Continental Shelf Sand Resources for North Topsail Beach, NC

William J. Cleary

12 February 2015

Continental Shelf Sand Resources for North Topsail Beach

Beach Nourishment is a viable management option for North Topsail Beach since existing investigation had already identified over a decade ago, that sufficient compatible sand resources were available. In fact the Town of North Topsail Beach has already completed Phase I of a Multi-Phase Inlet Management, Beach Restoration and Maintenance Plan, for its 11.1 mile-long shoreline protection project for its oceanfront. Approximately 550,000 cy of sand was placed along the northern 7,000 ft of shoreline. The fill material was derived from the realignment of the New River Inlet's outer bar channel that occurred during the period from mid November 2012 to mid January 2013. Currently the Town is placing ~ 1.2 M cy of sand derived from an offshore borrow site along the southernmost 3.85 miles of its oceanfront shoreline (Phase V). The Town will most likely complete the initial construction of the shoreline protection project (Phases II-IV) in 2016/2017 with material derived from the offshore borrow site and potentially from the maintenance of the bar channel.

According to Pilkey and Neal (2009) *Three important environmental factors make beach nourishment costly on North Topsail Beach: (1) relatively high wave energy (by U.S. East Coast standards, (2) high frequency of storms, both nor'easters and hurricanes and 93) shortage of suitable continental shelf sand. The least environmentally damaging source of sand for North Carolina beaches is the continental shelf. Finding such sand deposits, however, requires extensive and costly seismic surveying and vibracoring. The continental shelf off Topsail Island is rock, and sand deposits are presumed to be spotty and small, requiring extensive seismic surveying and vibracoring to find sand for beach replenishment.* The inferences derived from the above assertions made by Pilkey and Neal (2009) suggests that no data existed regarding the availability of sand resources offshore North Topsail Beach when their paper was submitted for publication. In reality, several island-wide investigations of the inner-shelf had been completed by 2003 and by 2005 significant advances in the identification of potential borrow sources had occurred. Pilkey and Neal (2009) seem to have neglected to mention the existence of these data that was known to the coastal geologic community in North Carolina.

In early 2001 the USACE, Wilmington District contracted with the author through HDR, an engineering firm in Charlotte, NC to investigate the availability of suitable borrow sites offshore Topsail Beach. The HDR (2002) report indentified several potential target areas offshore Topsail Beach that could contain significant quantities of beach fill material. The above report formed the impetus for the USACE to proceed to the next exploratory and exploitation phase that consisted of seismic and vibracore surveys within the target areas offshore Topsail Beach.

Concurrent with the above USACE efforts, it was speculated that a similar sand resource potential would exist off the remainder of Topsail Island (Surf City to New River Inlet). In the interest of locating the most economical and environmentally acceptable borrow sites that could support the USACE proposed projects, information dealing with the availability of beach quality material, or its non-availability, was needed. Therefore, a site-specific assessment of the inner-shelf offshore North Topsail Beach and Surf City was necessary. The goal of the 2003 investigation was the identification and delineation of suitable borrow sites that contained compatible material for federally funded nourishment projects. An equally important objective was the identification of areas of environmentally sensitive hardbottoms.

The following brief narrative is a summary of the second investigation funded by the USACE through HDR (2003) for the North Topsail Beach to Surf City inner shelf area. The inner-shelf off the northern portion of North Topsail Beach is dominated by a platform-like submarine headland comprised of well-indurated limestone (Fig. 1). Fathometer sonargraphs showed that the highly irregular surface was characterized by a series of low- (<1.6 ft) to high-relief (>6.6 ft) hardbottom scarps and intervening flat hardbottoms. The nature of the shoreface, from Alligator Bay to the Town of Surf City's southern limit, was similar to the shoreface segment off the northeastern part of North Topsail Beach. The most significant difference was the lack of high-relief hardbottoms.

The uppermost rock unit mapped from seismic survey data crops out over most of the northern portion of the study area, and is correlative to the upper Oligocene Belgrade Fm. This unit forms the majority of the limestone platform that controls the bathymetry of the inner shelf area northeast of Alligator Bay (Fig. 1). The Trent Fm, similar to the Belgrade Fm crops out over a significant portion of the Surf City shoreface. A second and distinct major rock unit, the Oligocene River Bend Fm, also underlies a portion of Surf City and adjacent Topsail Beach (Fig. 1). Vibracore data and numerous diver surveys from

offshore Surf City indicated that the River Bend Fm is variably cemented olive green, fine-grained, quartz sand and siltstone.

