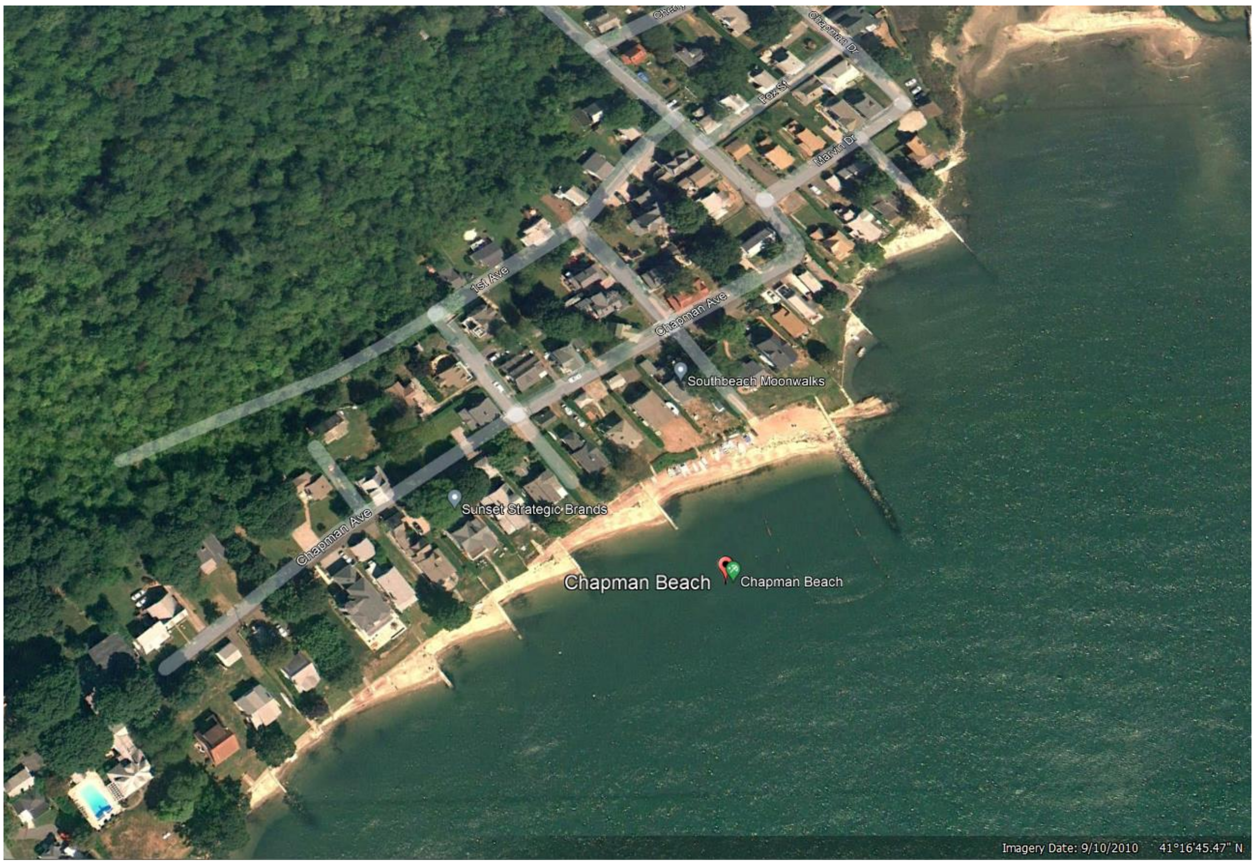
On the Advisability of Removing Groin C and Groin E

Chapman Beach, Westbrook, Connecticut



W. Frank Bohlen
Mystic, Connecticut

November 27, 2023

Executive Summary

A variety of studies and direct observations have shown that Chapman Beach, in common with much of the Connecticut shoreline, is subject to continuing erosion due to an excess of transport energy relative to available sediment supply. This process is dominated by surface wind waves in combination with tidal currents , wind, and the progressive rise of mean sea level. In an effort to reduce this erosion and to extend the utility of the sand margin as recreational beach and shore protection structure an array of discrete shore perpendicular structures, or groins (termed jetties), were placed along the beach many years ago. These structures were intended to interrupt the longshore movement of sand and to provide some degree of shoreline sheltering from incoming surface waves. The importance and complexity of this latter factor is often overlooked. Examination of historical aerial photographs indicates that these structures have served well contributing to reasonably stable shoreline contours and an ability to accommodate some extreme storm conditions.

