ABSTRACT

Title of Document: PEDOGENESIS, INVENTORY, AND UTILIZATION OF SUBAQUEOUS SOILS IN CHINCOTEAGUE BAY, MARYLAND

Danielle Marie Balduff, Ph.D., 2007

Directed By: Professor Martin C. Rabenhorst, Department of Environmental Science and Technology

Chincoteague Bay is the largest (19,000 ha) of Maryland's inland coastal bays bounded by Assateague Island to the east and the Maryland mainland to the west. It is connected to the Atlantic Ocean by the Ocean City inlet to the north and the Chincoteague inlet to the south. Water depth ranges mostly from 1.0 to 2.5 meters mean sea level (MSL). The objectives of this study were to identify the subaqueous landforms, evaluate the suitability of existing subaqueous soil-landscape models, develop a soils map, and demonstrate the usefulness of subaqueous soils information.

Bathymetric data collected by the Maryland Geological Survey in 2003 were used to generate a digital elevation model (DEM) of Chincoteague Bay. The DEM was used, in conjunction with false color infrared photography to identify subaqueous landforms based on water depth, slope, landscape shape, depositional environment, and geographical setting (proximity to other landforms). The eight such landforms identified were barrier cove, lagoon bottom, mainland cove, paleo-flood tidal delta, shoal, storm-surge washover fan flat, storm-surge washover fan slope, and submerged headland. Previously established soil-landscape models were evaluated and utilized to create a soils map of the area.

Soil profile descriptions were collected at 163 locations throughout Chincoteague Bay. Pedons representative of major landforms were characterized for a variety of chemical, physical and mineralogical properties. Initially classification

using *Soil Taxonomy* (Soil Survey Staff, 2006) identified the major soils as Typic Sulfaquents, Haplic Sulfaquents, Sulfic Hydraquents, and Thapto-Histic Sulfaquents. Using a proposed modification to *Soil Taxonomy* designed to better accommodate subaqueous soils with the new suborder of Wassents, soils of Chincoteague Bay were primarily classified as Fluvic Sulfiwassents, Haplic Sulfiwassents, Thapto-Histic Sulfiwassents, Sulfic Hydrowassents, and Sulfic Psammowassents.

To illustrate the application of subaqueous soils information, the suitability of soils for submerged aquatic vegetation (SAV) habitat was assessed, based upon past and current growth patterns in Chincoteague Bay and sediment properties known to affect SAV establishment and growth. The refined soil-landscape models and extensive soil characterization obtained in this study have advanced our understanding of subaqueous soils in coastal lagoon systems, and should prove valuable to coastal specialists managing these critical resources.

PEDOGENESIS, INVENTORY, AND UTILIZATION OF SUBAQUEOUS SOILS
IN CHINCOTEAGUE BAY, MARYLAND

By

Danielle Marie Balduff

Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
2007

Advisory Committee:
Professor Martin C. Rabenhorst, Chair
Professor Bruce James
Dr. Douglas Levin
Dr. Roberta Marinelli
Assistant Professor Brian Needelman
Associate Professor Karen Prestegaard

Acknowledgements

This research was funded through a grant from the U.S. Department of Agriculture, Natural Resources Conservation Service. Thank you for your support.

I sincerely thank all who have contributed to my success.

Martin Rabenhorst, my advisor, who has passed on a great deal of knowledge and excitement for this field and who was an excellent and patient editor of this work, thank you for being a wonderful mentor. To my committee members, Bruce James, Doug Levin, Roberta Marinelli, Brian Needelman, and Karen Prestegaard, for teaching me concepts that have helped to make me a more well-rounded scientist and for your feedback and guidance on this work. I wish to thank Del Fanning for teaching me how to play bridge and for sharing his knowledge about pedology and mineralogy. I wish to express my appreciation to Richard Weismiller for allowing me to assist in teaching ENST 105 and for reminding me how much I like to teach and why I decided to pursue my Ph D in soil science. I wish to thank Susan Demas for providing me with a place to stay at her home during the summer of 2005, while I was doing my field work, thank you for your hospitality and your friendship. To Amanda Haase and Ross McAllen, my summer field assistants, who helped collect, describe, and sample the soils in Chincoteague Bay, thank you for having a great attitude and for your flexibility in dealing with boat engine problems, bad weather, and long days when the weather was perfect. To Cary Coppock for teaching me how to collect and describe subaqueous soils and to drive a boat and pull a trailer, thanks for all of your help. I wish to express my appreciation to Mark Stolt and Phil King teaching me how to describe and classify subaqueous soils, create subaqueous soil series, and in understanding landscape-soil relationships. I wish to thank Patrick Morton, Adam Gray, Rebecca Bourgault, Phil Zurheide, Karen Vaughan, John Wah, and Rosalynd Orr for your friendship, advice, and help in finishing my doctoral work.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

Background

According to Bates and Jackson (1987) a lagoon is a “shallow stretch of salt and brackish water partially or completely separated from a sea or lake by an offshore reef, barrier island, sandbank or spit”. Lagoons have high productivity, are important ecological habitats, and are important economic resources. These environments support many species, including macrophytes, benthic fauna, and aquatic fauna. These areas have been studied within a broad range of disciplinary specialties, where the vegetation (Koch and Beer, 1996), benthic fauna (Fox and Ruppert, 1985), and sediment distributions (Bartberger, 1976; Wells and Conkwright, 1999) have been examined. Until recently these areas have not been studied by soil scientists.

In the last decade, the definition of soils has been expanded to include areas that are permanently submerged with deeper water (up to 2.5 m) (Soil Survey Staff, 1999). Subaqueous soils form from permanently submerged sediments located in rivers, lakes, and tidal environments. There have been several studies examining subaqueous soils in subtidal lagoons located in Delaware, Maine, Maryland, and Rhode Island from a pedological perspective (Demas, 1998; Bradley and Stolt; 2003; Osher and Flannagan, 2006). These studies involved characterizing the morphological properties of the soils and describing them using terminology commonly used for subaerial soils. These studies highlight the relationships between subaqueous landforms and soil types (Demas, 1998;

Bradley and Stolt; 2003; Osher and Flannagan, 2006). The subaqueous soil-landscape models developed from these studies could potentially be extended to coastal lagoons throughout the Atlantic coast.

Study Area

There are five coastal lagoons in Maryland that have locally been termed coastal bays: Assawoman Bay, Isle of Wight Bay, Sinepuxent Bay, Newport Bay, and Chincoteague Bay (Figure 1-1). These coastal lagoons are located on the Atlantic coast of the Delmarva Peninsula. Fenwick and Assateague Islands are barrier islands that separate the coastal lagoons from the Atlantic Ocean. Assawoman Bay and Isle of Wight Bay are located north of the Ocean City Inlet. The southern bays consist of Sinepuxent Bay, Newport Bay, and Chincoteague Bay. Newport Bay and Sinepuxent Bay are contiguous with Chincoteague Bay at their southern boundaries and are located between the Ocean City inlet and the Chincoteague inlet.

Chincoteague Bay is the largest of the Maryland coastal lagoons. Chincoteague Bay is a 19,000 ha coastal lagoon bounded by Assateague Island to the east and Maryland mainland (Worcester County) to the west. It is connected to the Atlantic Ocean by the Ocean City inlet to the north and the Chincoteague inlet to the south (approximately 52 km apart). The restricted access of water inflows and outflows means that it takes approximately 63 days for 99% of the water in Chincoteague Bay to be replaced by tidal exchange (EPA, 1999). Chincoteague Bay is a microtidal (tidal range < 2 m) lagoon with a very small average daily tidal range of 10-20 cm near Public Landing, MD (Wazniak et al., 2005). Generally the water depths are less than 2.5 m throughout the bay.

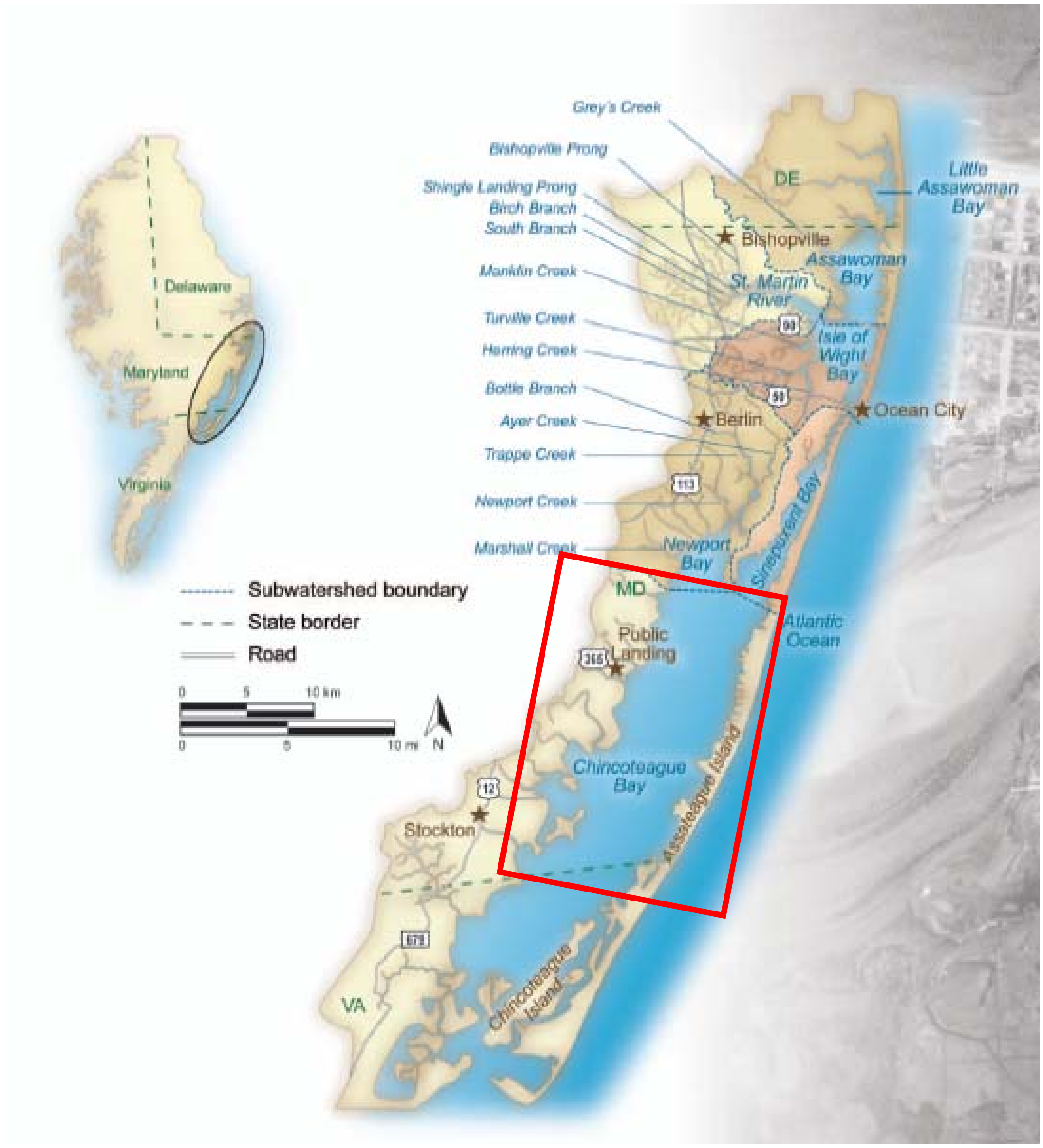

Figure 1-1. Map of Maryland coastal lagoons. The study area is highlighted. (Modified from Wazniak et al., 2004).

Chincoteague Bay is polyhaline, meaning that the salinity changes seasonally within a range of 26 to 34 ppt. The highest salinity values occur in the summer due to higher evaporation rates, poor circulation, and decline in fresh water inputs (Wells and Conkwright, 1999). The Chincoteague Bay watershed is largely undeveloped. The western shore watershed is composed of wetlands (15%), forest and brush (40%), agricultural (33%), and developed land (4%) (Shanks, 2005). Assateague Island to the east was established as a national park (Assateague National Seashore Park) in 1965 and has remained undeveloped since that time.

The health of Maryland's coastal bays was assessed by the Maryland Department of Natural Resources (Wazniak and Hall, 2005) using three different types of indicators: water quality; living resources; and habitat. Chincoteague Bay was ranked second highest after Sinepuxent Bay, due to its relatively undeveloped watershed and its degree of flushing through the Ocean City and Chincoteague Inlet. But due to the prevalence of brown tides and macroalgae blooms its overall ranking was reduced (Wazniak and Hall, 2005). Chincoteague Bay has good/excellent water quality, but the water clarity (measured by Secchi disk) was less than 0.5 m in the summer months (Wazniak and Hall, 2005) due to algal blooms that occur throughout the summer. This is supported by chlorophyll a concentrations (measurement of algal populations), which tend to be less than 15 $\mu g\ l^{-1}$ (Wazniak and Hall, 2005). The dissolved oxygen concentrations are generally greater than 5.0 $mg\ l^{-1}$, however in the summer months in near-shore areas, the oxygen concentrations are lower, dropping into the range of 5 to 3 $mg\ l^{-1}$. Nutrient inputs into the coastal bays through non-point sources (agriculture, septic systems, and atmospheric deposition) and groundwater were thought to be responsible for the increase of nitrogen and phosphorus into these systems. Average total nitrogen concentrations ranged from 0.04 to 1 mg l^{-1} and average total phosphorus concentrations ranged from 0.025 to 0.1 mg l^{-1} in Chincoteague Bay (Wazniak and Hall, 2005), which are lower values that those observed in other coastal lagoons in the Mid-Atlantic area. The sediments of Chincoteague Bay also appear to be relatively pristine according to Wells and Conkwright (1999). The sediments are not enriched in metals (Cd, Cu, Cr, Ni, Pb, or Zn) and nutrients (N or P) due to anthropogenic activities, with levels in the sediments falling within established background levels (Wells and Conkwright, 1999). Brown tides, which are the result of large quantities (>200,000 cell ml^{-1}) of the pelagophyte *Aureococcus anophagefferens*, are detrimental to benthic organisms in Chincoteague Bay by decreasing oxygen concentrations and light. These were observed in Chincoteague Bay between 1999 and 2003 and occurred mainly from May to July and September to early November (Simjouw et al., 2004).

Chincoteague Bay supports a variety of fish, benthic flora, and fauna species. Over 130 different fish species have been identified over the last 30 years, including summer flounder, croaker, weakfish, spot, striped bass, and black sea bass (Wazniak and Hall, 2005; Shanks, 2005). Blue crabs are abundant and have maintained a steady population over the last 13 years (Wazniak and Hall, 2005) (in contrast to the Chesapeake Bay, where crab populations have been in serious decline (Miller et al., 2005)). Oysters were once extensive throughout the bay, but have declined drastically during the 20th century due to harvesting, disease, and predation (Shanks, 2005; Wazniak and Hall, 2005). When surveys in Chincoteague Bay were made during 2000-2004, oysters were found to be absent from subtidal shoals and former oyster bars (Wazniak and Hall, 2005).

Bay scallops were prevalent until the 1930's when eelgrass beds declined due to wasting disease, but have recently (since 2002) been found in all coastal bays. The recent resurgence was attributed to the increase in seagrass coverage over the last twenty years (Wazniak and Hall, 2005). Hard clam populations have been stable over the last 10 years, at an average density of approximately 0.27 clams m^{-2}, but historically the populations were greater (Wazniak and Hall, 2005). In 1953 the reported clam density was 1.3 clams m^{-2} (Shanks, 2005). Submerged aquatic vegetation was virtually eliminated from the bays in the 1930's by disease, but in the last 20 years submerged aquatic vegetation has increased in extent from approximately 2129 ha in 1986 to 3204 ha in 2006. However there has been a reported decline in the seagrass population since 2002 from 6235 to 3204 ha (Maryland Department of Natural Resources, 2007). This decline has been attributed to warmer temperatures and lower water clarity. Most of the submerged aquatic vegetation beds are located on the eastern side of Chincoteague Bay along Assateague Island. In recent years a few submerged aquatic vegetation beds have begun to appear on the western side of the bay as well (Orth et al., 2005).

Geologists have examined the sediments of Chincoteague Bay (Bartberger, 1970; Wells and Conkwright, 2004) and ecologists have worked to assess the biologic productivity (Drobeck et al., 1970; Leber and Lippson, 1970; Shanks, 2005) and primary productivity of the lagoon (Anderson, 1970; Orth et al., 2005). This area has not been studied by soil scientists from a pedological perspective, although pedological work has been done in the adjacent but much smaller Sinepuxent Bay, to the north (Demas and Rabenhorst, 1999). Undertaking an effort to study the subaqueous soils of a large coastal lagoon like Chincoteague Bay will allow us to assess, and hopefully enhance the predictive capability of subaqueous soil-landscape models developed in more limited settings and to determine their applicability from a regional perspective. Furthermore, the acquisition of spatial soils information for Chincoteague Bay should provide a valuable resource for use in ecological research and management.

Objectives

The objectives of this study were: 1) to identify and delineate the subaqueous landforms of Chincoteague Bay, Maryland; 2) to evaluate the suitability of existing subaqueous soil-landscape models of Atlantic coastal lagoons when applied to a broader scale and to modify or enhance those models as needed; 3) to develop a soil map of Chincoteague Bay; and 4) to demonstrate the potential usefulness of subaqueous soils information by assessing the suitability of Chincoteague Bay soils for submerged aquatic vegetation habitat.

Chapter 2: Literature Review

Barrier Islands and Coastal Lagoons

Barrier islands are located along the coasts of every continent, except Antarctica. There are approximately 2200 barrier islands most of which exist in the northern hemisphere (73%) and of these, 405 are in the United States. Most of the barrier islands world-wide are located on wide continental shelves found along the east coasts of the North and South American continents (Pilkey, 2003). Nine types of barrier islands have been described: coastal plain barrier islands; delta barrier islands; Arctic barrier islands; bay mouth barrier islands; sandur barrier islands; composite barrier islands; accidental barrier islands; man-made barrier islands; and lagoon barrier islands (Pilkey, 2003). According to this classification the barrier islands along the Mid-Atlantic coast are coastal barrier islands, because they meet these five basic requirements: rising sea level (transgressive coastline); gently sloping mainland surface; supply of sand; energetic waves; and a low to intermediate tidal range (Pilkey, 2003).

Sea levels have moved up and down many times during the last three million years, the most significant of which have been related to glaciation. Each time glacial ice accumulated (generally related to glacial advances) sea level dropped, at times as much as 120 m (Pilkey, 2003). During these times when water formerly contained in oceans became glacial ice, the sea level dropped and sediments on the continental shelf were exposed as the shelf moved seaward. When the last glaciation (Wisconsinan) began approximately 120,000 B.P., sea levels were approximately five to six meters above present (Toscano et al., 1989). But as the glaciers formed by accumulating ice and advanced toward their maximum extent during the late Wisconsinan period (18,000 yr B.P.), the sea level dropped to approximately 100 m below present levels (Biggs, 1970; and Sugarman, 1998). The subsequent retreat of glacial ice and sea level rise at the end of the Pleistocene are thought to have occurred in two major steps with the first beginning 12,500 yr B.P. and ending at 11,000 yr B.P. The sea level at the end of this period was estimated to have been between 26 m (Kraft et al., 1986) and 30 m (Colman et al., 2000) below present levels. A second episode of rapid sea level rise occurred around 9,500 yr B.P. and was followed by slower rates of sea level rise throughout the remainder of Holocene (Faribanks, 1989). Most of the coastal and estuarine features, such as barrier islands and lagoons, formed as a result of the rise in sea level during the last 20,000 years (Biggs, 1970; Toscano et al., 1989).

There are three main theories of the origin of barrier islands: 1) spit breaching; 2) beach ridge isolation; and 3) submarine bar up growth. The spit breaching concept proposed in the 1880's by G.K. Gilbert (Gilbert, 1885) stated that on coastal plains recently flooded by sea level rise, sand spits form across the mouths of bays and lagoons because the waves from the open ocean refract as they came in contact with the bay. The refraction of the waves along the shoreline reduced the energy of the waves and their capacity to carry sand-sized particles. The sand was dropped at the entrance of the bay and spits were formed over time. Figure 2-1 illustrates the formation of a barrier island from a spit through sediments transported by littoral and longshore currents. Over time, as the spits grew and developed, storms would break through the spits and form islands

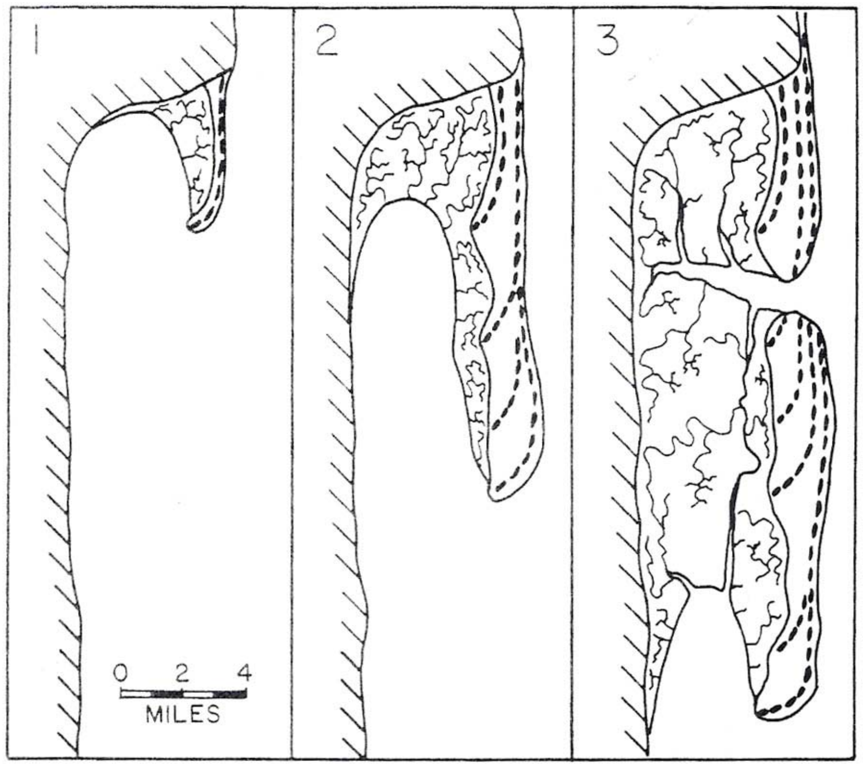

Figure 2-1. Idealized diagram of Gilbert's Theory of barrier island formation from a spit through sediments transported by littoral and longshore currents. 1 and 2) The spit develops in the direction of longshore sediment transport. 3) The spit is breached to form a barrier island (Modified from Hoyt, 1967).

(Gilbert, 1885; Pilkey, 2003). It was generally accepted that barrier islands could develop from spits on limited scales, so long as there was an abundance of sediment available for longshore and littoral transport.

Hoyt (1967) proposed the beach ridge isolation theory for barrier island formation, which is a modification of de Beaumont's theory (Pilkey, 2003). Hoyt theorized that barrier island formation has three components: 1) the sea intersects the mainland along the shoreline, 2) a dune or beach ridge forms adjacent to the shoreline, and 3) submergence (such as during rapid sea level rise of the late Holocene period) floods the area landward of the dune or beach ridge forming lagoons and islands. Over time the islands may shift landward, seaward, or remain stationary. This movement is dependent on sediment supply, the rate of submergence, and hydrodynamic factors.

The earliest theory on barrier island formation, however, was the work conducted by de Beaumont in 1845. De Beaumont's hypothesis stated that wave action on the shallow continental shelf removes sediments and then piles them up to form a bank parallel to the shoreline as the waves lose energy and that the sediment bank eventually develops into a barrier island. This theory was further examined by Otvos (1977) with his work in the Gulf of Mexico. He observed barrier islands as sandbars are built up during high storm surges to maintain equilibrium with the higher sea level. After the storm water levels drops quickly, the sandbar remains intact and above sea level. This barrier island formation theory is most likely restricted to the broad trailing edge continental shelves that normally have low waves.

Hayes (1979) described three basic barrier island inlet types which influence the barrier island morphologies: tide-dominated; wave-dominated; and transitional (Hayes, 1979). The inlet types are governed by the ratio of wave energy to tidal current, volume of the tidal prism, nature and size of back-barrier area, and time-velocity asymmetry of the tidal currents (Hayes, 1980). Levin (1993) observed changes in tidal prism and sediment supply resulted in sequential changes in inlet morphology in the Mississippi River delta plain. He noted sequential changes in inlet morphology as increased tidal prism caused a wave-dominated inlets to develop tide-dominated morphology and changed back to wave-dominated as sediment supply decreased (Levin, 1993).

The tide-dominated inlets are characterized by strong ebb currents influencing sediments seaward of the shore zone and have small or non-existent flood-tidal deltas. These inlets occur along the Georgia and southern South Carolina. The barrier islands in these areas are generally 5 to 15 km long and 1 to 5 km wide. These islands tend to be wide in the central portion and narrow towards the ends (Hubbard et al., 1979). Due to the higher tidal range these islands have extensive marshes behind the barrier island. The inlets are characterized by a deep channel and weakly developed or absent flood-tidal deltas (Hubbard et al., 1979).

In wave-dominated inlets sand is pushed through the inlet into the lagoon due to the high wave energy and weak ebb flow in these environments. Figure 2-2 illustrates a wave-dominated inlet setting. Examples of wave-dominated inlets include Assateague Island located on the Delmarva Pennisula and the Outer Banks of North Carolina. The larger waves and low tidal ranges produce barrier islands which are long and thin with only a few tidal inlets and have wide, open lagoons behind the barrier island (Hayes, 1979). The ebb-tidal deltas are small and only extend a short distance from the coast, however, in contrast the flood-tidal delta is large and multilobate occurring behind the

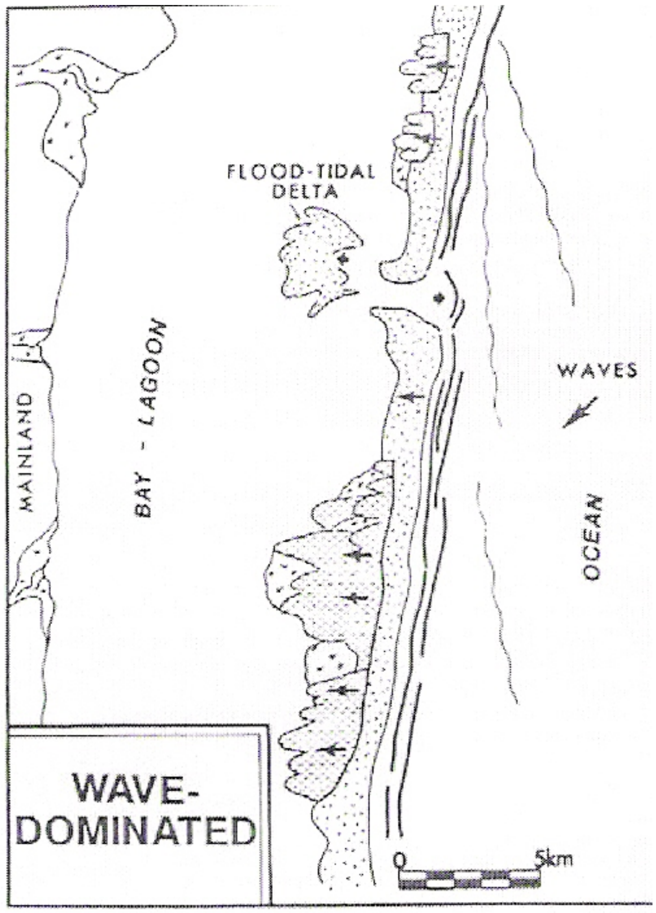

Figure 2-2. Illustration of a wave-dominated inlet and the major sedimentary features identified (From Davis, 1994).

inlet where the sediment carrying capacity of the flow decreases (Hubbard et al., 1979). The inlets are characterized by a single channel which is shallower than tide-dominated inlets (Hubbard et al., 1979). Inlets associated with these barrier islands are unstable with regard to their location and size, which is caused by high rates of littoral drift, longshore currents, and small tidal prisms. These inlets tend to close over time and new inlets are created during summer hurricanes and winter storms called “Nor’ Easters”.

In transitional inlets the waves and tides have equal effects and the majority of the sand occurs in the inlet. These are an intermediate between wave- and tide-dominated inlets which occur along the Virginia, South Carolina, and Louisiana coasts. The inlet morphology is variable in these settings, but the sand deposits are confined to the inlet channel. The inlet is characterized by one main channel and smaller secondary channels (Hubbard et al., 1979).

Chincoteague Bay

An estuary is “a semi-enclosed coastal body of water which has free connection with the open sea within which sea water is measurably diluted with fresh water derived from land drainage” (Pritchard, 1967). Estuaries are mostly embayments in the coast with a barrier island that may be a spit or a bar, but is usually detached from the mainland. Estuaries accumulate sediments from streams carrying detrital sediments, tidal currents, and from biogenic materials produced in the estuary. The Chesapeake Bay is one of the largest estuaries in the United States. Lagoons differ from estuaries by the paucity of sediments supplied to the lagoons due to low runoff and limited inlets. The small quantity of fresh water inputs into these coastal lagoons elevates the salinity levels which impacts the benthic communities that inhabit the lagoons. Sediments are received into the lagoon mainly by washover and aeolian process on the adjacent barrier islands. The lagoons generally have hypersaline conditions and support a benthic community tolerant of these conditions. Chincoteague Bay is an example of a coastal lagoon.

The formation of Assateague Island and Chincoteague Bay started with sea level rise about 18,000 years ago at the end of the Wisconsinan glacial maximum period, due to the melting and receding of glaciers (Biggs, 1970). Around 13,500 years BP, sea level was approximately 100 m below present levels and the coast was roughly 97 km east of its present location (Pielou, 1991). The present continental shelf was composed of fresh water ponds, grasslands, and spruce forests (Emery, 1967). The sea level continued to rise and by 9,600 years BP the portion of the continental shelf now occupied by Chincoteague Bay had become an estuary, as evidenced by the presence of oyster shells in the sediments (Emery, 1967). The presence of oyster shells in the sediment supports that oysters were living in the lagoon at this time and there may have been a barrier island seaward of this position (Biggs, 1970). A series of barrier islands were present after 5,000 years BP creating Chincoteague Bay. This is evidenced by dating salt marsh peat located at depths of 7 to 8.5 m below MSL being dated by ^{14}C at approximately 4,500 years BP, indicating that barrier islands existed seaward of the Delmarva for at least the past 4,500-5,000 years (Biggs, 1970). Biggs (1970) hypothesized that the current Assateague Island formed by the coalescence of several islands over time. Halsey (1978) suggested that Assateague Island formed during the late Holocene when Pirates Island, Pope Island, and the shoals seaward of Morris Island and Cape Chincoteague coalesced and what is now Assateague Island consisted of at least two islands until the Green Run inlet closed around 1900.

Chincoteague Bay, the largest of Maryland's inland coastal bays (Figure 2-3), is a 19,000 ha coastal lagoon bounded by Assateague Island to the east and Maryland mainland to the west. It is connected to the Atlantic Ocean by the Ocean City inlet to the north and the Chincoteague inlet to the south (approximately 52 km apart). Chincoteague Bay is a microtidal (tidal range < 2 m) lagoon with an average daily tidal range of 10-20 cm near Public Landing, MD. Generally the water depths are less than 2.5 m throughout the bay. The restricted access of water inflows and outflows results in a flushing rate of 63 days for 99% of the water in Chincoteague Bay to be replaced by tidal exchange (Pritchard, 1961).Salinity within Chincoteague Bay changes seasonally, from 26 to 34 ppt. The highest salinity values occur in the summer due to high evaporation rates, poor circulation, and decrease in fresh water inputs (Wells and Conkwright, 1999).

Bartberger (1976) studied the sediment sources and sedimentation rates in Chincoteague Bay. Chincoteague Bay receives approximately 90,000 m^3 of sediment annually, with an average sedimentation rate of 0.03 cm yr^{-1}. There are four sources contributing detrital sediment to Chincoteague Bay: 1) from the mainland through streams; 2) from shoreline erosion; 3) from Assateague Island by eolian transport and overwash events; and 4) through the two inlets (Ocean City and Chincoteague). The erosion of the mainland shore and inflowing streams provided most of the finer textured sediments to the bay, whereas the overwash events and eolian transport provided the coarser sediments. It has been estimated that most of the finer textured sediments come from shoreline erosion of the mainland (40 km^3) with less from streams (5 km^3) (Bartberger, 1976). Two-thirds of the coarse sediments are derived from Assateague Island by overwash events (30 km^3) and one-third by eolian transport (15 km^3)

(Bartberger, 1976). The sediments contributed through the tidal inlets only impact the areas immediately adjacent to the inlet. The ratio of finer textured materials to coarser textured materials (sand:mud) entering the bay is 1:1 (Bartberger, 1976). Bartberger's (1976) work provided an estimate of the present annual sedimentation rate of 0.03 cm yr^{-1}. This is significantly lower than the long term average of 0.15 cm yr^{-1} over the past 5,000 years that was estimated based on sediment thickness recorded in borings (Bartberger, 1976). Sedimentation rates for three cores collected in Chincoteague Bay during the late 1990's using ^{210}Pb ranged from 0.17 to 0.33 cm yr^{-1} (Wells and Conkwright, 1999). These rates were more similar to the long term average estimated by Bartberger (1976), who suggested that the change in sedimentation rates could be related to the present lack of tidal inlets along Assateague Island. Bartberger (1976) suggested that this is an unusual situation and is not what was typical over the last 5,000 years. From historical maps there is evidence that several inlets have opened and closed over the past 200 years. With the closing of the inlets the only supply of sediment from the eastern shore of the bay is through overwash events and eolian transport.

There are three significant marsh areas in Chincoteague Bay (Johnson Bay area, Middlemoor area, and Tingles Island area) as shown in Figure 2-3. The marshes located in Johnson Bay (especially Mills Island) are associated with dune deposits and are aligned with Sinepuxent Neck and Robins Marsh, and both are part of Pleistocene beach ridges (Rasmussen and Slaughter, 1955). Thus, many of the islands in Johnson Bay area are believed to be late Pleistocene in age rather than Holocene (Wells and Conkwright,

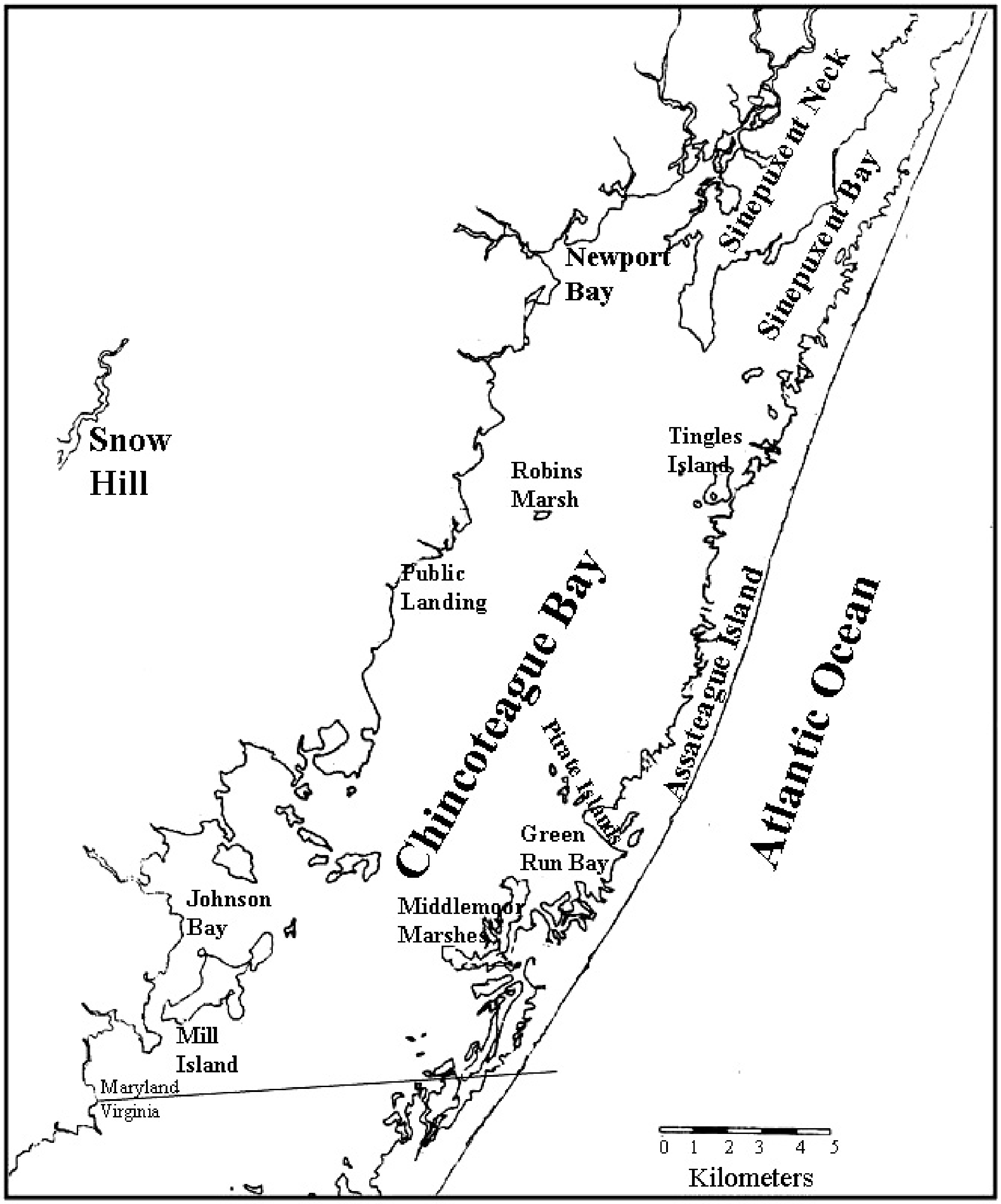

Figure 2-3. Map of Chincoteague Bay, Maryland showing three major areas of marshes (Modified from Biggs, 1970).

1999). The Middlemoor and Tingles Island marshes are associated with relict inlets. The Middlemoor marshes are associated with the Green Run inlet, which was open in 1850 and closed 1900 (Figure 2-4). These inlets were located at the “right” position to have supplied sediment and tidal range to stimulate marsh development (Bartberger and Biggs, 1970). Tingles Island marshes are associated with the now closed North Beach inlet. Biggs (1970) hypothesized that the Middlemoor and Tingles Island marshes are retrograding because the inlets associated with their formation have closed, thus decreasing the source of sediment to create new shoals for marsh encroachment.

Several relict inlets have been documented along Assateague Island as shown in Figure 2-5. These inlets formed during storms and eventually filled in with sediments. These relict inlets helped to shape Assateague Island and had an important role on the distribution and character of the bay bottom sediments. However, today there are only two inlets. The Ocean City Inlet formed in 1933 during an August hurricane. The inlet was stabilized by jetties in 1935 by the Army Corps of Engineers (Shepard and Wanless, 1971). Due to a strong littoral current that flows southward, the north jetty trapped sand and formed a triangular shaped beach, while starving Assateague Island south of the inlet. This caused the northern portion of Assateague Island to recede about 1,500 feet and by 1961 the beach was no longer connected to the jetty. In 1963, dredging operations reconnected the jetty and beach. The Chincoteague inlet is located in the southern portion of Assateague Island and Chincoteague Island (Figure 2-3).

Sediment Mapping in the Coastal Bays

Biggs (1970) examined the sediments underlying Chincoteague Bay and Assateague Island by collecting 26 cores on six transects (Figure 2-6). Salt marsh peat

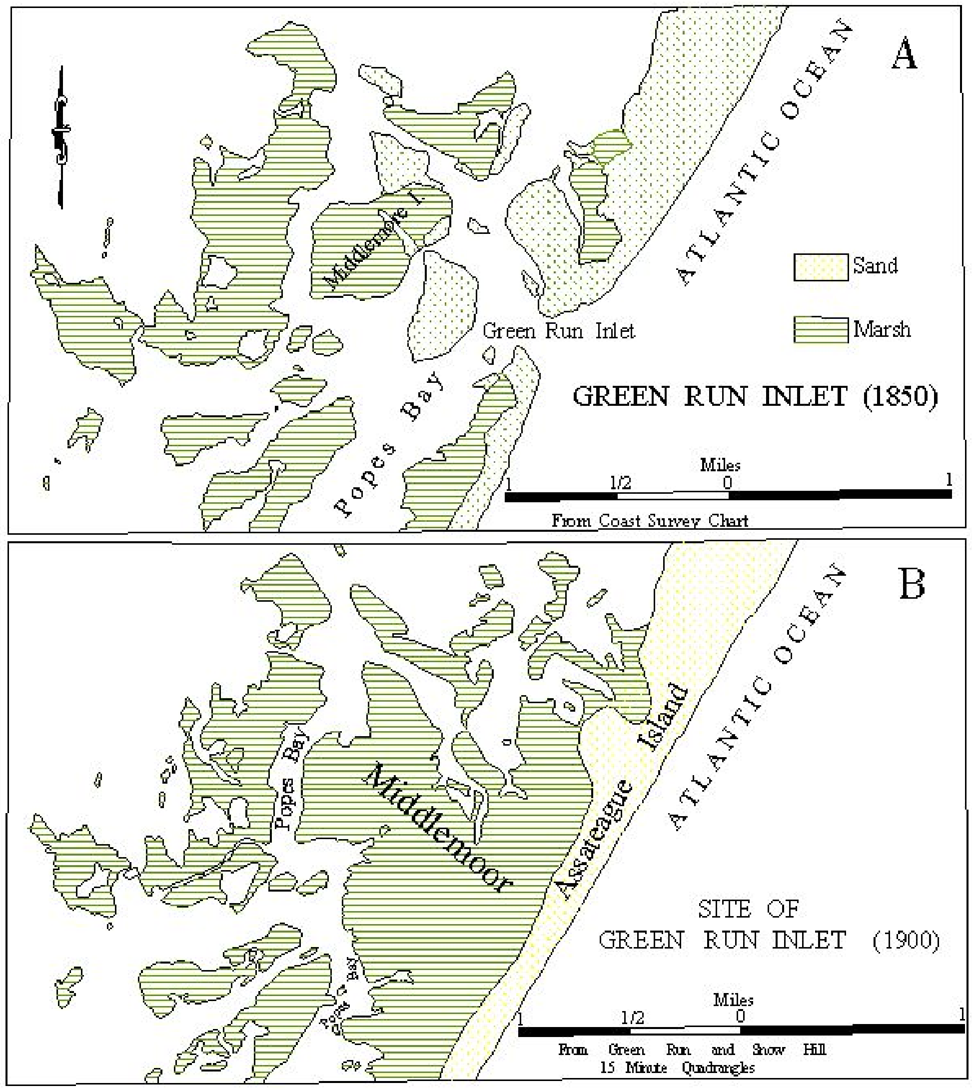

Figure 2-4. Historical record of the development of Middlemoor and the closing of Green Run Inlet (From Gawne, 1966).

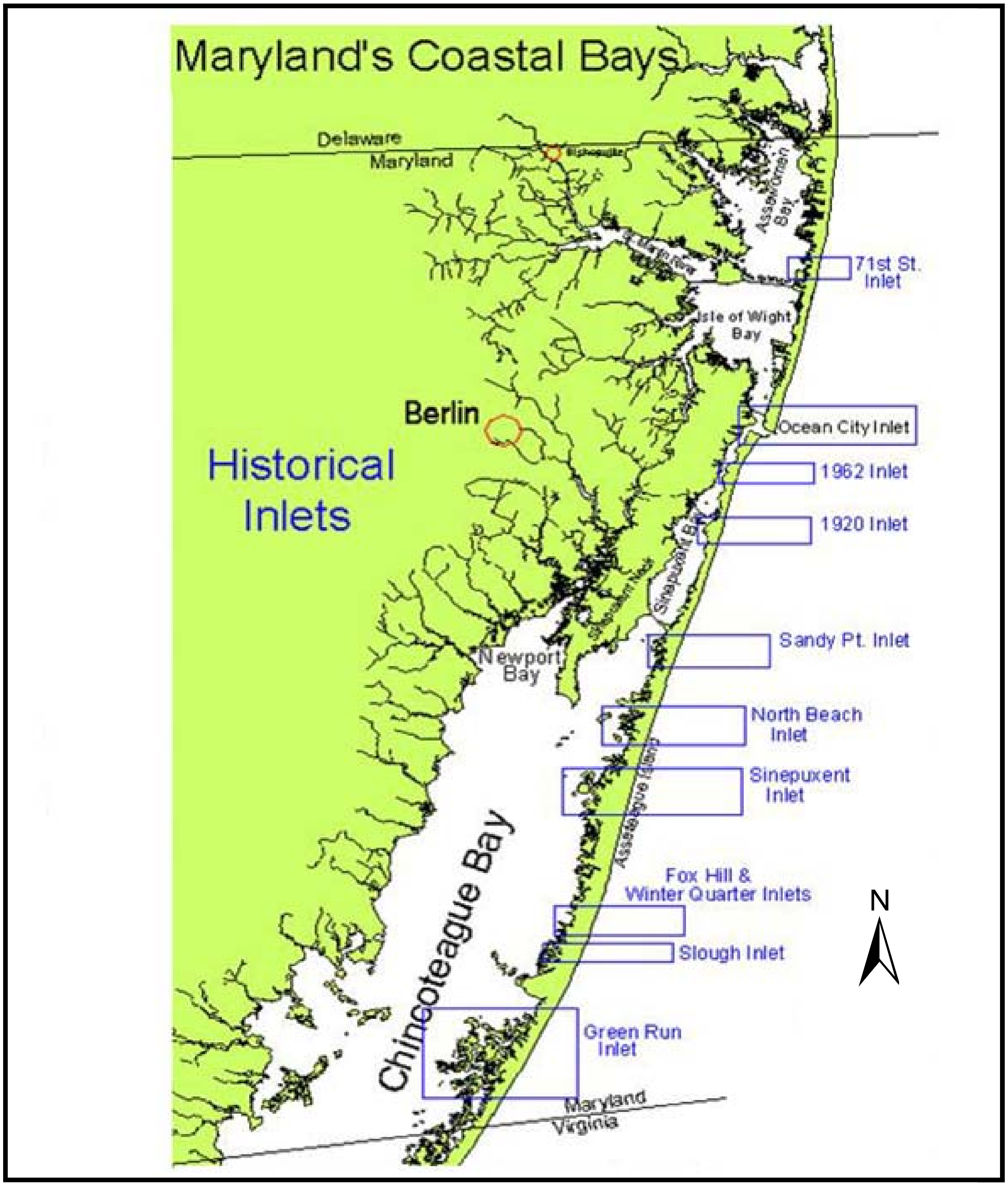

Figure 2-5. Locations of prior inlets once open, but now closed located on Assateague Island, Maryland (From Wells and Conkwright, 1999).

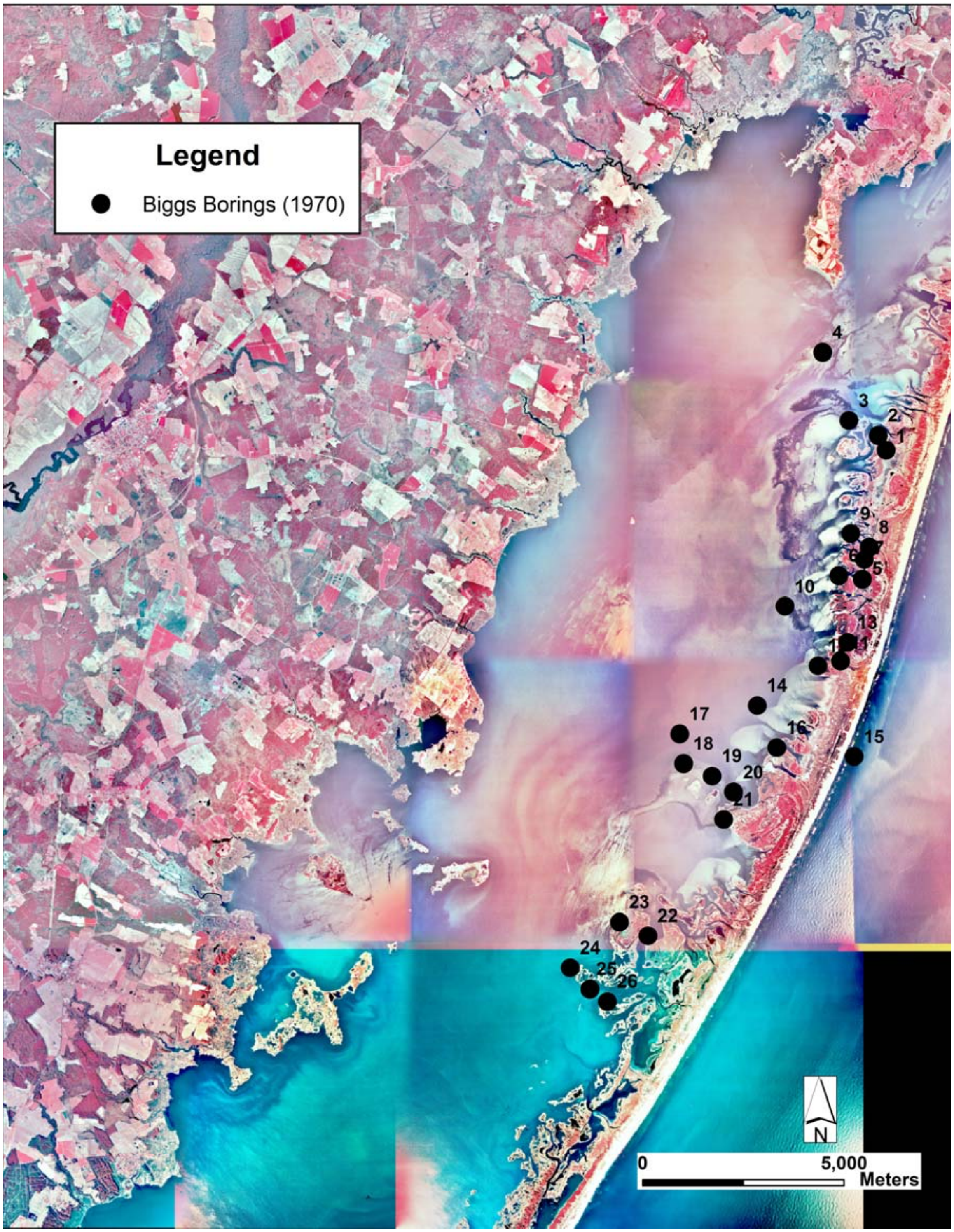

Figure 2-6. Locations of borings from Biggs (1970).

was identified in several of the cores, which marks the approximate sea level at the time the peat accumulated. The presence of salt marsh peat at 7 to 8.5 m below present MSL and the accompanying ^{14}C dates provide an approximate age of 4,500 to 5,000 years BP for these marsh surfaces. The marsh deposits at the surface of the cores were thin (< 0.5 m) and indicated that prior to marsh development these areas of the lagoon were open water (Biggs, 1970). Daddario (1963) dated basal peat (1,900 years BP) in the lagoon west of Atlantic City, New Jersey found at a depth of 3 m below MSL. Newman and Munsart (1968) found Wachapreague marshes (in Virginia) were only 1 m thick indicating that marsh formation began approximately 1,000 years BP. They suggested that the marsh formation was inhibited by a rapid rise in relative sea level prior to this. Biggs (1970) data collected from Assateague Island is consistent with these findings, indicating that marsh formation began approximately 1000 years BP as sea level rise slowed allowing marsh vegetation to grow.

A map showing the sand content (2 to 0.625 mm) of Chincoteague Bay surface sediments is shown in Figure 2-7 and was based on 147 surficial sediment samples (Bartberger, 1976). The eastern portion of the bay, adjacent to Assateague Island, contains sediments composed of >80% sand (0.125 to 0.250 mm in diameter) (Bartberger, 1976). As water depth increased (from 1.5 m to 2.5 m) from the barrier toward the mainland, there was a decrease in sand content and an increase in finer sediments (average particle diameter of 0.008 mm) (Bartberger, 1976). These finer sediments in water deeper than 1.5 m contain less than 20% sand (Bartberger and Biggs, 1970). The map shows a pocket of finer grained sediments that extends from the middle of the bay to Assateague Island that corresponds to Green Run Bay. This is the site of the

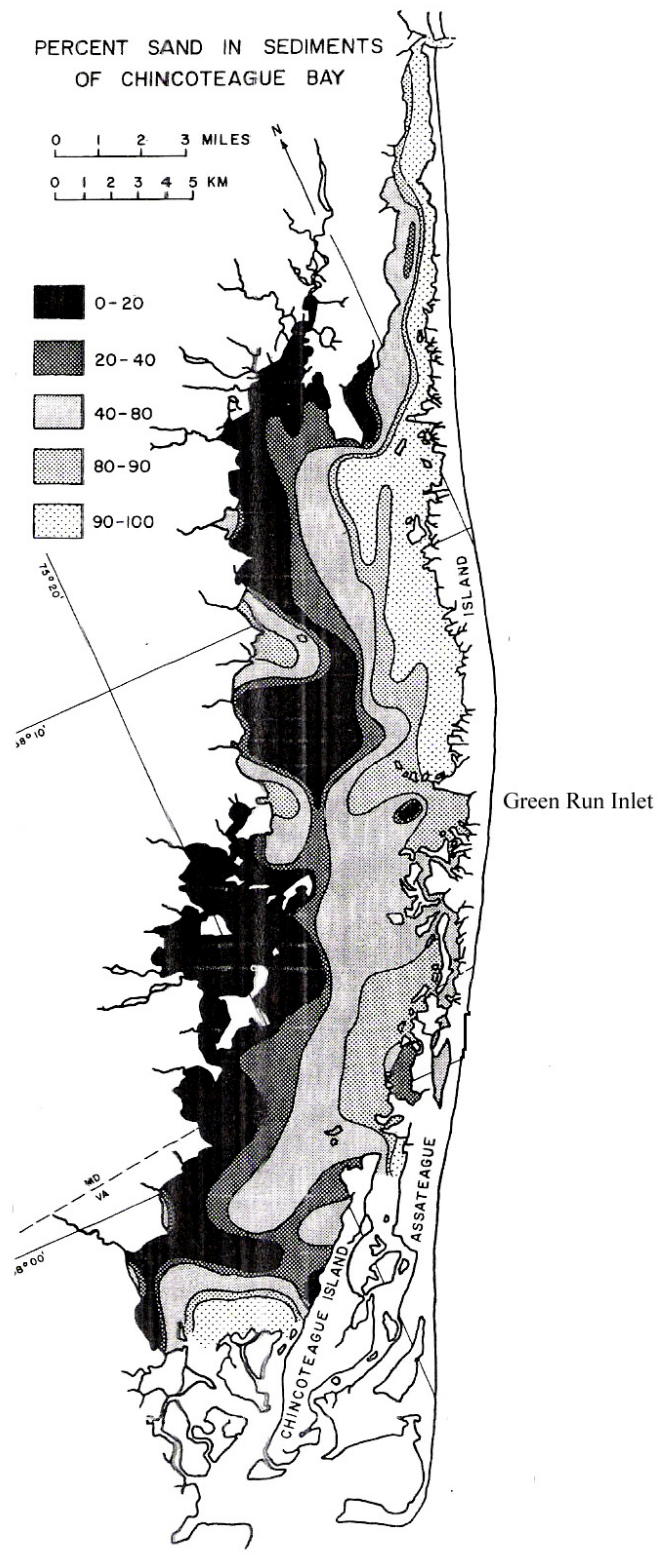

Figure 2-7. Percent of sand in surficial sediments of Chincoteague Bay in 1976 (Modified from Bartberger, 1976). The location of a relict inlet, Green Run Inlet, is identified.

former inlet, which a channel into the lagoon scoured to a depth of approximately 2.4 m (Bartberger and Biggs, 1970).

During the 1990's the Maryland Geological Survey (Wells and Conkwright, 1999) conducted a sampling project to collect surficial sediments of Chincoteague Bay, MD. The sampling was conducted on a 500 m by 500 m grid, and the samples were colleted using a grab type sampler (an approximate sample area of was 19 cm^2 by 14 cm). The sample descriptions included a brief narrative that described the texture (Shepard's sediment classification) and fauna of the location. Data collected for each sample included percent water, percent gravel, percent sand (2.0-0.63 mm), percent silt (0.63-0.004 mm), percent clay (<0.004 mm), total nitrogen, total carbon, and percent sulfur. An additional 12 (1 m deep) sediment cores were also collected throughout Chincoteague Bay. The cores were x-rayed, photographed, described, and sampled at specific locations based on visual and radiographic observations. X-ray radiographs showed such features as worm channels and sedimentary stratification in the profile. Similar data as those collected for the surface grab samples were also collected from the sediment cores and additional metal data were collected (chromium, copper, iron, manganese, nickel, and zinc). A sediment distribution map shown in Figure 2-8 based on Shepard's Classification scheme (Shepard, 1954) was developed using 988 surficial samples. Sandy (2-0.625 mm) sediments (<25% silt and clay) cover 45% of the bay and were located primarily along Assateague Island (Wells and Conkwright, 1999). The source of the sand-sized particles is thought to be the adjacent barrier island with the sands being transported by eolian or washover events. In the northern half of Chincoteague Bay the sandy sediments extend farther across the bay. These sediments were deposited on the paleo-flood tidal delta that formed when the Sinepuxent inlet was open (Figure 2-5). Another large expanse of sand-sized sediments is located between Middlemoor and Johnson Bay. These deposits were deposited on a paleo-flood tidal delta that formed when the Green Run Inlet was open during the end of the 19th century (Wells and Conkwright, 1999). Clayey silts cover 26% of the bay bottom (Figure 2-8) and are located along the western shore of the bay from Public Landing to Johnson Bay (Wells and Conkwright, 1999). The sources of these fine grained sediments likely include surface run-off and shoreline erosion. The finer grained sediments were deposited in areas of low-energy where the wave action is at a minimum. There are also pockets of fine grained sediments south of Tingles Island that they attribute to the presence of extensive submerged aquatic vegetation beds which trapped the finer sediments by slowing the currents allowing the finer particles to settle out of the water column (Wells and Conkwright, 1999). Generally the sediments from east to west grade from sandy sediments to clayey silts, with transitional textures occurring in the transitional zones between the high-energy and low-energy environments. A distribution of the sand content from the Wells and Conkwright (1999) data set is shown in Figure 2-9.

Limitations of Previous Approaches

Many sediment maps are based upon data collected from regularly spaced grid patterns (Wells et al., 1994). Wilding and Drees (1983) have suggested that grid sampling should be utilized when spatial relationships among soil properties are not understood, based upon the underlying assumption that variability is more random than systematic or simply cannot be predicted from any other properties or features (Wilding and Drees, 1983). The continued use of grid pattern sampling may have limited the development and

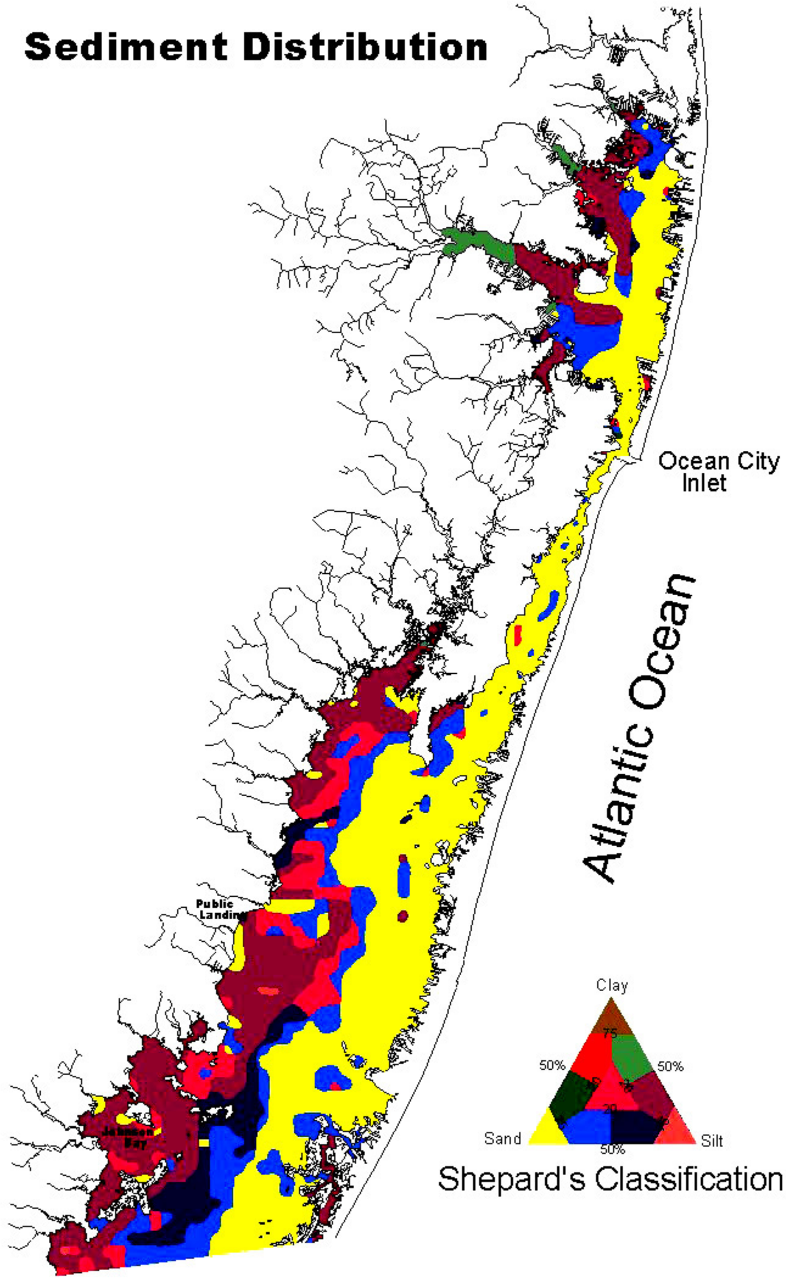

Figure 2-8. Distribution of sediment type of surficial sediments of Chincoteague Bay based on Shepard's classification scheme (Modified from Wells and Conkwright, 1999). The particle-size classes are: sand (2.0-0.63 mm); silt (0.63 to 0.004 mm); and clay (<0.004 mm).

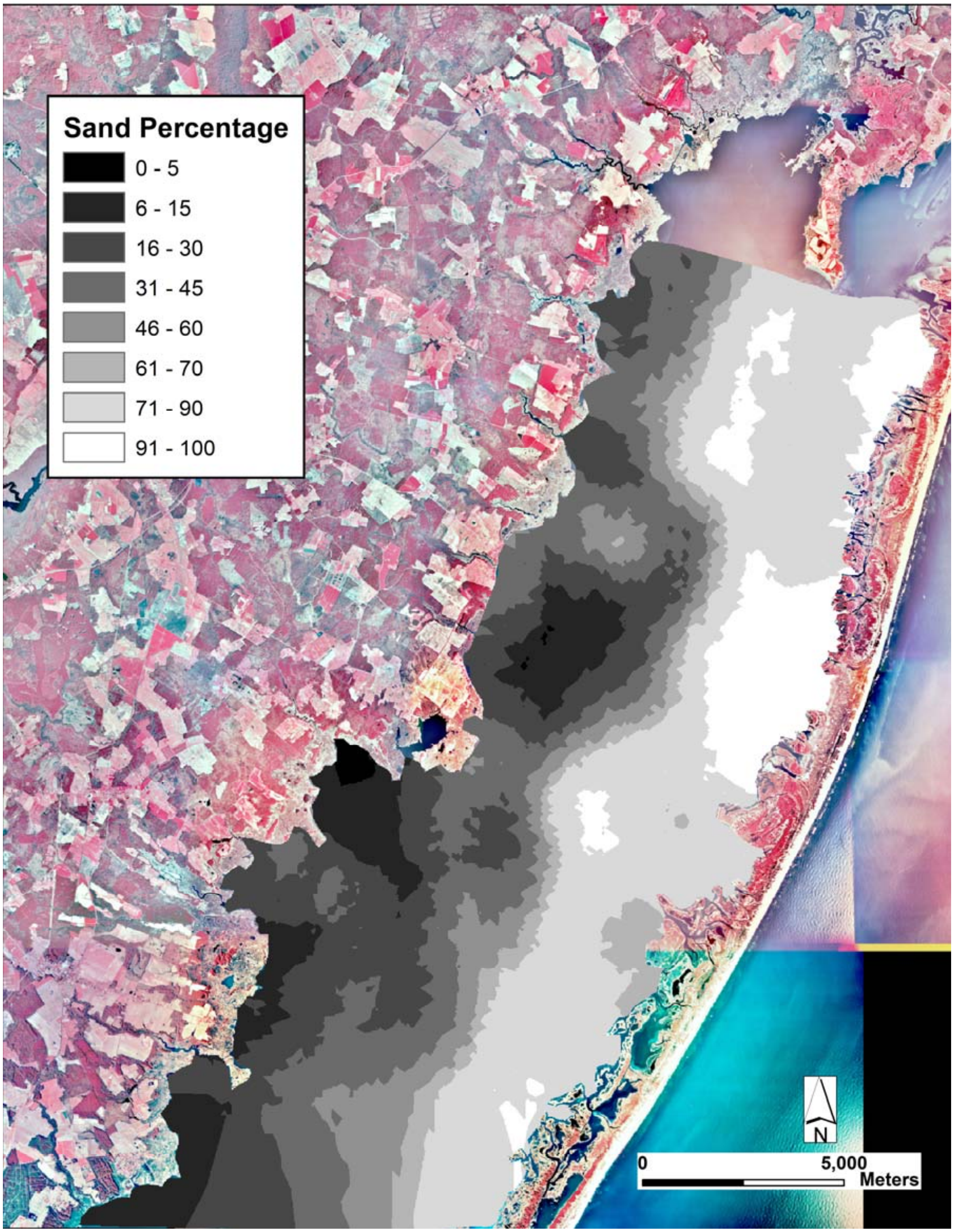

Figure 2-9. Percent of sand (>0.63 mm) in surficial sediments of Chincoteague Bay collected by Wells and Conkwright (1999). This map was created using the Maryland Geological Survey data set in ArcMap using the geostatistical analyst.

understanding of sediment spatial relationships (Demas and Rabenhorst, 2001). The sediments are often only sampled to a depth of 30 cm or less. Sampling at a fixed depth often has the effect of mixing together surface and subsurface horizons. Using this approach, maps that have been developed to date represent single parameters, such as grain size distribution. A number of these studies sometimes have included the collection of a few sediment cores (depths ranging from 1 to 10 m or more) from the central portions of lagoons or at equidistant locations along transects. The cores are then often described based on regularly spaced intervals. There are several different geological sediment classifications that tend to use broad classes to describe the sediment, such as mud, silty sand (Flemming, 2000), and sand-silt-clay (Shepard, 1954). This may cause problems when trying to compare sediments that were described using different classification schemes due to the lack of consistency in the terminology.

An alternative strategy using a pedologic approach to study shallow water substrates was first applied by Demas (1996) in Sinepuxent Bay, MD. With this approach the shallow water substrates are considered soils and are studied as a three-dimensional collection of horizons that are linked across the landscape (Demas and Rabenhorst, 1999; Bradley and Stolt, 2001). These studies are based on the underlying assumption that the soils vary systematically across landscape units. Therefore, the soils are characterized based upon their physical and chemical properties as a function of depth, instead of as single surface parameters. By studying these areas as soils, a hierarchical taxonomic classification system can be utilized that provides more detailed information. For example, rather than classifying surficial sediment simply as a mud, one might better describe the entire pedon using the soil classification system, as a fine-silty, Typic

Sulfaquent. This classification provides information regarding the texture (18-35% clay), the presence of sulfidic materials in the profile, and the low bearing capacity of the soil. And if this soil were classified as a particular soil series, even more useful information can be included. This additional knowledge about the physical and chemical properties of the soils can be utilized in making decisions about the use and management of these estuaries and coastal lagoons.

Subaqueous Soils

Sediments are "solid bits and pieces of materials (fragments of rocks and minerals) produced by weathering, transported by various agents like wind, ice, running water, and mass movement, either deposited or precipitated in layers on, at, or near the Earth's surface normally as loose, unconsolidated material" (Prothero and Schwab, 2004). Sediments deposited in water bodies have been described and mapped according to sedimentary geological terms. There have been several suggestions over the last 150 years that these subaqueous sediments be considered within the realm of soil science (v. Post, 1862; Kubiena, 1953; Muckenhausen, 1965; Ponnamperuma, 1972). According to Hansen (1959), in the 1860's v. Post (1862) developed a nomenclature for subaqueous soils where he introduced the terms "gyttja" and "dy" to describe limnic sediments. Gyttja soil was a "coprogenic formation consisting of a mixture of fragments from plants, numerous frustules from diatoms, grains of quartz and mica, siliceous spicules from Spongilla, and exoskeletons from insects and crustaceans" (Hansen, 1959). Dy soils consisted of the same constituents as gyttja, but in addition had "brown humus particles" (Hansen, 1959). These gyttja and dy soil materials differed in the amount of organic materials they contained with gyttja being organic rich and dy being organic poor.

Kubiena (1953) proposed a soil classification system for Europe that included sub-aqueous soils. His classification system was comprehensive and included all soils "including the neglected sub-aqueous soils" to facilitate a better understanding of soil formation processes. Kubiena (1953) separated the sub-aqueous soils into two main categories: 1) young soils always covered with water that do not form peat (our subaqueous soils); and 2) young sub-aqueous soils with peat formation (what would mostly be Histosols in emergent wetlands, bogs, or forests). Kubiena's sub-aqueous soils classification system is presented in Table 2-1. The terms developed by Kubiena are not currently used in *Soil Taxonomy* or the World Reference Base. Therefore it is a difficult system to use in describing subaqueous soils. Kubiena also introduced horizonation of the sub-aqueous soil profiles. For example, (A)C, AC, and AG soils described soils that do not have a distinct humus layer (an A horizon), those that do have a distinct humus layer, and those with a humus layer underlain by a gleyed horizon, respectively. Although Kubiena was the first to develop a classification system for subaqueous soils, there is no evidence that this classification system is currently in use anywhere. Muckenhausen (1965) proposed a soil classification system for the Republic of Germany based on Kubiena's (1953) work. He classified these soils as Subhydric soils and described four types of soils (Table 2-2). Ponnamperuma (1972) also thought that use of the term soil was justified for the uppermost layers of unconsolidated aqueous sediments found in rivers, lakes, and oceans for the following reasons: 1) they were formed from soil components; 2) soil forming processes were occurring; 3) they contained organic matter and living organisms; 4) the bacteria occurring there were similar to those found in

Table 2-1. Classification of Sub-Aqueous soils in Kubiena's Soils of Europe (Modified from Kubiena, 1953).

Sub-Aqueous Soils not Forming Peat	Interpretation of the Soil
I Protopedon Chalk deficient Protopedon Dystrophic lake iron Protopedon Lake Marl Protopedon Sea Chalk Protopedon	Sediments without organic material accumulation
II Dy	Muds low in organic matter and nutrients
III Gyttja Limnic Gyttja 1. Eutrophic Gyttja 2. Chalk Gyttja 3. Oligotrophic Gyttja 4. Dygttja Marine Gyttja 1. Schlickwatt Gyttja 2. Sandwatt Gyttja 3. Cyanophyceae Gyttja	Organic rich muds, high in nutrients Lake (fresh water) sediments Marine (saline water) sediments
IV Sapropel Limnic Sapropel Marine Sapropel 1. Mudwatt Sapropel 2. Diatomwatt Sapropel	Dark colored sediments rich in organic matter Lake (fresh water) sediments Marine (saline water) sediments
Peat Forming Sub-Aqueous Soils	
V Fen Turf-Fen (Turf Peat Moor) 1. Phragmites-Fen (Reed Peat Moor) 2. Carex-Fen (Sedge Peat Moor) 3. Hypnum-Fen (Hypnum Peat Moor) Wood-Fen (Swamp Wood Peat Moor)	Emergent wetlands, bogs, and forests

Table 2-2. Classification of Subhydric Soils in the Federal Republic of Germany Soil Categories (Modified from Muckenhausen, 1965). The types of subhydric soils are based on Kubiena's (1953) classification of sub-aqueous soils.

Class	Types
Subhydric soils	I Protopedon
	II Gyttja
	III Sapropel
	IV Dy

terrestrial soils; 5) horizonation was present; and 6) there were differences in texture, mineralogy, and organic matter content.

In the first edition of *Soil Taxonomy* (Soil Survey Staff, 1975) soils were defined as “the collection of natural bodies on the earth’s surface, in places modified or even made by man of earthly materials, containing living matter and capable of supporting plants out-of-doors”. For the most part subaqueous sediments were excluded by this definition, due to the primary requirement that they be able to support rooted plants. Another issue was related to defining the boundaries of soils. The first edition of *Soil Taxonomy* (1975) stated that the upper limit of the soils was “air or shallow water. At its margins it grades into deep water or to barren areas of rock or ice” (Soil Survey Staff, 1975). Therefore, these sediments were further excluded due to their permanent saturation beneath “deep” water.

The definition of soils was changed in the second edition of *Soil Taxonomy* (1999) to accommodate among others, the recent research examining subaqueous materials as soils by Demas (1998). Even though much of his work was published at or after 1999, the work was done prior to this, and in fact, was to a large degree what led to the change in the definition. The change in the definition did inspire others to follow his lead – including Stolt, Bradley, Coppock, Osher etc (Personal communication with Rabenhorst, 2007). The new definition included materials as soils that either demonstrated the formation of soil horizons OR those materials that were capable of supporting growth of higher rooted plants. In addition the boundaries of soil were expanded so that the upper limit of soils became “…soil and air, shallow water, live plants, or plant materials that have not begun to decompose. Areas are not considered to have soil if the surface is permanently covered by water too deep (typically greater than 2.5 m) for the growth of rooted plants. Soil's horizontal boundaries are where it grades into deep water, barren areas, rock, or ice" (Soil Survey Staff, 2006). These changes allowed for subaqueous environments to be studied as soils, owing to the presence pedogenic horizons, regardless of whether plants are growing there.

Nine years ago, the World Reference Base (International Society of Soil Science, 1998) defined soil cover as "a continuous natural body which has three spatial and one temporal dimension". The soil cover had three main features: 1) they were formed by mineral and organic components that include solid, liquid, and gas phases; 2) the components were organized into structures; and 3) soils were undergoing constant evolution. The international definition of soils has also changed over time to accommodate any object forming part of the Earth's surface. In 2006, the World Reference Base (International Union of Soil Science Working Group WRB, 2006) defined soils as "any material within 2 m from the Earth's surface that is in contact with the atmosphere, with the exclusion of living organisms, areas with continuous ice not covered by other material, and water bodies deeper than 2 m. This new definition includes areas of continuous rock, paved urban soils, soils of industrial areas, cave soils, and subaqueous soils (at least in water shallower than 2 m). The change in the USDA's definition of soils as well as that of the International society (WRB) has included environments that are permanently submerged. Therefore, soil scientists have begun to study the sediments of shallow subtidal lagoons and bays and to describe them as soils.

Pedogenic Paradigm Extended to Subaqueous Environments

Demas and Rabenhorst (1999) demonstrated that soil horizons were recognizable and had formed in shallow water substrates due to pedologic processes, and therefore shallow water substrates should be considered subaqueous soils and could be accommodated under a pedologic paradigm. This work resulted in the change in the definition of soils in the second edition of *Soil Taxonomy* (1999).

Simonson's generalized theory of soil formation and Jenny's state factor equation for soil formation have been used to develop an understanding of subaqueous soil development processes. Simonson (1959) proposed that soil genesis be considered as two overlapping steps: 1) accumulation of parent materials and 2) differentiation of horizons in the profile. He attributed horizon differentiation to be the result of the processes of additions, losses, transfers, and transformations. Therefore, following this model of Simonson, to conclude that estuarine sediments are actually soils, it is not sufficient merely that sediments support the growth of higher plants, as required in *Soil Taxonomy* (1999) but it must also be demonstrated that pedogenic processes in these systems are resulting in the formation and development of soil horizons. Demas and Rabenhorst (1999) found evidence of pedogenic processes (additions, losses, transfers, and transformations) active in shallow water sediments leading to the formation of soil horizons. Pedogenic additions in subaqueous soils include the accumulation of shells, vegetative debris, and organic matter, leading to the formation of A horizons in the sediments. In subaqueous systems transfers or translocations of materials into and through the sediments occur through processes of diffusion and bioturbation. An example of this is the movement of oxygen from the overlying water column into the upper portion (centimeters) of the soil profile both by diffusion and bioturbation caused by benthic fauna. This results in a thin oxidized horizon at the surface. Examples of pedogenic transformations in subaqueous soils included the formation of solid phase sulfide minerals by the process of sulfidization and also the microbial decomposition of organic residues. The combination of these processes that are acting in the shallow water sediments of Sinepuxent Bay led to the development of identifiable pedogenic soil horizons and therefore, these systems were understood to be subaqueous soils (Demas and Rabenhorst, 1999).

Jenny (1941) developed the state factor equation to explain the genesis and distribution of subaerial soils: $S = f\,(C, O, R, P, T, \ldots)$. Based on his work, soils were seen as a product of five interacting factors – climate, organisms, relief, parent material, and time. In this equation climate (C) included the temperature and precipitation conditions under which the soils form. The organisms (O) factor represented the role of plants, animals, and microbes impacting the soil formation processes. The relief (R) term reflected the influence of topography or location on the formation of soils across a landscape. The parent material (P) factor included the nature, mineralogy, and origin of the geological material from which the soils form. The time (T) term reflected the length of time the other factors have been influencing soil formation, or the age of the soil. The "dot" factor was a later edition to the model that allowed for additional yet unspecified factors that impact the formation of soils.

In 1972, Folger described the primary factors affecting estuarine sediment composition and distribution. Folger's model is abbreviated using the following equation: $Se = f\,(G, H, B)$ and describes sediment accumulation as a function of three factors, geology (G), hydrology (H), and bathymetry (B). Geology (G) represents the physical and mineralogical properties of the geologic material from which the sediments were derived. Hydrology (H) included such components as the rate of fresh water influx, salinity, tidal range, and current velocities. Bathymetry (B) refers to the depth of water within the estuary which affects such things as energy of transport, wave action, etc.

State Factors of Subaqueous Soil Formation

Jenny's factors of terrestrial soil formation and Folger's factors for estuarine sediment composition and distribution were integrated and enhanced to develop a state factor model for the formation of subaqueous soils shown in Figure 2-10 (Demas and Rabenhorst 2001). The climatic regime (C) in subaqueous soils primarily includes regional temperature effects. Temperature has direct impact on the rate of chemical reactions in the soil and has the indirect affect of impacting the fauna and flora that are present. Organisms (O) that impact subaqueous soil formation include macroflora, macrofauna, and microbes. The macroflora, such as submerged aquatic vegetation or macroalgae, add organic matter to the soil through growth and subsequent decomposition. This of course also provides an energy source for microbes to facilitate other biogeochemical processes, such as nutrient cycling. The subsurface plant activity can also modify the soil chemistry. For example, seagrasses release oxygen into the sediments which oxidize compounds such as reduced iron and sulfides (Holmer et al., 2005). Macroflora can physically stabilize the surface by protecting the soil against erosion by slowing water currents at the soil surface. Their effectiveness at doing so, however, is dependent on the density of the plants. Low population densities of some plants can be destabilizing due to erosion around the base of individual plants (Koch,

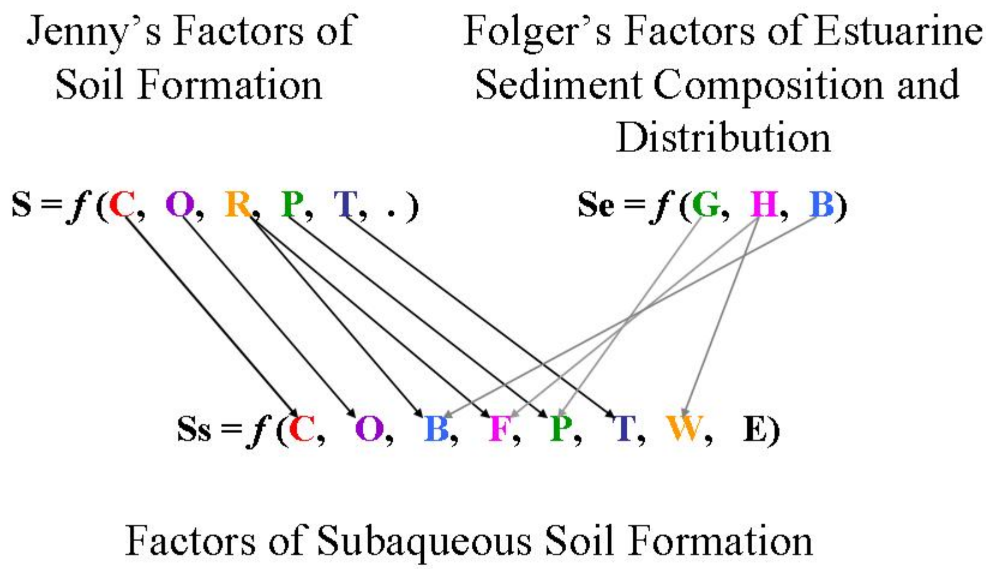

Figure 2-10. Synthesis of Jenny's Factors of Soil Formation and Folger's factors of estuarine sediment composition and distribution were used to create the Factors of Subaqueous Soil Formation. Jenny's factors of soil formation included climate (C), organisms (O), relief (R), parent material (P), time (T), and dot factor (**.**). Folger's factor of estuarine sediment composition and distribution included geology (G), hydrology (H), and bathymetry (B). The factors of subaqueous soil formation included climate (C), organisms (O), bathymetry (B), flow regime (F), parent material (P), time (T), water column attributes (W), and catastrophic events (E).

2001). The macrofauna, such as clams and worms as well as epibenthic forms such as crabs, can cause mixing of the surface horizons, which aids in the oxidation of the upper portion of the soil by incorporating oxygenated water. The bathymetry factor (B) includes the depth of water and also the relief. The slope of the landscape in most subaqueous soil systems is very subtle. Furthermore, the topography is difficult to observe due to the overlying water. Nevertheless, a study of subaqueous topography may permit the recognition of distinctive subaqueous landforms. The flow regime (F) includes the speed, direction, and fluctuation of the moving water. These parameters are in turn related to location in the estuary, distance to the inlet, the magnitude of tidal activity, and the bathymetry. The parent material (P) refers to the geologic source materials from which or in which the soils are found and includes such properties as sediment mineralogy of the soils and particle size distribution. Time (T) refers to the length of time that the pedogenic processes have been active, or the age of the soil. Subaqueous soils in estuarine systems are generally young (late Holocene age) but can vary in age. Some of the late Holocene age soils may overlie, buried, or truncated soils that are older (late Pleistocene or even older). The water column attributes (W) are related to the chemistry of the water, such as salinity, alkalinity, percent oxygen saturation, and sulfate content. These parameters affect the flocculation of particles, oxidation rates, and the propensity to form of hydrogen sulfide gas, which can be toxic to some benthic species and which is involved in the formation of sulfide minerals. Catastrophic events (E) refer to such episodes as hurricanes and northeastern storms which can potentially impact the stability of the landscapes and in some cases cause significant erosion or deposition. This state factor equation allows for the development of conceptual models that aid in the understanding of the genesis and distribution of subaqueous soils within an estuary.

Research on Subaqueous Soils

The pedologic paradigm refers to the use of landforms as a tool to predict how the soils change across the landscape (Hudson, 1999). The components of the soil landscape paradigm can be described in the following statements: 1) the factors of soil formation interact and as a result soils within the same region develop the same soil; 2) the more similar two landscape units are the more similar the soils are; 3) adjacent areas have a predictable spatial relationship; and 4) once the soil-landscape relationship has been identified it can be used to predict soil cover in other areas by determining the characteristic soil-landscape unit. (Hudson, 1992).