A sidescan-sonargraph mosaic (Fig. 1) compiled from numerous surveys indicated that several distinct types and zones of sea-floor morphology occurred within the area. The distinctly different accoustic "signatures" were indicative of lateral changes in the lithology and relief of the underlying rock units and the nature and thickness of the sediment cover. Interpretation of the data indicated that sediment accumulation was extremely limited particularly in the northern portion of the study area.

Vibracore data indicated that the sediment sequence was thin and consisted of units of very fine quartz sands intercalated with gravel mixtures. Mud-rich back barrier sequences were recovered in a number of vibracores. Thickness of the modern sediment package ranged from less than one-half inch in hardbottom areas to more than 11.0 ft in intervening depressions. The sediment cover on the northern part of the study area was generally too thin (0.65 ft) to core, except in isolated bathymetric lows and in a narrow channel-like or dissolution feature off New River Inlet. The broad limestone platform off New River Inlet was generally barren of sediment.

The shoreface in the southern part of the study area was underlain by relatively thin sequences of very fine quartz sands interbedded with sandy gravels. Some of the thickest sediment sequences cored were recovered from mud-peat filled paleo-channels or dissolution-related depressions. The majority of the individual units present were less than 1.3 ft thick. Gravel rich units are widespread and comprise major portions of the sediment sequences. Much of the southern portion of the study area is covered by sediment sequences less than ~ one foot thick. The area with the thickest deposits of sediment (3.0 - 6.0 ft) is restricted to a small region located within the central portion of the shoreface offshore the southern portion of North Topsail Beach. The sea floor in this area is characterized by irregular shore-normal depressions. This highly irregular region is underlain by siltstone. A second area where relatively thick sediments were found was located offshore the southern portion of Surf City.

The volume of material contained in Borrow Area I (offshore New River Inlet) is estimated to be ~1.4 Million cubic yards (M cy). The prospect of locating significant suitable accumulations of compatible sand in this area is probably low due to the proximity of hardbottoms; nonetheless, the area warrants a detailed investigation.

Approximately 70 percent of the shoreface southwest of Alligator Bay has no potential for significant volumes of compatible beach fill material. However, there are several areas (Borrow Areas II through V) where thin (<3 feet) sandy sequences may have accumulated. However, the compatibility and continuity of these materials is unknown.

The irregularly shaped Area II covers approximately 4.8 mi^2 of the shoreface (Fig. 2). The thickness of quality beach fill material in Area II is likely to be extremely variable and, at best, probably averages less than 3.0 ft in thickness. The volume of material contained in Area II is estimated to be ~ 15.0 Mcy. The proximity of hardbottoms is likely to restrict the exploitation of sand resources in the narrower regions of Area II. Areas IIa and IIb are the only viable areas within the confines of Area II where there is a possibility of finding beach fill material. Areas IIa (1.5 $mile^2$) and IIb (0.7 $mile^2$) comprise approximately 45 percent of Area II (Fig. 2). The potential volume of usable sand in these areas is estimated to range from 2.1 to 3.1 Mcy in Areas IIa and IIb, respectively.

Area III, located southwest of Area II, is an 8.4 $mile^2$ area that may contain as much as 2.3 Mcy of questionable quality material (Fig. 2). The presence of hardbottoms may also impact the availability and exploitation of sand resources in the narrower regions of Area III. Area IV, that encompasses 1.6 $miles^2$ of the shoreface, is located ~ 4.5 miles offshore Stump Sound (Fig. 2). The volume of potentially usable material contained in this region is ~ 0.3 Mcy Area V encompasses ~ 1.1 mi^2 and it is speculated that as much as 1.5 Mcy of material is contained within the target site. The total volume of potentially usable material was estimated in 2003 to be ~ 24.3 Mcy in the borrow areas identified on Figure 2.

Recommendations that stemmed from the investigation included the following: To adequately resolve the shallow stratigraphy of the targeted borrow areas, detailed geophysical surveys utilizing a high-quality Chirp system is required. Data from the surveys would be crucial to the detailed mapping of the three-dimensional aspects of the sediment sequences within the borrow areas as well as those subsequently indentified. A detailed coring program should be implemented to ascertain the compatibility of the materials within the target areas. Core data can be used to define the complex three-dimensional aspects of the discontinuous sand sequences. The core data can also provide the necessary means of ground truthing the seismic data in areas where weathered rock units underlie what is interpreted to be a thick sequence of usable material. Additional

high-resolution side-scan sonar surveys will be necessary to better define the boundaries of selected target sites in hardbottom areas.