Over the years the groins along Chapman Beach have required aperiodic maintenance resulting in the present day variety of structures including pile and timber, loose placed stone and concrete. Associated maintenance costs have progressively increased. In an effort to reduce these costs questions have been raised about the need for the number of groins and the potential effect of removal of two (2) of them (Groin C and E Fig. 1). This study addressed these questions.

The required spacing of groins along a beach is primarily a function of the angle of incidence between the shoreline and the crest of the incoming waves. For example, using the orientation of the concrete retaining wall along the backshore of Chapman Beach as the shoreline, waves approaching the beach from the southeast would have a small angle of incidence. Such conditions would likely result in relatively small longshore transport allowing wider spacing of placed groins. As this angle of incidence increases groin spacing would decrease.

The direction of advance of the wind waves affecting Chapman Beach is a function of the prevailing winds and the water depth contours, or bathymetry, in the areas offshore of the beach. For much of a typical year southwest winds dominate with southerlies, southeasterlies and easterlies confined to aperiodic

events and storms. Northwesterly winds dominate during the winter months. Waves advancing from the southwest will progressively rotate counterclockwise on approach to the Connecticut shoreline as water depths decrease. Wave fronts, or crests, will in the limit, become nearly shore parallel. More typically, advancing waves will intersect the beach at some small angle. The extent of this "obliquity" determines the required groin spacing.

Examination of the water depth contours immediately offshore of Chapman Beach indicates that incoming waves from the southwest will display a small degree of obliquity on approach to the shore. This angle favors alongshore transport of sand to the east resulting in the angle between the high water line contour on the beach and the adjoining backshore concrete retaining wall in each segment of the beach between the groins (See Fig. 1). Given the dominance of southwesterly winds these are the design conditions governing groin spacing on Chapman Beach even though the occasional storm might produce very different beachfront contours.

Using the mean high water contour as the indicator of recreational beach width, the 2021 survey (Fig. 1) shows beach widths ranging from a maximum of approximately 60 ft on the west side of Groin B to minima of 25 ft to the east of Groin C decreasing to less than 15 ft east of Groins D and E (See Fig 1). This trapezoidal pattern, resulting from the obliquity of the dominant incoming wave field, indicates that removal of Groin C has the potential to significantly reduce beach width to the east of Groin D exposing the bordering seawall to more frequent wave impacts and possible undermining. Similar effects can be expected in the area west of Groin E following its removal. These results indicate that the proposed removal of Groin C and E would reduce the recreational utility of the beach, complicate long-term management, and reduce the effectiveness of the sand margin as a storm barrier. The proposed removal cannot be recommended.

Any proposed groin removal must also consider the current regulatory climate affecting the construction of shore erosion control structures. Current State of Connecticut policy limits (at best) new construction. If after removal conditions develop warranting re-placement of Groins C and E the required new construction permit will likely be difficult to impossible to obtain. With this in mind retention of the structures and the initiation of a phased maintenance program is recommended.

Introduction

Concerns regarding the costs of continuing repairs and reconstruction required to maintain the groins, or shore perpendicular structures, sited along Chapman Beach have raised questions regarding the effectiveness of these structures in long-term shore erosion control and the savings to be realized by the removal of two of these Groin C and Groin E (Fig.1). A study intended to address these questions was initiated in early November, 2023. The following provides a summary of the results of this study.

Study Area

Chapman Beach is located along the northern shore of Long Island Sound approximately 2.5 nm to the west of the entrance to the Connecticut River (Fig.2). The sand beach is bordered inshore by a constructed masonry seawall fronting a relatively dense residential community. The beach is used for recreation and provides some amount of protection of the seawall by dissipating incoming surface wind wave energies. The armoring seawall has effectively eliminated backshore erosion which historically served as a source of sediment to the beach. This in combination with rising sea level has affected the balance between transport energies and sediment supply essential to the long term maintenance of a stable beach. This imbalance has required human intervention to reduce beach erosion rates and to maintain reasonably stable beach contours over extended periods of time. Intervention began more 60 years ago with the placement of a number of shore perpendicular structures, or groins, to interrupt the longshore movement of sand and to provide some sheltering of the beach and backshore from the incoming wind wave field. The effectiveness of these structures varies as a function of the local sediment transport regime.