The soil-landscape paradigm can be considered a synthesis of soil forming factors and landscape position (Hudson, 1992). By using the soil-landscape paradigm soils are studied as pedons, (natural three-dimensional entities) which are linked across the landscape. Soil pedons are studied and characterized by observing a combination of properties that are found in each pedon (which include multiple soil horizons) instead of focusing on a single property (and only in a single, usually surface, horizon). The collection of soil properties are synthesized and used to aid in the mapping of soil units. The landscapes are delineated into units that have similar soil properties and characteristics within a specific region. The use of the association of certain soils with certain landforms aids in the identification of soils across a landscape. In estuaries and coastal lagoons, direct observation of landscape units covered by water greater than one meter is nearly impossible due to the obscuring effects of the overlying water. However, shallow water landforms (generally in water <1 m in depth) are identifiable on high resolution infrared photographs. Using high quality bathymetric digital elevation models (DEMs) landscape units can be delineated based on water depth, slope, landscape shape, depositional environment, proximity to fresh water, and geographical setting. Relationships between subaqueous landscapes and associated soils have already been documented in previous studies by Demas (1998) in Sinepuxent Bay, MD, Bradley and Stolt (2003) in Ninigret Pond, RI, and Osher and Flannagan (2006) in Taunton Bay, ME. Thus, the association of certain soils with certain landforms (or what is called a soil-landscape model) that have been developed within each of these settings, can be used to predict where the various soils occur on similar landscapes nearby.

A first attempt at obtaining soils information can be obtained for a particular area by collecting geomorphic maps, high quality aerial photography, and established soil-landscape models for the region. A preconceived notion of what types of soils to expect is based upon established soil-landscape models. This is the fundamental principle of the pedologic paradigm (Hudson, 1990). Initially soil boundaries are based on landforms (geomorphic maps). These boundaries are checked by collecting information on the soils across the landforms and boundaries to confirm the soil properties and systematic changes (Schaetzl and Anderson, 2005). This process leads to confirming the lines, adding new lines, or aggregating landforms together. In subaerial settings, changes in topography (slope curvature, steepness, or aspect) affect which soils can exist at a site and soils can be identified on terrain alone (Moore et al., 1993). In subaqueous settings the slope is very subtle and is not as useful in identification of landforms and soils.

However, water depth and depositional environments are more useful in the identification of particular soils.

Demas (1998) created the first subaqueous soil investigation in the USA in Worcester County, Maryland. The study area was a 1300 ha portion of Sinepuxent Bay. Sinepuxent Bay has an average daily tidal range of less than 0.5 to 0.75 m and water depths less than 4.5 m and is connected to the Atlantic Ocean through Ocean City inlet. In this work, Demas identified seven distinct subaqueous landforms based on slope gradients, concavity, and convexity, and water depths (actual elevation), to which he applied the following names: mid-bay shoal; overwash fans; barrier island flats; shallow mainland coves; deep mainland coves; transition zones; and central basin. From 85 soil profile descriptions and associated characterization data, Demas identified six soil series that were associated with the seven major landforms described in Sinepuxent Bay, concluding that subaqueous soil properties are a function of the landform. He observed that bathymetry, flow regime, and geomorphic setting had the greatest impact on the properties and classification of the subaqueous soils on the various landforms. The major soils associated with the landforms identified in Sinepuxent Bay are shown in Table 2-3.

Bradley and Stolt (2003) conducted a soil investigation in a 116 ha portion of Ninigret Pond, Rhode Island. Ninigret Pond was a shallow, microtidal (average daily tidal range of 7 to 16 cm) estuary open to the Atlantic Ocean through Block Island Sound. Bradley and Stolt delineated 12 subaqueous landforms based on water depth, slope, landscape shape, and depositional environment. In naming the landforms they

Table 2-3. Landforms and the associated soils found in Sinepuxent Bay, Maryland (Modified from Demas, 1999).

Landform Name	**Classification (*Soil Taxonomy*)**	**Series**	**Diagnostic Soil Properties Used in Series Differentia**
Mid-Bay Shoal	Coarse-loamy, Typic Sulfaquents	Sinepuxent	1. Sulfidic materials 2. Fluid (n value >0.7) 3. Multiple lithologic discontinuities
Overwash Fans	Typic Psammaquents	Fenwick	1. Sandy soils 2. Non-fluid (n value <0.7) 3. Low organic C content
Barrier Island Flats	Coarse-loamy, Sulfic Fluvaquents	Tizzard	1. Sulfidic materials 2. Irregular Organic C distribution
Shallow Mainland Coves	Typic Psammaquents	Newport	1. Sandy soils 2. Chroma 3 or greater in subsoil
Deep Mainland Coves	Fine-silty, Typic Sulfaquents	South Point	1. Finer textured 2. Fluid (n value > 0.7) 3. Buried organic horizons within upper 1m 4. Sulfidic materials 5. Highest organic C contents
Transition Zones	Typic Psammaquents	Wallops	
Central Basin	Fine-silty, Typic Sulfaquents	No Series Available	

observed, they tried as much as possible to use terms already in use in the geological and geographical literature. The 12 landforms identified in Ninigret Pond were named lagoon bottom, storm-surge washover fan flat, flood-tidal delta flat, storm-surge washover fan slope, flood-tidal delta slope, barrier cove, mainland submerged beach, mainland cove, mainland shallow cove, mid-lagoon channel, barrier submerged beach, and shoal. The subaqueous soils that they found to be associated with these landforms were classified into six different subgroups according to *Soil Taxonomy* (1999). The major soils associated with the landforms identified in Ninigret Pond are shown in Table 2-4. The distribution of the subaqueous soils across the landforms supported the use of soil-landscape paradigm and the models created for Sinepuxent Bay, MD were enhanced to accommodate the soils described in Rhode Island.

Osher and Flannagan (2007) studied the subaqueous soils in Taunton Bay, Maine a 1,300 ha shallow, mesotidal (mean tidal range is 2.7 m) estuary open to the Atlantic Ocean through Frenchman's Bay. Osher and Flannagan (2007) delineated seven landforms based on photo tone, water depth, slope, and position on landscape. Landforms identified in Taunton Bay are different from those described in Rhode Island and Maryland due to the different processes that shaped the landforms and soils. Taunton Bay differed from these other coastal lagoons by the absence of a barrier island system and a much greater tidal range. The seven new landforms identified in Taunton Bay were named terrestrial edge, coastal cove, submerged fluvial stream, mussel shoal, fluvial marine terrace, channel shoulder, and channel. Ten different soil map units were identified and delineated according to slope class, geomorphic position, depositional

Table 2-4. Landforms and the associated soils found in Ninigret Pond, Rhode Island (Modified from Bradley and Stolt, 2003).

Landscape Unit	**Classification (*Soil Taxonomy***
Lagoon Bottom	Typic Hydraquent
Storm-surge Washover Fan Flat	Typic Sulfaquent
Flood-tidal Delta Flat	Typic Psammaquent
Storm-surge Washover Fan Slope	Typic Fluvaquent
Flood-tidal Delta Slope	Typic Fluvaquent
Mainland Submerged Beach	Typic Endoaquent
Barrier Cove	Typic Sulfaquent
Mainland Shallow Cove	Typic Endoaquent
Mid-lagoon Channel	Typic Endoaquent
Barrier Submerged Beach	Typic Endoaquent
Shoal	Typic Endoaquent
Mainland Cove	Thapto-Histic Hydraquent

environment, and soil characteristics. The major soil map units and the soils associated with the landforms identified in Taunton Bay are presented in Table 2-5.

In conjunction with this study, Jespersen and Osher (2006) estimated the carbon stored in subaqueous soils of Taunton Bay, Maine. The average organic carbon content in the upper 100 cm of the estuarine soils was 2.4% with an average bulk density of 0.67 g cm^{-3}. The organic C content within soils of the estuary was 136 Mg C ha^{-1}, which was greater than the C content in Maine's subaerial soils. The soil map units identified by Osher and Flannagan (2007) were regrouped based on the depth of the fine estuarine parent material and landscape position. The submerged fluvial stream and marshes had the highest organic C content with 177 Mg C ha^{-1} and the recently submerged edges and coves had the lowest organic C content with 67 Mg C ha^{-1}. The data collected in this study provided valuable data for regional and global C budgets.

There are several other subaqueous soil investigations currently underway. Coppock et al. (2003) is working on the subaqueous soil inventory of a 5,000 ha coastal lagoon in Rehoboth Bay, Delaware. Coppock et al. delineated 22 landform units throughout Rehoboth Bay. Eleven subaqueous soil map units were delineated and were differentiated based on texture, the presence or absence of sulfidic materials, and occurrence of buried organic horizons (Coppock, 2003). Payne and Stolt (2006) are investigating subaqueous soils in Little Narragansett Bay, Greenwich Bay, and Wickford Harbor, RI. Between 40 and 45 individual soil-landscape units have been identified and delineated based on slope, water depth, surficial geology, and geographical location. The dominant landforms identified include: bay bottom, depositional shoreline platform, mainland cove, fluviomarine bottom, and submerged beach. Several anthropogenic

Table 2-5. Landforms and the associated soils found in Taunton Bay, Maine (Modified from Osher and Flannagan, 2007).

Landscape Unit	**Soil Map Unit**	**Classification (*Soil Taxonomy*)**
Terrestrial Edge	Submerged Marsh	Fine-silty, Typic Sulfaquents
	Submerged Beach	Coarse-loamy, Haplic Sulfaquents
	Submerged Fluvial Delta	Sandy, Haplic Sulfaquents
	Terrestrial Edge	Coarse-loamy, Sulfic Endoaquents
Coastal Cove	Shallow Coastal Cove	Coarse-loamy, Haplic Sulfaquents
	Deep Coastal Cove	Coarse-silty, Typic Sulfaquents
Submerged Fluvial Stream	Submerged Fluvial Stream	Fine-silty, Typic Sulfaquents
Mussel Shoal	Mussel Shoal	Fine-silty, Typic Sulfaquents
Fluvial Marine Terrace	Fluvial Marine Terrace	Fine-silty, Typic Sulfaquents
Channel Shoulder	Channel Shoulder	Fine-silty, Typic Sulfaquents Fine-silty, Typic Endoaquents
Channel		

landform units were identified; these include marina units, dredged channels, and dredge deposit shoals.

Submerged Aquatic Vegetation Habitat Requirements

Subaqueous soil information collected in coastal estuaries and lagoons could make considerable contributions to estuarine research and restoration efforts. Due to increased eutrophication of many estuaries, submerged aquatic vegetation (SAV) restoration studies have been focused on water quality parameters affecting the availability of light for photosynthesis. However, in areas where the water quality is not limiting other parameters have the potential to control the suitability of the site for SAV growth (Batiuk et al., 2000). Several studies have begun to recognize sediment characteristics as another important factor affecting the seagrass distribution. Sediments can impact the growth, morphology, and distribution of seagrasses due to erosional/depositional processes, availability of nutrients, and presence or absence of phytotoxins. Several sediment characteristics have been documented to impact the growth and success of SAV including porewater sulfide concentration, organic matter content, and grain size distribution. An overview of these studies is presented in Table 2-6.

Hydrogen sulfide is a known phytotoxin to wetland macrophytes including *Spartina alterniflora, Spartina townsendii, Panicum hemitomon,* and rice plants (Koch and Mendelssohn, 1989; Goodman and Williams, 1961; Okajima and Takagi, 1953). In hydroponic experiments, Goodman and Williams (1961) demonstrated that the addition of 0.94 mM H_2S caused *Spartina townsendii* rhizomes to become 'soft rotted' and in similar studies, Koch and Mendelssohn (1989) demonstrated that the addition of 1.0 mM

Table 2-6. Summary of sediment characteristics defining habitat constraints for submerged aquatic vegetation in fresh water and marine environments.

Sediment Characteristics	Seagrass Type	Ecological Environment	Range where growing	Optimum Range	Limiting Range	Type of Research	Reference
Sulfide concentrations	*Zostera marina*	Polyhaline	200 to >800 µM	<200 µM	>400 µM	Laboratory experiment in Chincoteague Bay, MD using mesocosms collected from Chincoteague Bay sediments and to treated to reduce or increase ambient sulfide levels to study the impact on photosynthesis	Goodman et al 1995
			<6.5 µM in porewater unvegetated sites 1.1 to 43 µM in porewater vegetated sites AVS and CRS 0.6 to 3.2µM cm^{-3} (0.02 to 0.5 g kg^{-1})			Field study in Roskilde Fjord, Denmark measuring biomass and sediment sampling.	Holmer and Nielsen 1997
			72.7 µM			Field study Roskilde Fjord, Denmark examining the effect of the addition of sucrose on sediment conditions.	Terrados et al. 1999
			< 5 g kg^{-1} Chromium reducible sulfides			Field study in Sinepuxent Bay, MD measuring biomass and soil types.	Demas 1998

Table 2-6. Continued.

Sediment Characteristics	Seagrass Type	Ecological Environment	Range where growing	Optimum Range	Limiting Range	Type of Research	Reference
Sulfide Concentrations	*Zostera marina*	Polyhaline	0.3 to 1.5 g kg^{-1} Acid volatile sulfides			Field study in Ninigret Pond, RI measuring biomass and soil types.	Bradley and Stolt 2006
	Ruppia maritima		< 5 g kg^{-1} Chromium reducible sulfides			Field study in Sinepuxent Bay, MD measuring biomass and soil types.	Demas 1998
	Seagrasses				>200 µM	Review of literature.	Kemp et al. 2004
				<100 µM	>400 µM	Compilation of data from literature, suggested values only.	Koch 2001
	Thalassia testudinum		350 to 1000 µM	<100 µM	>200 µM	Field study in Florida Bay.	Carlson et al. 1998
			< 2000 µM			Compilation of data from literature, suggested values only.	Koch 2001
	Thalassia hemprichii		2.3 µM			Field study examining the effect of the addition of sucrose on sediment conditions.	Terrados et al. 1999
	Cymodocea nodosa		50.2 µM			Field study examining the effect of the addition of sucrose on sediment conditions.	Terrados et al. 1999
Organic Matter	*Zostera marina*		0.4 to 0.5 % organic matter			Field study in North Carolina measuring biomass and sediment sampling.	Fonseca and Bell 1998

Table 2-6. Continued.

Sediment Characteristics	**Seagrass Type**	**Ecological Environment**	**Range where growing**	**Optimum Range**	**Limiting Range**	**Type of Research**	**Reference**
Organic Matter	*Zostera marina*	Polyhaline	0.8 to 1.4 % organic matter			Field study in Chesapeake Bay measuring biomass and sediment sampling.	Orth 1977
			0.9 to 3.4 % organic carbon	<2 % organic carbon	>3 % organic carbon	Field study in Sinepuxent Bay, MD measuring biomass and soil types.	Demas 1998
			0.2 to 7 % organic carbon			Field study in Ninigret Pond, RI measuring biomass and soil types.	Bradley and Stolt 2006
			<4 % organic carbon			Observations made in Taunton Bay, ME during soil sampling.	Osher and Flannagan 2007
	Ruppia maritima		0.9 to 3.4 % organic carbon	<2 % organic carbon	>3 % organic carbon	Field study in Sinepuxent Bay, MD measuring biomass and soil types.	Demas 1998
		Mesohaline	<2 % organic matter			Field study in Chesapeake Bay examining suspended particulate material in vegetated areas.	Ward et al. 1984
	Halodule wrightii	Polyhaline	0.4 to 0.5 % organic matter			Field study in North Carolina measuring biomass and sediment sampling.	Fonseca and Bell 1998
	Thalassia testudinum		Avg. 0.78% organic carbon			Field study in Laguna Madre, TX.	Lee and Dunton, 2000
			1.5 to 4.6% organic carbon			Field observations in reef lagoon of Puerto Morelos in Mexico.	Enriquez et al. 2001
	Syringodium filforme		1.5 to 4.6% organic carbon			Field observations in reef lagoon of Puerto Morelos in Mexico.	Enriquez et al. 2001

Table 2-6. Continued.

Sediment Characteristics	Seagrass Type	Ecological Environment	Range where growing	Optimum Range	Limiting Range	Type of Research	Reference
Organic Matter	Seagrasses	Fresh water to polyhaline	0.8 to 16.4 % organic matter	<5 % organic matter	6.5 to 16.4 % organic matter	Compilation of data from literature, suggested values only.	Koch 2001
				<5 % organic matter	>5 %	Review of literature.	Kemp et al. 2004
	Hydrilla verticillata	Fresh water	1 to 65 % organic matter	<5 % organic matter	> 20% organic matter	Laboratory growth experiments on sediments collected from 17 North American lakes.	Barko and Smart 1986
			5 to 20% organic matter	<5 % organic matter	> 10% organic matter	Greenhouse experiments using sediments from Lake Washington, WA with five organic matter additions	Barko and Smart 1983
	Elodea Canadensis		5 to 20% organic matter	<5 % organic matter	> 10% organic matter	Greenhouse experiments using sediments from Lake Washington, WA with five organic matter additions	Barko and Smart 1983
	Myriophyllum spicatum		5 to 20% organic matter	<5 % organic matter	> 10% organic matter	Greenhouse experiments using sediments from Lake Washington, WA with five organic matter additions	Barko and Smart 1983
			1 to 65 % organic matter	<5 % organic matter	> 20% organic matter	Laboratory growth experiments on sediments collected from 17 North American lakes.	Barko and Smart 1986
Grain Size	*Zostera marina*	Polyhaline		Sandy substrates		Observational study in Chesapeake Bay, MD.	Hurley 1990
			Sand to sandy loam	Loamy sand	Silt loam Dense sands	Field study in Sinepuxent Bay, MD measuring biomass and soil types.	Demas 1998

Table 2-6. Continued.

Sediment Characteristics	Seagrass Type	Ecological Environment	Range where growing	Optimum Range	Limiting Range	Type of Research	Reference
Grain Size	*Zostera marina*	Polyhaline	Coarse sand to silt loam	Very fine sandy loam to silt loam	Coarse sand to very fine sand	Field study in Ninigret Pond, RI measuring biomass and soil types.	Bradley and Stolt 2006
			5 to 11 % silt and clay			Field study in North Carolina measuring biomass and sediment sampling.	Fonseca and Bell 1998
			85 to 92% sand			Field study in Chesapeake Bay measuring biomass and sediment sampling.	Orth 1977
			Silt Loam			Field observations in Taunton Bay, ME	Osher and Flannagan 2007
			Cobble free and < 70% silt/clay			Site selection model, Preliminary Transplant Suitability Index (PTSI) for identification of potential *Zostera marina* habitat in New Hampshire.	Short et al 2002
	Ruppia maritima		Silt/clay mixture to coarse sand	Fine to medium sand		Experimental using grain sizes of ground glass.	Seeliger and Koch (unpublished)
			Sand to sandy loam	Loamy sand	Silt loam Dense sands	Field study in Sinepuxent Bay, MD measuring biomass and soil types.	Demas 1998
			Soft muddy sediments to sandy substrates	Sandy substrates		Observational study in Chesapeake Bay, MD.	Hurley 1990
	Halodule wrightii		5 to 11 % silt and clay			Field study in North Carolina measuring biomass and sediment sampling.	Fonseca and Bell 1998

Table 2-6. Continued.

Sediment Characteristics	**Seagrass Type**	**Ecological Environment**	**Range where growing**	**Optimum Range**	**Limiting Range**	**Type of Research**	**Reference**
Grain Size	*Halodule wrightii*	Polyhaline		High quantities of sand, low quantities of silt and clay		Field descriptive study in Apalachee Bay, northeast Gulf Coast of Florida.	Livingston et al. 1998
	Thalassia testudinum			High quantities of sand, low quantities of silt and clay		Field descriptive study in Apalachee Bay, northeast Gulf Coast of Florida.	Livingston et al. 1998
	Syringodium filforme			High quantities of sand, low quantities of silt and clay		Field descriptive study in Apalachee Bay, northeast Gulf Coast of Florida.	Livingston et al. 1998
	Seagrasses	Marine/ estuarine	0.4 to 72% silt and clay (<63 µm)	<20% silt and clay		Compilation of data from literature, suggested values only.	Koch 2001
			0.4 to 72% silt and clay (<63 µm)	<20 to 30% silt and clay (by weight)		Review of literature.	Kemp et al. 2004
	Seagrass meadows	Polyhaline	1 to 50% silt and clay	<10% silt and clay	>20% silt and clay	Field study in Andaman coast of Southern Thailand and Western Philippines coast.	Terrados et al. 1999
	Potomogeton perfoliatus	Fresh water to mesohaline	Firm muddy sediments			Observational study in Chesapeake Bay, MD.	Hurley 1990
	Hydrillia verticillata	Fresh water	Silt to muddy substrates			Observational study in Chesapeake Bay, MD.	Hurley 1990

Table 2-6. Continued.

Sediment Characteristics	Seagrass Type	Ecological Environment	Range where growing	Optimum Range	Limiting Range	Type of Research	Reference
Sediment Density	*Zostera marina*	Polyhaline			Dense sands	Field study in Sinepuxent Bay, MD measuring biomass and soil types.	Demas 1998
					Dense sands	Field study in Ninigret Pond, RI measuring biomass and soil types.	Bradley and Stolt 2006
	Ruppia maritima				Dense sands	Field study in Sinepuxent Bay, MD measuring biomass and soil types.	Demas 1998
	Myriophyllum spicatum	Fresh water to mesohaline	0.1 to 1.3 g ml^{-1}	0.2 to 0.9 g ml^{-1}	<0.2 or >0.9 g ml^{-1}	Laboratory growth experiments on sediments collected from 17 North American lakes.	Barko and Smart 1986
	Hydrillia verticillata	Fresh water	0.1 to 1.3 g ml^{-1}	0.2 to 0.9 g ml^{-1}	<0.2 or >0.9 g ml^{-1}	Laboratory growth experiments on sediments collected from 17 North American lakes.	Barko and Smart 1986

H_2S resulted in lower biomass of marsh grass species *Spartina alterniflora* and *Panicum hemitomon*. Okajima and Takagi (1953) showed limited rice above ground growth and root hair development in the presence of 1.0 mM H_2S.

It has also been demonstrated that porewater sulfide is toxic to estuarine and marine SAV species. Seagrasses inhabit sediments that are often anoxic below the upper 2 to 3 cm and may be highly reduced due to the presence of sulfides in the porewater (Terrados et al., 1999). In organic-rich sediments the sulfide concentrations are often elevated and extended periods of sediment hypoxia have been associated with the decline of *Thalassia testudinum* (Carlson et al., 1994; Koch, 1999). However, oxygen produced during photosynthesis by seagrasses may be transported through the roots into the rhizosphere. Thus, reduced compounds in the sediments, such as iron and sulfides, become oxidized by the released oxygen creating a less toxic environment for the seagrasses. Elevated porewater sulfide levels may contribute to seagrass die-off in areas with extra stresses such as decreased light availability due to water column turbidity or shading by macroalgae or epiphytes (Lee and Dunton, 2000). In Florida Bay, porewater sulfide concentrations were higher in die-off areas than healthy seagrass beds (*Thalassia testudinum*), suggesting that the sulfide toxicity may be a factor in seagrass loss (Carlson et al., 1994). Correlations between porewater sulfide concentrations and growth of *Thalassia testudinum* have indicated that concentrations above 100 μM may be toxic (Carlson et al., 1994), which was similar to observations by Goodman et al. (1985). They demonstrated that mesocosm sediments with sulfide concentrations between 100 and 200 μM had a negative impact on photosynthesis in *Zostera marina*. Due to the ephemeral and transitory nature of porewater sulfide in these environments it is often difficult to quantify (Carlson et al., 1994). Sediment sulfide concentrations, as sulfide bearing minerals, could be used as a surrogate in estimating the concentration of soluble sulfide in estuarine/marine environments. It can be reasoned that sediments with higher soluble sulfide generation have an increased likelihood for sediment sulfide accumulation as monosulfides and disulfides. The concentration of solid phase sulfides in these sediments is less ephemeral and more easily obtainable in these environments. Thus these data could be used to indicate the potential for sulfide toxicity. In Sinepuxent Bay, MD, where sediment sulfide concentrations were measured in areas with healthy *Zostera marina* and *Ruppia martima* beds the levels were less than 5 g kg^{-1} (Demas and Rabenhorst, 1999). These values were greater than concentrations measured by Bradley and Stolt (2006) in sediments supporting healthy *Zostera marina* where concentrations were less than 1.5 g kg^{-1} and in Demark sediments supporting *Zostera marina* had values less than 0.5 g kg^{-1} (Holmer and Nielsen, 1997). Although the studies examining the relationship between sediment sulfide concentrations and SAV growth are limited, we can reasonably surmise that low sediment sulfide concentrations are favorable for healthy SAV habitats.

Organic matter in submerged sediments has been shown to have a positive effect on plant growth, due to the release of nitrogen and phosphorus during the mineralization of the organic matter (Sand-Jensen and Sondergaard, 1979). However, at high quantities organic matter have a negative effect on the growth of submerged macrophytes probably due to their contribution to the formation of phytotoxins, such as S^{2-} in brackish sediments (Barko and Smart, 1983). Barko and Smart (1983) demonstrated using laboratory experiments that the growth of fresh water SAV was limited to sediments containing less than 5% organic matter and SAV growth diminished at levels greater than 5% organic matter. In the Mid-Atlantic region healthy *Zostera marina* has been observed growing on sediments with organic matter contents less than 2% (Orth, 1977; Ward et al., 1984; Demas, 1998). However in Rhode Island, Bradley and Stolt (2006) found *Zostera marina* growing on soils with higher organic matter contents (up to 4%) than in the Mid-Atlantic region. In warmer climates, *Thalassia testudinum* was observed on sediments with organic carbon levels of 0.8 to 4.6%, which is similar to the Mid-Atlantic region (Lee and Dunton, 2000; Enriquez et al., 2001). The limitation of higher organic matter content on SAV growth is not well understood (Koch, 2001) although it may be related to nutrient limitation in very fine sediments associated with high organic deposits (Barko and Smart, 1986) or to high sulfide concentrations associated with increased reduction of sulfate and organic matter oxidation (Nienhus, 1983; Goodman et al., 2005). Overall the organic matter content of sediments supporting healthy *Zostera marina* and *Ruppia martima* was generally less than 5% (3% organic carbon) (Table 2-6).

Submerged aquatic vegetation growth is also impacted by physical and geochemical processes that are associated with grain size distribution (Barko and Smart, 1986). In experiments using glass beads, Seeliger and Koch (unpublished) found that *Ruppia maritima* had maximum growth in fine to medium sand-sized particles. Demas (1998) observed *Zostera marina* and *Ruppia martima* growing on loamy sand (<15 % silt and clay) soils in Sinepuxent Bay, MD, which was similar to observations made by Orth (1977) in the Chesapeake Bay where *Zostera marina* was growing on sediments with 85 to 92% sand. Hurley (1990) also made observations in regard to the type of sediments inhabited by several SAV species in Chesapeake Bay, including *Zostera marina* which grew primarily on sandy substrates and *Ruppia maritima* that was occasionally found on soft muddy sediments but was more commonly on sandy substrates. In contrast to these Mid-Atlantic based studies, Bradley and Stolt (2006) observed *Zostera marina* growing on soils in Ninigret Pond, RI, with greater quantities of silt (>21%) and clay (>8). Observations collected by Osher and Flannagan (2007) in Taunton Bay, ME, also described *Zostera marina* growing on finer textured (silt loam) soils. According to a review of Kemp et al. (2004), *Zostera marina* and *Ruppia maritima* are generally more abundant in sediments in which silts and clays constitute less than 20 to 30% (by weight). However, several studies (Bradley and Stolt, 2006; Osher and Flannagan, 2007) indicated that healthy *Zostera marina* beds were located on sediments with higher amounts of silt and clay. Short et al. (2002) developed a three phase site selection model for *Zostera marina* transplant projects. In this model a general rule was derived from the literature indicating that the preferred sites have sediment conditions that were cobble free and contained less than 70% silt and clay.

Grain size distribution impacts the rate of porewater exchange in the sediments and the amount of nutrients in the sediments. Grain size distributions that are skewed towards silt/clay have lower porewater exchange rates with the overlying water column than sandier sediments (Huettel and Gust, 1992), which can lead to increased nutrient levels but also higher sulfide concentrations in the sediments and porewater (Kenworthy et al., 1982; Holmer and Nielsen, 1997). In higher salinity (18 to 30 ppt) environments it seems as though SAV prefer to inhabit more oxygenated coarser textured sediments (Koch, 2001) that permit higher porewater exchange with the overlying water, which helps maintain tolerable sulfide concentrations in these soils.

Sediment density was another factor that has been shown to influence the growth of submersed fresh water macrophytes, *Myriophyllum spicatum* and *Hydrilla verticillata* (Barko and Smart, 1986). Densities of 0.9 to 1.3 g ml^{-1} occurred in sediments with sand contents >75% and these sediments resulted in reduced growth. Barko and Smart (1986) attributed the reduced growth in these high density sediments to low natural fertility levels associated with these extremely sandy sediments rather than the density itself. Densities of 0.2 g ml^{-1} or less and high organic matter contents also resulted in diminished growth, which the authors attributed to longer diffusion distances (greater tortuosity) that resulted in lower nutrient uptake. In Sinepuxent Bay, MD, Demas (1998) noted the absence of SAV on extremely sandy soils with higher densities. He also attributed the lack of SAV growth on these soils to low fertility levels and difficulty in roots penetrating the dense sands. In a similar field study, Bradley and Stolt (2006) also suggested that *Zostera marina* colonization may be hindered on dense sandy or gravelly soils which have physical characteristics which impede rhizome elongation and nutrient levels. However, Demas (1998) and Bradley and Stolt (2006) did not conclusively determine a density that negatively impacts the health of SAV in these environments and the lower inherit fertility of these materials also complicates the interpretation.

The sediment factors impacting SAV growth and distribution in estuarine and marine environments are not completely independent factors as presented. As wave and current energies decrease, finer sediments and organic matter collect in these low energy environments. These low-energy environments are also conducive for sediment sulfide generation. Thus, the areas with finer textured sediments tend to have higher organic matter and sediment sulfide contents compared to the high-energy environments.

The seagrasses reproduction and recruitment also plays a role in the location and distribution in estuarine environments. Orth et al. (1994) broadcast *Zostera marina* seeds into three unvegetated plots in the Chesapeake Bay (York River, VA) which historically supported vegetation. The seedlings were distributed within 5 m plots, but not beyond these areas. They suggested that the seeds were protected from current flows by microtopographic features (burrows, pits, mounds, and ripples) and demonstrated that seeds settled rapidly and became incorporated into the sediments. These results suggest that seeds stay locally where they were distributed and do not tend to have large scale distribution patterns. Thus, the seed distribution should be taken into consideration in restoration of large landscapes.

Chapter 3: Topographic Analysis and Subaqueous Landforms

Introduction

Traditionally, shallow-water mineral substrates have been studied only by geologists. These sediments were generally sampled using regularly spaced grid patterns (Wells et al., 1994), which were utilized because the spatial relationships among the sediments were not established and there was an underlying assumption that sediment variability was more random than systematic (Wilding and Drees, 1983). Sediments were typically sampled to some fixed depth (< 30 cm) rather than by layer or horizon. As a result of this sampling method, often samples would be composed of a combination of the surface and subsurface materials (horizons). The grid pattern sampling has limited the development and understanding of sediment spatial relationships as it relates to landforms (Demas and Rabenhorst, 2001). Demas et al. (1996) proposed the application of a pedologic paradigm for the mapping of subaqueous soils found in subtidal habitats. They subsequently demonstrated that soil horizons formed in shallow water substrates due to pedologic processes, and that shallow water substrates should be considered subaqueous soils that can be accommodated under a pedologic paradigm (Demas and Rabenhorst, 2001).

Topographic maps are often used as base maps during landscape analysis because landscape units can be delineated based on slope and land-surface shape. As is true with subaerial landscapes, subaqueous landscapes possess discernable topography from which specific landforms can be identified (Demas, 1998; Bradley and Stolt, 2003). Traditional methods used in landscape analysis, such as stereo-photo interpretation and visual assessment of the landscape, have only limited application in submerged environments because the subaqueous landscape units cannot be easily observed in water deeper than 1 m or so. However, in very shallow water these photographs are helpful in identifying specific landforms, such as storm-surge washover features behind barrier islands. Overall, one of the most useful tools in assessing the types of underwater landforms is the development or acquisition of subaqueous topography or bathymetry (Demas, 1998; Bradley and Stolt, 2002).

Topographic information on the subaqueous landscape can be acquired by using bathymetric methods (Demas and Rabenhorst, 1998). Traditionally, bathymetric data are collected by using acoustic soundings, which utilize radio waves transmitted from a transducer head. Water depth is calculated from the time between the transmission and the reception of the reflected signal. In tidal settings, the data set must also be corrected for tidal fluctuations, because the water depths change due to tides. One limitation to using acoustic soundings is that data cannot be collected in very shallow areas, because the water is not deep enough to accommodate the boat draught and transducer head. This limitation can be overcome if the data in shallow areas are collected during exceptionally high tides. Development of a subaqueous topographic map of detail sufficient to perform terrain analysis for the identification and delineation of subaqueous landforms requires a high density and accurate data set. Demas (1998) collected bathymetric data for Sinepuxent Bay, MD at an average density of 0.06 ha per sounding in order to create an accurate bathymetric map. Using this detailed map, he was able to identify subaqueous landforms in Sinepuxent Bay, MD.

Subaqueous landforms and soils have been identified and described in several Atlantic coastal lagoons including Sinepuxent Bay, MD (Demas, 1998), Ninigret Pond, RI (Bradley and Stolt, 2003), Rehoboth Bay, DE (Coppock et al., 2003), and Taunton Bay, ME (Flannagan, 2005). The subaqueous landscapes have been delineated based on submerged topography, land-surface shape, geographic location, water depths, and depositional environments. The types of subaqueous landforms that have been identified in previous studies include barrier coves, dredge channels, flood-tidal delta flats, flood-tidal delta slopes, lagoon bottoms, mainland coves, shoals, storm-surge washover fan flats, and storm-surge washover fan slopes (Table 3-1).

The objectives of this study were to 1) to acquire or develop a subaqueous topographic dataset for Chincoteague Bay; and 2) to identify and describe the subaqueous landforms of Chincoteague Bay.

Materials and Methods

Study Area

Chincoteague Bay is the largest of Maryland’s inland coastal bays with an area of 19,000 ha (in the Maryland portion). It is bounded by Assateague Island to the east and the Maryland mainland to the west and is connected to the Atlantic Ocean by the Ocean City inlet to the north and the Chincoteague inlet to the south (Figure 3-1). Chincoteague Bay’s water depths range mostly from 1.0 to 2.2 m; with an approximate daily tidal range of 10 to 20 cm (Wells et al., 2004).

Table 3-1. Subaqueous landforms commonly found in Atlantic coastal lagoons.

Definitions adapted from Subaqueous Soils Subcommittee, 2005.

SUBAQUEOUS LANDFORMS	DEFINITION
Barrier Cove	Area adjacent to barrier island that forms an embayment or cove.
Dredge Channel	A linear, deep channel created by dredging for navigational purposes.
Flood-tidal Delta	A landform created as sand-sized particles accumulate from the flood tide entering the tidal inlet; are usually multi-lobed and are unaffected by ebb tides.
Flood-tidal Delta Slope	Extension of the flood-tidal delta that slopes towards the lagoon bottom.
Fluviomarine Bottom	A nearly level or slightly undulating, relatively low-energy, depositional environment with relatively deep water (1.0 to >2.5 m) directly adjacent to an incoming stream and composed of interfingered and mixed fluvial and marine sediments (fluviomarine deposits).
Lagoon Bottom	Central portion of low-energy, depositional basin.
Mainland Cove	Area adjacent to mainland coast that forms an embayment or cove, usually below the wave base.
Shoal	An area that is substantially shallower than the surrounding area.
Storm-surge Washover Fan Flat	An area created by the overwash from storm-surges that carry sandy sediments from the barrier dunes into the adjacent lagoon.
Storm-surge Washover Fan Slope	Extension of the storm-surge washover fan flat that slopes towards the lagoon bottom.

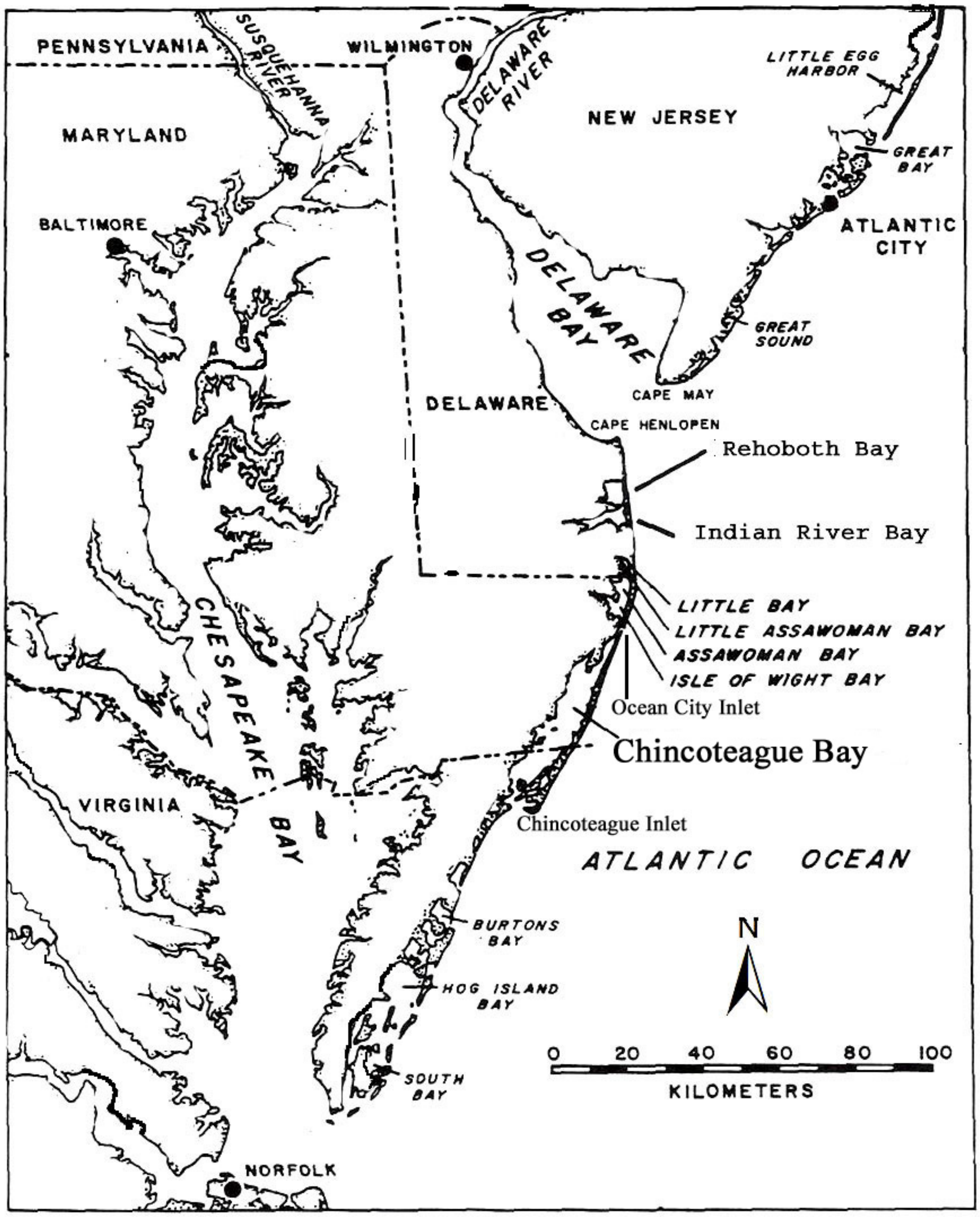

Figure 3-1. The Delmarva Peninsula and the inland coastal bays of Delaware, Maryland, and Virginia (Biggs, 1970).

Bathymetric Data Collection

During the summer of 2003 the Maryland Geological Survey (MGS) collected over 600,000 geo-referenced fathometer soundings at a density of 0.032 ha per sounding (Figure 3-2) in the Maryland portion of Chincoteague Bay (Wells et al., 2004). As part of this study, a second bathymetric data set was collected to spot check the MGS fathometer soundings using a Raytheon DE-719C marine research fathometer (Raytheon Company, MA). These bathymetric surveys were made in August and November 2003. The survey consisted primarily of cross sections and edge surveys. The fathometer was calibrated prior to data collection and checked periodically. The fathometer has accuracy to within 1 cm once calibrated. The fathometer is limited to water deeper than 60 cm, due to boat draft and the minimum depth requirements of the transducer. Over 7400 geo-referenced fathometer soundings (Figure 3-3) were collected in the 4600 ha study area (approximately 0.62 ha per sounding). The high resolution orthomosaic photograph used in Figures 3-2, 3-3, 3-5, 3-6, 3-7, 3-8, 3-9, and 3-10 was provided by USDA-NRCS Geospatial Data Branch in Fort Worth, TX (USDA-NRCS, 2001).

Location data was collected utilizing a Rockwell PLGR+ PPS Global Positioning System (GPS) unit (Rockwell International, WI). The operation of the GPS unit required downloading of the almanac for the day prior to data collection, to obtain maximum accuracy. A Figure of Merit (FOM) value of 1 ensured an accuracy level of 1 m in unobstructed areas, such as Chincoteague Bay (Rockwell Corp. Staff, 1994). The location data collected was monitored to maintain FOM 1 levels.

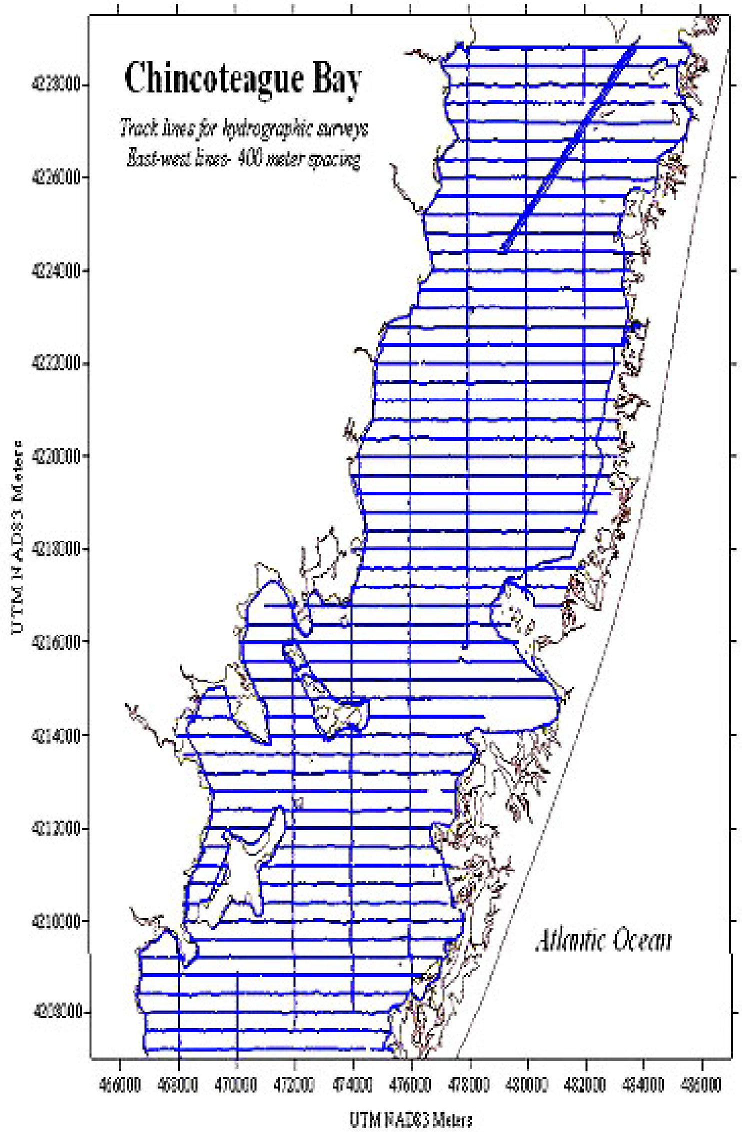

Figure 3-2. Point data collected for the Maryland portion of Chincoteague Bay by the Maryland Geological Survey, from May through September 2003 using differential global positioning system techniques and digital dual frequency echo sounding equipment. Water level data was also collected at four locations within the study area and were used to correct the echo soundings for tide and wind offsets (Wells et al., 2004).

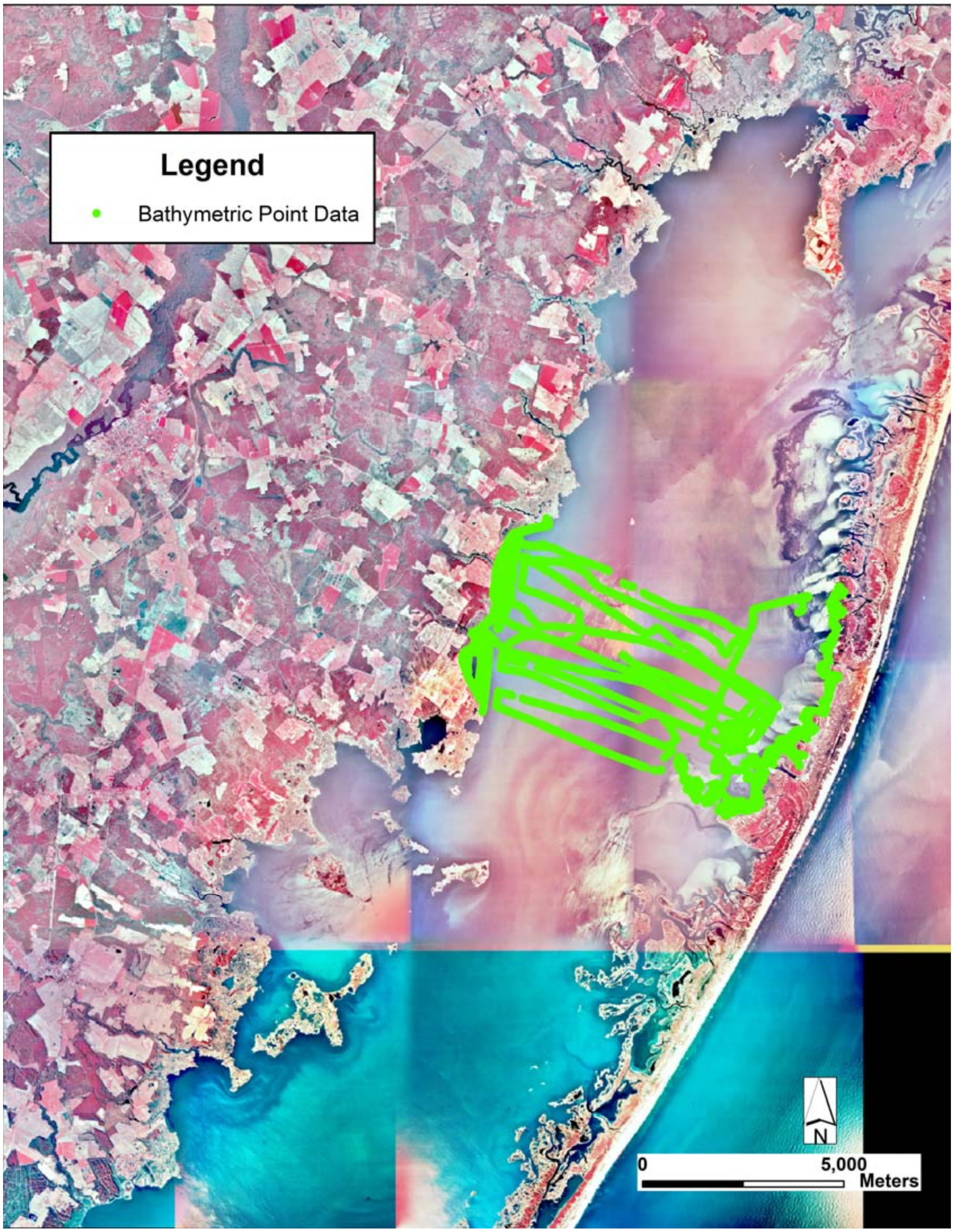

Figure 3-3. Location of bathymetric data collected in August and November, 2003 in a 4600 ha study area of Chincoteague Bay, MD using a fathometer that utilizes acoustic soundings. The average density of measurements was approximately 0.62 ha per sounding.

The GPS unit and fathometer were connected to a laptop computer equipped with GeoLink 6.1 XDS software (Michael Baker Corporation, 2004). The software provided the capability to simultaneously record the time of day, “real time” GPS data locations, and fathometer soundings. Data were collected at a boat speed of approximately nine kilometers per hour with soundings and locations collected every five seconds. This resulted in soundings spaced approximately 12 to 15 m apart.

A Remote Data Systems WL40 Tide Gauge was installed on a piling at the entrance of the inlet to the Public Landing boat ramp to record tide data during the same days that bathymetric data were collected (Figure 3-4). Tide heights were recorded every five minutes. The tide gauge calibration point was set at 0 mean sea level (MSL) through an elevation survey linked to National Ocean Service tidal station disk 3034, located on the bottom concrete step on the south side of the Driscoll residence, located on the corner of Public Landing Road and Public Landing Wharf Road (38° 8’ 57.7” N, 75° 17’ 13.9” W). These data were later used to normalize all of the fathometer soundings to depth below MSL.

The mainland and barrier island shorelines were hand-digitized using ArcMap 9.0 (ESRI Inc., 2006) and assigned 0 MSL prior to creating bathymetric maps. A bathymetric map was created using ordinary kriging with a spherical model and nearest neighbor of 12 in ArcMap 9.0 geostatistical analyst.

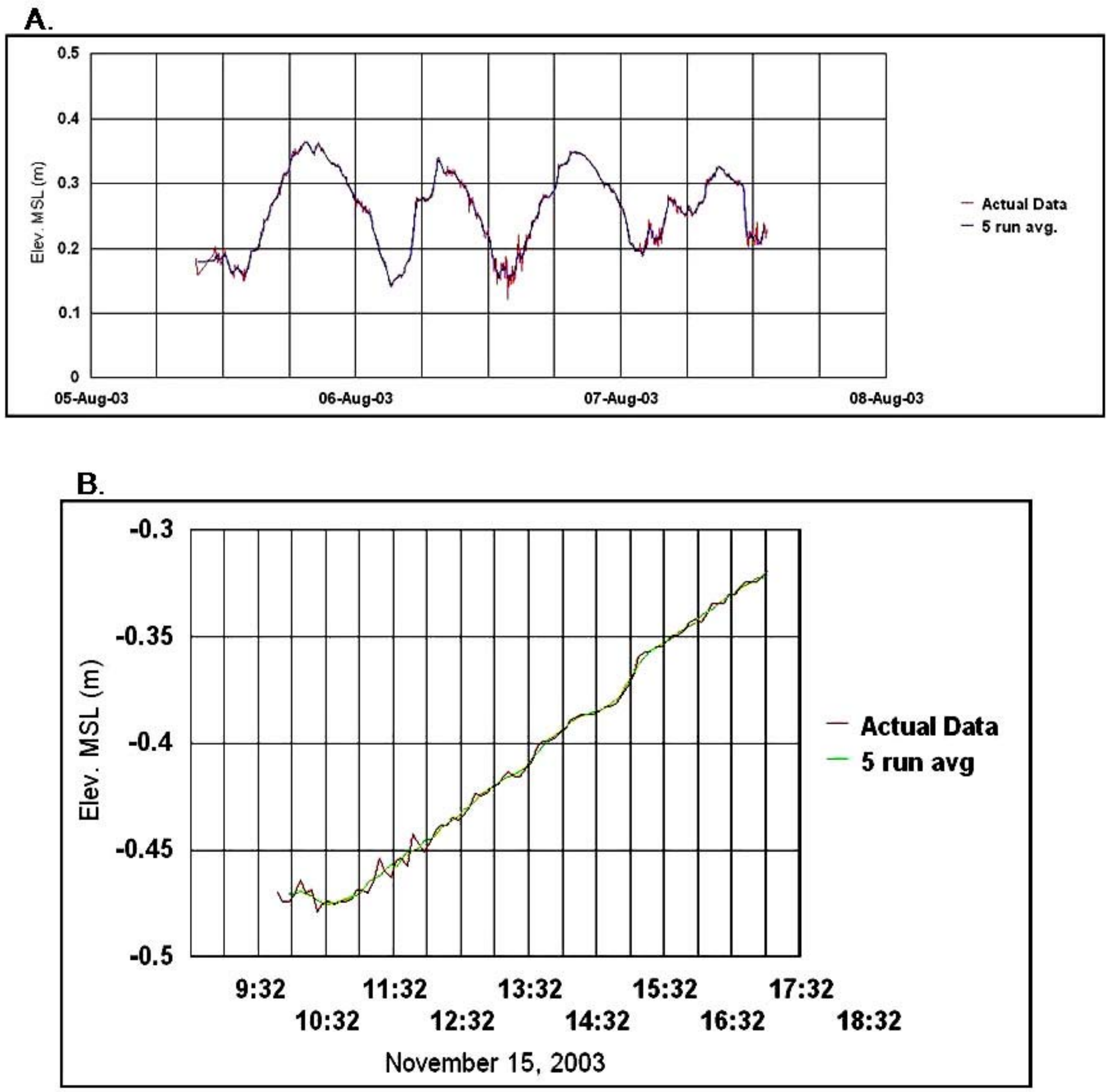

Figure 3-4. Tide data collected in Chincoteague Bay during August, 2003 (A) and November, 2003 (B) near Public Landing, Maryland.

Evaluation of Maryland Geologic Survey Data

In order to evaluate the quality of the bathymetric data collected by MGS, the data set was compared with the smaller data set generated independently as part of this study. The bathymetric data sets were assessed by using a spatial join in which all of the data points from the two data sets that were within a 20 m distance of each other were compared.

Due to the high point density of the MGS data set along transects (4.5 m between points) relative to the distance between transects (approximately 400 m), we decided to remove four-fifths of the data points from the MGS data set (saving every fifth point) to create a bathymetric map with an average point density of 0.45 ha per sounding. The bathymetric map (using one-fifth of the MGS data points) was created by using ordinary kriging with a spherical model and nearest neighbor of 9 in ArcMap 9.0 geostatistical analyst (ESRI Inc., 2006). A slope map was created using ArcMap 9.0 spatial analyst with a 30 m cell size.

Landform Delineation

Landforms in the study area were identified by using water depth, slope, landscape shape, depositional environment, and geographical setting based on the DEM and high resolution photography. The high resolution orthomosaic photographs for Worcester County, Maryland, were provided by USDA-NRCS Geospatial Data Branch in Fort Worth, TX (USDA-NRCS, 2001). The defining criteria for the landforms are presented in Table 3-1. Landforms were delineated by hand digitizing the outline in ArcMap 9.0 (ESRI Inc., 2006).

Results and Discussion

Subaqueous Topographic Maps

Navigation charts typically display bathymetric data as Mean Lower Low Water, but the MGS data set was collected as Mean Sea Level (MSL) data, which was reported relative to the North American Vertical Datum of 1988 (NAVD88). The data collected using NAVD 88 provides a more accurate depiction of the bay topography compared to data adjusted to Mean Lower Low Water (Wells et al., 2004).

The bathymetric data set we collected for the central portion of Chincoteague Bay was used to create the bathymetric map shown in Figure 3-5. The water depths range from 0 to 250 cm below MSL. An initial bathymetric map for the entire bay was created from the MGS data set and is shown in Figure 3-6. The water depths for the entire Maryland portion of Chincoteague Bay range from 0 to 250 cm below MSL. The comparison of the bathymetric data generated by the MGS and University of Maryland (UMD) is shown in Figure 3-7. There was a strong linear relationship between the datasets (r^2=0.90) and the regression line was very similar to the 1:1 line. There was more scatter at shallower depths and vegetation in these areas could have contributed to these differences. The mean difference between the two data sets was 2.7 cm and given the variability, was deemed to be a non-significant, and thus acceptable, error. A graph showing the frequency distribution of error between the two data sets is presented in Figure 3-8. Most of the pairs of points (80%) fall within ±15 cm of the mean of 2.7 cm. Since the observed error between the data sets was minor, we were satisfied that the MGS data set was generally accurate.

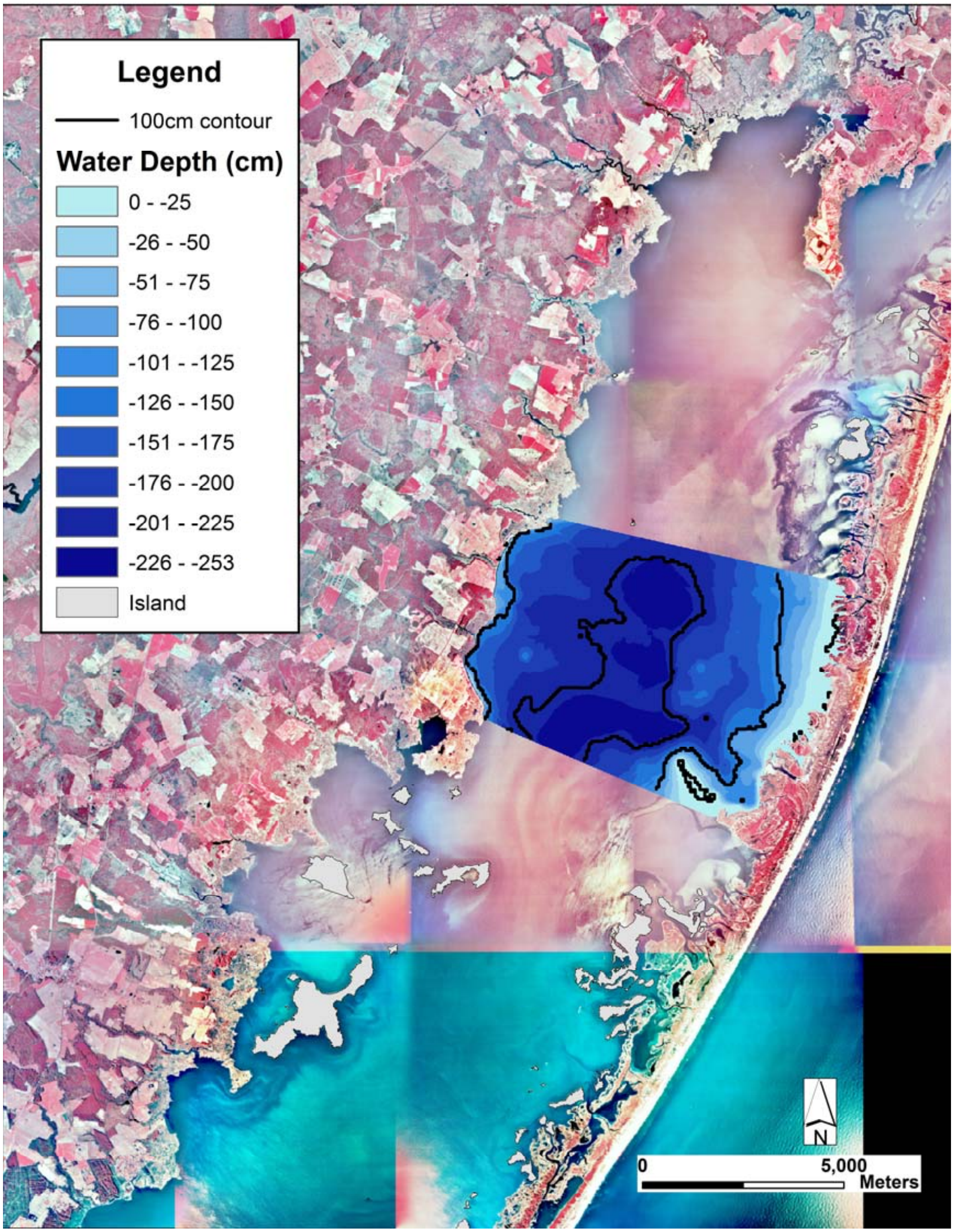

Figure 3-5. Subaqueous topographic map of Chincoteague Bay created by kriging the data we collected in ArcMap using geostatistical analyst. Contour intervals are 100 cm and were generated using spatial analyst surface analyst in ArcMap.

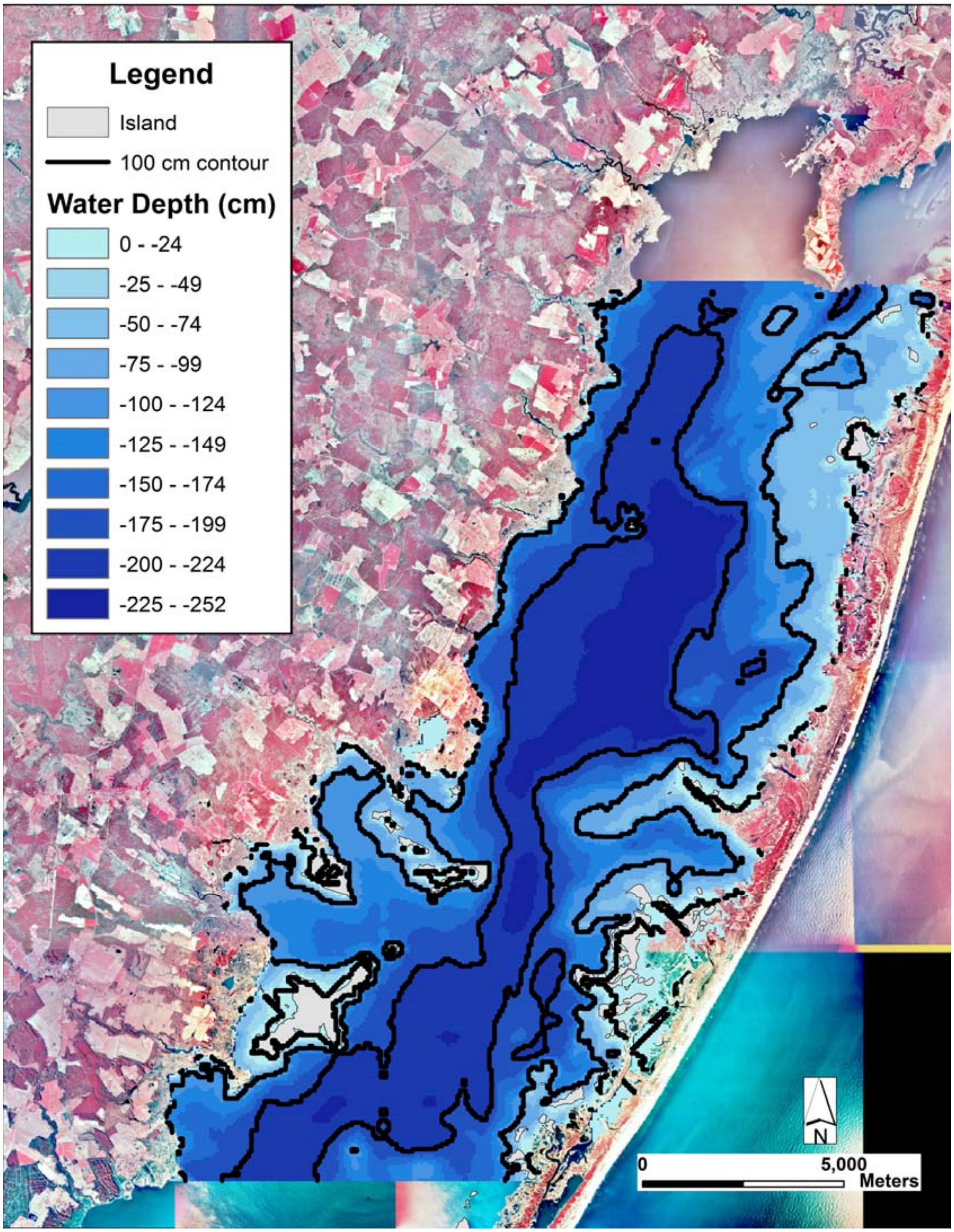

Figure 3-6. Subaqueous topographic map of Chincoteague Bay created by kriging the Maryland Geologic Survey data set in ArcMap using geostatistical analyst. Contour intervals are 100 cm and were generated using spatial analyst surface analyst in ArcMap.

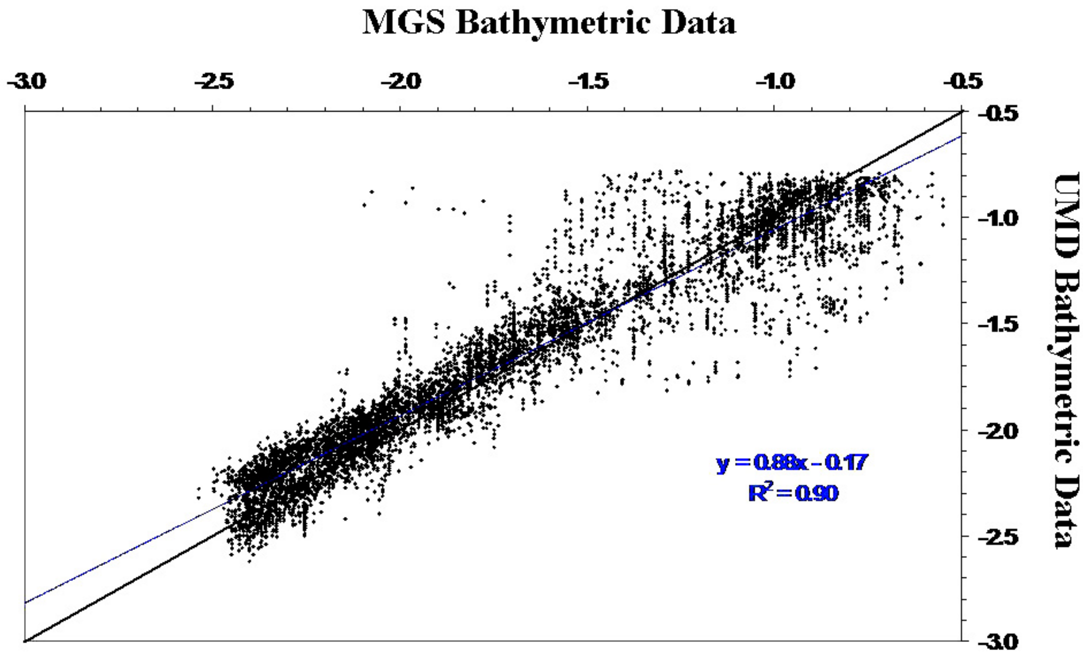

Figure 3-7. Comparison of the water depths measured by the Maryland Geological Survey (MGS) and our study. The points compared were positioned less than 20 m apart. The 1:1 line is shown as a solid black line.

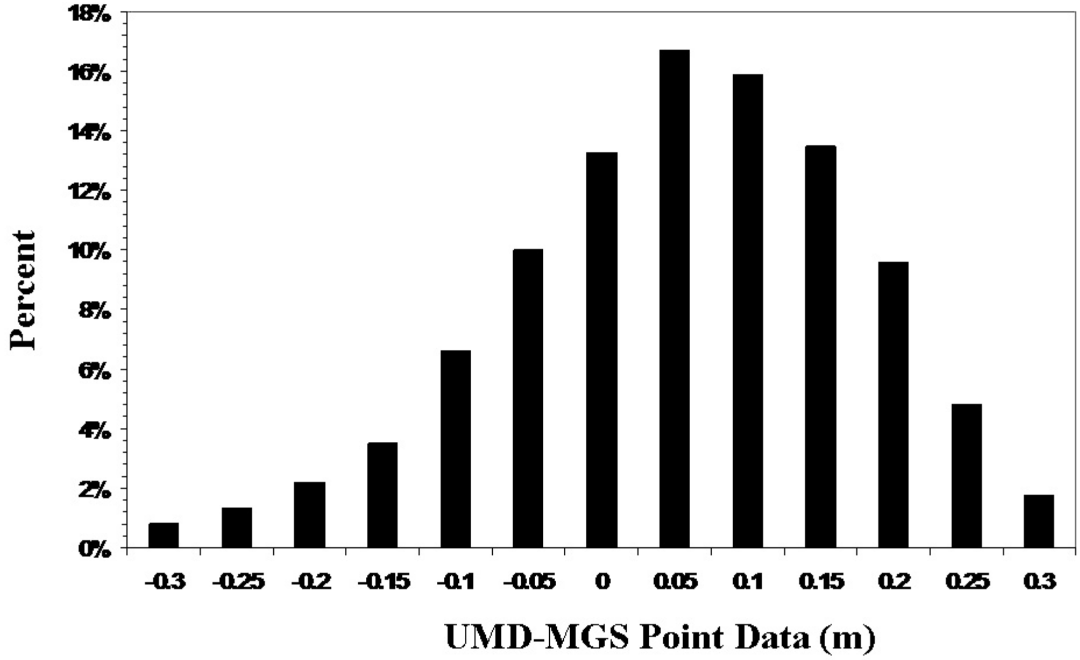

Figure 3-8. Frequency distribution of the depth differences observed between the Maryland Geological Survey bathymetric data sets and the data set we collected. The pairs of points compared were positioned within 20 m from each other. The data are normally distributed with a mean of 0.027 m, which given the variability, was deemed to be a non-significant, and thus acceptable, error.

Subaqueous Landforms

Landscape units were delineated in Chincoteague Bay based on water depth, slope gradients, landscape shape, depositional environment, and geographical relationships. The slopes of the subaqueous soil surface in Chincoteague Bay ranged from 0 to >0.35 %, and are shown in Figure 3-10. Most of the slopes in Chincoteague Bay are very subtle with less than 0.1% slope. Several landforms have a distinctive shape. For example, washover fans have a lobate shape, which can easily be identified and delineated using bathymetry and aerial photography. Geographical relationships within the bay, such as the proximity to the barrier island, mainland, or mouth of a tidal creek or river, were used to help identify several landforms. For example, washover fan landforms occur in shallow water adjacent to the barrier island. The depositional environments within the bay (low-energy versus high-energy regions) were also used to identify several landforms. In shallow water areas within the bay, false color infrared photographs could be utilized to identify landforms and define their extent. Using the subaqueous topographic map of Chincoteague Bay, we delineated 30 distinct subaqueous landscape units, which belonged to 10 specific landform types.

The names of these 10 landforms and their aerial extent are given in Table 3-2. The location of these landforms in Chincoteague Bay is shown in Figure 3-10. The landforms identified in Chincoteague Bay were similar to landforms found in previously studied Atlantic coastal lagoons (Demas, 1998; Bradley and Stolt, 2003; and Coppock et al., 2004) even though Chincoteague Bay is much larger than the lagoons previously studied (for example Chincoteague Bay is 14 times larger than the

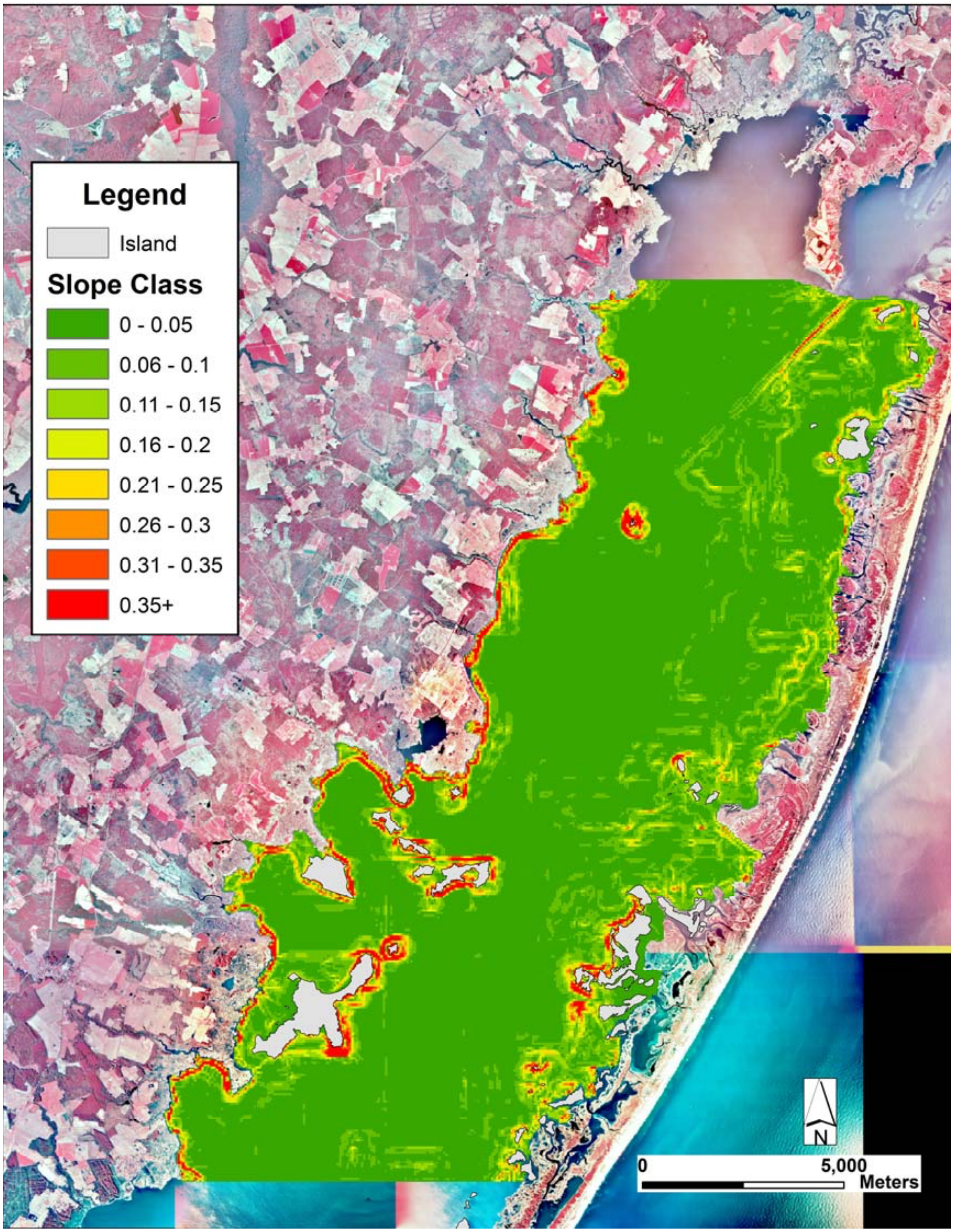

Figure 3-9. The subaqueous slope map of Chincoteague Bay was created using the Maryland Geological Survey data set with spatial analyst surface analyst in ArcMap.

Table 3-2. Subaqueous landscape units and cumulative extent in Chincoteague Bay, MD.

Subaqueous Landform	Number of landscape units	Area ha (% of study area)
Barrier Coves	2	1357 (6.4%)
Dredged Channel	1	123 (0.6%)
Fluviomarine Bottom	1	1148 (5.4%)
Lagoon Bottom	1	10501 (49.5%)
Mainland Coves	10	1544 (7.3%)
Paleo-flood Tidal Delta	1	971 (4.6%)
Shoals	4	1018 (4.8%)
Storm-surge Washover Fan Flat	3	1926 (9.1%)
Storm-surge Washover Fan Slope	1	1849 (8.7%)
Submerged Wave-cut Headland	8	1556 (7.3%)

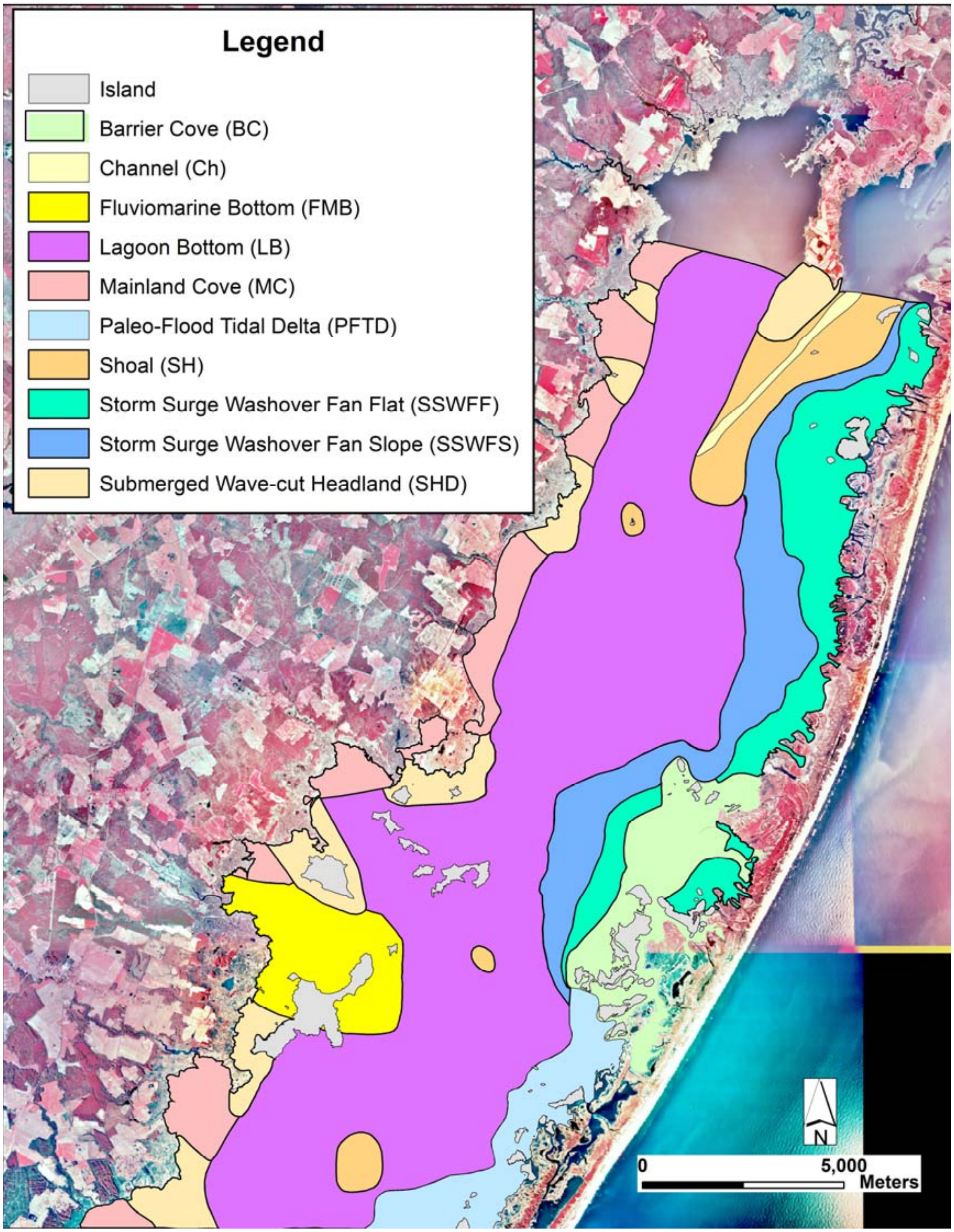

Figure 3-10. Subaqueous landforms delineated in Chincoteague Bay were hand-digitized using ArcMap. The subaqueous landforms were delineated based on slope, water depth, geographic location, and depositional environment.

adjacent Sinepuxent Bay). The landforms in Chincoteague Bay are larger and there are more landscape units than in lagoons previously studied. The number of landscape units and cumulative extent of each subaqueous landform is shown in Table 3-2. The paleo-flood tidal delta and the submerged wave-cut headland are newly described features that have not been identified in previously studied Atlantic coastal lagoons. A brief description of each of the 10 landforms follows below.

Adjacent to the barrier islands are storm-surge washover fan flats that are broad, flat, fan-shaped or lobate features. These features tend to be sandy, gently sloping (less than 0.15%), and shallow with water depths ranging from 0.0-1.00 m. These areas are created as overwash from high-energy storm surge transport of sediments from the seaside of the barrier island and are deposited in the adjacent coastal lagoon. The storm-surge washover fan flat is the second most extensive unit in Chincoteague Bay.

The storm-surge washover fan slope is a landform that slopes away from the storm-surge washover fan flats towards the lagoon bottom. These units are sandy, and are moderately to strongly sloping (0.06-0.45%). The water depth ranges from 1.00-1.50 m. The steepest slopes in the bay are found on this landform.

The paleo-flood tidal delta landform is a relict fan-shaped deposit of sand-sized sediments that were transported through an inlet (in this particular case, Green Run Inlet) (Figure 2-5). The paleo-flood tidal delta is found adjacent to the barrier island in the southern portion of the bay and is nearly level (slope less than 0.10%) with water depths ranging from 0.20 to 1.00 m. During its formation, the flood tidal delta was a high-energy depositional area impacted daily by tidal cycles. The sediment was transported through the inlet and over a flood tidal ramp where the current slowed and dissipated and the coarser particles were deposited. In lagoons examined in previous studies (Demas, 1996; Bradley and Stolt, 2003; Coppock et al., 2004), active inlets were recognized and the associated landform was a flood-tidal delta. There are currently no active inlets in the Maryland portion of Chincoteague Bay, but there is evidence of past inlets and the relict flood-tidal deltas are still present.

Barrier coves are semi-enclosed areas adjacent to the barrier island. These are gently sloping (less than 0.1%) areas with water depths ranging from 0.2-1.50 m. Thus, they are low-energy depositional areas, which allow finer-textured materials (silts, clays, and organic materials) to settle out of suspension. Due to their proximity to the barrier island these areas often have a sandy cap due to washover events.

Shoals are areas that are shallower than the surrounding area. Generally the shoals are moderately sloping (0.60% or less) and are found in water depths ranging from 1.00-1.50 m. In Chincoteague Bay the shoals are either depositional areas created from dredging projects or they may represent the remnants of old marsh islands.

Dredged channels are deeper water areas within a lagoon that is maintained by dredging activities as shipping channels. These areas are linear and deeper that the surrounding areas. The dredged channel is the smallest of the landforms.

The lagoon bottom is the low-energy central portion of the study area. The lagoon bottom is nearly level (slope less than 0.10%) and has the greatest water depth of all landforms. This portion of the study area is dominated by very slow current speeds, which allows the finer-textured sediments to settle out of suspension. The lagoon bottom unit is the largest and most extensive portion of the study area.

The fluviomarine bottom is a nearly level or slightly undulating, relatively low-energy depositional environment with water depths ranging between 1.0 to 1.5 m that is directly adjacent to an incoming stream, (in this study area, Scarboro Creek). The fluviomarine bottom is composed of mixed fluvial and marine sediments. In this environment, colloidal-sized detrital sediments carried in fresh water enter the higher salinity lagoon and in the fresh-saline water boundary the sediments become flocculated due the higher ionic strength of the saline water (Duinker, 1980). This process creates deposits with higher proportions of silt and clay. These deposits also have a very high n value (very low bearing capacity) and lower bulk density.

Mainland coves are areas adjacent to the mainland that form an embayment along the coast. The mainland coves are gently sloping (0.0-0.20%) towards the lagoon bottom with water depths shallower than 1.50 m. These landforms are dominated by low tidal currents; water depth of these coves is below the wave base, which allows finer-textured suspended particles to settle out.

The submerged wave-cut headland landform is a subaqueous, relict erosional landform produced by coastal wave erosion of headlands which are subsequently submerged by rising sea level or subsiding land surface. These units are moderately sloping (0.01-0.25%) with water depths that range from 1.00-1.50 m. These areas may contain marsh islands that were once connected to the mainland that are subjected to continuous wave erosion.

Conclusions

The extensive bathymetric dataset collected by the MGS was deemed suitable for use since the observed error between the data sets was minor. This data set was used to create a detailed and accurate subaqueous topographic map that was suitable for identifying and delineating subaqueous landscape units. Ten subaqueous landforms were identified and delineated in Chincoteague Bay (barrier coves, dredged channel, fluviomarine bottom, lagoon bottom, mainland coves, paleo-flood tidal delta, shoals, storm-surge washover fan flat, storm-surge washover fan slope, and submerged wave-cut headlands). The landforms identified in this study were similar to subaqueous landforms identified in other Atlantic coastal lagoons (Demas, 1998; Bradley and Stolt, 2003; Coppock et al., 2004). However, we also identified two landforms not previously identified, which were the paleo-flood tidal delta and the submerged wave-cut headland. The terrain analysis and delineation of the landscape units were obtained in order to be utilized during the investigation of subaqueous soils in Chincoteague Bay.

Chapter 4: Characterization and Classification of Subaqueous Soils in Chincoteague Bay, MD

Introduction

The purpose of classification systems is “to arrange objects in such an order that ideas precede or accompany one another in a way that provides the command of knowledge and leads to the acquisition of more knowledge” (Soil Survey Staff, 1975). *Soil Taxonomy* provides the structure to understand the relationships between soils and the factors responsible for their genesis. *Soil Taxonomy* is based on soil characteristics that are definable, measurable, and sampleable. It is primarily a morphological taxonomic system with strong genetic undertones. The taxonomic system is a hierarchical system with six categories, from broadest to most detailed, being order, suborder, great group, subgroup, family, and series.

