Material _X_ Timber __ Steel __ Concrete
Water Depth: 1-6'	Time of Day: 9:00 AM	Tide: Low (7:45 am)	Weather: Sunny 60

Bent	Pile	Dimension		Pile Condition					Type Damage			Cap	Comment
No.	No.	Low	Upp	ND	MN	MD	MJ	SV	ME	BIO	FUNC		
A	A1	36	36	X								steel	
A	A2	25.5	27.5			X			X	X	X	no	failed bolts, no bearing
A	B1	33	32.5	X								steel	
A	B2	25.5	27.5			X			X	X	X	no	failed bolts, no bearing
A	C1	31.5	31.5	X								steel	
A	C2	25.5	27.5			X			X	X	X	no	failed bolts, no bearing

Comments: A2, B2, C2 - major loss @ ground, bolts to wale failed. Connections need to be re-established, piles that are in good condition should be independent of failing piles

Picture 1

Picture 2

PILE INSPECTION REPORT

Location: Wychmere Harbor Timber Bulkhead	Date: May 26, 2009 Page 2 of 6

Pier Name/No. Bent 0 Timber Bulk	Pile Type __ Bearing _X_ Fender __	Pile Material _X_ Timber __ Steel __ Concrete

Water Depth: 1-2'	Time of Day: 9:00 AM	Tide: Low (8:45 am)	Weather: Sunny 70

Bent	Pile	Dimension		Pile Condition					Type Damage			Cap	Comment
No.	No.	Low	Upp	ND	MN	MD	MJ	SV	ME	BIO	FUNC		
0	1A	30	30		X								
0	1B	42.5	42.5	X								no	
0	2A	35	33		X								
0	2B	44.75	45	X								no	
0	3A	33.5	33.5		X								bolt to timber curb
0	3B	-	-					X	X	X	X	no	major sectional loss
0	4A	31	31		X								bolt to timber curb
0	4B	38.5	38.5					X	X		X	no	hollow top, no bearing
0	5A	35	35		X								bolt to timber curb
0	5B	-	-					X	X		X	no	hollow, rotted
0	6A	33.5	33.5		X								
0	6B	-	-			X						no	marine borer, solid conn
0	7A	30	-		X								
0	7B	43	41.5				X					no	rot, substantial sect loss
0	8A	33	33		X								
0	8B	39	38.5		X					X		no	minor rot
0	9A	30.5	30.5		X								
0	9B	37.5	38.5			X				X		no	mod loss @ top

Comments: Majority of supplemental piles are in good condition. Previous piles that still remain are beyond their serviceable life. Connections need to be reinstated in majority of piles, some locations have no bearing capacity due to failed/improper connections.

Picture 1

Picture 2

PILE INSPECTION REPORT

Location: Wychmere Harbor		Date: May 26, 2009 Page 3 of 6	
Pier Name/No. Pier Area	Pile Type _X_ Bearing __ Fender __	Pile Material _X_ Timber __ Steel __ Concrete	
Water Depth: 1-6'	Time of Day: 9:00 AM	Tide: Low (7:45 am)	Weather: Sunny 60

Bent	Pile	Dimension		Pile Condition					Type Damage			Cap	Comment
No.	No.	Low	Upp	ND	MN	MD	MJ	SV	ME	BIO	FUNC		
1	A	38	38		X								fender (south)
1	B	31	31			X				X		header	peeling, disassociated
1	C	31	31				X			X		header	outer shell failing
1	D	31	31			X				X		header	peeling, disassociated
1	E			X									fender (north)
1	F												
1	G												
2	A	38	38	X									fender (south)
2	B	44	44			X				X		header	peeling, shell failing
2	C	43	43				X			X		header	peeling
2	D	42.5	43			X				X		header	outer shell failing
2	E	-	-										fender (north)
3	A	39.5	39.5	X									fender (south)
3	B	42	42				X			X		header	pile holding water
3	C	41.5	42			X				X		header	outer shell peeling
3	D	42.5	43				X			X		header	shell peeling
3	E	-	-	X									fender (north)
4	A	40	40.5	X									fender (south)
4	B	43	42.5			X				X		header	peeling
4	C	43	43				X			X		header	peeling
4	D	42.5	42.5			X				X		header	peeling

Comments: Fender piles at ends of pier have recently been replaced and are in good working condition. Pier bearing piles that hold load for concrete header beam are in fair to poor condition. Majority of piles are deteriorating (outer shell peeling). Large presence of water being held within the pile, causing accelerated rot and deterioration. Recommend replacement in 2-3 years.

Picture 1

Picture 2

PILE INSPECTION REPORT

Location: Wychmere Harbor	Date: May 26, 2009 Page 4 of 6

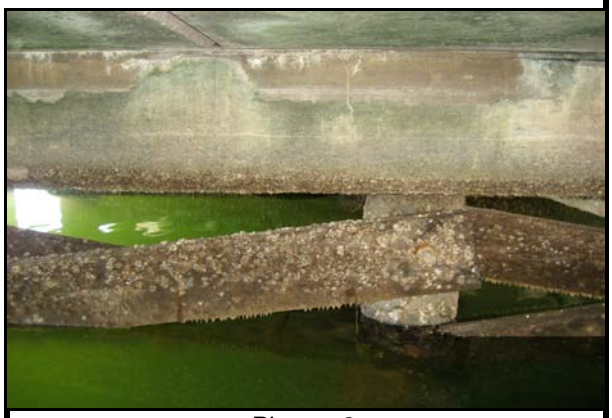
Pier Name/No. Pier Area	Pile Type _X_ Bearing __ Fender __	Pile Material _X_ Timber __ Steel __ Concrete

Water Depth: 1-6'	Time of Day: 9:00 AM	Tide: Low (7:45 am)	Weather: Sunny 60

Bent	Pile	Dimension		Pile Condition					Type Damage			Cap	Comment
No.	No.	Low	Upp	ND	MN	MD	MJ	SV	ME	BIO	FUNC		
4	E	-	-	X									fender (north)
5	A	40	40	X									fender (south)
5	B	40	41				X			X		header	outer shell peeling
5	C	41	41			X				X		header	peeling, shell failing
5	D	41.5	42				X			X		header	outer shell failing
5	E	-	-	X									fender (north)
6	A	41.5	40.5	X									fender (south)
6	B	40	40			X				X		header	shell failing
6	C	40	40			X				X		header	outer shell failing
6	D	40.5	41			X				X		header	outer skin peeling
6	E	-	-	X									fender (north)
7	A	40	40										fender (south)
7	B	41	41				X			X		header	peeling, easy to break
7	C	41.5	41.5			X				X		header	shell peeling
7	D	41	41			X				X		header	shell peeling
7	E	-	-	X									fender (north)
8	A	39.5	40										fender (south)
8	B	41	40			X				X		header	peeling, shell
8	C	41.5	41			X				X		header	peeling outer shell
8	D	40	40			X				X		header	shell peeling
8	E	-	-	X									fender (north)

Comments: Fender piles are in good condition. Bearing piles for pier are in fair to poor condition. Recommend replacement within 2-3 years due to outer shell becoming disassociated from pile. The pile is losing it's ability to function properly. Load bearing capacity is decreasing due to section loss of pile.

Picture 1



Picture 2

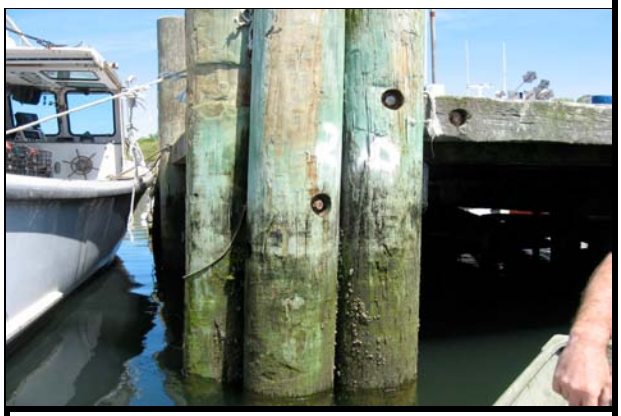
PILE INSPECTION REPORT

Location: Wychmere Harbor		Date: May 26, 2009 Page 5 of 6	
Pier Name/No. Pier Area	Pile Type _X_ Bearing __ Fender __	Pile Material _X_ Timber __ Steel __ Concrete	
Water Depth: 1-6'	Time of Day: 9:00 AM	Tide: Low (7:45 am)	Weather: Sunny 60

Bent	Pile	Dimension		Pile Condition					Type Damage			Cap	Comment
No.	No.	Low	Upp	ND	MN	MD	MJ	SV	ME	BIO	FUNC		
9	A	41.5	41	X									fender (south)
9	B	39	39			X				X		header	delamination
9	C	39	39				X			X		header	shell peeling
9	D	39	39.5			X				X		header	outer shell peeling
9	E	-	-	X									fender (north)
10	A	40.75	39.5	X									fender (south)
10	B	40	40.5			X				X		header	shell peeling
10	C	40	40			X				X		header	delamination
10	D	40.5	40.5				X			X		header	peeling
10	E	-	-	X									fender (north)
11	A	41	39.8	X									fender (south)
11	B	41	41			X				X		header	deteriorated shell
11	C	41	40.5			X				X		header	deteriorated shell
11	D	41	41			X				X		header	deteriorated shell
11	E	-	-	X									fender (north)
11	F	-	-			X				X			end pier
11	G	-	-			X				X			end pier
11	H	-	-			X				X			end pier
11	I	-	-			X				X			end pier
11	J	-	-			X				X			end pier

Comments: Piles at end section of pier are in poor condition. Major weathering and insect damage. In addition, bearing piles for pier are in poor condition.