The transport of sand along, to, and from Chapman Beach is primarily the result of wind waves acting in combination with local tidal currents and direct wind effects. Wind driven aeolian transport is generally negligible except along the more easterly segments adjoining the entrance to Cold Spring Brook. The wind field in the area is dominated by southwesterlies for much of the year. Winds from the northwest tend to dominate during the winter months with events rich in easterlies typically confined to aperiodic storm events and, to some extent, the seasonal spring and fall transition periods. The resulting surface wave field typically proceeds in a direction paralleling the wind direction in the deeper open waters of the Sound. On approach to shore however, the direction of advance progressively changes as decreasing water depths slow the speed of advance. This refraction causes the wave fronts to progressively rotate until they parallel or nearly parallel, local water depth contours. In the limit this process may result in wave fronts paralleling the high water contour as they break along the shoreline.. This shore normal approach favors onshore-offshore transport of sands with minor longshore displacement. Deviation from this condition with wave fronts impacting the shore at more oblique angles such as might occur during events producing an increase in tidal range and reductions in refraction would necessarily increase the relative importance of longshore transport.

Previous study (Bohlen, 2003) and recent topographic surveys indicate that sediment transport along Chapman Beach results from a combination of onshore-offshore transport and longshore transport. The relative dominance of these factors tend to vary seasonally with onshore-offshore transport typically dominating during the summer with longshore dominant during the more energetic spring and fall seasons and during storm events. Overall this system is characterized by a moderate to high degree of spatial variability.

Accommodating the variability in the transport system in the interest of stable shoreline contours required the placement of a significant number of groins along Chapman Beach initially more than 60 years ago. Groins were closely spaced with each extending offshore to beyond the mean low water contour (on the order of 15-50ft beyond) where crest elevation was set to intersect the mean high water line. Groin spacing was approximately equal to one to two times of the lengths of the adjoining groin consistent with U.S Army Corps of Engineers recommendations (USACE,1992). Initially most of the groins were pile and timber supplemented by some amount of loose placed stone at the distal end. Over the years repairs often resulted in modifications including more stone and concrete capping. The groins today display a fair amount of variability in constructed material.

Examination of aerial photographs for the period 1934 to present indicate that the groin field has served to maintain relatively stable contours along much of Chapman Beach. This despite the progressive increase in mean sea level amounting to slightly more than 9 in and several major storm events including

Storm Sandy in 2012 which dominated by southeasterly winds and effectively eliminated the barrier beach extending east from the easterly limits of Chapman Beach to the entrance to Cold Spring Brook (see the images on Fig. 3) The most recent survey (2021) indicates that the width of the recreation beach is greatest in the most eastern segment found at the extension of 1st Avenue. This segment is also unique in the absence of an inshore bordering seawall which limits wave reflection during times of high water favoring sand retention. Proceeding to the west, beach width, above the mean high water line, progressively decreases approaching less than 10ft to the west of Groin E. In each between groin segment the plan contours are for the most part crescentic with maxima sited along the west side of the easterly groin. The pattern is representative of a transport regime dominated by west to east transport. Personal observations have shown that this pattern can change significantly during events dominated by southeasterly to easterly winds which favor east to west transport. These changes are however relatively short lived and transient. These transport conditions provide the context in which the effects of the proposed removal of Groins C and E can be evaluated.

Discussion

The removal of Groin C and Groin E will substantially alter the spacing of groins along Chapman Beach. Between groin distance will increase from approximately 100ft to 220ft (e.g. Groin B-C compared to B- D Fig.1). This will substantially reduce the sheltering provided by the groins increasing transport energies along the shoreline and the associated rates of sediment transport. The aspect of sheltering is often overlooked when discussing the role of groins in the control of shoreline erosion with most emphasis placed on longshore transport. For systems similar to that active on Chapman Beach however, where net transport is the product of both alongshore movements and onshore-offshore transport sheltering warrants careful consideration.

A groin provides sheltering in several ways. First there is the direct “shadow” effect where the structure is blocking some fraction of wave energy associated with waves striking the groin at an oblique angle. These energies are dissipated on the groin and have no effect on the beach in the lee of the structure, in the shadow of the groin. This effect is necessarily dependent on the angle between the direction of wave advance and the groin orientation and decreases to near zero when the wave direction is parallel to the groin.