Classification schemes have been in development since the beginning of pedological research. Some of these schemes have, since their conception, included subaqueous materials as soils, whereas others did not include these materials in the beginning, but have subsequently considered these materials as soils. According to Hansen (1959) in the 1860’s Post (1862) developed a nomenclature for subaqueous soils. The terms “gyttja” and “dy” were introduced and described by v. Post as follows for limnic sediments: 1) “gyttja is a copogenic formation consisting of a mixture of fragments from plants, numerous frustules from diatoms, grains of quartz and mica, silicous spicules from Spongilla, and exoskeletons from insects and crustaceans” and 2) “dy consists of the same constituents as gyttja, but to these is added some brown humus particles” (Hansen, 1959). The gyttja and dy soils differed on the amount of organic materials in the soils, with gyttja being organic rich and dy being organic poor. Kubiena (1953) proposed a soil classification system for Europe that included subaqueous soils, and were described using the terms developed by v. Post (1862). Kubiena’s classification system was an attempt to be comprehensive and included all soil types “even the usually neglected sub-aqueous soils, so very important for a complete understanding of soil formation”. He noted that the sub-aqueous soils could become cultivated by the natural or artificial drying of these areas. Kubiena (1953) separated the sub-aqueous soils into two main categories 1) young soils always covered with water that do not form peat (our subaqueous soils); and 2) young sub-aqueous soils with peat formation (what would mostly be Histosols in emergent wetlands, bogs, and forests) (Table 4-1). The terms Kubiena used to describe the subaqueous soil classes are quite similar and seem to be differentiated based on organic matter type and content. These terms are not currently used in *Soil Taxonomy* or the World Reference Base. Therefore it is a difficult system to use in describing subaqueous soils. Kubiena also introduced horizonation of the sub-aqueous soil profiles, for example (A)C, AC, and AG-Soils, describing soils that do not have a distinct humus layer, those that do have a distinct humus horizon, and those with a humus layer underlain by a gleyed horizon, respectively. Muckenhausen (1965) proposed a soil classification system for the Federal Republic of Germany that included subhydric soils, and which used Kubiena’s subaqueous soil terms. Ponnamperuma (1972) described soils formed from river, lake, and ocean sediments

Table 4-1. Classification of Sub-Aqueous soils in Kubiena's Soils of Europe (Modified from Kubiena, 1953).

Sub-Aqueous Soils not Forming Peat	Interpretation of the Soil
I Protopedon	Sediments without organic material accumulation
Chalk deficient Protopedon Dystrophic lake iron Protopedon Lake Marl Protopedon Sea Chalk Protopedon	
II Dy	Muds low in organic matter and nutrients
III Gyttja	Organic rich muds, high in nutrients
Limnic Gyttja 1. Eutrophic Gyttja 2. Chalk Gyttja 3. Oligotrophic Gyttja 4. Dygttja	Lake (fresh water) sediments
Marine Gyttja 1. Schlickwatt Gyttja 2. Sandwatt Gyttja 3. Cyanophyceae Gyttja	Marine (saline water) sediments
IV Sapropel	Dark colored sediments rich in organic matter
Limnic Sapropel	Lake (fresh water) sediments
Marine Sapropel 1. Mudwatt Sapropel 2. Diatomwatt Sapropel	Marine (saline water) sediments
Peat Forming Sub-Aqueous Soils	
V Fen	Emergent wetlands, bogs, and forests
Turf-Fen (Turf Peat Moor) 1. Phragmites-Fen (Reed Peat Moor) 2. Carex-Fen (Sedge Peat Moor) 3. Hypnum-Fen (Hypnum Peat Moor) Wood-Fen (Swamp Wood Peat Moor)	

and justified their inclusion as soils because the physical, mineralogical, and chemical processes that occur in these sediments are analogous to the processes that occur in subaerial soils.

In the first edition of *Soil Taxonomy* (Soil Survey Staff, 1975), these subaqueous sediments were excluded as soils, due to the requirement that soils must be capable of supporting the growth of rooted plants. But perhaps a more important issue was related to the boundaries of soil. The first edition of *Soil Taxonomy* (1975) stated that the upper limit of soils is "…air or shallow water. At its margins it grades into deep water or to barren areas of rock or ice." Thus, due to the permanent saturation of these materials under "deep" water they were excluded. The definition of soils was changed in the second edition of *Soil Taxonomy* (1999) to accommodate among others, the recent research examining subaqueous materials as soils by Demas (1998). Even though much of his work was published at or after 1999, the work was done prior to this, and in fact, was to a large degree what led to the change in the definition. The new definition included materials as soils that either demonstrated the formation of soil horizons OR those materials that were capable of supporting growth of higher rooted plants. In addition the boundaries of soil were expanded so that the upper limit of soils became "…soil and air, shallow water, live plants, or plant materials that have not begun to decompose. Areas are not considered to have soil if the surface is permanently covered by water too deep (typically greater than 2.5 m) for the growth of rooted plants. Soil's horizontal boundaries are where it grades into deep water, barren areas, rock, or ice" (Soil Survey Staff, 2006). These changes allowed for subaqueous environments to be studied as soils due to the formation of pedogenic horizons.

Because subaqueous soils typically show weak development of horizons, they generally have been classified as Aquents. But this classification fails to recognize that they are permanently under water. Recently the Subaqueous Soils Committee of the Northeast Regional Cooperative Soil Survey conference (2007) proposed modifications to *Soil Taxonomy* to better accommodate these soils. In particular, they proposed the suborder of Wassents (Appendix A). The differentiating criterion to identify the Wassents is a positive water potential at the soil surface for 90% of each day. The criteria for the subgroup and great group classes of Wassents, using the terms sulfic, lithic, psammic, thapto-histic, fluvic, aeric, and typic, are similar to the criteria for those classes where they appear elsewhere in *Soil Taxonomy* (Soil Survey Staff, 2006). However, the order in which great groups of Wassents are introduced was rearranged relative to the way they appear in Aquents. In particular the Psammowassents appear higher in the key than (before) the Sulfiwassents. This change reflects the importance of soil texture in the use and management of these soils, relative to the presence of sulfidic materials (which is relatively common in estuarine subaqueous soils).

The objectives in this study were to 1) to characterize the soils of Chincoteague Bay; 2) classify the soils described in Chincoteague Bay according to *Soil Taxonomy*; 3) classify the soils according to the proposed amendments to *Soil Taxonomy*; and 4) assess the impact of the proposed changes to *Soil Taxonomy* as reflected by the soils of Chincoteague Bay.

Materials and Methods

Study Site

Chincoteague Bay is a 19,000 ha coastal lagoon along Maryland's eastern shore that formed as a result of sea level rise and consequent flooding of the low-lying areas following the last glacial period. Chincoteague Bay is separated from the Atlantic Ocean by a barrier island, Assateague Island, and is connected to the ocean by two inlets (Ocean City inlet and Chincoteague inlet). This coastal lagoon is relatively shallow with water depths reaching 2.5 m in the central portion of the lagoon. The average tidal fluctuations within Chincoteague Bay range from 10 to 20 cm. Chincoteague Bay is classified as a polyhaline lagoon with salinity levels ranging between 26 and 34 ppt, with the higher values occurring in the summer months (Wells and Conkwright, 1999). Parent materials of upland soils in this watershed include alluvium, aeolian sand, organic materials, and marine sediments (Soil Survey Staff, NRCS, USDA, 1997).

Soil Sampling

High resolution false-color infrared photography and a bathymetric map of Chincoteague Bay were used as a base maps in conjunction with data on slope, water depth, landscape shape, and proximity to other features, to delineate the subaqueous landscape units in the lagoon (Chapter 3). The high resolution orthomosaic photograph used in Figures 4-1, 4-42, and 4-43 was provided by USDA-NRCS Geospatial Data Branch in Fort Worth, TX (USDA-NRCS, 2001). Within and across the identified landforms, specific locations were chosen for sampling in order to document the composition and variability within each landscape unit and to identify differences between adjacent units. The soils were accessed by boat and their locations were recorded by using a global positioning (GPS) unit. Some of the soil cores were extracted from the lagoon using 7.6 cm-diameter Al pipes that were pushed into the soil using a vibracorer mounted on a 6.4 m (21 ft) pontoon boat. Before extraction of the core, the distance from the top of the pipe to the top of the soil surface (outside the pipe) and the distance from the top of the pipe to the top of the soil sample (inside the pipe) was measured to estimate the amount of compaction of the profile within the pipe. The cores were extracted and then split in half using a circular saw while on the boat. Soils were also extracted from the lagoon using a McCauley peat sampler by sampling in 50 cm increments from the soil surface. Using a vibracorer or a McCauley peat sampler, cores from 146 pedons (Figure 4-1) were extracted from the bay bottom and morphological descriptions were completed according to standard procedures (Schoeneberger et al., 2002). Soil horizons were separated based on changes in color, texture, n value, presence or absence of shells and organic fragments, where changes were recognizable and deemed to be pedologically significant. Abbreviated descriptions were collected at an additional 17 locations (Figure 4-1). Eighty-six of the pedons were sampled for possible laboratory analysis and were placed into plastic bags, sparged with N_2 gas, stored on ice, and then placed into a freezer at the end of the day. Samples were kept frozen until laboratory analyses were completed.

During the process of making soil descriptions, the presence or absence of H_2S gas and the intensity of its aroma were also noted for each horizon. If the intensity was strong, H_2S gas could be recognized during normal description protocols. But, if the intensity was weak or could not be detected, a small sample was placed into a plastic bag with approximately 1 to 2 ml 10% HCl and sealed. After 2 to 5 minutes was allowed for reaction, the sample in the bag was again checked for the presence of H_2S gas. These tests allowed us to qualitatively check for the presence or absence of acid volatile sulfides in the soil profile. Each horizon was placed into three classes for H_2S gas aroma: none (no odor); weak (odor after adding 10% HCl); or strong (odor recognized without adding 10% HCl) (Darmody et al., 1977; Darmody and Fanning, 1977).

Laboratory Analysis

Pedons representative of each landform were analyzed for a variety of chemical, physical, and mineralogical analyses including pH, sulfide content, electrical conductivity, particle-size distribution, carbon, and mineralogy. Soil pH was measured on a freshly thawed sample, using an approximate ratio of soil to distilled water of 1:1. These soil samples were then placed into 1cm deep Petri dishes and were incubated at room temperature under a moist, aerobic environment for 13 to 24 weeks. Soil pH measurements were recorded each week for the first eight weeks and then every two to three weeks for the remainder of the time. Acid-volatile sulfides (AVS) and chromium reducible sulfides (CRS) were determined using the procedure of Cornwell and Morse (1987). Frozen samples were handled under a nitrogen atmosphere in a glove-bag prior to analysis.

Electrical conductivity was measured for each horizon on a freshly thawed sample using a 1:5 (by volume) ratio of soil to distilled water. The moisture content

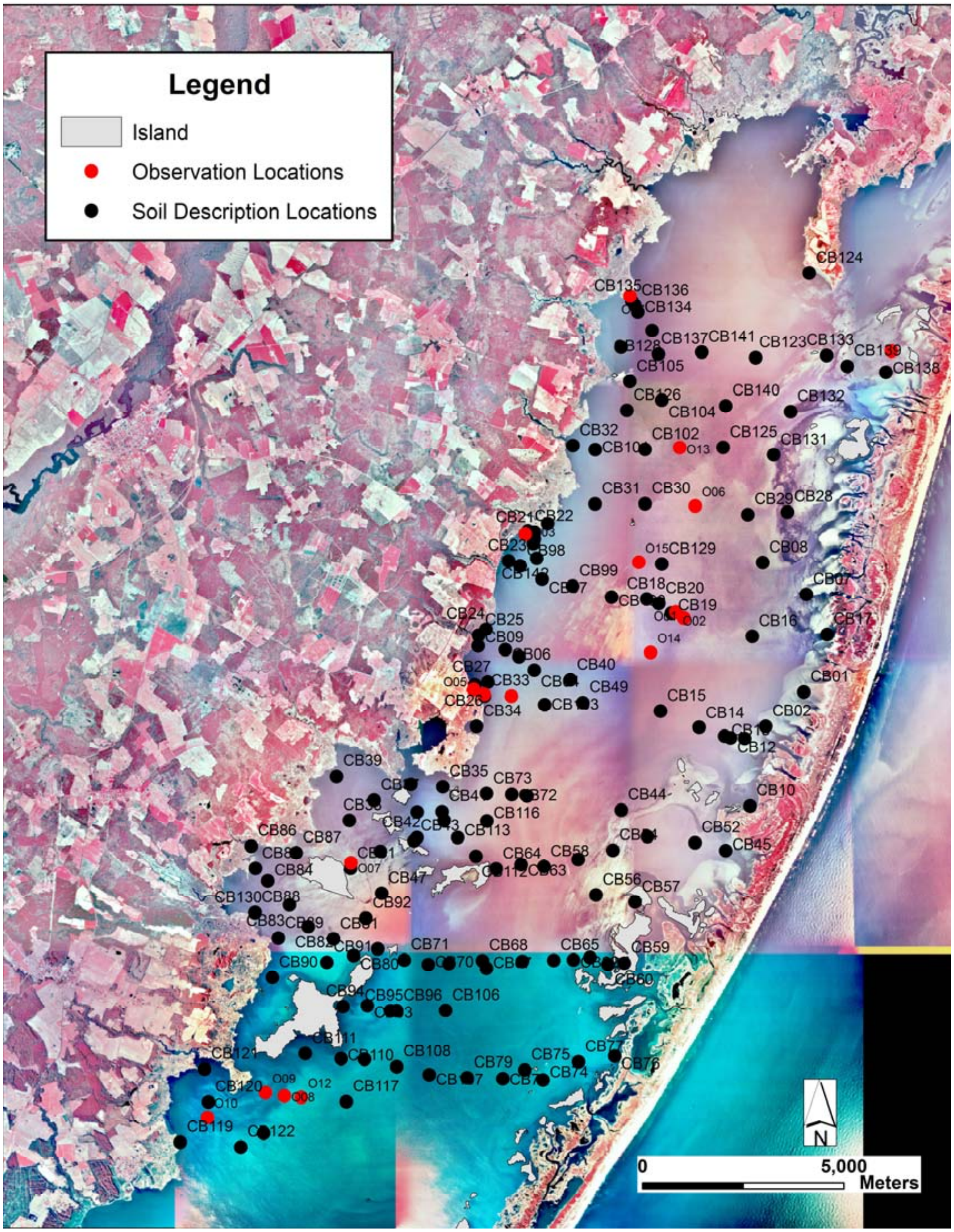

Figure 4-1. Locations of full subaqueous soil profile descriptions and brief observations and notes collected in Maryland's portion of Chincoteague Bay. Locations were selected to determine the composition and variability within landscape units and to identify differences between adjacent units.

was also determined on these samples at the same time. Electrical conductivity was measured using YSI Model 32 Conductance Meter (Yellow Springs Instrument Co, Inc., Yellow Springs, OH). The electrical conductivity measurements were converted from µmhos cm^{-1} to mg L^{-1} by multiplying by a conversion factor of 0.64 (SWAT Laboratory, 2006).

A portion of the sample was air dried, crushed, and sieved (<2 mm) for particle-size and carbon analyses. Particle-size analyses were performed by a modified pipette method (Kilmer and Alexander, 1949) where prior to the analysis the samples were dialyzed to remove salts. After the sands were removed by sieving, an aliquot of the sample was collected while being stirred to be able to calculate the amount of total silt and clay in the sample.

Bulk density was determined for pedons collected using the McCauley sampler (which provides an intact half core with a known volume) for each horizon by dividing the sample volume by the oven-dry weight (105ºC) of the sample. For pedons collected using the vibracorer method (generally sandier soils), bulk density was estimated by packing a container of known volume with freshly thawed soil. The oven dry weight was obtained for these samples and used to estimate the bulk density.

For carbon determination, dried soil samples were ground to pass through a 140 mesh (106 µm) sieve. Total carbon was determined by combustion at 990ºC with a LECO CHN-2000 Analyzer and a burn time of 174 sec (LECO Corp., St. Joseph, MI), which is higher and longer than the normal operating temperature of 900ºC to help ensure full combustion of carbonates. For organic carbon determination a portion of the sample (1 g) was placed into a 50 ml beaker to which approximately 5 to 10 ml of a 5% sulfurous acid solution (H_2SO_3) was added to dissolve any carbonates from the soils (Piper, 1942). Once reaction with the sulfurous acid ceased, the samples were placed into an evacuated desiccator containing NaOH pellets to remove water and excess sulfurous acid. Once all of the H_2SO_3 was removed, samples were placed into a 105ºC oven to dry; the samples were then reground to pass through the 140 mesh sieve (Nelson and Sommers, 1982). The carbon content of these treated samples was measured by combustion at 990ºC. Calcium carbonate-carbon was calculated as the difference between the total carbon and organic carbon (Nelson and Sommers, 1982). The presence or absence of carbonates was further confirmed for each sample by observing the soil under a 10x dissecting microscope when adding a few drops of 10% HCl. Five effervescence classes were used to indicate the intensity of the reaction observed under the microscope: non-effervescent (NE) – no reaction; very slightly effervescent (VS) – one or two bubbles; slightly effervescent (SL) – few bubbles; strongly effervescent (ST) – many bubbles; and violently effervescent (VE) – low foam (Schoeneberger et al., 1998).

The n value was estimated in the field by squeezing a portion of the soil and estimating how the soil flows through one's fingers. In the field four classes were used for n value estimations: <0.7 – non fluid, soil does not flow through fingers; 0.7-1.0 – slightly fluid, soil flows through fingers with some difficulty; >1.0 – moderately fluid, soil flows easily through fingers; and >>1.0 – very fluid, soil flows very easily through fingers. The n value was also calculated using the following equation developed by Pons and Zonneveld (1965):

$$n = ((A-0.2*R)/(L+3H)) \qquad \text{[Eq. 1]}$$

where A is the percentage of water at field condition; R is the percent of silt plus sand; L is the percent clay; and H is the percent organic matter (%OC*1.724).

Radiocarbon analysis of several buried organic horizons was performed by Beta Analytical, Inc. in Miami, Florida using a standard radiometric analysis with acid wash pre-treatment.

Mineralogy was assessed for selected sandy and loamy soils using grain counting methods (Balduff and Rabenhorst, 2007) while x-ray diffraction techniques were used for analysis of silt and clay for finer textured soils (Burt et al., 2004).

Grain Size Distribution

Particle-size data collected for 188 samples was divided into seven classes (vcS, cS, mS, fS, vfS, Si, and C). The median particle size, mean particle size, and sorting coefficients were determined graphically by plotting the percentage of each separate creating a cumulative frequency plot. The sorting coefficient developed by Trask (1932) expressed sorting as

$$S_o = (\phi 75-\phi 25)/1.35 \qquad \text{[Eq. 2]}$$

where ϕ75 and 25 are obtained from the cumulative frequency plots. Descriptive classes of Trask assigned from numerical values of S_o are: excellent- 0 to 0.58; well- 0.58 to 1.32; moderately well- 1.32 to 2.0; and poorly- > 2.0. Folk (1974) expressed sorting as

$$\sigma_i = [(\phi 84-\phi 16)/4] + [(\phi 95-\phi 5)/6.6] \qquad \text{[Eq. 3]}$$

where ϕ95, 84, 16, and 5 are obtained from the cumulative frequency plots. Soils with a sorting coefficient of 0 to 0.35 were considered to be very well sorted, 0.35 to 0.50 well sorted, 0.50 to 0.71 moderately well sorted, 0.71 to 1.00 moderately sorted, 1.00 to 2.00 poorly sorted, 2.00 to 4.00 very poorly sorted, and >4.00 extremely poorly sorted (Leeder, 1982).

Results and Discussion

Characterization of Subaqueous Soils

Subaqueous soils are similar to young alluvial soils that form on floodplains. These soils are characterized as having a well developed A horizon overlying C horizons that maintain many characteristics related to their environment of deposition. Subaqueous soils, like alluvial soils, are not described as stratigraphic geologic units due to pedogenic processes which alter these materials leading to the creation of soils. These processes include the addition of organic matter, biogenic $CaCO_3$, bioturbation from benthic biota, and chemical transformations of sulfur and iron in anoxic sediments, all of which differentiate surficial sediments into soil horizons (Demas and Rabenhorst, 1999).

In the field, hand texturing was used to determine the texture class of each horizon as recorded in the profile descriptions. It is more difficult to determine the correct texture of these samples compared to texturing subaerial soils due to the excess water in the subaqueous samples. Due to the difficulty in texturing, there was some uncertainty regarding the accuracy of our field data. Therefore, to assess the accuracy of field textures and their potential use in classifying soils, particle size data were plotted by groups based on field textures for 188 horizons. The field textures as compared to particle size classes are presented in Table 4-2. This table was used to help interpret the remaining field textures for pedons that were not analyzed in the laboratory. Generally our field textures were more accurate when the soils were sandy textured (sand, fine sand, loamy sand, loamy fine sand, sandy loam, and fine sandy loam) than when finer textured (Figure 4-2, 4-3, and 4-4). The sandy textured soils with a fine size modifier tended to be described in the field as a class finer than what was determined by particle-size analysis (Figure 4-3). For example, most soils that were textured in the field as loamy fine sand were in fact fine sand and those that were described as fine sandy loam were in fact mostly loamy fine sand (by particle-size analysis). The finer textured soil horizons (loams, clay loams, silty clay loams, silty clays and clays) tended to be described in the field as one class finer than the particle-size data showed them to be (Figure 4-2 and 4-4). For example, soils that were described in the field as silty clays were mostly silty clay loams and those described in the field as clay were mostly loams. However, the horizons in the field described as loams were in fact mostly loams. Soils that tended to be clay loams in the field tended to be coarser than we thought and laboratory analyses showed that these horizons were usually in the loam or sandy loam class. The horizons described in the field as silty clay loam tended to have more sand then we thought. Those samples tended to lie along the borders of the silty clay loam, clay loam, and loam classes. This probably would not impact the classification of the soils at the family class level because the majority of the sand is fine or very fine. The very fine sand fraction in these soils was included in the coarse silt fraction (as required by *Soil Taxonomy*). So, samples placed into the silty clay loam class in the field were accurate for our classification purposes. In conclusion the texture data collected in the field for profiles that were not analyzed in the lab are still usable for classification purposes when keeping in mind the trends and utilizing Table 4-2 to determine a

Table 4-2. Field textures compared to textures from particle-size data for selected horizons collected in the summers of 2004 and 2005 in Chincoteague Bay.

	Field	**Textures Based on Particle-Size Analysis**											
n	**Textures**	**S**	**fS**	**LS**	**LfS**	**SL**	**fSL**	**vfSL**	**L**	**SiL**	**CL**	**SiCL**	**SiC**
		---%---											
15	S		87		13								
9	fS		100										
16	LS		38		56		6						
10	LfS		70		20		10						
26	SL		4		35	31	19		12				
7	fSL				43		43				14		
1	SC			100									
18	L				11	11	28	6	33		11		
6	SiL					17					50		33
3	CL					33			33		33		
16	SiCL								13	18	19	50	
49	SiC				2	2			14	8	12	45	16
12	C					8		8	58	8	17		

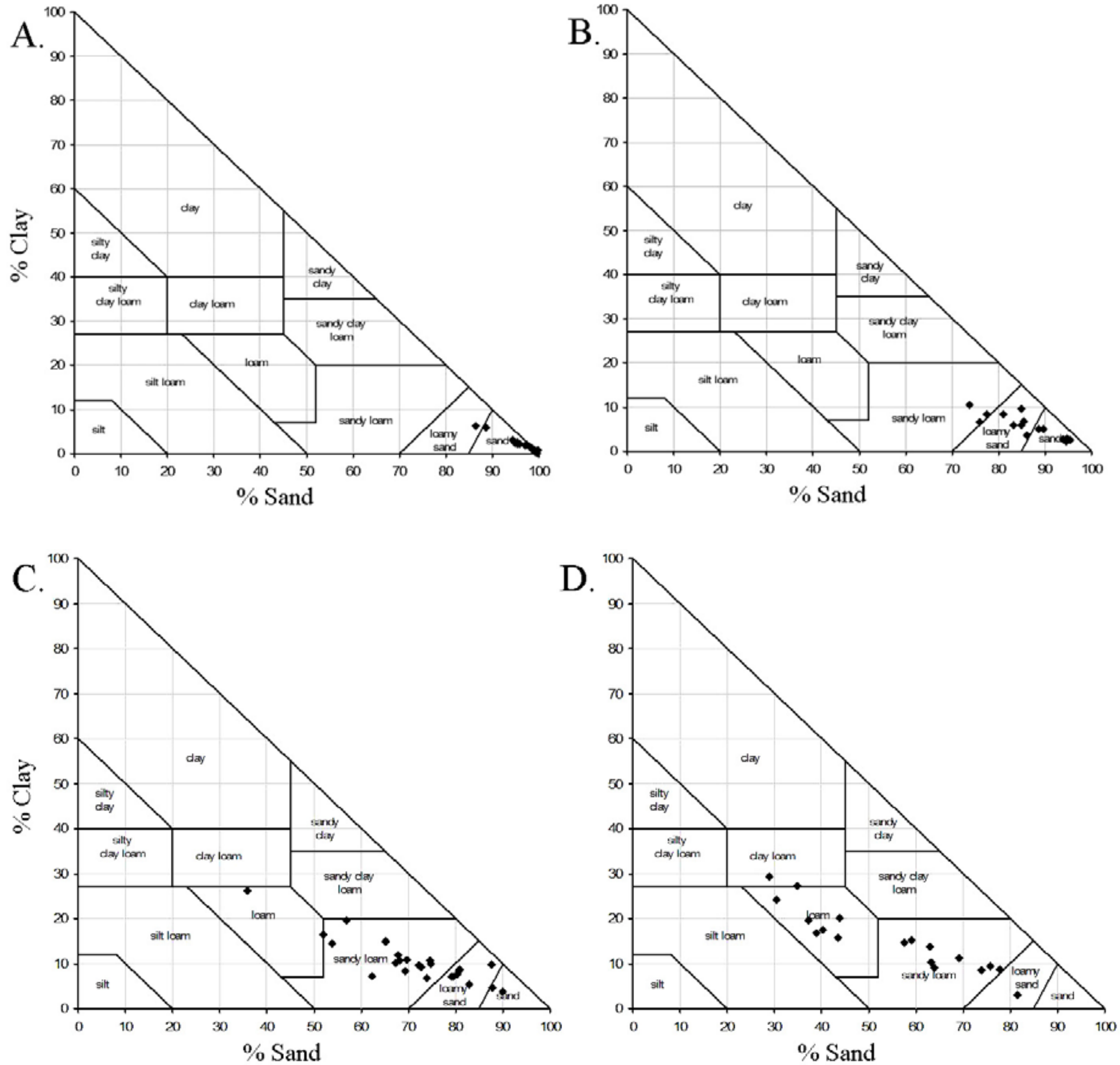

Figure 4-2. A. Particle-size data for soil horizons that were field textured as sands. B. Particle-size data for soil horizons that were field textured as loamy sands. C. Particle-size data for soil horizons that were field textured as sandy loams. D. Particle-size data for soil horizons that were field textured as loams.

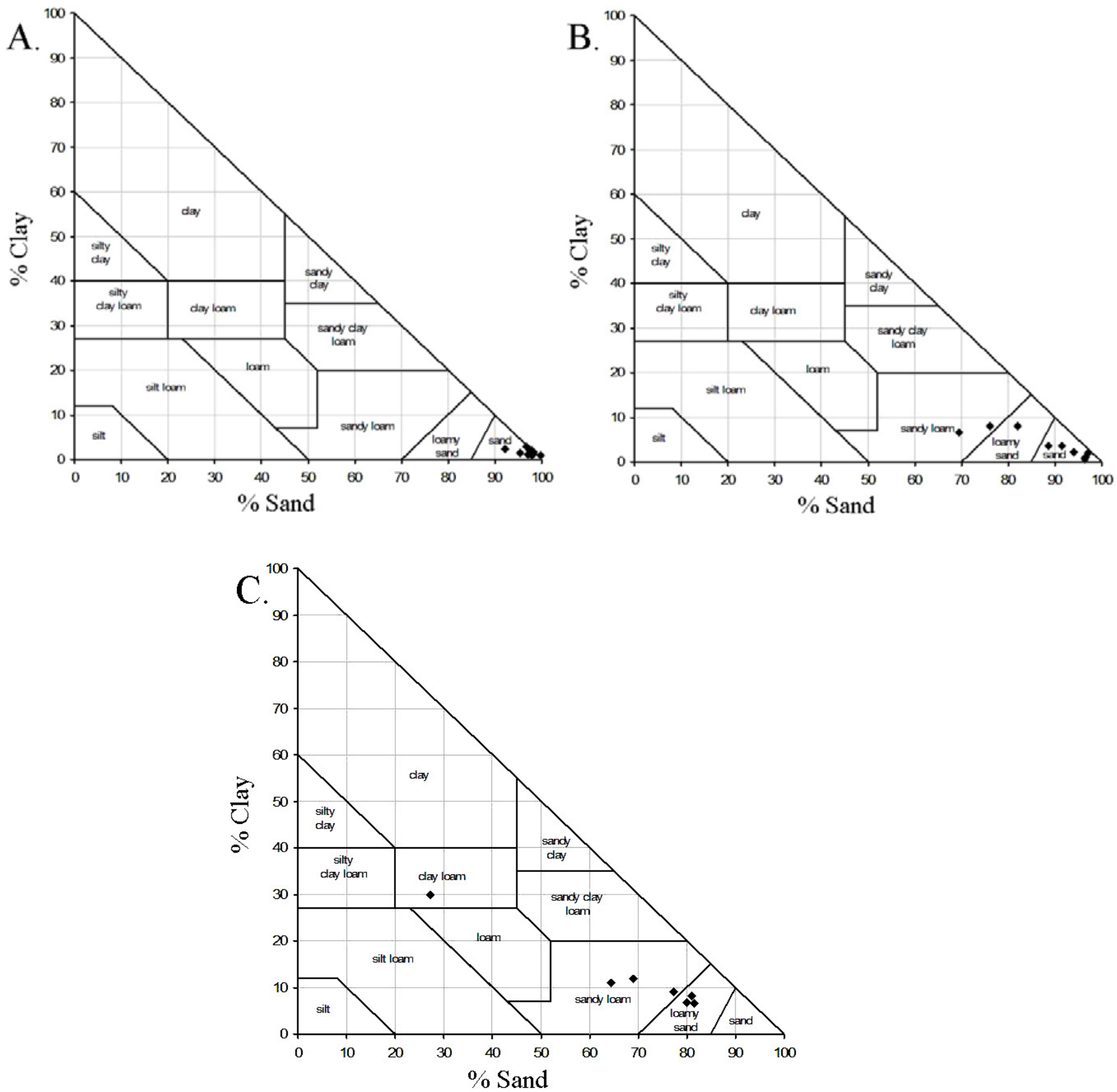

Figure 4-3. A. Particle-size data for soil horizons that were field textured as fine sands. B. Particle-size data for soil horizons that were field textured as loamy fine sands. C. Particle-size data for soil horizons that were field textured as fine sandy loams.

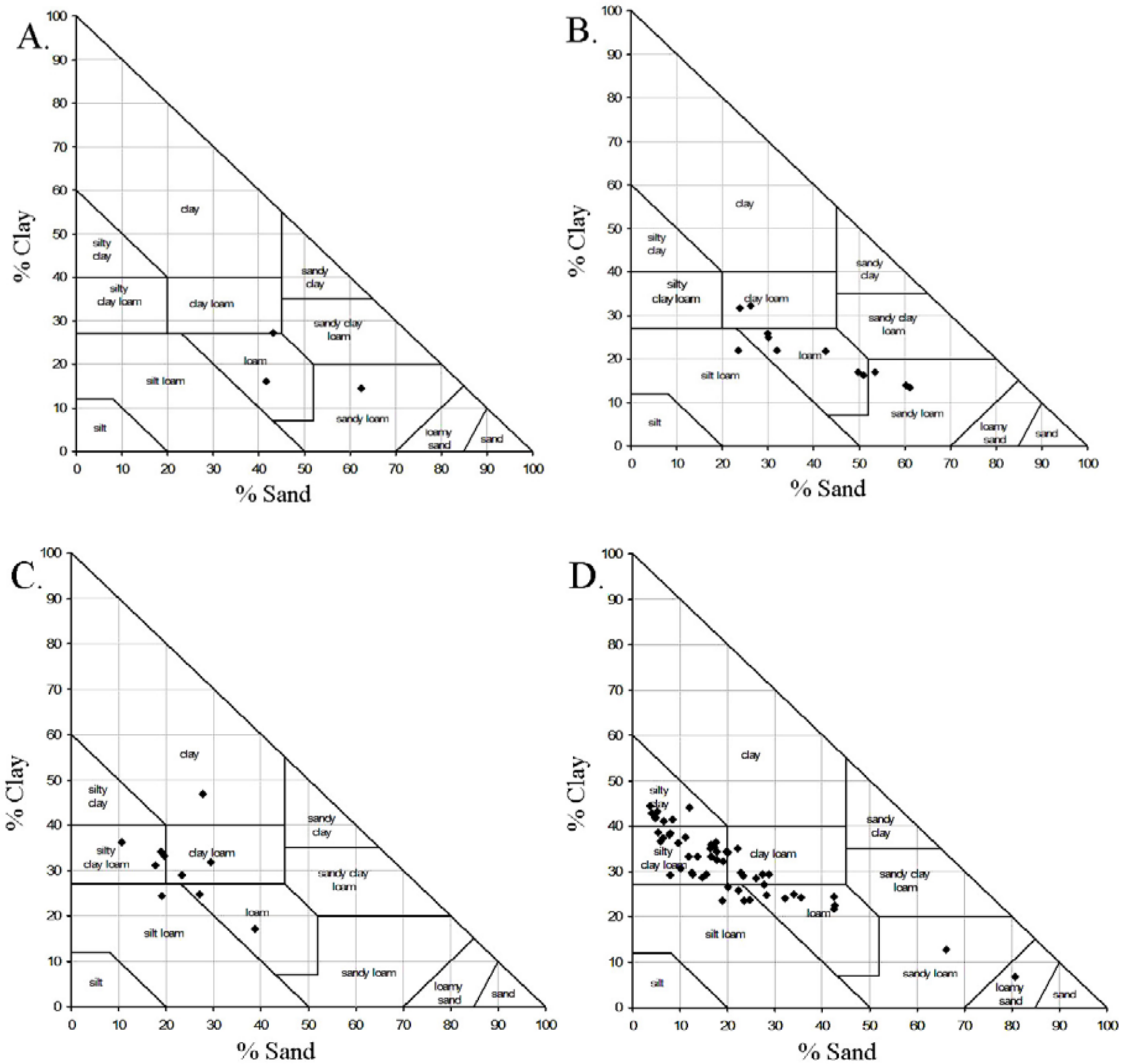

Figure 4-4. A. Particle-size data for soil horizons that were field textured as clay loams. B. Particle-size data for soil horizons that were field textured as clays. C. Particle-size data for soil horizons that were field textured as silty clay loams. D. Particle-size data for soil horizons that were field textured as silty clays.

more accurate assessment of the textures.

The particle-size distributions of all 188 subaqueous soil horizons analyzed are shown in Figure 4-5 where it can be seen that all the subaqueous horizons analyzed plot within a very narrow band. The unusual nature of this grouping can be seen when it was compared to the plots of particle-size data of subaerial soil horizons analyzed in the Maryland coastal plain (Figure 4-6). To try to explain the unusual nature of these particle-size data we examined the cumulative frequency plots for all analyzed pedons in Chincoteague Bay and made comparisons to several subaerial soils located in Wicomico County and Worcester County, Maryland. The cumulative frequency graphs provide general conclusions about the grain size distribution in a sample. Krumbein (1939) studied the sediments and depositional environments within Barataria Bay, LA, which is a tidal lagoon. Based on the sediment distribution of 98 samples, he was able to distinguish five different groups of sediments within the environment (Figure 4-7). The five types of sediments he identified were Type I: beach sands and shallow water sands in the zone of breakers with a median value of $\phi = 3$; Type II: predominately sandy, but with some silt and clay, and occurred in channels where currents were stronger with a median value of $\phi = 3.3$; Type III: composed of 50% sand and occurred on the border of channels and covered locally large areas with moderately deep water with a median of $\phi = 4$; Type IV: predominantly silty with an average of 25% sand, located in the basin with a median of $\phi = 4.7$; and Type V: contained the finest sediments with highest organic contents and a median $\phi = 6$; were located along the fringe of low islands and in areas farthest from the currents. The cumulative frequency graphs for the sediments in

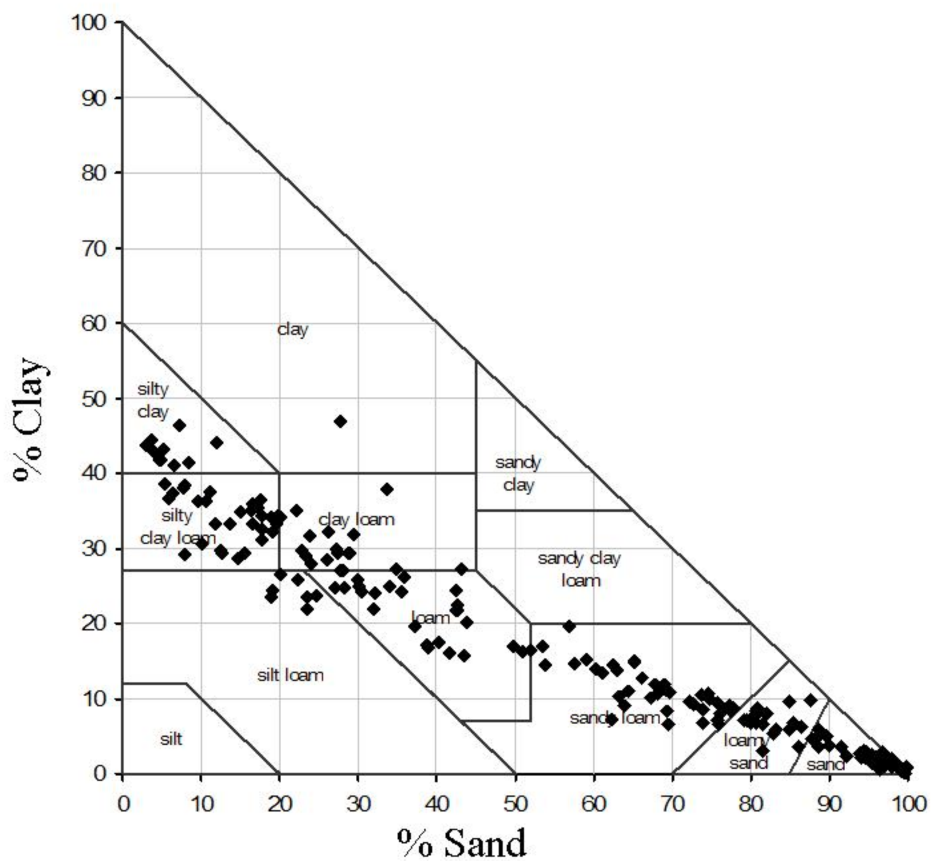

Figure 4-5. Distribution of particle-size data for 188 subaqueous soil horizons analyzed in this study.

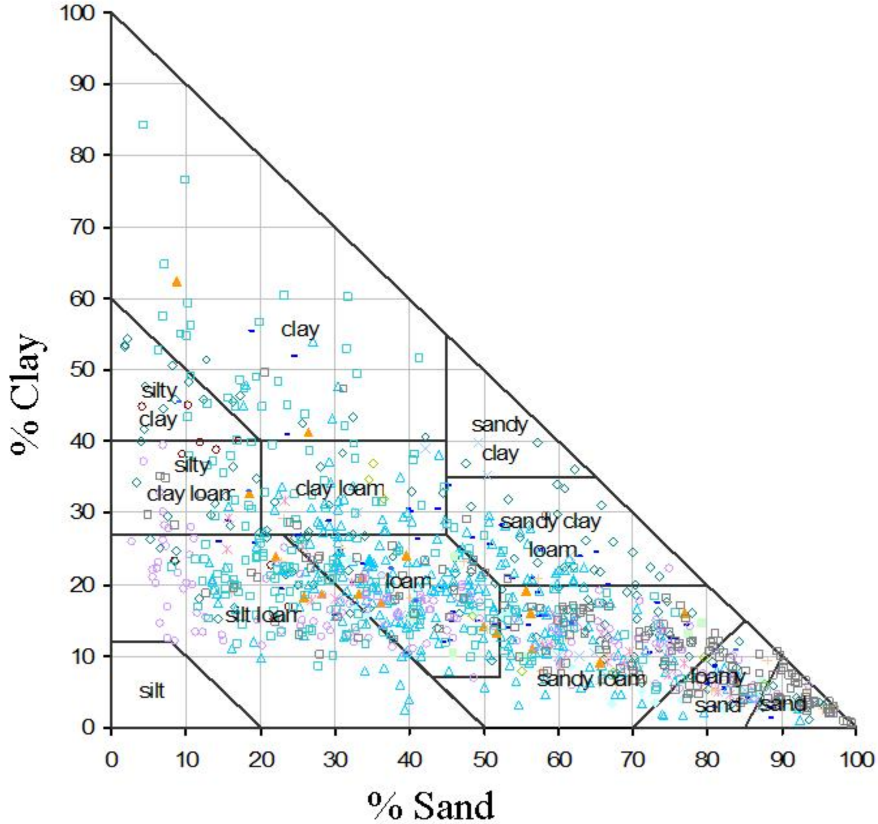

Figure 4-6. Distribution of particle-size data for subaerial soils found throughout Maryland (University of Maryland Pedology Lab, 2007). Each marker represents a different county in Maryland.

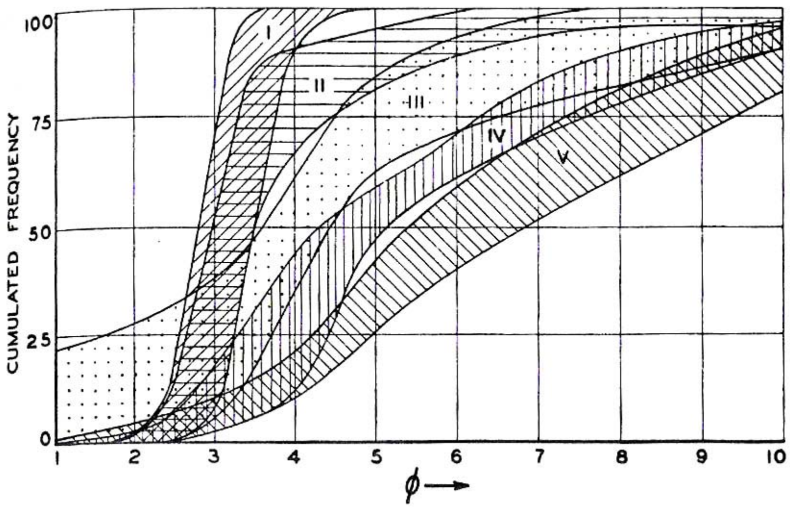

Figure 4-7. Cumulative frequency curves from sediment samples collected from Barataria Bay, LA, which is a tidal lagoon. These curves represent five different depositional environments found within Barataria Bay (From Krumbein, 1939). The five types of sediments are Type I: beach sands and shallow water sands in the zone of breakers with a median value of $\phi = 3$, Type II: predominately sandy, but with some silt and clay, and occurs in channels where currents are stronger with a median value of $\phi = 3.3$, Type III: composed of 50% sand and occur on the border of channels and cover locally large areas with moderately deep water with a median of $\phi = 4$, Type IV: predominantly silty with an average of 25% sand, located in the basin with a median of $\phi = 4.7$, and Type V: contains the finest sediments with highest organic contents and a median $\phi = 6$; are located along fringe of low islands and in areas farthest from the currents.

Chincoteague Bay are very similar to Krumbein's curves of the five types of sediments, although the type of curve is not always consistent with depth through the profile. The soils that were located on the storm-surge washover fan flats, storm-surge washover fan slopes, and paleo-flood tidal delta (Figure 4-8) generally show Type I curves. These are high-energy environments impacted by waves, tidal currents, and storm events, which winnows out the finer sediments from these areas. Soils found on the storm-surge washover fan slopes, barrier coves, and shoal landforms generally show Type II cumulative curves, which are generally sandy with small quantities of silt and clay (Figure 4-9). The quiet lagoon bottom and fluviomarine bottom sediments have curves most like Krumbein (1939) Type III and IV cumulative curves, reflecting a dominance of finer textured sediments (Figure 4-10). The mainland cove and submerged wave-cut headlands have cumulative frequency curves shaped similarly to the Type II, III, and IV curves which highlight a broader range of particle-sizes found on these landforms (Figure 4-11). The cumulative frequency curves for several horizons – Ab, BAb, and Btgb – had a bimodal distribution, which can be attributed to weathering or clay formation within the profile before submergence. The cumulative frequency curves from subaerial soils have shapes similar to Type II and III, but these curves also appear to be bimodal (Figure 4-12). These horizons are similar to curves we observed for horizons located below buried organic horizons, which we attributed to soil forming processes such as weathering or clay formation within a soil profile lending strength to the argument that some of the deeper horizons on the mainland side of the lagoon are in fact old subaerial soils that have been buried by younger materials.

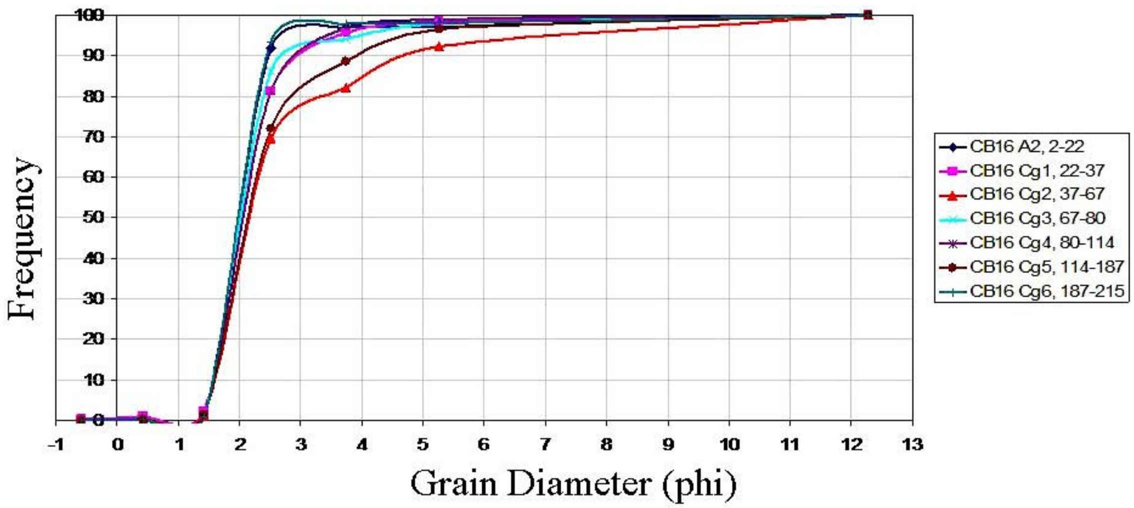

Figure 4-8. Cumulative frequency curve from the storm-surge washover fan flat in Chincoteague Bay (pedon CB16). These curves are similar to the Type I and II curves described by Krumbein (1939).

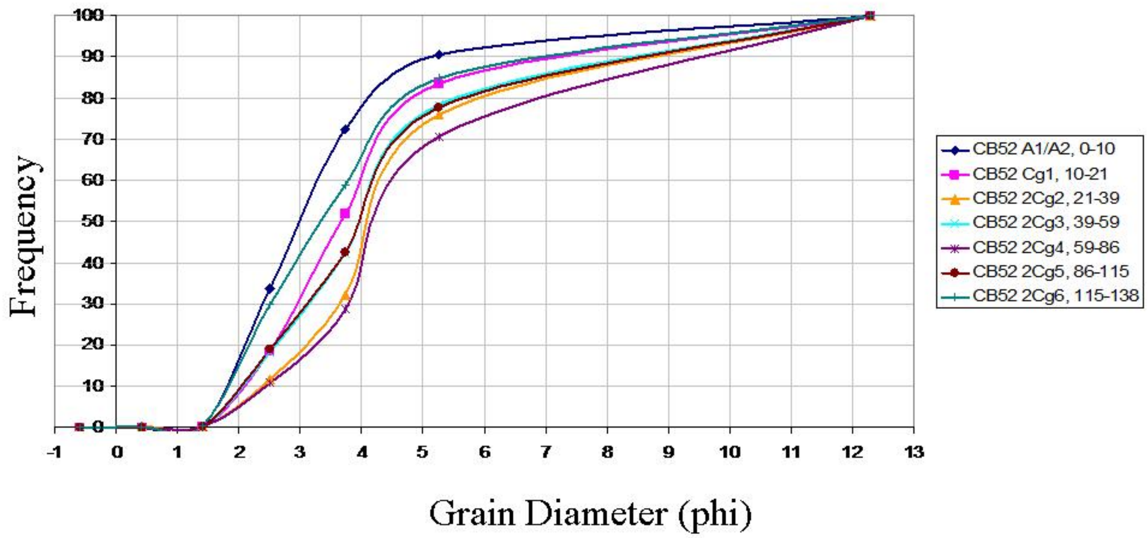

Figure 4-9. Cumulative frequency curve from the barrier cove in Chincoteague Bay (CB52). These curves are similar to the Type II curves described by Krumbein (1939).

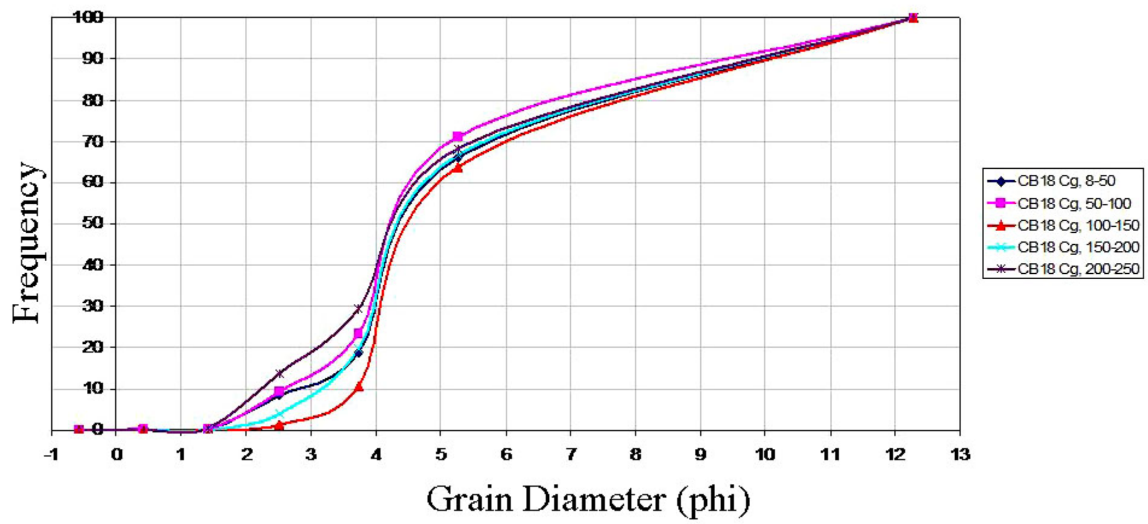

Figure 4-10. Cumulative frequency curve from the lagoon bottom in Chincoteague Bay (pedon CB18). These curves are similar to the Type III and IV curves described by Krumbein (1939).

The sorting coefficient of the population can provide information about a transporting agent's ability to entrain, transport, and deposit grains of different sizes. Sorting can reflect differences in velocity and the ability of the agent to preferentially transport and deposit particular grain sizes. Sorting coefficients developed by Trask (1932) and Folk (1974) were used in this study to document the degree of sorting of the Chincoteague Bay soils and to compare these soils to subaerial soils in Maryland. Most of the soils in Chincoteague Bay are poorly or very poorly sorted based on Folk's classification, whereas using Trask's system the soils are normally distributed from excellent to poorly sorted (Figure 4-13). The subaerial soils of Wicomico and Worcester Counties are poorly and very poorly sorted using Folk's classification and most are poorly sorted using Trask's sorting coefficient (Figure 4-14). Folk's sorting coefficient provides more detailed classes and includes more fractions to determine sorting, which broadens the range of sorting occurring in Chincoteague Bay when compared to subaerial soils of Maryland. The soils of Chincoteague Bay and the subaerial soils are both poorly sorted with some well sorted samples. Generally, the subaqueous soils are better sorted than the subaerial. The sorting coefficients and the cumulative frequency plots do not provide a definitive answer to explain why the particle-size distribution of soils from Chincoteague Bay lie in a very narrow band compared to the subaerial soils from Maryland.

The presence or absence of sulfidic materials within the soil profile has important ecological and environmental ramifications and is an important criterion in the characterization of these soils. The determination of whether or not sulfidic materials were present was based on moist, aerobic incubations of the soil horizons.

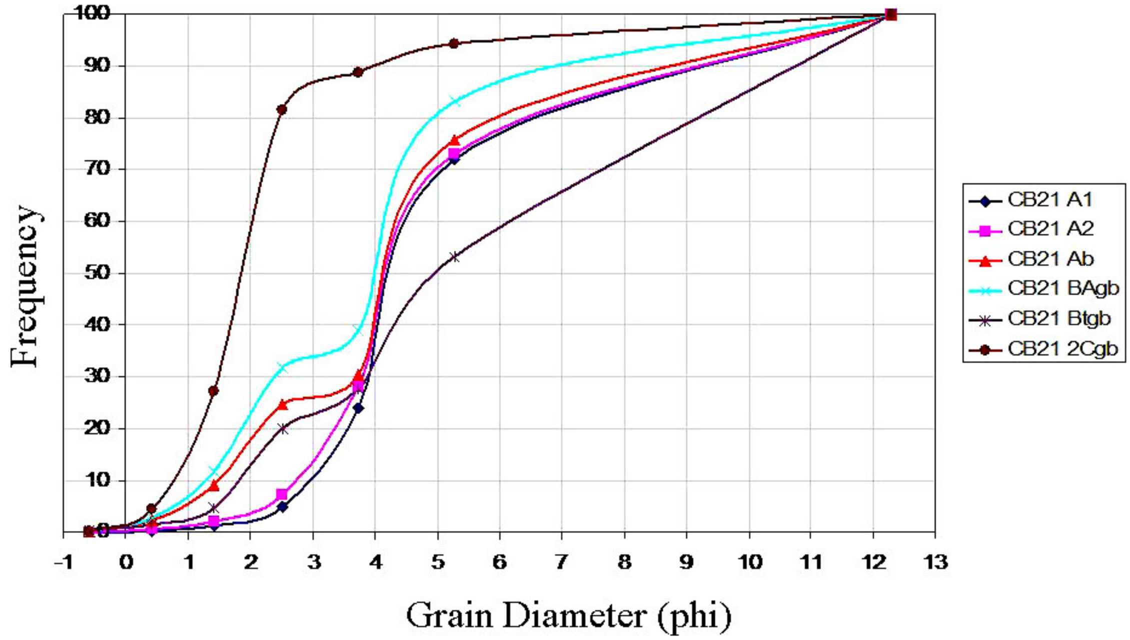

Figure 4-11. Cumulative frequency curve from the mainland cove in Chincoteague Bay (pedon CB21). These curves are similar to the Type III and IV described by Krubein (1939).

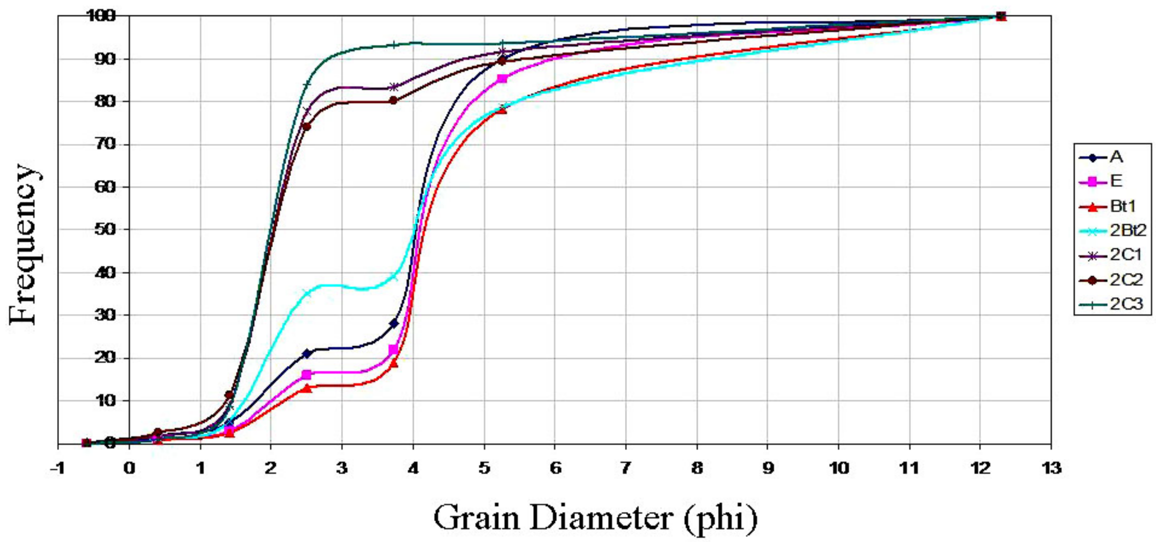

Figure 4-12. Cumulative frequency curves from a subaerial soil located in Worcester County, Maryland.

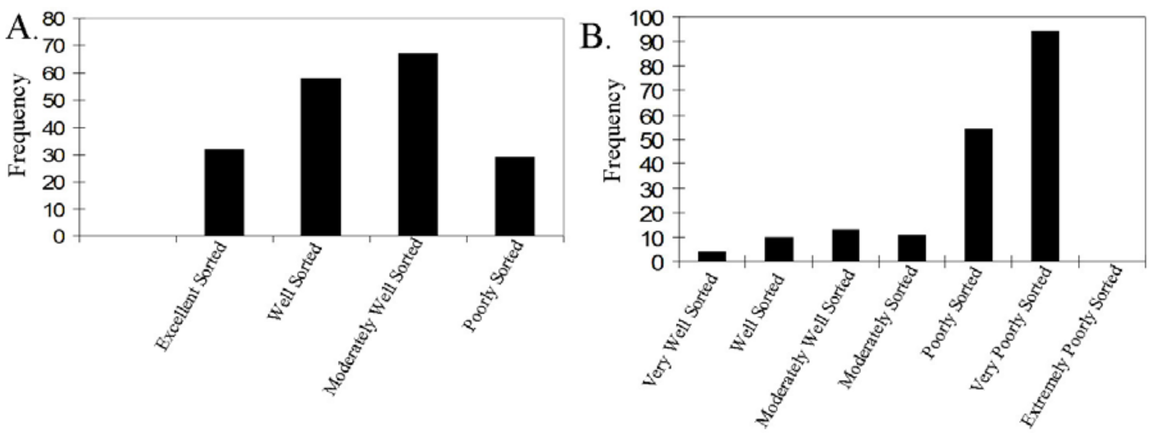

Figure 4-13. A. Distribution of Trask sorting coefficients (1939) for soils in Chincoteague Bay. Excellent sorted ranges from 0 to 0.58, well sorted ranges from 0.58 to 1.32, moderately well sorted ranges from 1.32 to 2.0, and poorly sorted is greater than 2. B. Distribution of Folk sorting coefficients (1974) for soils in Chincoteague Bay. Very well sorted ranges from 0 to 0.35, well sorted ranges from 0.35 to 0.50, moderately well sorted ranges from 0.50 to 0.71, moderately sorted from 0.71 to 1.0, poorly sorted ranges from 1.0 to 2.0, very poorly sorted ranges from 2.0 to 4.0, and extremely poorly sorted is greater than 4.0.

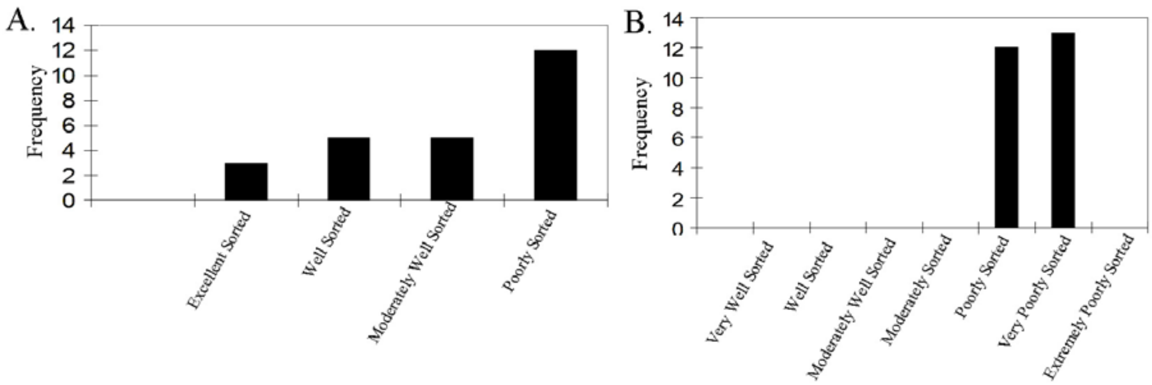

Figure 4-14. A. Distribution of Trask sorting coefficients (1939) for soils in Wicomico and Worcester County, Maryland. Excellent sorted ranges from 0 to 0.58, well sorted ranges from 0.58 to 1.32, moderately well sorted ranges from 1.32 to 2.0, and poorly sorted is greater than 2. B. Distribution of Folk sorting coefficients (1974) for soils in Wicomico and Worcester County, Maryland. Very well sorted ranges from 0 to 0.35, well sorted ranges from 0.35 to 0.50, moderately well sorted ranges from 0.50 to 0.71, moderately sorted from 0.71 to 1.0, poorly sorted ranges from 1.0 to 2.0, very poorly sorted ranges from 2.0 to 4.0, and extremely poorly sorted is greater than 4.0. Using both classification systems most of the subaerial soils are poorly sorted compared to subaqueous soils that are better sorted.

The definition of sulfidic materials requires that the pH drop below 4 within eight weeks (due to the oxidation of sulfides and the generation of acid). Our hypothesis was that soil horizons that had noticeable H_2S in the field should probably show a drop in pH below 4. However, pyritic forms of sulfides would not produce H_2S when HCl is applied, so we only could identify monosulfides in the field. Samples with sandy textures (s, ls, or sl) tend to show a quick drop to pH below 4, which is probably due to the low buffering capacity and lack of carbonates (Figure 4-15). Samples that have loamy textures (l, sicl, cl) seem to show a slower drop in pH, presumably due to the higher buffering capacity of these soils (Figure 4-16). Therefore, we monitored the pH for a longer period of 13 to 24 weeks to better allow more time for pH to drop and thus document the presence of sulfidic materials in these soils. If soil samples contain adequate calcium carbonate to neutralize the generated acidity their moist incubation pH values do not drop below pH 4 even after 24 weeks of monitoring (Figure 4-17). These samples had pH values that stayed near 7-8, which indicated the presence of excess carbonate. Based on these observations, the requirement for a drop in pH below 4 to occur within eight weeks might not adequately identify the presence of sulfidic materials in at least some of these soils. The samples that take longer than eight weeks to show a drop in pH should also be recognized as having sulfidic materials within their profiles. The majority of our samples (78%) showed a drop in pH below 4 within 25 weeks. Table 4-3 shows the length of time that samples needed for pH to drop below 4. A small portion (20 %) of the samples required only four weeks for pH to drop below 4, but only 57% of the samples required eight weeks for pH to drop below 4. By doubling the length of time,

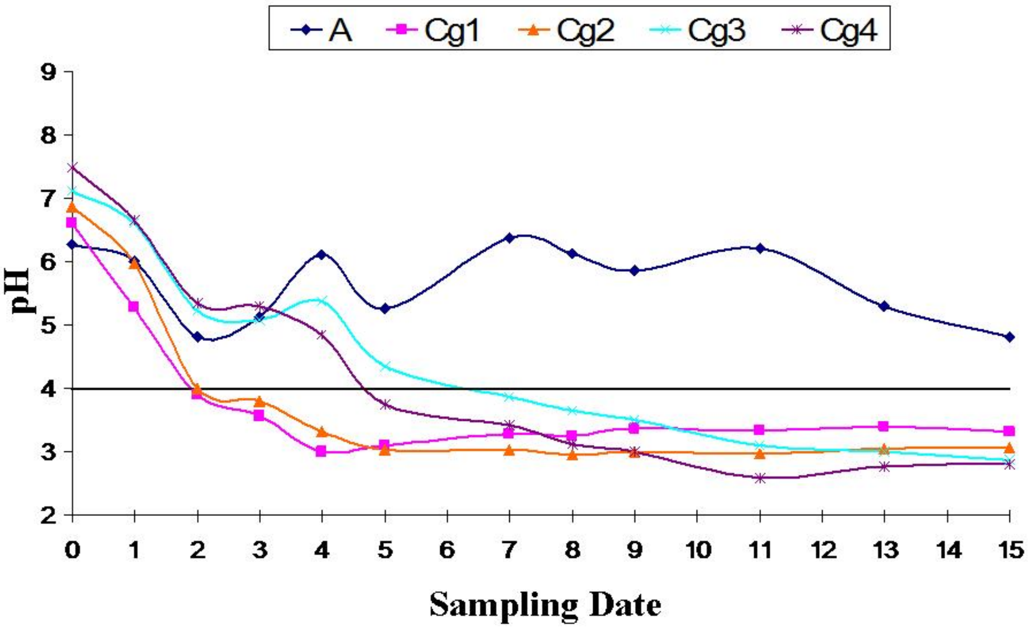

Figure 4-15. Moist incubation pH data for a sandy textured soil (Core CB01). In all horizons, except the surface, pH drops below 4 within eight weeks.

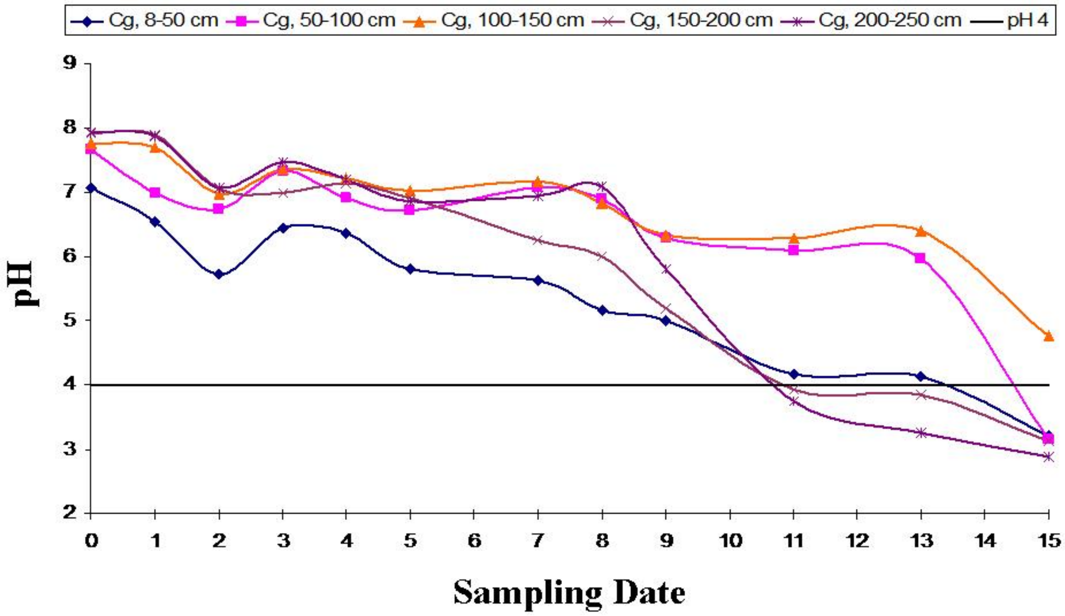

Figure 4-16. Moist incubation pH data for a loamy textured soil profile (Core CB18). None of the horizons showed a drop in pH within eight weeks, but they did begin to drop below 4 within 11 to 15 weeks.

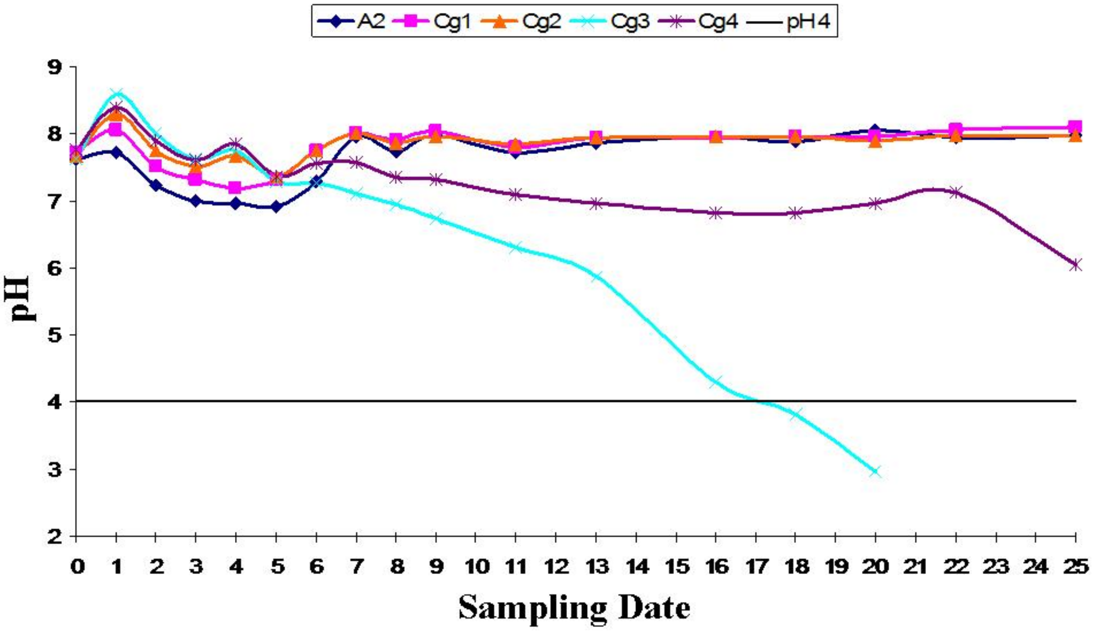

Figure 4-17. Moist incubation pH data for a loamy textured soil profile that contains biogenic calcium carbonate in several horizons (Core CB141). Note the samples with excess carbonates maintained a pH around 7-8.

Table 4-3. The length of time for 163 samples incubated under moist aerobic conditions to drop below a pH of 4. Only 51% of these samples that would eventually show a drop in pH to below 4 did so within the prescribed eight weeks.

Length of time to drop below pH 4	Number of samples†	% of Samples that eventually show a drop in pH<4
4 weeks	25 (16%)	20
8 weeks	73 (45%)	57
12 weeks	104 (64%)	81
16 weeks	117 (72%)	91
20 weeks	125 (77%)	98
24 weeks	128 (78%)	100

† 46 samples were only incubated for 16 weeks

pH dropped below 4 in 91 % of the samples. Therefore, we recommend monitoring the pH of these soils longer than the specified eight weeks if the goal is to identify the presence or absence of sulfidic materials in these environments.

The moist incubation pH data provides information regarding the presence or absence of sulfidic materials within the soil profile, but it does not provide information regarding the type or amount of sulfide bearing minerals within the soil. In the field we documented the presence or absence of H_2S and the intensity its aroma. When samples did not have a noticeable aroma we added a small quantity of 10% HCl to the sample, which allowed us to qualitatively check for the presence of acid volatile sulfides in the soil profile. The quantities of acid volatile sulfides (monosulfides) and chromium reducible sulfides (disulfides) were determined on several selected profiles from three major landforms in Chincoteague Bay (mainland cove, lagoon bottom, and storm- surge washover fan flat). The acid volatile sulfide and chromium reducible sulfide data are presented in Table 4-4. The acid volatile sulfide concentration was very low in these profiles, even when the chromium reducible sulfide concentrations were substantial. The distribution of chromium reducible sulfide (disulfides) in these selected pedons is shown in Figure 4-18. The lowest pyrite concentrations are in the sandy soils that occur on the storm-surge washover fan flats. These areas likely have lower pyrite concentrations due to lower organic carbon and lower iron inputs compared to the other sites. The highest pyrite values occurred in the buried organic horizons located in the mainland cove. The mainland coves provide optimal conditions for the formation of pyrite, which include a large source of oxidizable carbon and a supply of iron sorbed to fine mineral

Table 4-4. Acid volatile sulfide (monosulfides) and chromium reducible sulfide (disulfides) concentrations from the storm-surge washover fan flat (CB01), lagoon bottom (CB18 and CB58), barrier cove (CB52) and mainland cove (CB11).

Sample	**Acid Volatile Sulfides g kg^{-1}**	**Chromium Reducible Sulfides g kg^{-1}**	**Organic Carbon g kg^{-1}**	**Time for pH to drop below 4 (days)**	**Final pH**
CB01 A, 0-14 cm	0.00	0.08	0.76	nd†	4.8
CB01 Cg1, 14-76 cm	0.04	0.16	0.44	14	3.3
CB01 Cg2, 76-103 cm	0.00	1.03	0.82	21	3.1
CB01 Cg3, 103-170 cm	0.00	0.39	1.56	49	2.9
CB01 Cg4, 170-210 cm	0.06	1.81	3.09	35	2.8
CB11 A2, 2-12 cm	0.03	1.64	7.02	77	3.1
CB11 Cg1, 12-36 cm	0.03	13.31	19.56	35	2.6
CB11 Cg2, 36-56 cm	0.06	12.34	42.17	35	2.5
CB11 Oab1, 56-83 cm	0.00	27.52	157.00	21	2.3
CB11 Oab2, 83-109 cm	0.00	47.93	212.20	49	2.6
CB11 2Ab, 109-115 cm	0.12	4.48	71.30	---‡	5.2
CB11 2Cgb, 115-122 cm	0.05	0.79	22.32	---‡	6.2
CB18 A, 0-8 cm	0.02	2.33	nd	nd	nd
CB18 Cg, 8-50 cm	0.02	6.30	15.23	105	3.2
CB18 Cg, 50-100 cm	0.05	6.41	12.37	105	3.2
CB18 Cg, 100-150 cm	0.04	6.38	13.89	---‡	4.8
CB18 Cg, 150-200 cm	0.15	6.61	11.30	77	3.1
CB18 Cg, 200-250 cm	0.06	6.29	13.09	77	2.9
CB52 Cg1, 10-21 cm	0.00	4.02	9.04	77	2.63
CB52 2Cg2, 21-39 cm	0.00	5.96	11.57	77	2.60
CB52 2Cg3, 39-59 cm	0.04	5.95	14.14	63	3.03
CB52 2Cg4, 59-86 cm	0.07	5.09	16.95	77	2.80
CB52 2Cg5, 86-115 cm	0.21	4.18	9.77	112	3.60
CB52 2Cg6, 115-138 cm	0.08	4.77	6.13	---§	4.15
CB58 A2, 3-14 cm	0.05	1.01	2.18	---§	7.59
CB58 Cg1, 14-37 cm	0.02	3.16	3.96	112	3.75
CB58 Cg2, 37-106 cm	0.04	4.35	3.38	140	3.11
CB 58 2Cg3, 106-162 cm	0.02	7.54	10.31	112	3.12

† no data were collected for these samples
‡ a drop below pH 4 within 16 weeks did not occur in these samples
§ a drop below pH 4 within 25 weeks did not occur in these samples

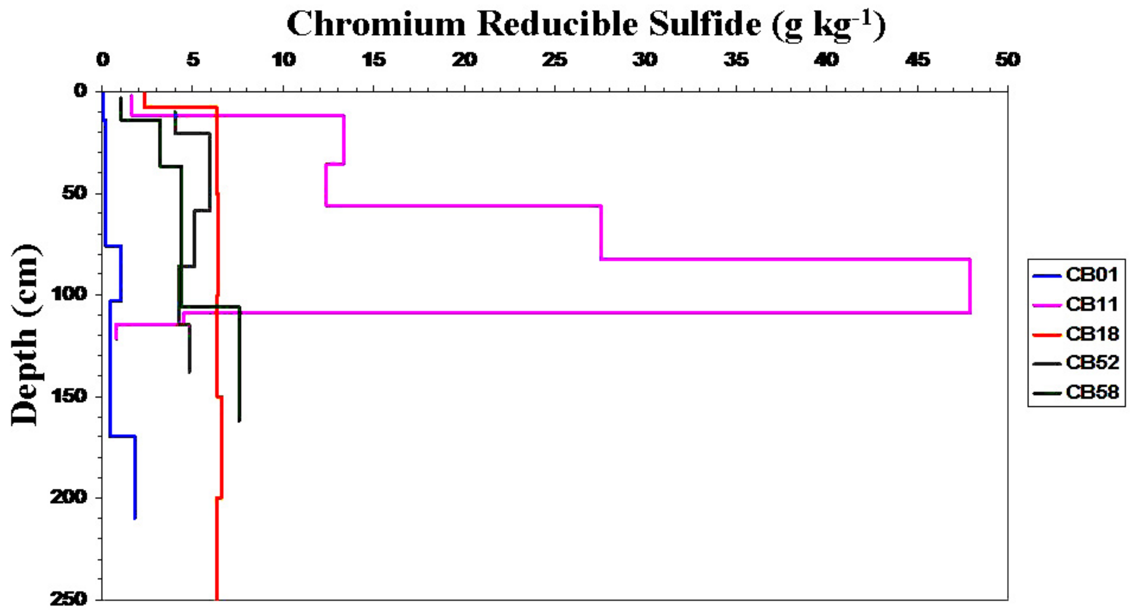

Figure 4-18. Distribution of chromium reducible sulfides (disulfides) with depth of soils on the storm-surge washover fan flat (CB01), lagoon bottom (CB11 and CB58), barrier cove (CB52), and mainland cove (CB11).

sediments.

The n value is an important criterion in classifying mineral soils at the great group and series level. The n value was estimated in the field by squeezing a portion of the soil and estimating how much of the soil flows through the fingers. The estimation of the field n value provided information regarding the bearing strength of the soil, the lower the n value the higher the bearing capacity. However, the calculated n value (Eq. 1) characterizes the relationship between the water content, percentage of sand and silt, percentage of clay, and organic matter. We calculated the n value for 163 samples for which we obtained the necessary inputs. Samples with more than 95% sand were not used in analysis because the very low clay contents resulted in deceivingly high values and furthermore extremely sandy soils are generally thought to have low n values. Therefore we examined the soils in two groups <80% sand or 80 to 95% sand. The frequency distribution for the calculated n values for these two groups of soils is shown in Figure 4-19. Both groups generally had n values greater than 1. However, we anticipated that the soils with 80 to 95% sand would mostly have n values less than 1. Usually, n values are not calculated but rather are estimated in the field by squeezing a handful of soil. The frequency of the field estimated n values for soils with 80 to 95% sand and <80% sand are shown in Figure 4-20. The soils with sandy textures (fS, LS, or LfS) mostly had field estimated n values less than 0.7 indicating that these soils are non-fluid. These soils were located on the storm-surge washover fan flat, storm-surge washover fan slope, and paleo-flood tidal delta landforms. The loamy textured soils (fSL, SL, or L) mostly had field estimated n values of 0.7-1. These soils are slightly fluid and were mostly found

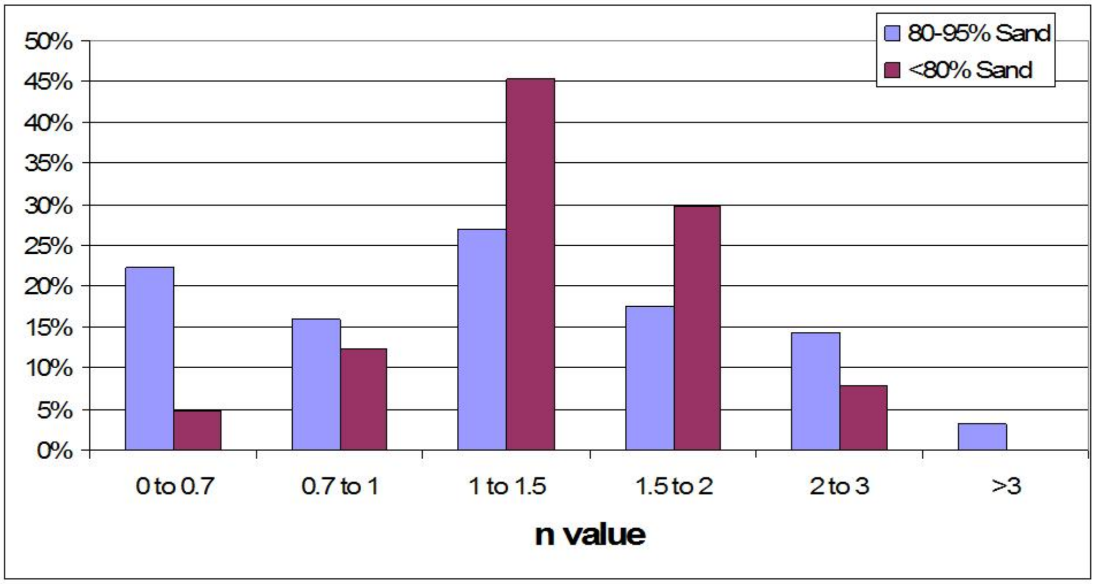

Figure 4-19. The frequency distribution of the calculated n values for 163 samples from Chincoteague Bay. The samples with more than 95% sand were not included because the values were erroneous.

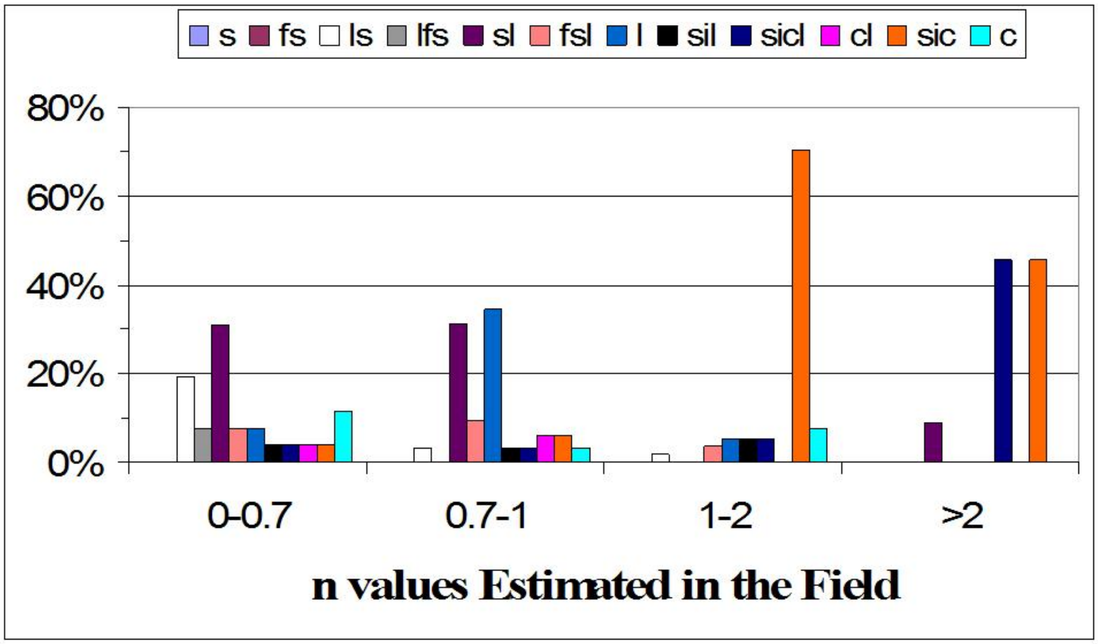

Figure 4-20. The frequency distribution of n values estimated in the field for 163 samples from Chincoteague Bay. Note the sandy textured soils (fs, ls, or lfs) mostly had n values less than 0.7 and the finer textured soils (sicl, sic, or c) had n values greater than 1.

on the storm-surge washover fan slopes, barrier coves, and barrier side of the lagoon bottom. The finer textured soils (SiCL, SiC, or C) mostly had field estimated n values greater than 1. These soils were moderately to very fluid which indicates that these soils would have a low bearing capacity and mostly located on the lagoon bottom, mainland cove, submerged wave-cut headland, barrier cove, and fluviomarine bottom landforms. A comparison between field estimated n values and calculated n values (from Eq. 1) are presented in Figure 4-21. According to *Soil Taxonomy* the "critical n value of 0.7" should be approximated closely in the field by using the squeeze test. Using the data obtained from the soils in Chincoteague Bay the calculated n values did not correlate with the field estimated n values for the sandier textured soils (>50% sand), but were better correlated for the finer textured soils (<50% sand). The field estimated n value provided a more accurate description of the fluidity and bearing capacity of the soil.