Picture 1



Picture 2

PILE INSPECTION REPORT

Location: Wychmere Harbor			Date: May 28, 2009 Page 6 of 6
Pier Name/No. Marina Area	Pile Type _X_ Bearing __ Fender __	Pile Material _X_ Timber __ Steel __ Concrete	
Water Depth: 1-6'	Time of Day: 9:00 AM	Tide: Low (9:45 am)	Weather: Sunny 60

Bent	Pile	Dimension		Pile Condition					Type Damage			Cap	Comment
No.	No.	Low	Upp	ND	MN	MD	MJ	SV	ME	BIO	FUNC		
12	1	-	-		X						X		timber
12	2	-	-		X						X		timber
12	3	-	-		X						X		timber
12	4	39	39	X									fiberglass
13	1	39	39		X						X		fiberglass
13	2	39	39		X						X		fiberglass
13	3	39	39	X									fiberglass
13	4	39	39	X									fiberglass
13	5	39	39			X					X		abrasions
13	6	41	40.5		X						X		timber
13	7	39	39		X						X		fiberglass
13	8	39	39	X									fiberglass
14	1	39	39	X									fiberglass
14	2	39	39	X									fiberglass
14	3	39	39	X									fiberglass
14	4	39	39			X					X		abrasions from boats
14	5	39	39		X						X		fiberglass
14	6	39	39	X									fiberglass

Comments: Majority piles are pearson fiberglass piles that were recently installed. Overall in good condition with minor abrasions caused from boats. Some corrosion/rust at intertidal zone.

Picture 1

Picture 2

PIER INSPECTION REPORT

Location: Wychmere Harbor Pier		Date: May 28, 2009	
Pier Name/No.: Wychmere Harbor	JRN/KES	Bulkhead Material __ Timber __ Steel _X_ Concrete	
Water Depth 1-2'	Time of Day: 9:30 AM	Tide: 9:30 AM low	Weather: Cloudy 60

Structural Members						Condition		
Component	Size	Material	Quantity	Total Length	Spacing	Good	Fair	Poor
Header/Cap	18"x30"	Concrete	11	23'	12' O.C.			X
Planks	4'x12'x6"	Concrete	50	123'	1"	X		
X-Bracing	4x12	Timber	53	Varies	12' O.C.		X	X
Curbing	12x12"	Timber	2	123'	-	X		
Fender Piles	12" Dia	Greenheart	27	ND	-	SEE PILE INSPECTION		
Bearing Piles	12" Dia	-	33	ND	6' O.C.	SEE PILE INSPECTION		

Additional Checklist Items	Extent of Damage			
	N/A	Minimal	Moderate	Substantial
Rust stains, cracks, spalled concrete			X	
Steel reinforcement exposed			X	
Efflorescence, disintegration, loss of concrete				X
Chemical deterioration, freeze/thaw deterioration			X	
Components of system missing		X		
Alkali silica, shrinkage				

Comments: Concrete header has substantial damage at Bents 1, 3, 4, 5, 6, 7, & 11. Concrete appears to be failing at ends and around bearing piles. Some weathering and spalling present, steel reinforcements exposed with signs of rusting. Possible efflorescence and chemical deterioration due to moisture and poor cement mixtures. Cross bracing members in overall fair shape, bottom horizontal members are in need of replacement. Major sectional loss and rot present. Outer shells of bearing piles are peeling and are becoming disassociated from the pile. Overall, poor condition. Pressure treated fender piles appear to be in moderate-good condition with no major damage present. Connection of fender pile to pier is insufficient (only connected to timber curbing)

Picture 1

Picture 2

BULKHEAD INSPECTION REPORT

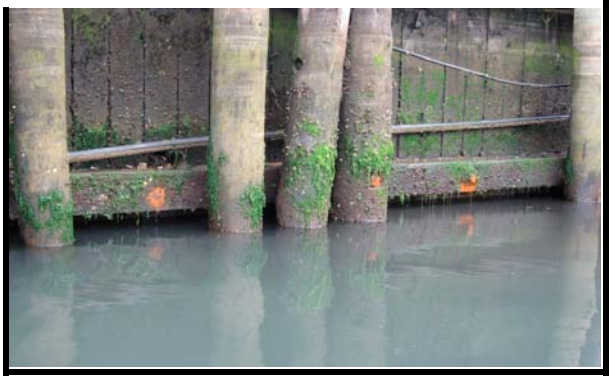
Location: Wychmere Harbor Timber Bulkhead		Date: May 26, 2009	
Pier Name/No.: Wychmere	JRN/KES	Bulkhead Material _X_ Timber __ Steel __ Concrete	
Water Depth 1-2'	Time of Day: 10:00 AM	Tide: 9:00 AM low	Weather: Sunny 70

Structural Members						Condition		
Component	Size	Depth	Material	No./Length	Spacing	Good	Fair	Poor
Sheeting	8" W	2"D	T&G Timb	91'	cont.		X	
Wale	10"	12"	Timber	2	5' vert		X	
Anchoring System	1.5"	-	Steel	11	8' O.C.			X
Cap	12"	12"	Timber	67'	cont.		X	
Fender Pilings	SEE PILE BENT 1 INSPECTION REPORT							

Additional Checklist Items	Extent of Damage			
	N/A	Minimal	Moderate	Substantial
Shifts in horizontal and vertical alignment of sheets		X		
Damage or deterioration of the sheet piling			X	
Wash-out of substrate under the sheeting at toe			X	
Signs of detrimental wave action, scouring sloughing			X	
Components of system missing	X			
Rust, corrosion, or bulging present				rust

Comments: Wall is in fair condition. Minor striations present, with few voids caused from rot or marine borers. Some deterioration seems to be caused from either birds or insects. 3" dia void between piles 5 & 6. Parking lot showing signs of slumping due to substrate loss at wall. Anchors are substantially rusted, recommend replacement. Previous fender piles have been supplemented with 12" PT pilings, new pilings are in excellent condition, however the single connection to the existing deteriorated pilings is insufficient. New piles should be connected to wall directly, independently from previous piles.

Picture 1



Picture 2

APPENDIX C

STRUCTURAL TESTING DATA

WYCHMERE HARBOR

AMERICAN PETROGRAPHIC SERVICES, INC.

REPORT OF CONCRETE TESTING

PROJECT:

WYCHMERE HARBOR
HARWICHPORT, MASSACHUSETTS

REPORTED TO:

COASTAL ENGINEERING COMPANY
260 CRANBERRY HWY.
ORLEANS, MA 02653

ATTN: DAVID MORAND

APS JOB NO: 10-05991

DATE: JUNE 30, 2009

INTRODUCTION

This report presents the results of laboratory work performed by our firm on four concrete core samples submitted to us by Mr. David Morand of Coastal Engineering Company on June 18, 2009. We understand the concrete cores were obtained from an exterior concrete wharf pier beams and planks that are currently under evaluation. The concrete was reportedly placed in 1973. The scope of our work was limited to 1) performing petrographic analysis testing on cores C-2, C-3 and C-4, and 2) documenting the chloride-ion content at various levels in all four cores.

CONCLUSIONS

Based on our observations, test results, and past experience, our conclusions are as follows:

1. The overall quality of the concrete was poor (C-2 and C-3) to good (C-4). The cement paste was moderately soft and porous with carbonation up to 5/16". The alluvial gravel aggregate was hard, sound, and durable. The concrete exhibited evidence of retempering and was placed with a moderate slump.

2. The concrete in cores C-2 and C-3 have poor durability. The concrete contained an air void system that is not consistent with current technology for resistance to freeze-thaw deterioration. We expect deterioration to continue in the carbonated surficial paste if exposed to freezing conditions when saturated.

3. Corrosion conditions are developed in all four cores tested. We measured chloride-ion content levels ranging from 105 to 3140 ppm.

SAMPLE IDENTIFICATION

Sample Number:	C-1	C-2	C-3	C-4
Sample Type:	Hardened Concrete Core			
Original Sample Dimensions, in:	95 mm (3-3/4") diameter x 104 mm (4-1/8") long	99 mm (3-7/8") diameter x 208 mm (8-3/16") long	99 mm (3-7/8") diameter x 187 mm (7-3/8") long	99 mm (3-7/8") diameter x 208 mm (8-3/16") long

TEST RESULTS

Our complete petrographic analysis test results appear on the attached sheets entitled 00 LAB 001 "Petrographic Examination of Hardened Concrete, ASTM:C856." A brief summary of the general concrete properties is as follows:

1. The coarse aggregate in the cores was comprised of 3/4 to 1" maximum sized alluvial gravel that was fairly well graded with good overall uniform distribution.

2. Pozzolanic admixtures were not observed in the concrete samples.

3. The paste color in the cores was light to medium gray with the slump estimated to be medium (3 to 5").

4. The paste hardness of the cores was judged to be medium with the paste/aggregate bond considered fair.

5. The depth of carbonation was up to 5/16".

6. The water/cement ratio of the cores was estimated at between 0.42 to 0.48 with approximately 2-5% unhydrated cement particles.