For shore normal waves the influence of the groin on transport energies is a bit more subtle. Here, assuming that the structure itself is positioned shore normal, the major effect is produced by the offshore end of the groin intersecting the incoming wave. Frictional effects cause a portion of the wave to adhere to both sides of the groin redirecting flows that were originally proceeding along the groin to rotate towards the groin and slow. This process, similar to what is observed at a coastal headland (on a larger scale) serves to reduce the shore normal transport energies for a portion of the beach on both sides of the groin. The alongshore distance affected varies as a function of groin and wave characteristics and water depths. The relatively narrow spacing for a groin field recommended by the Corps is intended to maximize the utility of this "diffraction" effect in the between groin area. This form of sheltering can be a particular value of groins in systems where sand transport is both alongshore and onshore-offshore i.e. shore normal such as is the case for Chapman Beach

Given the limited sediment supply in this area increased transport associated with reduced sheltering will, in a relatively short time, modify the average planview contour of each of the segments between Groin B and Groin D and between Groin D and the next groin to the west. Qualitative estimates of the extent of this process based on current contours indicate that removal of Groin C would produce a more crescentic profile increasing beach width to the west of Groin B while decreasing the high water width along the east side of Groin D and for some distance east along the adjoining seawall. A similar change can be expected to the west of Groin D following the removal of Groin E. In this segment however, given the existing narrow beach widths to the west and limited sediment supply, the additional transport would more significantly reduce the width of the recreational beach to widths of less than 10 ft for much of the area to the west of Groin D.

Reductions in beach width have the potential to increase reflected wave energy during periods of high water increasing transport rates and associated erosion and to facilitate undermining of the bounding seawall. The projected increase in mean sea level elevations over the next 30 years (potentially 20in) will only increase this potential increasing the frequency at which waters impact the seawall and the extent of the resulting transport influence. Given these factors efforts to maintain existing beach widths, if not enhancing them by placement of additional sands for example, appear worthwhile. This of course may be best realized by retention of the existing number of groins.

In considering the effects of the removal of Groins C and E there is one more factor to be considered and that is the current State of Connecticut regulatory climate. In general, the Department of Energy and Environmental Protection (DEEP) does not favor the new construction of groins and even looks carefully at the repair of historic structures. If after removal increasing rates of erosion call for replacement of the groins it may will be impossible to obtain the r permit required for replacement. Prudence favors retention of the existing structures and the initiation of a phased restoration program distributing costs over an extended period of time.