Salinity data for the soils analyzed in this study are presented in Figure 4-22 and Figure 4-23. The subaqueous soils of Chincoteague Bay had porewater salinity ranges from 16 to 37 ppt in the upper portion of the soil profile. Salinity distributions of pedons from the fluviomarine bottom, lagoon bottom, storm-surge washover fan slopes, storm-surge washover fan flats, paleo-flood tidal delta and barrier coves (eastern side of the bay) are shown in Figure 4-22. The salinity distributions within pedons located in the eastern portion of the bay remained high with depth and generally centered around 26 to 34 ppt, which is the salinity of the bay water. Several horizons within these pedons had salinity values greater than 36 ppt, which seem erroneously high, since one would think that the salinity should not be greater than

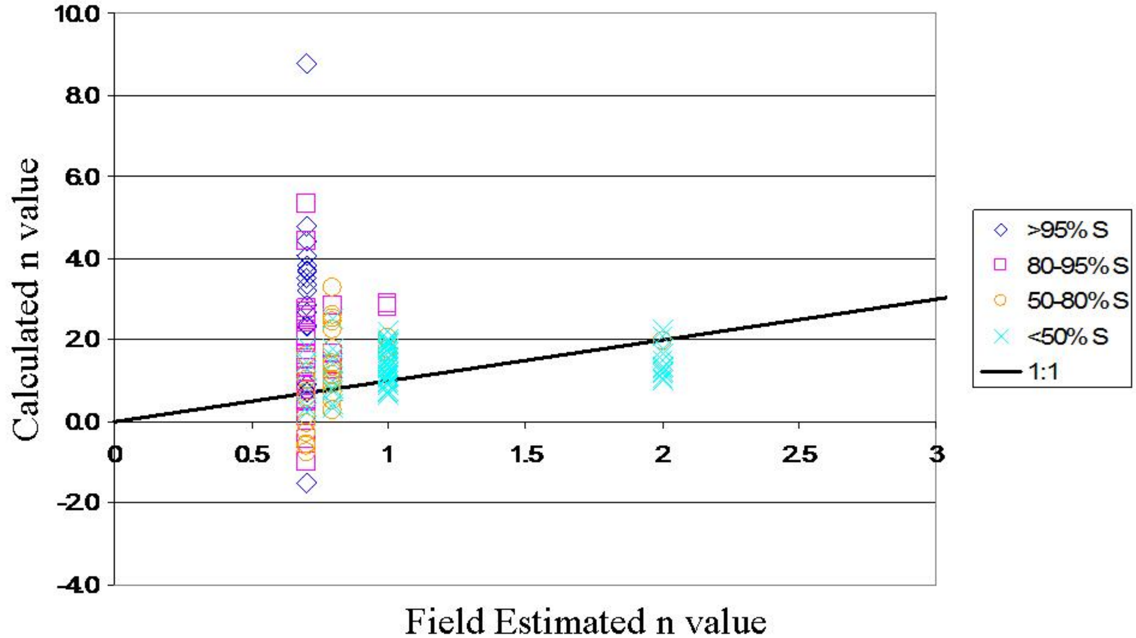

Figure 4-21. Comparison of the field estimated n values and the calculated n values for 163 samples collected in Chincoteague Bay. The field estimated n values for the sandier soils (>50% S) did not correlate well with the calculated n values, but the finer textured soils (<50% S) were better correlated. The field estimated n value provided a more accurate description of the fluidity and bearing capacity of the soils.

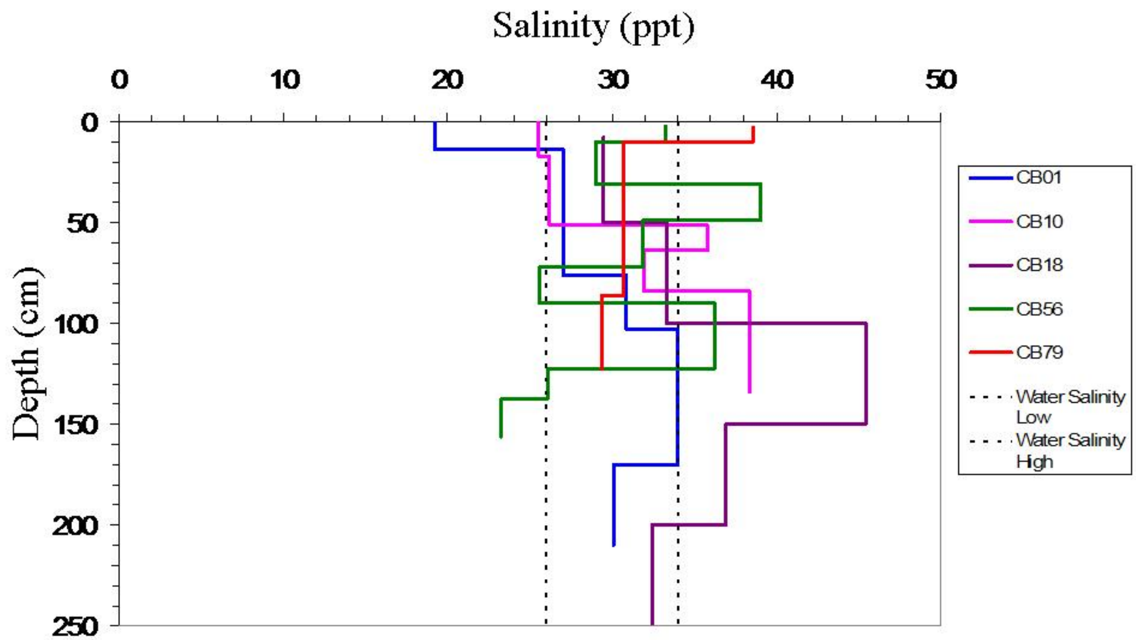

Figure 4-22. Porewater salinity for soils located on the storm-surge washover fan flats (CB01 and CB56), barrier coves (CB10), and lagoon bottom (CB18 and CB79). The salinity levels generally do not show a trend with depth and do not decrease below 20 ppt. Note the dashed lines represent the salinity range found within Chincoteague Bay.

the overlying water. The higher salinity values might be attributed to experimental errors or possibly even to exposure of the sample to an oxygenated environment which may have caused oxidation of sulfide bearing minerals and the formation of sulfate salts (although every precaution was taken during the sampling process to preclude oxidation of the samples). However, higher salinities have been reported in groundwater underlying Assateague Island. It was suggested that during the summer evaporation of seawater in barrier salt marshes produced the brine that sinks through the groundwater and flows along the silt confining layer until it pools in coarser old inlet channel sediments (Norton and Krantz, 2004).

Salinity distributions of pedons located close to the mainland (within the mainland cove and submerged wave-cut headland landforms) are shown in Figure 4-23. Salinity distributions of pedons located near the mainland tended to show a systematic decrease with depth. The salinity levels at the bottom of these pedons drops as low as 2 ppt, which is far different from the overlying sea water. The lower salinity values associated with these areas are likely the result of groundwater discharge into the bay from the surrounding watershed (Dillow et al., 2002).

Carbon Distribution in Subaqueous Soils

Total carbon, organic carbon, and calcium carbonate contents were determined for 51 pedons sampled in Chincoteague Bay. Following the methodology of Piper (1949) calcium carbonate was initially considered to be equal to the difference in carbon measured by dry combustion on paired samples that had, and had not, been treated with H_2SO_3 (sulfurous acid). It was observed, however, that even

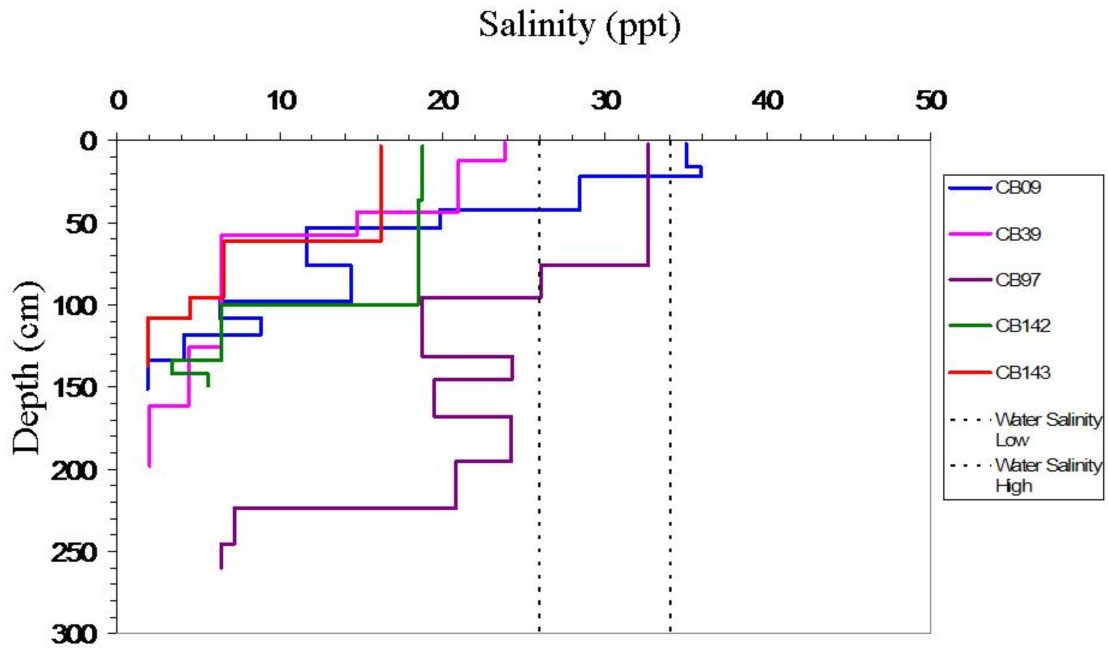

Figure 4-23. Porewater salinity contents for soils located near the mainland in the mainland cove and lagoon bottom landforms. CB09 is closest to the mainland (120 m) and CB97 is farthest from the mainland (1200 m). Salinity in the near surface horizons approached that of the overlying bay water, but decreases with depth. The decrease in porewater salinity levels with depth was attributed to groundwater influx into the bay. Note the dashed lines represent the salinity range found within Chincoteague Bay.

samples that showed no evidence of effervescence when HCl was applied, still showed a measurable difference between carbon in the treated and untreated samples. To investigate this possibility, 11 samples from acid subaerial soils without carbonates were evaluated. Carbon measured by dry combustion before and after treatment with H_2SO_3 is shown in Figure 4-24. Approximately 7.5% of the organic carbon present in the samples appeared to be oxidized by the H_2SO_3 treatment.

For the subaqueous soils in this study, we identified the presence or absence of carbonates in selected pedons by looking for a reaction with 10% HCl when observed under a 10x microscope. Those samples that did not react at all were considered free of carbonates. To further assess the oxidation of organic carbon by sulfurous acid, fifty-three non-effervescent samples were analyzed for carbon before and after treatment with H_2SO_3. The data are shown in Figure 4-25. On average, 4.5% (SD 3.1%) of the organic carbon in the samples was oxidized by the H_2SO_3 treatment. Using these data, the organic carbon content in soils that contained calcium carbonate was corrected and calcium carbonate levels were proportionally adjusted to remove this systematic error. The samples described (under the microscope with HCl acid) as having very slight effervescence had calcium carbonate quantities that ranged from 0.0 to 17.0 g kg^{-1} (mean 3.2). Samples described as having slight effervescence had calcium carbonate quantities that ranged from 0.0 to 30.4 g kg^{-1} (mean 7.4). Samples with strong or violent effervescence had significantly higher levels of calcium carbonate that ranged from 18.3 to 370.0 g kg^{-1} (mean 89.6).

Shell fragments were described in 123 soil profiles (84%), with quantities ranging from 1 to 80% by volume (using visual estimation). Larger fragments and

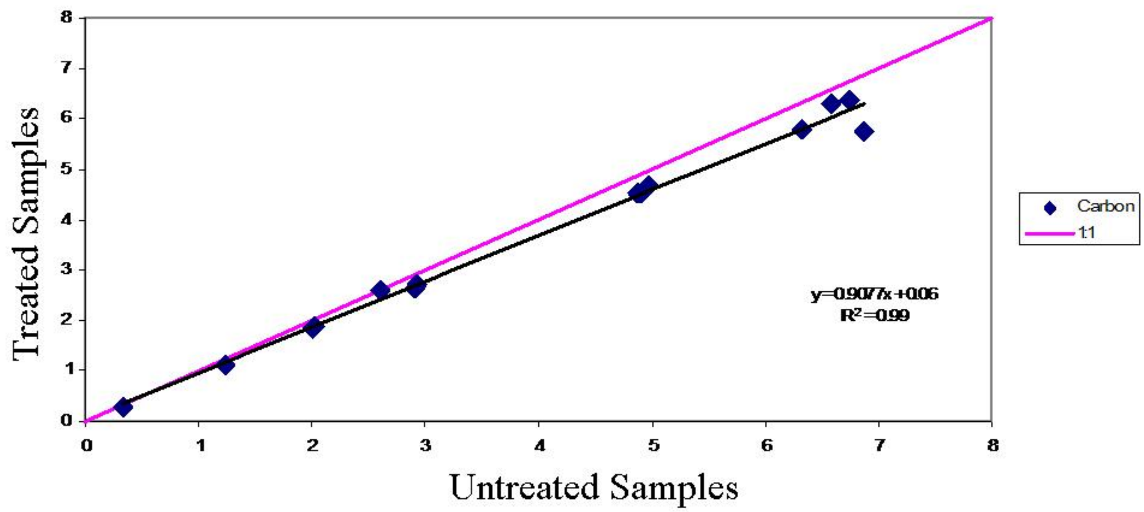

Figure 4-24. Samples collected from 11 acid non-calcareous subaerial soil samples that were treated with 5% sulfurous acid. The organic carbon contents of the untreated samples and treated samples differed by an average of 7.5% (SD 3.4%). This difference indicated that the sulfurous acid treatment oxidized a portion of the organic carbon.

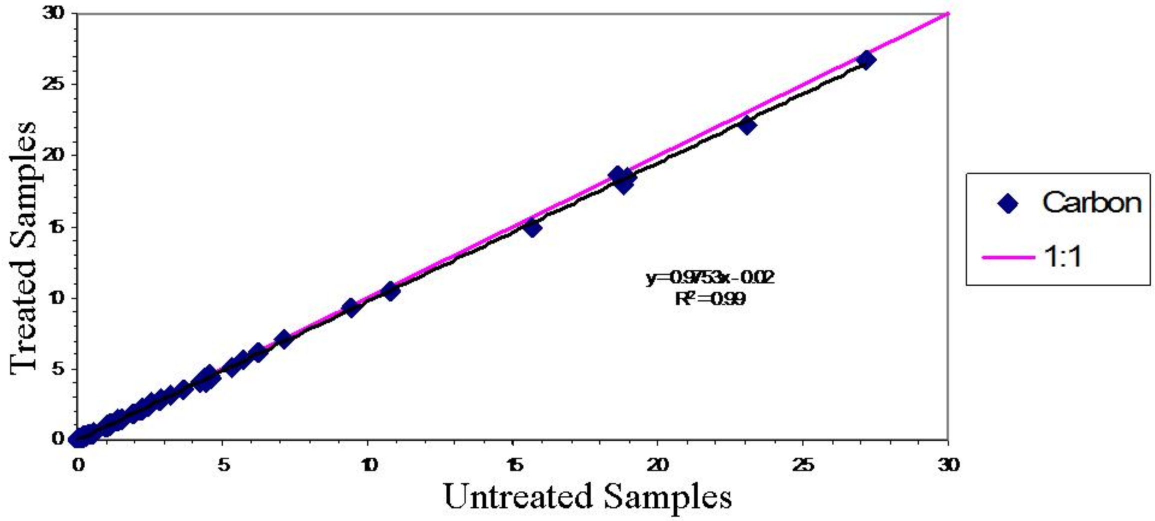

Figure 4-25. Samples collected from non-effervescent subaqueous soils were treated with 5% sulfurous acid. The organic carbon contents of the untreated samples and treated samples differed by an average of 4.5% (SD 3.1%). This difference indicated that the sulfurous acid treatment oxidized a portion of the organic carbon.

intact shells could be identified as gastropods, oysters, mussels, razor clams, and hard clams. Although shells were observed in the majority of the pedons, the quantity of calcium carbonate contributed to the soils by these organisms was generally low. The calcium carbonate distributions for four pedons located on the storm surge washover fan flats are shown in Figure 4-26. Calcium carbonate distributions for finer textured soils located on the lagoon bottom are shown in Figure 4-27. The coarser textured soils and the finer textured soils throughout the bay contained small quantities of calcium carbonate. The addition of biologic carbonates to these soils was generally a result of in situ benthic organisms. The coarser soils had calcium carbonate contents throughout the profiles compared to the finer textured soils that tended to have biogenic calcium carbonate only in the upper horizons. These coarser textured areas tend to be better habitats for bivalves (filter feeders) compared to finer textured soils (Rhoads and Young, 1970). However, this does not account for the shells found within the finer textured soils. Several pedons located in the lagoon bottom contained large quantities of shells and are presented in Figure 4-28. The shells in these horizons were usually broken and located in bands throughout the profile, which indicated that these shells were deposited during a storm event rather than in situ.

Along the mainland side of the bay, 26 pedons contained buried organic horizons with upper boundary depths ranging from 18 to 198 cm and the thickness of these horizons ranged from 9 to 64 cm. The organic carbon distributions for six pedons that contain buried organic horizons are shown in Figure 4-29. These profiles contain the highest organic carbon contents within Chincoteague Bay. The organic carbon distributions for six pedons located on the lagoon bottom are shown in

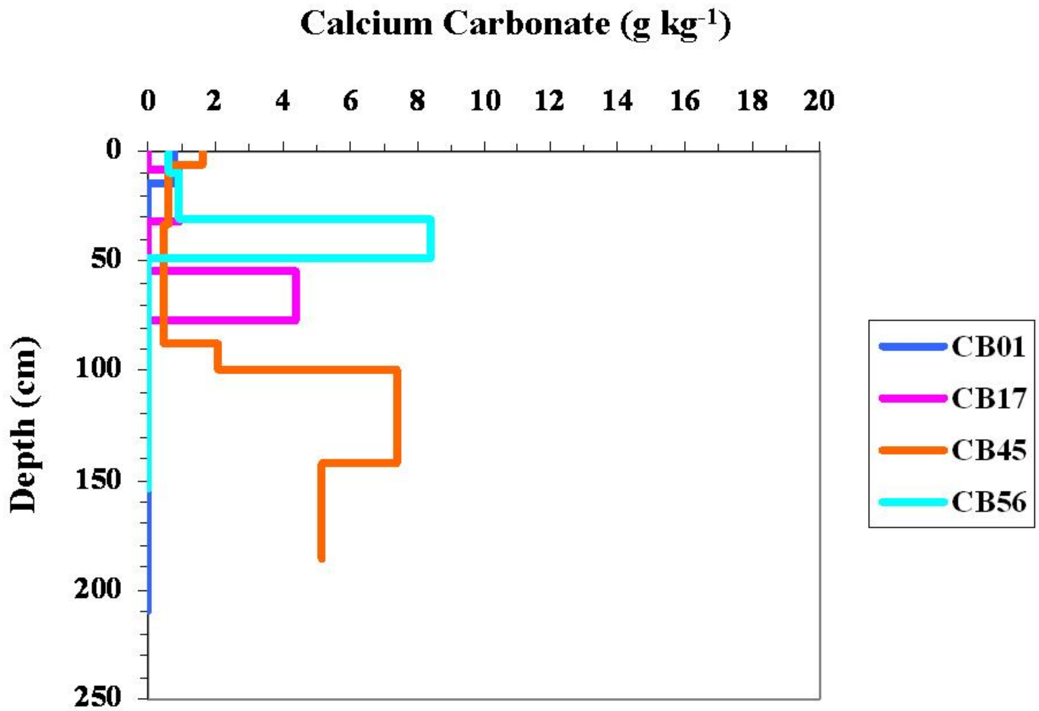

Figure 4-26. Calcium carbonate distributions of select pedons located on the storm-surge washover fan flat landform. These sandy soils have low quantities of calcium carbonate throughout the profile.

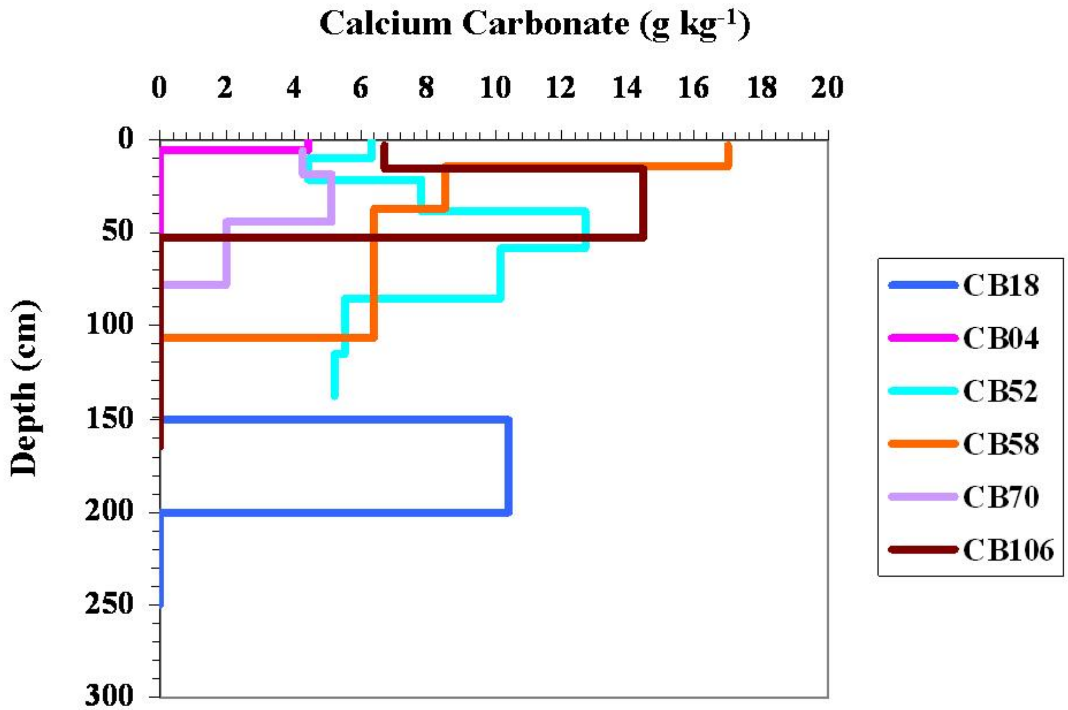

Figure 4-27. Calcium carbonate distributions of select pedons located on the lagoon bottom landform. These finer textured soils have low quantities of calcium carbonate throughout the profile.

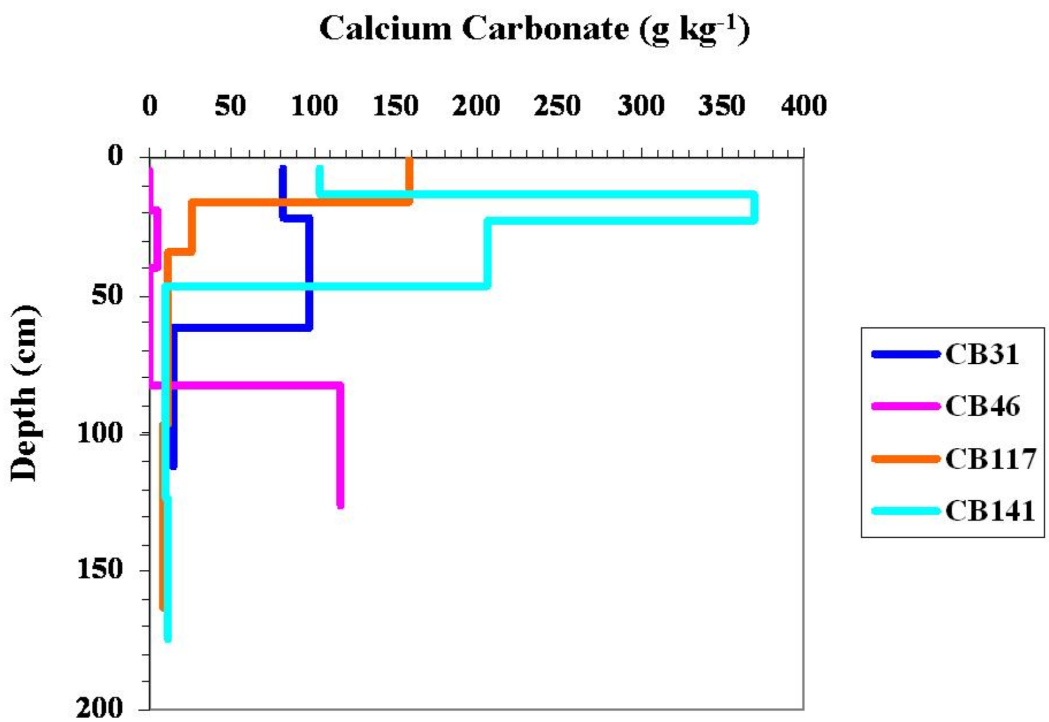

Figure 4-28. Calcium carbonate distributions of select pedons located on the lagoon bottom landform. These finer textured soils have high quantities of calcium carbonate within the upper 100 cm of the profile. The biogenic shells in these horizons were broken and located in bands which indicate that these shells may have been transported to these areas rather than from in situ organisms.

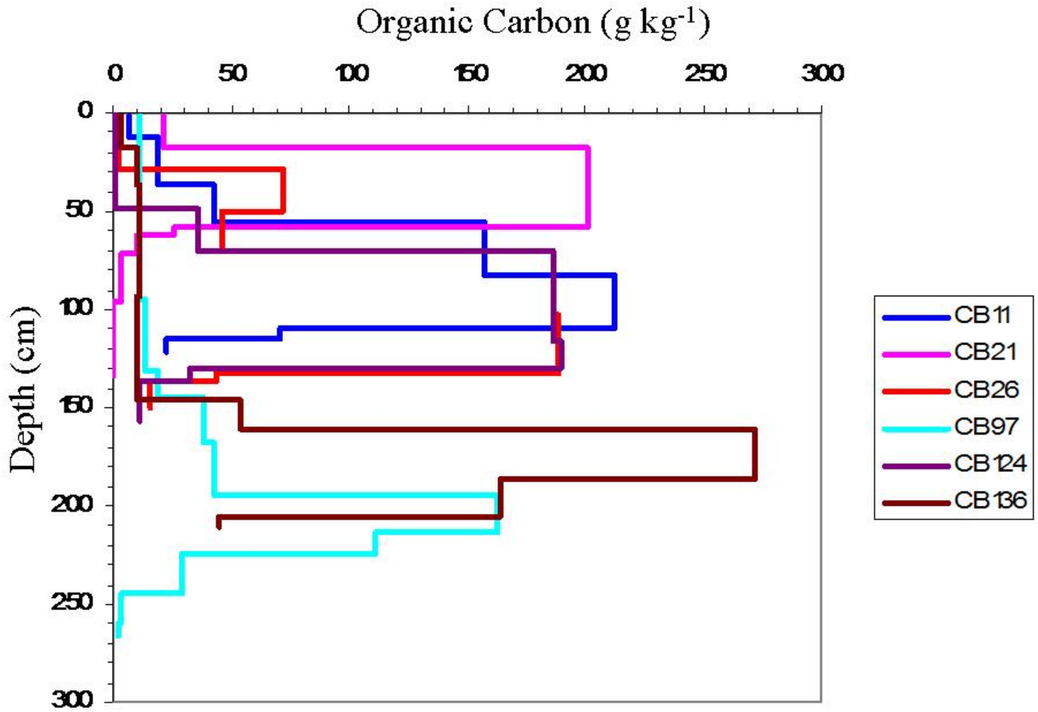

Figure 4-29. Organic carbon distributions of select pedons located on the mainland cove and submerged wave-cut headland landforms. Three pedons (CB11, CB21, and CB124) contained buried organic horizons within 100 cm of the soil surface. The remaining pedons (CB26, CB97, and CB136) contained buried organic horizons located deeper than 100 cm below the soil surface.

Figure 4-30. These pedons show an irregular organic carbon distribution with depth. The organic carbon distributions for four pedons located on the storm-surge washover fan flat are shown in Figure 4-31. These sandy soils had the lowest organic carbon contents within Chincoteague Bay. The surface horizons of the subaqueous soils had elevated C levels (1 to 24 g kg^{-1}) indicating an accumulation of C within these horizons, which is similar to subaerial surface horizons. Most of these profiles showed irregular distributions of organic carbon with depth. These irregular changes occurred due to the presence of buried organic horizons or reflected changes in texture related to changes in depositional environments. The C distributions within these soil profiles are not unlike those of alluvial soils located on floodplains in terrestrial environments. The finer textured soils occurred in low-energy environments that are conducive to the accumulation of organic materials compared to the high-energy environments where the sandy soils are located.

Within the upper meter of the soil, the organic carbon content of individual horizons ranged from 0.17 to 212.20 g kg^{-1}. The lowest values occurred in sandy textured horizons and the highest values in buried organic horizons. The pedons were grouped by landforms and the quantity of organic carbon stored in the upper 1 m of the soil is presented in Table 4-5 (data for individual pedons are located in Appendix D). Soils in the mainland coves and submerged wave-cut headland landforms have the highest quantity (5 to 34 kg m^{-2}) of carbon stored in the upper 1 m largely because they have buried organic horizons within the upper 1 m of the soil surface. The lagoon bottom, fluviomarine bottom, and barrier cove landforms have moderate quantities (4 to 21 kg m^{-2}) of carbon in the upper 1 m. These landforms are low-

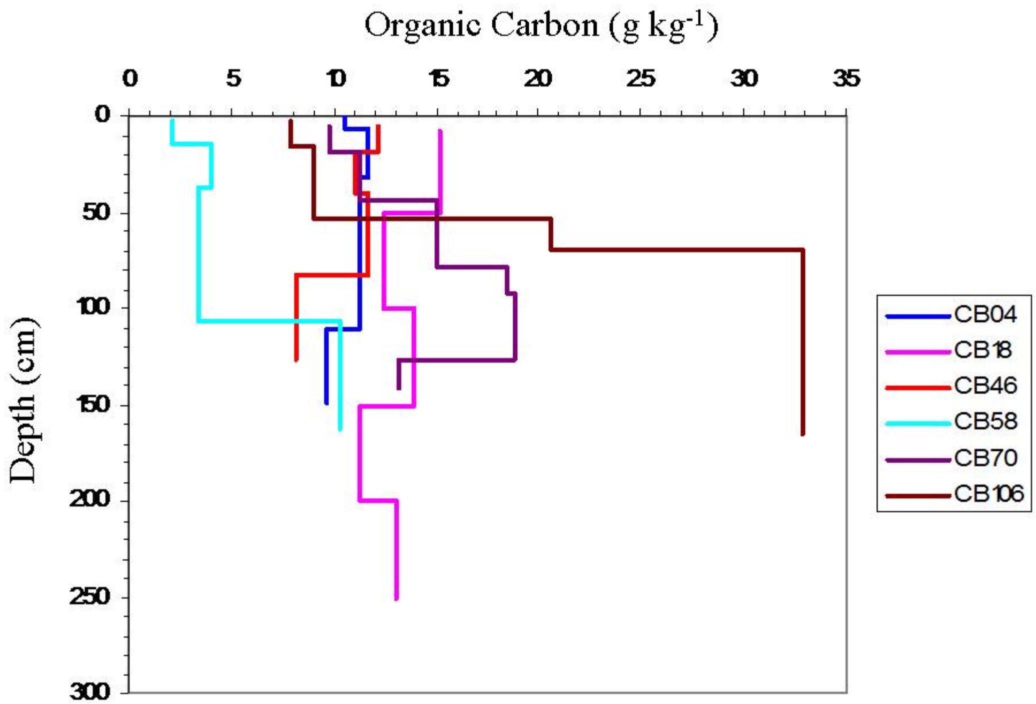

Figure 4-30. Organic carbon distributions of select pedons located on the lagoon bottom landform. These pedons display irregular carbon distribution with depth. Pedon CB58 is located on the barrier island side of the lagoon bottom and the upper portion of the soil formed in sandy barrier island sediments and the deeper portion of the soil formed in finer textured lagoon bottom sediments.

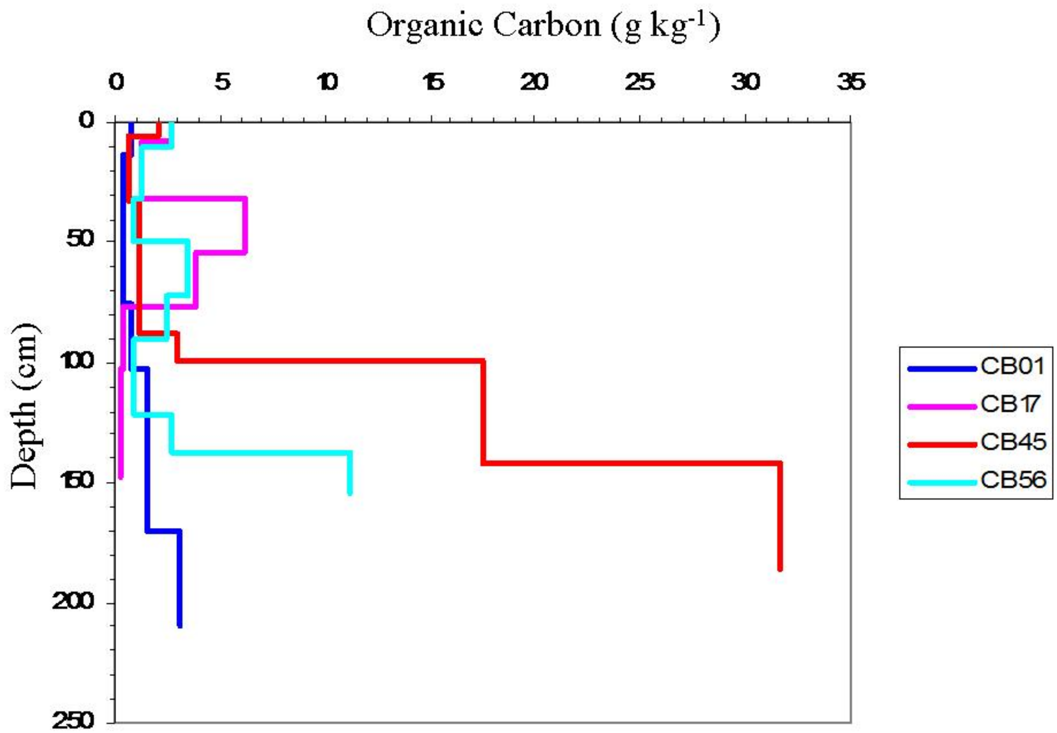

Figure 4-31. Organic carbon distributions of select pedons located on the storm-surge washover fan flat landform. These soils are sandy and have lower organic carbon contents than finer textured soils. Pedon CB45 has an irregular increase in organic carbon with depth. The upper portion of this soil formed in sandy barrier island sediments and the lower portion of the soil formed in finer textured sediments.

Table 4-5. Quantities of organic carbon stored in the upper 1 m of the soil within various landforms described in Chincoteague Bay.

Landform	**N**	**Avg. Organic Carbon Content kg m^{-2} to a depth of 1 m**	**Range of Organic Carbon Content kg m^{-2} to a depth of 1 m**
Storm-surge Washover Fan Flat	4	2.2	0.7-3.5
Storm-surge Washover Fan Slope	2	2.8	2.1-3.4
Paleo-flood Tidal Delta	1	3.6	
Barrier Cove	3	9.8	4.0-16.8
Shoal	1	15.6	
Lagoon Bottom	18	12.3	3.5-21.7
Fluviomarine Bottom	6	9.0	4.5-10.7
Mainland Cove	10	7.5	5.2-10.6
Mainland Cove with organic horizon within 1m	1	34.2	
Submerged Wave-cut Headland	3	8.8	7.4-10.6
Submerged Wave-cut Headland with organic horizon within 1m	3	23.1	16.8-30.1

energy depositional environments that tend to accumulate organic matter. The lowest quantities (0.7 to 3.6 kg m^{-2}) of organic carbon stored were found in soils located on the storm-surge washover fan flats, storm-surge washover fan slopes, and paleo-flood tidal delta landforms. These landforms are high-energy environments, and the amount of carbon stored in these soils is decreased by the winnowing action of the waves and currents.

The amount of organic carbon stored within the upper 1 m of the soils in Chincoteague Bay, MD was similar to the organic carbon stored (6.7 to 17.7 kg m^{-2}) in the subaqueous soils in Taunton Bay, ME (Jespersen and Osher, 2007). However, the extremely sandy soils located on the storm-surge washover fan flats in Chincoteague Bay had lower values (<3.6 kg m^{-2}) than any of the soils in Taunton Bay, ME. In Chincoteague Bay, the soils that stored the highest organic carbon (16.8 to 34.2 kg m^{-2}) were located in the mainland coves and submerged wave-cut headlands. These soils stored greater quantities of organic carbon due to the presence of organic horizons within the upper 1 m of the pedon, whereas in Taunton Bay the buried organic horizons were located deeper than 1 m and were not included in the organic carbon storage estimates. The subaqueous soils in Chincoteague Bay had carbon storage values that ranged between values reported for the poorly drained Othello soil series (6.3 kg m^{-2}) and the very poorly drained Sunken soil series (18.1 kg m^{-2}) located on the Delmarva Peninsula (Rabenhorst, 1995).

Osher and Jespersen (2006) used stable carbon isotope data to identify that the majority of the organic carbon stored in estuary soils of Taunton Bay, ME, was fixed by estuary biota and as distance from the shore increased the content of terrestrial organic matter decreased in the soils supporting that the carbon in these soils were produced in situ. These results contradict the belief that the organic carbon stored in estuarine systems is primarily transported from the surrounding watershed by surface water rather than in situ production. The carbon storage data from these studies may be an important missing component in the global carbon storage estimates.

Classification Using Current *Soil Taxonomy*

Of the 146 subaqueous soil profiles described, 144 were classified in the Entisols soil order (Soil Survey Staff, 2006). That portion of the classification hierarchy used for classification of subaqueous soils using the current classification reduction (such as chroma < 2 or positive reaction to α,α dipyridil). All of 144 profiles in the Entisols were classified within the suborder of Aquents. In the next (*Soil Taxonomy*) is shown in Table 4-6. The two profiles which were not Entisols had buried organic horizons close enough to the soil surface to be classified as Histosols. The Aquents suborder requires saturation for extend periods and evidence of level of *Soil Taxonomy* (great group), the order in which the great groups key out is based on the perceived significance of the soil properties. Two great groups of Aquents were recognized in Chincoteague Bay, being (in descending hierarchal order), Sulfaquents and Hydraquents. All but one of the Aquents keyed out into the Sulfaquents great group. Sulfaquents are Aquents that have sulfidic materials in any subhorizon within the upper 50 cm of the soil profile. A single Aquent profile (CB50) keyed out as a Hydraquent, due to the absence of sulfidic materials within the upper 50 cm of the soil surface. Four subgroups of Sulfaquents were used to classify the soil profiles.

Table 4-6. That portion of *Soil Taxonomy* (2006) used in the classification of 146 subaqueous soils in Chincoteague Bay. Note that sulfi great groups of Saprists and Aquents are distinguished by the presence of sulfidic materials in the upper 50 cm of the soil.

			Diagnostic/ Differentiating Criteria
Histosols	**Saprists**	**1. Sulfisaprists**	**1. Terric Sulfisaprists:** Sulfisaprists that have a mineral layer 30 cm or more thick that has its upper boundary within the control section, below the surface tier.
			2. Typic Sulfisaprists: Other Sulfisaprists
Entisols	**Aquents**	**1. Sulfaquents**	**1. Haplic:** In some horizon at a depth between 20 and 50 cm below the mineral soil surface, either or both: 1) n value of 0.7 or less; or 2) less than 8 percent clay in the fine-earth fraction
			2. Histic: Other Sulfaquents that have a histic epipedon
			3. Thapto-Histic: Other Sulfaquents that have a buried layer of organic soil materials, 20 cm or more thick, that has its upper boundary within 100 cm of the mineral soil surface
			4. Typic: Other Sulfaquents
		2. Hydraquents	**1. Sulfic:** Hydraquents that have, within 100 cm of the mineral soil surface, one or both of the following: 1) sulfidic materials; or 2) a horizon 15 cm or more thick that has all of the characteristics of a sulfuric horizon, except that it has a pH value between 3.5 and 4.0
			2. Thapto-Histic: Other Hydraquents that have a buried layer of organic soil materials, 20 cm or more thick, that has its upper boundary within 100 cm of the mineral soil surface
			3. Typic: Other Hydraquents

At the family level of classification, classes are differentiated according to five groups of criteria: 1) particle-size class; 2) mineralogical class; 3) cation-exchange activity class; 4) reaction class; and 5) temperature class. Particle-size classes of the subaqueous soils included sandy, coarse-loamy (>15% sand and < 18% clay), coarse-silty (<15% sand and <18% clay), fine-loamy (>15% sand and > 18 to 35% clay), fine-silty (<15% sand and 18 to 35% clay), and fine (>35% clay)[*]. The mineralogical class was determined for four pedons representing the major soils found in Chincoteague Bay. The particle-size distributions of these pedons are presented in Table 4-7. The grain counts for the horizons constituting the mineralogy control section of these select pedons are presented in Table 4-8. The minerals identified in the sand fractions included quartz, feldspars, mica, amphibole, garnet, diatoms, sponge spicules, and opaque minerals. The weighted average of the mineral fractions for each pedon, based on the particle-size control section, is presented in Table 4-9. For loamy and sandy soils the mineralogy class was determined from the grain counts of the dominant two or three sand fractions. Semi-quantitative estimates derived from the x-ray diffraction patterns of the mineral abundances in the fine silt fraction and coarse silt fraction of the loamy soils are presented in Table 4-10. The silt fractions are dominated by quartz, but also contain albite, amphibole, mica, kaolinite, ilmenite, and orthoclase minerals (Figure 4-32, 4-33, 4-34, 4-35). The mineralogy of loamy textured soils located on the mainland cove and lagoon bottom was determined to be mixed, since no single mineral was dominant in the 2 to 0.02 mm fractions. The pedon (CB01) located on the storm-surge washover fan flat was a sandy soil and

---

[*] Note that for family particle size classification, *Soil Taxonomy* specifies that very fine sand (50-100μm) be included within the silt. Thus, "sand" is really the fine and coarser sands.

contained 91.8% quartz and less than 10% weatherable minerals. The mineralogical composition of this pedon is borderline when taking into account the probable percentage error of ± 2.0% this pedon could be placed into the siliceous or mixed mineralogy class (the siliceous mineralogy class requires more than 90% silica minerals in the 0.02 to 2.0 mm fraction (Soil Survey Staff, 2006)). The soils in the mainland coves and the lagoon bottom contain more weatherable minerals than the sample on the storm-surge washover fan flat, however we have decided to also include these soils into the mixed mineralogy class until additional data can be collected to confirm the quantity of quartz and weatherable minerals found in sandy soils located on the storm-surge washover fan flat landscapes. Semi-quantitative estimates of the mineral abundances in the clay fraction of the loamy soils are presented in Table 4-11. The clay fractions contain quartz, illite, chlorite, vermiculite, kaolinite, amphiboles, cristobalite, and feldspar minerals (Figures 4-36, 4-37, 4-38, 4-39, 4-40, 4-41). During the removal of the organic matter from samples CB11 Cg1 and Cg2, jarosite formed in the clay fraction. The hydrogen peroxide used to remove organic matter oxidized the sulfide bearing minerals generating sulfuric acid and lowering the pH. This created an environment conducive to the formation of jarosite. Thus, the presence of jarosite in these samples was an artifact from the pretreatment of these samples.

The cation-exchange activity classes are only used to describe finer textured soils, which does not include the sandy particle-size family class. The cation-exchange activity class is defined using the ratio of cation exchange capacity (CEC) to percent clay. The CEC was not measured for the subaqueous soils in Chincoteague

Table 4-7. Particle-size distribution for select samples used for assessing the mineralogy of subaqueous soils.

Sample	%S	%Si	%C	%fSi	%cSi	%vcS	%cS	%mS	%fS	%vfS
CB01 Cg1, 14-76 cm	99.1	0.5	0.4	nd†	nd	0.3	7.3	34.0	56.6	0.8
CB01 Cg2, 76-103 cm	98.0	1.2	0.8	nd	nd	0.0	0.7	3.1	83.9	10.2
CB11 Cg1, 12-36 cm	11.2	51.3	37.5	26.9	24.4	0.1	0.4	1.0	6.5	3.2
CB11 Cg2, 36-56 cm	6.5	56.1	37.4	34.3	21.8	0.2	0.9	0.9	2.8	1.7
CB18 Cg, 8-50 cm	18.9	47.1	34.1	19.4	27.7	0.0	0.1	0.1	8.2	10.4
CB18 Cg, 50-100 cm	23.3	47.7	29.0	22.2	25.5	0.0	0.2	0.1	8.9	14.1
CB58 Cg1, 14-37 cm	75.8	14.8	9.4	5.6	9.2	0.1	0.1	0.2	49.7	25.7
CB58 Cg2, 37-106 cm	67.8	20.4	11.8	7.6	12.8	0.0	0.2	0.2	21.3	46.0

† not determined

Table 4-8. Mineralogical composition of the select samples based on the grain counts of the two or three dominant fractions that comprised 67% or more (by weight) of all fractions from 0.02 to 2.0 mm.

Sample	Frac.	Quartz	Feldspar	Mica	Opaque	Garnet	Amphibole	Diatoms/Sponge Spicules	Other
		--	%	--					
CB01 Cg1, 14-76 cm	mS	96.3±2.0	3.3±2.0	0.0	0.0	0.3±0.5	0.0	0.0	0.0
CB01 Cg1, 14-76 cm	fS	91.3±3.2	4.7±2.6	0.0	3.0±1.9	0.3±0.5	0.0	0.0	0.7±0.8
CB01 Cg2, 76-103 cm	fs	89.0±3.5	9.3±3.4	0.0	1.3±1.3	0.3±0.5	0.0	0.0	0.0
CB11 Cg1, 12-36 cm	fS	76.3±4.7	21.7±4.5	0.3±0.5	1.3±1.3	0.0	0.3±0.5	0.0	0.0
CB11 Cg1, 12-36 cm	CSi	51.3±5.6	38.0±5.4	2.7±1.8	3.3±2.0	0.0	4.0±2.4	0.7±0.8	0.0
CB11 Cg2, 36-56 cm	fS	78.0±4.5	20.3±4.4	0.0	0.7±0.8	0.0	0.3±0.5	0.7±0.8	0.0
CB11 Cg2, 36-56 cm	CSi	45.3±5.6	40.7±5.5	2.3±1.7	2.7±1.8	0.0	7.3±3.0	1.7±1.5	0.0
CB18 Cg, 8-50 cm	vfS	74.3±4.8	15.7±4.0	2.3±1.7	1.0±1.0	0.0	6.0±2.7	0.7±0.8	0.0
CB18 Cg, 8-50 cm	CSi	64.7±5.4	21.3±4.5	3.3±2.0	1.7±1.5	0.0	9.0±3.4	0.0	0.0
CB18 Cg, 50-100 cm	vfS	54.0±5.6	30.0±5.3	4.3±2.5	1.3±1.3	0.0	10.0±3.4	0.3±0.5	0.0
CB18 Cg, 50-100 cm	CSi	43.0±5.5	38.0±5.4	4.7±2.6	2.3±1.7	0.0	12.0±3.5	0.0	0.0
CB58 Cg1, 14-37 cm	fS	69.7±5.1	25.0±4.9	2.0±1.6	1.3±1.3	0.0	2.0±1.6	0.0	0.0
CB58 Cg1, 14-37 cm	vfS	58.3±5.6	29.7±5.1	1.3±1.3	1.7±1.5	0.0	9.0±3.3	0.0	0.0
CB58 Cg2, 37-106 cm	fS	60.7±5.6	27.0±5.0	7.7±2.8	0.0	0.0	3.7±2.4	1.0±1.0	0.0
CB58 Cg2, 37-106 cm	vfS	56.3±5.7	31.7±5.2	2.0±1.6	0.7±0.8	0.0	9.3±3.4	0.0	0.0

Table 4-9. Mineralogical composition of the select samples based on the grain counts of the dominant two or three dominant fractions that comprised 67% or more (by weight) of all fractions from 0.02 to 2.0 mm. The values represent the weighted average of the mineral fractions based on the horizon thickness in the control section. The pedons are not dominated by a single mineral and were classified as having a mixed mineralogy.

Sample	**Control Section**	**Quartz**	**Feldspar**	**Mica**	**Opaque**	**Garnet**	**Amphibole**	**Diatoms/Sponge Spicules**	**Other**
		---%---							
CB01	25-100 cm	91.8	5.8	0.0	1.7	0.3	0.0	0.0	0.3
CB11	25-56 cm	66.5	27.7	0.9	1.6	0.0	2.4	0.8	0.0
CB18	25-100 cm	54.5	29.5	4.0	1.7	0.0	10.0	0.2	0.0
CB58	25-100 cm	59.0	29.6	3.5	0.6	0.0	7.0	0.3	0.0

Table 4-10. Semi-quantitative mineral estimates of the fine silt (0.002 to 0.02 mm) and coarse silt (0.02 to 0.05 mm) fractions of selected samples. The composition of these fractions indicates that no single mineral fraction was dominant.

Sample	**Quartz**	**Albite**	**Mica**	**Amphiboles**	**Orthoclase**	**Kaolinite**	**Ilmenite**
CB11 Cg1, 12-36 cm fSi	XXX†	XX	X	X	X	X	x
CB11 Cg2, 37-56 cm fSi	XXX	XX	X	X	X	X	x
CB18 Cg, 8-50 cm fSi	XXX	XX	X			X	x
CB18 Cg, 50-100 cm fSi	XXX	XX	X			X	x
CB58 Cg1, 14-37 cm fSi	XXX	XX	X	X		x	x
CB58 Cg1, 14-37 cm cSi	XXX	XX	X	X	x	x	x
CB58 Cg2, 37-106 cm fSi	XXX	XX	X	X		x	x
CB58 Cg2, 37-106 cm cSi	XXX	XX	X	X	x	x	x

† x: 0-5%; X: 5-10%; XX: 10-30%; XXX: 30-70%; and XXXX: >70%.

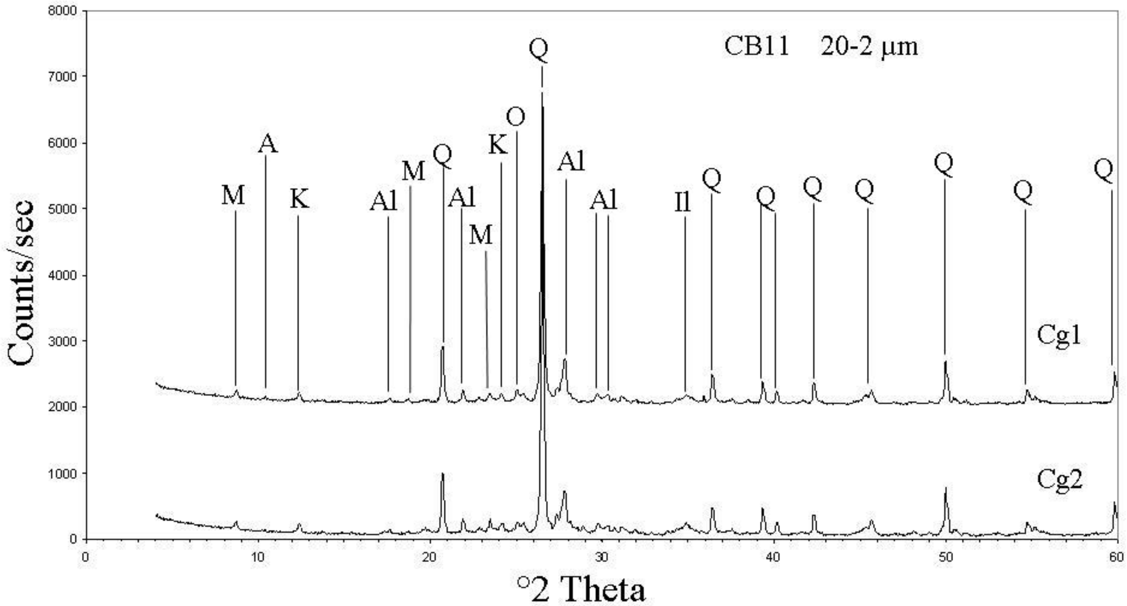

Figure 4-32. X-ray diffraction pattern of the fine silt fraction from sample CB11 Cg1 and Cg2. The sample is dominated by quartz (Q) and also contains amphibole (A), albite (Al), mica (M), kaolinite (K), and ilmenite (Il).

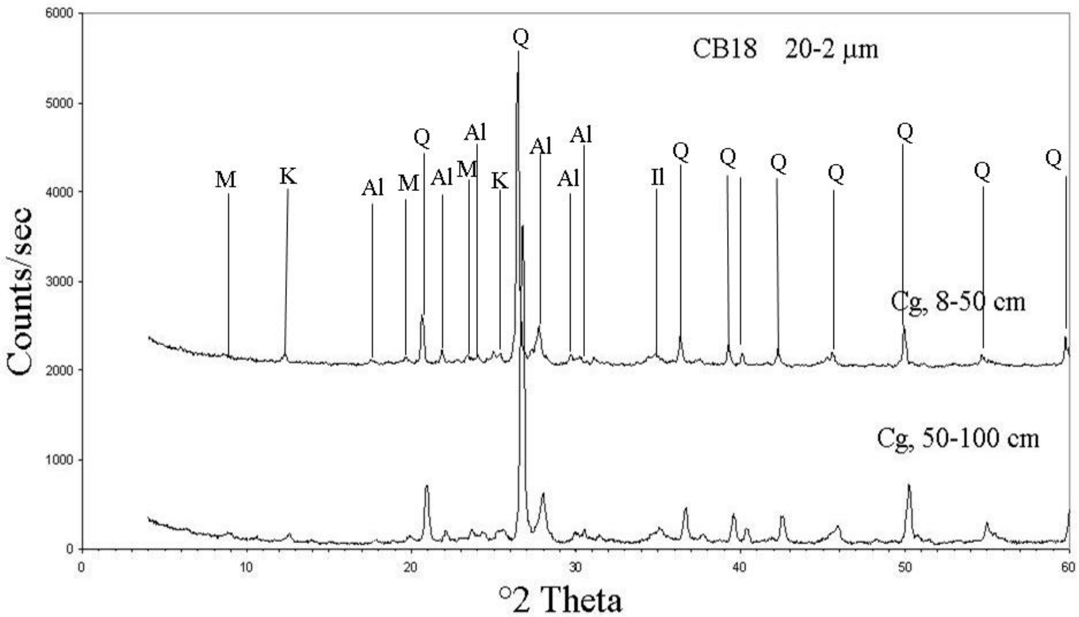

Figure 4-33. X-ray diffraction pattern of the fine silt fraction from sample CB18 Cg 8-50 cm and Cg 50-100 cm. The sample is dominated by quartz (Q) and also contains albite (Al), mica (M), kaolinite (K), and ilmenite (Il).

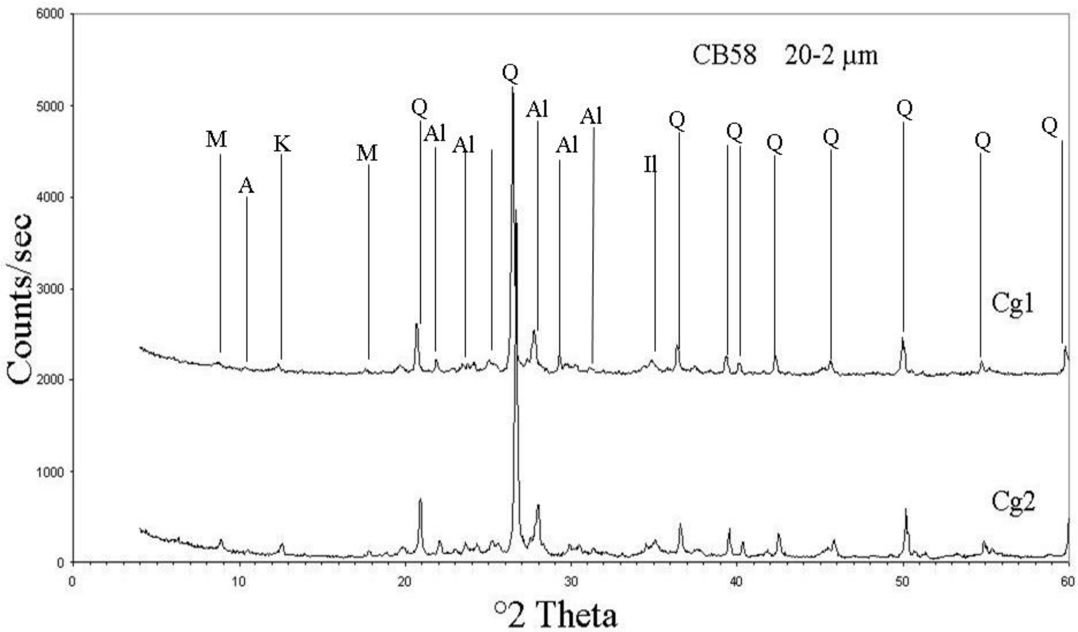

Figure 4-34. X-ray diffraction pattern of the fine silt fraction from sample CB58 Cg1 and Cg2. The sample is dominated by quartz (Q) and also contains amphibole (A), albite (Al), mica (M), kaolinite (K), and ilmenite (Il).

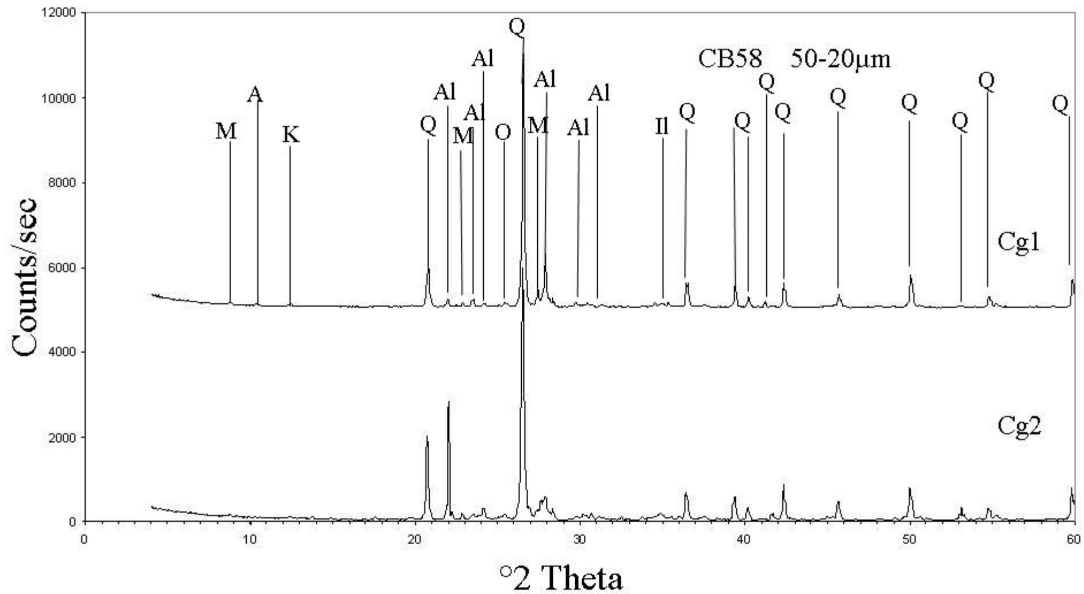

Figure 4-35. X-ray diffraction pattern of the coarse silt fraction from sample CB58 Cg1 and Cg2. The sample is dominated by quartz (Q) and also contains amphibole (A), albite (Al), mica (M), kaolinite (K), orthoclase (O), and ilmenite (Il).

Table 4-11. Semi-quantitative mineral estimates of the clay fraction of selected samples. The composition of these fractions indicates that no single mineral fraction was dominant. The jarosite peaks are an artifact in the clay fraction created during the removal of the organic matter from sample CB11 Cg1 and Cg2.

Sample	Quartz	Illite	Chlorite	Vermiculite	Kaolinite	Feldspars	Amphiboles	Cristobalite	Jarosite
CB11 Cg1, 12-36 cm	XX†	XXX	XX	X	XX	X	x	x	x
CB11 Cg2, 36-56 cm	XX	XXX	XX	X	XX	X	x	x	x
CB18 Cg, 8-50 cm	XX	XXX	XX	X	XX	X	x	x	
CB18 Cg, 50-100 cm	XX	XXX	XX	X	XX	X	x	x	
CB58 Cg1, 14-37 cm	XX	XXX	XX	X	XX	X	x	x	
CB58 Cg2, 37-106 cm	XX	XXX	XX	X	XX	X	x	x	

† x: 0-5%; X: 5-10%; XX: 10-30%; XXX: 30-70%; and XXXX: >70%.

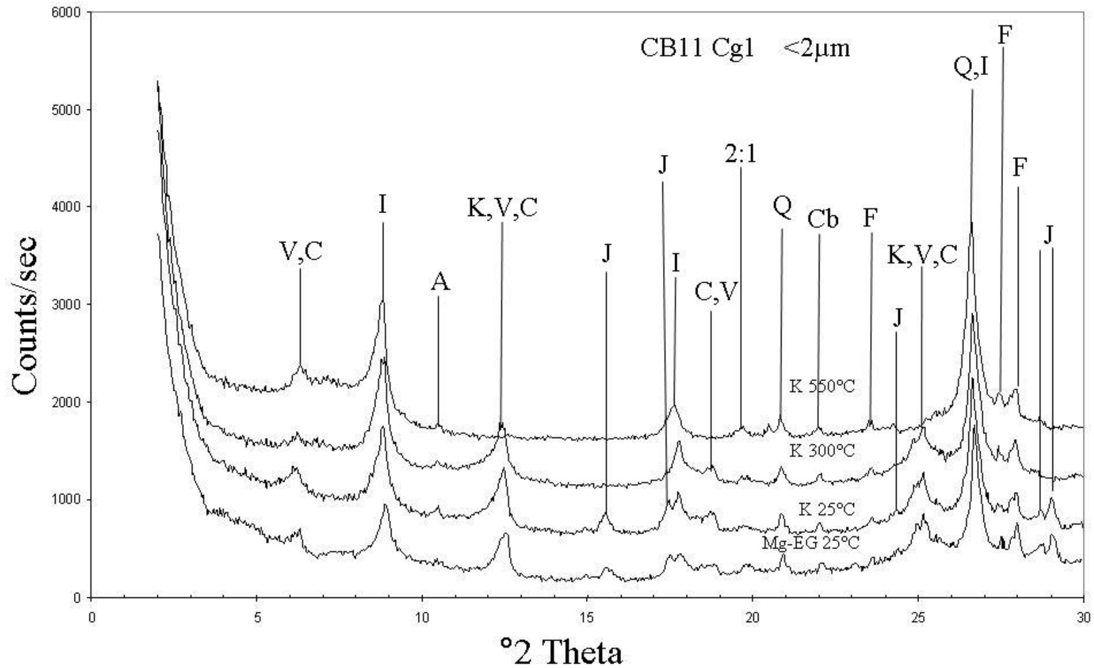

Figure 4-36. X-ray diffraction pattern of the clay fraction from sample CB11 Cg1. The sample contained vermiculite (V), chlorite (C), illite (I), amphibole (A), kaolinite (K), quartz (Q), feldspar (F), cristobalite (Cb), and jarosite (J) minerals.

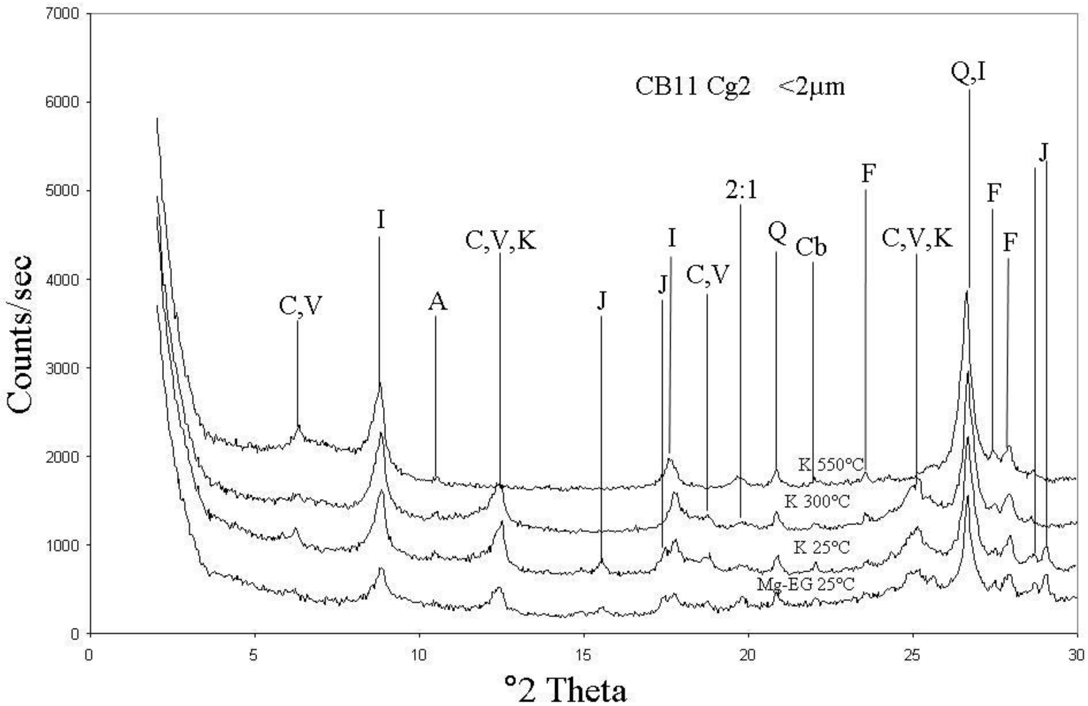

Figure 4-37. X-ray diffraction pattern of the clay fraction from sample CB11 Cg2. The sample contained vermiculite (V), chlorite (C), illite (I), amphibole (A), kaolinite (K), gibbsite (G), quartz (Q), feldspar (F), cristobalite (Cb), and jarosite (J) minerals.

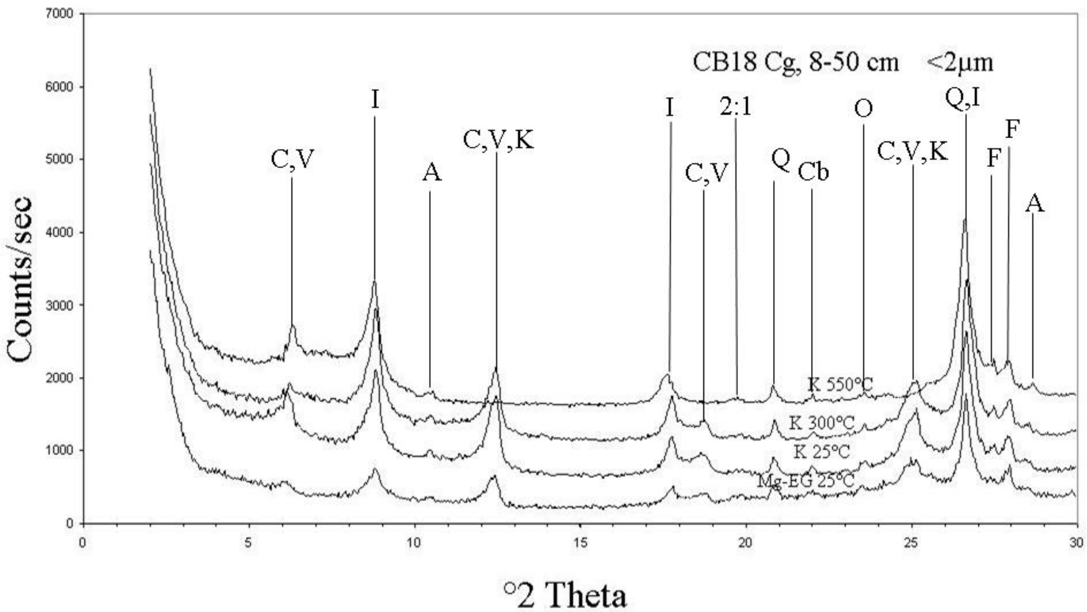

Figure 4-38. X-ray diffraction pattern of the clay fraction from sample CB18 Cg 8-50 cm. The sample contained vermiculite (V), chlorite (C), illite (I), amphibole (A), kaolinite (K), quartz (Q), feldspar (F), orthoclase (O), and cristobalite (Cb) minerals.

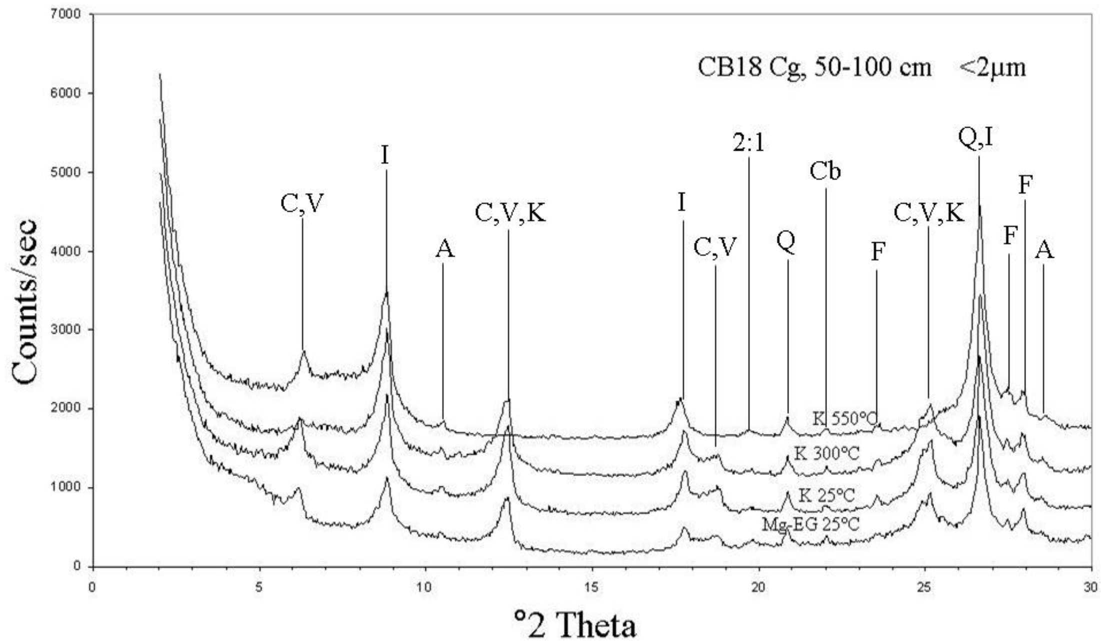

Figure 4-39. X-ray diffraction pattern of the clay fraction from sample CB18 Cg 50-100 cm. The sample contained vermiculite (V), chlorite (C), illite (I), amphibole (A), kaolinite (K), quartz (Q), feldspar (F), and cristobalite (Cb) minerals.

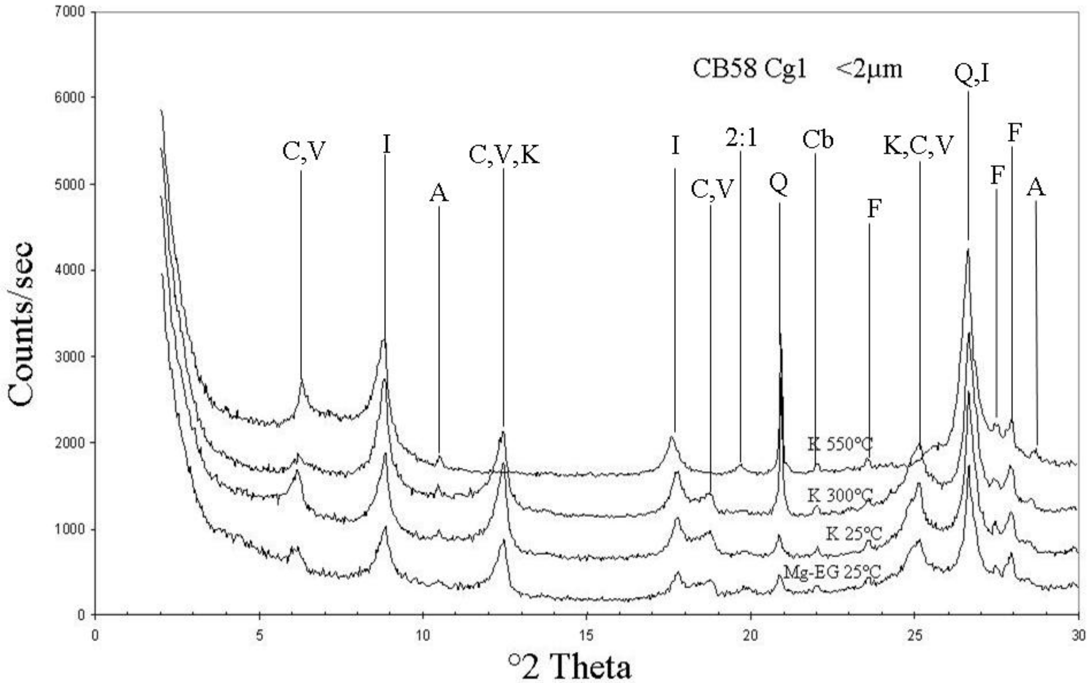

Figure 4-40. X-ray diffraction pattern of the clay fraction from sample CB58 Cg1. The sample contained vermiculite (V), chlorite (C), illite (I), amphibole (A), kaolinite (K), quartz (Q), feldspar (F), and cristobalite (Cb) minerals.

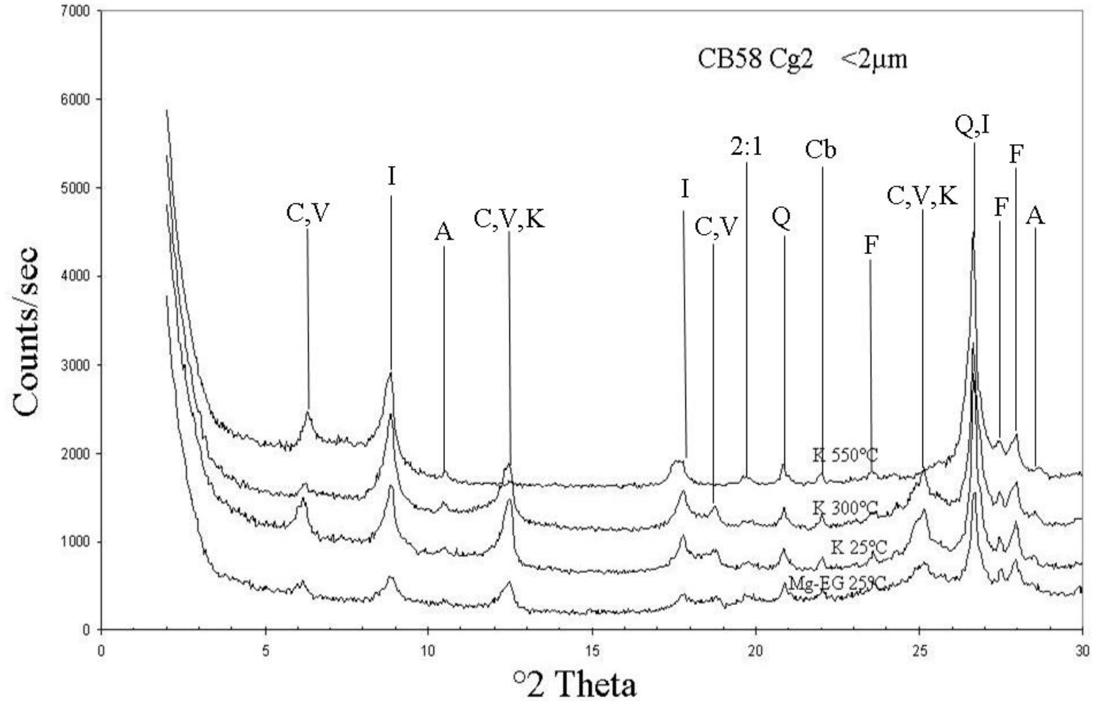

Figure 4-41. X-ray diffraction pattern of the clay fraction from sample CB58 Cg2. The sample contained vermiculite (V), chlorite (C), illite (I), amphibole (A), kaolinite (K), quartz (Q), feldspar (F), and cristobalite (Cb) minerals.

Bay. Therefore, our cation-exchange activity class for each of the subaqueous soils was assumed to be similar to the cation-exchange activity class of the subaerial soils located on the surrounding Delmarva Peninsula from which the subaqueous soils were derived. Because the cation-exchange activity class of the subaerial soils on the Delmarva Peninsula was generally active it was assumed that the cation-exchange activity class for the subaqueous soils was also active (0.4 to 0.6) (Soil Survey Staff, 2006). The reaction class for the Sulfaquents was determined to be nonacid based on the pH of freshly thawed samples, which ranged from 6.5 to 7.5. The reaction class for Histosols was determined to be Euic. The temperature class for the subaqueous soils of Chincoteague Bay is mesic (mean annual soil temperature ranged from 8 to 15ºC). Table 4-12 shows how the soils examined in Chincoteague Bay were classified to the family level using the existing structure in *Soil Taxonomy*. Nearly all of the soils were classified into the Sulfaquent great group, and most were classified into either the Haplic Sulfaquent or the Typic Sulfaquent subgroup classes.

Classification Using Proposed Changes to *Soil Taxonomy*

A modification to *Soil Taxonomy* to better accommodate subaqueous soils has been proposed by Northeast Regional Cooperative Soil Survey Subaqueous Soils Committee (2007). This new proposal adds Wassents and Wassists as new suborders. The new suborders are defined as having a positive water potential at the soil surface for 90% of each day (i.e. subaqueous). That portion of the classification hierarchy used for describing subaqueous soils using the proposed classification (*Soil Taxonomy*) is shown in Table 4-13. In the next level of the *Soil Taxonomy*, three great groups were proposed for Wassents, being (in descending hierarchal order) Psammowassents, Sulfiwassents, and Hydrowassents. The order in which the great groups key out is based on the perceived significance of soil properties. In the Wassents the great groups are ordered differently than is currently done in the Aquents great groups. In the Wassents, the presence of dominantly sandy soil texture was deemed of greater importance than the presence or absence of sulfidic materials in the upper 50 cm of the soil surface (which is very common in estuarine subaqueous soils) and thus Psammowassents key out before Sulfiwassents. Psammowassents are Wassents with textures of loamy fine sand or coarser. Sulfiwassents are Wassents that have sulfidic materials within 50 cm of the soil surface. Most of the Wassents were classified as Sulfiwassents. One soil profile was classified into the Hydrowassents, which had neither sulfidic material within 50 cm of the soil surface nor was dominantly sandy in texture. Table 4-14 shows the classification of the 146 subaqueous soil profiles to the family level, using the proposed soil taxonomic system. The distribution of the subaqueous soils and their classification to the family level is shown in Figure 4-42. All of the 144 soil profiles that were classified as Entisols met the criteria for the proposed Wassents subgroup. These 144 soils fell within the six proposed subgroups of Sulfic Psammowassents, Haplic Sulfiwassents, Thapto-Histic Sulfiwassents, Aeric Sulfiwassents, Fluvic Sulfiwassents, and Sulfic Hydrowassents. These subgroups have essentially the same diagnostic criteria as used for subgroups of Sulfaquents (see Table 4-12). The components of the family classification under the new proposed scheme would be essentially unchanged from the current classification system.

Table 4-12. Classification of 146 subaqueous soils described in Chincoteague Bay to the family level using current *Soil Taxonomy*. Numbers in parenthesis indicate the number of pedons in each taxon.

Order	Suborder	Great Group	Subgroup	Family (PS) Class
Histosols (2)	Saprists (2)	Sulfisaprists (2)	Terric Sulfisaprists (2)	Fine-silty, Terric Sulfisapists (2)
Entisols (144)	Aquents (144)	1. Sulfaquents (143)	1. Haplic Sulfaquents (49)	1. Sandy, Haplic Sulfaquents (30) 2. Sandy over loamy, Haplic Sulfaquents (1) 3. Coarse-loamy, Haplic Sulfaquents (11) 4. Fine-loamy, Haplic Sulfaquents (1) 5. Fine-silty, Haplic Sulfaquents (5) 6. Fine, Haplic Sulfaquents (1)
			2. Thapto-Histic Sulfaquents (7)	1. Coarse-loamy, Thapto-Histic Sulfaquents (1) 2. Coarse-silty, Thapto-Histic Sulfaquents (1) 3. Fine-loamy, Thapto-Histic Sulfaquents (1) 4. Fine-silty, Thapto-Histic Sulfaquents (3) 5. Fine, Thapto-Histic Sulfaquents (1)
			3. Typic Sulfaquents (87)	1. Coarse-loamy, Typic Sulfaquents (7) 2. Fine-loamy, Typic Sulfaquents (10) 3. Fine-silty, Typic Sulfaquents (69) 4. Fine, Typic Sulfaquents (1)
		2. Hydraquents (1)	1. Sulfic Hydraquents (1)	1. Coarse-silty, Sulfic Hydraquents (1)

Table 4-13. That portion of the proposed changes to *Soil Taxonomy* (2006) used in the classification of 146 subaqueous soils in Chincoteague Bay.

			Diagnostic/ Differentiating Criteria
Histosols	**Wassists**	**1. Sulfiwassists:** presence of sulfidic materials in the upper 50 cm of the soil.	**1. Sapric:** Sulfiwassists that have more thickness of sapric soil materials than any other kind of organic soil materials.
Entisols	**Wassents**	**1. Psammowassents:** textures of loamy fine sand or coarser.	**1. Sulfic:** Psammowassents that have sulfidic materials within 100 cm of the mineral soil surface.
		2. Sulfiwassents: presence of sulfidic materials in the upper 50 cm of the soil.	**1. Haplic:** Sulfiwassents that have, in some horizons at a depth between 20 and 50 cm below the mineral soil surface, either or both: 1. An *n* value of 0.7 or less; *or* 2. Less than 8 percent clay in the fine-earth fraction. **2. Thapto-Histic:** Sulfiwassents that have a buried layer of organic soil materials, 20 cm or more thick, that has its upper boundary within 100 cm of the mineral soil surface. **3. Fluvic:** Sulfiwassents that have *either* 0.2 percent or more organic carbon of Holocene age at a depth of 125 cm below the mineral soil surface *or* an irregular decrease in content of organic carbon from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower. **4. Aeric:** Sulfiwassents that have a chroma of 3 or more in 40% or more of the matrix of one or more horizons between a depth of 15 and 100 cm from the soil surface. **5. Typic:** Other Sulfiwassents.

Table 4-13. Continued.

			Diagnostic/ Differentiating Criteria
Entisols	**Wassents**	**3. Hydrowassents:** at a depth between 20 and 50 cm below the mineral soil surface, both an n value of more than 0.7 and 8 percent or more clay	**1. Sulfic:** Hydrowassents that have a sulfidic materials within 100 cm of the mineral soil surface.

Table 4-14. Classification of 146 subaqueous soils described in Chincoteague Bay using the proposed classification. Numbers in parenthesis indicate the number of pedons in the taxon.