Air Content Testing

Sample Identification:	C-2	C-3	C-4
Total Air Analysis -			
Air Void Content, %	4.0	3.1	3.8
Spacing Factor, in	0.009	0.009	0.005
Entrapped Air (%)	1.8	1.3	0.6
Entrained Air (%)	2.2	1.8	3.2

Chloride-ion Content Testing

Sample Number	Parts Per Million	Cl^- lbs/yd^3**
C1 (1.00"-2.00")	370	1.4
C1 (3.00"-4.00")	105	0.4
C2 (1.00"-2.00")	1645	6.4
C2 (3.00"-4.00")	825	3.2
C3 (1.00"-2.00")	3140	12.2
C3 (3.00"-4.00")	2760	10.7
C4 (1.00"-2.00")	975	3.8
C4 (3.00"-4.00")	215	0.8

**Calculations based on a 3870 lb. unit weight

TEST PROCEDURES

Laboratory testing was performed on June 18, 2009, and subsequent dates. Our procedures were as follows:

Petrographic Analysis

A petrographic analysis was performed in accordance with APS Standard Operating Procedure 00 LAB 001, "Petrographic Examination of Hardened Concrete," ASTM:C856-latest revision. The petrographic analysis consisted of reviewing cement paste and aggregate qualities on a whole basis as well as on a cut/polished section. The depth of carbonation was documented using a phenolphthalein indicator solution applied on a freshly cut and polished surface of the concrete sample. The water/cement ratio of the concrete was estimated by viewing a thin section of the concrete under an Olympus BH-2 polarizing microscope at magnification up to 1000x. Thin section analysis was performed in accordance with APS Standard Operating Procedure 00 LAB 013, "Determining the Water/Cement of Portland Cement Concrete, APS Method." The samples are first highly polished, then epoxied to a glass slide. The excess sample is cut from the glass and the slide is polished until the concrete reaches 25 microns or less in thickness.

Air Content Testing

Air content testing was performed using APS Standard Operating Procedure 00 LAB 003, "Microscopical Determination of Air Void Content and Parameters of the Air Void System in Hardened Concrete, ASTM:C457-latest revision." The linear traverse method was used. The concrete cores were cut perpendicular with respect to the horizontal plane of the concrete as placed and then polished prior to testing.

Chloride-ion Content Testing

We obtained a 3-gram pulverized portion of each sample either by crushing a dry saw-cut piece or by use of an impact drill. We then mix the powder with 20 ml of digestion solution for a total of 3 minutes and then added 80 ml of stabilizing solution. We then immersed a calibrated electrode coupled to an Orion Model 720 pH/ISE meter in the solution and recorded the chloride-ion concentration. This method is consistent with APS Standard Operating Procedure 00 LAB 017, "Sampling and Testing for Chloride-Ion in Concrete and Concrete Raw Materials, AASHTO:T260 - Procedure C."

By testing six pulverized concrete QA samples of known chloride content, we were able to determine the standard deviation for this chloride test. Each QA sample was tested five times and the following standard deviation ranges were calculated. Samples with chloride levels from 80-200 ppm have a STD = 14 ppm, 201-450 ppm STD = 21 ppm, 451-950 ppm STD= 54 ppm, 951-2000 ppm STD=117 ppm, 2001-4000 ppm STD=413 ppm and 4001-6000 ppm STD=737 ppm. Results that are <80 ppm or >6000 ppm are reported as such due to the high magnitude of the standard deviation in both cases.

REMARKS

The test samples will be retained for a period of at least thirty days from the date of this report. Unless further instructions are received by that time, the samples may be discarded. Test results relate only to the items tested. No warranty, express or implied, is made.

Report Prepared By:
American Petrographic Services, Inc.

Scott F. Wolter, P.G.
President
MN License No. 30024

Richard D. Stehly, P.E., FACI
MN License No. 12856

00 LAB 001 Petrographic Examination of Hardened Concrete
ASTM: C-856

Job No.	10-05991	Date:	6-25-2009/6-30-2009
Sample Identification:	C2	Performed by:	K. Borup/S. Malecha

I. General Observations

1. Sample Dimensions: Our analysis was performed on a 205 mm (8-1/16") x 99 mm (3-7/8") x 41 mm (1-5/8") thick polished section that was cut from the original 99 mm (3-7/8") diameter x 208 mm (8-3/16") long core.

2. Surface Conditions:
   Outer: Fairly smooth, formed surface; placed on form
   Inner: Rough, irregular, fractured surface

3. Reinforcement: A 13 mm (1/2") diameter rebar was observed approximately 86 mm (3-3/8") depth from the outer surface, and a 19 mm (3/4") diameter rebar was observed at approximately 106 mm (4-3/16") depth from the outer surface. No corrosion observed.

4. General Physical Conditions: A white, secondary calcite deposit, up to approximately 1 mm (1-5/8") thick, was observed partially covering the outer surface. A fracture, oriented sub-parallel to the outer surface, was observed proceeding across the entire diameter of the core between approximately 19 mm (3/4") and (1-1/4") depth from the outer surface. The fracture proceeds around most coarse aggregate particles. Many microcracks were present. Carbonation proceeds up to 1 mm (1/32") depth. The concrete contains purposeful air entrainment with a fairly well distributed air void system. Darker, denser, areas of paste were observed within the recesses of a few coarse aggregate notches. White ettringite was observed. No evidence of active alkali silica reaction observed. Poor overall condition.

II. Aggregate

1. Coarse: 19 mm (3/4") maximum sized gravel consisting of granite, gabbro, quartz and shale. The coarse aggregate was mostly sub-rounded with a few sub-angular particles. Fairly well graded with good overall uniform distribution.

2. Fine: Quartz sand with many lithic and several shale particles that was fairly well graded. The grains were mostly sub-angular with several sub-rounded and angular particles. Good overall uniform distribution.

III. Paste

1.	Air Content:	4.0% total
2.	Paste proportions:	24% to 26%
3.	Depth of carbonation:	Occurs intermittently up to 1 mm (1/32") depth from the outer surface
4.	Pozzolan/Slag presence:	None observed
5.	Paste/aggregate bond:	Fair
6.	Paste color:	Medium gray becoming medium tan within the carbonated top up to approximately 1 mm (1/32") of the sample
7.	Paste hardness:	Medium, becoming hard within the carbonated area
8.	Microcracking:	Many microcracks, oriented sub-parallel to the outer surface, were observed within the outer approximately (1-5/8") of the sample. A few other microcracks, oriented predominately sub-parallel to the outer surface, were observed scattered throughout the paste at various depths. Microcracking proceeds around most of the coarse aggregate particles and through a few fine aggregate particles.
9.	Secondary deposits:	White, acicular ettringite was observed thinly lining to partially filling several entrained sized air voids throughout the paste
10.	Slump:	Estimated, medium (3 to 5")
11.	Water/cement ratio:	Estimated at between 0.43 to 0.48 with approximately 3-5% unhydrated or residual portland cement clinker particles.
12.	Cement hydration:	Alites-fully; Belites-negligible to low

IV. Conclusions

The general overall quality of the concrete was poor.

00 LAB 001 Petrographic Examination of Hardened Concrete
ASTM: C-856

Job No.	10-05991	Date:	6-29-2009/6-30-2009
Sample Identification:	C3	Performed by:	K. Borup/S. Malecha

I. General Observations

1. Sample Dimensions: Our analysis was performed on a 184 mm (7-1/4") x 99 mm (3-7/8") x 44 mm (1-3/4") thick polished section that was cut from the original 99 mm (3-7/8") diameter x 187 mm (7-3/8") long core.

2. Surface Conditions:
   Outer: Fairly smooth, formed surface; placed on form
   Inner: Rough, irregular, fractured surface

3. Reinforcement: A 13 mm (1/2") diameter rebar was observed approximately 116 mm (4-9/16") depth from the outer surface and a 19 mm (3/4") diameter rebar was observed at approximately 116 mm (4-9/16") depth from the outer surface. Minor corrosion was observed. Also, a 13 mm (1/2") diameter rebar impression was observed at 89 mm (3-1/2") depth from the outer surface. No corrosion product observed.

4. General Physical Conditions: The sample was fractured, predominately oriented sub-parallel to the outer surface, between approximately 24 mm (15/16") and 32 mm (1-1/4") depth and multiple fractures below approximately 89 mm (3-1/2") depth from the outer surface. The fractures proceed through a few coarse aggregate particles. Numerous microcracks were present. Carbonation proceeds up to 8 mm (5/16") depth. White ettringite was observed. The concrete appears to contain purposeful air entrainment, but the air system has been compromised by secondary ettringite. No evidence of active alkali silica reaction observed. Poor overall condition.

II. Aggregate

1. Coarse: 25 mm (1") maximum sized gravel consisting of granite, siltstone and basalt. The coarse aggregate was mostly sub-rounded with several sub-angular particles. Fairly well graded with good overall uniform distribution.

2. Fine: Quartz feldspar and lithic sand that was fairly well graded. The grains were mostly sub-angular with several sub-rounded and angular particles. Good uniform distribution.