Summary

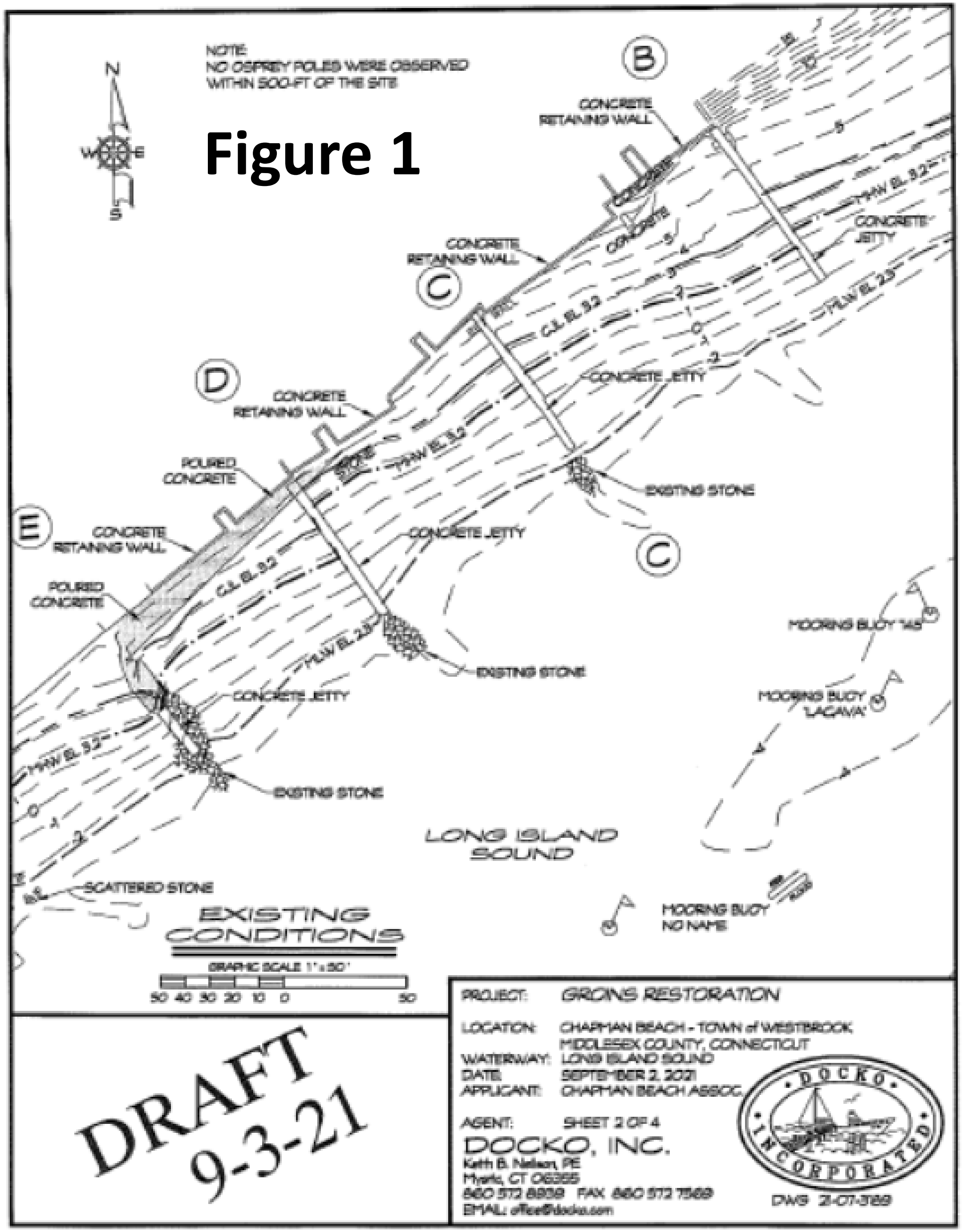
Reviews of historical aerial photographs indicate that the network of groins in place along Chapman Beach for more than 60 years have served to maintain a relatively stable beach despite limited sediment supplies and abundant transport energies. This groin field serves to effectively impede longshore transport and to provide segmentation and sheltering that in combination also retain materials moving onshore-offshore. The proposed removal of Groins C and E would reduce this segmentation increasing transport rates and modifying the planview contours of the beach. Associated reductions in beach width will increase the lateral extent and frequency of direct wave impact along the seawall increasing beachfront erosion and the potential for wall undermining. The expected increase in the rates of mean sea level rise will only increase the potential for these effects. With these factors in mind and in full consideration of the possible future difficulty associated with the acquisition of the State permit required if replacement was desired in the future the proposed removal of Groins C and E cannot be recommended.

References

Bohlen, W. Frank 2003 An Investigation of the Factors Governing Sediment Transport Affecting Shoreline Contours of Chapman Beach, Westbrook, Ct. Prepared for District of Chapman Beach. 10pps + Figs

USACE, 1992 Coastal Groins and Nearshore Breakwaters. U.S. Army Corps of Engineers Engineer Manual - EM 1110-2-1917

Figure 1


NOTE:
NO OSPREY POLES WERE OBSERVED
WITHIN 500-FT OF THE SITE
N
S
W
E
B
C
D
E
CONCRETE RETAINING WALL
CONCRETE JETTY
POURED CONCRETE
EXISTING STONE
SCATTERED STONE
MHW EL 3.2
C.L. EL 3.2
MLW EL 2.3
MOORING BUOY "45"
MOORING BUOY "LACAVA"
MOORING BUOY NO NAME
LONG ISLAND SOUND
EXISTING CONDITIONS
GRAPHIC SCALE 1" = 50'
50 40 30 20 10 0 50
DRAFT 9-3-21
PROJECT: GROINS RESTORATION
LOCATION: CHAPMAN BEACH - TOWN of WESTBROOK
MIDDLESEX COUNTY, CONNECTICUT
WATERWAY: LONG ISLAND SOUND
DATE: SEPTEMBER 2, 2021
APPLICANT: CHAPMAN BEACH ASSOC.
AGENT: SHEET 2 OF 4
DOCKO, INC.
Keith B. Neilson, PE
Mystic, CT 06355
860 572 8939 FAX 860 572 7569
EMAIL: office@docko.com
DOCKO INCORPORATED
DWG 21-07-3189
Keith B. Neilson P.E. Docko, Inc.
9/3/2021 12:09 PM