The USACE utilizing the information from the aforementioned initial reconnaissance investigation contracted for additional geophysical surveys and extensive vibracoring operations. As a result of the USACE efforts, additional borrow areas on the inner shelf were identified that increased the volume of potentially usable material to ~ 46.7 M cy. This later volume included the 6.7 M cy of material identified in a nearshore area off North Topsail Beach in 2005 by the non-federally funded work of CPE (Fig. 2). Subsequently, detailed mapping of hardbottom areas adjacent to all the borrow sites and extensive sediment analyses of the compatibility of the material in the borrow areas resulted in a proven sand resource total volume of ~24.5 Mcy (Fig. 3).

An additional source of sand that is available for beach nourishment not mentioned by Pilkey and Neal (2009), is the material derived from maintenance operations within the New River Inlet system that includes the outer bar channel and the interior navigation channel within the Cedar Bush Marsh area.

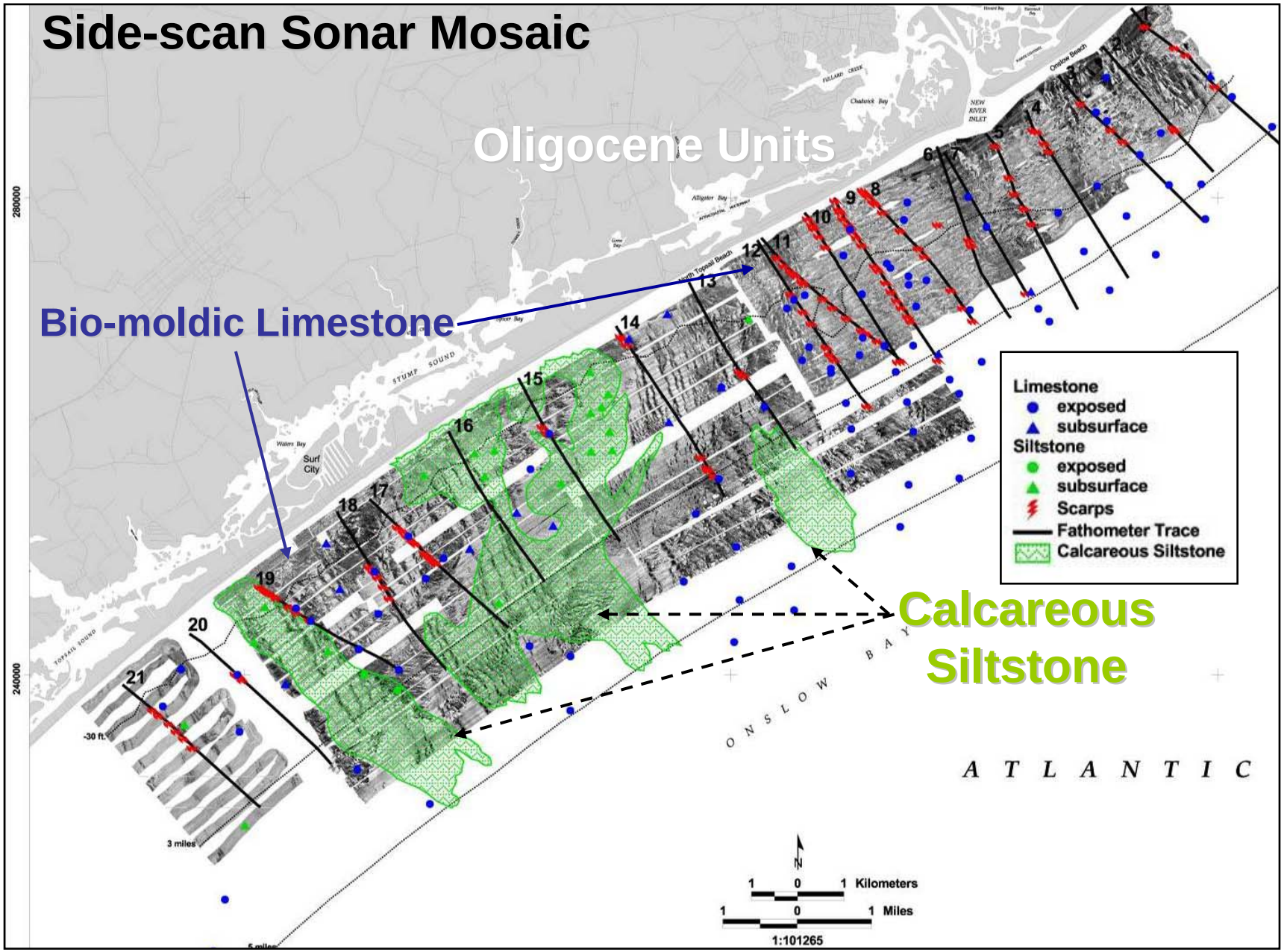

Figure 1. Side-scan sonar mosaic of the North Topsail Beach-Surf City inner shelf showing the distribution of the major lithologic units Fathometer trace locations and scarps. Modified after Cleary (2003).