III. Paste

1.	Air Content:	3.1% total
2.	Paste proportions:	23% to 25%
3.	Depth of carbonation:	Ranged from negligible up to 8 mm (5/16") depth from the outer surface
4.	Pozzolan/Slag presence:	None observed
5.	Paste/aggregate bond:	Fair
6.	Paste color:	Medium gray becoming medium tan within the carbonated outer up to 8 mm (5/16") of the sample
7.	Paste hardness:	Medium soft
8.	Microcracking:	Numerous microcracks, predominately oriented sub-parallel to the outer surface, were observed at various depths throughout the sample. The microcracking proceeds around most of the coarse aggregate particles and through a few fine aggregate particles.
9.	Secondary deposits:	White, acicular ettringite was observed lining to filling several air voids throughout the paste
10.	Slump:	Estimated, medium (3 to 5")
11.	Water/cement ratio:	Estimated at between 0.42 to 0.47 with approximately 3-5% unhydrated or residual portland cement clinker particles.
12.	Cement hydration:	Alites-fully; Belites-negligible to low

IV. Conclusions

The general overall quality of the concrete was poor.

00 LAB 001 Petrographic Examination of Hardened Concrete
ASTM: C-856

Job No.	10-05991	Date:	6-26-2009/7-2-2009
Sample Identification:	C4	Performed by:	K. Borup/S. Malecha

I. General Observations

1. Sample Dimensions: Our analysis was performed on a 208 mm (8-3/16") x 99 mm (3-7/8") x 44 mm (1-3/4") thick polished section that was cut from the original 99 mm (3-7/8") diameter x 208 mm (8-3/16") long core.

2. Surface Conditions:
   Outer: Rough, mortar eroded surface
   Inner: Smooth, formed surface; placed on form

3. Reinforcement: A 13 mm (1/2") diameter impression was observed approximately 86 mm (3-3/8") depth from the outer surface. Minor corrosion product observed.

4. General Physical Conditions: The outer surface was mortar eroded exposing many coarse aggregate particles. The sample was fractured, oriented sub-parallel to the outer surface, between 86 mm (3-3/8") and 94 mm (3-11/16") depth from the outer surface. Several microcracks were present. Carbonation proceeds up to 6 mm (1/4") depth. The concrete contains purposeful air entrainment with a fairly well distributed air void system. Darker, denser, areas of paste were observed within the recesses of a few coarse aggregate notches. Evidence of active alkali silica reaction observed. Fair to good overall condition.

II. Aggregate

1. Coarse: 19 mm (3/4") maximum sized crushed igneous rock consisting of granite, gabbro and diorite. The coarse aggregate was mostly sub-angular with several sub-rounded particles. Fairly well graded with good overall uniform distribution.

2. Fine: Quartz, feldspar, and lithic sand that was fairly well graded. The grains were mostly sub-angular with many angular particles. Good overall uniform distribution.

III. Paste

1.	Air Content:	3.2% total
2.	Paste proportions:	27% to 29%
3.	Depth of carbonation:	Ranged from negligible up to 6 mm (1/4") depth from the outer surface along microcracking
4.	Pozzolan/Slag presence:	None observed
5.	Paste/aggregate bond:	Fair
6.	Paste color:	Light gray, becoming light tan within the carbonated area, and becoming mottled light tan to dark gray within the inner approximately 4 mm (5/32") of the sample
7.	Paste hardness:	Medium, becoming hard within the carbonated area, as well as the inner approximately 4 mm (5/32") of the sample
8.	Microcracking:	A few microcracks, oriented sub-perpendicular to the outer surface, proceed up to 5 mm (3/16") depth from the outer surface. Also, a few microcracks, oriented sub-perpendicular to the inner surface, proceed up to approximately 4 mm (5/32") depth from the inner surface. Many microcracks were observed scattered throughout the paste at various depths and orientations in a shrinkage type pattern.
9.	Secondary deposits:	White, acicular ettringite was observed lining to partially filling a few air voids within the inner approximately 5 mm (3/16") of the sample. White, alkali silica gel was observed thinly lining an air void within the inner approximately 2 mm (1/16") of the sample.
10.	Slump:	Estimated, medium (3 to 5")
11.	Water/cement ratio:	Estimated at between 0.43 to 0.48 with approximately 2-4% unhydrated or residual portland cement clinker particles.
12.	Cement hydration:	Alites-fully; Belites-negligible to low

IV. Conclusions

The general overall quality of the concrete was good.

American Petrographic Services, Inc.

AIR VOID ANALYSIS

PROJECT:
WYCHMERE HARBOR
HARWICHPORT, MA

REPORTED TO:
COASTAL ENGINEERING COMPANY, INC
260 CRANBERRY HWY
ORLEANS, MA 02653

ATTN: DAVID MORAND
APS JOB NO:10-05991
DATE: JUNE 29, 2009

Sample ID: C2

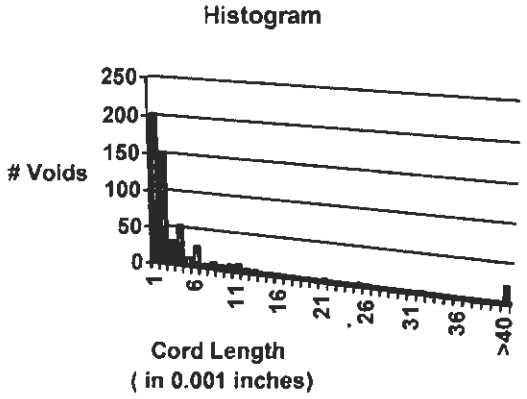
Conformance: The sample contains an air void system which is not consistent with current technology for freeze-thaw resistance.

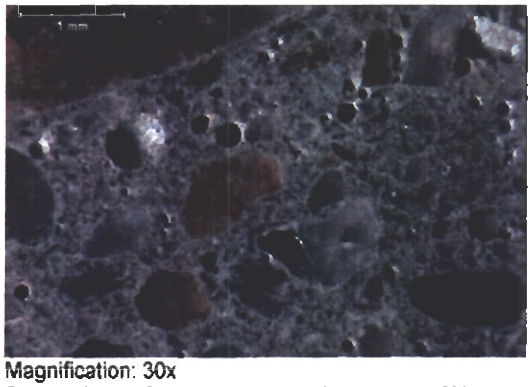
Sample Data:

Description: Hardened Concrete Core
Dimensions: 99 mm (3-7/8") diameter x 208 mm (8-3/16") long

Test Data: ASTM:C457 Linear Traverse Method, APS SOP 00LAB003 and ACI 116R

Air Void Content %	4.0
Entrained, % ≤ 0.040"	2.2
Entrapped, %> 0.040"	1.8
Air Voids/inch	6.16
Specific Surface, in2/in3	620
Spacing Factor, inches	0.009
Paste Content, % estimated	26.0
Magnification	50x
Traverse Length, inches	90
Test Date	06/25/2009





Magnification: 30x
Description: Overall hardened air content, 4.0% total

American Petrographic Services, Inc.

AIR VOID ANALYSIS

PROJECT:
WYCHMERE HARBOR
HARWICHPORT, MA

REPORTED TO:
COASTAL ENGINEERING COMPANY, INC
260 CRANBERRY HWY
ORLEANS, MA 02653

ATTN: DAVID MORAND
APS JOB NO:10-05991
DATE: JUNE 29, 2009

Sample ID: C3

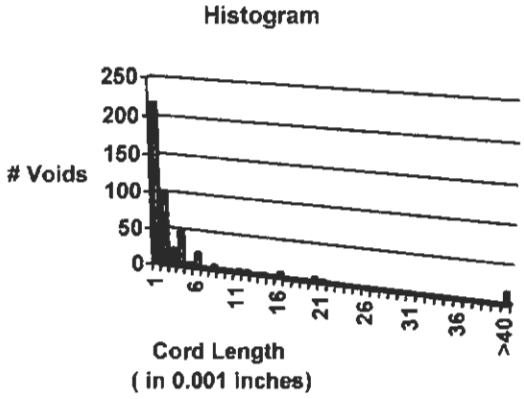
Conformance: The sample contains an air void system which is not consistent with current technology for freeze-thaw resistance.

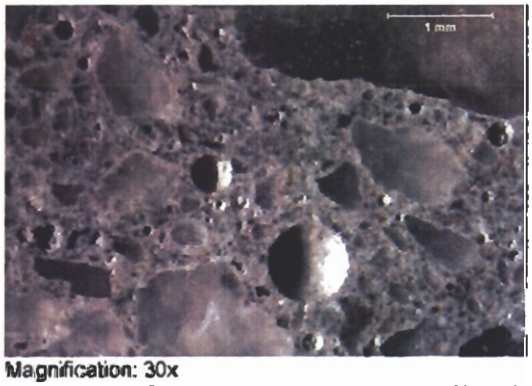
Sample Data:

Description: Hardened Concrete Core
Dimensions: 99 mm (3-7/8") diameter x 187 mm (7-3/8") long

Test Data: ASTM:C457 Linear Traverse Method, APS SOP 00LAB003 and ACI 116R

Air Void Content %	3.1
Entrained, % ≤ 0.040"	1.8
Entrapped, %> 0.040"	1.3
Air Voids/inch	5.06
Specific Surface, in2/in3	660
Spacing Factor, inches	0.009
Paste Content, % estimated	25.0
Magnification	50x
Traverse Length, inches	96
Test Date	06/29/2009





Magnification: 30x
Description: Overall hardened air content, 3.1% total

American Petrographic Services, Inc.