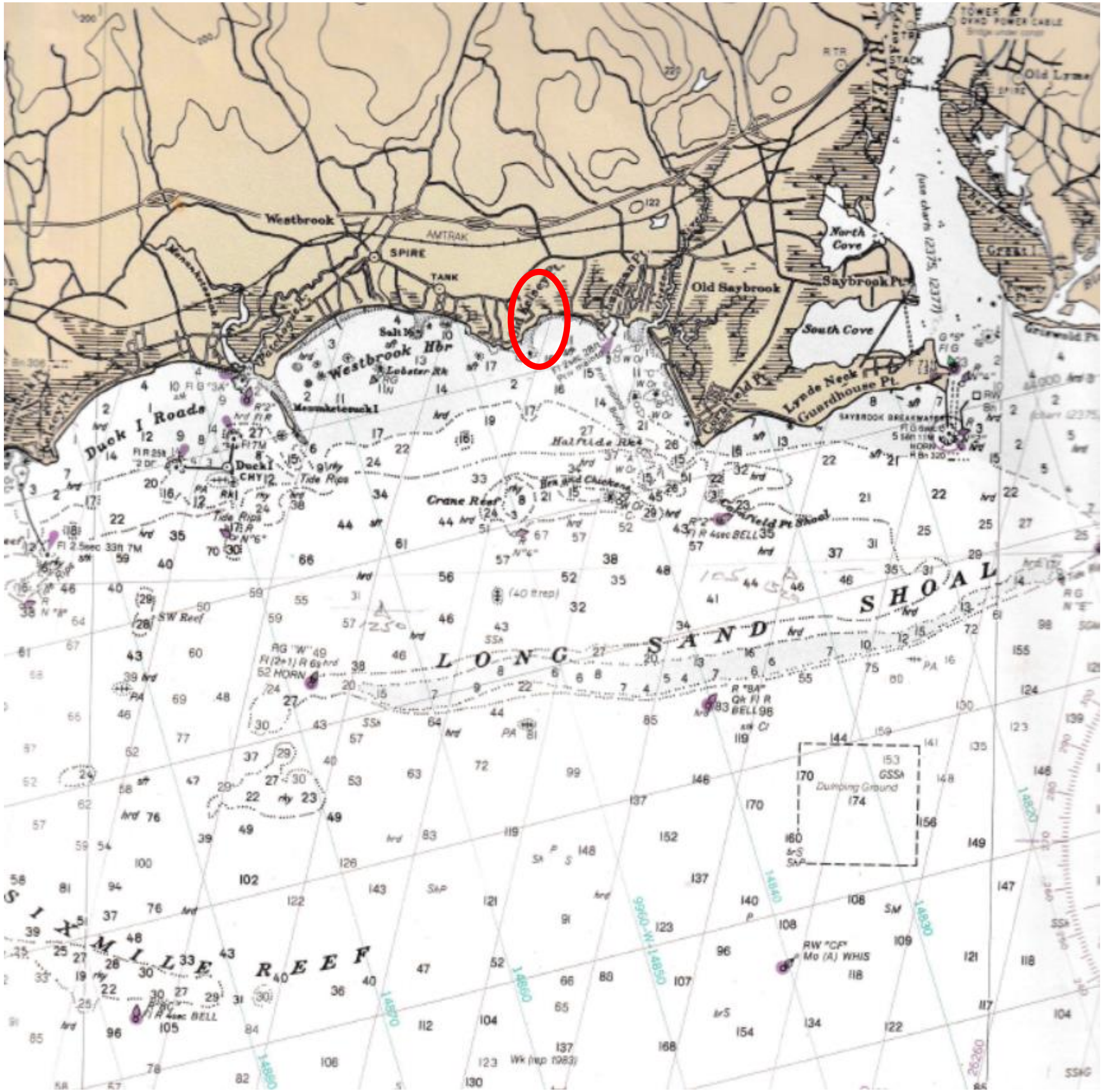


Figure 2
Study Area in Red

Note: Offshore
Water Depth Contours

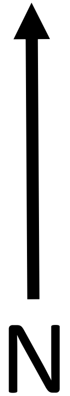


Figure 3 Aerial Views Comparing Chapman Beach 1934 to 2019 Conditions