Order	Suborder	Great Group	Subgroup†	Family (PS) Class
Histosols (2)	Wassists (2)	Sulfiwassists (2)	Sapric Sulfiwassists (2)	
Entisols (144)	Wassents (144)	1. Psammowassents (20)	1. Sulfic Psammowassents (20)	
		2. Sulfiwassents (124)	1. Haplic Sulfiwassents (26)	1. Sandy, Haplic Sulfiwassents (10) 2. Sandy over loamy, Haplic Sulfiwassents (1) 3. Coarse-loamy, Haplic Sulfiwassents (13) 4. Fine-loamy, Haplic Sulfiwassents (2) 5. Fine, Haplic Sulfiwassents (1)
			2. Thapto-histic Sulfiwassents (6)	1. Coarse-silty, Thapto-histic Sulfiwassents (1) 2. Fine-loamy, Thapto-histic Sulfiwassents (2) 3. Fine-silty, Thapto-histic Sulfiwassents (2) 4. Fine, Thapto-histic Sulfiwassents (1)
			3. Aeric Sulfiwassents (2)	1. Coarse-loamy, Aeric Sulfiwassents (2)
			4. Fluvic Sulfiwassents (88)	1. Coarse-loamy, Fluvic Sulfiwassents (4) 2. Fine-loamy, Fluvic Sulfiwassents (9) 3. Fine-silty, Fluvic Sulfiwassents (74) 4. Fine, Fluvic Sulfiwassents (1)
		3. Hydrowassents (1)	1. Sulfic Hydrowassents (1)	1. Coarse-silty, Sulfic Hydrowassents (1)

† see Table 4-13 for explanation.

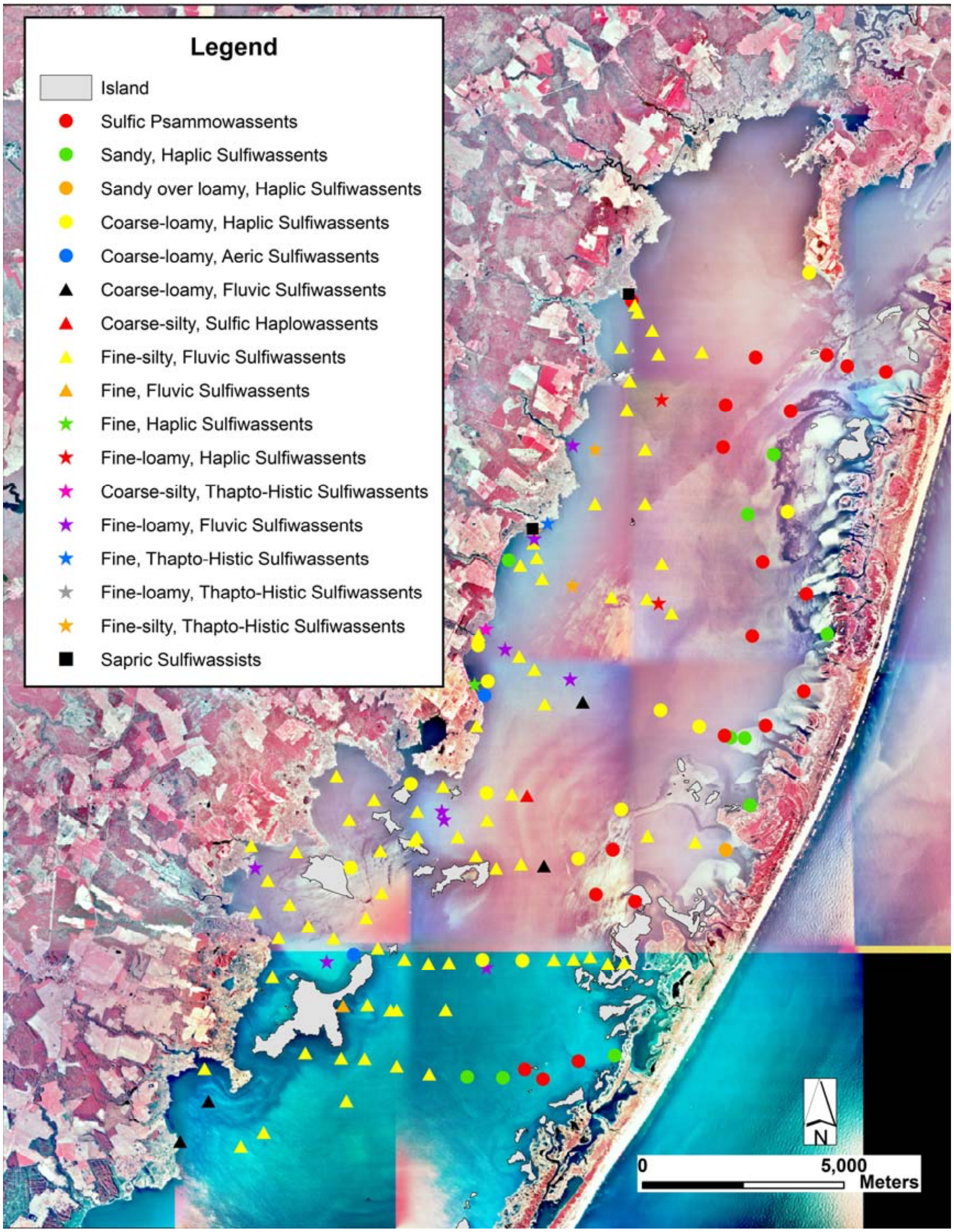

Figure 4-42. Classification of subaqueous soil profiles in Maryland's portion of Chincoteague Bay using the proposed changes to *Soil Taxonomy*.

Development of Subaqueous Soil Series

The soil series is the 6th and lowest category in *Soil Taxonomy* and further defines differences within a family that impact the use of the soils. Series differentiating criteria can include soil properties used as criteria at higher levels of *Soil Taxonomy*, other soil characteristics such as soil color or texture, or the depth at which unique horizons or characteristics are found within the soil profile. Therefore, the series control section can include properties from the soil surface to a depth of up to 2 m. There were several subaqueous soil series already established as a result of the work done by Demas (1998) in Sinepuxent Bay, MD. These series included Demas[*] (sandy, Haplic Sulfaquents), Sinepuxent (coarse-loamy, Typic Sulfaquents), Southpoint (fine-silty, Thapto-histic Sulfaquents), and Tizzard (sandy over loamy, aniso, Sulfic Fluvaquents). Although these soil series accommodate several of the soils found throughout Chincoteague Bay, they do not accommodate most of the subaqueous soils described in this study. Therefore eight new series are proposed here to accommodate the remaining soils. Table 4-15 shows the names and family level classification for the eight additional subaqueous soil series proposed for use in Chincoteague Bay, Maryland. The main criteria differentiating these series, as well as some accessory criteria and characteristics, are shown in Table 4-16. The classification to the series level of the pedons described in Chincoteague Bay is shown in Figure 4-43. The term taxadjunct is used for soils that have properties outside of the range of any recognized series because of one or more differentiating characteristics. A taxadjunct is given the name of an established series that is most similar in characteristics and in this sense is adjunct to the series. And while it is not part of the

[*] Named posthumously after the untimely death of George P. Demas in 1999. George Demas was considered as a pioneer in subaqueous soils research. This soil series was given the name Wallops in Demas' 1998 dissertation "Subaqueous Soils of Sinepuxent Bay".

series, it is treated as though it were a part of the named series (Soil Survey Division Staff, 1993). For example, the Southpoint soil series is a fine-silty, Thapto-histic Sulfiwassents, which recognizes the presence of buried organic horizons within the upper 100 cm of the soil. Core CB26 was classified as a fine, Haplic Sulfiwassents, which currently does not have a named series. Because this pedon does have a buried organic horizon within the upper 100 cm of the soil surface, and is thus similar to the Southpoint soils, it was classified as a Southpoint Taxadjunct (Tax.). It differs from Southpoint series primarily by having low n value materials within the upper 50 cm of the soil surface.

Four of the proposed new series are classified in the same fine-silty, Fluvic Sulfiwassents family, but they possess a number of properties that differ significantly within the series control section. The proposed Truitt Series exhibits a buried organic horizon that has its upper boundary between 1 to 2 m. A description of the modal pedon for the Truitt Series, (CB97) is shown in Table 4-17. Truitt differs from the Southpoint series because the organic horizons start below 1 m and are thinner, whereas, in the Southpoint Series the organic horizons start within the upper 1 m of the soil surface and the thickness of the organic horizon is at least 20 cm. The Tingles series differs from Truitt due to the absence of the organic horizons in Tingles and the n values must be > 1 throughout the entire soil profile. A description of the modal pedon for the Tingles Series (CB18) is shown in Table 4-18. The proposed Coards series differs from Truitt by lacking a buried organic horizon and differs from Tingles by having higher clay percentages (> 30%) and by having n values > or >> 1 (much greater than 1) throughout the entire soil profile. These soils have a very low bearing capacity and were often

Table 4-15. New soil series proposed for use in Chincoteague Bay, Maryland.

Soil Series Name	Soil Classification
Truitt	Fine-silty, mixed, active, nonacid, mesic Typic Sulfiwassents
Tingles	Fine-silty, mixed, active, nonacid, mesic Typic Sulfiwassents
Cottman	Coarse-loamy, mixed, active, nonacid, mesic Haplic Sulfiwassents
Figgs	Fine-loamy, mixed, active, nonacid, mesic Typic Sulfiwassents
Tumagan	Sapric Sulfiwassists
Middlemoor	Fine-silty, mixed, active, nonacid, mesic Typic Sulfiwassents
Coards	Fine-silty, mixed, active, nonacid, mesic Typic Sulfiwassents
Thorofare	Sandy, mixed, nonacid, mesic Haplic Sulfiwassents

Table 4-16. Differentiating criteria for proposed and established soil series for Chincoteague Bay, MD. Those soil series that are already officially established are shown as shaded.

Subaqueous Soil Series Name and Classification	**Series Criteria Differentia**	**Accessory Criteria**
Coards Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	N values >1 throughout the soil profile	1. Sulfidic materials within upper 50 cm of the soil surface 2. SiL, SiCL, or SiC textures
Tingles Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	1. N values >0.7 throughout the soil profile 2. >0.2% OC or irregular distribution of OC from 25-100 cm	1. Sulfidic materials within the upper 50 cm of the soil surface 2. High organic carbon contents 3. SiL, L, CL, SiCL textures in control section
Middlemoor Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	1. N values >0.7 in upper 100 cm; N values < 0.7 deeper than 100 cm 2. >0.2% OC or irregular distribution of OC from 25-100 cm	1. Sulfidic materials within upper 50 cm of the soil surface 2. SiCL, L, CL, or SiL textures in the control section 3. Discontinuity with coarser textures deeper in soil profile
Truitt Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	1. Buried organic horizons deeper than 100 cm (upper boundary begins within 200 cm), at least 5 cm thick 2. >0.2% OC or irregular distribution of OC from 25-100 cm	1. Sulfidic materials within upper 50 cm of the soil surface 2. High organic carbon contents 3. N values > 0.7 in upper 150 cm of the soil surface 4. Buried pre-Holocene subaerial soils below organic horizons
Southpoint Fine-silty, Thapto-Histic Sulfaquents (Fine-silty, Thapto-Histic Sulfiwassents)	Buried organic horizons at least 20 cm thick that starts within the upper 100 cm of the soil surface	1. Sulfidic materials within the upper 50 cm of the soil surface
Tumagan Fine-silty, Terric Sulfisaprists (Sapric Sulfiwassists)	Buried organic horizons at least 40 cm thick that starts within the upper 80 cm of the soil surface	1. Subaqueous, permanently submerged 2. Less than 30 cm of recent estuarine sediments burying the organic soil

Table 4-16 Continued.

Subaqueous Soil Series Name and Classification	**Series Criteria Differentia**	**Accessory Criteria**
Figgs (Fine-loamy, Typic Sulfaquents) Fine-loamy, Fluvic Sulfiwassents	1. N values > 0.7 within upper 100 cm of the soil surface 2. >0.2% OC or irregular distribution of OC from 25-100 cm	1. Sulfidic materials within the upper 50 cm of the soil surface 2. SiL, CL, L, fSL textures in the control section
Sinepuxent Coarse-loamy, Typic Sulfaquents (Coarse-loamy, Fluvic Sulfiwassents)	1. N values <0.7 in the control section 2. >0.2% OC or irregular distribution of OC from 25-100 cm	1. SL, SiL, S, LS textures in the control section 2. At least one lithologic discontinuity
Cottman Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)	N values < 0.7 or less than 8 percent clay within 20 to 50 cm of the soil surface	1. Sulfidic materials within the upper 50 cm of the soil surface 2. SL, L, LS, SiCL textures within the control section 3. Discontinuity with finer textured materials
Tizzard Sandy over loamy, aniso, Sulfic Fluvaquents (Sandy over loamy, aniso, Haplic Sulfiwassents)	Lithologic discontinuity within the control section with sandy sediments overlying silty sediments	1. Sulfidic materials within the upper 100 cm (50cm) of the soil surface
Thorofare Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)	fSL or coarser textures throughout the soil profile	1. N values < 1 in the control section 2. No discontinuity with finer textured materials
Whittington Typic Psammaquents (Fluventic Psammowassents)	Buried A horizons within the soil profile-irregular distribution of OC content at 125 cm below the soil surface	1. LfS or coarser textures in the control section 2. No sulfidic materials within the upper 100 cm of the soil surface
Trappe Typic Psammaquents (Aeric Psammowassents)	Chroma 3 or more, abundance 40% or greater within the control section	1. LfS or coarser textures throughout control section 2. no sulfidic materials within upper 100 cm of the soil surface

Table 4-16 Continued.

Subaqueous Soil Series Name and Classification	**Series Criteria Differentia**	**Accessory Criteria**
Demas Typic Psammaquents (Sulfic Psammowassents)	N values < 0.7 throughout the profile	1. LfS or coarser textures throughout profile 2. Sulfidic materials within upper 100 cm of the soil surface May have a lithologic discontinuity with coarser textured sand
Unnamed B Coarse-silty, Sulfic Hydraquents (Coarse-silty, Sulfic Hydrowassents)	Contains sulfidic materials within 50 to 100 cm of the soil surface	1. n values > 1 in control section 2. L textures in the control section
Unnamed C Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Aeric Sulfiwasents)	Contains sulfidic materials within 50 cm of the soil surface and chroma 3 or more, abundance 40% or greater within the control section	1. fSL or coarser textures in control section 2. n values <1 in control section

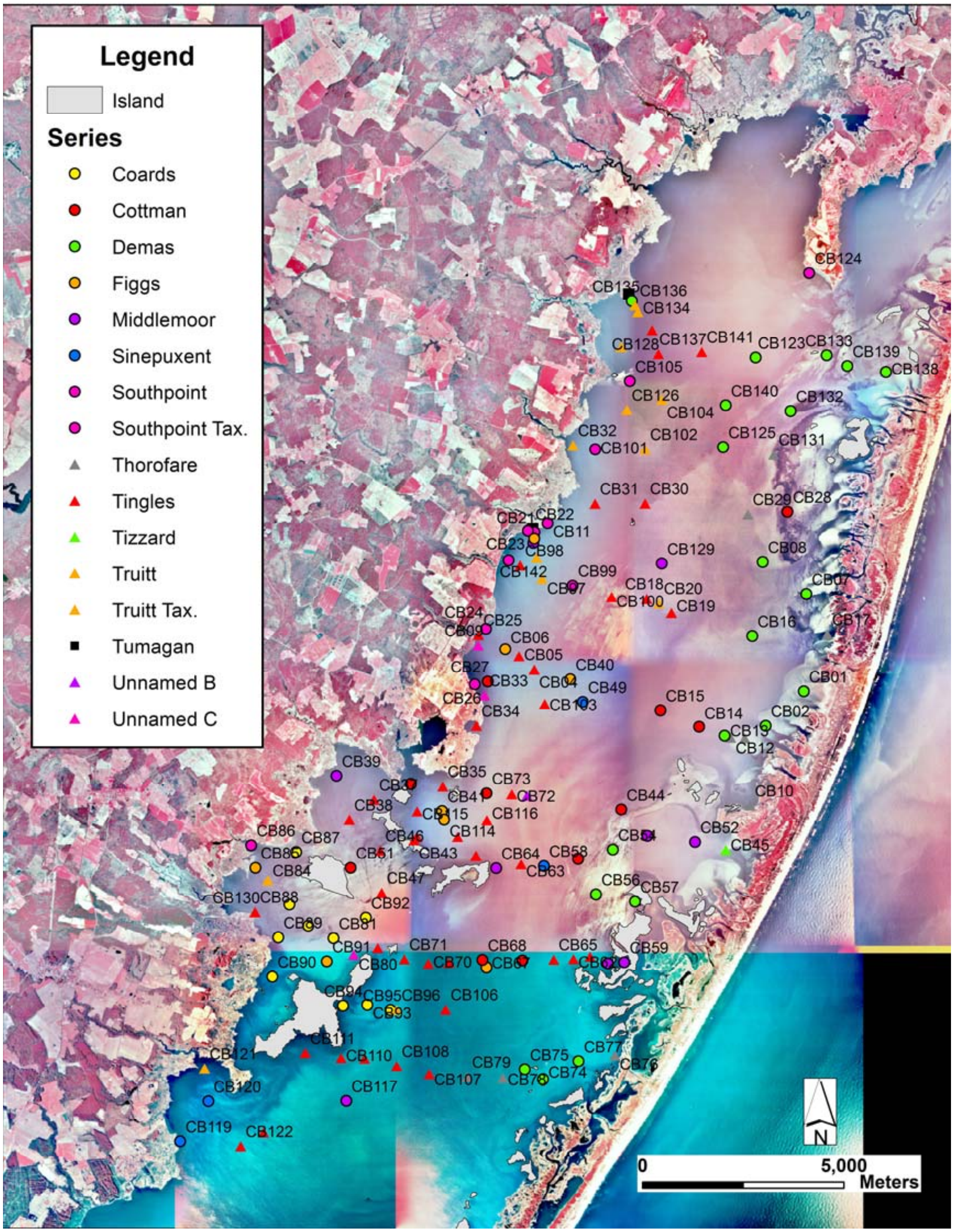

Figure 4-43. Classification of pedons described in Chincoteague Bay, MD, to the series level.

described in the field as having a "soup-like" or "jelly" consistency in some horizons. A description of the modal pedon for the Coards series (CB93) is shown in Table 4-19. The Middlemoor Series differs from Truitt by lacking a buried organic horizon, from Tingles by having n values < 1, and from Coards by having less than 30% clay and n values < 1. A description of the modal pedon for the Middlemoor series (CB39) is shown in Table 4-20.

The remaining four proposed subaqueous soil series differ at higher categories of *Soil Taxonomy* (mainly at the family or subgroup level). The Cottman series has either an n value < 0.7 or < 8% clay from 20 to 50 cm of the soil surface (making it Haplic) and a discontinuity within the soil profile with finer textured materials below 100 cm. A description of the modal pedon for the Cottman series (CB55) is shown in Table 4-21. The proposed Thorofare series differs from Cottman with sandy textures (fine sandy loam, sandy loam, loamy sand, loamy fine sand, or sand) and n values < 0.7 occurring throughout the soil profile (is also Haplic). A description of the modal pedon for the Thorofare series (CB29) is shown in Table 4-22. The Figgs series has n values >0.7 in the upper 1m of the soil profile and silt loam, clay loam, loam, or sandy loam textures in the particle-size control section (making it Fluvic). A description of the modal pedon for the Figgs series (CB41) is shown in Table 4-23.

The final proposed series, Tumagan, included soils that are permanently submerged Histosols that have less than 30 cm of recent estuarine material deposited on top of the organic horizon. These soils were recently submerged marshes and occur adjacent to the mainland shoreline. A description of the modal pedon for the Tumagan series (CB146) is shown in Table 4-24.

Table 4-17. Field morphological description of subaqueous soil profile CB97. Modal pedon for the Truitt Series.

38º 08' 35.9" N, 75º 16' 30.0"
Water Depth 220 cm
Sample CB97
Fine-silty, Fluvic Sulfiwassents

Horiz.	Boundary		USDA Texture		Matrix Color	Redoximorphic Features		Organic Fragments		Structure		Wet Const.	n value	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Abun .%	Color	Gr.	Shape				
A	2	a	SiC		5Y 3/1					0	ma	ns	>1		Strong
Cg1	76	c	SiC	SiL	10Y 3/1					0	ma	ms	>1		Strong
Cg2	95	c	C	L	10Y 3/1					0	ma	ms	>1		Strong
Cg3	131	c	SiC	SiCL	10Y 3/1					0	ma	ms	>1	3	Strong
Cg4	145	c	SiC	SiCL	10Y 3/1			2	2.5Y 5/6	0	ma	ms	>1		Strong
Cg5	168	c	SiC	SiC	5Y 3/2 10Y 3.5/1			15	2.5Y 5/6	0	ma	ss	>1	2	Strong
Oa/Cg	195	a	MkSiCL	-	5Y 4/1			15	2.5Y 5/6	0	ma	ss	>1		Strong
Oab1	213	c	Mk	-	5Y 3/2			40	2.5Y 5/4						Strong
Oab2	224	c	Mk	-	10YR 2/1										Strong
2Ab	245	c	MkL	L	10YR 2/1					0	ma	ss	>1		Strong
2Cgb1	260	c	SL	L	5GY 4/1					0	ma	ms	>1		None
2Cgb2	266	-	SL	SL	5GY 5/1	3-5%	5Y 5/4			0	ma	ss	>1		None

Remarks: Profile description by D. Balduff, 21 August 2005 at 8:12 am
Sampled using McCauley peat auger
0% vegetative cover, worm tubes on surface

Table 4-18. Field morphological description of subaqueous soil profile CB18. Modal pedon for the Tingles Series.

38º 08’ 19.95” N, 75º 14’ 43.10” W
Water Depth 270 cm
Sample CB18
Fine-silty, Fluvic Sulfiwassents

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	8	a	SiCL/SiC		10Y 2.5/0.5			0	ma	vs	>>>1			None
Cg	50		SiCL/SiC	SiCL	10Y 3/1			0	ma	vs	>>1			
	100			CL										
	150			SiCL										
	200			SiCL										
	245			CL										

Remarks: Profile described by D. Balduff, M.Stolt, and M. Rabenhorst, 21 September 2004 at 3:00pm
Sampled using McCauley peat auger
0% vegetative cover

Table 4-19. Field morphological description of subaqueous soil profile CB95. Modal pedon for the Coards Series.

38º 02’ 52.30” N, 75º 19’ 26.90” W
Water Depth 190 cm
Sample CB93
Fine-silty, Fluvic Sulfiwassents

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	4	A	SiC	SiL	5Y 4/1			0	ma	ns	>>1			None
A2	15	C	SiC	SiL	10Y 2.5/1			0	ma	vs	>1		2	Weak
Cg1	42	C	SiC	SiL	10Y 3/1			0	ma	ms	>1			Strong
Cg2	81	G	SiC	SiCL	10Y 3/1	3	5Y 4/4	0	ma	ms	>1		2	Strong
Cg3	210		SiC	SiCL	10Y 3.5/1			0	ma	vs	>1			Strong

Remarks: Profile described by D. Balduff, 20 July 2005 at 10:00 am
Sampled using McCauley peat sampler
0% vegetative cover

Table 4-20. Field morphological description of subaqueous soil profile CB39. Modal pedon for the Middlemoor Series.

38º 05’ 56.50” N, 75º 19’ 59.20” W
Water Depth 130 cm
Sample CB39
Fine-silty, Fluvic Sulfiwassents

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	1		SiC		5Y 4/2			0	ma	ms	>1			Weak
A2	12		SiC	SiCL	10Y 2.5/1			0	ma	ms	>1		1	None
Cg1	43		SiC	SiCL	10Y 3/1			0	ma	ms	>1			None
Cg2	57		SiC	SiC	5GY 3/1			0	ma	ms	>>1			None
Cg3	126		SiC	SiL	10Y 3/1			0	ma	ms	>1			None
2Cg4	161		LS	fSL	10Y 3/1			0	sg	ss	<0.7			None
2Cg5	198		LS	LfS	5Y 5/2			0	sg	ss	<0.7			None

Remarks: Profile described by D. Balduff, 23 June 2005 at 12:22 pm
Sampled using McCauley peat auger
0% vegetative cover, worm tubes on surface

Table 4-21. Field morphological description of subaqueous soil profile CB55. Modal pedon for the Cottman Series.

38º 04' 50.40" N, 75º 15' 52.40" W
Water Depth 185 cm
Sample CB55
Coarse-loamy, Haplic Sulfiwassents

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	3	a	SL	fS	5Y 4/1			0	ma	ns	<0.7			Strong
A2	12	a	SL	fS	N 3			0	ma	ns	<0.7		5	Strong
Cg1	41	c	SL	LfS	10Y 3.5/1			0	ma	ss	<0.7		3	Strong
Cg2	90	g	SL	LfS	5GY 3.5/1	3	2.5Y 3/3	0	ma	ss	0.7-1		1	Strong
2Cg3	143	g	C	L	5GY 3/1			0	ma	ms	>1		1	Strong
2Cg4	162	c	L	SL	10Y 3/1	4	5Y 4/4	0	ma	ss	0.7-1		1	Strong
2Cg5	198	-	SiC	L	10Y 3/1	7	5Y 4/4	0	ma	ms	>1		1	Strong

Remarks: Profile described by D. Balduff, 6 July 2005 at 8:15 am
Sampled using Vibracorer, depth inside core 170 cm, depth outside core 165 cm
0% vegetative cover, worm tubes on surface

Table 4-22. Field morphological description of subaqueous soil profile CB56. Modal pedon for the Thorofare Series.

38º 09' 28.2" N, 75º 13' 0.10" W
Water Depth 190 cm
Sample CB29
Sandy, Haplic Sulfiwassents

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	2	a	fSL		5Y 3/1			0	ma	VS/VP	>1	<1	0	Strong
Cg1	6	c	fSL		5Y 2.5/1			0	ma	VS/VP	>1		1	Strong
Cg2	24	c	fSL		N 3/			0	ma	MS/MP	<0.7		Trace	Strong
Cg3	89	c	SL	LfS	10Y 3/1			0	ma	SS/NP	<0.7		Trace	Strong
2Ab	111	c	LS	fS	5GY 3/1			0	sg	NS/NP	<0.7		35	Strong
2Cgb	159	-	LS		N 4/			0	sg	NS/NP	<0.7		2	Strong

Remarks: Profile described by D. Balduff, 8 June 2005 at 9:45 am
Sampled using Vibracorer, depth inside core 235 cm, depth outside core 230 cm

Table 4-23. Field morphological description of subaqueous soil profile CB41. Modal pedon for the Figgs Series.

38º 06' 07.20" N, 75º 19' 00.40" W
Water Depth 130 cm
Sample CB41
Fine-loamy, Fluvic Sulfiwassents

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	3	a	L	-	5Y 3.5/1			0	ma					Strong
A2	17	c	L	FSL	10Y 2.5/1			0	ma		0.7-1		1	Strong
2Cg1	52	c	FSL	CL	10Y3/1			0	ma		>1		15	Strong
2Cg2	143	-	SiC	CL	5GY 3.5/1			0	ma		>1			None

Remarks: Profile described by D. Balduff, 24 June 2005 at 10:49 am
Sampled using McCauley peat sampler
0% vegetative cover, worm tubes on surface

Table 4-24. Field morphological description of subaqueous soil profile CB146. Modal pedon for the Tumagan Series.

38º 12’ 25.10” N, 75º 15’ 2.50” W
Water Depth 40 cm
Sample CB146
Fine-silty, Terric Sulfisaprists
Sapric Sulfiwassists

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	2	a	SL	5Y 4/1			0	ma	ss	<0.7			Strong
Cg	6	c	SiC	10Y 3.5/1	10	2.5Y 5/6	0	ma	ss	>1			Strong
Oa	24	c	Mk	5Y 3/2									Strong
C’g	39	c	MkSiCL	10Y 3.5/1			0	ma	ss	>1			Strong
Oab1	71	c	Mk	5Y 3/2									Strong
Oab2	103	c	Mk	10YR 2/1									Strong
C”g	160	c	SiC	5GY 3.5/1	25	5Y 6/6	0	ma	ss	>1			Strong
Oab	210	c	Mk	10YR 2/2									Strong
2Ab	220	c	L	10YR 2/1	7	2.5Y 4/4	0	ma	ss	0.7-1			Strong
2Cgb	229	-	SL	10Y 3/1	3	2.5Y 4/4	0	ma	ss	<0.7			Strong

Remarks: Profile described by D. Balduff 18 August 2005 at 10:57 am
Sampled using McCauley peat sampler
0% vegetative cover, worm tubes on surface

Conclusions

Soils were characterized for a variety of physical and chemical properties. The particle-size analyses collected for 188 samples indicated that the field textures collected could be used for the samples that do not have particle-size data by taking into account minor systematic shifts. The presence of sulfidic materials and the concentration of sulfides in the soils is an important criterion in the classification of these soils. Based on moist incubation pH data collected for 27 pedons, most of the soils contained sulfidic materials within the profile. The lowest concentrations of acid volatile sulfides and chromium reducible sulfides were associated with the very sandy soils located on the storm-surge washover fan flats, whereas the highest concentrations were associated with the finer textured, organic rich soils in the mainland coves. Overall, the acid volatile sulfide concentrations were very low even in profiles where chromium reducible sulfides were substantial. Sandy textured soils mostly had field estimated n values less than 0.7 and the finer textured soils generally had field estimated n values greater than 1. The field estimated n values differed dramatically from the calculated n values. The field estimated n values were a better predictor of the fluidity and bearing capacity of the soils than the calculated values. The porewater salinities of surface horizons were similar to the overlying water, which ranged from 26 to 36 ppt. Salinity within pedons located on the eastern side of the bay toward the barrier island remained high with depth with values centered around 26 to 34 ppt. However, pedons located near the mainland tended to show a systematic decrease in salinity with depth. The lower salinity values associated with these areas are likely the result of groundwater discharge into the bay from the surrounding watershed. The soil mineralogy of these soils were not dominated by any single mineral and were classified into the mixed mineralogy class.

The sandy soils located on the storm-surge washover fan flat and paleo-flood tidal delta landforms had the lowest organic carbon contents. The amount of organic carbon stored in the upper 1m was lowest (0.7 to 3.6 kg m^{-2}) in the sandy soils located on the storm-surge washover fan flat, storm-surge washover fan slope, and paleo-flood tidal delta landforms. The profiles that contained the buried organic horizons had the highest organic carbon contents within Chincoteague Bay. The lagoon bottom, fluviomarine bottom, and barrier cove landforms have moderate quantities (4.0 to 21.0 kg m^{-2}) of organic carbon stored in the upper 1 m of the soils, while those soils in the mainland coves and submerged wave-cut headlands have the highest (5.0 to 34.0 kg m^{-2}) organic carbon contents in the upper 1m. The carbon stored in these sediments may be produced in situ by benthic and aquatic organisms and these data may need to be considered in the global carbon storage estimates. The calcium carbonate contents are generally low in the soils throughout Chincoteague Bay.

The subaqueous soils of Chincoteague Bay were better accommodated when using the proposed suborder of Wassents for classification compared to the current suborder of Aquents, which is also used for subaerial soils that are not permanently saturated. The order in which the great groups of Wassents are introduced places importance on soil texture in the control section, whereas in the Aquents the priority was placed on the presence of sulfidic materials. When the current classification scheme was used, nearly all (98%) of the subaqueous soils were classified as

Sulfaquents. The proposed classification recognizes the sandy soils first as Psammowassents (14%) and the remainder of the soils classify as Sulfiwassents (86%). The proposed amendment to *Soil Taxonomy* does a better job of differentiating soils in estuarine systems

The currently approved subaqueous soil series accommodated only 24% of the soils described in Chincoteague Bay. Therefore eight additional subaqueous soil series were proposed to accommodate the remainder of the soils at the series level of classification. The proposed series were differentiated based on such properties as the presence or absence of organic horizons, soil texture in the particle-size control section, textural changes with depth, and n values throughout the profiles. By identifying and using these new soil series, the differences among the soils can be better highlighted. The properties of the soil series can then be used to assess the potential uses of these soils by ecological managers, scientists, and engineers.

Chapter 5: Subaqueous Soil-Landscape Relationships in Chincoteague Bay, MD

Introduction

Demas and Rabenhorst (2001) first identified the pedogenic processes that form subaqueous soils and demonstrated that the subaqueous soils of Sinepuxent Bay, MD were systematically distributed across landscape units. Demas (1998) developed the initial subaqueous soil-landscape models for shallow coastal bays. Later studies by Bradley and Stolt (2003) in Ninigret Pond, RI, Osher and Flannagan (2007) in Taunton Bay, ME, and Coppock et al. (2004) in Rehoboth Bay, DE, continued to define and enhance the subaqueous soil-landscape models for coastal lagoons and estuaries.

Demas (1998) identified seven distinct subaqueous landforms, to which he applied the following names: mid-bay shoal, overwash fans, barrier island flats, shallow mainland coves, deep mainland coves, transition zones, and central basin. He also proposed six soil series that were found in association with the seven major landforms described in Sinepuxent Bay, MD. The dominant soils associated with each landform are presented in Table 5-1. Most of the soil series were differentiated on the basis of texture and the presence or absence of sulfidic materials in the soil profile. According to Demas, most of the sandy soils did not contain sulfidic materials. He observed, for example, that soils located on the overwash fan, shallow

Table 5-1. Major landforms and the associated soils found in Sinepuxent Bay, Maryland (summarized from Demas, 1998).

Landform Name	Series	Family Level Classification (*Soil Taxonomy*)	Distinctive Soil Properties
Mid-Bay Shoal	Sinepuxent	Coarse-loamy, Typic Sulfaquents	1. Sulfidic materials 2. Fluid (n value >0.7) 3. Lithologic discontinuities
Overwash Fans	Fenwick (Whittington)	Typic Psammaquents	1. Sandy 2. Non-fluid (n value <0.7)
Barrier Island Flats	Tizzard	Coarse-loamy, Sulfic Fluvaquents	1. Sulfidic materials 2. Irregular distribution of organic C
Shallow Mainland Coves	Newport (Trappe)	Typic Psammaquents	1. Sandy 2. Non-fluid (n value <0.7) 3. Subsoil colors, chroma 3 or greater
Deep Mainland Coves	South Point (Southpoint)	Fine-silty, Thapto-Histic Sulfaquents	1. Buried organic horizons within 100cm of soil surface 2. Finer textured 3. Fluid (n value >0.7) 4. Sulfidic materials 5. Highest organic C contents
Transition Zones	Wallops (Demas)	Typic Psammaquents	1. Sandy 2. Surface colors, chroma 2 or less
Central Basin	No Series Available	Fine-silty, Typic Sulfaquents	1. Sulfidic materials 2. Finer textured 3. Fluid (n value >0.7) 4. Moderate organic C contents

mainland cove, and transition zone landscape units had very small quantities of monosulfides and disulfides within their profiles, whereas remaining landscape units contained soils that had higher quantities of monosulfides and disulfides within the profile. Demas (1998) did not incubate the samples to determine the presence or absence or sulfidic materials as prescribed in *Soil Taxonomy*. Rather he measured the quantity of monosulfides and disulfides in the soils and inferred from these data which soils contained “sulfidic materials”. Another observation of Demas (1998) was that many soils in the deep mainland coves contained buried organic horizons within 100 cm of the soil surface. These buried organic horizons likely represent former tidal marshes that were submerged by rising sea levels during the Holocene. What Demas termed the central basin was the largest landscape unit in Sinepuxent Bay, but the soils were not studied in as much detail as the other landforms. The single pedon sampled by Demas (1998) in this unit contained disulfides within the profile. This low-energy environment possessed the ideal combination of factors to facilitate sulfide mineral formation, including an anaerobic environment, a source of SO_4^{2-}, fresh organic matter (in the form of algal detritus), an iron source (iron oxides sorbed to mineral sediments), and sulfate reducing bacteria (Ponnamperuma, 1972; Rickard, 1973; Pons et al., 1982).

Bradley and Stolt (2003) examined the subaqueous soil-landscape relationships of Ninigret Pond, RI and identified 12 distinct landforms. The dominant soils (presented as subgroups of *Soil Taxonomy*) associated with each of the landforms they identified are presented in Table 5-2. From their study more suitable and descriptive landform terms were developed from marine geological terms, such

Table 5-2. Major landforms and the associated soils found in Ninigret Pond, Rhode Island (summarized from Bradley and Stolt, 2003).

Landscape Unit	**Classification (*Soil Taxonomy*)**	**Distinctive Soil Properties**
Lagoon Bottom	Typic Hydraquent	1. Fine textures (SiL, SiCL, fSL) 2. Fluid (n values > 1) 3. High organic C contents
Storm-surge Washover Fan Flat	Typic Sulfaquent	1. Sandy (fS, S) 2. Sulfidic materials 3. Low organic C contents
Flood-tidal Delta Flat	Typic Psammaquent	1. Sandy (fS, S) 2. Low organic C contents
Storm-surge Washover Fan Slope	Typic Fluvaquent	1. Buried A horizons in the profile 2. Irregular organic C distribution
Flood-tidal Delta Slope	Typic Fluvaquent	1. Buried A horizons in the profile 2. Irregular organic C distribution
Mainland Submerged Beach	Typic Endoaquent	1. Sandy (LS, coS), with coarse fragments 2. Surface contains iron mono-sulfide coatings 3. Low organic C contents
Barrier Cove	Typic Sulfaquent	1. Sulfidic materials 2. Finer textured
Mainland Shallow Cove	Typic Endoaquent	1. Thin estuarine deposits, dominated by glaciofluvial parent materials
Mid-lagoon Channel	Typic Endoaquent	1. Sandy (LS, coS), with coarse fragments 2. Surface contains iron mono-sulfide coatings 3. Low organic C contents
Barrier Submerged Beach	Typic Endoaquent	1. Sandy (LS, coS), with coarse fragments 2. Surface contains iron mono-sulfide coatings 3. Low organic C contents
Shoal	Typic Endoaquent	1. Sandy (LS, coS), with coarse fragments 2. Surface contains iron mono-sulfide coatings 3. Low organic C contents
Mainland Cove	Thapto-Histic Hydraquent	1. Buried organic horizon within the upper 100 cm of the soil surface; both freshwater and salt water marsh origins 2. Mostly SiL, fSL, and LS textures

as storm-surge washover fan flats to replace the "overwash fans" described by Demas (1998). Their work also examined what Demas (1998) called "transitional zones" and provided landform names, such as storm-surge washover fan slopes, and conceptualized the formation of the soils on these units. Bradley and Stolt (2003) also identified the broader extent of the sulfidic materials in coastal lagoons, especially recognizing sulfidic materials in sandy soils, such as those located on the storm-surge washover fan flats. They also examined the lagoon bottom in greater detail, although the properties of these soils were similar to those previously described by Demas (1998). One major difference, however, was that in Ninigret Pond, RI, soils in the lagoon bottom did not contain sulfidic materials even though the conditions seemed appropriate for sulfide mineral formation. It is not clear whether this results from a lack of sulfides or the presence of carbonate that can neutralize the acidity from oxidation of sulfides. Buried organic horizons were also described within the mainland coves similar to those described in Sinepuxent Bay, MD. They identified and described soils on several newly identified landforms, including the mainland submerged beaches, flood-tidal delta flats, flood-tidal delta slopes, barrier coves, mid-lagoon channel, and barrier submerged beaches. Flood-tidal delta landforms are associated with active inlets into the lagoon. These landforms are sinks of sand-sized particles that are carried into the lagoon during the daily flood tides. These are very active areas where the tidal currents continuously winnow out fine and organic materials and supplies oxygenated water to the sediments. Therefore the conditions needed for sulfide minerals to form are not present in these environments. The barrier cove landforms of Bradley and Stolt (2001) contain soils that are similar to the lagoon bottom, except these soils do contain sulfidic materials.

Osher and Flannagan (2007) studied the subaqueous soil-landscape relationships in a mesotidal estuary in Maine. Different processes have shaped the landforms and soils located in Taunton Bay, due to the absence of a barrier island system that was present in the coastal lagoons previously studied (Demas, 1998; Bradley and Stolt, 2001) and a greater tidal range. Seven subaqueous landforms were identified and the following names were applied: terrestrial edge, coastal cove, submerged fluvial stream, mussel shoal, fluvial marine terrace, channel shoulder, and channel. The dominant soils and the associated landforms in Taunton Bay are presented in Table 5-3. Although, these landforms were different from those described in previous studies, similar processes and soils were described. For example, on the terrestrial edge landform, several different soils were identified, but generally these soils were composed of recently deposited estuarine materials overlying buried subaerial soils. The submerged marsh map unit contained soils that have buried organic horizons deeper than 100 cm below the soil surface that overlie subaerial soil horizons and contained sulfidic materials within the upper portion of the profile. The submerged marsh soils were similar to those described in the Sinepuxent Bay, MD, mainland coves (Demas, 1998). The fluvial marine terrace was a landform that supports soils similar to those found in the lagoon bottoms described in Sinepuxent Bay, MD in that these soils found in low-energy environments, were fine textured and contain sulfidic materials within the profile. The channel shoulder landform was adjacent to the fluvial marine bottom and the soils on the channel shoulder were similar to those on the fluvial marine bottom except in areas where the

Table 5-3. Major landforms and associated soils found in Taunton Bay, Maine (summarized from Osher and Flannagan, 2007).

Landscape Unit	**Soil Map Unit**	**Classification (*Soil Taxonomy*)**	**Distinctive Soil Properties**
Terrestrial Edge	Submerged Marsh	Fine-silty, Typic Sulfaquents	1. Buried organic horizons deeper than 1m below the soil surface 2. Buried subaerial soils below the organic horizons 3. Fine textured (sicl)
	Submerged Beach	Coarse-loamy, Haplic Sulfaquents	1. Sulfidic materials 2. SiL, SL, and S textures
	Submerged Fluvial Delta	Sandy, Haplic Sulfaquents	1. Sulfidic materials 2. SiL textures over S and LcoS textures 3. Low organic C contents
	Terrestrial Edge	Coarse-loamy, Sulfic Endoaquents	1. Sulfidic materials 2. SiL textures
Coastal Cove	Shallow Coastal Cove	Coarse-loamy, Haplic Sulfaquents	1. Sulfidic materials 2. L textures
	Deep Coastal Cove	Coarse-silty, Typic Sulfaquents	1. Sulfidic materials 2. L and SiL textures
Submerged Fluvial Stream	Submerged Fluvial Stream	Fine-silty, Typic Sulfaquents	1. Sulfidic materials 2. SiL textures 3. High organic C contents
Mussel Shoal	Mussel Shoal	Fine-silty, Typic Sulfaquents	1. Sulfidic materials 2. Very shelly surface 3. Si and SiL textures
Fluvial Marine Terrace	Fluvial Marine Terrace	Fine-silty, Typic Sulfaquents	1.Sulfidic materials 2. SiL and SiCL textures
Channel Shoulder	Channel Shoulder	Fine-silty, Typic Endoaquents	1. Monosulfides present to 35 cm below the soil surface 2. SiL textures, some horizons are very shelly
Channel			

vegetative cover exceeds 50%. Those areas covered by vegetation supported soils that did not contain sulfidic materials within the profile and were similar to the lagoon bottom soils in Ninigret Pond, RI. Osher and Flannagan (2007) hypothesized that the soils formed under a vegetative cover differed from the non-vegetated soils due to differences in soil chemistry resulting from oxygen transport by the growing vegetation which precluded the formation of sulfide minerals. It is not clear, however, why and how the shallow zone oxygenated by SAV roots should inhibit the formation of sulfide minerals at greater depths.

Coppock et al.(2004) studied the subaqueous soil-landscape relationships in Rehoboth Bay, DE, which is a microtidal estuary. He identified landforms similar to those of Demas (1998) and Bradley and Stolt (2003), but identified one new landform which he called a fluviomarine bottom. The fluviomarine bottom lay within the mouth of a fresh water stream entering the brackish estuary or lagoon where the subaqueous soils develop from mixed fluvial and marine sediments as the river-borne sediments flocculate and settle as they encounter the brackish water. The soils were very fluid (n values > or >> 1), fine textured (SiCL, CL, SiC, or C) with high organic carbon levels, and have sulfidic materials within the profile.

Studies to date have examined subaqueous soil-landscape relationships in relatively small coastal lagoons or estuaries (mostly between 120 to 6,000 ha with the largest being (the 6,000 ha) Rehoboth Bay, DE). My intention was to determine the suitability of the current models within the framework of a larger coastal system. The objectives of this study were 1) to evaluate the suitability of existing subaqueous soil-landscape models from Atlantic coastal lagoons and estuaries in describing the distribution of the soils of Chincoteague Bay; 2) to modify or enhance those soil-landscape models as needed to accommodate observations in Chincoteague Bay; and 3) to conduct a soil resource inventory of Chincoteague Bay.

Materials and Methods

Study Site

Chincoteague Bay is the largest of Maryland's inland coastal lagoons with an area of 19,000 ha that formed as a result of sea level rise following the last glacial period and the consequent flooding of low-lying areas. This coastal lagoon is bounded by Assateague Island to the east and the Maryland mainland to the west and is connected to the Atlantic Ocean by the Ocean City inlet to the north and the Chincoteague inlet to the south (approximately 52 km apart). Chincoteague Bay is classified as a microtidal (tidal range < 2 m) lagoon with an average daily tidal range of 10-20 cm near Public Landing, MD. Generally the water depths are less than 2.5 m throughout the bay. Salinity within Chincoteague Bay changes seasonally, from 26 to 34 ppt with the highest salinity values occurring in the summer due to high evaporation rates, poor circulation, and limited fresh water inputs (Wells and Conkwright, 1999). The soils surrounding Chincoteague Bay have formed from alluvium, aeolian sand, organic materials, and marine sediments (Worcester County Soil Survey). Sediment enters the lagoon through tidal inlets, tidal creeks, shoreline erosion, storm-surge overwash events on the barrier island, and aeolian transport (Bartberger, 1976).

Soil Sampling Techniques and Laboratory Analysis

Base maps, such as a detailed bathymetric map and high resolution false-color infrared photography of Chincoteague Bay, were used to delineate the subaqueous landscape units (USDA-NRCS, 2001). The different landscape units were delineated based on slope, water depth, landscape shape, depositional environment, and geographic proximity to other units (Chapter 3). The high resolution orthomosaic photograph used in Figures 5-1, 5-2, 5-3, 5-6, 5-7, 5-8, 5-9, 5-10, 5-11, 5-12 was provided by USDA-NRCS Geospatial Data Branch in Fort Worth, TX (USDA-NRCS, 2001). The soils were examined at multiple locations within each landscape unit. Pedon locations and their associated landforms are shown in Figure 5-1. The sites were chosen to document the composition and variability within each landscape unit and to determine the differences or similarities between adjacent units. Pedons along two additional transects (consisting of 10 observations each) were described in the adjacent mainland marshes. These descriptions were collected to determine the depths at which organic horizons occurred in these marshes, which were to be compared with similar features described in adjacent subaqueous soils. The soils were accessed by boat and locations where soils were described and sampled were recorded using a global positioning unit (GPS). One-hundred and forty six soils were examined using a vibracorer or a McCauley peat sampler and profiles were described on the boat according to the National Soil Survey Center guidelines (Schoeneberger et al., 2002). Samples from 86 of the pedons were collected for further laboratory analyses. Methods of handling and analyses of samples are presented in Chapter 4.

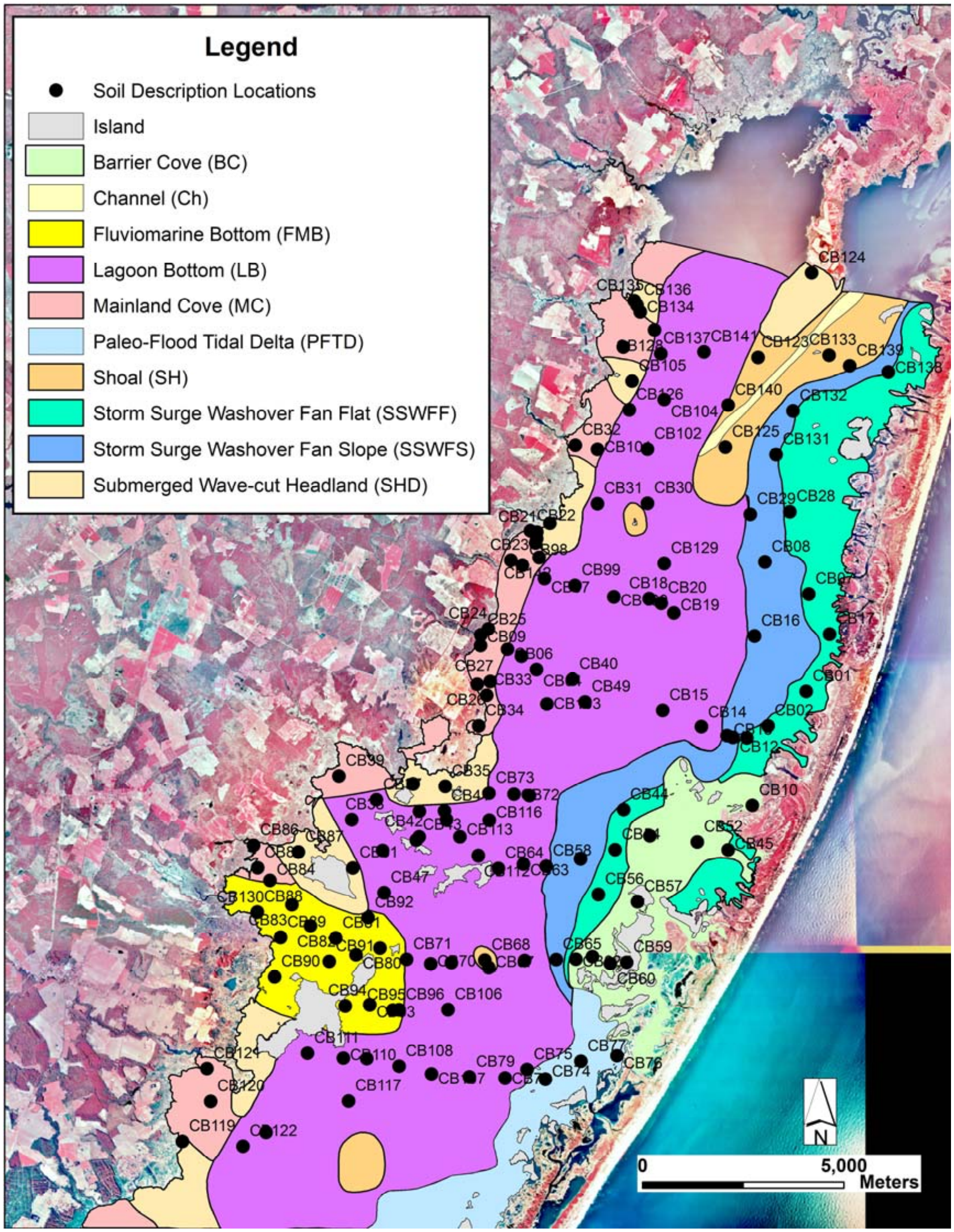

Figure 5-1. Location map of the subaqueous soil profiles described in Chincoteague Bay and the subaqueous landscape units they occupy.

Soil-Landscape Analysis

After characterization, the soils were classified to the series level according to the Keys to *Soil Taxonomy* (Soil Survey Staff, 2006) and proposed amendments to *Soil Taxonomy* (Northeast Regional Cooperative Soil Survey Subaqueous Soils Committee, 2007). Eight new series were proposed to accommodate soils of significant extent that did not fall within the range of characteristics for previously established series (Chapter 4). Existing soil-landscape models were compared with observations from Chincoteague Bay. Where the models were partially adequate, they were utilized and enhanced to accommodate the soils identified in Chincoteague Bay and where they were inadequate or non-existing, new concepts were developed for those landforms. Once the soil-landscape models were developed for Chincoteague Bay, a soil resource inventory (map) was developed.

Development of Soils Map

A first attempt at gathering soils information can be obtained for a particular area by collecting geomorphic maps, high quality aerial photography, and established soil-landscape models for the region. A preconceived notion of what types of soils to expect is based upon established soil-landscape models. This is the fundamental principle of the pedologic paradigm (Hudson, 1990). Initially soil boundaries are based on landforms (geomorphic maps). These boundaries are checked by collecting information on the soils across the landforms and boundaries to confirm the soil properties and systematic changes (Schaetzl and Anderson, 2005). This process leads to confirming the lines, adding new lines, or aggregating landforms together. In subaerial settings, changes in topography (slope curvature, steepness, or aspect) affect which soils can exist at a site and soils can be identified on terrain alone (Moore et al., 1993). In subaqueous settings the slope is very subtle and is not as useful in identification of landforms and soils. However, water depth and depositional environments are more useful in the identification of particular soils.

Results

Subaqueous Soil-Landscape Relationships

In Chincoteague Bay, 10 major landforms were identified (Chapter 3). These were storm-surge washover fan flats, storm-surge washover fan slope, paleo-flood tidal delta, barrier cove, dredged shoal, lagoon bottom, fluviomarine bottom, mainland cove, and submerged wave-cut headland. Each of these ten landforms and their associated soils will be discussed, starting on the barrier island side of the lagoon and migrating westward toward the mainland shore of Chincoteague Bay. The dominant soils associated with each landform are presented in Table 5-4.

The soils of the storm-surge washover fan flat were formed in extremely sandy materials transported by overwash events on the adjacent barrier island. These landscapes were located in shallow water and were influenced by wave action. These soils have high fine sand contents (Table 5-5) and generally lack discontinuities (vertical uniformity), which resulted from the material being derived entirely from the subaerial soils on the barrier island, and carried during high-energy overwash events. In these landscape units finer grained materials (silts and clays) were essentially absent, because of high-energy deposition and winnowing by wind generated waves (Wells and Conkwright, 1999). The soils on this landform were characterized by

Table 5-4. Classification of subaqueous soil profiles in each Chincoteague Bay landform. All profiles classified according to the Proposed Changes to *Soil Taxonomy* (Northeast Regional Cooperative Soil Survey Subaqueous Soils Committee, 2007).

Landform Name	**# Profiles (Total)**	**Classification (Proposed *Soil Taxonomy*)**	**# Observations (Percentage)**
Barrier Cove	8	Fine-silty, Typic Sulfiwassents	6 (75%)
		Sandy, Haplic Sulfiwassents	1 (12.5%)
		Sulfic Psammowassents	1 (12.5%)
Dredged Channel	0		
Dredged Shoal	7	Sulfic Psammowassents	5 (71%)
		Coarse-loamy, Haplic Sulfiwassents	1 (14.5%
		Fine-loamy, Typic Sulfiwassents	1 (14.5%)
Fluviomarine Bottom	15	Fine-silty, Typic Sulfiwassents	13 (87%)
		Fine-loamy, Typic Sulfiwassents	1 (6.5%)
		Coarse-loamy, Aeric Sulfiwassents	1 (6.5%)
Lagoon Bottom	51	Fine-silty, Typic Sulfiwassents	35 (67%)
		Fine-loamy, Typic Sulfiwassents	3 (6%)
		Coarse-loamy, Haplic Sulfiwassents	3 (6%)
		Coarse-loamy, Typic Sulfiwassents	2 (4%)
		Fine-loamy, Haplic Sulfiwassents	2 (4%)
		Sandy, Haplic Sulfiwassents	2 (4%)
		Coarse-silty, Sulfic Haplowassents	1 (2%)
		Fine-silty, Fluvic Sulfiwassents	1 (2%)
		Sulfic Psammowassents	1 (2%)
		Fine-loamy, Thapto-Histic Sulfiwassents	1 (2%)
Mainland Cove	24	Fine-silty, Typic Sulfiwassents	13 (54%)
		Fine-loamy, Typic Sulfiwassents	3 (13%)
		Coarse-loamy, Haplic Sulfiwassents	2 (8%)
		Coarse-loamy, Typic Sulfiwassents	1 (4%)
		Coarse-loamy, Aeric Sulfiwassents	1 (4%)
		Fine, Haplic Sulfiwassents	1 (4%)
		Sandy, Haplic Sulfiwassents	1 (4%)
		Coarse-silty, Thapto-histic Sulfiwassents	1 (4%)
		Fine-silty, Thapto-histic Sulfiwassents	1 (4%)
Paleo-Flood Tidal Delta	3	Sulfic Psammowassents	2 (67%)
		Sandy, Haplic Sulfiwassents	1 (33%)

Table 5-4. Continued.

Landform Name	# Profiles (Total)	Classification (Proposed *Soil Taxonomy*)	# Observations (Percentage)
Storm-surge Washover Fan Flat	13	Sulfic Psammowassents	7 (54%)
		Sandy, Haplic Sulfiwassents	3 (23%)
		Coarse-loamy, Haplic Sulfiwassents	2 (15%)
		Sandy over loamy, Haplic Sulfiwassents	1 (8%)
Storm-surge Washover Fan Slope	8	Sulfic Psammowassents	3 (37.5%)
		Sandy, Haplic Sulfiwassents	2 (25%)
		Coarse-loamy, Haplic Sulfiwassents	1 (12.5%)
		Coarse-loamy, Typic Sulfiwassents	1 (12.5%)
		Fine-silty, Typic Sulfiwassents	1 (12.5%)
Submerged Wave-cut Headland	16	Fine-silty, Typic Sulfiwassents	5 (31%)
		Coarse-loamy, Haplic Sulfiwassents	3 (19%)
		Sapric Sulfiwassists	2 (12.5%)
		Fine-loamy, Thapto-histic Sulfiwassents	2 (12.5%)
		Sulfic Psammowassents	1 (6%)
		Fine, Thapto-histic Sulfiwassents	1 (6%)
		Coarse-loamy, Typic Sulfiwassents	1 (6%)
		Fine-loamy, Typic Sulfiwassents	1 (6%)

gleyed colors (N-5GY, value 2.5-5, chroma 0-1) and sandy textures (fS, LfS, fSL, or SL). They were non-fluid (n values <0.7), and contained sulfidic materials within the profile. Most pedons had a thick (2 to 12 cm) oxidized surface horizon that was slightly yellower and a unit higher in value and chroma (5Y 4/1) than the underlying horizons. Most pedons contained fragments of partially decomposed organic materials associated with the seagrasses that commonly inhabit these soils. Organic carbon contents ranged from 0.22 to 5.59 g kg^{-1}. Most of the pedons had noticeable hydrogen sulfide odor.

The storm-surge washover fan slope landform had the greatest slopes observed within the bay, ranging from 0.1 to 0.3%. This landform was located in deeper water than the fan flats and therefore there was decreased wave agitation and increased tidal current influence. The soils were composed of sandy materials transported by overwash events in the upper part, but also had a lithologic discontinuity, below which we found finer textured lagoon bottom sediments. These soils were characterized by gleyed colors (10Y-5GY, values 2.5-4, chroma 0-1) and sandy or loamy textures (SL, fSL, fS, LfS, or L). They were non-fluid to slightly fluid (n values 0.7 to 1) and contained sulfidic materials in the profile. Most pedons had an oxidized surface horizon (1 to 6 cm thick) that was slightly yellower and a unit higher in value and chroma than the underlying horizons. Most pedons contain organic fragments, which were deposited in these profiles from wave erosion of the adjacent flats. Organic carbon contents ranged from 0.38 to 8.84 g kg^{-1}, with the higher contents occurring deeper in the profile associated with the finer textured sediments.

Table 5-5. Weighted fine sand content (0-50 cm) for the subaqueous soil profiles located on the storm-surge washover fan flats.

Sample	**Average % fS (upper 50 cm)**	**Weighted % fS (upper 50 cm)**
CB01	57.5	57.1
CB17	64.5	65.9
CB45	90.6	91.0
CB56	79.5	89.1

Soils of the paleo-flood tidal delta were dominated by sandy materials that were transported into the bay when the Green Run Inlet was active, and since its closure sandy materials have continued to be deposited by washover events from the barrier island. These soils were characterized by dark gray colors (5Y-10Y, values 2.5-4, chroma 0-1) and sandy textures (SL, LfS, fS, or coS). They were non-fluid (n values <0.7) and contained sulfidic materials in the profile. Most pedons had oxidized surface horizons (2 to 7 cm thick) that were slightly yellower and a unit higher in value and chroma than the underlying horizons. Most pedons contained organic fragments, which were deposited in these profiles from wave erosion of the adjacent barrier island marshes or seagrass beds on the washover flats. Organic carbon contents ranged from 0.47 to 3.25 g kg^{-1}, with the highest contents occurring in the surface horizons.

The barrier coves were low-energy environments located in embayments or protected areas adjacent to the barrier island. These low-energy environments allowed finer textured suspended materials to accumulate, although these soils showed influence of washover events that created sandy surfaces on many of the soil profiles. Most of the soils had a lithologic discontinuity with sandy loam textures below the finer texture materials, which probably reflect the relict flood tidal delta sediments that were deposited when the Green Run Inlet was active. These soils were characterized by gleyed colors (N-10Y, values 2.5-4, chroma 0-1) with a yellower (5Y 4/1) oxidized surface horizon. They were loamy textured (fSL, L, SiCL, or CL) and contained sulfidic materials within the profile. Most pedons contained organic fragments, deposited in these profiles from wave erosion of the adjacent island marshes found within the barrier coves and from adjacent seagrass beds. Organic carbon contents ranged from 1.75 to 61.90 g kg^{-1}, with the lower values occurring closer to the barrier island and deeper in the profile. The highest values occurred in the upper 75 cm of the soil profile.

Dredged shoals were created during the dredging of a shipping channel and the dredging associated with a channel marker located in the southern portion of the bay. These soils were characterized by gleyed colors (N-5GY, value 2.5-6, chroma 0-1) with thin (2 cm) oxidized surface horizons (5Y 4/1) and sandy textures (S, LS, or SL). They are non-fluid (n values <0.7) and contain sulfidic materials within the profile. The sandy material in these soils was derived from overwash on the barrier island and relict materials when Sinepuxent Inlet was active. The pedons located on the dredge shoal in the middle of the lagoon bottom contain soils that were loamy textured and were more similar to the surrounding soils on the barrier island side of the lagoon bottom.

The lagoon bottom is a deep water, central, low-energy, depositional landform. This landform is dominated by tidal currents, but the > 2.0 m water depth and wide expanse of the landform reduced their impact and made the wind generated wave agitation negligible. The soils of the lagoon bottom were moderately fluid (n value >1) and fine textured throughout. These soils were characterized by gleyed colors (10Y-10GY, value 2.5-5 (mostly <4), chroma 0-1) with a very thin (1 to 2 cm) oxidized surface horizon (5Y 4/1), have loamy (SiCL, CL, SiL, or L) textures, and contained sulfidic materials throughout the profile. Most pedons had horizons that contained organic fragments and shell fragments (identifiable shells include razor clams, oyster, gastropod, and mussel). Organic carbon contents ranged from 0.93 to 31.47 g kg^{-1}, with the lower values occurring in coarser textured materials. Along the barrier island side of the lagoon bottom, the upper portion of the soil profiles were composed of sandier materials that overlie finer textured materials at depth. The sandier nature of the upper parts of these profiles was likely the result of increased delivery of coarse particles out into the bay during storm events with higher energies. Several soil profiles located adjacent to the paleo-flood tidal delta were coarse textured throughout, which may have resulted from similar storm events discharging coarser materials farther into the bay. Along the mainland side of the lagoon bottom several soil profiles contained buried organic horizons that generally occurred deeper than 1m below the soil surface, and which were similar to soils further to the west, closer to the mainland. In the southern portion of the mainland side of the lagoon bottom, several soil profiles had thin horizons (14 to 40 cm thick) composed of sandy loam textures at or near the soil surface. These areas were associated with numerous islands, which were eroding, creating the source of these coarser sediments (Wells and Conkwright, 1999).

The fluviomarine bottoms are low-energy environments that lay within the mouth of an incoming stream. The soils of the fluviomarine bottom were moderately to very fluid (n values > or >>1) and fine textured (SiCL or CL) throughout. Due to the very fluid nature of these soils they have a very low bearing capacity. These soils were characterized by gleyed colors (N-5GY, value 2.5-4, chroma 0-1) with thin (1 to 3 cm) oxidized surface horizons and contained sulfidic materials. Most pedons contained horizons with up to 40% organic fragments (by volume) from the adjacent mainland marshes and marsh islands in the landform. Organic carbon contents ranged from 4.90 to 20.98 g kg^{-1}. Along Mills Island there are two pedons that were a little coarser (SL, L or fS) and these soils may be part of a submerged mainland beach. One of the profiles contained horizons with brighter matrix color of chroma 3 deeper in the profile (75 to 116 cm) which may represent relict subaerial soil features or may possibly be related to the upwelling of oxygenated groundwater into the bay (Dillow et al., 2002).

Mainland coves were located along the western (mainland) shore and are deeper, low-energy depositional areas. Due to the combination of a low-energy environment and the adjacent tidal marshes, these soils were generally composed of silts and clays with higher amounts of organic matter. Several profiles contained buried organic horizons that occur between 56 and 198 cm below the soil surface. Many of these buried organic horizons were underlain by soil horizons thought to be originally associated with subaerial soils (described as Ab, BAgb, Btgb, or Cgb). These horizons may contain redoximorphic features, soil structure, or a low salinity, which were indicative of an upland environment. These soil profiles usually contained a least one discontinuity in the profile, and generally sandier materials underlie the buried organic horizons. These soils were characterized by gleyed colors (2.5Y-5GY, values 2.5-6, chroma 0-1) and loamy textures (SiCL, CL, L, SiL, or fSL). They were slightly fluid to moderately fluid (n values >0.7), and contained sulfidic materials. Most pedons contained organic fragments, which may have been transported into the coves by wave erosion of the adjacent tidal marshes. Organic carbon contents ranged from 2.52 to 221.75 g kg^{-1}, with the highest values in the buried organic horizons. The pedons close to the mainland generally had lower porewater salinity levels with depth. The soils that did not contain buried organic horizons were fine textured and were similar to the soils described on the lagoon bottom landform.

The submerged wave-cut headlands were gently sloping, erosional landforms adjacent to the mainland coast. Most pedons contained buried organic horizons that occurred between 18 and 161 cm below the soil surface. Many of these buried organic horizons were underlain by soil horizons formed in subaerial environments, such as Ab, BAgb, or Cgb. These horizons were characterized by redoximorphic features or low salinity levels indicative of formation in an upland environment. The soils on these landforms were generally characterized by gleyed colors (N-5GY, values 2.5-5, chroma 0-1), loamy textures (SiCL, CL, L, fSL, SL, LS, or fS), and contained sulfidic materials. Organic carbon contents ranged from 2.76 to 266.80 g kg^{-1}, with the higher values being associated with buried organic horizons. The pedons close to the mainland generally had lower porewater salinity levels with depth. Several soil pedons that did not contain organic horizons were fine textured and fluid throughout and were similar to the soils located on the lagoon bottom, although these pedons have sandier textured surface horizons.

Buried Organic Soils

Several buried organic rich horizons were described along the mainland side of the bay, and were located within mainland cove, submerged wave-cut headland, and lagoon bottom landforms. Similar buried O horizons have also been identified in mainland coves in other Atlantic estuaries, such as Sinepuxent Bay, MD, Ninigret

Pond, RI, and Taunton Bay, ME (Demas and Rabenhorst 1998; Bradley and Stolt, 2003; Osher and Flannagan, 2007). These paleosols are likely of late Holocene age and were buried by recent estuarine sediments that ranged in thickness from 28 to 198 cm. The overlying water depths ranged from 20 to 250 cm, depending on the distance from the mainland coast. These soils were classified as Sapric Sulfiwassists, Thapto-histic Sulfiwassents, or Typic Sulfiwassents depending on the thickness of the overlying estuarine soil material. In general, buried horizons occurred at shallower depths in profiles closer to the mainland and at greater depths when the pedon was located farther from the shoreline. This relationship was explored further by making two transects from the mainland coast into the adjacent marshes. The transects are shown in Figures 5-2 and 5-3.

During the Pleistocene glaciation the sea level was over 100 m shallower than at present (Biggs, 1973). At the end of the Pleistocene as glaciers began to melt and recede, sea levels began to rise and caused submergence of coastlines. The rates of sea level rise during the early to mid Holocene (12,000 to 4,000 yr BP) was rapid (Bloom and Stuvier, 1963), but the rate of sea level rise began to slow to a rate of approximately 1 mm yr^{-1} (Redfield and Rubin, 1962), which allowed colonization of the tidal mud flats by salt tolerant vegetation (Bloom and Stuvier, 1963; Redfield, 1972). Therefore, it was likely that the tidal marshes along the mainland side of Chincoteague Bay began to form around 4,000 to 5,000 yr BP. These marshes grow and function at or near sea level and the thickness of the accumulated organic horizons were dependent on sea level rise and the associated marsh accretion. If for some reason the marsh failed to keep up with sea level rise, it became permanently

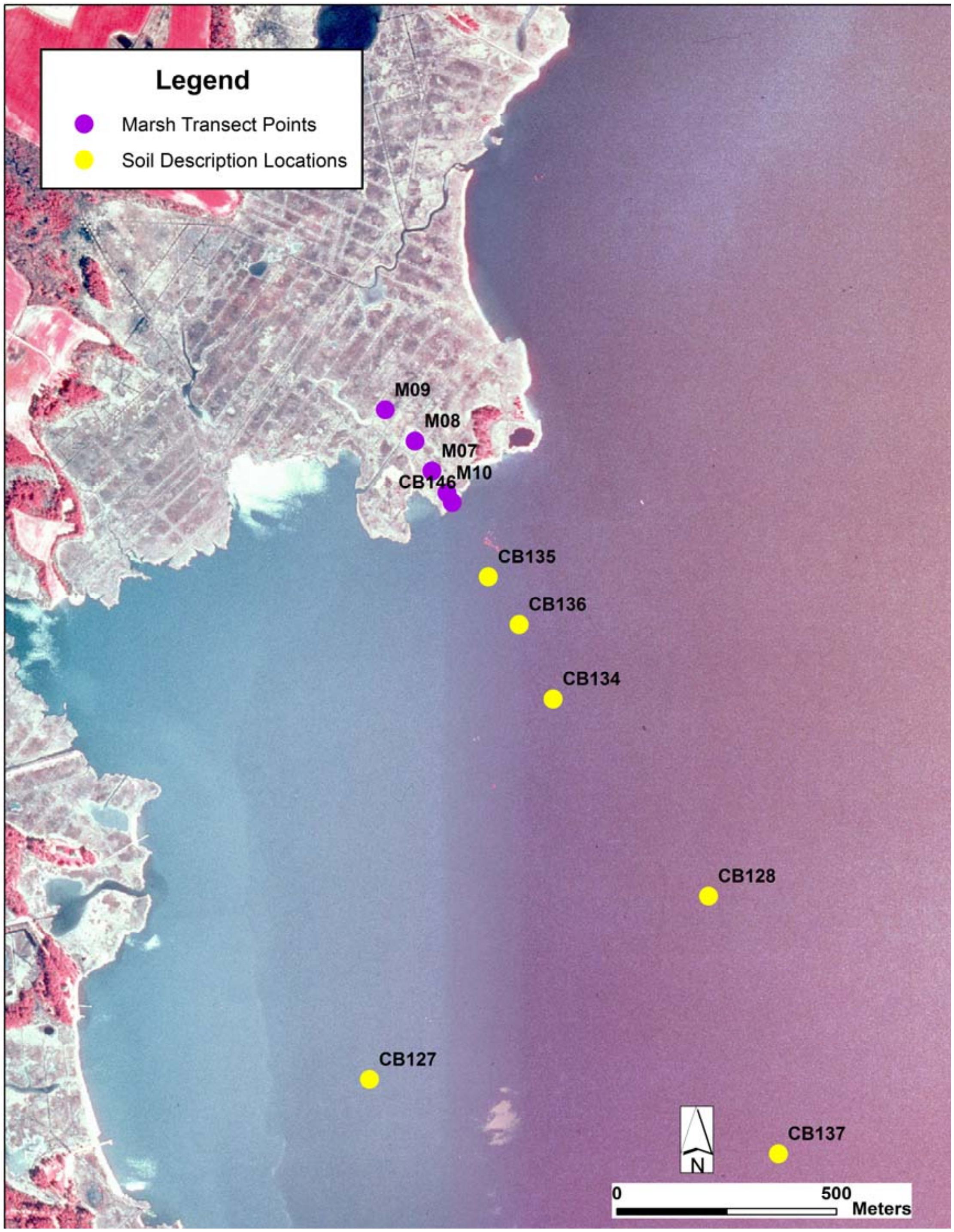

Figure 5-2. Location of described pedons located along transect 1 from the adjacent tidal marsh into Chincoteague Bay.

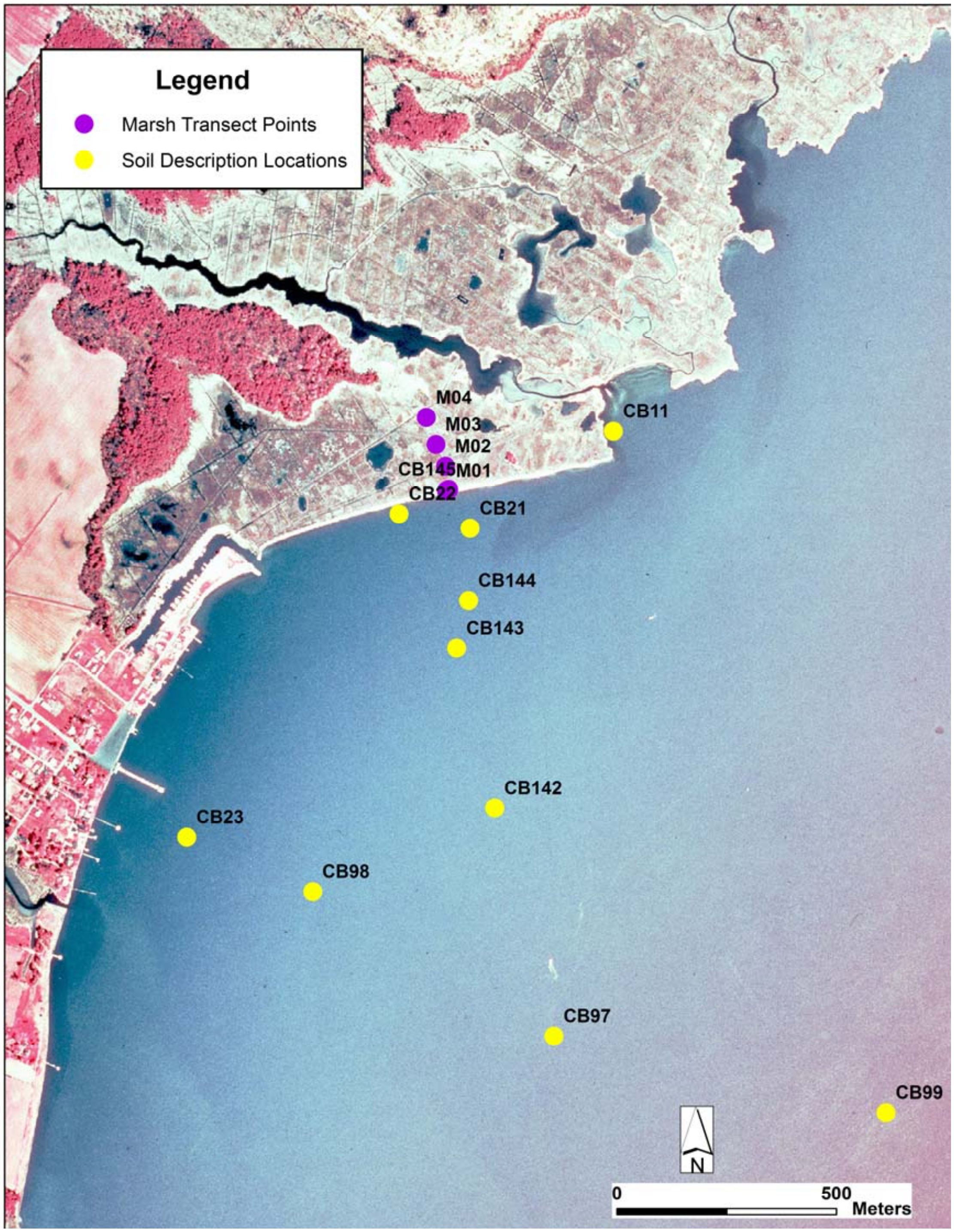

Figure 5-3. Location of described pedons located along transect 2 from the adjacent tidal marsh into Chincoteague Bay.

inundated and submerged. The marsh surfaces found buried within the soils along mainland side of the bay were the result of marsh submergence due to sea level rise. The radiocarbon in the buried marsh horizons reflects the date when those horizons were at or near sea level. Therefore, by obtaining radiocarbon age and elevation of the buried marsh surfaces we could estimate rates of average sea level rise during the intervening period. However, in these marsh ecosystems, organic matter has been altered over time due to decomposition and compression under its own weight causing consolidation of the layers and increases in bulk density (Kearney and Ward, 1986). The autocompaction of the deeper organic-rich layers shifts downward from the original position of the organic horizon leading to apparent higher rates of marsh accretion or erroneous high values of sea level rise (Craft and Richardson, 1998). This can be avoided by selecting basal peat samples that are collected above dense, low n value, submerged mineral soil surfaces (Hussein et al., 2004). With the depth of the organic horizons being deeper than their original position, the calculated average sea level rise rates would be higher than values based on basal peat radiocarbon dates.

Carbon-14 dates from five buried organic horizons are reported in Table 5-6. Dates were obtained from samples collected along transects described earlier and are shown in Figures 5-4 and 5-5. Based on the carbon age and the elevation of the current marsh surface the average rate of sea level rise in the intervening period ranged from 1.24 to 1.55 mm yr^{-1}. These rates were similar to the rates of relative sea level rise of 2.0 to 4.0 mm yr^{-1} reported by others for the Chesapeake Bay region (Hick et al., 1983; Rabenhorst and Griffin, 1989). Using a date collected by Demas (1998) from a wood sample in an organic horizon located in the deep mainland cove

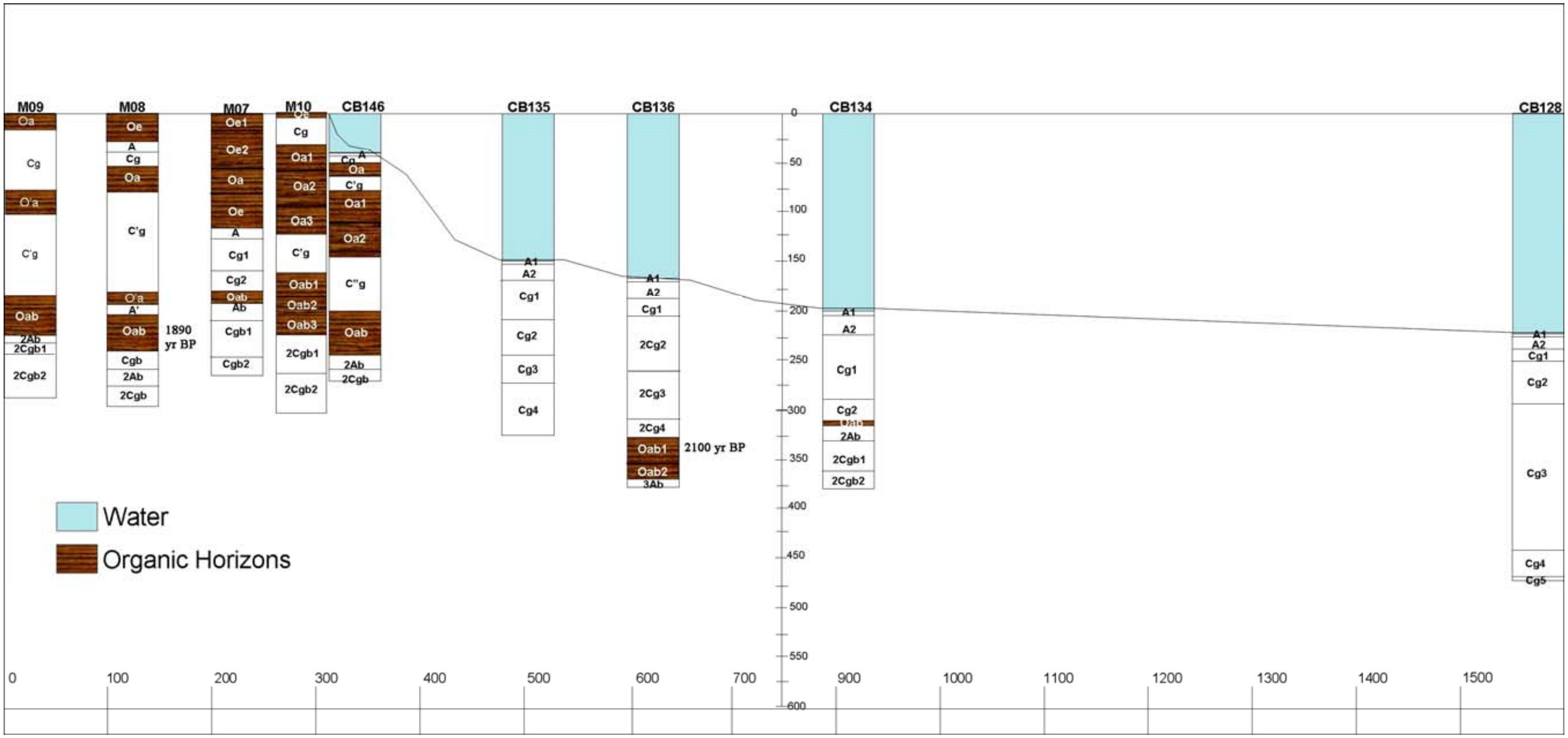

Figure 5-4. Soil profiles described on transect 1. Carbon-14 dates for two buried organic horizons.

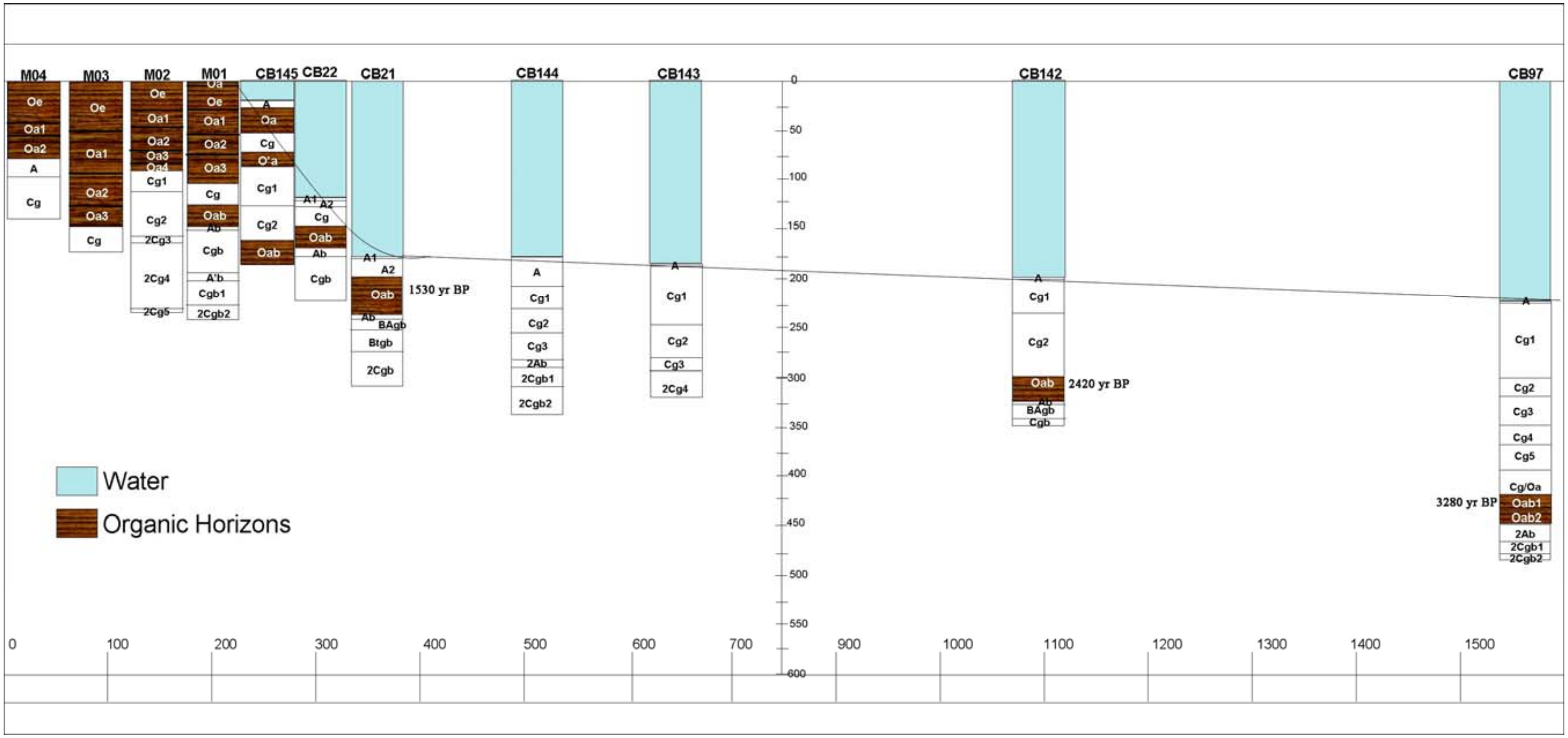

Figure 5-5. Soil profiles described on transect 2. Carbon-14 dates for three buried organic horizons.

landform (Table 5-5), the calculated average sea level rise rate was 1.8 mm yr^{-1}, which (was slightly greater than the rates obtained from our study but was still within in the range of rates reported for the Mid-Atlantic region. Two dates collected by Hussein (1996) in Hell Hook Marsh (Dorchester County), MD, from estuarine peat samples (Table 5-6) provided rates of 1.44 to 1.52 mm yr^{-1}, which were also similar to rates obtained from our study. However, these samples were not basal peats and therefore had likely undergone autocompaction, which may generate higher rates of sea level rise. In contrast, rates collected from a series of basal peats in Hell Hook Marsh and Cedar Creek Marsh (Dorchester County), MD, yielded average rates of sea level rise over the last 2000 years of 0.5 to 1.0 mm per year (Hussein et al., 2004).