AIR VOID ANALYSIS

PROJECT:
WYCHMERE HARBOR
HARWICHPORT, MA

REPORTED TO:
COASTAL ENGINEERING COMPANY, INC
260 CRANBERRY HWY
ORLEANS, MA 02653

ATTN: DAVID MORAND
APS JOB NO:10-05991
DATE: JUNE 29, 2009

Sample ID: C-4

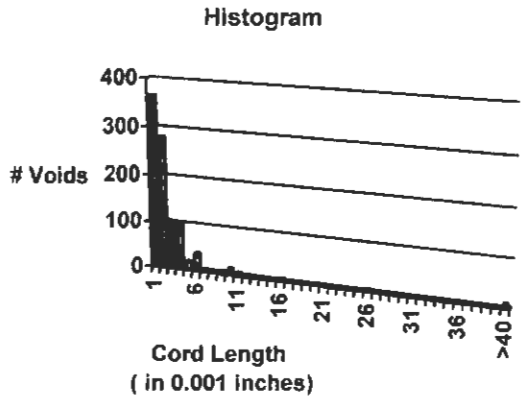
Conformance: The sample contains an air void system which is consistent with current technology for freeze-thaw resistance.

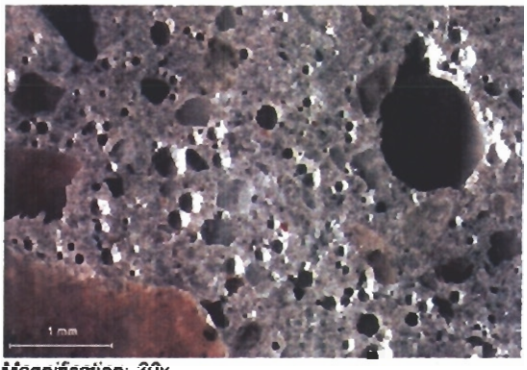
Sample Data:

Description: Hardened Concrete Core
Dimensions: 99 mm (3-7/8") diameter x 208 mm (8-3/16") long

Test Data: ASTM:C457 Linear Traverse Method, APS SOP 00LAB003 and ACI 116R

Air Void Content %	3.8
Entrained, % ≤ 0.040"	3.2
Entrapped, %> 0.040"	0.6
Air Voids/inch	10.80
Specific Surface, in2/in3	1130
Spacing Factor, inches	0.005
Paste Content, % estimated	27.0
Magnification	50x
Traverse Length, inches	90
Test Date	06/26/2009





Magnification: 30x
Description: Overall hardened air content, 3.8% total

APS #: 10-05991 **DATE:** JUNE 29, 2009
PROJECT: WYCHMERE HARBOR, HARWICHPORT, MA

SAMPLE ID: C1, C2, C3 and C4 **DESCRIPTION:** Samples as received.

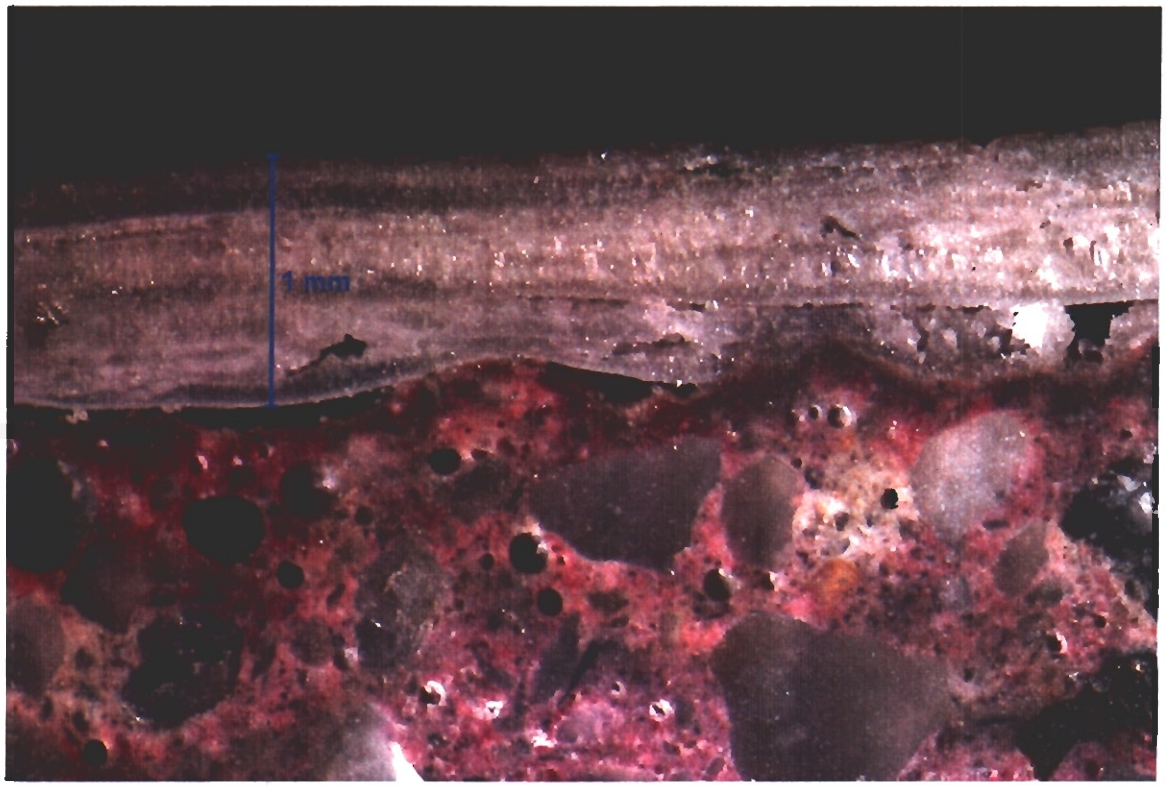
SAMPLE ID: C2 **DESCRIPTION:** Outer surface of sample as received

APS #: 10-05991 **DATE:** JUNE 29, 2009
PROJECT: WYCHMERE HARBOR, HARWICHPORT, MA

SAMPLE ID: C3 **DESCRIPTION:** Outer surface of sample as received.

SAMPLE ID: C4 **DESCRIPTION:** Outer surface of sample as received.

APS #: 10-05991 **DATE:** JUNE 29, 2009
PROJECT: WYCHMERE HARBOR, HARWICHPORT, MA



SAMPLE ID: C2 **DESCRIPTION:** Secondary calcite deposit on the outer surface of the sample.
MAG: 30x

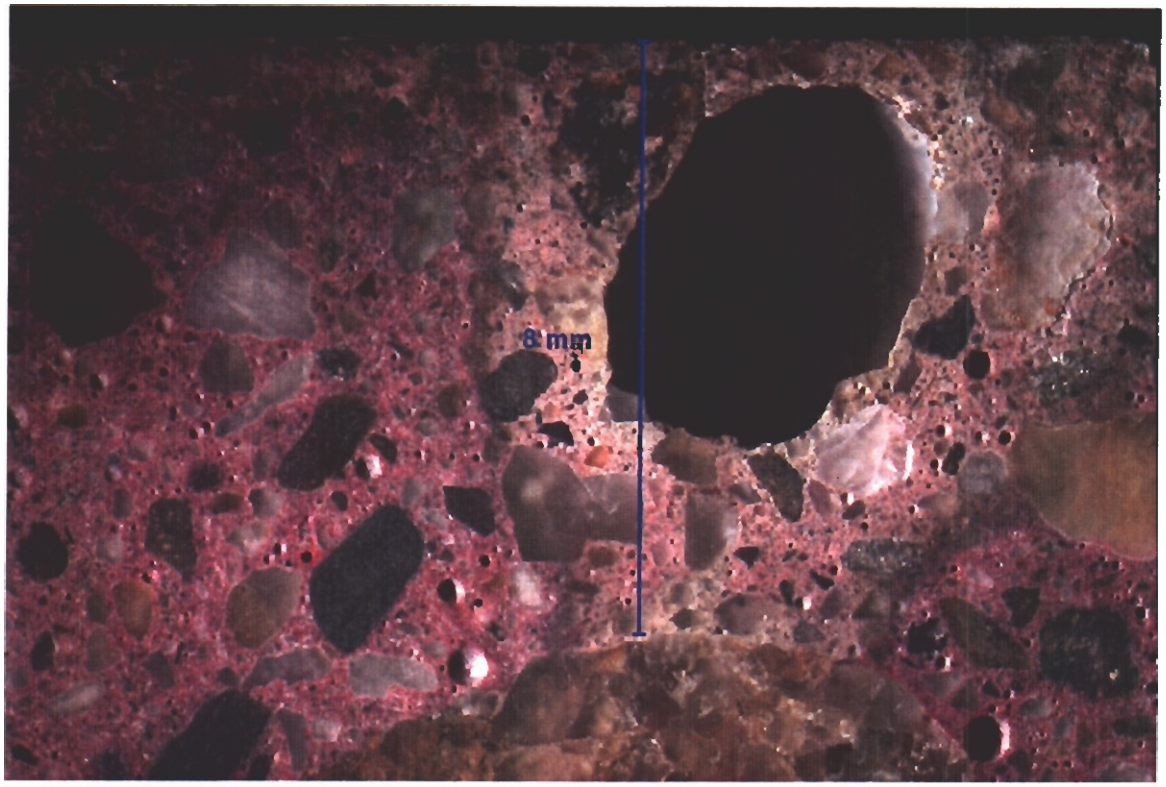
SAMPLE ID: C2 **DESCRIPTION:** Microcracking (mapped in red) across one half of the cut and polished cross section of concrete.