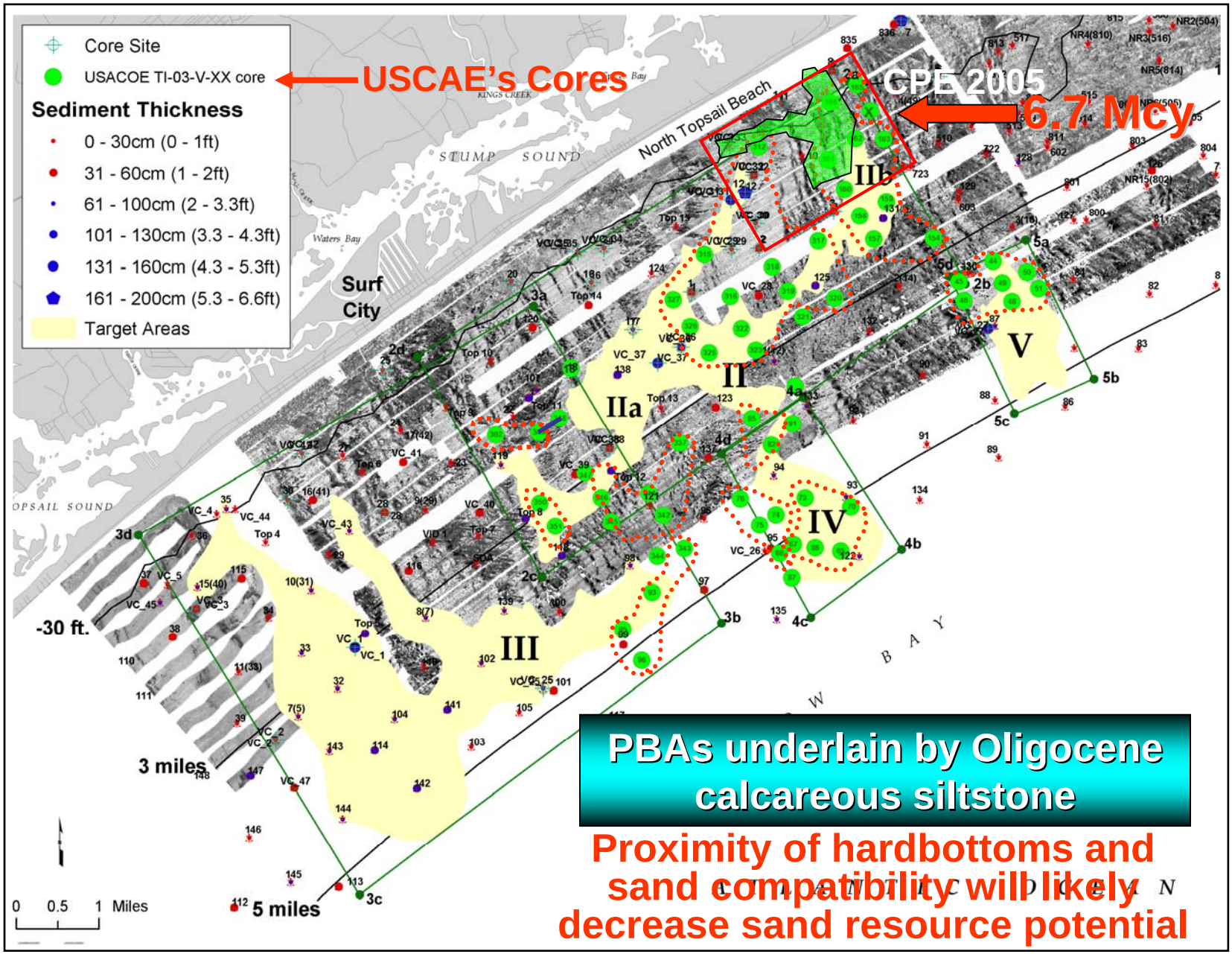

Figure 2. Side-scan sonar mosaic of the North Topsail Beach-Surf City inner shelf showing the distribution of the potential borrow areas (PBAs) and the location of additional USACE vibracores recovered in 2003 -2005. The majority of the PBAs are underlain by a calcareous siltstone. Green colored polygon refers to the proven borrow area indentified by CPE (2005) in separate non-federal investigation.Modified after Cleary (2003).