Soil Map Unit Composition and Variability

A soil map unit is a collection of areas (delineations) that contain the same soil components (Soil Survey Division Staff, 1993). A soil map unit is usually named for the dominant component (soil series), but it also contains other soil components that are included in the map unit due to the scale of mapping and the natural variability within the map unit (Soil Survey Division Staff, 1993).

Thirteen soil map units were designated for the study area and are listed in Table 5-7. The soil map unit symbol consists of two letters that represent the dominant soil series (used in the map unit name) followed by a Greek symbol indicating the depth of water (at mean sea level). The water depth classes used for the map unit symbol are as follows: α is 0.2 to 1.0 m; β is 1.0 to 1.5 m; γ is 1.5 to 2.0 m; δ is 2.0 to 2.5 m. The map name includes the dominant soil series for which the unit is named, the dominant surface texture, and the range of water depths located in the unit. The surface textures of the 146

Table 5-6. Carbon-14 dates for four buried organic horizons located in Chincoteague Bay, one buried organic horizon located in an adjacent tidal marsh area, one wood fragment from adjacent Sinepuxent Bay, MD (Demas and Rabenhorst, 1999), and two peats from Hell Hook Marsh and Cedar Creek Marsh (Dorchester County), MD (Hussein, 1996). Average sea level rise rates were also calculated for these horizons.

Pedon	**Sample**	**Water Depth (MSL) (mm)**	**Depth Below Soil Surface (mm)**	**Total Depth Below MSL (mm)**	**Age (B.P.)**	**Long-Term Average Sea Level Rise (mm yr^{-1})**
CB21	Oab	1730	180	1910	1530±60	1.25
CB97	Oab1	2200	1950	4150	3280±70	1.27
CB136	Oab1	1650	1610	3260	2100±50	1.55
CB142	Oab	2000	1000	3000	2420±60	1.24
M08	Oab	NA	2030	NA	1890±50	1.07
Demas (1999)	Wood Fragment	1000	1500	2500	1430±60	1.80
Hussein (1996)	Peat	NA	2500	NA	1740	1.44
Hussein (1996)	Peat	NA	3030	NA	2000	1.52

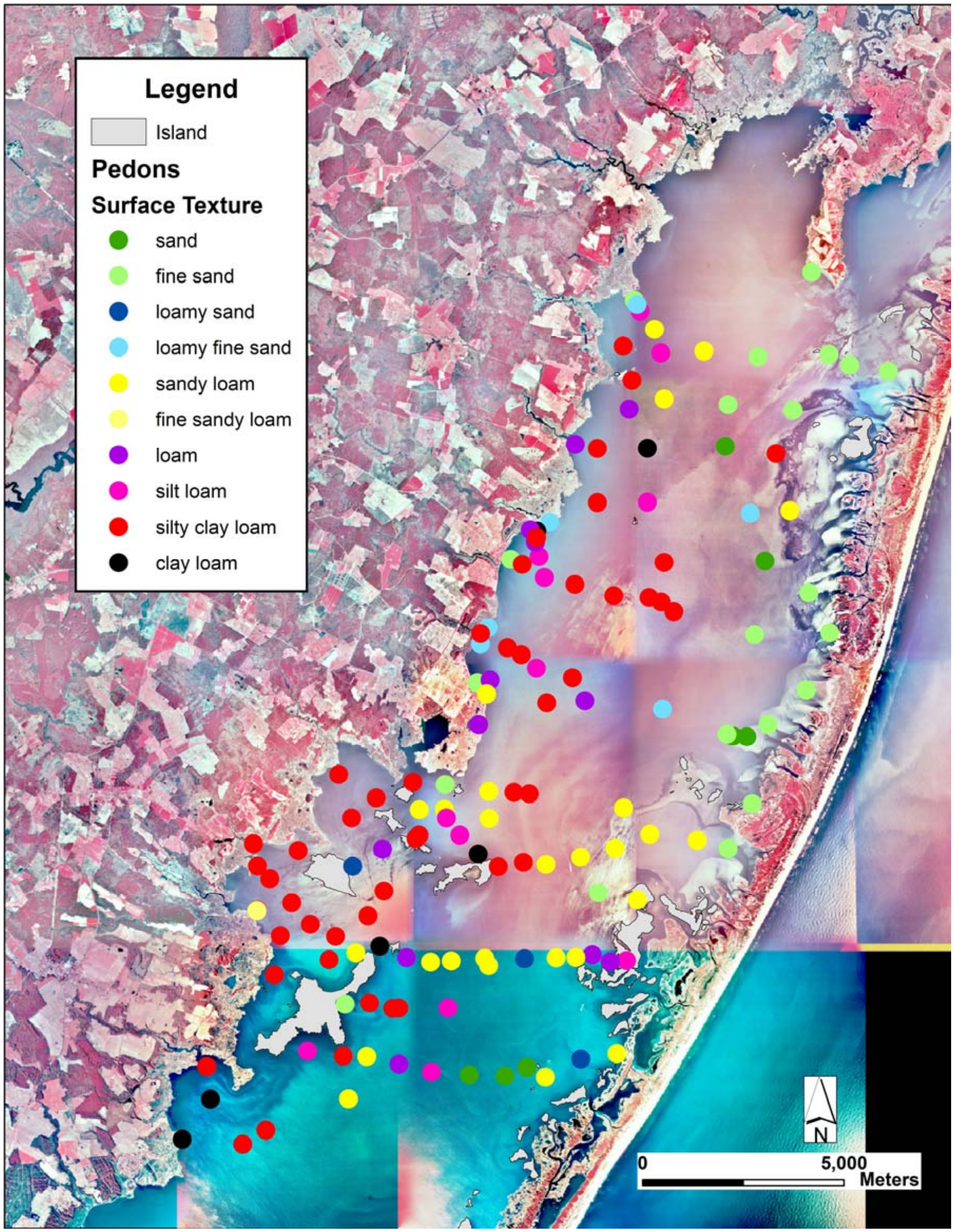

Figure 5-6. Surface textures of soil profiles described in Chincoteague Bay.

soil pedons described in Chincoteague Bay are shown in Figure 5-6. The soil map unit delineations are presented in Figure 5-7. The composition of each of the 13 soil map units is presented in Table 5-8. The location of pedons classified to the family level of *Soil Taxonomy* and their corresponding soil map units are shown in Figure 5-8. The location of pedons classified to the series level of *Soil Taxonomy* and their corresponding map units are shown in Figure 5-9. Below is a short narrative description of each of the 13 subaqueous soil map units used in Chincoteague Bay.

Coards silty clay loam, 1.0 to 1.5 m MSL (Coβ) – This unit consists of very deep, very poorly drained soils that are permanently submerged below 1.0 to 1.5 m of water (MSL). These soils occur on the fluviomarine bottom in the southeastern portion of the bay. They formed in mixed fluvial and lagoonal sediments. The Coards and similar soils (80%) are finer textured (SiCL or CL), moderately to very fluid (n values > or >> 1), with moderately high organic carbon levels and sulfidic materials. Contrasting soils (20%) are loamy textured soils, soils with buried organic horizons deeper than 100 cm below the soil surface (located mainly at the eastern edge near a marsh island), or are coarse textured soils that contain redoximorphic features within the upper 100 cm of the soil surface.

Cottman sand, 1.5 to 2.0 m MSL (Ctγ) – This unit consists of deep, very poorly drained soils that are permanently submerged below 1.5 to 2.0 m of water (MSL). These soils occur on the barrier island side of the lagoon bottom. They formed in mixed lagoonal and barrier island dune sediments. The Cottman and similar soils are coarse textured (sandy loams, loamy sands, and sands), that are non-fluid (n values <0.7) or slightly fluid (n values from 0.7 to 1), with moderately low organic carbon contents and

Table 5-7. Subaqueous Soil Mapping Legend for Chincoteague Bay, Maryland.

Map Unit Symbol	**Map Unit Name**
Coβ [†]	Coards silty clay loam, 1.0 to 1.5 m depth
Ctγ	Cottman sand, 1.5 to 2.0 m depth
Deα	Demas fine sand, 0.2 to 1.0 m depth
Deβ	Demas fine sand, 1.0 to 1.5 m depth
Dmβ	Demas sandy loam, 1.0 to 1.5 m depth
Mmα	Middlemoor sandy loam, 0.2 to 1.0 m depth
Mmβ	Middlemoor sandy loam, 1.0 to 1.5 m depth
Siβ	Sinepuxent loam, 1.0 to 1.5 m depth
Spβ	Southpoint silty clay loam, 1.0 to 1.5 m depth
Tgβ	Tingles silty clay loam, 1.0 to 1.5 m depth
Tgδ	Tingles silty clay loam, 2.0 to 2.5 m depth
Thβ	Thorofare sandy loam, 1.0 to 1.5 m depth
Trα	Truitt silty clay loam, 0.2 to 1.0 m depth

[†] Water depth symbols: α- 0.2 to 1.0 m below MSL; β- 1.0 to 1.5 m below MSL; γ- 1.5 to 2.0 m below MSL; and δ- 2.0 to 2.5 m below MSL.

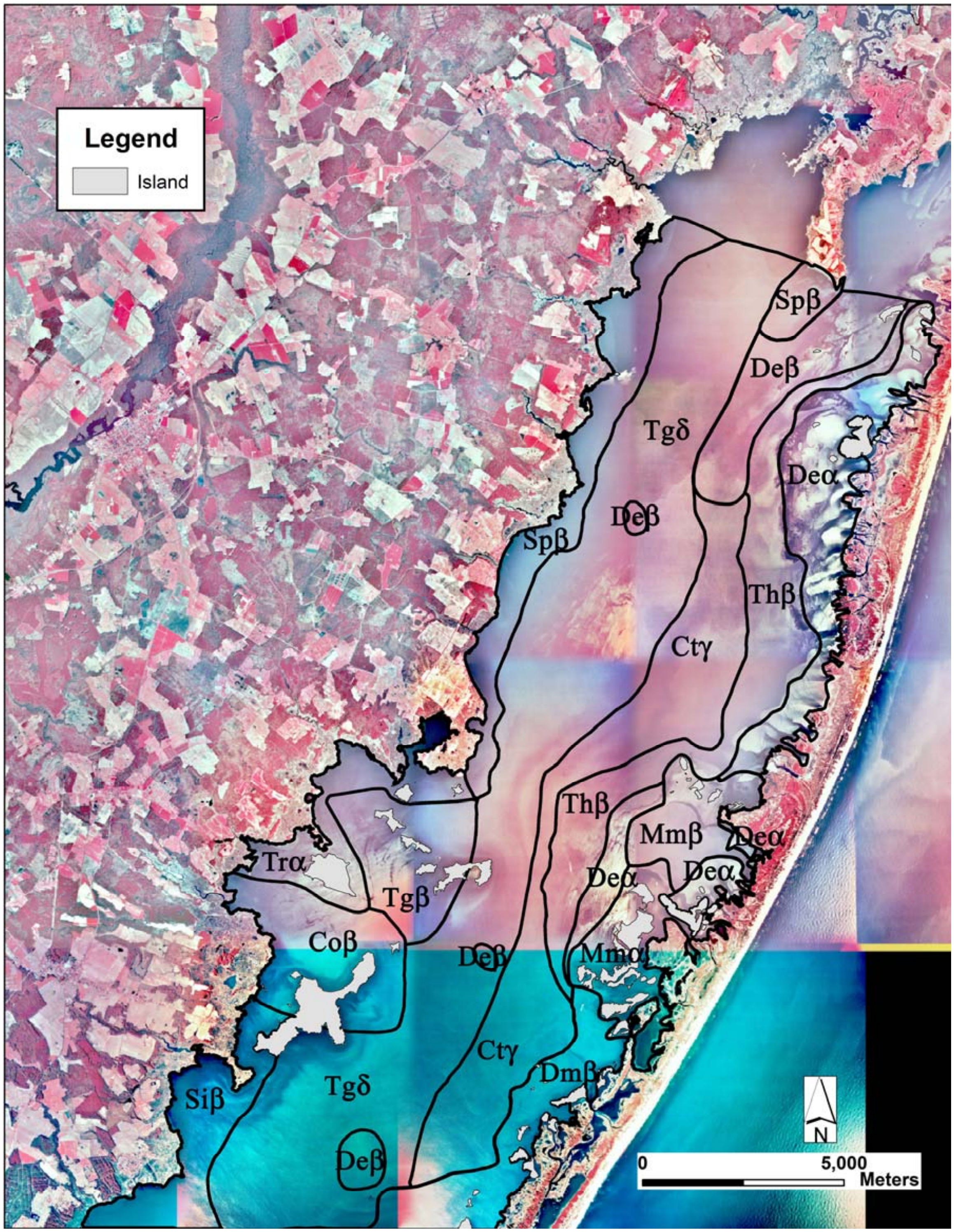

Figure 5-7. Subaqueous soil map of Chincoteague Bay. The legend for this map is given in Table 5-7.

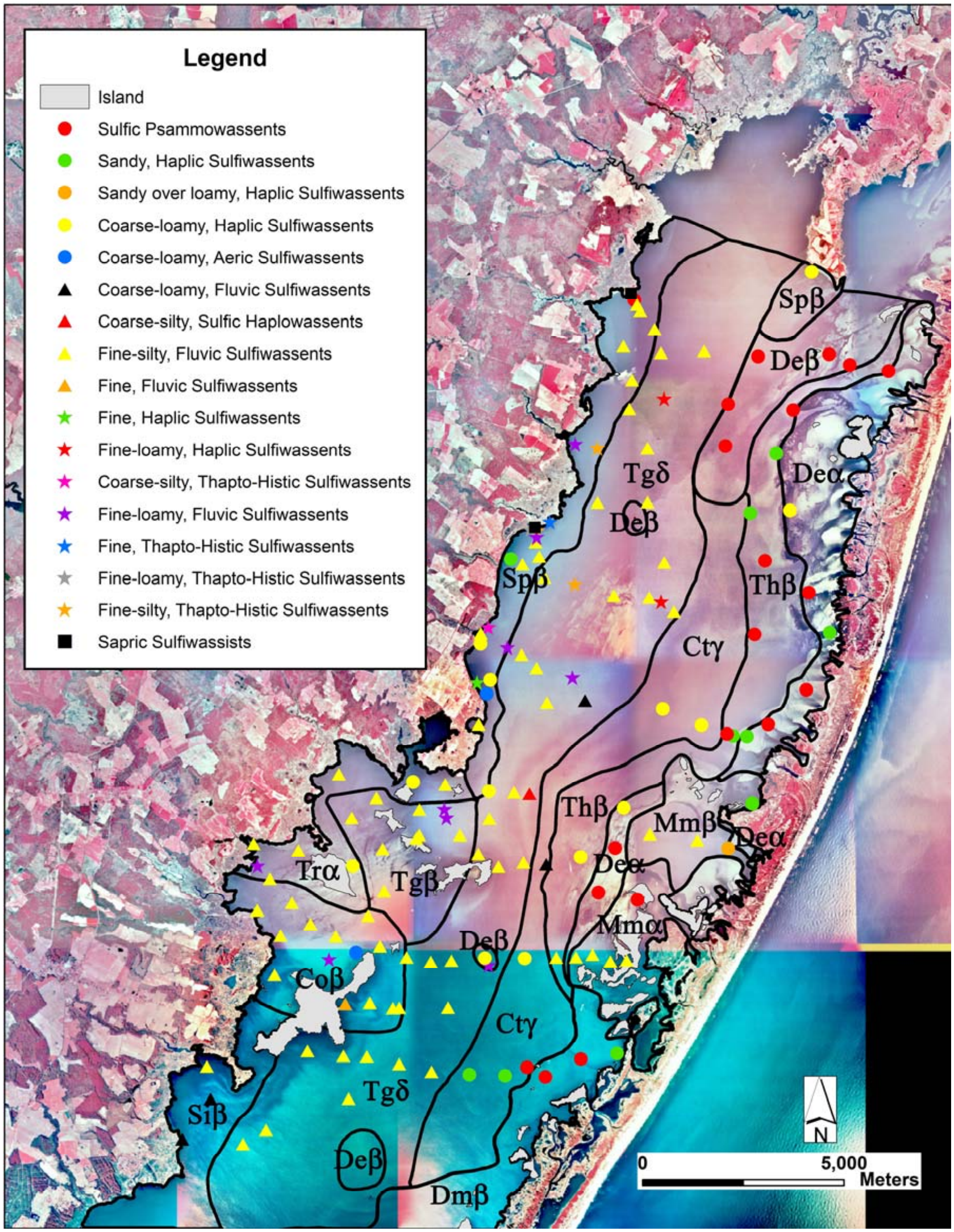

Figure 5-8. Location map of described pedons classified to the family level of *Soil Taxonomy* and the corresponding soil map units.

Table 5-8. Soil taxonomic classifications and components of each of the 10 soil map units identified in Chincoteague Bay.

Map Unit	# Profiles (Total)	Series	# Observations (percentage)
Coβ	15	Coards†	11 (72%)
		Tingles†	1 (7%)
		Figgs	1 (7%)
		Truitt	1 (7%)
		Unnamed C	1 (7%)
Ctγ	7	Cottman†	3 (43%)
		Thorofare†	2 (29%)
		Demas†	1 (14%)
		Sinepuxent	1 (14%)
Deα	10	Demas†	5 (50%)
		Thorofare†	2 (20%)
		Cottman†	2 (20%)
		Tizzard	1 (10%)
Deβ	7	Demas†	5 (72%)
		Cottman†	1 (14%)
		Figgs	1 (14%)
Dmβ	3	Demas†	2 (67%)
		Thorofare†	1 (33%)
Mmα	5	Middlemoor†	2 (40%)
		Tingles†	2 (40%)
		Demas	1 (20%)
Mmβ	3	Middlemoor	2 (67%)
		Thorofare	1 (33%)
Siβ	3	Sinepuxent	2 (67%)
		Truitt	1 (33%)

† Indicates similar soils

Table 5-8. Continued.

Map Unit	**# Profiles (Total)**	**Series**	**# Observations (percentage)**
Spβ	28	Southpoint Tax. †	8 (29%)
		Southpoint†	1 (4%)
		Truitt†	4 (14%)
		Truitt Tax. †	1 (4%)
		Tumagan†	2 (7%)
		Tingles	4 (14%)
		Cottman	2 (7%)
		Figgs	2 (7%)
		Unnamed C	2 (7%)
		Middlemoor	1 (4%)
		Demas	1 (4%)
Tgβ	10	Tingles	8 (80%)
		Figgs	2 (20%)
Tgδ	37	Tingles†	25 (68%)
		Truitt	3 (8%)
		Truitt Tax.	2 (5%)
		Middlemoor†	3 (8%)
		Figgs	1 (3%)
		Sinepuxent	1 (3%)
		Southpoint	1 (3%)
		Unnamed B	1 (3%)
Thβ	10	Demas†	5 (50%)
		Thorofare†	3 (30%)
		Cottman†	1 (10%)
		Tingles	1 (10%)
Trα	8	Truitt†	1 (12.5%)
		Cottman	2 (25%)
		Coards	1 (12.5%)
		Figgs	1 (12.5%)
		Middlemoor	1 (12.5%)
		Southpoint Tax. †	1 (12.5%)
		Tingles	1 (12.5%)

† Indicates similar soils

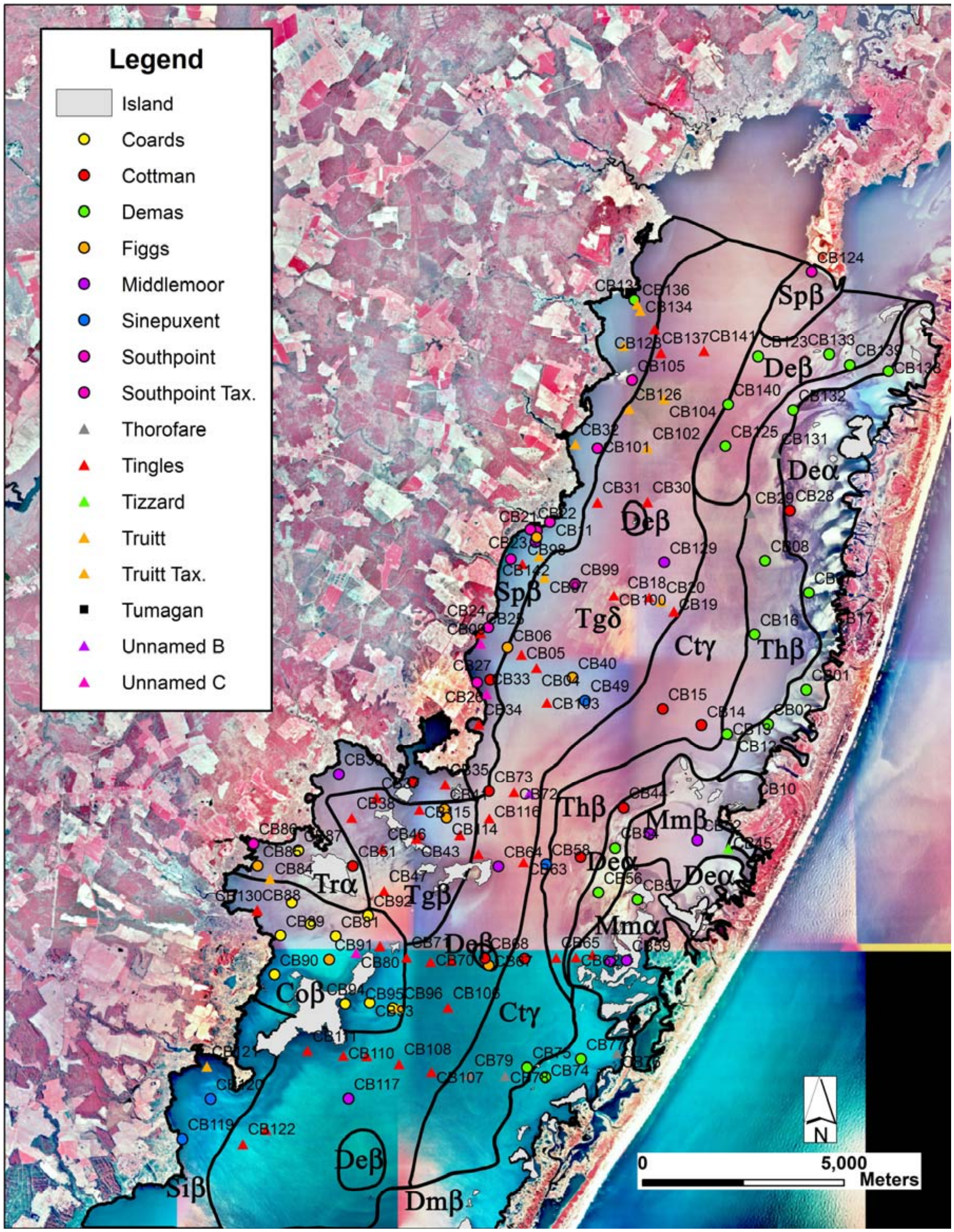

Figure 5-9. Location map of described pedons classified to the series level of *Soil Taxonomy* and the corresponding soil map units.

contain sulfidic materials.

Demas fine sand, 0.2 to 1.0 m MSL (Deα) – This unit consists of deep, very poorly drained soils that are permanently submerged below 0.2 to 1.0 m of water (MSL). These soils occur mainly on storm-surge washover fan flats. They formed in barrier island dune sediments. The Demas and similar soils are sandy, and non-fluid (n values <0.7), with low organic carbon contents and sulfidic materials. Contrasting soils (10%) are composed of sandy materials that overlay finer textured materials and are located on the edge near the barrier cove landform or in deeper scour channels within the fan flats.

Demas fine sand, 1.0 to 1.5 m MSL (Deβ) – This unit consists of deep, very poorly drained soils that are permanently submerged below 1.0 to 1.5 m of water (MSL). These soils occur mainly on dredged shoals. They formed in mixed lagoonal and barrier island dune sediments. The Demas and similar soils are sandy, and non-fluid (n values <0.7), with low organic carbon contents and sulfidic materials. Contrasting soils (14%) are located close to the lagoon bottom that formed from lagoonal sediments, and are finer textured throughout.

Demas sandy loam, 1.0 to 1.5 m MSL (Dmβ) – This unit consists of deep, very poorly drained soils that are permanently submerged below 1.0 to 1.5 m of water (MSL). These soils occur mainly on paleo-flood tidal deltas. These soils formed from sand-sized particles transported into the bay through a relict inlet overlain by recent barrier island dune sediments. Demas and similar soils are sandy, and non-fluid (n values <0.7), with low organic carbon contents and sulfidic materials.

Middlemoor sandy loam, 0.2 to 1.0 m MSL (Mmα) – This unit consists of deep, very poorly drained soils that are permanently submerged below 0.2 to 1.0 m of water (MSL). These soils occur in barrier coves. These soils formed from eroded marsh sediments and lagoonal sediments, which overlay relict flood tidal delta sediments. Middlemoor and similar soils (80%) are finer textured over coarser textured sediments, and are moderately fluid (n value > 1) within the control section, with moderately high organic carbon contents and sulfidic materials. These profiles may also have a cap of recent barrier island dune sediments, depending on their proximity to the barrier island. Contrasting soils (20%) are sandy throughout and are located near the barrier island, thus these profiles reflect a strong influence of the barrier island washover events.

Middlemoor sandy loam, 1.0 to 1.5 m MSL (Mmβ) – This unit consists of deep, very poorly drained soils that are permanently submerged below 1.0 to 1.5 m of water (MSL). These soils occur in barrier coves. These soils formed from eroded marsh sediments and lagoonal sediments, which overlay relict flood tidal delta sediments. Middlemoor and similar soils are finer textured (SiL, SiCL, or CL) over coarser textured sediments (fSL or LfS), and are moderately fluid (n value > 1) within the control section, with moderately high organic carbon contents and sulfidic materials. These profiles may also have a cap of recent barrier island dune sediments, depending on their proximity to the barrier island. Contrasting soils (33%) are sandy throughout and are located near the paleo-flood tidal delta, and thus these profiles reflected a strong influence of the barrier island washover events.

Sinepuxent loam, 1.0 to 1.5 m MSL (Siβ) – This unit consists of deep, very poorly drained soils that are permanently submerged below 1.0 to 1.5 m of water (MSL). These soils occur on mainland coves and submerged wave-cut headlands, in the southern portion of the bay. These soils formed in lagoonal sediments. Sinepuxent soils (67%) are loamy textured, and slightly fluid (n values > 0.7), with moderately low levels of organic carbon, and contain sulfidic materials. Contrasting soils (33%) are finer textured with buried organic horizons deeper than 100 cm below the soil surface located adjacent to the subaerial tidal marshes in the area.

Southpoint silty clay loam, 1.0 to 1.5 m MSL (Spβ) – This unit consists of very deep, very poorly drained soils that are permanently submerged below 1.0 to 1.5 m of water (MSL). These soils occur on mainland coves and submerged wave-cut headlands in the northern half of Chincoteague Bay. These soils formed from lagoonal sediments, relict marsh sediments, and upland subaerial soils. Southpoint and similar soils are finer textured (SiL, L, SiCL, or CL), and slightly fluid (n values > 0.7), contain sulfidic materials, and have buried organic horizons within the upper 100 cm of the soil surface. The origin of these organic horizons in these profiles is former emergent wetlands, especially tidal marshes, which were later submerged as a result of sea-level rise during the Holocene. Similar soils include profiles that have organic horizons located deeper than 100 cm of the soil surface and those profiles that have greater than 40 cm of organic materials. Contrasting soils (43%) are may be finer textured throughout the profile and do not contain buried organic horizons, loamy texture throughout the profile, coarse textured throughout the profile or coarse textured soils that contained redoximorphic features within the upper 100 cm of the soil surface.

Tingles silty clay loam, 1.0 to 1.5 m MSL (Tgβ) – This unit consists of very deep, very poorly drained soils that are permanently submerged below 1.0 to 1.5 m of water (MSL). These soils occur on the lagoon bottom and thus formed in lagoonal sediments. Tingles and similar soils (80%) are finer textured (SiCL or CL), and moderately fluid (n values >1), with high organic carbon contents and contained sulfidic materials within the soil profile. Contrasting soils (20%) are loamy, but are coarser textured.

Tingles silty clay loam, 2.0 to 2.5 m MSL (Tgδ) – This unit consists of very deep, very poorly drained soils that are permanently submerged below 2.0 to 2.5 m of water (MSL). These soils occur on the lagoon bottom and formed in lagoonal sediments. Tingles and similar soils are finer textured (SiCL or CL), and moderately fluid (n values >1), with high organic carbon contents and contain sulfidic materials. Contrasting soils (22%) are fine textured and have buried organic horizons deeper than 100 cm below the soil surface and are located on the mainland side of the lagoon bottom, soils that contain sulfidic materials deeper in the soil profile, or soils that are loamy textured.

Thorofare sandy loam, 1.0 to 1.5 m MSL (Thβ) – This unit consists of deep, very poorly drained soils that are permanently submerged below 1.0 to 1.5 m of water (MSL). These soils occur on the storm-surge washover fan slope and formed from mixed lagoon and barrier island dune sediments. Thorofare and similar soils are sandy (sandy loams, loamy sands, and sand), and non-fluid (n values <0.7) with moderately low organic carbon contents, and contain sulfidic materials. Contrasting soils (10%) are finer textured and are located near the barrier cove landform.

Truitt silty clay loam, 0.2 to 1.0 m MSL (Trα) – This unit consists of deep, very poorly drained soils that are permanently submerged below 0.2 to 1.0 m of water (MSL). These soils occur on the mainland coves and submerged wave-cut headlands in the Johnson Bay area. These soils formed from lagoonal sediments overlying buried organic horizons that formed at or near sea level when it was at a lower elevation. Truitt and similar soils (25%) are finer textured (SiCL or CL) and contain buried organic horizons deeper than 100 cm below the soil surface, are slightly fluid (n values >0.7) with moderately high organic carbon contents and contain sulfidic materials. Contrasting soils (75%) are finer textured and do not contain buried organic horizons, finer textured (SiCL or CL) over coarser textured soil (SL or LS), or loamy textured.

Discussion

In this study, one of our research objectives was to test the existing subaqueous soil-landscape models from other regions and determine their applicability in Chincoteague Bay. Soils occurring in the shallow, high-energy storm-surge washover fan flats were similar to those found in Ninigret Pond, RI. The soils were sandy (LfS, fS, S, or fSL), low n value, and contained sulfidic materials within the profile (Figure 5-11). However, in adjacent Sinepuxent Bay, MD, the soils on the same landforms were sandy, but sulfidic materials were not described in these profiles. Demas and Rabenhorst (1999) measured the percent chromium reducible sulfide for these soils and found it to be less than 0.1% and thus concluded that sulfidic materials were not present. They did not however, conduct moist incubations to see if the pH would drop as is required in *Soil Taxonomy*. Had this been done it is likely that the pH of these soils would have dropped below a pH 4, even though the sulfide minerals were present in low quantities because of the low buffering capacity and lack of carbonates. Therefore, sulfidic materials should have been described in these pedons and these soils would then be similar to those we described in adjacent Chincoteague Bay.

The soils occurring on the strongly sloping storm-surge washover fan slope were sandy (LfS, fS, S, or fSL), had low n values, and contained sulfidic materials within the profile (Figure 5-10). In Ninigret Pond, RI, the soils on the storm-surge washover fan slopes were very similar to those in Chincoteague Bay, but the pedons in Ninigret Pond contained buried A horizons and had an irregular C distribution with depth. In adjacent Sinepuxent Bay, MD, the most similar environment and landform was what Demas described as transitional zones. Although these soils were sandy throughout, they did not describe sulfidic materials within the pedons, perhaps for the same reasons sulfide materials were not described in the storm-surge washover fan flats.

The soils occurring on the deeper, low-energy lagoon bottom, were much like those described by Demas in adjacent Sinepuxent Bay, being finer textured (SiL, SiCL), high n value, and containing sulfidic materials within the profile (Figure 5-11). We noticed that some of the upper horizons in some soils on the barrier island side of the lagoon bottom in Chincoteague Bay were coarser textured and had lower n values where they appeared to have been influenced by materials from the barrier island (Figure 5-11). This had not been recognized in previous studies, although some of the areas Demas (1998) referred to as the transition zones of Sinepuxent Bay, MD, did contain similar soils with sandy over finer textured lagoon bottom sediments. In Taunton Bay, ME the fluvial marine bottom is located in the central portion of the bay and is most similar to what we described as a lagoon bottom. Soils on this landform were also finer textured and contained sulfidic materials making them much like the soils of the lagoon bottom in Chincoteague Bay. In Taunton Bay the fluvial marine bottom is adjacent to the channel shoulder landform. Soils on this landform were also finer textured, but the presence of

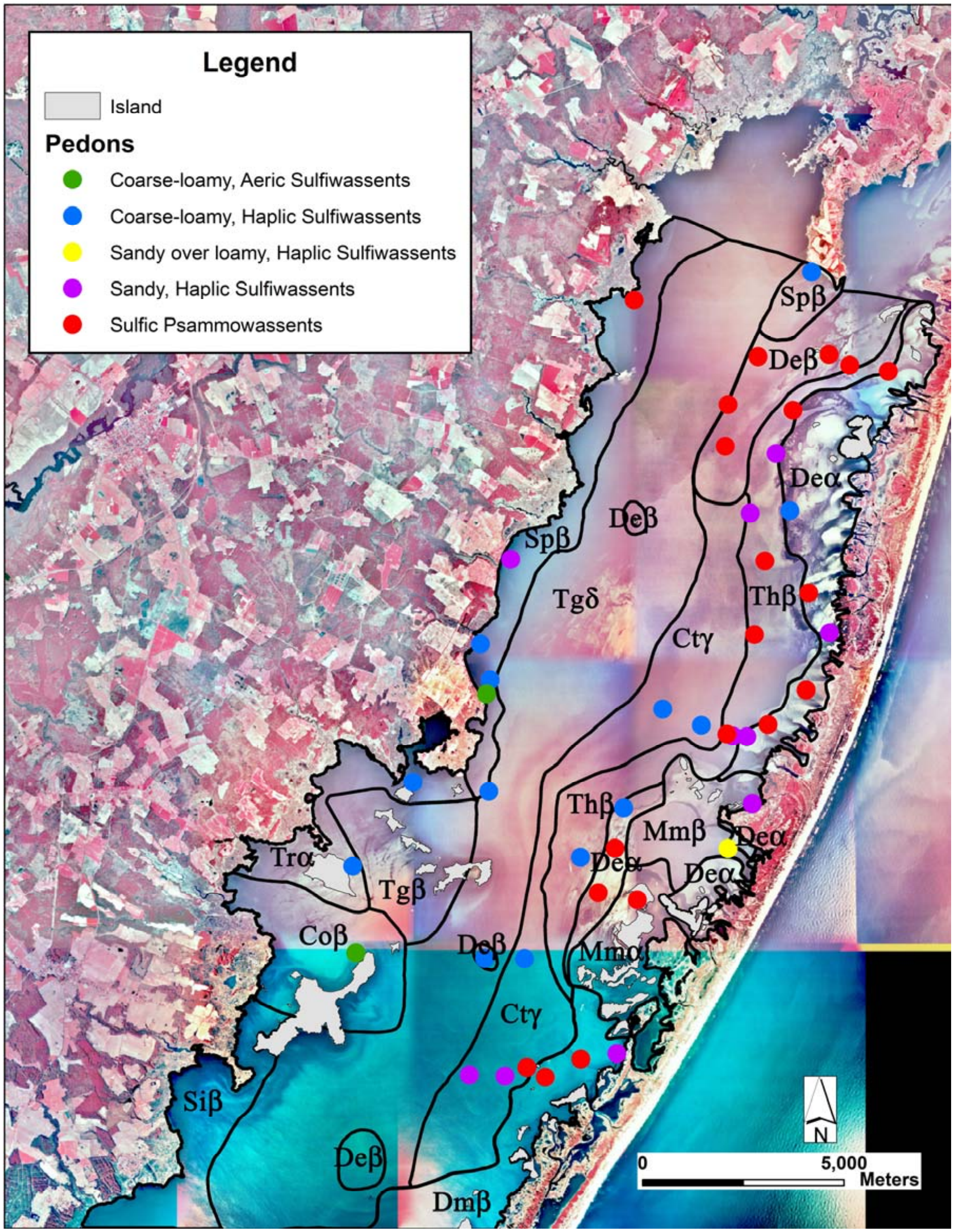

Figure 5-10. Pedons composed of sandy materials and the corresponding map units.

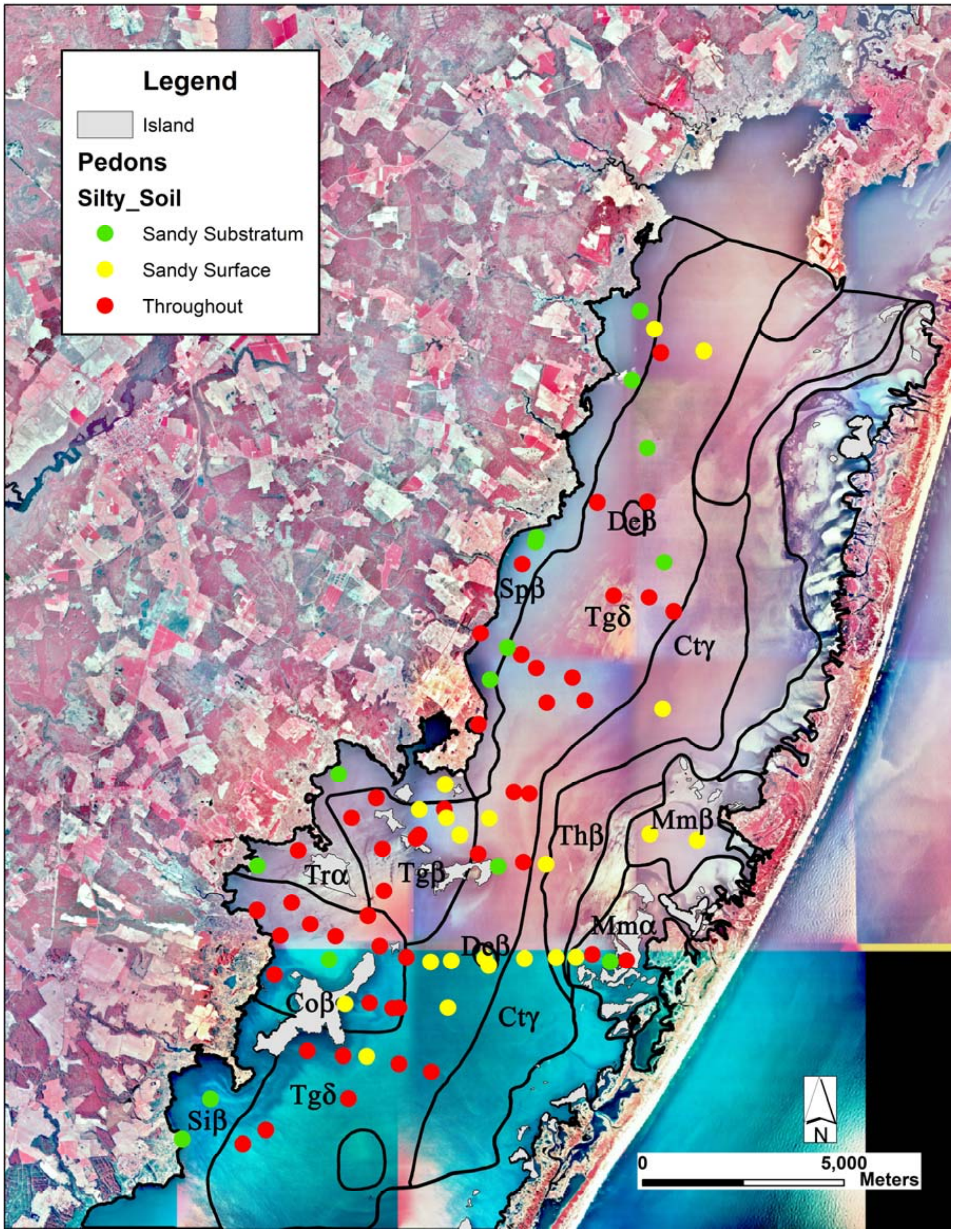

Figure 5-11. Pedons composed of silty textures throughout (SiCL, SiL, or CL), pedons with coarser textured materials in the substratum, and pedons with a sandy surface horizons and the corresponding map units.

sulfidic materials was not consistent throughout the landform. They reported that areas of soil that had a vegetative cover of eelgrass (densities >50%) did not contain sulfidic materials, whereas areas with little (< 50%) or no eelgrass cover did contain sulfidic materials in the profile. In Ninigret Pond, RI, the soils of the lagoon bottom were similar to the channel shoulder soils described in Taunton Bay, ME, being fine textured, covered by eelgrass beds, and absent of sulfidic materials.

It has been suggested by Osher and Flannagan (2007) that the presence or absence of vegetative cover controls the sulfur chemistry in these soils. Both the lagoon bottom of Ninigret Pond, RI, and channel shoulder of Taunton Bay, ME, are low-energy environments that should possess that ideal set of combination of properties to facilitate sulfide mineral formation, namely an anaerobic environment, a source of sulfate, fresh organic matter in the form of eelgrass detritus, an iron source (as iron oxides sorbed to fine textured mineral sediments), and sulfate reducing bacteria (Pons et al., 1982). An eelgrass vegetative cover on these soils does not seem to adequately explain the absence of sulfide bearing minerals in these environments. Eelgrass rhizomes have the ability to transport oxygen into the rhizosphere, which may oxidize sulfides to sulfates, but the rhizomes usually occur only in the upper 2 to 3 cm of the soil profile (Hansen and Lomstein, 1999). It is difficult to imagine how the oxygen transported by rhizomes could have any long term affect on soil materials deeper in the profile. Thus, this does not seem adequate to account for the lack of sulfides deeper in the soil profile. Bradley and Stolt (2001) documented sulfidic materials based on moist incubation pH data. They observed that after 120 days all of the samples showed a decline in pH (38 samples), but only one sample dropped below pH 4. These soils may have a higher buffering capacity than the sandy soils which could delay the pH drop, however, these soils contained small but measurable levels of $CaCO_3$ (1 to 20 g kg^{-1}), which was needed to keep the pH values remained around 7. It is possible that had the incubations continued for a longer period, the pH of some of these samples might have dropped below 4. Osher and Flannagan (2007) collected acid volatile sulfide data (using the method described by Cline (1969) and Ulrich et al. (1997)) in horizons to a depth of 35 cm and their data indicates the presence of monosulfides in the upper horizons (to a depth of 50 cm), but they did not indicate whether pedons were vegetated.

The soils in Chincoteague Bay that were adjacent to the mainland were described in mainland cove and submerged headland landscape units and were placed into three different map units, but they generally bore certain similarities. In particular, they were finer textured (SiL, L, CL, or SiCL), contained sulfidic materials, and possessed buried organic horizons within the soil profile. The presence of the buried organic horizons was captured in the Southpoint, Truitt, and Tumagan series concepts, all of which contain buried organic horizons within the profile (Figure 5-12). The Southpoint soils have buried organic horizons within 100 cm of the soil surface that are at least 20 cm thick, whereas, the Truitt soils have a buried organic horizon occurring deeper than a meter and which must be at least 5 cm thick. Tumagan soils are Histosols and thus have organic horizons that comprise at least 40 of the upper 80 cm of the soil. We observed that the organic horizons often tend to become thinner and denser the deeper they are found in the profile. This phenomenon may be due to decomposition or the compaction caused by the weight of the overlying horizons and water. These buried organic horizons are located at the shallowest depths closest to the mainland shore and are found deeper in the soil

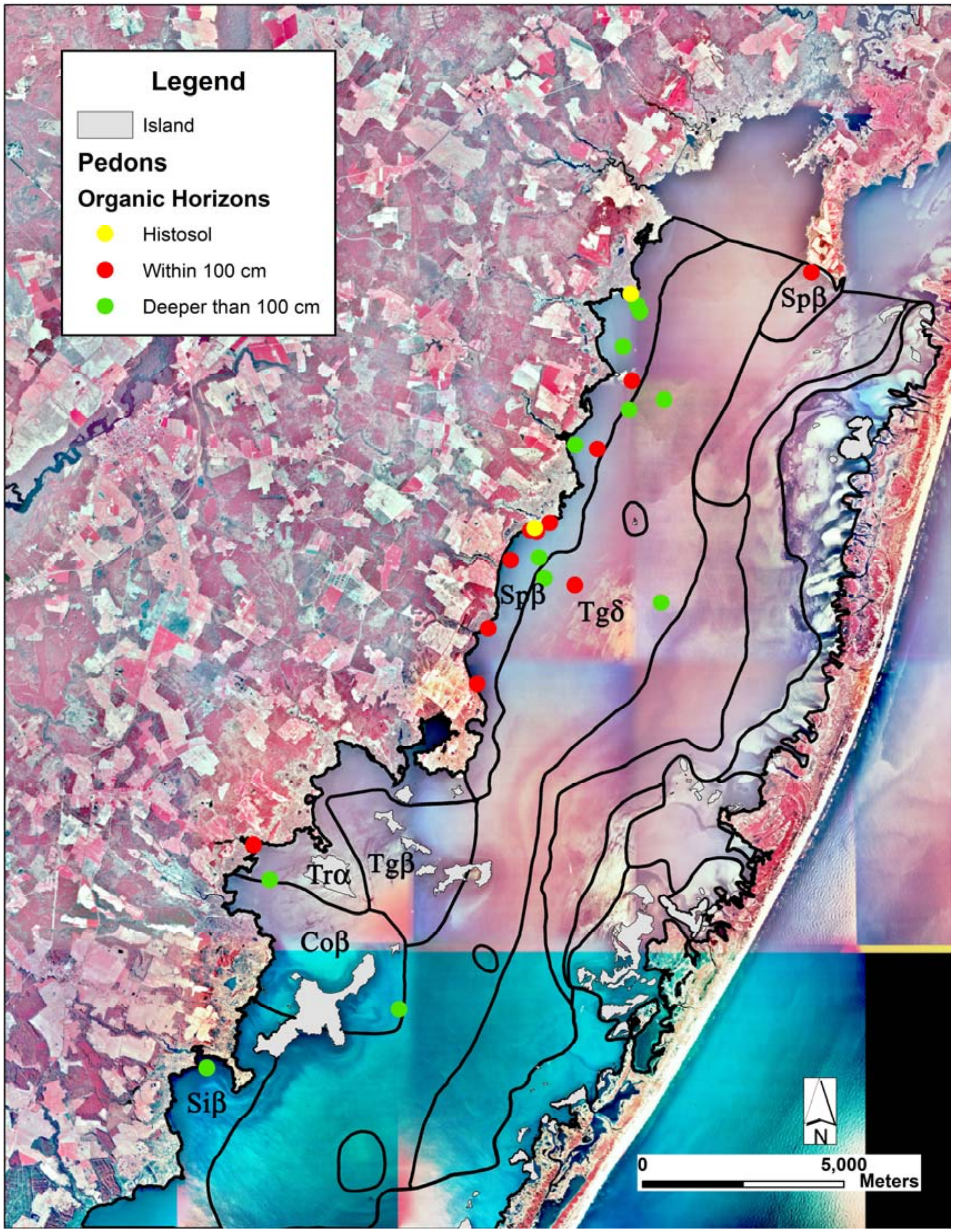

Figure 5-12. Location of pedons in Chincoteague Bay that were shallow organic soils (Histosols, Tumagan series), or that contained organic horizons within 100 cm of the soil surface (Thapto-Histic, Southpoint series), or organic horizons deeper than 100 cm (Typic, Truitt series).

profile with increasing distance from the shoreline, extending into the lagoon bottom landform. The depth of the buried organic horizon and the distance below MSL were used in conjunction with the ^{14}C dates to determine when these horizons were at sea level. The dates indicate that buried organic horizons closest to the current shoreline are the youngest, whereas the horizons farthest from the shoreline were the oldest. Therefore, I believe these horizons represent intact portions of a larger tidal marsh system that became submerged overtime due to sea level rise, rather than organic fragments collecting in these low-energy environments due to wave erosion of adjacent tidal marsh areas. In adjacent Sinepuxent Bay, MD, deep mainland coves contained soils similar to those described on the mainland cove and submerged headland landscape units. Soils on the deep mainland coves were fine textured (SiL or SiCL), contained sulfidic materials, and buried organic horizons within the upper 100 cm of the soil surface. However, in Ninigret Pond, RI, mainland cove soils were loamy textured (SiL, fSL, or LS) and contained organic horizons within the upper 100 cm of the soil surface, but apparently did not contain sulfidic materials (identified using moist incubations). Osher and Flannagan (2007) described soils on the terrestrial edge located in the intertidal regions that were most similar to what we described on the mainland side of the lagoon bottom. Soils in the submerged marsh unit located on the terrestrial edge are fine textured (SiCL), contain sulfidic materials, and have buried organic horizons located deeper than 100 cm below the soil surface.

The soils occurring in the low-energy barrier coves were finer textured in the upper horizons overlying coarser materials at depth and contained sulfidic materials within the profile. In adjacent Sinepuxent Bay, MD, the most similar environments and landforms are what Demas (1998) described as the barrier island flats. These soils were coarse textured with an irregular organic C distribution and had sulfidic materials within the profile. Bradley and Stolt (2003) described soils located in the barrier coves which were similar to those we described in Chincoteague Bay, being finer textured overlying sand or gravel with sulfidic materials within the upper profile.

The soils occurring on dredged shoals were sandy and contained sulfidic materials in the profile. In adjacent Sinepuxent Bay, Demas described soils on a mid-bay shoal that were loamy, but coarser textured with sulfidic materials in the profile. These soils also contained buried A horizons that probably represented the original surface before the dredging activities. Bradley and Stolt (2003) described soils on shoals (island remnants) being sandy textured; however, these soils did not contain sulfidic materials as we found in Chincoteague Bay. In Taunton Bay, ME, the shoals that were described were not the result of dredging or eroded islands, but were created from the biological activity of mussels. The soils were different from those we described in Chincoteague Bay being that they were silty textured (less than 8% clay), had very shelly surface horizons (containing greater than 60% shells), but nevertheless contained horizons within the upper portion of the profile that met the qualifications for sulfidic materials (Osher and Flannagan, 2007).

The soils occurring in the fluviomarine bottom in Chincoteague Bay were much like those first described by Coppock et al. (2004) in Rehoboth Bay, DE. These soils formed in areas where fresh water inputs collided with brackish water, which caused flocculation of the suspended fraction (Aston, 1980). This process of flocculation and settling created soils that were finer textured, very fluid (n values > or >>1), and contained sulfidic materials within the profile. Nothing comparable to this landform was described other than Coppock et al. (2004).

The soils occurring on the shallow, high-energy paleo-flood tidal delta were unique to Chincoteague Bay. This study was the first to document soils occurring on the paleo-flood tidal delta landforms, although several studies have described the soils located on active flood-tidal delta flats (Bradley and Stolt, 2003; Coppock et al., 2004). The soils were sandy and contained sulfidic materials within the profile. In contrast, soils located on active flood-tidal delta flats are young, sandy soils that do not contain sulfidic materials due to the constant influx of oxygenated waters through the inlet and the instability of the soils and landforms themselves (Bradley and Stolt, 2003). Once the inlet closed, the flood-tidal delta flats age and sulfides begun to accumulate in the soils, due to the lack of oxygenated waters flushing through the sediments and greater stability of the landforms due to weaker currents.

The conceptual models developed in previous studies to describe the soil-landscape relations on mainland coves, barrier coves, storm-surge washover fan flats, and fluviomarine bottoms were useful in Chincoteague Bay in describing the distribution of subaqueous soils in Chincoteague Bay. The subaqueous soil-landscape model developed for the lagoon bottom by Demas (1998) was accurate so far as it went in describing the subaqueous soils of Chincoteague Bay, but was poorly documented with only a single pedon description but with no accompanying lab data. The work in Chincoteague Bay has enhanced this model making it more robust by adding a significant body of characterization data on these soils. We revised the model to better accommodate soils on the barrier island side of the lagoon bottom that are influenced by barrier island overwash during very strong storm events. The concepts developed by Demas (1998) for the transitional areas and by Bradley and Stolt (2003) for the storm-surge washover fan slopes did not accommodate the soils of Chincoteague Bay very well. Therefore we modified the model to reflect the presence of sulfidic materials. The model developed for shoals in previous studies has limitations in describing the soils located on shoals in Chincoteague Bay. Due to the nature of the shoals (or how they were created) it may not be possible to develop a more general model that will be accommodating for all coastal lagoons or estuaries. In Ninigret Pond, RI, the shoals were island remnants. The islands were eroded by waves and submerged by sea level rise. The soils located on these shoals are composed of primarily of upland soils rather than estuarine materials. In contrast, the shoals in Taunton Bay, ME, formed as a result of mussels growing on the fluvial marine terrace landscape surfaces. The soils of paleo-flood tidal delta landforms had not been previously described. Therefore, this was a new addition to concepts describing soil-landscape relationships on the barrier side of the coastal lagoon. The soils of submerged wave-cut headlands landform had not been previously described in other studies. These landforms are found adjacent to promontory areas located along the Chincoteague Bay coast and formed as a result of erosion and submergence due to sea level rise. The soils on these landforms were similar to those described in the adjacent mainland cove landscape units. Therefore, the model developed for the mainland coves accurately described the majority of the soils located on these landforms.

Conclusions

Several of the subaqueous-soil landscape models previously developed in other coastal lagoons and estuaries were substantially applicable in the large coastal lagoon, Chincoteague Bay. However, the subaqueous soil-landscape models developed for the lagoon bottom, storm-surge washover fan slopes, and shoals had limitations and needed to be enhanced to accommodate the soils described in Chincoteague Bay. We added to the existing models to include two additional subaqueous landforms that were not identified in previous studies. These were the paleo-flood tidal delta and submerged wave-cut headlands. Based on the subaqueous soil-landscape models, 13 subaqueous soil map units were identified in the construction of a soil map of Chincoteague Bay, Maryland, providing the first soil resource inventory for the largest of Maryland's coastal bays.

Chapter 6: Utilization of Subaqueous Soils Information for Assessing Submerged Aquatic Vegetation Habitat

Introduction

Submerged aquatic vegetation (SAV) performs a variety of important ecosystem services. They function as feeding sites for waterfowl, nurseries, and cover areas for juvenile shellfish and finfish. Their leaves provide a substrate for the attachment of eggs and organisms such as barnacles and polychaetes. Submerged aquatic vegetation also modifies soil geochemistry through photosynthesis, by releasing oxygen into the soil and through the cycling and uptake of nutrients (Batiuk et al., 2000). The health and abundance of plants that live in bay soils often are used as indicators of estuarine health (Stevenson et al., 1979; Wazniak and Hall, 2005), as plants require relatively clear water for photosynthesis.

In the 1970s decline of SAV beds in the Chesapeake Bay was documented, and the potential causes for that decline included disease, nutrient enrichment, high levels of suspended solids, low levels of dissolved oxygen, toxic contaminants, and decreased light availability. Following the loss of SAV beds, declines in waterfowl, rockfish, oyster, and crab populations were observed (Chesapeake Bay Program, 1991). Thus, research efforts were directed towards identifying the causes of SAV decline, and the Chesapeake Bay Program (1992) published a report concluding poor water quality was responsible.

Water Quality Parameters

Seagrass populations have been studied since the 1930s when the seagrass *Zostera marina* experienced a dramatic decline along the Atlantic coast (Short, 1987).

These studies have attempted to identify the environmental factors that influence seagrass populations. The primary cause for the loss of SAV in many estuaries and coastal lagoons has been related to the reduction in light availability (Kemp et al., 2004). Reductions in light availability have been linked to increased nutrient inputs, chlorophyll-a, and suspended sediments (Kemp et al., 1983; Batiuk, 1992). The processes responsible for the attenuation of light in estuaries that reduces its availability to SAV are shown in Figure 6-1. Dissolved inorganic nutrients (nitrogen and phosphorus) in the water column increase the growth of phytoplankton and algae which decreases the amount of light that reaches the SAV (Batiuk et al., 2000). The water quality parameters established for the Chesapeake Bay are presented in Table 6-1. As expressed in these factors, Kemp et al., (2004) estimated the minimum light for SAV survival required at the canopy height (percent light through water (PLW)) to be 22% and at the leaf surface (percent light at the leaf (PLL)) to be 15 to 9% for the polyhaline regions of Chesapeake Bay. Tides and waves change the water column height and increase the suspended solids through the resuspension of bottom sediments, which changes the light attenuation in the water column (Koch, 2001).

Several other factors have been implicated as factors controlling seagrass populations including water depth, availability of nutrients, toxic material, and sediment conditions (Short, 1987). However, the factors that affect the success and survival of seagrasses often are overlapping and it becomes difficult to evaluate these factors independently. The range in suitable water depths has largely been attributed to differences in light attenuation. The maximum depth of seagrass occurrence in these coastal waters is often determined based on maximum light attenuation in clear water, but

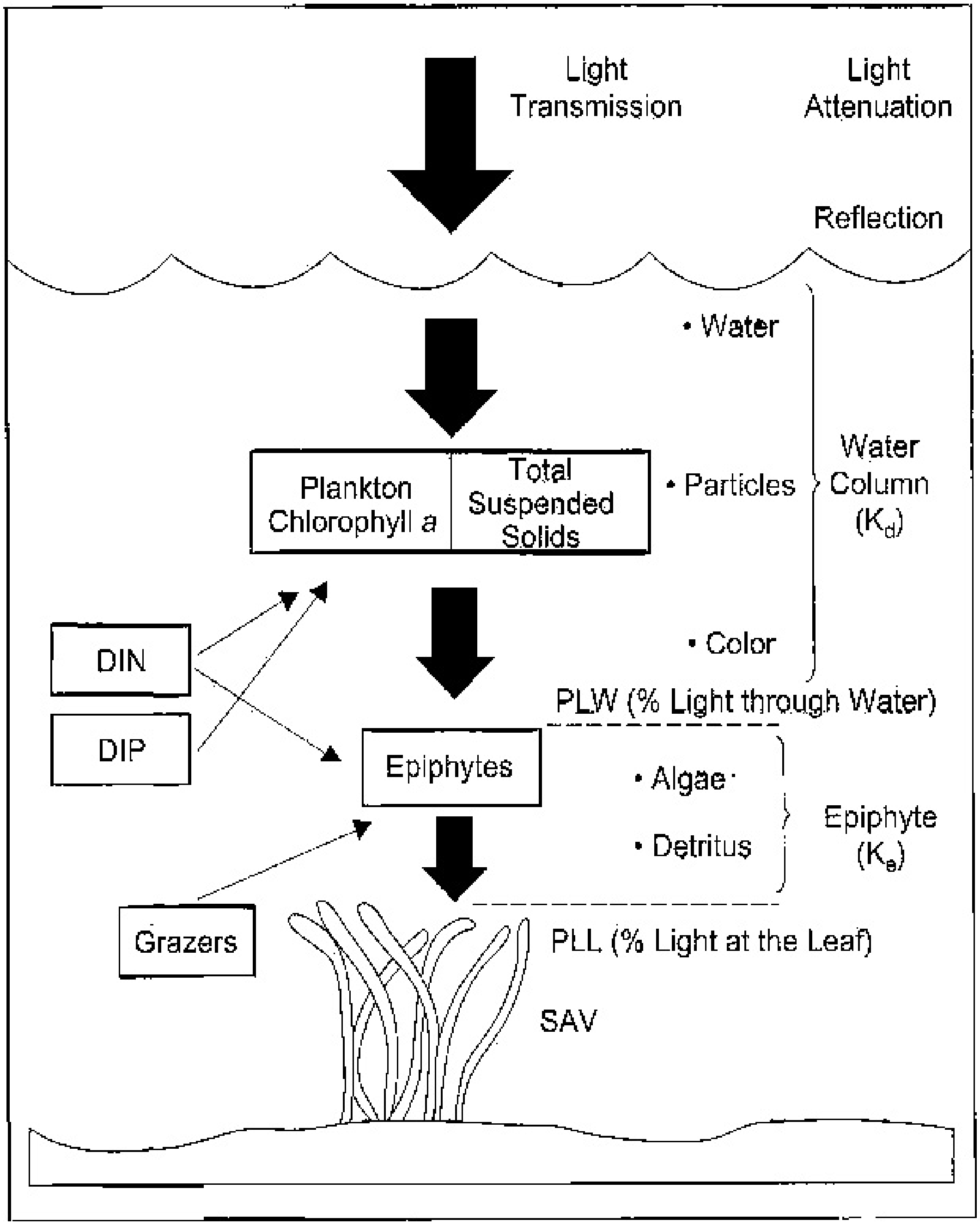

Figure 6-1. A conceptual model showing how the attenuation of light as it passes through the estuarine water column that reduces its availability for SAV to support photosynthesis (modified by Batiuk et al., 2000).

Table 6-1. Habitat recommendations for submerged aquatic vegetation growth and survival in the polyhaline portion of Chesapeake Bay developed by the Chesapeake Bay Program (modified from Batiuk, 2000).

Component	**Habitat Requirements**
Minimum Light Requirement	> 15%
Water Column Light Requirement	> 22%
Total Suspended Solids	< 15 mg l^{-1}
Plankton Chlorophyll-*a*	< 15 µg l^{-1}
Dissolved Inorganic Nitrogen	<0.15 mg l^{-1}
Dissolved Inorganic Phosphorus	<0.01 mg l^{-1}

microalgal blooms and turbidity will limit the depth that seagrasses will survive. Water depth also impacts the grain size composition of the sediments. In shallow, high-energy environments the sediments are often coarse textured and contain little to no fine materials and organic matter compared to deeper, low-energy settings that contain finer textured sediments high in organic matter. Therefore, the water depth influences the maximum depth seagrasses would grow, but is also dependent on the water quality parameters including chlorophyll-a and total suspended solids and the sediment composition.

Soil Parameters

In addition to water quality parameters several studies have begun to recognize soil characteristics as another important factor affecting seagrass distribution. Soils can impact the growth, morphology, and distribution of seagrasses due to erosional/ depositional processes, availability of nutrients, and presence or absence of phytotoxins. Several soil characteristics have been shown to impact the growth and success of SAV including high porewater sulfide concentration, high organic matter content, and grain size distribution. These factors are often correlated. An overview of these studies is presented in Table 6-2.

Hydrogen sulfide is a known phytotoxin to wetland macrophytes including *Spartina alterniflora, Spartina townsendii, Panicum hemitomon,* and rice plants (Koch and Mendelssohn, 1989; Goodman and Williams, 1961; Okajima and Takagi, 1953). In hydroponic experiments, Goodman and Williams (1961) demonstrated that the addition of 0.94 mM H_2S caused *Spartina townsendii* rhizomes to become 'soft rotted' and in similar studies, Koch and Mendelssohn (1989) demonstrated that the addition of 1.0 mM

Table 6-2. Summary of soil/sediment characteristics defining habitat constraints for submerged aquatic vegetation in fresh water and marine environments.

Sediment Characteristics	**Seagrass Type**	**Ecological Environment**	**Range where growing**	**Optimum Range**	**Limiting Range**	**Type of Research**	**Reference**
Sulfide concentrations	*Zostera marina*	Polyhaline	200 to >800 µM	<200 µM	>400 µM	Laboratory experiment in Chincoteague Bay, MD using mesocosms collected from Chincoteague Bay sediments and to treated to reduce or increase ambient sulfide levels to study the impact on photosynthesis	Goodman et al 1995
			<6.5 µM in porewater unvegetated sites 1.1 to 43 µM in porewater vegetated sites AVS and CRS 0.6 to 3.2µM cm^{-3} (0.02 to 0.5 g kg^{-1})			Field study in Roskilde Fjord, Denmark measuring biomass and sediment sampling.	Holmer and Nielsen 1997
			72.7 µM			Field study Roskilde Fjord, Denmark examining the effect of the addition of sucrose on sediment conditions.	Terrados et al. 1999
			< 5 g kg^{-1} Chromium reducible sulfides			Field study in Sinepuxent Bay, MD measuring biomass and soil types.	Demas 1998

Table 6-2. Continued.

Sediment Characteristics	Seagrass Type	Ecological Environment	Range where growing	Optimum Range	Limiting Range	Type of Research	Reference
Sulfide Concentrations	*Zostera marina*	Polyhaline	0.3 to 1.5 g kg^{-1} Acid volatile sulfides			Field study in Ninigret Pond, RI measuring biomass and soil types.	Bradley and Stolt 2006
				<100 µM	>400 µM	Compilation of data from literature, suggested values only.	Koch 2001
	Ruppia maritima		< 5 g kg^{-1} Chromium reducible sulfides			Field study in Sinepuxent Bay, MD measuring biomass and soil types.	Demas 1998
	Seagrasses				>200 µM	Review of literature.	Kemp et al. 2004
Organic Matter	*Zostera marina*		0.4 to 0.5 % organic matter			Field study in North Carolina measuring biomass and sediment sampling.	Fonseca and Bell 1998
			0.8 to 1.4 % organic matter			Field study in Chesapeake Bay measuring biomass and sediment sampling.	Orth 1977
			0.9 to 3.4 % organic carbon	<2 % organic carbon	>3 % organic carbon	Field study in Sinepuxent Bay, MD measuring biomass and soil types.	Demas 1998
			0.2 to 7 % organic carbon			Field study in Ninigret Pond, RI measuring biomass and soil types.	Bradley and Stolt 2006
			<4 % organic carbon			Observations made in Taunton Bay, ME during soil sampling.	Osher and Flannagan 2007

Table 6-2. Continued.

Sediment Characteristics	**Seagrass Type**	**Ecological Environment**	**Range where growing**	**Optimum Range**	**Limiting Range**	**Type of Research**	**Reference**
Organic Matter	*Ruppia maritima*	Polyhaline	0.9 to 3.4 % organic carbon	<2 % organic carbon	>3 % organic carbon	Field study in Sinepuxent Bay, MD measuring biomass and soil types.	Demas 1998
	Ruppia maritima	Mesohaline	<2 % organic matter			Field study in Chesapeake Bay examining suspended particulate material in vegetated areas.	Ward et al. 1984
	Halodule wrightii	Polyhaline	0.4 to 0.5 % organic matter			Field study in North Carolina measuring biomass and sediment sampling.	Fonseca and Bell 1998
	Seagrasses	Fresh water to polyhaline	0.8 to 16.4 % organic matter	<5 % organic matter	6.5 to 16.4 % organic matter	Compilation of data from literature, suggested values only.	Koch 2001
				<5 % organic matter	>5 %	Review of literature.	Kemp et al. 2004
Grain Size	*Zostera marina*	Polyhaline		Sandy substrates		Observational study in Chesapeake Bay, MD.	Hurley 1990
			Sand to sandy loam	Loamy sand	Silt loam Dense sands	Field study in Sinepuxent Bay, MD measuring biomass and soil types.	Demas 1998
			Coarse sand to silt loam	Very fine sandy loam to silt loam	Coarse sand to very fine sand	Field study in Ninigret Pond, RI measuring biomass and soil types.	Bradley and Stolt 2006
			5 to 11 % silt and clay			Field study in North Carolina measuring biomass and sediment sampling.	Fonseca and Bell 1998
			85 to 92% sand			Field study in Chesapeake Bay measuring biomass and sediment sampling.	Orth 1977

Table 6-2. Continued.

Sediment Characteristics	Seagrass Type	Ecological Environment	Range where growing	Optimum Range	Limiting Range	Type of Research	Reference
Grain Size	*Zostera marina*	Polyhaline	Silt loam			Observations made in Taunton Bay, ME during soil sampling.	Osher and Flannagan 2007
			Cobble free and < 70% silt/clay			Site selection model, Preliminary Transplant Suitability Index (PTSI) for identification of potential *Zostera marina* habitat in New Hampshire.	Short et al 2002
	Ruppia maritima		Silt/clay mixture to coarse sand	Fine to medium sand		Experimental using grain sizes of ground glass.	Seeliger and Koch (unpublished)
			Sand to sandy loam	Loamy sand	Silt loam Dense sands	Field study in Sinepuxent Bay, MD measuring biomass and soil types.	Demas 1998
	Halodule wrightii		5 to 11 % silt and clay			Field study in North Carolina measuring biomass and sediment sampling.	Fonseca and Bell 1998
	Seagrasses	Marine/ estuarine	0.4 to 72% silt and clay (<63 µm)	<20% silt and clay		Compilation of data from literature, suggested values only.	Koch 2001
			0.4 to 72% silt and clay (<63 µm)	<20 to 30% silt and clay (by weight)		Review of literature.	Kemp et al. 2004

H_2S resulted in lower biomass of marsh grass species *Spartina alterniflora* and *Panicum hemitomon*. Okajima and Takagi (1953) showed limited rice aboveground growth and root hair development in the presence of 1.0 mM H_2S. It has also been demonstrated that porewater sulfide is toxic to estuarine and marine SAV species. Elevated porewater sulfide levels may contribute to seagrass die-off in areas with extra stresses such as decreased light availability due to water column turbidity or shading by macroalgae or epiphytes (Lee and Dunton, 2000). Goodman et al. (1985) demonstrated that mesocosm sediments with sulfide concentrations between 100 and 200 μM had a negative impact on photosynthesis in *Zostera marina*. Measurements of porewater sulfides in estuarine systems were more difficult to obtain due to the ephemeral and transitory nature of soluble sulfide in these environments (Carlson et al., 1994). Sediment sulfide concentrations, as sulfide bearing minerals, can be used as a surrogate in estimating the concentration of soluble sulfide in estuarine/marine environments. It can be reasoned that sediments with higher soluble sulfide generation have an increased likelihood for sediment sulfide accumulation as monosulfides and disulfides. The concentration of solid phase sulfides in these sediments is less ephemeral and easily obtainable in these environments. Thus these data could be used to indicate the potential for sulfide toxicity. In Sinepuxent Bay, MD, where sediment sulfide concentrations were measured in areas with healthy *Zostera marina* and *Ruppia martima* beds the levels were less than 5 g kg^{-1} (Demas and Rabenhorst, 1999). These values were greater than concentrations measured by Bradley and Stolt (2006) in sediments supporting healthy *Zostera marina* where concentrations were less than 1.5 g kg^{-1} and in Demark sediments supporting *Zostera marina* had values less than 0.5 g kg^{-1} (Holmer and Nielsen, 1997). Although the studies examining the relationship between sediment sulfide concentrations and SAV growth are limited, we can reasonably surmise that low sediment sulfide concentrations are favorable for healthy SAV habitats.

Organic matter in submerged sediments has been shown to have a positive effect on plant growth, due to the release of nitrogen and phosphorus during the mineralization of the organic matter (Sand-Jensen and Sondergaard, 1979). However, at high quantities organic matter has a negative effect on the growth of submerged macrophytes probably due to their contribution to the formation of phytotoxins, such as S^{2-} in anoxic sediments (Barko and Smart, 1983). In the Mid-Atlantic region healthy *Zostera marina* has been observed growing on sediments with organic matter contents less than 2% (Orth, 1977; Ward et al., 1984; Demas, 1998). However in Rhode Island, Bradley and Stolt (2006) found *Zostera marina* growing on soils with higher organic matter contents (up to 4%) than in the Mid-Atlantic region. The limitation of higher organic matter content on SAV growth is not well understood (Koch, 2001) although it may be related to nutrient limitation in very fine sediments associated with high organic deposits (Barko and Smart, 1986) or to high sulfide concentrations associated with increased reduction of sulfate and organic matter oxidation (Nienhus, 1983; Goodman et al., 2005). Overall the organic matter content of sediments supporting healthy *Zostera marina* and *Ruppia martima* was generally less than 5% (3% organic carbon) (Table 6-2).

Submerged aquatic vegetation growth is also impacted by physical and geochemical processes that are associated with grain size distribution (Barko and Smart, 1986). In experiments using glass beads, Seeliger and Koch (unpublished) found that *Ruppia maritima* had maximum growth in fine to medium sand-sized particles. Demas

(1998) observed *Zostera marina* and *Ruppia martima* growing on loamy sand (<15 % silt and clay) soils in Sinepuxent Bay, MD, which was similar to observations made by Orth (1977) in the Chesapeake Bay where *Zostera marina* was growing on sediments with 85 to 92% sand. Hurley (1990) also made observations in regard to the type of sediments inhabited by several SAV species in Chesapeake Bay, including *Zostera marina* which grew primarily on sandy substrates and *Ruppia maritima* that was occasionally found on soft muddy sediments but was more commonly on sandy substrates. In contrast to these Mid-Atlantic based studies, Bradley and Stolt (2006) observed *Zostera marina* growing on soils in Ninigret Pond, RI, with greater quantities of silt (>21%) and clay (>8). Observations collected by Osher and Flannagan (2007) in Taunton Bay, ME, also described *Zostera marina* growing on finer textured (silt loam) soils. According to a review of Kemp et al. (2004), *Zostera marina* and *Ruppia maritima* are generally more abundant in sediments in which silts and clays constitute less than 20 to 30% (by weight). However, several studies indicated that healthy *Zostera marina* beds were located on sediments with higher amounts of silt and clay. Short et al. (2002) developed a three phase site selection model for *Zostera marina* transplant projects. In this model a general rule was derived from the literature indicating that the preferred sites have sediment conditions that were cobble free and contained less than 70% silt and clay.

Grain size distribution impacts the rate of porewater exchange in the sediments and the amount of nutrients in the sediments. Grain size distributions that are skewed towards silt/clay have lower porewater exchange rates with the overlying water column than sandier sediments (Huettel and Gust, 1992), which can lead to increased nutrient levels but also higher sulfide concentrations in the sediments and porewater (Kenworthy et al., 1982; Holmer and Nielsen, 1997). In higher salinity (18 to 30 ppt) environments it seems as though SAV prefer to inhabit more oxygenated coarser textured sediments (Koch, 2001) that permits higher porewater exchange with the overlying water, which helps maintain tolerable sulfide concentrations in these soils. The sediment factors impacting SAV growth and distribution in estuarine and marine environments are not completely independent factors as presented. As wave and current energies decrease, finer sediments and organic matter collect in these low energy environments. These low-energy environments are also conducive for sediment sulfide generation. Thus, the areas with finer textured sediments tend to have higher organic matter and sediment sulfide contents compared to the high-energy environments.

The seagrasses reproduction and recruitment also plays a role in the location and distribution in estuarine environments. Orth et al. (1994) broadcast *Zostera marina* seeds into three unvegetated plots in the Chesapeake Bay (York River, VA) which historically supported vegetation. The seedlings were distributed within 5 m plots, but not beyond these areas. They suggested that the seeds were protected from current flows by microtopographic features (burrows, pits, mounds, and ripples) and demonstrated that seeds settled rapidly and became incorporated into the sediments. These results suggest that seeds stay locally where they were distributed and do not tend to have large scale distribution patterns. Thus, the seed distribution should be taken into consideration in restoration of large landscapes.

Due to this overlapping influence of variables within the water column and the sediment it is particularly hard to evaluate suitable habitats for SAV growth and success. But in this chapter we will be focusing on the properties of the soils that impact SAV knowing that the surrounding environmental conditions are also impacting their growth and success.

Uses of Soil Inventory Data

Soil inventory data are commonly used to provide information regarding the suitability or limitations of the soils for specific land uses. This involves evaluating soil attributes that impact a specific land use in order to make predictions about how a soil will behave or about how the soil properties will affect certain land uses. This information is usually expressed in suitability maps or tables highlighting the severity of the limitations and the limiting soil properties for specific land uses. These suitability maps and tables are often used to assist in management decisions. For example, soil inventory data commonly are used to generate potential agricultural yields, to assess suitability for septic leaching fields, or to predict usefulness for wetland wildlife habitat. In each of these examples, factors other than soils also impact the success or viability of particular land uses, but the limitations offered by the soils themselves can nevertheless be evaluated independently. In a similar fashion, the subaqueous soils information obtained for Chincoteague Bay can potentially be used to help identify which areas are well suited or poorly suited for SAV habitat based on the physical and chemical properties of the soils. The suitability of the subaqueous soils for potential SAV habitat restoration, for example, could then be displayed in tabular or graphical form.

The objectives of this study were 1) to compare published data on soil properties affecting SAV growth to the properties of the soils of Chincoteague Bay; 2) using information obtained in objective 1, create a suitability map for SAV growth based on the soil properties of Chincoteague Bay; and 3) to evaluate the usefulness of the suitability map by comparing it with SAV distributions documented in Chincoteague Bay.

Material and Methods

Study Site

Chincoteague Bay is the largest coastal lagoon (19,000 ha in Maryland) on Maryland's eastern shore with inlets located at Ocean City, MD and Chincoteague, VA. It is a shallow (<3 m), microtidal lagoon with salinity values ranging from 26 to 34 ppt. Wazniak and Hall (2005) summarized overall ecological conditions of the Maryland coastal bays by using the estuarine health indicators comprised of water quality (water quality index, brown tides, and macroalgae), living resource indicators (benthic index, hard clam abundance, sediment toxicity), and habitat indicators (seagrass area, wetland area, natural shoreline). According to this report, the northern most bays (Assawoman Bay, Isle of Wight Bay, and Newport Bay) have the poorest estuarine health, whereas the health of Sinepuxent Bay and Chincoteague Bay is better. The good condition of Chincoteague Bay is due primarily to the relatively undeveloped watershed, low sediment toxicity values, and presence of seagrass beds. However the presence of brown tides and macroalgal blooms reduced its overall ranking to second (behind Sinepuxent Bay).

Soils of Chincoteague Bay

One-hundred and forty-six pedons from Chincoteague Bay were examined and described according to the National Soil Survey Center guidelines (Schoeneberger et al., 2002). Samples from 51 of the pedons were analyzed for selected properties. Methods of handling and analyses of the samples were presented in Chapter 4. After characterization, the soils were classified to the series level according to the Keys to *Soil Taxonomy* (Soil Survey Staff, 2006) and proposed amendments to *Soil Taxonomy* (Northeast Regional Cooperative Soil Survey Subaqueous Soils Committee, 2007). The classification of these soils is presented in Chapter 4. Using the soil-landscape models developed for Chincoteague Bay, a soil resource map was developed and is presented in Chapter 5. The soil map and accompanying characterization data set were compared with published information from the literature to determine optimum soil characteristics for SAV growth. The high resolution orthomosaic photograph used in Figures 6-2, 6-4, 6-5, 6-6, and 6-10 was provided by USDA-NRCS Geospatial Data Branch in Fort Worth, TX (USDA-NRCS, 2001).

Submerged Aquatic Vegetation Information for Chincoteague Bay

Submerged aquatic vegetation coverage was obtained from the Virginia Institute of Marine Science (VIMS). The Virginia Institute of Marine Science has been collecting SAV coverage data for the Chesapeake Bay and the Maryland coastal bays since 1986. The available SAV coverage was mapped from 1:24,000 black and white aerial photographs obtained during the peak growing season of the species known to occur in the area (Orth et al., 2005). In Chincoteague Bay *Zostera marina* (eelgrass) has a growing season from March through May and October through November and *Ruppia maritima* (widgeon grass) has a growing season from April through October. Using rectified photography, the distribution of SAV was mapped and density was determined using a crown density scale developed for establishing crown cover of forest trees (Orth et al., 2005). For quality assurance purposes the SAV beds identified by aerial photo interpretation were also field checked by VIMS staff and collaborators.

Analysis

Using soil characteristics that impact the growth of SAV a soil suitability map for potential SAV habitats was created using ArcMap 9.0 (ESRI Inc., 2006). The 2004 SAV coverage map was used to evaluate the usefulness of the soil suitability map by determining the SAV coverage and density within each soil map unit using ArcMap 9.2 (ESRI Inc., 2006).

During the process of describing soils at 146 locations in Chincoteague Bay we noted the presence of SAV growing on these soils or evidence of roots within the surface horizons if the vegetation was absent. The location of the pedons with and without evidence of SAV was compared with the soil map using ArcMap 9.0 (ESRI Inc., 2006).

Results

Based on the data collected from the literature presented in Table 6-2, we summarized the soil characteristics that impact SAV growth and success. A summary of pertinent soil characteristics and the ranges associated with the suitability classes are presented in Table 6-3. Porewater sulfide concentrations were not measured in these soils. However, it has been suggested that soil sulfide concentrations can be used as a surrogate for porewater sulfide concentrations. Soils with low sulfide contents and low organic carbon contents would have low porewater sulfide levels since organic matter would tend to limit sulfate reduction in these soils. Thus, the soil sulfide concentrations should be positively related to porewater sulfide concentrations in these environments. Therefore, we are using soil sulfide concentrations as a property to indicate porewater sulfide toxicity on SAV growth. The organic carbon content in these soils for favorable conditions was based on studies indicating that SAV was found on soils with less than 5% organic matter (3% organic carbon) (Koch, 2001; Kemp et al., 2004). The soils with mildly detrimental levels of organic carbon were based on the upper limit where healthy SAV was found growing (Bradley and Stolt, 2006). In the Mid-Atlantic region, SAV was found on sandier soils than farther to the Northeast where SAV was found growing on loamy textured soils. Therefore, the favorable textures reflect the Mid-Atlantic region and the mildly detrimental textures reflected the loamier textures found in the Northeast. These characteristics were then used to determine the overall rating of the soils in Chincoteague Bay. The favorable and potentially limiting soil characteristics that impact SAV growth in Chincoteague Bay and the overall rating of the soils are presented in Table 6-4. Based on these soil characteristics we predicted the suitability of the soils in Chincoteague Bay for potential SAV habitats as slight, moderate, or severe. The predicted soil suitability map is shown in Figure 6-2. The soils in Chincoteague Bay that have slight limitations for SAV growth had sandy surface textures (fs or lfs), low and moderately low organic carbon contents (<2.7 g kg^{-1}), and low sulfide levels (<0.07 g kg^{-1}). The soils with moderate limitations for SAV growth had sandy to loamy surface textures (cS, fS, LfS, SL, fSL, L, SiL, or SiCL), moderately low to high organic carbon contents (2 to 57 g kg^{-1}), and intermediate sulfide levels (1.5 to 11.6 g kg^{-1}). The soils in Chincoteague Bay with severe limitations for SAV growth had finer surface textures (L,

Table 6-3. Summary of soil properties based on a literature review of *Zostera marina* (eelgrass) and *Ruppia maritima* (widgeon grass) which were used to determine the suitability of the soils in Chincoteague Bay.

Soil Property	Favorable	Mildly Detrimental	Strongly Detrimental
Sulfide concentration	<5 g kg^{-1}		>5 g kg^{-1}
Organic carbon content	< 30 g kg^{-1}	30-70 g kg^{-1}	>70 g kg^{-1}
Texture	<20% silt and clay (by weight)	20 to 50% silt and clay (by weight)	>50% silt and clay (by weight)
	S or LS	SL, SCL, or L	SiL, SiCL, CL, SiC, C

Table 6-4. Soil map units and favorable and limiting soil characteristics that may impact SAV growth in Chincoteague Bay.