APS #: 10-05991 **DATE:** JUNE 29, 2009
PROJECT: WYCHMERE HARBOR, HARWICHPORT, MA

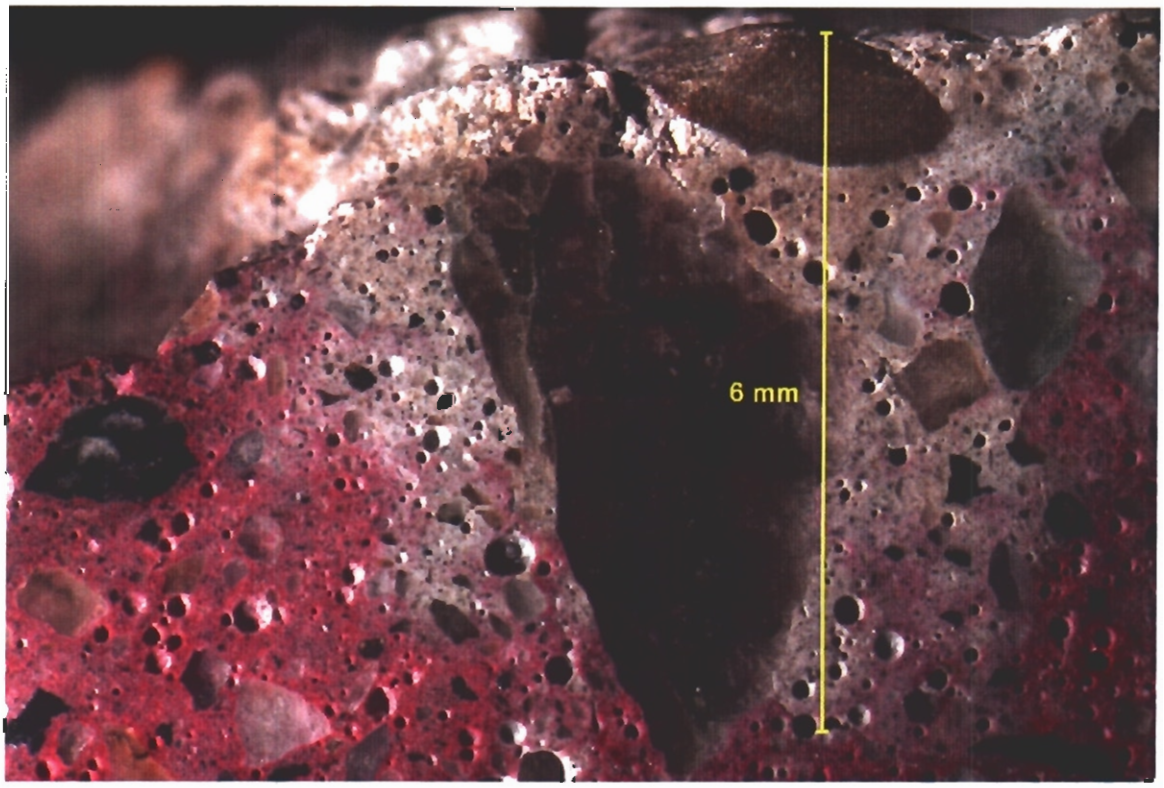
SAMPLE ID: C3 **DESCRIPTION:** Microcracking (mapped in red) across one half of the cut and polished cross section of concrete. Note the fractures orientated sub-parallel to the outer surface of the sample.

SAMPLE ID: C2 **DESCRIPTION:** Carbonation (unstained) proceeds up to 3 mm (1/8") depth from the outer surface.
MAG: 30x

APS #: 10-05991 **DATE:** JUNE 29, 2009
PROJECT: WYCHMERE HARBOR, HARWICHPORT, MA

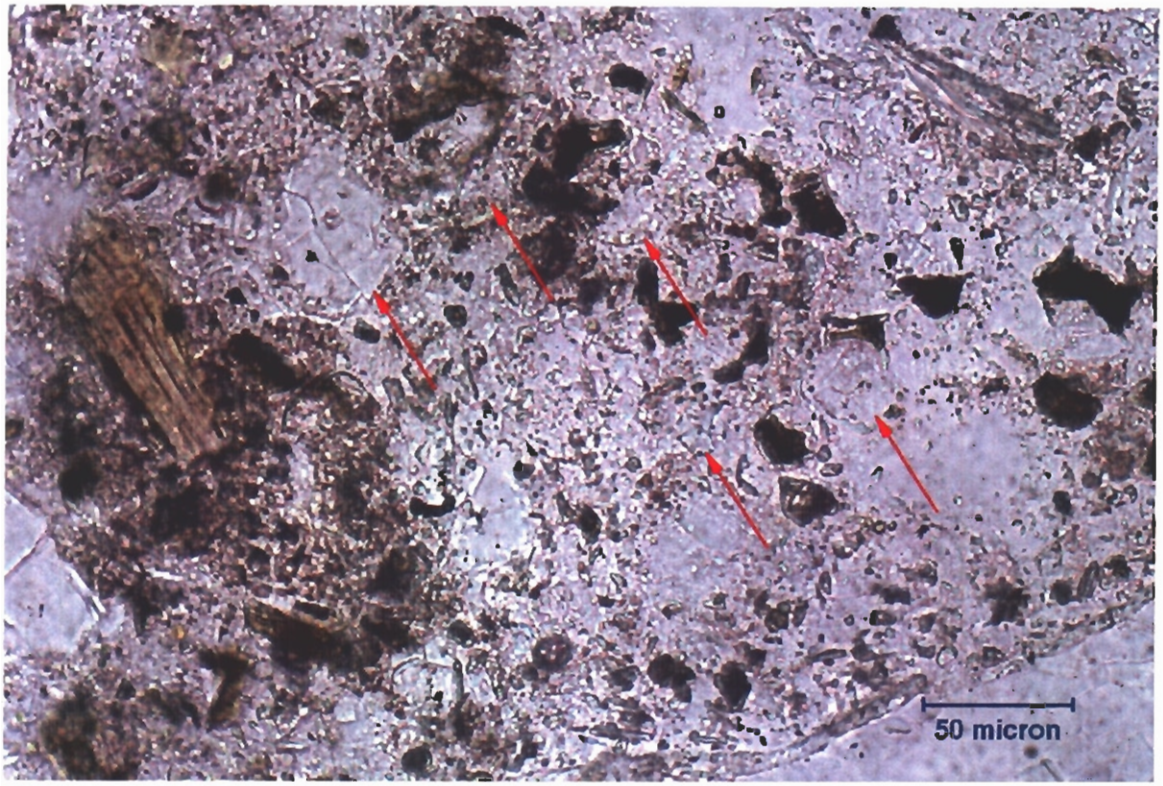


SAMPLE ID: C3
MAG: 10x
DESCRIPTION: Carbonation (unstained) proceeds up to 8 mm (5/16") depth from the outer surface.



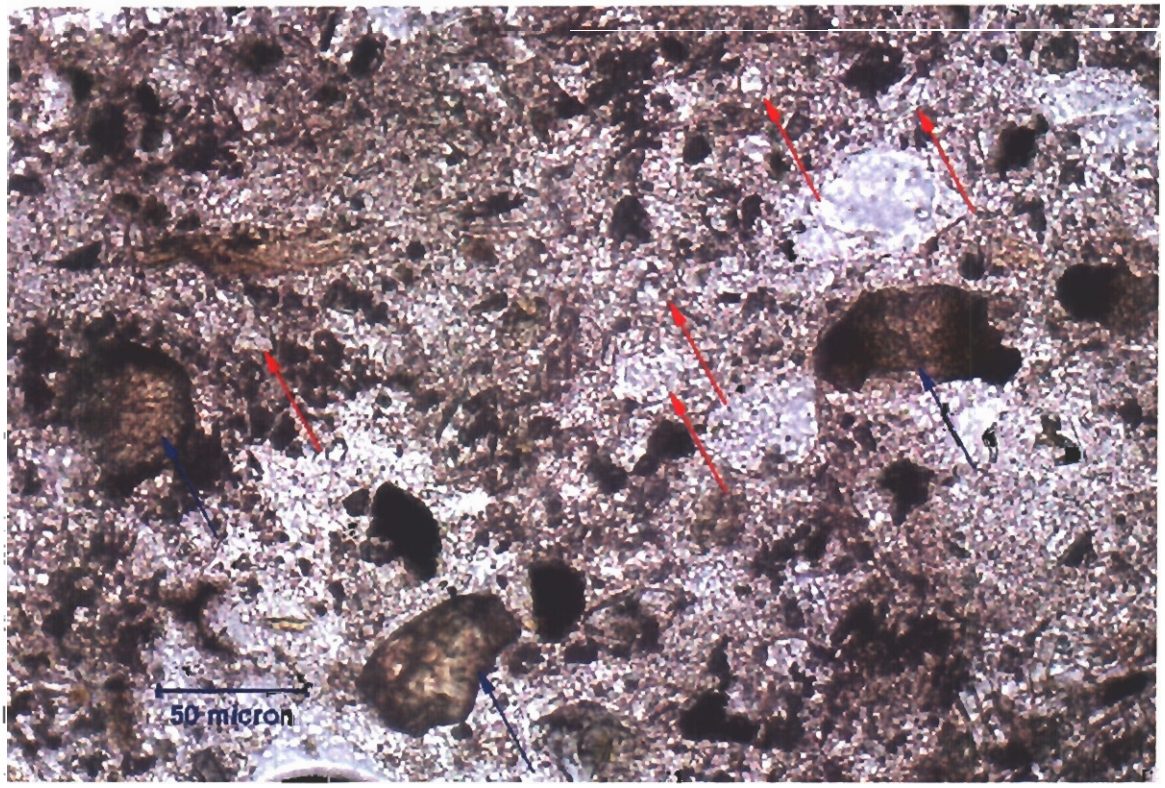
SAMPLE ID: C4
MAG: 15x
DESCRIPTION: Carbonation (unstained) proceeds up to 6 mm (1/8") depth from the outer surface.