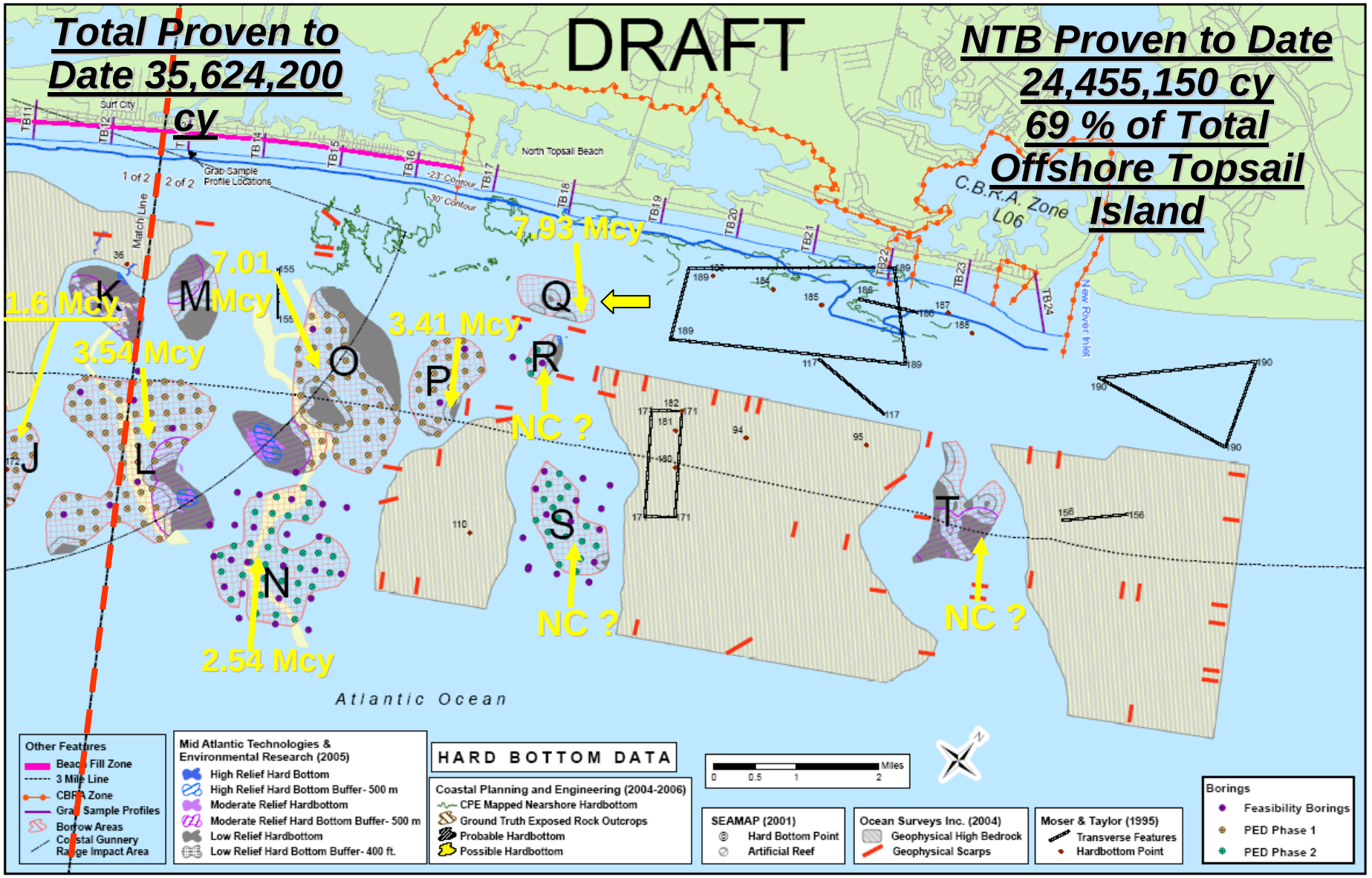

Figure 3. Map depicting the location of the Potential Borrow Areas offshore North Topsail Beach-Surf City. The various USACE funded geophysical and vibracoring surveys were completed by late 2005. Modified after USACE (2014) Draft Report. Approximately 24.5 million cy of proven sand resources are located offshore on the inner shelf (69% of the total sand volume identified offshore Topsail Island).