Soil Map Unit	Favorable Properties	Potentially Limiting Properties	Overall Rating
Coβ: Coards silty clay loam, 1.0 to 1.5 m depth	Organic carbon content 9.0-21.0 g kg^{-1}	high levels of sulfides, SiCL or CL textures	Severe
Ctγ: Cottman sand, 1.5 to 2.0 m depth	Organic carbon content 1.5-4.0 g kg^{-1}, sandy textures	Moderate levels of sulfides (1.5 to 6.5 g kg^{-1}),	Slight
Deα: Demas fine sand, 0.2 to 1.0 m depth	Organic carbon content 0.4-2.7 g kg^{-1}, low levels of sulfides (0.07 to 0.32 g kg^{-1}), sandy textures		Slight
Deβ: Demas fine sand, 1.0 to 1.5 m depth	Organic carbon content 0.5-3.0 g kg^{-1}, low levels of sulfides, sandy textures		Slight
Dmβ: Demas sandy loam, 1.0 to 1.5 m depth	Organic carbon content 2.4-7.5 g kg^{-1}, low levels of sulfides, sandy textures		Slight
Mmα: Middlemoor sandy loam, 0.2 to 1.0 m depth		Organic carbon content 24.0-57.0 g kg^{-1}, moderate levels of sulfides, SL, L, or SiL surface textures	Moderate
Mmβ: Middlemoor sandy loam, 1.0 to 1.5 m depth	S surface textures, organic carbon content 2.0-14.0 g kg^{-1}	Moderate to high levels of sulfides (1.1 to 7.6 g kg^{-1})	Moderate
Siβ: Sinepuxent loam, 1.0 to 1.5 m depth	Organic carbon content 9.6-23.5 g kg^{-1}	SL, L, or SiCL surface textures, moderate levels of sulfides	Moderate
Spβ: Southpoint silty clay loam, 1.0 to 1.5 m depth		High quantities of silt and clay, organic carbon content 2.5-202.0 g kg^{-1}, high levels of sulfides (16.2-19.7 g kg^{-1})	Severe
Tgβ: Tingles silty clay loam, 1.0 to 1.5 m depth	Organic carbon content 5.6-12.0 g kg^{-1}	High quantities of silt and clay, high levels of sulfides	Severe
Tgδ: Tingles silty clay loam, 2.0 to 2.5 m depth	Organic carbon content 5.3-17.0 g kg^{-1}	High quantities of silt and clay, moderate to high levels of sulfides (3.2-10.0 g kg^{-1})	Severe
Thβ: Thorofare sandy loam, 1.0 to 1.5 m depth	Sandy textures, low organic carbon (0.7-3.0 g kg^{-1})	Moderate levels of sulfides	Slight
Trα: Truitt silty clay loam, 0.2 to 1.0 m depth	LfS or LS surface textures, Organic carbon content 9.7-18.6 g kg^{-1}	CL or SiCL surface textures, moderate levels of sulfides	Severe

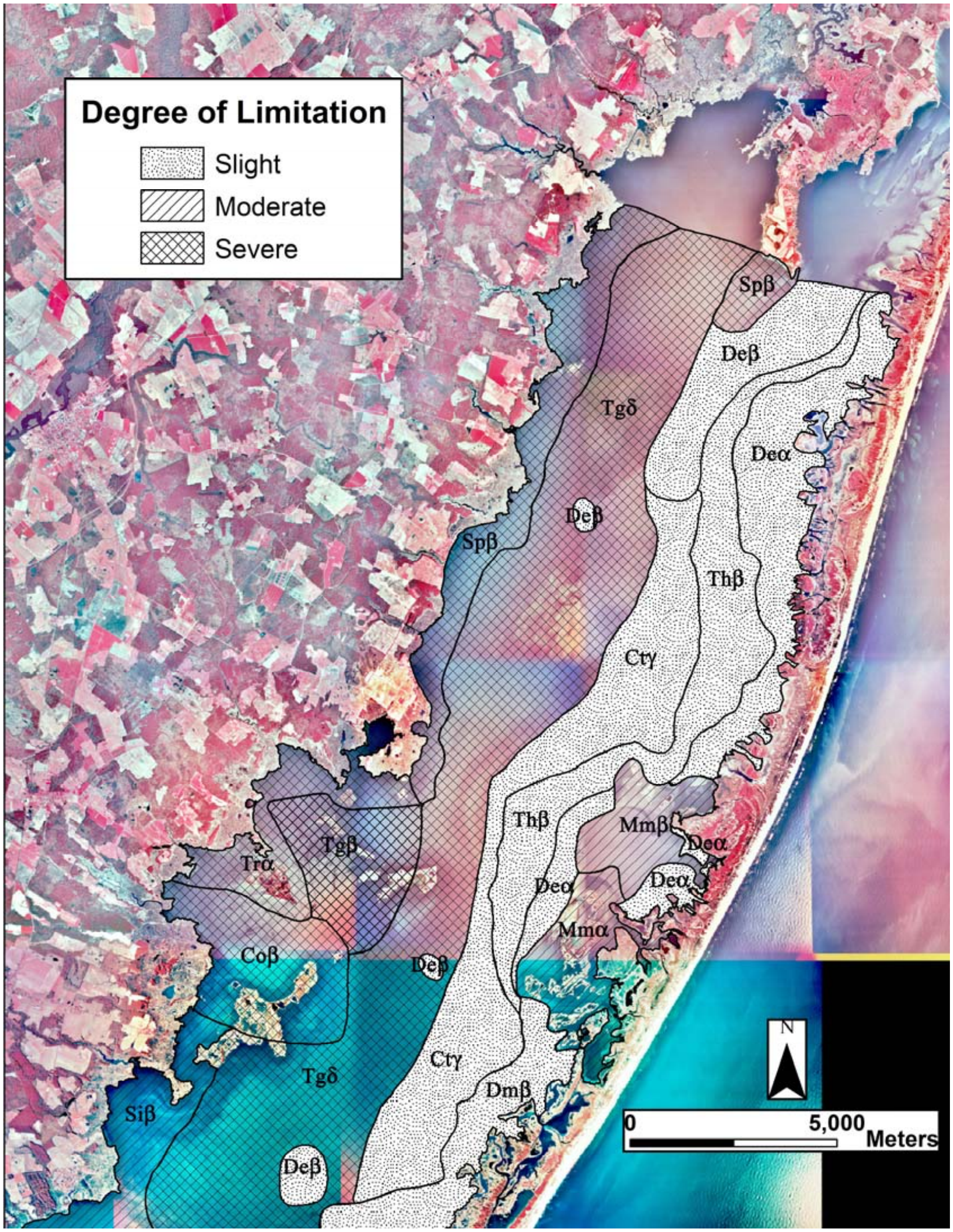

Figure 6-2. Predicted soil suitability for SAV habitat based on soil characteristics including sulfide concentration, texture, and organic carbon content. Soil map units were grouped based upon their degree of limitation (slight, moderate, or severe) for SAV habitat.

SiL, SiCL, or CL), moderately high to high organic carbon contents (5.6 to 202.0 g kg^{-1}), and intermediate to high sulfide levels (3 to 66 g kg^{-1}).

In the 1930's the eelgrass disappeared from Chincoteague Bay due to an eelgrass blight (discovered to be a marine pathogenic slime mold) which impacted the East Coast from North Carolina to Newfoundland (Short et al., 1993). Maryland's coastal bays gradually recovered from the massive decline but according to Orth and Moore (1983) have not reached the historical high levels. Since 1986 the Virginia Institute of Marine Science (VIMS) has conducted annual surveys of SAV distribution in the Maryland coastal bays. Seagrass coverage has increased by an average of 301 ha per year (Figure 6-3), however between 2004 and 2006 there was a serious decline (44%) in the seagrass coverage from 5732 ha to 3204 ha (Orth et al., 2004; Maryland Department of Natural Resources, 2007). This decline has been attributed to an increase in water temperatures in 2005 along with increasing nutrient and chlorophyll trends in the area (Maryland Department of Natural Resources, 2007). Although there has been a decline in seagrass beds since 2004, Chincoteague Bay continues to have the highest SAV coverage in the Maryland coastal bays. The SAV distribution and density collected in 1986 (this was the first data collected when the monitoring began in the coastal bays) is shown in Figure 6-4. The most recent SAV distribution and density data available was collected in 2004 and is shown in Figure 6-5. Four density classes were identified based on the percent cover: very sparse (<10% coverage); sparse (10-40% coverage); moderate (40-70% coverage); and dense (>70% coverage). Most of the seagrass beds occur on the eastern side of

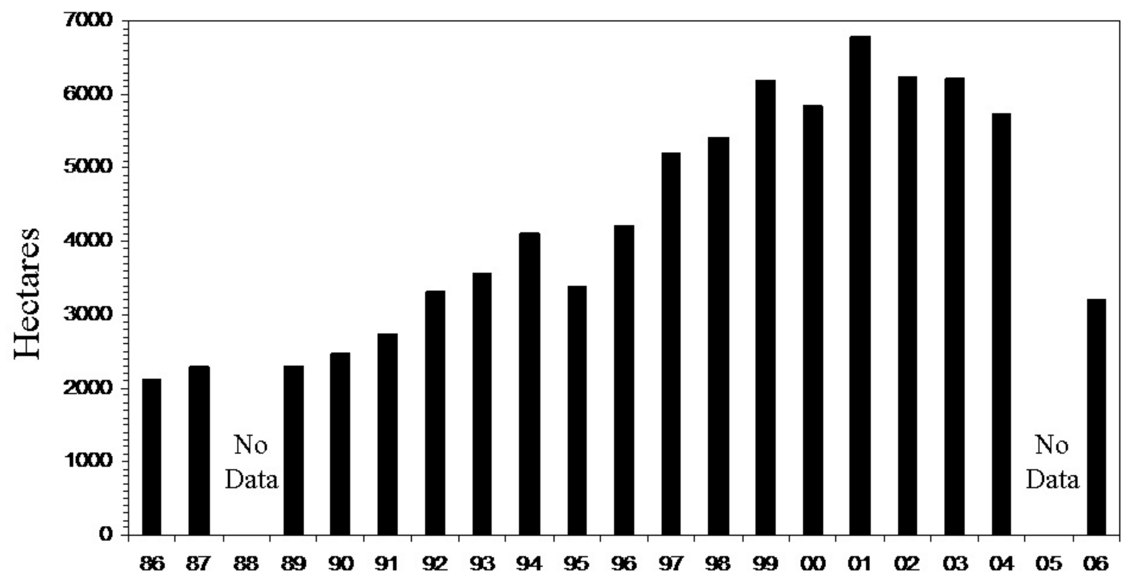

Figure 6-3. Annual seagrass coverage (ha) for Chincoteague Bay from 1986 through 2006. Submerged aquatic vegetation coverage was obtained from the Virginia Institute of Marine Science (VIMS).

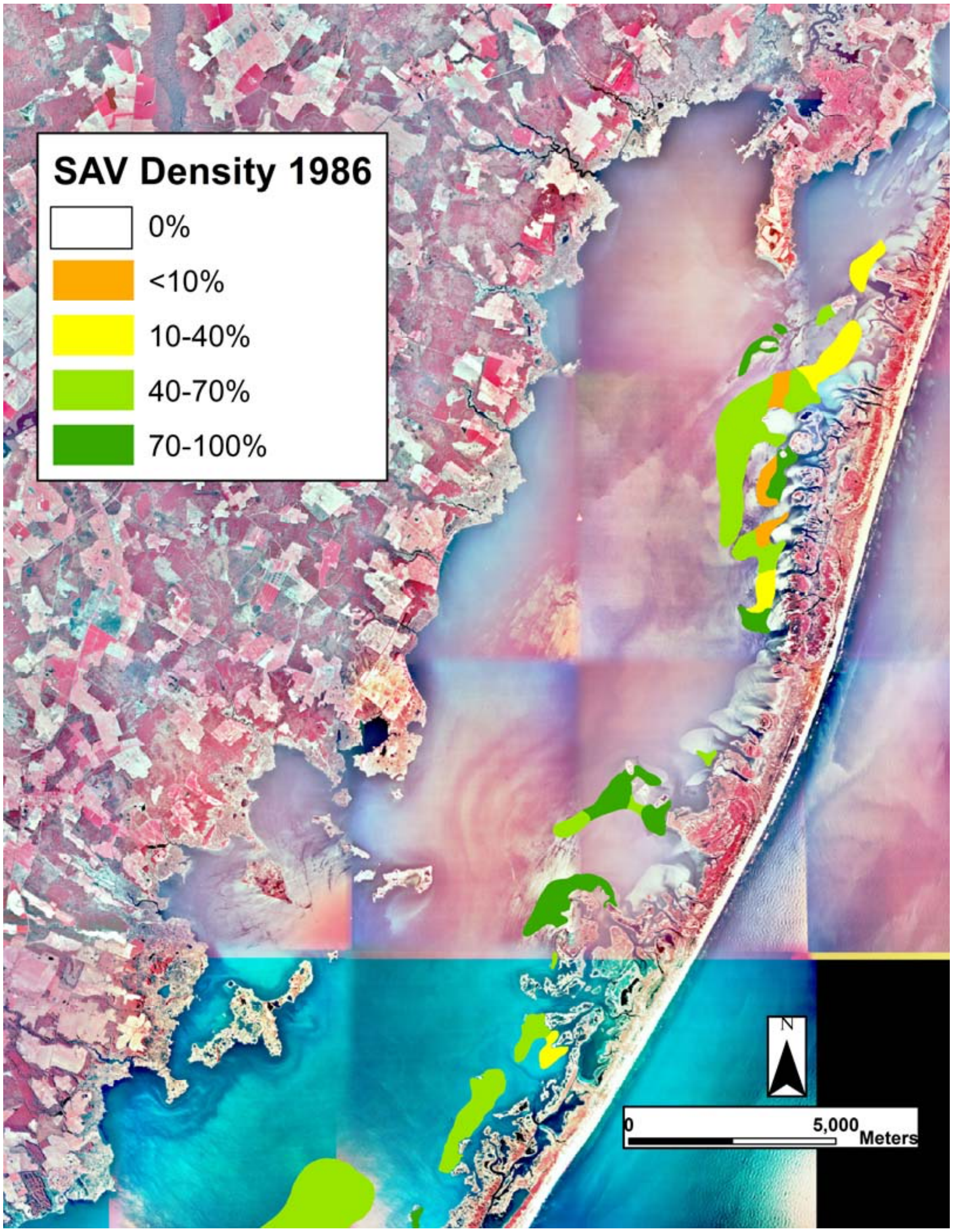

Figure 6-4. The SAV distribution and density collected in 1986 by VIMS using rectified photography was obtained during peak SAV growing season. Four density classes were identified based on the percent cover: very sparse (<10% coverage); sparse (10-40% coverage); moderate (40-70% coverage); and dense (>70% coverage).

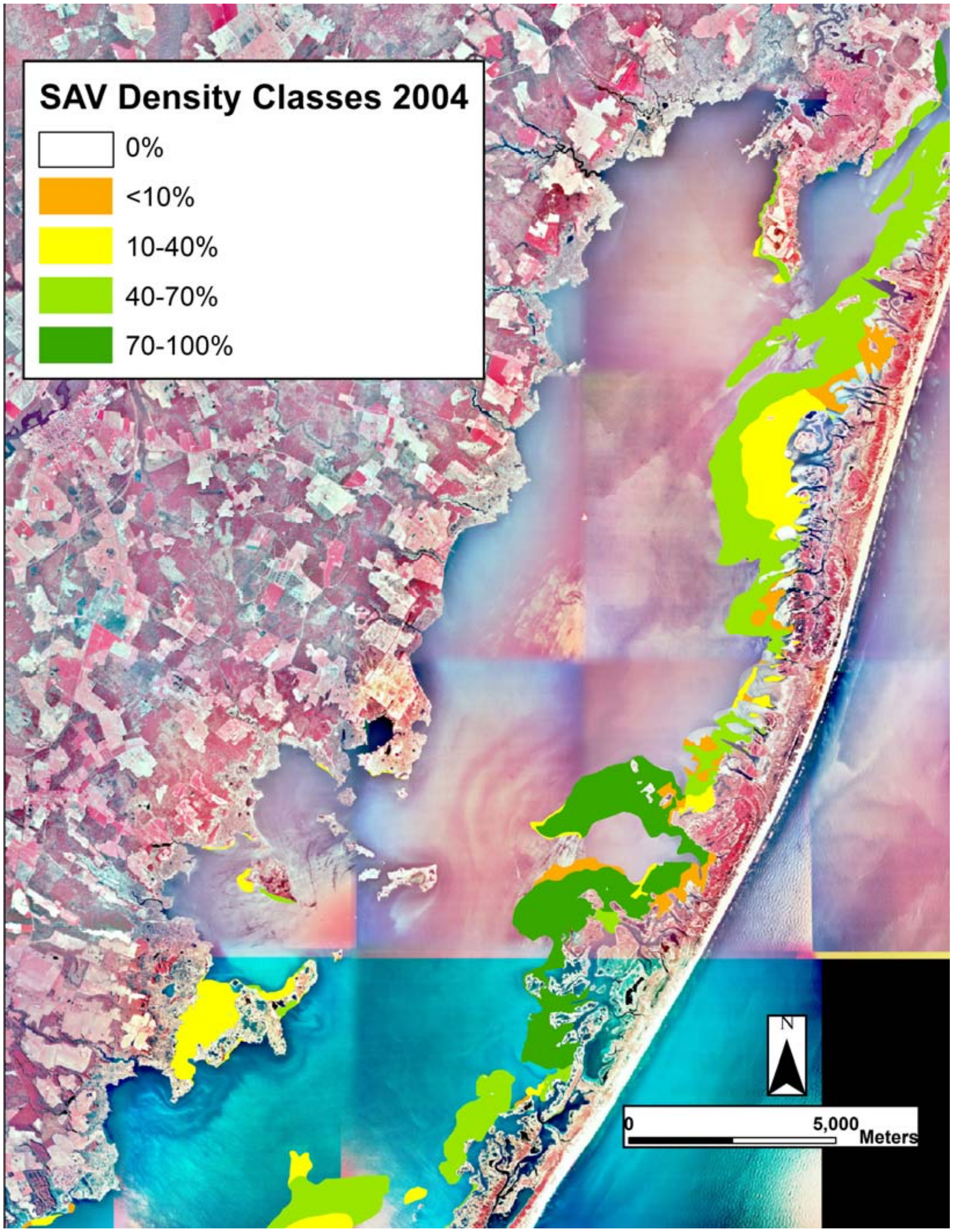

Figure 6-5. The SAV distribution and density collected in 2004 by VIMS using rectified photography was obtained during peak SAV growing season. Four density classes were identified based on the percent cover: very sparse (<10% coverage); sparse (10-40% coverage); moderate (40-70% coverage); and dense (>70% coverage).

Chincoteague Bay behind Assateague Island. However in 2004 several beds were located along the mainland in the southern portion of the bay. The 2004 VIMS data set is the most recent digital dataset available and was used in this study because the total SAV coverage has changed very little from 1998 through 2004.

In order to test the usefulness of the soil rating scheme that was developed using the criterion in tables 6-3 and 6-4, the locations of actual SAV beds identified by VIMS in 2004 were compared with the suitability map using ArcGIS. The VIMS 2004 SAV coverage for Chincoteague Bay was overlain on the soil suitability map Chincoteague Bay (Figure 6-6). From this data set we calculated the area of SAV within each density class that was located within each soil suitability class using ArcGIS 9.2 (ESRI Inc., 2006). The total area of SAV for each density class within each soil suitability unit is presented in Figure 6-7. The greatest SAV coverage (approximately 3000 ha) was located on the soils identified as having a slight limitation. These soils with slight limitations contained the broadest SAV coverage in each of the SAV density classes. The soils with severe limitations had the lowest SAV coverage (140 ha) and do not contain any SAV beds with dense (70-100%) coverage. The percentage distribution of each SAV density class among the three soil suitability units is shown in Figure 6-8. By far the greatest proportion of each density coverage occurs on soils with slight limitation. With the exception of the lowest density class (<10 %), the proportion is much greater on soils described as having moderate limitation than on those with severe limitations. The percent of SAV coverage for each suitability class is shown in Figure 6-9. The soils with slight limitations had the greatest percent coverage (36 %) of the suitability classes for each density class, with exception of the >70 % class which had the greatest coverage on

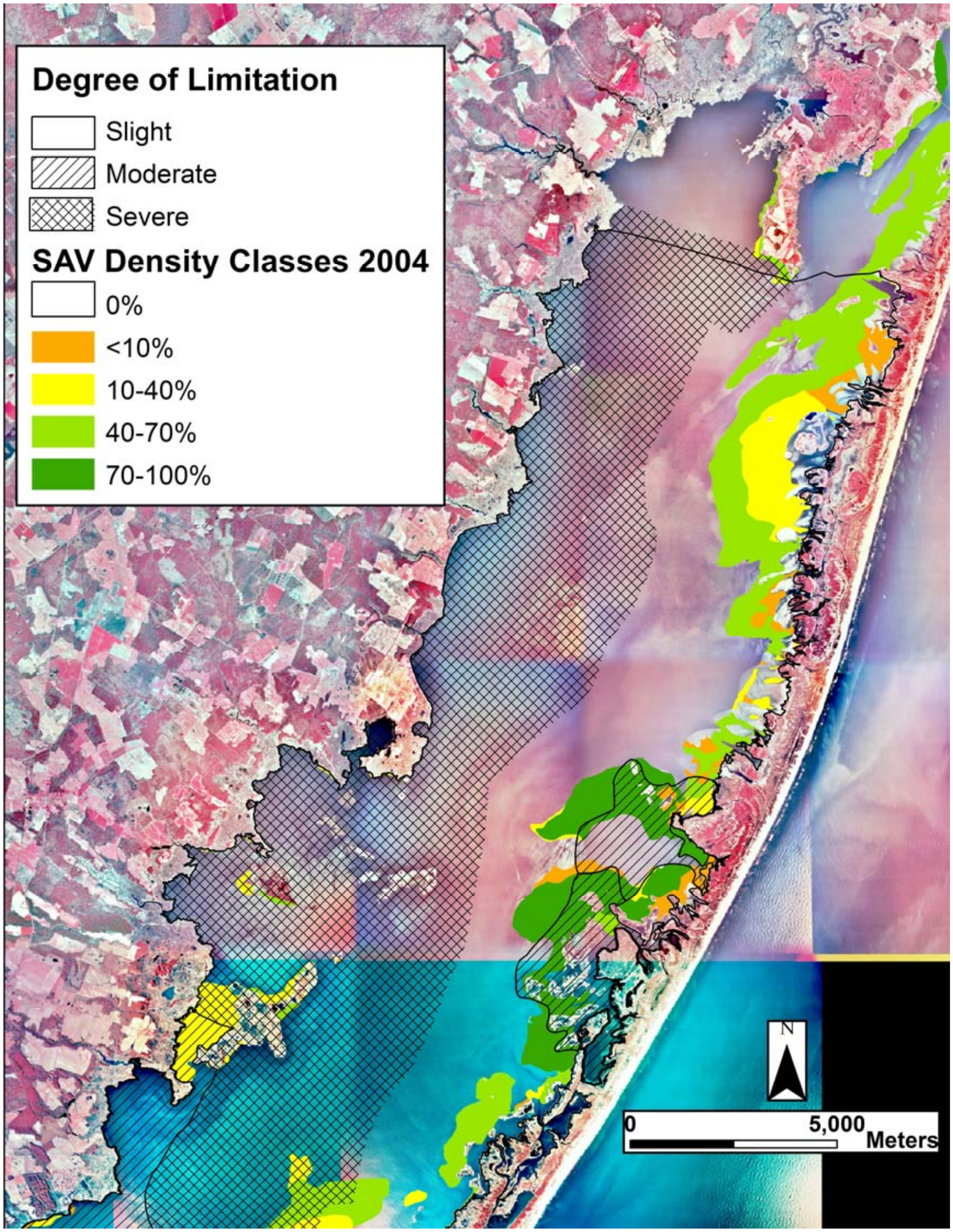

Figure 6-6. The SAV coverage in 2004 and the potential suitability for SAV growth based on soil characteristics of Chincoteague Bay. Note that most of the SAV beds are located adjacent to the barrier island.

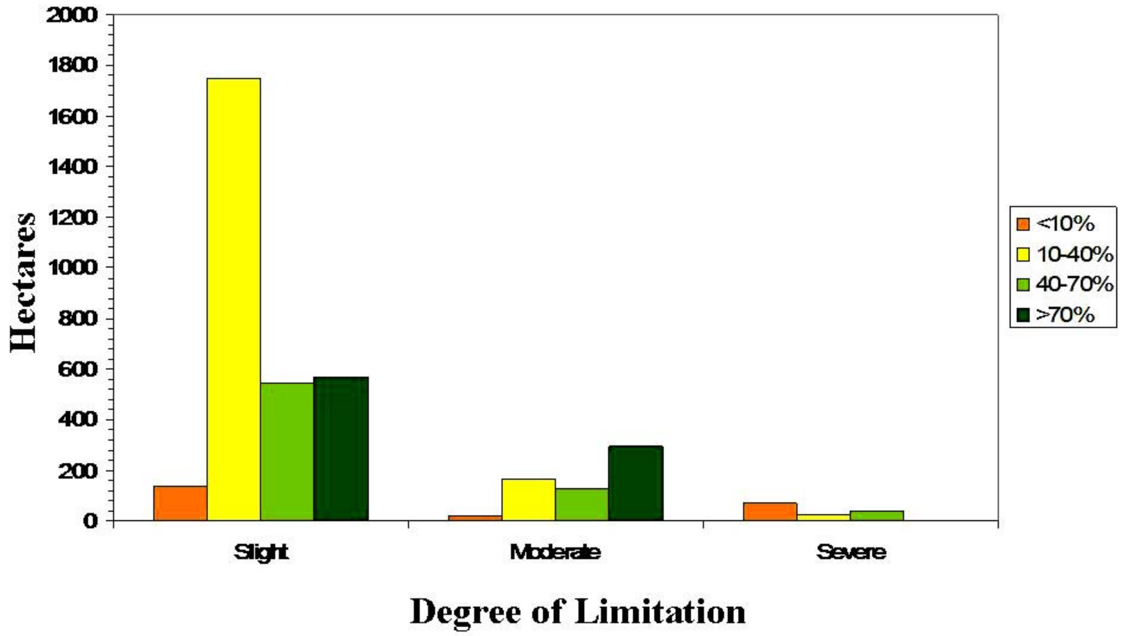

Figure 6-7. The total hectares of SAV per density class found within each soil suitability unit in Chincoteague Bay, Maryland. Note the highest SAV coverage is found within the slight class.

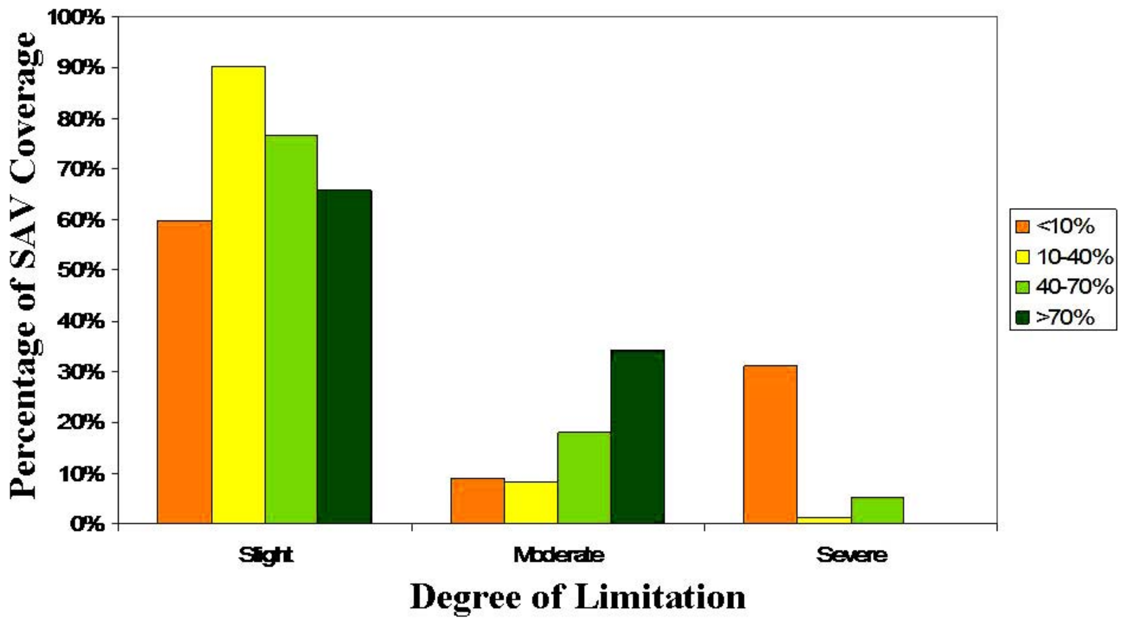

Figure 6-8. The percentage of SAV for each density class is shown for each suitability class (each density class adds up to 100%). Note the greatest SAV coverage was located on soils with slight limitations for SAV growth.

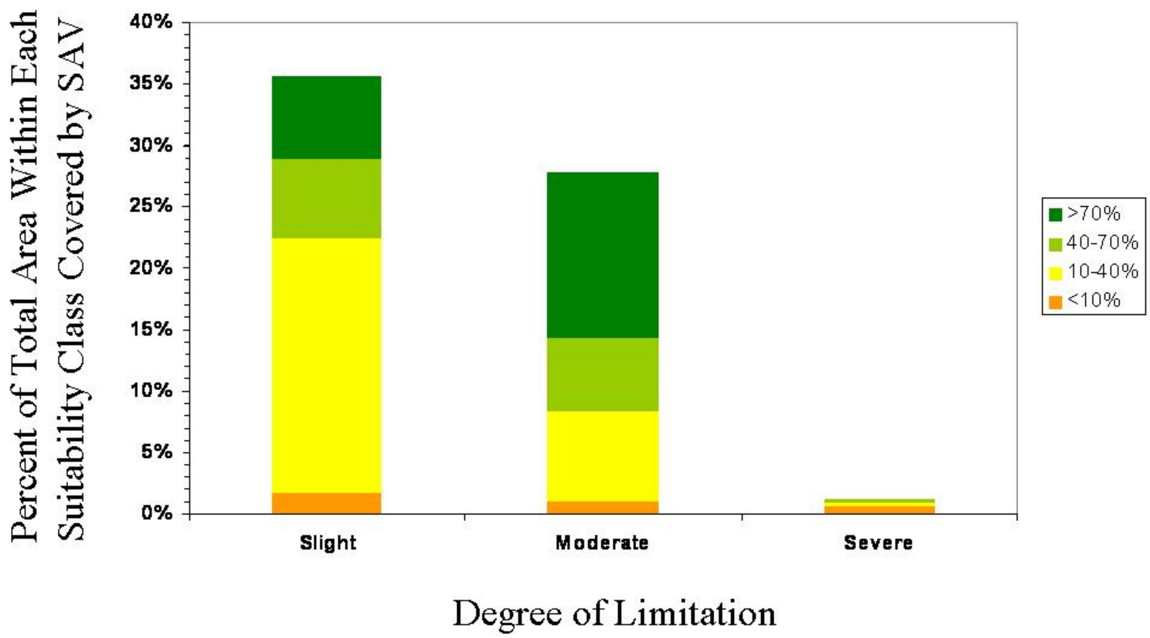

Figure 6-9. Percent of the total area designated within each soil suitability class in Chincoteague Bay that supported SAV growth in 2004 (by density class). Note the highest percentage (35%) by SAV occurred in areas with slight limitations with only 1% coverage in areas with severe limitations.

the soils with moderate limitations. The soils with severe limitation had only 1% of the total area covered by SAV. Based on this analysis SAV was most abundant on the soils with slight limitations and almost non existent on those soils with severe limitations. Therefore, our assessment based on the soil characteristics seemed to accurately reflect the SAV distribution within Chincoteague Bay.

During our own work in Chincoteague Bay (describing soils), 14 soils were noted as supporting SAV on the surface or having plant roots within the surface horizon. We were unable to visually observe SAV coverage while describing the soils during the summer months since the water visibility was less than 50 cm due to microalgae blooms. Therefore, we could only make observations about SAV coverage based on the existence of plants or roots collected from these small cores (diameter of 7.6 cm), which were collected during the summer months (the non-peak growing season for SAV). These 14 soils and the soil map units are shown in Figure 6-10. Essentially all of the profiles were located along the eastern side of Chincoteague Bay behind the barrier island and occurred on all of the landforms in that area. These included the storm-surge washover fan flats, storm-surge washover fan slope, barrier coves, shoals, and paleo-flood tidal delta landforms. Eleven pedons were located on soils with slight limitations. Of these pedons, five were located in moderate (40-70%) beds and four were located in dense (>70 %) beds. However, two pedons were located in areas where SAV coverage (as reported by VIMS) was absent. Two pedons were located on soils with moderate limitations in sparse (10-40 %) and dense (>70 %) SAV beds. Only one pedon was located on the western side of the bay on soils with severe limitations. This pedon was described as having 5% roots in the

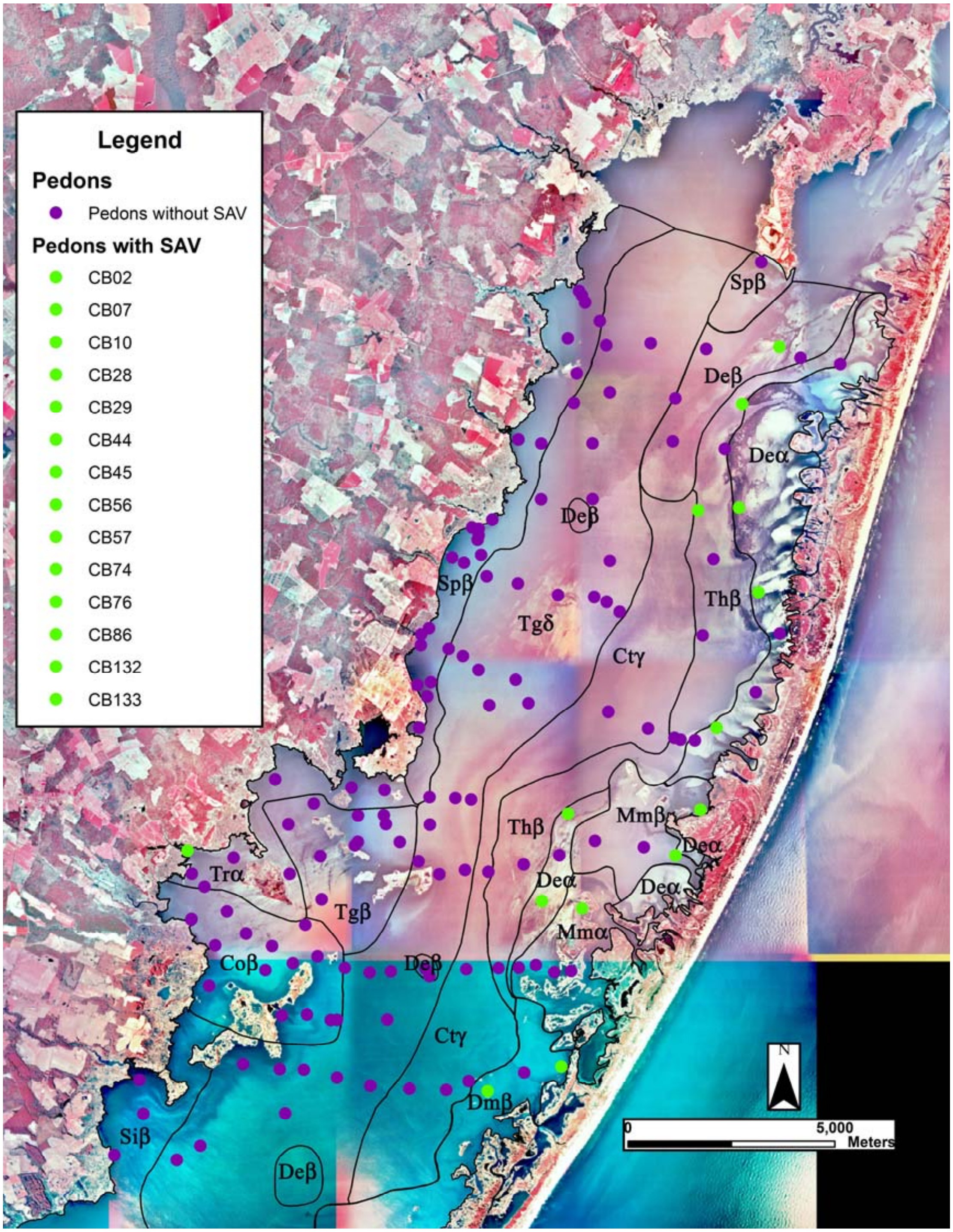

Figure 6-10. Location of soil descriptions made during the summers of 2004 and 2005. Twelve soils were described as supporting SAV on the surface or having plant roots within the surface horizons.

surface horizon, however this pedon was located in an area without SAV coverage. We also described eight soil profiles in areas where the VIMS 2004 survey indicated SAV beds were occurring, but we did not observe SAV on these soils. Six of these profiles were located on the eastern side of the bay. Five of these pedons were located on soils with slight limitation and moderate (40-70 %) coverage and the remaining pedon was located on soils with moderate limitation and dense (>70 %) coverage. The other two soils were located on the western side of the bay. These pedons were located on soils with severe limitation for SAV growth and in areas with sparse (10-40 %) and moderate (40-70 %) coverage.

Discussion

We predicted the suitability of soils in Chincoteague Bay for potential SAV habitat based on previous studies that documented the importance of sulfide concentrations, organic matter, and texture. Comparisons were made between current growth patterns of SAV as reported by VIMS, observations we made during the collection of soil pedons, and the soil characteristics. Based on these comparisons, we assessed the suitability of soils in Chincoteague Bay as potential SAV habitats and determined that three groups of soils had a slight suitability rating for SAV growth: Demas soil series (Sulfic Psammowassents), Thorofare soil series (sandy Haplic Sulfiwassents), and Cottman soil series (coarse-loamy Sulfiwassents). Demas (1998) identified soils on the eastern side of adjacent Sinepuxent Bay that were similar to those on the eastern side of Chincoteague Bay. However, these soils did not support SAV growth and Demas concluded that these soils were too dense and had low fertility levels.

In Sinepuxent Bay, SAV grew the best on sites located on the western side of the bay in the shallow mainland coves, which had low amounts of silt and clay, low organic carbon contents, and low concentrations of sulfides. These soils were similar to those we described in Chincoteague Bay on the washover fans but were not quite as sandy. Perhaps more important, the soils in the shallow mainland coves had high concentrations of porewater ammonium. These areas show evidence of groundwater intrusion, which accounts for the low sulfide concentrations and high concentrations of ammonium (Demas, 1998). In our work, several SAV beds were also observed by VIMS on the western side of Chincoteague Bay on fine-silty Fluvic Sulfiwassents, but the coverage was less dense. Based on our assessment, these areas had severe limitations for potential SAV habitats. These soils were loamy or clayey textured (loam, silt loam, silty clay loam, clay loam, and silty clay) and had organic carbon contents >5 g kg^{-1}. The VIMS SAV coverage on the western side of the bay was located along the coastal and island margins. These areas may have coarser textured surface horizons due to wave erosion and winnowing, which could explain why the SAV coverage was confined to the margins and did not extend out into the bay where the soils are finer textured. Within the center of these areas, the soils were similar to those identified in Sinepuxent Bay that did not contain SAV beds (Demas, 1998). Demas (1998) identified soils in deep mainland coves that had higher quantities of silt and clay, high organic carbon contents (35 g kg^{-1}), and high porewater sulfide concentrations. The high sulfide concentrations in these soils were considered to be toxic to SAV and inhibit their growth in these areas. Another possible limitation in these soils is that the silty surfaces in these areas could easily be resuspended by waves or tidal currents that could limit light penetration which would affect SAV growth.

Several soils had moderate suitability rating for SAV growth. These soils were coarse-loamy Fluvic Sulfiwassents, fine-silty Fluvic Sulfiwassents, and fine-silty Thapto-histic Sulfiwassents. The coarse-loamy Fluvic Sulfiwasents soils had sandy surface textures and moderately low organic carbon contents, which are favorable for SAV growth. The fine-silty Fluvic Sulfiwassents had severe suitability ratings in other map units, however in the barrier coves these soils had sandy surface textures and lower organic carbon contents, which were more favorable for SAV growth; however below the surface, the textures become finer and the organic carbon contents increase. Therefore these soils were given moderate suitability ratings due to the soil properties below the surface.

In contrast to observations in Sinepuxent Bay and Chincoteague Bay, SAV coverage in Ninigret Pond, RI, extended across the barrier coves, lagoon bottom, and flood-tidal delta slope landforms (Bradley and Stolt, 2006). The lagoon bottom and barrier cove landforms are low-energy depositional areas and contained soils which are finer textured, have higher quantities of organic carbon, and higher total nitrogen levels. However, the flood-tidal delta slope landform is a high-energy area and contained soils that are coarser textured with lower organic carbon contents, total nitrogen, and acid volatile sulfides. These coarser soils are more similar to these in Chincoteague Bay where the SAV coverage was dominant. In Ninigret Pond, RI the SAV may be confined to these deeper water landforms due to ice scour during the winter months which would destroy plant life in shallower water (Bradley and Stolt, 2006).

An additional soil characteristic, soil salinity, was used by Bradley and Stolt (2006) to explain the presence or absence of eelgrass in Ninigret Pond, RI. They found salinities that ranged from 34 to 44 ppt supported the most eelgrass. They observed coarser textured soils located near the barrier island and loamy soils located near the mainland had salinity levels between 19 and 27 ppt and these areas did not support eelgrass. *Zostera marina* is found in a wide range of salinity levels (10 to 39 ppt) (McRoy, 1966). Therefore, in Ninigret Pond, RI, the salinity levels should support the growth of *Zostera marina* and the absence of *Zostera marina* may be related to another factor. These areas may be receiving groundwater inputs, which has been linked to eelgrass decline due to the higher amounts of nutrients carried in these waters (eutrophication from housing development and agriculture) (Taylor et al., 1995). However, in Sinepuxent Bay the highest SAV biomass was found in areas adjacent to the mainland in areas suspected of receiving groundwater inputs that were high in ammonium and thought to be enhancing SAV growth (Demas, 1998).

Conclusions

Many studies have highlighted the importance of water quality and light availability for the growth and survival of SAV. However, when these criteria are met SAV growth and survival may still be limited by other physical and chemical properties of the soils. Several other factors have been implicated as factors controlling seagrass populations including water depth, availability of nutrients, toxic material, and soil conditions. However, the factors that affect the success and survival of seagrasses often are overlapping and it becomes difficult to evaluate these factors independently. Soil properties are interrelated with water depth (as a factor of soil formation) and water depth which itself can impact SAV growth by filtering light by suspended materials. It has been documented that the soils can control the success or failure of SAV establishment.

The soil properties that have the greatest impact on SAV growth are sulfide content, organic carbon content, and texture. The soil suitability map for potential SAV habitats in Chincoteague Bay, MD, was created using the combination of these three characteristics. Based on our analysis SAV was most abundant on the soils with slight limitations and were almost non existent on soils with severe limitations. The soils with slight limitations had low amounts of silt and clay (sand, loamy sand, and sandy loam textures), low organic carbon contents (0.2 to 7 g kg^{-1}), and low concentrations of sulfide minerals (AVS ranged from 0.04 to 0.06 g kg^{-1} and CRS ranged from 0.08 to 1.81 g kg^{-1}). Based on these criteria, the following soils are well suited for SAV growth and success: Demas soil series (Sulfic Psammowassents), Thorofare soil series (sandy Haplic Sulfiwassents), Tizzard soil series (sandy over loamy Haplic Sulfiwassents), and Cottman soil series (coarse-loamy Haplic Sulfiwassents). In Chincoteague Bay these soils are located on the storm-surge washover fan flat, storm-surge washover fan slope, shoal, and paleo-flood tidal delta landforms.

Chapter 7: Dissertation Summary and Conclusions

This study has provided a comprehensive soil resource inventory for the largest of Maryland's coastal bays. I have identified several new landforms, increased the data available on subaqueous soils, enhanced the subaqueous soil-landscape models currently available for coastal lagoons, proposed eight new soil series for use in the Mid-Atlantic region, and highlighted the application of subaqueous soils data for the restoration of submerged aquatic vegetation. This inventory of soils for Chincoteague Bay provides information that has important ecological and environmental ramifications regarding their use for specific land uses. By combining this data set with other data regarding benthic flora and fauna and physical properties of the estuary I would be able to develop suitability maps to identify locations for specific land uses, such as shell fish production or dock placement, and to better predict the potential impact of changes to the subaqueous soils and the ecosystem from dredging or shoreline stabilization activities.

In this study, we identified and delineated 10 subaqueous landforms based on water depth, slope, landscape shape, geographical setting, and depositional environment. The landforms identified in Chincoteague Bay were similar to subaqueous landforms identified in other Atlantic coastal lagoons. However, we also identified two new landforms, the paleo-flood tidal delta and the submerged wave-cut headland. The paleo-flood tidal delta landform was a relict fan-shaped deposit of sandy sediments that were transported through an active inlet and after the closure of the inlet became a stable landform from which the subaqueous soils formed. The submerged wave-cut headlands were located on the western side of Chincoteague Bay and were produced by coastal wave erosion of headlands which were subsequently submerged by rising sea level or subsidence. The soils located on these landforms were similar to those found in the adjacent mainland coves. The soil-landscape models developed in previous studies were useful in describing most of the soils in Chincoteague Bay. However, we enhanced the models to better accommodate and describe the soils located on the lagoon bottom, storm-surge washover fan slope, and shoal landforms and we also added to the existing model by including the two new landforms identified in Chincoteague Bay.

The soils in Chincoteague Bay display systematic variation in physical and chemical properties from the barrier island side to the mainland side of the bay. On the barrier island side of Chincoteague Bay the soils were sandy and had low n values. These are high-energy environments that winnow out the fine sediments and detrital carbon in these settings. Therefore, these soils have low organic carbon and iron contents, which limits the sulfide mineral formation. Due to the low carbon and sulfide contents, these sandy soils were favorable for submerged aquatic vegetation habitat. The past and current distribution of submerged aquatic vegetation in Chincoteague Bay supports this SAV habitat. The sand content decreases when transecting westward from the barrier island to the lagoon bottom. The lagoon bottom was a low-energy environment which is conducive to the formation of finer textured soils with higher quantities of organic carbon and high n values. This low-energy environment possessed the ideal combination of factors to facilitate sulfide mineral formation. These soils have sufficient quantities of organic carbon from detrital sources, such as eelgrass and algae and an iron source as iron oxides sorbed to fine textured mineral sediments. On the mainland side of Chincoteague Bay the soils often contain buried organic horizons which occur at shallower depths closer to the mainland. These are low-energy environments and contain soils that are finer textured, have high n values, and high organic carbon contents. These environments facilitate the formation of sulfide minerals due to the large quantity of oxidizable carbon from the adjacent marshes and in the buried organic horizons and a source of iron as iron oxides sorbed to finer textured mineral sediments. These soils contain the highest organic carbon and sulfide contents in Chincoteague Bay. The soils in the western and central portions of Chincoteague Bay possess several properties which are detrimental to submerged aquatic vegetation. As a result only limited occurrences of SAV beds (only with low densities) have been reported on these soils.

The characterization of the soils for a variety of physical and chemical properties enhanced the current data set available for these coastal lagoons. We documented that most of the soils contained sulfidic materials based on moist incubation pH data. However, the moist incubations required a longer time period to identify the presence of sulfidic materials in these soils. When using the current eight week period required by *Soil Taxonomy* only 57% of the samples displayed a drop in pH below 4, but by doubling the length of time to 16 weeks, 91% of the samples met and maintained the required drop in pH below 4. Therefore, we recommend monitoring the pH for longer than the eight week period currently required by *Soil Taxonomy* to identify sulfidic materials in these estuarine systems. The n value is an important criterion in classifying soils at the great group level and is used to estimate the fluidity and bearing capacity of the soil. In the field the n values were estimated using the squeeze test for each horizon. The sandy textured soils (fS, LfS, or LS) generally had n values less than 0.7, whereas the finer textured soils (SiCL, SiC, or C) mostly had n values greater than 1. The exceptions to this trend were namely in high density submerged upland soils, such as in the subsoil of submerged wave-cut headlands. However when the n value was calculated based on the equation in *Soil Taxonomy*, and the percent of sand, silt, clay, organic matter, and water content, the values did not correlate well with the field estimated n value especially for the extremely sandy soils. The field estimated n value is a better predictor of the fluidity and bearing capacity of the soils and is a useful matrix. In contrast, the calculated n values seem to be substantially flawed and may not be of much value as it currently stands for subaqueous soils. Data on porewater salinity through the soil profile provided an interesting perspective on the soil hydrology of these systems. Porewater salinity in surface horizons had values similar to the overlying water column which ranged from 26 to 36 ppt. Salinity within pedons located on the eastern side of Chincoteague Bay remained high with depth with values centered around 26 to 34 ppt. However, pedons located near the mainland tended to show a systematic decrease in salinity with depth. The lower salinity values associated with these areas are likely the result of groundwater discharge into the bay from the surrounding watershed.

Obtaining accurate organic carbon content for soils containing calcium carbonate is always problematic, but we thought that our use of Piper's (1949) methodology would minimize difficulties. It, however, also proved problematic due to the oxidation of organic carbon by sulfurous acid treatment. Once recognized, this was overcome by using a correction factor obtained from soils without calcium carbonate. Measured values for organic carbon were lowest in the sandy soils located on the storm-surge washover fan flat and paleo-flood tidal delta landforms. The profiles that contained buried organic horizons had the highest organic carbon contents within Chincoteague Bay. The lowest quantities (0.7 to 3.6 kg m^2) of organic carbon stored in the upper 1 m were found in the sandy soils located on the storm-surge washover fan flat, storm-surge washover fan slope, and paleo-flood tidal delta landforms. The finer textured lagoon bottom, fluviomarine bottom, and barrier cove landforms have moderate quantities (4.0 to 21.0 kg m^{-2}) of organic carbon while those in the mainland coves and submerged wave-cut headlands have the highest organic carbon (5.0 to 34.0 kg m^{-2}) stored due to the presence of buried organic horizons within the profile. These values fall within the range of organic carbon (6.7 to 17.7 kg m^{-2}) stored in subaqueous soils located in Taunton Bay, ME. Generally, the quantities of carbon stored in these subaqueous soils ranged between values obtained from the poorly drained (such as the Othello soil series 6.3 kg m^{-2}) and the very poorly drained (such as the Sunken soil series 18.1 kg m^{-2}) subaerial soils located on the Delmarva Peninsula. This work should provide additional data for use in regional and carbon budgets of the shallow water estuaries. The calcium carbonate contents are generally low in this environment.

The classification of these soils helps provide very important information about the subaqueous soils of Chincoteague Bay to knowledgeable users. When the current edition of *Soil Taxonomy* (2006) was used, nearly all (98%) of the subaqueous soils were classified as Sulfaquents. The proposed changes to *Soil Taxonomy* that include a new suborder Wassents seems to better accommodate subaqueous soils. Because the new approach places a higher priority on recognizing sandy textures over the presence of sulfidic materials, thus more information is conveyed in the great group classification.

There are currently six soil series approved for subaqueous soils and these series only accommodated 24% of the soils described in Chincoteague Bay. Therefore, eight additional soil series were proposed to accommodate the remainder of the soils at the series level of classification. The proposed series were differentiated based on the presence or absence of organic horizons, textural changes with depth, and n values of horizons within various portions of the profile.

Based on previous studies and the soils information collected in Chincoteague Bay we were able to evaluate the suitability of the soils as potential submerged aquatic vegetation habitat. The submerged aquatic vegetation beds are mostly located on soils with low organic carbon contents (0.2 to 7.0 g kg^{-1}), low concentration of sulfide minerals (AVS ranged from 0.0 to 0.4 g kg^{-1} and CRS ranged from 0.07 to 1.76 g kg^{-1}) and high quantities of sand (>80 %). Based on these data several soils were identified as having the greatest potential for submerged aquatic vegetation growth and success in healthy estuaries. This was a test case for Chincoteague Bay based on the past and current growth patterns of submerged aquatic vegetation. However, more research is required to determine which properties are most important in restoring submerged aquatic vegetation in degraded estuaries and coastal lagoons.

The information provided by this study enriches the current data set available on subaqueous soils and highlights the importance of the use of subaqueous soil data in ecological studies. This data set should be used in conjunction with other ecological studies to in order to identify premium restoration sites for benthic flora and fauna and to locate areas that are able to support engineering structures.

List of Appendices

Appendix A: Proposed Changes to *Soil Taxonomy*

Entisols

Key to Suborders

Entisols that have a positive water potential at the soil surface for 90% of each day.

Wassents

Key to Great Groups

Wassents that have, in all horizons within 100 cm of the mineral soil surface, an electrical conductivity of <0.2 dS m^{-1} in a 1:5 by volume mixture of soil and water.

Frasiwassents

Other Wassents that have less than 35 percent (by volume) rock fragments and a texture of loamy fine sand or coarser in all layers within the particle-size control section.

Psammowassents

Other Wassents that have sulfidic materials within 50 cm of the mineral soil surface.

Sulfiwassents

Other Wassents that have, in all horizons at a depth between 20 and 50 cm below the mineral soil surface, both an n value of more than 0.7 and 8 percent or more clay in the fine earth fraction.

Hydrowassents

Other Wassents that have either 0.2 percent or more organic carbon of Holocene age at a depth of 125 cm below the mineral soil surface or an irregular decrease in content of organic carbon from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Fluviwassents

Other Wassents.

Haplowassents

Fluviwassents

Key to Subgroups

Fluviwassents that have sulfidic materials within 100 cm of the mineral soil surface.

Sulfic Fluviwassents

Other Fluviwassents that have a lithic contact within 100 cm of the mineral soil surface.

Lithic Fluviwassents

Other Fluviwassents that have a buried layer of organic soil materials, 20 cm or more thick, that has its upper boundary within 100 cm of the mineral soil surface.

Thapto-Histic Fluviwassents

Other Fluviwassents that have a chroma of 3 or more in 40% or more of the matrix of one or more horizons between a depth of 15 and 100 cm from the soil surface.

Aeric Fluviwassents

Other Fluviwassents.

Typic Fluviwassents

Frasiwassents

Key to Subgroups

Frasiwassents that have, in all horizons at a depth between 20 and 50 cm below the mineral soil surface, both an n value of more than 0.7 and 8 percent or more clay in the fine earth fraction.

Hydric Frasiwassents

Other Frasiwassents that have a lithic contact within 100 cm of the mineral soil surface.

Lithic Frasiwassents

Other Frasiwassents have less than 35 percent (by volume) rock fragments and a texture of loamy fine sand or coarser in all layers within the particle-size control section.

Psammic Frasiwassents

Other Frasiwassents have a buried layer of organic soil materials, 20 cm or more thick, that has its upper boundary within 100 cm of the mineral soil surface.

Thapto-Histic Frasiwassents

Other Frasiwassents that have either 0.2 percent or more organic carbon of Holocene age at a depth of 125 cm below the mineral soil surface or an irregular decrease in content of organic carbon from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Fluvic Frasiwassents

Other Frasiwassents that have a chroma of 3 or more in 40% or more of the matrix of one or more horizons between a depth of 15 and 100 cm from the soil surface.

Aeric Frasiwassents

Other Frasiwassents.

Typic Frasiwassents

Haplowassents

Key to Subgroups

Haplowassents that have sulfidic materials within 100 cm of the mineral soil surface.
Sulfic Haplowassents

Other Haplowassents that have a lithic contact within 100 cm of the mineral soil surface.
Lithic Haplowassents

Other Haplowassents that have a chroma of 3 or more in 40% or more of the matrix of one or more horizons between a depth of 15 and 100 cm from the soil surface.
Aeric Haplowassents

Other Haplowassents.
Typic Haplowassents

Hydrowassents

Key to Subgroups

Hydrowassents that have sulfidic materials within 100 cm of the mineral soil surface.
Sulfic Hydrowassents

Other Hydrowassents that have, in all horizons at a depth between 20 and 100 cm below the mineral soil surface, both an n value of more than 0.7 and 8 percent or more clay in the fine earth fraction.
Grossic Hydrowassents

Other Hydrowassents that have a lithic contact within 100 cm of the mineral soil surface.
Lithic Hydrowassents

Other Hydrowassents that have a buried layer of organic soil materials, 20 cm or more thick, that has its upper boundary within 100 cm of the mineral soil surface.
Thapto-Histic Hydrowassents

Other Hydrowassents.
Typic Hydrowassents

Psammowassents

Key to Subgroups

Psammowassents that have sulfidic materials within 100 cm of the mineral soil surface.
Sulfic Psammowassents

Other Psammowassents that have a lithic contact within 100 cm of the mineral soil surface.

Lithic Psammowassents

Other Psammowassents that have either 0.2 percent or more organic carbon of Holocene age at a depth of 125 cm below the mineral soil surface or an irregular decrease in content of organic carbon from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Fluventic Psammowassents

Other Psammowassents that have a chroma of 3 or more in 40% or more of the matrix of one or more horizons between a depth of 15 and 100 cm from the soil surface.

Aeric Psammowassents

Other Psammowassents.

Typic Psammowassents

Sulfiwassents

Key to Subgroups

Sulfiwassents that have a lithic contact within 100 cm of the mineral soil surface.

Lithic Sulfiwassents

Other Sulfiwassents that have, in some horizons at a depth between 20 and 50 cm below the mineral soil surface, either or both: 1. An n value of 0.7 or less; or 2. Less than 8 percent clay in the fine-earth fraction.

Haplic Sulfiwassents

Other Sulfiwassents that have a buried layer of organic soil materials, 20 cm or more thick, that has its upper boundary within 100 cm of the mineral soil surface.

Thapto-Histic Sulfiwassents

Other Sulfiwassents that have either 0.2 percent or more organic carbon of Holocene age at a depth of 125 cm below the mineral soil surface or an irregular decrease in content of organic carbon from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.

Fluvic Sulfiwassents

Other Sulfiwassents that have a chroma of 3 or more in 40% or more of the matrix of one or more horizons between a depth of 15 and 100 cm from the soil surface.

Aeric Sulfiwassents

Other Sulfiwassents.

Typic Sulfiwassent

Wassists

Wassists are subaqueous Histosols. Defined as Histosols that have a positive water potential at the soil surface for 90% of each day. These soils are the second suborder to classify out under Histosols after Folists. The formative element Wass is derived from the German (Swiss) word “wasser” for water.

Key to Great Groups

Wassists that have, in all horizons within 100 cm of the mineral surface, an electrical conductivity of <0.2 dS m^{-1} in a 5/1 by volume mixture of water and soil.

Frasiwassists

Other Wassists that have sulfidic materials within 50 cm of the mineral soil surface.

Sulfiwassists

Other Wassists.

Haplowassists

Frassiwassists

Key to Subgroups

Other Frassiwassists that:

1. Have more thickness of fibric soil materials than any other kind of organic soil material either:
    a. In the organic parts of the subsurface tier if there is no continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier; or
    b. In the combined thickness of the organic parts of the surface and subsurface tiers if there is a continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier; and
2. Do not have a sulfuric horizon that has its upper boundary within 50 cm of the soil surface; and
3. Do not have sulfidic materials within 100 cm of the soil surface.

Fibric Frasiwassists

Other Frasiwassists that have more thickness of sapric soil materials than any other kind of organic soil material either:

1. In the organic parts of the subsurface tier if there is no continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier; or
2. In the combined thickness of the organic parts of the surface and subsurface tiers if there is a continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier.

Sapric Frasiwassists

Other Frasiwassists

Hemic Frasiwassists

Sulfiwassists

Key to Subgroups

Other Sulfiwassists that have more thickness of fibric soil materials than any other kind of organic soil material either:

1. In the organic parts of the subsurface tier if there is no continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier; or
2. In the combined thickness of the organic parts of the surface and subsurface tiers if there is a continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier.

Fibric Sulfiwassists

Other Sulfiwassists that have more thickness of sapric soil materials than any other kind of organic soil material either:

1. In the organic parts of the subsurface tier if there is no continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier; or
2. In the combined thickness of the organic parts of the surface and subsurface tiers if there is a continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier.

Sapric Sulfiwassists

Other Sulfiwassists.

Hemic Sulfiwassists

Haplowassists

Key to Subgroups

Other Haplowassists that have more thickness of fibric soil materials than any other kind of organic soil material either:

1. In the organic parts of the subsurface tier if there is no continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier; or
2. In the combined thickness of the organic parts of the surface and subsurface tiers if there is a continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier.

Fibric Haplowassists

Other Sulfiwassists that have more thickness of sapric soil materials than any other kind of organic soil material either:

1. In the organic parts of the subsurface tier if there is no continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier; or
2. In the combined thickness of the organic parts of the surface and subsurface tiers if there is a continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier.

Sapric Haplowassists

Other Sulfiwassists.

Hemic Haplowassists

Appendix B: Landforms, Map Units, and Classification of Soil Pedons

Pedon	**Landform**	**Soil Map Unit**	**Current Soil Classification (Proposed Soil Classification)**	**Series**
CB01	Storm-surge washover fan flat	Deα	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas
CB02	Storm-surge washover fan flat, scour channel	Deα	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas
CB03	Storm-surge washover fan flat	Deα	Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)	Thorofare
CB04	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB05	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB06	Mainland Cove	Spβ	Fine-loamy, Typic Sulfaquents (Fine-loamy, Fluvic Sulfiwassents)	Figgs
CB07	Storm-surge washover fan flat	Deα	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas
CB08	Storm-surge washover fan slope	Thβ	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas
CB09	Mainland cove	Spβ	Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)	Unnamed C
CB10	Barrier cove	Mmβ	Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)	Thorofare
CB11	Submerged wave-cut headland	Spβ	Fine, Thapto-Histic Sulfaquents (Fine, Thapto-Histic Sulfiwassents)	Southpoint Tax.
CB12	Storm-surge washover fan slope	Thβ	Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)	Thorofare
CB13	Storm-surge washover fan slope	Thβ	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas
CB14	Lagoon bottom	Ctγ	Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)	Cottman
CB15	Lagoon bottom	Ctγ	Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)	Cottman
CB16	Storm-surge washover fan slope	Thβ	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas

Appendix B: Continued.

Pedon	Landform	Soil Map Unit	Current Soil Classification (Proposed Soil Classification)	Series
CB17	Storm-surge washover fan flat, scour channel	Deα	Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)	Thorofare
CB18	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB19	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB20	Lagoon bottom	Tgδ	Fine-loamy, Typic Sulfaquents (Fine-loamy, Fluvic Sulfiwassents)	Truitt Tax.
CB21	Submerged wave-cut headland	Spβ	Fine-loamy, Thapto-Histic Sulfaquents (Fine-loamy, Thapto-Histic Sulfiwassents)	Southpoint Tax.
CB22	Submerged wave-cut headland	Spβ	Fine-loamy, Thapto-Histic Sulfaquents (Fine-loamy, Thapto-Histic Sulfiwassents)	Southpoint Tax.
CB23	Mainland cove	Spβ	Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)	Southpoint Tax.
CB24	Mainland cove	Spβ	Coarse-silty, Thapto-Histic Sulfaquents (Coarse-silty, Thapto-Histic Sulfiwassents)	Southpoint Tax.
CB25	Mainland cove	Spβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB26	Mainland cove	Spβ	Fine, Haplic Sulfaquents (Fine, Haplic Sulfiwassents)	Southpoint Tax.
CB27	Mainland cove	Spβ	Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)	Cottman
CB28	Storm-surge washover fan flat	Deα	Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)	Cottman
CB29	Storm-surge washover fan slope	Thβ	Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)	Thorofare
CB30	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB31	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles

Appendix B: Continued.

Pedon	Landform	Soil Map Unit	Current Soil Classification (Proposed Soil Classification)	Series
CB32	Mainland cove	Spβ	Fine-loamy, Typic Sulfaquents (Fine-loamy, Fluvic Sulfiwassents)	Truitt Tax.
CB33	Mainland cove	Spβ	Coarse-loamy, Typic Sulfaquents (Coarse-loamy, Aeric Sulfiwassents)	Unnamed C
CB34	Mainland cove	Spβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB35	Submerged wave-cut headland	Trα	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB36	Submerged wave-cut headland	Trα	Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)	Cottman
CB37	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB38	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB39	Mainland Cove	Trα	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Middlemoor
CB40	Lagoon bottom	Tgβ	Fine-loamy, Typic Sulfaquents (Fine-loamy, Fluvic Sulfiwassents)	Figgs
CB41	Lagoon bottom	Tgβ	Fine-loamy, Typic Sulfaquents (Fine-loamy, Fluvic Sulfiwassents)	Figgs
CB42	Lagoon bottom	Tgβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB43	Lagoon bottom	Tgβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB44	Storm-surge washover fan flat	Deα	Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)	Cottman
CB45	Storm-surge washover fan flat	Deα	Sandy over loamy, Haplic Sulfaquents (Sandy over loamy, Haplic Sulfiwassents)	Tizzard
CB46	Lagoon bottom	Tgβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles

Appendix B: Continued.

Pedon	Landform	Soil Map Unit	Current Soil Classification (Proposed Soil Classification)	Series
CB47	Lagoon bottom	Tgβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB48	Fluviomarine bottom	Coβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB49	Lagoon bottom	Tgδ	Coarse-loamy, Typic Sulfaquents (Coarse-loamy, Fluvic Sulfiwassents	Sinepuxent
CB50	Lagoon bottom	Tgδ	Coarse-silty, Sulfic Hydraquents (Coarse-silty, Sulfic Hydrowassents)	Unnamed B
CB51	Submerged wave-cut headland	Trα	Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)	Cottman
CB52	Barrier cove	Mmβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Middlemoor
CB53	Barrier cove	Mmβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Middlemoor
CB54	Storm-surge washover fan flat	Deα	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas
CB55	Storm-surge washover fan slope	Thβ	Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)	Cottman
CB56	Storm-surge washover fan flat	Deα	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas
CB57	Barrier cove	Mmα	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas
CB58	Lagoon bottom	Ctγ	Coarse-loamy, Typic Sulfaquents (Coarse-loamy, Fluvic Sulfiwassents	Sinepuxent
CB59	Barrier cove	Mmα	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Middlemoor
CB60	Barrier cove	Mmα	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Middlemoor
CB61	Barrier cove	Mmα	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB62	Barrier cove	Mmα	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB63	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB64	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Middlemoor

Appendix B: Continued.

Pedon	Landform	Soil Map Unit	Current Soil Classification (Proposed Soil Classification)	Series
CB65	Storm-surge washover fan slope	Thβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB66	Lagoon bottom	Ctγ	Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)	Cottman
CB67	Shoal	Deβ	Fine-loamy, Typic Sulfaquents (Fine-loamy, Fluvic Sulfiwassents)	Figgs
CB68	Shoal	Deβ	Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)	Cottman
CB69	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB70	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB71	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB72	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB73	Mainland cove	Spβ	Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)	Cottman
CB74	Paleo-flood tidal delta	Dmβ	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas
CB75	Lagoon bottom	Ctγ	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas
CB76	Paleo-flood tidal delta	Dmβ	Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)	Thorofare
CB77	Paleo-flood tidal delta	Dmβ	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas
CB78	Lagoon bottom	Ctγ	Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)	Thorofare
CB79	Lagoon bottom	Ctγ	Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)	Thorofare
CB80	Fluviomarine bottom	Coβ	Coarse-loamy, Typic Sulfaquents (Coarse-loamy, Aeric Sulfiwassents)	Unnamed C
CB81	Fluviomarine bottom	Coβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Coards
CB82	Fluviomarine bottom	Coβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Coards
CB83	Fluviomarine bottom	Coβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Coards
CB84	Mainland cove	Trα	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Truitt

Appendix B: Continued.

Pedon	Landform	Soil Map Unit	Current Soil Classification (Proposed Soil Classification)	Series
CB85	Mainland cove	Trα	Fine-loamy, Typic Sulfaquents (Fine-loamy, Fluvic Sulfiwassents)	Figgs
CB86	Mainland cove	Trα	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Southpoint Tax.
CB87	Submerged wave-cut headland	Trα	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Coards
CB88	Fluviomarine bottom	Coβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Coards
CB89	Fluviomarine bottom	Coβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Coards
CB90	Fluviomarine bottom	Coβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Coards
CB91	Fluviomarine bottom	Coβ	Fine-loamy, Typic Sulfaquents (Fine-loamy, Fluvic Sulfiwassents)	Figgs
CB92	Fluviomarine bottom	Coβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Coards
CB93	Fluviomarine bottom	Coβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Coards
CB94	Fluviomarine bottom	Coβ	Fine, Typic Sulfaquents (Fine, Fluvic Sulfiwassents)	Coards
CB95	Fluviomarine bottom	Coβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Coards
CB96	Fluviomarine bottom	Coβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Truitt
CB97	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Truitt
CB98	Mainland cove	Spβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB99	Lagoon bottom	Tgδ	Fine-silty, Thapto-Histic Sulfaquents (Fine-silty, Thapto-Histic Sulfiwassents)	Southpoint
CB100	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB101	Mainland cove	Spβ	Fine-silty, Thapto-Histic Sulfaquents (Fine-silty, Thapto-Histic Sulfiwassents)	Southpoint
CB102	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Truitt
CB103	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB104	Lagoon bottom	Tgδ	Fine-loamy, Haplic Sulfaquents (Fine-loamy, Haplic Sulfiwassents)	Truitt Tax.

Appendix B: Continued.

Pedon	Landform	Soil Map Unit	Current Soil Classification (Proposed Soil Classification)	Series
CB105	Submerged wave-cut headland	Spβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Southpoint Tax.
CB106	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB107	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB108	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB109	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB110	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB111	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB112	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB113	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB114	Lagoon bottom	Tgδ	Fine-loamy, Typic Sulfaquents (Fine-loamy, Fluvic Sulfiwassents)	Figgs
CB115	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB116	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB117	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Middlemoor
CB118	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB119	Submerged wave-cut headland	Siβ	Coarse-loamy, Typic Sulfaquents (Coarse-loamy, Typic Sulfiwassents)	Sinepuxent
CB120	Mainland cove	Siβ	Coarse-loamy, Typic Sulfaquents (Coarse-loamy, Typic Sulfiwassents)	Sinepuxent
CB121	Mainland cove	Siβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Truitt
CB122	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB123	Shoal	Deβ	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas

Appendix B: Continued.

Pedon	Landform	Soil Map Unit	Current Soil Classification (Proposed Soil Classification)	Series
CB124	Submerged wave-cut headland	Spβ	Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)	Southpoint Tax.
CB125	Shoal	Deβ	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas
CB126	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Truitt
CB127	Mainland cove	Spβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Truitt
CB128	Mainland cove	Spβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB129	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Middlemoor
CB130	Fluviomarine bottom	Coβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Coards
CB131	Storm-surge washover fan slope	Thβ	Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)	Thorofare
CB132	Storm-surge washover fan slope	Thβ	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas
CB133	Shoal	Deβ	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas
CB134	Submerged wave-cut headland	Spβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Truitt
CB135	Submerged wave-cut headland	Spβ	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas
CB136	Submerged wave-cut headland	Spβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Truitt
CB137	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB138	Storm-surge washover fan slope	Thβ	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas
CB139	Shoal	Deβ	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas
CB140	Shoal	Deβ	Sandy, Haplic Sulfaquents (Sulfic Psammowassents)	Demas

Appendix B: Continued.

Pedon	**Landform**	**Soil Map Unit**	**Current Soil Classification (Proposed Soil Classification)**	**Series**
CB141	Lagoon bottom	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles
CB142	Mainland cove	Spβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Truitt
CB143	Mainland cove	Spβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Middlemoor
CB144	Submerged wave-cut headland	Spβ	Fine-loamy, Typic Sulfaquents (Fine-loamy, Fluvic Sulfiwassents)	Figgs
CB145	Submerged wave-cut headland	Spβ	Fine-silty, Terric Sulfisaprists (Sapric Sulfiwassists)	Tumagan
CB146	Submerged wave-cut headland	Spβ	Fine-silty, Terric Sulfisaprists (Sapric Sulfiwassists)	Tumagan

Appendix C: Soil Morphological Descriptions

Abbreviations Used in Soil Morphological Descriptions

Horizon Nomenclature:

Based on accepted master horizons and suffix notations in the Field Book for Describing and Sampling Soils, Version 2.0 (Schoenberger et al., 2002) and Keys to Soil Taxonomy, 10th ed. (Soil Survey Staff, 2006).

USDA Textural Class: From the Field Book for Describing and Sampling Soils, Version 2.0 (Schoenberger et al., 2002)

S (sand), cS (coarse sand), fS (fine sand), LS (loamy sand), LfS (loamy fine sand), SL (sandy loam), fSL (fine sandy loam), vfSL (very fine sandy loam), SCL (sandy clay loam), L (loam), SiL (silt loam), SiCL (silty clay loam), CL (clay loam), SiC (silty clay), C (clay), MkSiL (mucky silt loam), MkL (mucky loam), Mk (muck).

Feature Abundance: From the Field Book for Describing and Sampling Soils, Version 2.0 (Schoenberger et al., 2002)

f (faint), d (distinct), p (prominent)

Structure: From the Field Book for Describing and Sampling Soils, Version 2.0 (Schoenberger et al., 2002)

Grade: 0 (none), 1 (weak), 2 (moderate)

Shape: sg (single grain), ma (massive), gr (granule), sbk (subangular blocky), pr (prismatic)

Moist Consistence: From the Field Book for Describing and Sampling Soils, Version 2.0 (Schoenberger et al., 2002)

l (loose), vfr (very friable), fr (friable), fi (firm)

Wet Consistence: From the Field Book for Describing and Sampling Soils, Version 2.0 (Schoenberger et al., 2002)

ns (non sticky), ss (slightly sticky), ms (moderately sticky), vs (very sticky)
np (non plastic), vp (very plastic)

n value: From the Keys to Soil Taxonomy, 10th ed. (Soil Survey Staff, 2006)

Values based on "squeeze test": <0.7 (material does not flow between fingers when squeezed), 0.7-1 (material flows with some difficulty between fingers when squeezed), >1 (material flows easily between fingers when squeezed), >>1 (material runs through fingers without squeezing)

Boundary: From the Field Book for Describing and Sampling Soils, Version 2.0 (Schoenberger et al., 2002)

a (abrupt), c (clear), g (gradual)

Sample CB01

Sandy, Haplic Sulfaquents (Sulfic Psammowassents)
38˚ 07’ 05.57” N, 75˚ 12’ 02.62” W
Water Depth 69 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	14	a	S	fS	10Y 3/1			0	sg	lo	<0.7			None
Cg1	76	a	S	fS	10Y 5/1			0	sg	lo	<0.7			Strong
Cg2	103	c	fS	fS	5GY 4/1	10	10YR 3/2	0	ma	vfr	<0.7		1	Strong
Cg3	170	c	LfS	fS	5GY 4/1			0	ma	vfr	<0.7			Strong
Cg4	210	-	fSL	LfS	5GY 3/1	0.5	10YR 3/2	0	ma	vfr	<0.7			Strong

Remarks: Profile description by D.M. Balduff, M.C. Rabenhorst, and P.T. Morton; 17 August 2004 at 9:25 am
Sampled using a vibracorer; depth inside core 93 cm, depth outside core 86 cm
Large clam shell at 76 cm
Krotovina at 28 cm, 2cm wide filled with N 2.5/ soil

Sample CB02

Sandy, Haplic Sulfaquents (Sulfic Psammowassents)
38˚ 06' 37.84" N, 75˚ 12' 41.44" W
Water Depth 177 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.			Abun. %	Color	Gr.	Shape					
A	14	a	fS/LfS	10Y 2.5/1			0	ma	vfr	<0.7		1	Strong
Cg/A	30	c	LfS	5GY 3/1 10Y 2.5/1 (10%)			0	ma	vfr	<0.7			Strong
Cg1	73	c	LfS/fSL	5GY 3/1			0	ma	fr	<0.7			Strong
Cg2	103	c	LfS/fSL	5GY 3/1	4	10YR 3/3	0	ma	vfr	<0.7		5	Strong
Cg3	136	-	fS	5GY 3/1			0	ma	vfr	<0.7			Strong

Remarks: Profile description by D.M. Balduff, M.C. Rabenhorst, and P.T. Morton; 17 August 2004 at 11:54 am
Sampled using a vibracorer; depth inside core 184 cm, depth outside core 177 cm
Presence of decomposed eelgrass on surface

Sample CB03

Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)
38˚ 06’ 27.96” N, 75˚ 13’ 02.91” W
Water Depth 109 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	8	a	S	5Y 2.5/1			0	ma	lo	<0.7			Strong
Cg1	43	a	S	5Y 4/1 5Y 2.5/1 (15%)			0	ma	lo	<0.7			Strong
Cg2	86	c	fS	5Y 2.5/1			0	ma	vfr	0.7-1			Strong
2Cg3	109	c	fSL/L	10Y 3/1	1	10YR 3/2	0	ma	fr	<0.7		15	Strong
2Cg4	134	g	fSL	5GY 3/1	1	10YR 3/2	0	ma	fr	<0.7			Strong
2Cg5	149	-	LfS	10GY 3.5/1			0	ma	vfr	<0.7			Strong

Remarks: Profile description by D.M. Balduff, M.C. Rabenhorst, and P.T. Morton; 17 August 2004 at 1:43 pm
Sampled using a vibracorer; depth inside core 104 cm, depth outside core 97 cm

Sample CB04

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 07'27.48" N, 75˚ 16' 37.84" W
Water Depth 230 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	6	c	SiC/SiCL		10GY 2.5/1			0	ma	vfr	>1			Strong
Cg1	32	g	SiC/SiCL	SiL	5GY 2.5/1			0	ma	vfr	>1		1	Strong
Cg2	111	c	SiC/SiCL	SiL/SiCL	5GY 3/1			0	ma	vfr	>1		1	Strong
Cg3	149	-	SiC/SiCL	SiCL	10GY 3.5/1	1-2	10YR 3/3	0	ma	vfr	>1			Strong

Remarks: Profile description by D.M. Balduff, M.C. Rabenhorst, and P.T. Morton; 18 August 2004 at 8:14 am
Sampled using a McCauley sampler

Sample CB05

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 07' 33.36" N, 75˚ 16' 53.29" W
Water Depth 230 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	6	a	SiC/SiCL	N 3/			0	ma	vfr	>1			Strong
A2	37	c	SiC/SiCL	N 2.5/			0	ma	vfr	>>1			Strong
Cg1	94	g	SiC/SiCL	5GY 3/1	1	10YR 3/2	0	ma	vfr	>1		1	Strong
Cg2	152	-	SiC/SiCL	10Y 3.5/1			0	ma	vfr	>1			Strong

Remarks: Profile description by D.M. Balduff, M.C. Rabenhorst, and P.T. Morton; 18 August 2004 at 8:40 am
Sampled using a McCauley sampler
A2 had a "jelly" consistence

Sample CB06

Fine-loamy, Typic Sulfaquents (Fine-loamy, Fluvic Sulfiwassents)
38˚ 07' 39.00" N, 75˚ 17' 07.46" W
Water Depth 215 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	3	a	SiC/SiCL		10Y 3/1			0	ma	vfr	>1			Strong
Cg1	59	a	SiC/SiCL	SiCL	5GY 2.5/1			0	ma	vfr	>1			Strong
2Cg2	81	c	fSl/SCL	fSL	10Y 3/1			0	ma	fr	0.7-1		0.5	Strong
2Cg3	107	c	fSl	LfS	10Y 4/1	1	10YR 3/2	0	ma	vfr	0.7-1			Strong
2Cg4	125	a	fSL		5Y 5/1			0	ma	vfr	0.7-1			Strong
2Cg5	153	-	LfS		5Y 6/1			0	ma	vfr	<0.7			Strong

Remarks: Profile description by D.M. Balduff, M.C. Rabenhorst, and P.T. Morton; 18 August 2004 at 8:54 am
Sampled using a McCauley sampler

Sample CB07

Sandy, Haplic Sulfaquents (Sulfic Psammowassents)
38˚ 08' 23.89" N, 75˚ 12' 01.00" W
Water Depth 72 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	3	a	LfS	5Y 4/1			0	ma	vfr	<0.7	5		None
Cg/A	19	a	fS	10Y 5/1 5Y 3/1 (10%)			0	sg	lo	<0.7			Strong
Cg1	56	c	fS	5GY 3.5/1			0	sg	lo	<0.7			Strong
Cg2	110	c	LfS	5GY 3/1	2	10YR 3/2	0	ma	vfr	<0.7		3	Strong
Cg3	132	a	LfS	5GY 2.5/1			0	ma	vfr	<0.7		0.5	
Cg4	154	-	S	5GY 4/1			0	sg	lo	<0.7			

Remarks: Profile description by D.M. Balduff, C.C. Coppock, A.L. Gray; 23 August 2004 at 11:08 am
Sampled using a vibracorer; depth inside core 150 cm, depth outside core 148 cm
Eelgrass on surface
Clam shell in Cg2; Mud Snail shell in Cg3

Sample CB08

Sandy, Haplic Sulfaquents (Sulfic Psammowassents)
38˚ 08' 49.72" N, 75˚ 12' 44.89" W
Water Depth 131 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	4	a	S	5Y 4/2			0	sg	lo	<0.7			None
A2	24	c	S	5Y 3.5/1			0	sg	lo	<0.7			Strong
Cg1	37	c	fS	10Y 3/1			0	sg	lo	<0.7		0.5	Strong
Cg2	47	c	LfS	10Y 3/1			0	ma	vfr	<0.7			Strong
Cg3	84	g	LfS	10Y 3/1			0	ma	vfr	<0.7		1	Strong
Cg4	134	c	S	5GY 4/1	1	10YR 3/2	0	sg	lo	<0.7			Strong
2Cg5	142	-	fSL	5GY 4/1			0	ma	vfr	0.7-1			Strong

Remarks: Profile description by D.M. Balduff, C.C. Coppock, A.L. Gray; 23 August 2004 at 1:09 pm
Sampled using a vibracorer; depth inside core 151 cm, depth outside core 146 cm

Sample CB09

Sandy, Haplic Sulfaquents (Sulfic Psammowassents)

38˚ 07’ 41.93” N, 75˚ 17’ 35.15” W

Water Depth 175 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Redoximorphic Features		Organic Fragments		Structure		Moist Const.	n value	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Abun.%	Color	Gr.	Shape				
A1	2	a	LS/Sl	-	5Y 4/1					0	ma	vfr	0.7-1		None
A2	16	a	LS/SL	LfS	10Y 3/1					0	ma	vfr	0.7-1	1	None
Cg1	22	c	LS	LfS	10Y 3/1					0	ma	vfr	<0.7		None
Cg2	42	c	LfS	fSL	5Y 4/1			5 f,D	10YR 3/3	0	ma	vfr	<0.7		None
Cg/Bwb	53	c	SL	LfS/fSL	5Y 5/1	5 P 3 P	10YR 4/4 10YR 5/6	8 m,D	10YR 3/3	0	ma	vfr	<0.7		None
2Bgb	76	c	SL	fSL	5Y 4/2	7 D 2 P	10YR 4/4 N 2.5/	2 f,D	10YR 3/3	0	ma	vfr	<0.7		None
2Bwb1	98	c	LS	LfS	2.5Y 4/3	20 D 5 P	10YR 4/6 N 2.5/			0	ma	vfr	<0.7		None
2Bwb2	108	c	SL	SL	2.5Y 4/3	10 P 15 D	5Y 5/1 10YR 5/6			0	ma	vfr	<0.7		None
2BCgb	118	a	LS	LfS	5Y 5/1	2 D 3 P	10Y 6/1 10YR 4/6			0	ma	vfr	<0.7		None
2Cgb1	133	a	SL	fSL	5GY5.5/1	8 P	10YR 4/6			0	ma	vfr	<0.7		None
2Cgb2	151	-	S	LfS	5GY 6/1					0	sg	vfr	<0.7		None

Remarks: Profile description by D.M. Balduff, C.C. Coppock, A.L. Gray; 23 August 2004 at 3:30 pm.
Sampled using a vibracorer; depth inside core 252 cm, depth outside core 249 cm.