APS #: 10-05991 **DATE:** JUNE 29, 2009
PROJECT: WYCHMERE HARBOR, HARWICHPORT, MA



SAMPLE ID: C3
MAG: 400x

DESCRIPTION: Mostly fully hydrated alite portland cement clinker particles (red arrows) in thin section of the cement paste under plane polarized light.



SAMPLE ID: C4
MAG: 400x

DESCRIPTION: Mostly fully hydrated alite portland cement clinker particles (red arrows) and poorly hydrated belite particles (blue) in thin section of the cement paste under plane polarized light.

APPENDIX D

REFERENCES

References

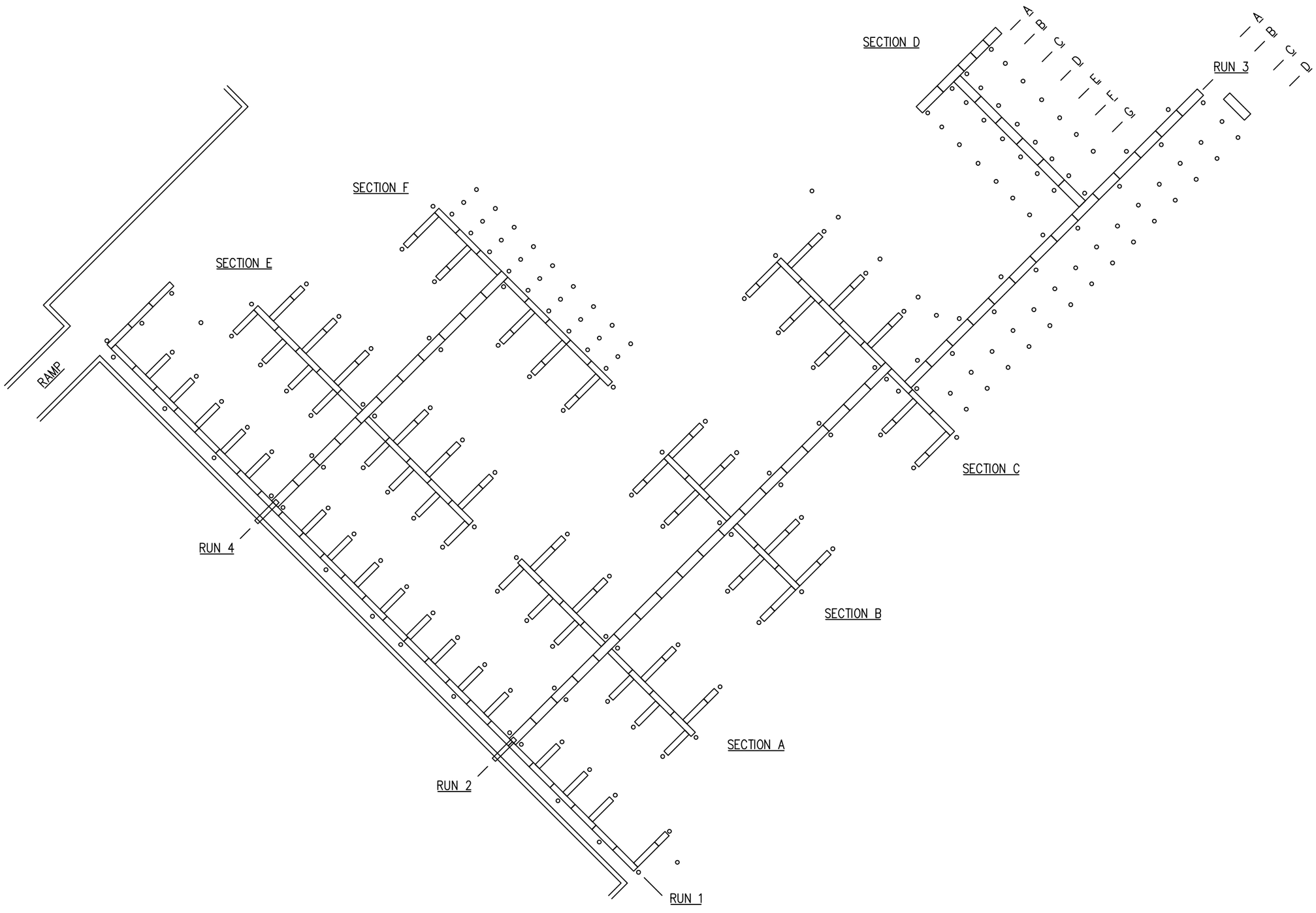
- http://threeharbors.com/main6.html

- *Unified Facilities Criteria (UFC), Maintenance of Waterfront Facilities*. U.S. Army Corps of Engineers

- *Controlling Decay in Waterfront Structures.* Evaluation, Prevention, and Remedial Treatments. Terry L. Highley and Theodore Scheffer,United States Department of Agriculture

APPENDIX E

LOCUS PLANS



COASTAL ENGINEERING COMPANY, INC.
260 Cranberry Hwy. Orleans, MA 02653
508.255.6511 Fax: 508.255.6700

NO.	DATE	REVISION	BY

SEAL

PROJECT
SAQUATUCKET HARBOR
HARWICH, MA

SHEET TITLE
PLAN SHOWING
APPROXIMATE MARINA REPRESENTATION

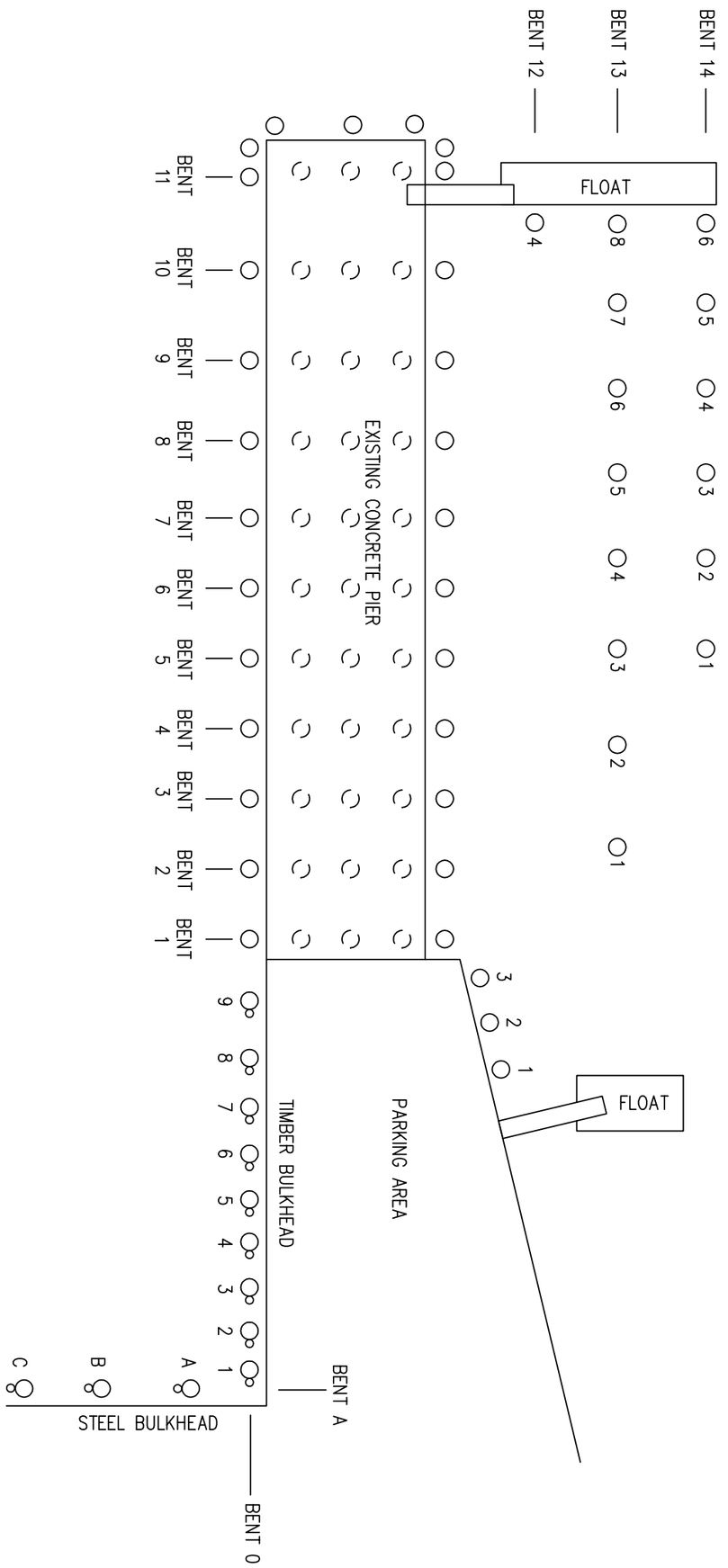
SCALE	AS NOTED
DRAWING FILE	C17209.dwg
DATE	7-30-09
DRAWN BY	JRN
CHECKED BY	

SKC-1

_ OF _ SHEETS

PROJECT NO. C17209.00

D:\DOCS\C17209\17209HARWICH HARBOR\SKC1.dwg Aug 18, 2009 - 12:23pm



C17209.dwg
DRAWN BY: JRN

COASTAL ENGINEERING COMPANY, INC.
260 Cranberry Hwy. Orleans, MA 02653
508.255.6511 Fax: 508.255.6700

PROJECT

WYCHMERE HARBOR

PLAN SHOWING EXISTING SITE CONDITIONS

ADDRESS HARWICH, MA

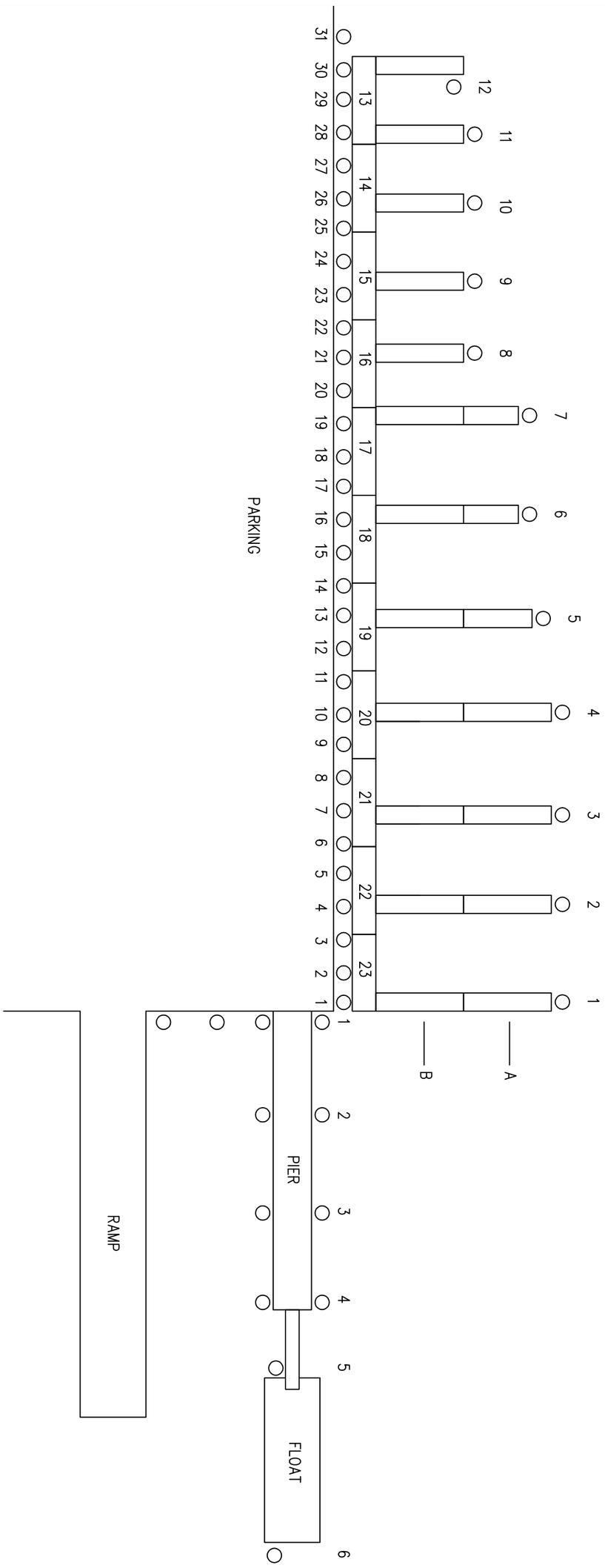
SHEET NO. SKC-2

PROJECT NO. C17209.00

SCALE AS NOTED

DATE 8-12-09

D:\DOC\C17200\17209\HARWICH HARBORS.dwg Aug 18, 2009 - 12:29pm



C17209.dwg
DRAWN BY: JRN

COASTAL ENGINEERING COMPANY, INC.
260 Cranberry Hwy. Orleans, MA 02653
508.255.6511 Fax: 508.255.6700

PROJECT

ALLEN HARBOR

PLAN SHOWING EXISTING SITE CONDITIONS

ADDRESS HARWICH, MA

SHEET NO. SKC-3

PROJECT NO. C17209.00

SCALE AS NOTED

DATE 8-12-09

APPENDIX F

COST ESTIMATE SPREADSHEET

Projected Cost Estimate Town of Harwich Harbors and Marine Fac. July 21, 2009 REO/JRN	Bulkhead		Boat Ramp		Pier**		Buildings***			
	TOTAL BULKHEAD	TOTAL + 30 PERCENT*	TOTAL BOAT RAMP	TOTAL + 30 PERCENT*	TOTAL PIER	TOTAL + 30 PERCENT*	TOTAL (PARKING/ BUILDING)	TOTAL + 30 PERCENT*		GRAND TOTALS WITH CONTINGENCY	
Year 2011											
Saquatucket East											
Saquatucket North/West											
Wychmere Harbor											
Allen Harbor	$15,040	**$19,552**					$84,000	**$109,200**		**$128,752**	
Round Cove											
Herring River											
Herring River Lower					$34,260	**$44,538**				**$44,538**	
TOTALS	**$15,040**	**$19,552**			**$34,260**	**$44,538**	**$84,000**	**$109,200**		**$173,290**	**YEAR 2011 TOTAL**
Year 2012											
Saquatucket East	$232,860	**$302,718**								**$302,718**	
Saquatucket North/West											
Wychmere Harbor							$84,000	**$109,200**		**$109,200**	
Allen Harbor											
Round Cove											
Herring River					$3,000	**$3,900**				**$3,900**	
Herring River Lower											
TOTALS	**$232,860**	**$302,718**			**$3,000**	**$3,900**	**$84,000**	**$109,200**		**$415,818**	**YEAR 2012 TOTAL**
Year 2013											
Saquatucket East											
Saquatucket North/West											
Wychmere Harbor	$132,660	**$172,458**			$800,000	**$1,040,000**				**$1,212,458**	
Allen Harbor											
Round Cove											
Herring River											
Herring River Lower											
TOTALS	**$132,660**	**$172,458**			**$800,000**	**$1,040,000**	**$1,500**	**$1,950**		**$1,214,408**	**YEAR 2013 TOTAL**
Year 2014											
Saquatucket East											
Saquatucket North/West											
Wychmere Harbor											
Allen Harbor	$162,200	**$210,860**								**$210,860**	
Round Cove											
Herring River											
Herring River Lower											
TOTALS	**$162,200**	**$210,860**								**$210,860**	**YEAR 2014 TOTAL**
Year 2015											
Saquatucket East											
Saquatucket North/West											
Wychmere Harbor											
Allen Harbor					$28,200	**$36,660**				**$36,660**	
Round Cove											
Herring River											
Herring River Lower											
TOTALS					**$28,200**	**$36,660**				**$36,660**	**YEAR 2015 TOTAL**
Year 2016											
Saquatucket East							$10,000	**$13,000**		**$13,000**	
Saquatucket North/West	$534,050	**$694,265**								**$694,265**	
Wychmere Harbor											
Allen Harbor											
Round Cove											
Herring River											
Herring River Lower											
TOTALS	**$534,050**	**$694,265**					**$10,000**	**$13,000**		**$707,265**	**YEAR 2016 TOTAL**
Year 2017											
Saquatucket East					$1,200,000	**$1,560,000**				**$1,560,000**	
Saquatucket North/West											
Wychmere Harbor											
Allen Harbor											
Round Cove											
Herring River											
Herring River Lower											
TOTALS					**$1,200,000**	**$1,560,000**				**$1,560,000**	**YEAR 2017 TOTAL**
Year 2018 +											
Saquatucket East			$10,000	**$13,000**			$21,000	**$27,300**		**$40,300**	
Saquatucket North/West					$1,200,000	**$1,560,000**				**$1,560,000**	
Wychmere Harbor							$241,750	**$314,275**		**$314,275**	
Allen Harbor			$217,000	**$282,100**	$24,210	**$31,473**	$330,500	**$429,650**		**$743,223**	
Round Cove	$171,940	**$223,522**	$90,000	**$117,000**	$7,000	**$9,100**	$117,300	**$152,490**		**$502,112**	
Herring River			$139,600	**$181,480**			$133,300	**$173,290**		**$354,770**	
Herring River Lower					$10,000	**$13,000**				**$13,000**	
TOTALS	**$171,940**	**$223,522**	**$456,600**	**$593,580**	**$1,241,210**	**$1,613,573**	**$843,850**	**$1,097,005**		**$3,527,680**	**YEAR 2018 + TOTAL**
GRAND TOTAL	**$1,248,750**	**$1,623,375**	**$456,600**	**$593,580**	**$3,306,670**	**$4,298,671**	**$1,023,350**	**$1,330,355**		**$7,845,981**	**GRAND TOTAL**

* 30% CONTINGENCY FOR ENGINEERING AND PERMITTING
** PIER DESIGNATION INCLUDES FLOATS, PILES, STRUCTURAL MEMBERS AND HARDWARE
*** BUILDINGS DESIGNATION INCLUDES PARKING AND DRAINAGE UPGRADES