Sample CB10

Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)
38˚ 05’ 33.68” N, 75˚ 12’ 57.21” W
Water Depth 110 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	17	a	LfS	fS	10Y 3/1 5Y 4/2 (3%),			0	ma	vfr	<0.7	2		Strong
Cg1	51	c	fS	fS	5Y 3.5/1			0	sg	lo	<0.7			Strong
2Cg2	64	a	fSL	LfS	10Y 3/1			0	ma	vfr	<0.7		2	Strong
2Cg3	84	c	SL/L	fSL	10Y 3/1			0	ma	vfr	0.7-1		3	Strong
2Cg4	89	a	LS	LfS	10Y 3/1	1 f,D	10YR 3/2	0	ma	vfr	<0.7			Strong
3Cg5	134	-	S	fS	10Y 4/1			0	sg	lo	<0.7		1	Strong

Remarks: Profile description by D.M. Balduff, C.C. Coppock, and A.L. Gray; 24 August 2004 at 9:30 am
Sampled using a vibracorer; depth inside core 173 cm, depth outside core 163 cm
Eelgrass on surface
Large clam shell Cg3
Krotovina at 33 cm, 2cm wide filled with N 2.5/ soil

Sample CB11

Fine, Thapto-Histic Sulfaquents (Fine, Thapto-Histic Sulfiwassents)
38˚ 06' 34.32" N, 75˚ 18' 19.96" W
Water Depth 140 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Redoximorphic Features		Organic Fragments		Structure		Moist Const.	n value	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Abun.%	Color	Gr.	Shape				
A1	2	a	fSL	-	5Y 3/1					0	ma	vfr	>1		Strong
A2	12	a	fSL	LfS/fSL	N 2.5/					0	ma	vfr	>1		Strong
2Cg1	36	g	SiCL/ SiC	SiCL	10Y 3/1					0	ma	vfr	>>1		Strong
2Cg2	56	a	SiCL/ SiC	SiCL	10Y 3/1			3 f,D	10YR 3/2	0	ma	vfr	>>1		Strong
Oab1	83	c	MK	-	7.5YR 2.5/1			5 m,D	2.5Y 5/6	0					Strong
Oab2	109	a	MK	-	10YR 2/1			5 m,D	2.5Y 5/6	0					Strong
3Ab	115	a	MkL	CL	N 2.5/					0	ma	vfr	>>1		Strong
3Cgb	122	-	SiCL	L	10YR 4/1	1 f,P	5Y 5/1	3 f, D	2.5Y 5/6	0	ma	vfr	0.7-1		Strong

Remarks: Profile description by D.M. Balduff, C.C. Coppock, and A.L. Gray; 24 August 2004 at 2:05 am
Sampled using a vibracorer; depth inside core 185 cm, depth outside core 180 cm
Bands of 10Y 3/1 mineral material 1cm thick in Oab1.

Sample CB12

Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)
38˚ 06' 28.45" N, 75˚ 13' 17.17" W
Water Depth 130cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	2	a	S	5Y 4/1			0	sg	lo	<0.7			None
A2	12	c	S	N 3/			0	sg	lo	<0.7			None
Cg1	56	a	S	N 3.5/			0	sg	lo	<0.7		2	Strong
Cg2	78	a	fS	5GY 4/1	5 f,D	10YR 3/2	0	sg	lo	<0.7			Strong
2Cg3	102	c	fSL	5GY 3.5/1	12 f,D	10YR 3/2	0	ma	vfr	<0.7			Strong
2Cg4	109	c	fSL/L	5GY 3.5/1	1 f,D	10YR 3/2	0	ma	vfr	>1		2	Strong
2Cg5	126	c	fSL/L	5GY 3.5/1			0	ma	vfr	0.7-1			Strong
2Cg6	151	-	fSL/L	5GY 3/1	3 f,D	10YR 3/2	0	ma	vfr	0.7-1			Strong

Remarks: Profile description by D.M. Balduff and C.C. Coppock; 25 August 2004 at 9:30 am.
Sampled using a vibracorer; depth inside core 156 cm, depth outside core 158 cm

Sample CB13

Sandy, Haplic Sulfaquents (Sulfic Psammowassents)
38˚ 06’ 29.91” N, 75˚ 13’ 23.23” W
Water Depth 166cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	5	c	fS	5Y 4/1			0	sg	lo	<0.7		1	None
A2	38	c	fS	N 3/			0	sg	lo	<0.7		0.5	None
Cg1	62	a	fS	N 3.5/			0	sg	lo	<0.7		0.5	None
2Cg2	78	c	fSL	5GY 3/1	1 f,D	10YR 3/2	0	ma	vfr	<0.7			Strong
2Cg3	98	c	fSL	5GY 3.5/1	0.5 f,D	10YR 3/2	0	ma	vfr	<0.7			Strong
2Cg4	134	c	fSL	5GY 3.5/1	0.5 f,D	10YR 3/2	0	ma	vfr	<0.7		0.5	Strong
3Cg5	149	a	LfS	5GY 3.5/1	0.5 f,D	10YR 3/2	0	ma	vfr	<0.7			Strong
3Cg6	182	-	S	5GY 4/1			0	sg	lo	<0.7		2	None

Remarks: Profile description by D.M. Balduff, C.C. Coppock; 25 August 2004 at 11:47 am.
Sampled using a vibracorer; depth inside core 209 cm, depth outside core 205 cm
Scallop shell at 60 cm in Cg1

Sample CB14

Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)
38˚ 06’ 37.08” N, 75˚ 13’ 49.42” W
Water Depth 255 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	10	c	fSL	5GY 3/1			0	ma	vfr	>1			Strong
A2	25	-	fSL	5GY 4/1			0	ma	vfr	>1			Strong

Remarks: Profile description by D.M. Balduff, C.C. Coppock; 25 August 2004 at 1:27 pm.
Sampled using a McCauley sampler (Could not go past 25 cm)

Sample CB15

Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)
38° 06' 50.03" N, 75° 14' 28.87" W
Water Depth 290cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	13	c	fSL	5GY 3/1			0	ma	vfr	>1			Strong
Cg1	37	c	L	5GY 3/1			0	ma	vfr	>1		1	Strong
Cg2	79	c	fSL	5GY 4/1	1 f,D	10YR 3/2	0	ma	vfr	0.7-1			Strong
Cg3	109	-	fSL	5GY 3.5/1			0	ma	vfr	0.7-1		1	Strong

Remarks: Profile description by D.M. Balduff, C.C. Coppock; 25 August 2004 at 3:30 pm.
Sampled using a McCauley sampler (could not go deeper than 110 cm).

Sample CB16

Sandy, Haplic Sulfaquents (Sulfic Psammowassents)
38˚ 07’ 50.15” N, 75˚ 12’ 55.35” W
Water Depth 172 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	2	a	fS	-	5Y 4/2			0	ma	NSNP	<0.7			None
A2	22	c	fS	fS	10Y 3/0.5			0	ma	NSNP	<0.7			Strong
Cg1	37	g	fS	fS	10Y 3/1			0	ma	NSNP	<0.7			Strong
Cg2	67	c	LfS/fSL	LfS	10Y 3/1	1 f,P	10YR 3/4	0	ma	NSNP	<0.7			Strong
Cg3	80	c	LfS	fS	2.5GY 3.5/1			0	ma	NSNP	<0.7		3	Strong
Cg4	114	c	fS	fS	5GY 4/0.5			0	ma	NSNP	<0.7			Strong
Cg5	187	c	LfS	fS	10Y 3/1			0	ma	NSNP	<0.7		1	Strong
Cg6	215	-	fS	fS	5GY 4/0.5			0	ma	NSNP	<0.7			Strong

Remarks: Profile description by D.M. Balduff, M.C. Rabenhorst, and M.H. Stolt; 21 September 2004 at 10:59 am. Sampled using a vibracorer; depth inside core 177 cm, depth outside core 170 cm.

Sample CB17

Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)
38˚ 07' 51.75" N, 75˚ 11' 38.86" W
Water Depth 100 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	8	a	LfS	fS	7.5Y 3/0.5			0	ma	NPNS	<0.7			-
Cg/A	32	c	LfS	fS	7.5Y 4/0.5 (70) 7.5Y 3.0.5 (30)			0	ma	NPNS	<0.7		1	-
2Cg1	54	c	L	fSL	2.5GY 3/1	2 f,P	10YR ¾	0	ma	VS	<0.7		1	-
2Cg2	77	a	fSL	LfS	2.5GY 3/1	1 f,P	2.5Y 5/4	0	ma	NPSS	<0.7		1	-
3Cg3	102	a	S	fS	10Y 5/1 N 2.5/ (5)			0	ma	NPNS	<0.7			-
3Cg4	148	-	fS	fS	10Y 4/0.5			0	ma	NPNS	<0.7			-

Remarks: Profile description by D.M. Balduff, M.C. Rabenhorst, and M.H. Stolt; 21 September 2004 at 1:20 pm. Sampled using a vibracorer; depth inside core 158 cm, depth outside core 143 cm.

Sample CB18

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 08' 19.95" N, 75˚ 14' 43.10" W
Water Depth 270 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	8	a	SiCL/SiC	-	10Y 2.5/0.5			0	ma	VS	>>>1			None
Cg	245	-	SiCL/SiC	SiCL/CL	10Y 3/1			0	ma	VS	>>1			Strong

Remarks: Profile description by D.M. Balduff, M.C. Rabenhorst, and M.H. Stolt; 21 September 2004 at 3:00 pm.
Sampled using a McCauley sampler.
Oxidized zone 2mm thick.
Sandy layer with shells from 204-208 cm.

Sample CB19

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 08’ 08.52” N, 75˚ 14’ 17.82” W
Water Depth 280 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	9	a	SiCL/SiC	10Y 2.5/0.5			0	ma	VS	>>1			None
Cg1	38	a	SiCL/SiC	10Y 3/1			0	ma	VS	>>1			None
2Cg2	50	-	L	10Y 3/1			0	ma	SS	<0.7		2	None

Remarks: Profile description by D.M. Balduff, M.C. Rabenhorst, and M.H. Stolt; 21 September 2004 at 4:00 pm.
Sampled using a McCauley sampler.
Worm tubes on surface.

Sample CB20

Fine-loamy, Haplic Sulfaquents (Fine-loamy, Haplic Sulfiwassents)
38˚ 08’ 16.28” N, 75˚ 14’ 30.77” W
Water Depth 275 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	8	a	SiCL	10Y 2.5/1			0	ma		>1			
Cg1	32	c	SiC/SiCL	10Y 3/1			0	ma		>1			
2Cg2	60	c	fSL	10Y 3/0.5			0	ma		<0.7		2	
2Cg3	115	c	fSL	10Y 3/0.5			0	ma		0.7-1		1	
3Cg4	153	a	L	10Y 3/1			0	ma		0.7-1		1	
3Oab	184	a	MK	5YR 2.5/2								Trace	Strong
3Ab	193	c	SiL/L	2.5Y 2.5/1	2 f,P	7.YR 4/3	0	ma		<0.7			Strong
3Cgb	200	-	SiL/SiCL	10Y 5/1	2 f,P	2.5YR 4/3	0	ma		<0.7			Strong

Remarks: Profile description by D.M. Balduff, M.C. Rabenhorst, and M.H. Stolt; 21 September 2004 at 4:10 pm.
Sampled using a McCauley sampler.
Worm tubes and razor clam on surface.

Sample CB21

Fine-loamy, Thapto-Histic Sulfaquents (Fine-loamy, Thapto-Histic Sulfiwassents)
38˚ 09’ 13.34” N, 75˚ 16’ 37.98” W
Water Depth 173 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	2	a	SiL/SiCL	CL	5Y 4/2			0	ma		>1			None
A2	18	a	SiL/SiCL	CL	10Y 2.5/0.5			0	ma		>1			None
Oab	58	a	MK	-	10YR 2/1									Strong
Ab	62	c	L	L	2.5Y 3/2	1 m,P	10YR 3/4	1	f,m gr		<0.7			None
BAgb	71	c	L	L	2.5Y 4/1	5 m,P	2.5Y 4/3	1	m sbk		<0.7			None
Btgb	96	a	SiCL	C	N 3.5 10Y 3/1 (15)	7 m,P	2.5Y 4/3	2	m pr m sbk		<0.7			None
2Cgb	134	-	S	LfS	10Y 6/1			0	sg	lo	<0.7			None

Remarks: Profile description by D.M. Balduff, M.C. Rabenhorst, M.H. Stolt, and P. King; 22 September 2004 at 8:37 am. Sampled using a vibracorer; depth inside core 266 cm, depth outside core 262 cm.

Sample CB22

Fine-loamy, Thapto-Histic Sulfaquents (Fine-loamy, Thapto-Histic Sulfiwassents)
38˚ 09’ 14.38” N, 75˚ 16’ 44.63” W
Water Depth 120 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	3	a	L	5Y 4/2			0	ma		>1			
A2	9	a	L	N 2.5/			0	ma		>1			
Cg	28	a	L	10Y 2.5/0.5	30 m,P	10YR 3/4	0	ma		>1			
Oab	50	a	MK	10YR 2/1									
Ab	58	c	L	2.5Y 3/2	5 f,P	10YR 3/4	0	ma		0.75			
Cgb	102	-	CL	2.5Y 4/1	3 f,P	2.5Y 4/3	0	ma		0.75			

Remarks: Profile description by D.M. Balduff, M.C. Rabenhorst, M.H. Stolt, and P. King; 22 September 2004 at 10:51 am. Sampled using a McCauley sampler.

Sample CB23

Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)
38˚ 08’ 50.48” N, 75˚ 17’ 04.40” W
Water Depth 149 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	9	a	LfS	5Y 3/0.5			0	ma	NSNP	<0.7			
Cg/A	21	c	LfS	10Y 3.5/0.5 5Y 3/1.5 (25)			0	ma	NSNP	<0.7		2	
Cg1	40	c	LfS	10Y 3/0.7			0	ma	NSNP	<0.7			
Cg2	56	a	S	5Y 4/1 10Y 3/0.7 (40)			0		NSNP	<0.7			
Oab1	107	a	MK	10YR 2/2									Strong
Oab2	137	a	MK	10YR 2/1									Strong
A/C	146	-	MK fSL	10YR 2/1	3 f,D	10YR 3/4	0	ma	NSNP	0.7-1			Strong

Remarks: Profile description by D.M. Balduff, M.C. Rabenhorst, M.H. Stolt, and P. King; 22 September 2004 at 11:15 am.
Sampled using a vibracorer; depth inside core 160 cm, depth outside core 150 cm.
Oxidized surface 1 cm thick 5Y 4/2. Lenses of 10Y 5/1 in A/C horizon.

Sample CB24

Coarse-loamy, Thapto-Histic Sulfaquents (Coarse-loamy, Thapto-Histic Sulfiwassents)
38˚ 07' 55.29" N, 75˚ 17' 27.17" W
Water Depth 155 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	2	a	fSL	5Y 4/2			0	ma		0.75			
A2	22	c	fSL	N 3/			0	ma		0.75		Trace	
O/C	50	c	MK SiL	10YR 3/2	50 m,D	10YR 3/4	0	ma		>1			Strong
C/O	71	a	MK SiL	2.5Y 4/1	40 m,D	10YR 3/4	0	ma		>1			Strong
Oab1	97	c	MK	10YR 3/2									Strong
Oab2	133	a	MK	10YR 2/1									Strong
Ab	139	a	fSL	2.5Y 2.5/1			0	ma		0.7-1			Strong
Cgb	152	-	SL	10Y 3/0.5			0	ma		<0.7			Strong

Remarks: Profile description by D.M. Balduff, M.C. Rabenhorst, M.H. Stolt, and P. King; 22 September 2004 at 1:00 pm. Sampled using a McCauley sampler.

Sample CB25

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 07’ 50.48” N, 75˚ 17’ 34.90” W
Water Depth 160 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	15	c	SiCL/SiC	10Y 2.5/0.5			0	ma	VS	>>1			Strong
Cg1	40	c	SiCL/SiC	10Y 3/1	5 m,P	10YR 4/4	0	ma	VS	>>1			Strong
Cg2	250	-	SiCL/SiC	10Y 3/1	1 m,P	10YR 4/4	0	ma	VS	>>1		1	

Remarks: Profile description by D.M. Balduff, M.C. Rabenhorst, M.H. Stolt, and P. King; 22 September 2004 at 1:40 pm. Sampled using a McCauley sampler.

Sample CB26

Fine, Haplic Sulfaquents (Fine, Haplic Sulfiwassents)
38˚ 07' 10.50" N, 75˚ 17' 38.37" W
Water Depth 110 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	2	a	S		2.5Y 4/2			0	ma		<0.7			Strong
Cg	28	a	S	fS	10Y 2.5/1			0	ma		<0.7			Strong
2A'	50	c	MK SiL	SiC	N 2.5/	5 m,P	10YR 3/1	0	ma		0.7-1			Strong
2C'g	70	c	SiL	SiC	10Y 3/1	5 m,P	10YR 3/1	0	ma		>1			Strong
2C/O	103	c	SiL/SiCL		10Y 2.5/1	20 m,P	10YR 3/1	0	ma		>1			Strong
2Oab	132	c	MK		7.5YR 2.5/1									Strong
2Ab	137	c	MK SiL	CL	10YR 2/1			1	sbk		<0.7			Strong
2Btg	150	-	CL	CL	2.5Y 2.5/1			1	sbk		<0.7			Strong

Remarks: Profile description by D.M. Balduff, M.C. Rabenhorst, M.H. Stolt, and P. King; 22 September 2004 at 11:15 am.
Sampled using a vibracorer; depth inside core 155 cm, depth outside core 113 cm.
Large wood fragment found at 150 cm.

Sample CB27

Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)
38˚ 07' 12.84" N, 75˚ 17' 25.08" W
Water Depth 190 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Redoximorphic Features		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	2	a	L	10Y 3/1			0	ma	vsvp	> 1		1	Strong
Cg1	16	c	L	5GY 3/1			0	ma	vsvp	> 1			Strong
Cg2	28	c	L	5GY 2.5/1			0	ma	vsvp	> 1			Strong
2Cg3	43	c	SL	5Y 5/2	30 p 15 d	10YR 4/4 N 5.5	0	ma	nsnp	< 0.7			None
2Cg4	54	c	fSL	5Y 5/2	20 p	2.5 Y 5/4	0	ma	ns p	< 0.7			None
2Cg5	62	-	LS	5Y 5/1			0	ma	ns np	< 0.7			None

Remarks: Profile description by D.M. Balduff; 7 June 2005 at 2:20 pm.
Sampled using a vibracorer; depth inside core 245 cm, depth outside core 240 cm

Sample CB28

Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)
38° 09' 30.3" N, 75° 12' 19.6" W
Water Depth 50 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	10	c	SL	5Y 3/1 10Y 4/1 30%			0	ma	ms	< 0.7		1	Strong
Cg1	36	c	SL	10Y 4.5/1	trace	10YR 3/3	0	ma	ms	< 0.7			Strong
Cg2	50	a	SL	10Y 3.5/1	1% p	10YR 3/3	0	ma	ms	< 0.7		1	Strong
Cg3	78	a	fSL	10Y 3.5/1	3% p	10YR 3/3	0	ma	vs sp	> 1			Strong
2Cg4	109	-	LfS	10Y 4.5/1			0	sg	ns	< 0.7		1	Strong

Remarks: Profile description by D.M. Balduff, 8 June 2005 at 9:00 am.
Sampled using a vibracorer; depth inside core 190 cm, depth outside core 175 cm.

Sample CB29

Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)
38˚ 09' 29.2" N, 75˚ 13' 00.1" W
Water Depth 190 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	2		fSL		5Y 3/1			0	ma	vs vp	> 1	1		Strong
Cg1	6		fSL		5Y 2.5/1			0	ma	vs vp	> 1		1	Strong
Cg2	24		fSL		N 3			0	ma	msmp	< 0.7		tr	Strong
Cg3	89		SL	LfS	10Y 3/1			0	ma	ss np	< 0.7		tr	Strong
2Ab	111		LS	fS	5GY 3/1			0	sg	ns np	< 0.7		35	Strong
2Cgb	159		LS		N 4			0	sg	ns np	< 0.7		2	Strong

Remarks: Profile description by D.M. Balduff, 8 June 2005 at 9:45 am.
Sampled using a vibracorer; depth inside core 235 cm, depth outside core 230 cm.

Sample CB30

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 09' 36.78" N, 75˚ 14' 45.12" W
Water Depth 200 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	1		SiL/SiCL	10Y 4/1			0	ma		> 1			Strong
A2	17		SiL/SiCL	5GY 3/1			0	ma		> 1		2	Strong
Cg1	102		SiL/SiCL	5GY 3/1	3% P	10YR 3/3	0	ma		> 1			Strong
Cg2	150		SiL/SiCL	10Y 3/1			0	ma		> 1			Strong

Remarks: Profile description by D.M. Balduff, 8 June 2005 at 1:10 pm.
Sampled using a McCauley sampler.

Sample CB31

Fine, Haplic Sulfaquents (Fine, Haplic Sulfiwassents)
38° 09' 21.7" N, 75° 15' 32.7" W
Water Depth 180 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	4	a	SiC		10Y 3.5/1			0	ma	vs	>> 1			None
A2	22	c	SiC		5GY 2.5/1			0	ma	vs	>> 1		5	Weak
Cg1	62	c/g	SiC		5GY 3/1			0	ma	vs	>1			None
Cg2	112	a	SiC		5GY 3/1			0	ma	vs	>1			Strong
Cg3	156	c	SiC		5GY 3/1			0	ma	vs	>1		30	Strong
Cg4	185	-	SiC		5GY 3.5/1			0	ma	vs	>1		1	Strong

Remarks: Profile description by D.M. Balduff, 9 June 2005 at 9:47 am.
Sampled using a McCauley sampler.

Sample CB32

Fine-loamy, Typic Sulfaquents (Fine-loamy, Fluvic Sulfiwassents)
38° 10' 23.2" N, 75° 15' 58.7" W
Water Depth 130 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	6	a	CL/C	10Y 3/1.5			0	ma	vs	>>1		1	None
A2	21	c	CL/C	10Y 3/1			0	ma	vs	>1		1	Weak
Cg1	38	c	CL/C	10Y 3/1			0	ma	vs	>1		1	Weak
Cg2	62	c	CL/C	10Y 3/1			0	ma	vs	>1		1	Strong
Ab	97	c	Mk SiCL	10Y 3/1			0	ma	vs	>1			Strong
Cgb1	150	g	SiCL	10Y 3/1			0	ma	vs	>1			Strong
Cgb2	198	a	SiCL	10Y 4/0.5			0	ma	vs	>1			Strong
Oab	218	-	Mk	10YR 2/2									Strong

Remarks: Profile description by D.M. Balduff, 9 June 2005 at 11:28 am.
Sampled using a vibracorer; depth inside core 192 cm, depth outside core 172 cm.
Worm tubes on surface.

Sample CB33

Coarse-loamy, Typic Sulfaquents (Coarse-loamy, Aeric Sulfiwassents)
38° 07' 01.8" N, 75° 17' 28.7" W
Water Depth 130 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	3	a	SL	5Y 4/1			0	ma	ns	< 0.7			None
A2	25	a	SL	N3			0	ma	ns	< 0.7		1	None
Cg1	39	a	SL	5Y 5/1			0	ma	ns	< 0.7			None
Cg2	58	c	SL	5Y 5/2			0	ma	ns	< 0.7			None
Cg3	119	-	SL	5Y 5/2			0	ma	ns	< 0.7			None

Remarks: Profile description by D.M. Balduff, 10 June 2005 at 8:05 am.
Sampled using a vibracorer; depth inside core 185 cm, depth outside core 175 cm.

Sample CB34

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 06' 57.7" N, 75˚ 17' 27.1" W
Water Depth 130 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	3	a	L	5Y 4/1			0	ma		0.7-1			Strong
A2	23	c	SiC	10Y 2.5/1			0	ma		>1			Strong
Cg1	55	c	SiC	10Y 3/1	15	10Y 7/6	0	ma		>1			Strong
Ab	99	c	Mk SiC	10Y 3.5/1	45	10YR 3/3	0	ma		>1			Strong
Cgb1	114	c	SiC	10Y 3/1	7	10YR 3/3	0	ma		>>1			Strong
Cgb2	157	c	SiC	10Y 3/1	20	10YR 3/3	0	ma		>>1			Strong
Cgb3	200	-	SiC	10Y 3.5/1	10	10YR 6/6	0	ma		>1			Strong

Remarks: Profile description by D.M. Balduff, 10 June 2005 at 10:15 am.
Sampled using a McCauley sampler.

Sample CB35

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 05’ 01.5” N, 75˚ 17’ 46.8” W
Water Depth 87 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	3		LfS	5Y 4/2			0	ma	vs	>>1			Strong
A2	16		fSL	N3			0	ma	ss	0.7-1			Strong
2Cg1	30		SiCL/SiC	10Y 3/1			0	ma	vs	>1			Strong
2Cg2	72		SiCL/SiC	5GY 3/1			0	ma	vs	>1		25	Strong
2Cg3	99		SiCL/SiC	10Y 3.5/1			0	ma	vs	>1		10	Strong
2Cg4	125		SiCL/SiC	10Y 3.5/1			0	ma	vs	>1		10	Strong
2Cg5	162		SiCL/SiC	10Y 3.5/1	2	5Y 5/6	0	ma	vs	>1		15	Strong

Remarks: Profile description by D.M. Balduff, 23 June 2005 at 8:13 am.
Sampled using a vibracorer; depth inside core 145 cm, depth outside core 97 cm.
Oyster and gastropod shells in 2Cg3 and 2Cg4.

Sample CB36

Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)
38˚ 05’ 50.3” N, 75˚ 18’ 43.4” W
Water Depth 109 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	1		SiCL	5Y 4/2			0	ma	vs	>>1			Strong
A2	38		SiCL	10Y 3/1	1	2.5Y 3/3	0	ma	vs	>1			Weak
2Cg1	62		SL	10Y 4/1			0	ma	ss	< 0.7			Strong
2Cg2	89		LS	10Y 4.5/1			0	sg	ss	< 0.7			Strong

Remarks: Profile description by D.M. Balduff, 23 June 2005 at 10:03 am.
Sampled using a McCauley Sampler.

Sample CB37

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 05’ 37.3” N, 75˚ 19’ 20.8” W
Water Depth 110 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	3	a	SiC	5Y 4/2			0	ma	vs	>>1			Strong
Cg1	114	g	SiC	5GY 3/1			0	ma	vs	>1		1	Strong
Cg2	152	g	SiC	10Y 4/1	10	2.5Y 3/3	0	ma	vs	>1		2	Strong
Cg3	199	-	SiC	10Y 4/1			0	ma	vs	>1		3	Strong

Remarks: Profile description by D.M. Balduff, 23 June 2005 at 10:36 am.
Sampled using a McCauley Sampler.

Sample CB38

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 05’ 21.2” N, 75˚ 19’ 46.0” W
Water Depth 135 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	6		SiC	5Y 4/1			0	ma	ms	>>1			Strong
Cg1	54		SiC	10Y 3/1			0	ma	ms	>1		1	Strong
Cg2	72		SiC	10Y 3/1			0	ma	ms	>1		10	Strong
Cg3	162		SiC	10Y 3/1			0	ma	ms	>1		1	Strong

Remarks: Profile description by D.M. Balduff, 23 June 2005 at 11:41 am.
Sampled using a McCauley Sampler.

Sample CB39

Fine-silty, Typic Sulfaquent (Fine-silty, Fluvic Sulfiwassents)
38º 05’ 56.50” N, 75º 19’ 59.20” W
Water Depth 130 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	1		SiC		5Y 4/2			0	ma	ms	>1			Weak
A2	12		SiC	SiCL	10Y 2.5/1			0	ma	ms	>1		1	None
Cg1	43		SiC	SiCL	10Y 3/1			0	ma	ms	>1			None
Cg2	57		SiC	SiC	5GY 3/1			0	ma	ms	>>1			None
Cg3	126		SiC	SiL	10Y 3/1			0	ma	ms	>1			None
2Cg4	161		LS	fSL	10Y 3/1			0	sg	ss	<0.7			None
2Cg5	198		LS	LfS	5Y 5/2			0	sg	ss	<0.7			None

Remarks: Profile described by D. Balduff, 23 June 2005 at 12:22 pm
Sampled using McCauley peat auger
Worm tubes on surface

Sample CB40

Fine-loamy, Typic Sulfaquents (Fine-loamy, Fluvic Sulfiwassents)
38˚ 07' 14.8" N, 75˚ 16' 1.0" W
Water Depth 225 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	13	c	SiC	5GY 3/1			0	ma	ms	>>1			Strong
Cg1	50	c	SiC	5GY 3/1			0	ma	ms	>1		2	Strong
Cg2	83	g	fSL	10Y 3/1			0	ma	ss	>1			Strong
Cg3	120	c	C	5GY 3/1			0	ma	ms	>1			Strong
Cg4	130	c	SiC	5GY 3/1			0	ma	ss	>>1			Strong
Cg5	152	-	SiC	10Y 3/1			0	ma	ms	>1		1	Strong

Remarks: Profile description by D.M. Balduff, 24 June 2005 at 9:09 am.
Sampled using a McCauley Sampler.

Sample CB41

Fine-loamy, Typic Sulfaquents (Fine-loamy, Fluvic Sulfiwassents)
38º 06’ 07.20” N, 75º 19’ 00.40” W
Water Depth 130 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	3	a	L	-	5Y 3.5/1			0	ma					Strong
A2	17	c	L	fSL	10Y 2.5/1			0	ma		0.7-1		1	Strong
2Cg1	52	c	fSL	CL	10Y3/1			0	ma		>1		15	Strong
2Cg2	143	-	SiC	CL	5GY 3.5/1			0	ma		>1			None

Remarks: Profile described by D. Balduff, 24 June 2005 at 20:49 am
Sampled using McCauley peat sampler, stopped at 143 cm
Worm tubes on surface

Sample CB42

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 06' 6.0" N, 75˚ 19' 4.5" W
Water Depth 107 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	3	a	SiC	5Y 4/2			0	ma	ms	>1			Strong
A2	29	c	SiC	10Y 3/1			0	ma	ms	>1			Strong
Cg1	46	g	SiC	5GY 4/1	3	2.5Y 3/3	0	ma	ms	>1			Strong
Cg2	83	c	SiC	10Y 3/1	5	2.5Y 3/3	0	ma	ss	>1			Strong
Ab	95	c	Mk SiC	2.5Y 3/2	45	2.5Y 5/6	0	ma	ss	>1			Strong
Cgb1	138	g	Mk SiC	10Y 3/1	30	2.5Y 5/6	0	ma	ss	>1			Strong
Cgb2	172	g	SiC	5GY 3.5/1	3	2.5Y 6/6	0	ma	ms	>1			Strong
Cgb3	199	-	SiC	5GY 3.5/1			0	ma	ms	>1		1	Strong

Remarks: Profile description by D.M. Balduff, 24 June 2005 at 11:30 am.
Sampled using a McCauley Sampler.
Worm tubes on surface. Gastropod shell in Cgb3

Sample CB43

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 05’ 4.9” N, 75˚ 18’ 40.0” W
Water Depth 120 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	4	a	SiC	5Y 4/1			0	ma	ms	>>1			Strong
A2	16	c	SiC	N3			0	ma	ms	>>1		trace	Strong
Cg1	32	g	SiC	10Y 3/1	20	10YR 3/3	0	ma	ms	>1			Strong
Cg2	123	g	SiC	10Y 3/1	20	5Y 5/4	0	ma	ms	>1			Strong
Cg3	199	-	SiC	10Y 3/1	3	5Y 5/4	0	ma	ms	>1			Strong

Remarks: Profile description by D.M. Balduff, 24 June 2005 at 12:44 pm.
Sampled using a McCauley Sampler.
Worm tubes on surface.

Sample CB44

Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)
38˚ 05' 30.1" N, 75˚ 15' 8.6" W
Water Depth 90 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	6	a	Sl	N 2.5			0	ma	>1		15		Strong
A2	18	c	SL	10Y 3/1			0	ma	0.7-1			1	Strong
Cg1	43	c	SL	10Y 3.5/1			0	ma	<0.7				Strong
Cg2	67	c	L	10Y 3.5/1			0	ma	0.7-1				Strong
Cg3	85	c	SL	10Y 3.5/1			0	ma	0.7-1			2	Strong
2Cg4	104	c	LS	N 4			0	sg	<0.7				Strong
2Cg5	137	-	SL	N 4			0	sg	<0.7			1	Strong

Remarks: Profile description by D.M. Balduff, 28 June 2005 at 8:50 am.
Sampled using a vibracorer; depth inside core 129 cm, depth outside core 111 cm.
Eelgrass on surface.

Sample CB45

Sandy over loamy, Haplic Sulfaquents (Sandy over loamy, Haplic Sulfiwassents)
38˚ 04' 59.1" N, 75˚ 13' 53.7" W
Water Depth 90 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	6	c	S	fS	5Y 4/1 N3 25%			0	sg	ns	<0.7	15		Strong
A/Cg	33	c	S	fS	N4 N3 20%			0	sg	ns	<0.7			Strong
Cg1	88	c	LS	fS	N 3.5			0	sg	ns	<0.7			Strong
Cg2	99	c	LS/SL	LfS	10Y 3.5/1			0	ma	ss	<0.7			Strong
2Cg3	142	a	SiC	L	10Y 3/1	15	5Y 5/6	0	ma	ms	>1			Strong
2Cg4	186	-	SiC	SiCL	10Y 3/1	20	5Y 5/6	0	ma	ss	0.7-1		1	Strong

Remarks: Profile description by D.M. Balduff, 28 June 2005 at 1:46 pm.
Sampled using a vibracorer; depth inside core 120 cm, depth outside core 113 cm.
Eelgrass on surface.

Sample CB46

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 05' 37.3" N, 75˚ 19' 20.8" W
Water Depth 90 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	5	a	L	5Y 4/1			0	ma	ss	>>1			Weak
Cg1	19	c	L	10Y 3/1			0	ma	ms	>1		1	Weak
Cg2	40	c	SiC	5GY 3/1			0	ma	ms	>1			Weak
Cg3	82	c	SiC	10Y 3/1			0	ma	ms	>1			Weak
Cg4	126	a	SiC	10Y 3.5/1			0	ma	ms	>1		2	Weak
Cg5	160	-	SiC	10Y 4/1			0	ma	ss	>1		10	Weak

Remarks: Profile description by D.M. Balduff, 30 June 2005 at 9:22 am.
Sampled using a McCauley sampler.

Sample CB47

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 03’ 59.7” N, 75˚ 19’ 0.4” W
Water Depth 150 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	5	a	SiC	5Y 4/1			0	ma	ss	>>1			Strong
A2	18	c	SiC	10Y 2.5/1			0	ma	ms	>1		2	Strong
A/Cg	31	c	SiC	10Y 3/1			0	ma	ss	>1			Strong
Cg1	111	g	SiC	10Y 3/1			0	ma	ss	>1			Strong
Cg2	148	-	SiC	10Y 3/1			0	ma	ss	>1			Strong

Remarks: Profile description by D.M. Balduff, 30 June 2005 at 11:20 am.
Sampled using a McCauley sampler.

Sample CB48

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 02' 57.3" N, 75˚ 18' 48.0" W
Water Depth 140 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	3	c	C	10Y 2.5/1			0	ma	ss	0.7-1		1	Strong
Cg1	23	c	C	10Y 3/1			0	ma	ss	0.7-1		3	Strong
Cg2	44	g	SiC	10Y 3/1			0	ma	ss	>1		Trace	Strong
Cg3	103	g	SiC	10Y 3/1			0	ma	ms	>>1		Trace	Strong
Cg4	254	-	SiC	10Y 3/1			0	ma	ms	>1		1	Strong

Remarks: Profile description by D.M. Balduff, 30 June 2005 at 12:17 pm.
Sampled using a McCauley sampler.

Sample CB49

Coarse-loamy, Typic Sulfaquents (Coarse-loamy, Fluvic Sulfiwassents)
38˚ 06' 52.2" N, 75˚ 15' 47.9" W
Water Depth 280 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	2	a	SiC		10Y 3/1			0	ma	ms	>>1			Strong
A2	10	c	L	L	10Y 4/1			0	ma	ms	>1			Strong
Cg1	42	c	C	SL	10Y 3/1			0	ma	ms	>1		1	Strong
Cg2	80	c	CL	fSL	10Y 3/1			0	ma	ms	>1		5	Strong
Ab	105	a	L		10Y 3/1			0	ma	ns	0.7-1		10	Strong
Cgb1	131	a	SiC		10Y 3.5/1			0	ma	ss	>1		25	Strong
Cgb2	147	-	SiC		10Y 3.5/1			0	ma	ms	>1			Strong

Remarks: Profile description by D.M. Balduff, 1 July 2005 at 8:37 am.
Sampled using a vibracorer; depth inside core 260 cm, depth outside core 253 cm.

Sample CB50

Coarse-silty, Sulfic Hydraquents (Coarse-silty, Sulfic Hydrowassents)
38° 05’ 41.2” N, 75° 16’ 44.8” W
Water Depth 250 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	3	a	SiC		5Y 4/1			0	ma	ss	>>1		10	Weak
A2	21	a	C	SL	N 3			0	ma	ss			60	Weak
A/Cg	45	c	C	L	10Y 3/1			0	ma	ss			40	Weak
Cg1	60	c	C	L	10Y 3.5/1			0	ma	ms	>1		7	Weak
Cg2	92	g	C	L	5GY 3/1			0	ma	ss	0.7-1		15	Strong
Cg3	160	-	C	vfSL	5GY 3/1			0	ma	ss	0.7-1		7	Strong

Remarks: Profile description by D.M. Balduff, 1 July 2005 at 10:29 am.
Sampled using a vibracorer; depth inside core 240 cm, depth outside core 220 cm.
Whole mussel at 35 cm, Clam at 84 cm, Oyster at 33 cm, Gastropods throughout.

Sample CB51

Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)
38° 04' 25.5" N, 75° 19' 34.3" W
Water Depth 130 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	5	a	LS	5Y 4/1			0	sg	ns	< 0.7			None
A2	25	c	LS	10Y 4.5/1 N 2.5 (30)			0	sg	ns	< 0.7		3	None
Cg1	36	c	LS	5GY 3/1			0	sg	ns	< 0.7		3	None
2Ab	56	c	Mk L	5GY 3/1	40	10YR 3/2	0	ma	ms	0.7-1			None
2Cgb1	65	c	SL	5GY 3.5/1	10	5Y 5/4	0	ma	ss	0.7-1			None
2Cgb2	83	c	SL	N 4	10	5Y 5/4	0	ma	ns	< 0.7			None
2Cgb3	102	-	SL	N 5			0	ma	ns	< 0.7			None

Remarks: Profile description by D.M. Balduff, 1 July 2005 at 12:48 pm.
Sampled using a vibracorer; depth inside core 95 cm, depth outside core 90 cm.
Worm tubes on surface.

Sample CB52

Fine-silty, Typic Sulfaquent (Fine-silty, Fluvic Sulfiwassents)
38º 05' 4.1" N, 75º 13' 53.3" W
Water Depth 200 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	5	a	SL	SL	5Y 4/1			0	ma	ss	>>1			Strong
A2	10	a	Sl	SL	N 2.5			0	ma	ns	>1			Strong
Cg1	21	c	Sl/L	L	10Y 2.5/1			0	ma	ns	< 0.7		3	Strong
2Cg2	39	c	SiC	L	10Y 3/1			0	ma	ss	>1		1	Strong
2Cg3	59	g	SiC	L	10Y 3/1			0	ma	ms	>1			Strong
2Cg4	86	c	SiC	CL	10Y 3.5/1			0	ma	ss	>1		2	Strong
2Cg5	115	c	SiC	L	10Y 3/1			0	ma	ms	>1		2	Strong
2Cg6	138	-	L	SL	10Y 3.5/1			0	ma	ss	0.7-1			Strong

Remarks: Profile described by D. Balduff, 5 July 2005 at 10:45 am
Sampled using McCauley peat auger.

Sample CB53

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 05' 9.0" N, 75˚ 14' 41.8" W
Water Depth 200 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	6	c	Sl	5Y 4/1			0	ma	ss	>>1			Strong
Cg1	22	c	Sl	10Y 3/1			0	ma	ns	< 0.7			Strong
2Cg2	48	g	SiC	10Y 3/1			0	ma	ms	>1			Strong
2Cg3	113	g	SiC	10Y 3/1			0	ma	ms	>1		3	Strong
2Cg4	178	c	SiC	10Y 3.5/1			0	ma	ms	>1			Strong
2Cg5	184	-	L	10Y 3.5/1			0	ma	ss	0.7-1		1	

Remarks: Profile description by D.M. Balduff, 5 July 2005 at 12:00 pm.
Sampled using a McCauley sampler.
Worm tubes on surface.

Sample CB54

Sandy, Haplic Sulfaquents (Sulfic Psammowassents)
38° 04' 57.7" N, 75° 15' 17.1" W
Water Depth 160 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	12	a	Sl	5Y 4/1			0	ma	ns	< 0.7		1	None
A2	23	a	LS	N 2.5			0	sg	ns	< 0.7		4	None
Cg1	42	c	LS	10Y 3/1			0	sg	ns	< 0.7		5	None
Cg2	67	c	S	N 4.5	3	5Y 3/2	0	sg	ns	< 0.7		2	None
Cg3	101	c	S	N 4.5			0	sg	ns	< 0.7		1	None
Cg4	132	c	S	N 5			0	sg	ns	< 0.7		1	None
Cg5	165	a	S	10Y 5/1			0	sg	ns	< 0.7		2	Weak
2Cg6	195	-	L	5GY 4/1			0	ma	ns	0.7-1		1	None

Remarks: Profile description by D.M. Balduff, 5 July 2005 at 12:00 pm.
Sampled using a Vibracorer, depth inside core 178 cm, depth outside core 172 cm.

Sample CB55

Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)
38º 04’ 50.40” N, 75º 15’ 52.40” W
Water Depth 185 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	3	a	SL	fS	5Y 4/1			0	ma	ns	<0.7			Strong
A2	12	a	SL	fS	N 3			0	ma	ns	<0.7		5	Strong
Cg1	41	c	SL	LfS	10Y 3.5/1			0	ma	ss	<0.7		3	Strong
Cg2	90	g	SL	LfS	5GY 3.5/1	3	2.5Y 3/3	0	ma	ss	0.7-1		1	Strong
2Cg3	143	g	C	L	5GY 3/1			0	ma	ms	>1		1	Strong
2Cg4	162	c	L	SL	10Y 3/1	4	5Y 4/4	0	ma	ss	0.7-1		1	Strong
2Cg5	198	-	SiC	L	10Y 3/1	7	5Y 4/4	0	ma	ms	>1		1	Strong

Remarks: Profile described by D. Balduff, 6 July 2005 at 8:15 am.
Sampled using Vibracorer, depth inside core 170 cm, depth outside core 165 cm.
Worm tubes on surface.

Sample CB56

Sandy, Haplic Sulfaquents (Sulfic Psammowassents)
38º 04' 21.8" N, 75º 15' 34.1" W
Water Depth 95 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	2	a	LS		5Y 4/1 N2.5 (25)			0	sg	ns	< 0.7	15		Strong
A2	10	a	LS	fS	N3	5	10YR 3/2	0	sg	ns	< 0.7			Strong
Cg1	31	c	S	fS	N4			0	sg	ns	< 0.7			Strong
Cg2	49	c	S	fS	N4.5			0	sg	ns	< 0.7		5	Strong
Cg3	72	c	Sl	LfS	10Y 3/1	3	10YR 3/2	0	ma	ns	< 0.7		3	Strong
Cg4	90	g	LS	fS	10Y 3/1			0	sg	ns	< 0.7			Strong
Cg5	122	g	LS	fS	10Y 3/1			0	sg	ns	< 0.7			Strong
Cg6	137	a	LS	fS	10Y 3/1			0	sg	ns	< 0.7		2	Strong
2Ab	154	-	SiC	LfS	5GY 3.5/1	30	10YR 4/6 2.5Y 5/6	0	ma	ms	>1			Strong

Remarks: Profile described by D. Balduff, 6 July 2005 at 9:35 am.
Sampled using Vibracorer, depth inside core 78 cm, depth outside core 70 cm.
Eelgrass and worm tubes on surface.

Sample CB57

Sandy, Haplic Sulfaquents (Sulfic Psammowassents)
38˚ 04’ 16.1” N, 75˚ 14’ 54.3” W
Water Depth 120 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	3	c	SL	10Y 2.5/1			0	ma	ns	< 0.7	10	10	Strong
A2	18	c	SL	10Y 3/1	2	10YR 3/2	0	ma	ns	< 0.7		10	Strong
Cg1	33	g	LS	5GY 3/1			0	sg	ns	< 0.7		3	Strong
Cg2	58	c	LS	5GY 3/1			0	sg	ns	< 0.7		2	Strong
Cg3	83	g	S	5GY 3.5/1			0	sg	ns	< 0.7		1	Strong
Cg4	111	a	SL	5GY 3/1	1	10YR 3/3	0	ma	ns	< 0.7			Strong
2Cg5	130	-	C	5GY 3.5/1	5	10YR 5/4	0	ma	ms	> 1			Strong

Remarks: Profile description by D.M. Balduff, 23 June 2005 at 11:15 am.
Sampled using a vibracorer; depth inside core 80 cm, depth outside core 72 cm.
A1- 0.5 cm thick 5Y 3/1.
A2 and Cg3- oyster shells.

Sample CB58

Coarse-loamy, Typic Sulfaquents (Coarse-loamy, Fluvic Sulfiwassents)
38º 04' 44.5" N, 75º 16' 27.4" W
Water Depth 240 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	3	a	SL	-	5Y 4/1			0	ma	ms	>>1			Strong
A2	14	a	L	LfS	N 3			0	ma	ss	>1		2	Strong
Cg1	37	c	L	fSL	10Y 3/1			0	ma	ms	0.7-1		10	Strong
Cg2	106	c	SL	fSL	N 3.5	3	10YR 5/6	0	ma	ss	0.7-1		2	Strong
2Cg3	162	-	SiC	SiCL	10Y 3.5/1	5	10YR 5/6	0	ma	ms	>1			Strong

Remarks: Profile described by D. Balduff, 6 July 2005 at 12:56 pm.
Sampled using Vibracorer, depth inside core 235 cm, depth outside core 225 cm.

Sample CB59

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 03' 27.0" N, 75˚ 15' 5.1" W
Water Depth 120 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	5	a	SiL	5Y 4/2			0	ma	ss	> 1			Strong
A2	29	a	SiL	10Y 2.5/1			0	ma	ss	> 1			Strong
Cg1	35	c	Mk SiCL	10Y 3/1			0	ma	ss	> 1			Strong
Cg2	74	c	Mk SiCL	10Y 3.5/1	40	2.5Y 6/6	0	ma	ss	> 1			Strong
Cg3	86	c	SiC	10Y 3/1	25	2.5Y 4/6	0	ma	ms	> 1			Strong
Cg4	127	a	SiC	10Y 3/1	10	2.5Y 6/6	0	ma	ms	> 1			Strong
2Cg5	135	-	SL	N 3.5	3	2.5Y 5/6	0	ma	ss	0.7-1			Strong

Remarks: Profile description by D.M. Balduff, 9 July 2005 at 9:27 am.
Sampled using a McCauley sampler.
Worm tubes on surface.

Sample CB60

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38° 03' 26.0" N, 75° 15' 21.8" W
Water Depth 150 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	7	a	CL	5Y 4/2	3	10Y 3/2	0	ma	ms	> 1			Strong
A2	11	a	SiL	N 3			0	ma	ss	> 1			Strong
A3	40	a	Mk SiC	10Y 3/1	30	5Y 6/6	0	ma	ms	> 1			Strong
Cg1	49	c	SiC	10Y 3/1	2	5Y 6/6	0	ma	ms	> 1			Strong
Cg2	66	c	L	5GY 3/1	2	5Y 6/6	0	ma	ss	0.7-1			Strong
Cg3	87	c	SiC	10Y 3/1	25	5Y 6/6	0	ma	ms	> 1			Strong
Cg4	115	c	C	10Y 3/1	5	5Y 6/6	0	ma	ms	> 1			Strong
Cg5	149	c	C	10Y 3/1			0	ma	ms	> 1			Strong
Cg6	165	a	SiC	10Y 3/1			0	ma	ms	> 1			Strong
2Cg7	203	-	SL	10Y 3/1			0	ma	ms	0.7-1			Strong

Remarks: Profile description by D.M. Balduff, 9 July 2005 at 10:02 am.
Sampled using a McCauley sampler.

Sample CB61

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 03' 31.5" N, 75˚ 15' 40.0" W
Water Depth 178 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	3	a	L	5Y 4/2			0	ma	ss			10	Strong
A2	9	a	L	N 2.5			0	ma	ss			60	Strong
Cg1	62	g	SiC	10Y 3/1			0	ma	ms	>1			Strong
Cg2	123	g	SiC	10Y 3/1			0	ma	ms	>1		10	Strong
Cg3	152	-	SiC	10Y 3/1	3	5Y 5/6	0	ma	ms	>1		3	Strong

Remarks: Profile description by D.M. Balduff, 9 July 2005 at 10:42 am.
Sampled using a McCauley sampler.
Shells in A2 were broken. Identified clam, gastropod, and oyster shells.

Sample CB62

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38° 03' 29.5" N, 75° 15' 56.9" W
Water Depth 200 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	3	a	SL	5Y 4/1			0	ma				15	Strong
A2	10	a	SL	10Y 2.5/1			0	ma				65	Strong
Cg1	35	c	L	10Y 3/1			0	ma	ss	0.7-1		3	Strong
2Cg2	95	-	SiC	10Y 3/1			0	ma	ms	> 1		20	Strong

Remarks: Profile description by D.M. Balduff, 9 July 2005 at 11:23 am.
Sampled using a McCauley sampler.
Broken shells in A2. Bands of broken shells in 2Cg2 45-47 cm and 64-65 cm.
Identified oyster and gastropod shells.
Could not sample deeper than 95 cm with McCauley sampler.

Sample CB63

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 04' 46.0" N, 75˚ 16' 50.6" W
Water Depth 300 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	3	a	SiC	5Y 4/1			0	ma	ms	>> 1			None
A2	38	c	SiC	10Y 2.5/1			0	ma	ms	> 1			None
Cg1	72	g	SiC	10Y 3/1			0	ma	ms	> 1		5	Strong
Cg2	172	-	SiC	10Y 3/1	1	10YR 3/3	0	ma	ms	> 1			Strong

Remarks: Profile description by D.M. Balduff, 9 July 2005 at 12:41 pm.
Sampled using a McCauley sampler.

Sample CB64

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 01' 42.6" N, 75˚ 17' 16.1" W
Water Depth 227 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	3	a	SiC	5Y 4/1			0	ma	ms	>> 1			Strong
Cg1	22	c	SiC	10Y 2.5/1			0	ma	ms	> 1			Strong
Cg2	43	c	SiC	10Y 3/1	3	10YR 5/6	0	ma	ms	> 1		2	Strong
Cg3	82	c	SiC	10Y 3/1	15	10YR 6/6	0	ma	ms	> 1			Strong
Cg4	141	g	SiC	10Y 3/1	7	10YR 6/6	0	ma	ms	> 1			Strong
2Cg5	150	c	SL	10Y 3.5/1			0	ma	ms	0.7-1			Strong
2Cg6	160	-	L/SL	10Y 3.5/1			0	ma	ss	0.7-1		3	Strong

Remarks: Profile description by D.M. Balduff, 9 July 2005 at 1:23 pm.
Sampled using a McCauley sampler.
Oyster shell identified in 2Cg6.

Sample CB65

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 03' 29.1" N, 75˚ 16' 17.0" W
Water Depth 235 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	6	a	SL	5Y 3/2			0	ma	ss	< 0.7		2	Strong
A2	11	c	SL	N 3			0	ma	ss	< 0.7		30	Strong
2Cg1	29	c	SiC	10Y 3/1			0	ma	ms	> 1		2	Strong
2Cg2	106	g	SiC	10Y 3/1			0	ma	ms	> 1		10	Strong
2Cg3	155	-	SiC	10Y 3/1			0	ma	ms	> 1		3	Strong

Remarks: Profile description by D.M. Balduff, 10 July 2005 at 9:28 am.
Sampled using Vibracorer, depth inside core 220 cm, depth outside core 220 cm.

Sample CB66

Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)
38˚ 03' 28.2" N, 75˚ 16' 49.1" W
Water Depth 230 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	10	a	LS	5Y 3/2			0	sg	ns	< 0.7			Weak
A2	13	a	SL	N 3			0	ma	ns	< 0.7		3	Weak
Cg/A	44	c	SL	10Y 3/1			0	ma	ns	< 0.7		5	Weak
2Cg1	94	g	L	10Y 3/1			0	ma	ms	0.7-1		2	Strong
2Cg2	159	c	C	10Y 3/1			0	ma	ms	> 1		2	Strong
2Cg3	168	-	SiC	10Y 3/1			0	ma	ms	> 1		30	Strong

Remarks: Profile description by D.M. Balduff, 10 July 2005 at 10:35 am.
Sampled using Vibracorer, depth inside core 205 cm, depth outside core 200 cm.
Krotovina in Cg/A- N 3/ soil material in channel.
Broken shells in 2Cg3.
Clam and mussel on surface.

Sample CB67

Fine-loamy, Typic Sulfaquents (Fine-loamy, Fluvic Sulfiwassents)
38˚ 03' 22.6" N, 75˚ 17' 25.6" W
Water Depth 235 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	2	a	SL	5Y 4/2			0	ma	ss	>> 1			None
A2	13	c	SL	N 2.5			0	ma	ss	0.7-1			None
Cg/A	35	c	L	10Y 3/1 N 3 (10)	15	10YR 3/3	0	ma	ms	> 1		1	None
2Cg1	73	g	SiC	10Y 3.5/1	25	10YR 4/4	0	ma	ms	> 1		1	Weak
2Cg2	135	c	SiC	10Y 3/1	10	2.5Y 6/6	0	ma	ms	> 1		2	Weak
2Cg3	146	-	C	N 3.5	5	2.5Y 6/6	0	ma	ms	> 1			Weak

Remarks: Profile description by D.M. Balduff, 10 July 2005 at 11:45 am.
Sampled using a McCauley sampler.

Sample CB68

Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)
38° 03' 28.5" N, 75° 17' 29.7" W
Water Depth 50 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	2	a	SL	5Y 3/1			0	ma				80	Strong
Cg1	14	c		10Y 3/1			0	sg				90	Strong
Cg2	35	c		10Y 3/1			0	sg				90	Strong
Cg3	47	c	LS	10Y 3.5/1			0	ma				40	Strong
2Cg4	68	c	SiC	10Y 3.5/1			0	ma	ms	> 1		10	Strong
2Ab	97	-	Mk SiC	10Y 3/1	20	5Y 6/6	0	ma	ms	> 1			Strong

Remarks: Profile description by D.M. Balduff, 11 July 2005 at 8:45 am.
Sampled using Vibracorer, depth inside core 95 cm, depth outside core 115 cm.
Cg1 contained small broken shells. Cg2 contained large broken shells.

Sample CB69

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 03' 25.3" N, 75˚ 18' 3.9" W
Water Depth 210 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	4	a	SL	5Y 4/1			0	ma	ss	>> 1			Weak
A2	22	c	SL	10Y 3/1 N 3 (15)			0	ma	ss	0.7-1		10	Weak
2Cg1	47	c	SiC	10Y 3.5/1			0	ma	ms	> 1		3	Strong
2Cg2	77	c	SiC	10Y 3/1			0	ma	ss	> 1			Strong
2Cg3	117	g	SiC	10Y 3/1	15	5Y 5/6	0	ma	ms	> 1			Strong
2Cg4	152	-	SiC	10Y 3/1	5	5Y 5/6	0	ma	ms	> 1			Strong

Remarks: Profile description by D.M. Balduff, 11 July 2005 at 9:41 am.
Sampled using Vibracorer, depth inside core 220 cm, depth outside core 190 cm.

Sample CB70

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38° 03' 25.4" N, 75° 18' 24.9" W
Water Depth 210 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	5	a	L	5Y 4/2			0	ma	ss	> 1			None
A2	19	c	SL	2.5Y2.5/1 N 3 (5)			0	ma	ss	0.7-1			None
2Cg1	44	c	SiC	10Y 3/1 N 3 (3)			0	ma	ms	> 1		2	None
2Cg2	78	c	SiC	10Y 3/1			0	ma	ms	> 1			Weak
2Cg3	92	g	SiC	10Y 3/1	10	5Y 5/8	0	ma	vs	> 1			Weak
2Cg4	127	c	SiC	10Y 3/1	5	5Y 5/8	0	ma	ms	>> 1			Weak
2Cg5	141	-	SiC	10Y 3/1	3	5Y 5/8	0	ma	vs	> 1			Weak

Remarks: Profile description by D.M. Balduff, 11 July 2005 at 10:24 am.
Sampled using a McCauley sampler.

Sample CB71

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38° 03' 28.9" N, 75° 18' 49.5" W
Water Depth 194 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	4	a	L	5Y 3/2			0	ma	ss	>> 1			Weak
Cg1	34	c	C	10Y 3/1	3	2.5Y 3/2	0	ma	ms	> 1		2	Weak
Cg2	61	g	SiC	10Y 3/1	10	5Y 6/6	0	ma	ms	> 1		3	Strong
Cg3	135	g	SiC	10Y 3/1	5	2.5Y 5/6	0	ma	ms	> 1			Strong
Cg4	214	-	SiC	5GY 3/1	2-Jan	2.5Y 3/2	0	ma	ms	> 1			Strong

Remarks: Profile description by D.M. Balduff, 11 July 2005 at 11:22 am.
Sampled using a McCauley sampler.

Sample CB72

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 05’ 42.3” N, 75˚ 17’ 0.4” W
Water Depth 245 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	2	a	SiC	5Y 4/1			0	ma	ss	>> 1			None
A2	13	c	SiC	N 2.5 10Y 2.5/1			0	ma	ms	> 1		1	None
Cg1	48	c	SiC	10Y 3/1			0	ma	ms	> 1			None
Cg2	69	g	SiC	10Y 3.5/1			0	ma	ms	> 1		3	None
Cg3	107	g	SiC	10Y 3/1			0	ma	ms	> 1			None
Cg4	131	g	C	10Y 3/1			0	ma	ms	> 1			Weak
Cg5	156	-	SiC	10Y 3/1			0	ma	ms	> 1			Weak

Remarks: Profile description by D.M. Balduff, 11 July 2005 at 12:20 pm.
Sampled using a McCauley sampler.

Sample CB73

Coarse-loamy, Haplic Sulfaquents (Coarse-loamy, Haplic Sulfiwassents)
38° 05' 43.0" N, 75° 17' 26.1" W
Water Depth 205 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	4	a	SL	5Y 4/2			0	ma	ss	0.7 - 1			None
A2	18	a	SL	N 2.5			0	ma	ss	< 0.7		5	None
Cg1	34	c	L	10Y 3/1	1	5Y 6/4	0	ma	ss	0.7 - 1			None
Cg2	54	c	SiC	10Y 4/1 10Y 3/1 (20)	3	5Y 6/4	0	ma	ss	0.7 - 1		10	None
Cg3	78	c	L	10Y 4/1 10Y 5/1 (30)	15	5Y 6/4	0	ma	ms	0.7 - 1			None
Cg4	91	-	SL	10Y 4/1 5Y 5/3 (20)			0	ma	ms	0.7 - 1			None

Remarks: Profile description by D.M. Balduff, 11 July 2005 at 12:46 pm.
Sampled using a McCauley sampler.

Sample CB74

Sandy, Haplic Sulfaquents (Sulfic Psammowassents)
38º 01’ 52.8” N, 75º 16’ 27.6” W
Water Depth 60 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Root s %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	2	a	SL		5Y 3/2			0	ma	ss	0.7 - 1	10		None
A2	19	c	SL	SL	10Y 2.5/1	2	10YR 3/2	0	ma	ss	0.7 - 1	10		None
Cg1	55	c	SL	LfS	10Y 3/1	2	10YR 3/2	0	ma	ns	< 0.7			None
Cg2	89	c	SL	LfS	10Y 3.5/1	2	10YR 3/2	0	ma	ns	0.7 - 1		1	None
Cg3	109	c	LS	LfS	10Y 3/1	5	10YR 3/2	0	ma	ss	0.7 - 1			Weak
2Cg4	142	c	LS	LfS	10Y 3.5/1			0	sg	ns	< 0.7		3	Weak
2Cg5	174	-	S	fS	N 4			0	sg	ns	< 0.7			None

Remarks: Profile described by D. Balduff, 12 July 2005 at 9:12 am.
Sampled using Vibracorer, depth inside core 64 cm, depth outside core 42 cm.

Sample CB75

Sandy, Haplic Sulfaquents (Sulfic Psammowassents)
38˚ 02' 0.6" N, 75˚ 16' 46.3" W
Water Depth 165 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	7	c	cS	N 3 5Y 4/1 (10)			0	sg	ns	< 0.7		2	None
A2	26	c	cS	N3 10Y 3/1(25)			0	sg	ns	< 0.7		5	None
Cg1	88	c	SL	10Y 3/1			0	ma	ns	< 0.7		10	Weak
Cg2	107	g	LS	10Y 3/1			0	sg	ns	< 0.7		5	Weak
Cg3	191	-	S	10Y 4/1			0	sg	ns	< 0.7		1	Weak

Remarks: Profile description by D.M. Balduff, 12 July 2005 at 10:45 am.
Sampled using Vibracorer, depth inside core 173 cm, depth outside core 170 cm.

Sample CB76

Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)
38˚ 02' 12.1" N, 75˚ 15' 14.6" W
Water Depth 130 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	6	c	SL	5Y 3/1			0	ma	ns	0.7 - 1	15		Weak
A2	21	c	SL	10Y 3/1			0	ma	ns	< 0.7	15		Strong
Cg1	58	c	SL	10Y 3/1			0	ma	ns	< 0.7		10	None
Cg2	105	c	S	10Y 3.5/1			0	sg	ns	< 0.7		1	Weak
Cg3	151	c	LS	10Y 3/1		2.5Y 3/2	0	sg	ns	< 0.7		1	None
Cg4	169	-	S	10Y 4/1			0	sg	ns	< 0.7			None

Remarks: Profile description by D.M. Balduff, 12 July 2005 at 12:19 pm.
Sampled using Vibracorer, depth inside core 65 cm, depth outside core 70 cm.
Eelgrass on surface.
Razor clam at 42 cm. Broken clam shells in Cg3.

Sample CB77

Sandy, Haplic Sulfaquents (Sulfic Psammowassents)
38˚ 02' 7.4" N, 75˚ 15' 51.4" W
Water Depth 175 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	7	a	LS	5Y 4/1			0	sg	ns	< 0.7			None
A2	20	c	LS	N 3			0	sg	ns	< 0.7		2	None
Cg1	33	c	SL	10Y 3/1			0	ms	ns	< 0.7			None
Cg2	49	c	LS	10Y 3/1			0	sg	ns	< 0.7			None
Cg3	72	a	S	N 4			0	sg	ns	< 0.7		2	None
Cg4	124	c	cS	N 5			0	sg	ns	< 0.7		5	Weak
Cg5	153	c	cS	N 4	10	10YR 3/2	0	sg	ns	< 0.7		2	Weak
2Cg6	178	c	C	10Y 3/1	5	10YR 3/2	0	ma	ms	> 1		1	Strong
2Cg7	224	-	SiC	10Y 3/1	3	10YR 3/2	0	ma	ms	> 1		1	Strong

Remarks: Profile description by D.M. Balduff, 12 July 2005 at 1:33 pm.
Sampled using Vibracorer, depth inside core 180 cm, depth outside core 175 cm.
From 129-133 cm band of 10Y 3/1 with SL texture.

Sample CB78

Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)
38˚ 01’ 53.7” N, 75˚ 17’ 8.6” W
Water Depth 195 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Moist Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	2	a	S	5Y 4/1			0	sg	ns	< 0.7			None
A2	17	c	S	N 3			0	sg	ns	< 0.7		1	None
Cg1	50	c	SL	10Y 3/1	2	2.5Y 3/3	0	ma	ns	0.7 - 1		3	None
Cg2	162	c	S	N 4			0	sg	ns	< 0.7			Weak
Cg3	209	-	LS	N 4			0	sg	ns	< 0.7		2	Weak

Remarks: Profile description by D.M. Balduff, 13 July 2005 at 9:04 am.
Sampled using Vibracorer, depth inside core 187 cm, depth outside core 177 cm.

Sample CB79

Sandy, Haplic Sulfaquents (Sandy, Haplic Sulfiwassents)
38º 01' 54.4" N, 75º 17' 45.0" W
Water Depth 235 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	3	a	S		5Y 4/1			0	sg	ns	< 0.7		2	None
A2	10	a	S	fS	N 2.5			0	sg	ns	< 0.7		15	None
Cg1	50	c	SL	fSL	10Y 3/1			0	ma	ss	0.7 - 1		3	Strong
Cg2	86	c	SL	LfS	5GY 3.5/1			0	ma	ss	0.7 - 1		2	Strong
Cg3	123	-	S	fS	N 4			0	sg	ns	< 0.7			Strong

Remarks: Profile described by D. Balduff, 13 July 2005 at 9:55 am.
Sampled using Vibracorer, depth inside core 210 cm, depth outside core 200 cm.

Sample CB80

Coarse-loamy, Typic Sulfaquents (Coarse-loamy, Aeric Sulfiwassents)
38˚ 03’ 32.4” N, 75˚ 19’ 41.1” W
Water Depth 150 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Redoximorphic Features		Organic Fragments		Structure		Moist Const.	n value	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Abun. %	Color	Gr.	Shape				
A1	8	a	SL	5Y 4/1					0	ma	ns	>> 1		None
A2	17	c	L	10Y 3/1					0	ma	ms	0.7 - 1	2	None
Cg1	30	c	L	10Y 3/1					0	ma	ms	0.7 - 1	7	None
Cg2	57	a	L	5Y 4/1	15 10	10Y 5/1 2.5Y 4/1	10	10YR 3/3	0	ma	ms	0.7 - 1	2	None
2Cg3	75	c	SCL	5Y 5/1	15	5Y 5/4	7	2.5Y 3/2	0	ma	ss	< 0.7		None
2C1	102	c	SL	5Y 4/2	20 2 4	5Y 4/4 10YR 3/6 N 4	7	2.5Y 3/2	0	ma	ns	< 0.7		None
2C2	116	-	SL	2.5Y 4/3	5 3	10YR 4/6 N 4			0	ma	ns	< 0.7		None

Remarks: Profile description by D.M. Balduff; 13 July 2005 at 11:20 am
Sampled using a vibracorer; depth inside core 125 cm, depth outside core 115 cm.
Live razor clam in A2 during sampling.

Sample CB81

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 03' 45.7" N, 75˚ 20' 1.8" W
Water Depth 170 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Root s %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	2	a	SiC	5Y 4/1			0	ma	ss	>> 1			Weak
A2	18	c	SiC	10Y 3/1			0	ma	ms	>> 1			Weak
Cg1	154	g	SiC	10Y 3.5/1			0	ma	ms	> 1		3	Weak
Cg2	213	-	SiC	10Y 3.5/1	5	2.5Y 4/4	0	ma	ms	> 1			Strong

Remarks: Profile description by D.M. Balduff; 18 July 2005 at 10:57 am.
Sampled using a McCauley sampler.
Wormtubes on the surface.

Sample CB82

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38° 03’ 55.5” N, 75° 20’ 27.6” W
Water Depth 150 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	5	a	SiC	5Y 4/1			0	ma	ns	>> 1			None
Cg1	35	c	SiC	10Y 3/1			0	ma	ss	> 1			Weak
Cg2	60	g	SiC	10Y 3/1 N 3 (20)			0	ma	ss	> 1		5	Weak
Cg3	158	g	SiC	10Y 3.5/1			0	ma	ss	> 1			Strong
Cg4	196	-	SiC	10Y 3/1			0	ma	ms	> 1			Strong

Remarks: Profile description by D.M. Balduff; 18 July 2005 at 11:37 am.
Sampled using a McCauley sampler.
Worm tubes on the surface.
Cg1 has pockets of 3% 5Y 4/3 associated with worm tubes.

Sample CB83

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38° 04' 12.8" N, 75° 20' 46.7" W
Water Depth 145 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	2	a	SiC	5Y 3/1			0	ma	ss	>> 1			Weak
A2	16	c	SiC	10Y 3/1			0	ma	ss	> 1		1	Weak
Cg1	36	c	SiC	10Y 3.5/1			0	ma	ss	> 1		20	Strong
Cg2	130	c	SiC	10Y 3.5/1			0	ma	ss	> 1		1	Strong
Cg3	143	-	SiC	10Y 3.5/1			0	ma	ss	> 1		15	Strong

Remarks: Profile description by D.M. Balduff; 18 July 2005 at 12:17 pm.
Sampled using a McCauley sampler.
Worm tubes on surface.
A2 contains 3% pockets of 5Y 4/3.

Sample CB84

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 04' 32.2" N, 75˚ 21' 9.1" W
Water Depth 130 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	6	c	SiC	5Y 4/1			0	ma	ns	> 1			None
Cg1	72	c	SiC	10Y 3/1			0	ma	ss	> 1		7	None
Cg2	138	c	SiC	10Y 3/1			0	ma	ss	> 1			Strong
Cg3	157	a	Mk SiC	10Y 3/1	15	10YR 4/4	0	ma	ms	> 1			Strong
Oab	166	c	Mk	5Y 3/2	45	10YR 4/4							Strong
Cgb1	176	c	SiC	5Y 4/2	10	10YR 4/4	0	ma	ss	> 1			Strong
2Cgb2	216	-	SL	5Y 4/2	10	10YR 4/4	0	ma	ss	0.7 - 1			Strong

Remarks: Profile description by D.M. Balduff; 18 July 2005 at 12:41 pm.
Sampled using a McCauley sampler.
Worm tubes on surface.

Sample CB85

Fine-loamy, Typic Sulfaquents (Fine-loamy, Fluvic Sulfiwassents)
38º 04' 42.3" N, 75º 21' 21.7" W
Water Depth 120 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	5	a	SiC		5Y 4/1			0	ma	ms	>> 1			None
A2	21	c	SiC		10Y 2.5/1 N 3 (2)			0	ma	ms	> 1		3	None
Cg1	33	c	C	CL	10Y 3/1			0	ma	ms	> 1			None
Cg2	57	c	C	CL	10Y 3/1			0	ma	ms	> 1		2	None
2Cg3	92	c	SL	SL	10Y 4/1 10Y 5/1 (10) 10Y 3/1 (5)			0	ma	ss	0.7 - 1			None
2Cg4	120	c	SL	LfS	10Y 6/1	3	5Y 5/4	0	ma	ns	< 0.7			None
2Cg5	139	-	SL		10Y 6/1			0	ma	ns	< 0.7			None

Remarks: Profile described by D. Balduff, 19 July 2005 at 8:17 am.
Sampled using Vibracorer, depth inside core 105 cm, depth outside core 90 cm.

Sample CB86

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 05' 0.3" N, 75˚ 21' 26.0" W
Water Depth 110 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	3	a	SiC	5Y 3/1			0	ma	ms	> 1	5		None
Cg1	35	c	SiC	10Y 3/1			0	ma	ms	> 1			None
Cg2	93	c	SiC	5GY 3.5/1			0	ma	ms	> 1			None
Oab	105	c	Mk	10YR 2/1	30	5Y 6/6							None
Cgb	138	-	L	10Y 2.5/1			0	ma	ss	> 1			None

Remarks: Profile description by D.M. Balduff; 19 July 2005 at 10:00 am.
Sampled using a McCauley sampler.

Sample CB87

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 04' 55.0" N, 75˚ 20' 40.2" W
Water Depth 120 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	2	a	SiC	5Y 4/1			0	ma	ss	>> 1			None
Cg1	47	c	SiC	10Y 3/1			0	ma	vs	> 1			Weak
Cg2	164	g	SiC	10Y 3/1			0	ma	ms	> 1		2	Strong
Cg3	240	-	SiC	10Y 3/1			0	ma	ms	> 1		3	Strong

Remarks: Profile description by D.M. Balduff; 19 July 2005 at 10:45 am.
Sampled using a McCauley sampler.

Sample CB88

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 04' 6.8" N, 75˚ 21' 21.9" W
Water Depth 130 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	3	a	SiC	5Y 4/1			0	ma	ss	>> 1			None
A2	21	c	SiC	10Y 3/1			0	ma	vs	> 1			None
Cg1	115	g	SiC	10Y 3.5/1			0	ma	ms	> 1			Strong
Cg2	200	-	SiC	10Y 3.5/1			0	ma	ms	> 1		3	Strong

Remarks: Profile description by D.M. Balduff; 19 July 2005 at 11:20 am.
Sampled using a McCauley sampler.
Gastropod and oyster shells in Cg2.

Sample CB89

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 03' 46.2" N, 75˚ 20' 58.1" W
Water Depth 130 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Redoximorphic Features		Organic Fragments		Structure		Moist Const.	n value	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Abun. %	Color	Gr.	Shape				
A1	2	a	SiC	5Y 4/1					0	ma	ss	> 1		None
A2	21	c	SiC	10Y 3/1	1	10YR 4/4			0	ma	ms	> 1		None
Cg1	88	c	SiC	10Y 3/1			20	5Y 6/6	0	ma	ms	> 1		Strong
Cg2	184	-	SiC	10Y 3.5/1					0	ma	ms	> 1		Strong

Remarks: Profile description by D.M. Balduff; 19 July 2005 at 12:00 pm.
Sampled using a McCauley sampler.

Sample CB90

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 03' 14.6" N, 75˚ 21' 4.0" W
Water Depth 110 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	2	a	SiC	5Y 4/2			0	ma	ns	>> 1			Strong
Cg1	32	c	SiC	10Y 2.5/1	3	2.5Y 3/3	0	ma	vs	> 1			Strong
Cg2	42	a	SiC	10Y 3/1	5	2.5Y 4/3	0	ma	ms	> 1			Strong
Cg3	72	c	SiC	10Y 3/1 N 3 (15)	5	5Y 5/3 2.5Y 3/3	0	ma	ns	>>> 1		10	Strong
Cg4	95	c	SiC	10Y 3/1	3	5Y 6/6	0	ma	ms	> 1			Strong
Cg5	114	c	SiC	10Y 3.5/1	2	5Y 5/6	0	ma	ss	> 1		10	Strong
2Cg6	165	-	SL	10Y 3/1	1	5Y 5/6	0	ma	ms	> 1		1	Strong

Remarks: Profile description by D.M. Balduff; 19 July 2005 at 12:45 pm.
Sampled using a McCauley sampler.

Sample CB91

Fine-loamy, Typic Sulfaquents (Fine-loamy, Fluvic Sulfiwassents)
38º 03' 27.0" N, 75º 20' 8.4" W
Water Depth 165 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	3	a	SiC		5Y 4/2			0	ma	ns	>> 1			Weak
Cg1	54	c	SiC	L	10Y 3/1			0	ma	vs	> 1			Weak
2Cg2	61	c	SL	SL	10Y 4/1			0	ma	ns	0.7 - 1			Weak
3Cg3	139	g	SiC	SiCL	10Y 3/1			0	ma	ms	> 1			Weak
3Cg4	169	c	SiC	L	10Y 3/1			0	ma	ms	> 1		3	Weak
4Cg5	191	-	SL	SL	10Y 3.5/1			0	ma	ss	0.7 - 1		10	Weak

Remarks: Profile described by D. Balduff, 20 July 2005 at 8:28 am.
Sampled using a McCauley sampler.
Worm tubes on surface.

Sample CB92

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 04' 2.5" N, 75˚ 19' 28.8" W
Water Depth 170 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	3	a	SiC	5Y 4/1			0	ma	ns	>> 1			Strong
Cg1	37	c	SiC	10Y 3/1			0	ma	ms	> 1			Strong
Cg2	94	c	SiC	10Y 3/1	2	5Y 5/6	0	ma	ms	> 1		10	Strong
Cg3	161	-	SiC	10Y 3/1	5	5Y 5/6	0	ma	ms	> 1			Strong

Remarks: Profile description by D.M. Balduff; 20 July 2005 at 9:24 am.
Sampled using a McCauley sampler.

Sample CB93

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38º 02' 52.30" N, 75º 19' 26.90" W
Water Depth 190 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	4	a	SiC	SiL	5Y 4/1			0	ma	ns	>>1			None
A2	15	c	SiC	SiL	10Y 2.5/1			0	ma	vs	>1		2	Weak
Cg1	42	c	SiC	SiL	10Y 3/1			0	ma	ms	>1			Strong
Cg2	81	g	SiC	SiCL	10Y 3/1	3	5Y 4/4	0	ma	ms	>1		2	Strong
Cg3	210	-	SiC	SiCL	10Y 3.5/1			0	ma	vs	>1			Strong

Remarks: Profile described by D. Balduff, 20 July 2005 at 10:00 am
Sampled using McCauley peat sampler

Sample CB94

Fine, Typic Sulfaquents (Fine, Fluvic Sulfiwassents)
38º 02’ 51.4” N, 75º 19’ 51.8” W
Water Depth 110 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	1	a	S		5Y 5/2			0	ma	ns	< 0.7			None
A2	12	c	S	fS	N3 10Y 4/1			0	ma	ns	< 0.7		2	Weak
2Cg1	33	c	SiC	SiC	10Y 3/1	3	5Y 6/6	0	ma	ms	> 1		1	Strong
2Cg2	94	c	SiC	SiC	5GY 3/1	10	5Y 6/6	0	ma	ms	> 1			Strong
2Cg3	107	c	SiC	SiC	10Y 3/1			0	ma	ms	> 1		10	Strong
2Cg4	145	-	SiC	SiC	10Y 3/1	7	5Y 6/6	0	ma	ss	>> 1			

Remarks: Profile described by D. Balduff, 20 July 2005 at 11:14 am
Sampled using Vibracorer, depth inside core 80 cm, depth outside core 75 cm.
2Cg4 had a “jelly” consistence.

Sample CB95

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 02' 48.1" N, 75˚ 19' 3.4" W
Water Depth 210 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	3	a	SiC	5Y 4/1			0	ma	ns	>> 1			None
Cg1	31	c	SiC	10Y 2.5/1			0	ma	ms	> 1			Weak
Cg2	48	c	SiC	10Y 3/1			0	ma	ss	> 1		15	Strong
Cg3	74	c	SiC	10Y 3/1			0	ma	ss	>> 1			Strong
Cg4	101	c	SiC	10Y 3/1			0	ma	ss	> 1		2	Strong
Cg5	180	-	SiC	10Y 3.5/1	5	10YR 5/6	0	ma	ms	> 1			Strong

Remarks: Profile description by D.M. Balduff; 20 July 2005 at 12:33 pm.
Sampled using a McCauley sampler.
Cg3 had a "soupy" consistence.

Sample CB96

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38° 02' 48.3" N, 75° 18' 57.0" W
Water Depth 235 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	10	c	SiC	5Y 4/1			0	ma	ns	> 1			Strong
Cg1	40	c	SiC	10Y 3/1			0	ma	ms	> 1		2	Strong
Cg2	81	c	SiC	10Y 3/1			0	ma	ms	> 1			Strong
Cg3	127	c	SiC	10Y 3.5/1			0	ma	ms	> 1		10	Strong
Cg4	158	c	SiC	5GY 4/1	20	10YR 3/2	0	ma	ms	> 1			Strong
Oa/Cg	188	-	Mk SiC	2.5Y 4/1	40	10YR 3/2	0	ma	ms	> 1			Strong

Remarks: Profile description by D.M. Balduff; 20 July 2005 at 1:04 pm.
Sampled using a McCauley sampler.

Sample CB97

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38° 08' 35.9" N, 75° 16' 30.0" W
Water Depth 220 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	2	a	SiC		5Y 3/1			0	ma	ns	> 1			Strong
Cg1	76	c	SiC	SiL	10Y 3/1			0	ma	ms	> 1			Strong
Cg2	95	c	C	L	10Y 3/1			0	ma	ms	> 1			Strong
Cg3	131	c	SiC	SiCL	10Y 3/1			0	ma	ms	> 1		3	Strong
Cg4	145	c	SiC	SiCL	10Y 3/1	2	2.5Y 5/6	0	ma	ms	> 1			Strong
Cg5	168	c	SiC	SiC	5Y 3/2 10Y 3.5/1	15	2.5Y 5/6	0	ma	ss	> 1		2	Strong
Oa/Cg	195	a	Mk SiCL		5Y 4/1	15	2.5Y 5/6	0	ma	ss	> 1			Strong
Oab1	213	c	Mk		5Y 3/2	40	2.5Y 5/6							Strong
Oab2	224	c	Mk		10YR 2/1									Strong
Ab	245	c	Mk L	L	10YR 2/1			0	ma	ss	0.7 - 1			Strong
Cgb1	260	c	SL	L	5GY 4/1			0	ma	ms	0.7 - 1			None
Cgb2	266	-	SL	SL	5GY 4/1 5Y 4/2 (5)			0	ma	ss	0.7 - 1			None

Remarks: Profile description by D.M. Balduff; 21 July 2005 at 8:12 am.
Sampled using a McCauley sampler.

Sample CB98

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 08' 46.5" N, 75˚ 16' 52.6" W
Water Depth 200 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	2	a	SiC	5Y 4/1			0	ma	ns	>> 1			None
Cg1	63	c	SiC	10Y 2.5/1			0	ma	ss	> 1			Weak
Cg2	128	c	SiC	10Y 3/1			0	ma	ms	> 1		2	Strong
Cg3	212	-	SiC	10Y 3/1	5	10YR 3/6	0	ma	ms	> 1			Strong

Remarks: Profile description by D.M. Balduff; 21 July 2005 at 8:57 am.
Sampled using a McCauley sampler.

Sample CB99

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38° 08' 30.3" N, 75° 15' 58.9" W
Water Depth 250 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	5	a	SiC	5Y 4/2			0	ma	ss	> 1			Strong
A2	24	c	SiC	10Y 2.5/1			0	ma	ms	> 1			Strong
Cg1	51	c	SiC	10Y 3/1			0	ma	ms	> 1			Strong
Cg2	91	c	SiC	10Y 3/1	2	2.5Y 3/2	0	ma	ms	> 1		10	Strong
Oab1	101	c	Mk	10YR 2/2	50	2.5Y 3/2							Strong
Oab2	134	-	Mk	10YR 3/2	50	2.5Y 6/6							Strong

Remarks: Profile description by D.M. Balduff; 21 July 2005 at 9:27 am.
Sampled using a McCauley sampler.

Sample CB100

Fine-silty, Typic Sulfaquent (Fine-silty, Fluvic Sulfiwassents)
38º 08' 21.3" N, 75º 15' 19.1" W
Water Depth 260 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	3	a	SiC		5Y 4/1			0	ma	ns	> 1			Strong
Cg1	53	c	SiC	SiCL	10Y 2.5/1			0	ma	ms	> 1			Strong
Cg2	80	c	C	L	10Y 3/1			0	ma	ss	> 1			Strong
Cg3	100	g	SiC	SiCL	10Y 3/1			0	ma	ms	> 1		5	Strong
Cg4	201	-	SiC		10Y 3/1			0	ma	ms	> 1			Strong

Remarks: Profile described by D. Balduff, 20 July 2005 at 10:20 am.
Sampled using McCauley peat auger.
Worm tubes on surface.

Sample CB101

Fine-silty, Thapto-histic Sulfaquents (Fine-silty, Thapto-histic Sulfiwassents)
38˚ 10’ 20.0” N, 75˚ 15’ 36.2” W
Water Depth 210 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	2	a	SiCL	5Y 4/1			0	ma	ns	> 1			None
A2	12	c	SiCL	10Y 2.5/1			0	ma	ns	> 1		2	None
Cg1	52	c	SiC	10Y 3/1			0	ma	ms	> 1		2	None
Cg2	78	c	SiC	10Y 3.5/1			0	ma	vs	> 1			None
Oab1	93	c	Mk	10YR 2/2	50	2.5Y 5/4							None
Oab2	99	c	Mk	10YR 2/1	50	2.5Y 5/4							None
Ab	106	c	SL	2.5Y 3/2			0	ma	ns	0.7 - 1			None
Cgb	115	-	SL	2.5Y 4/1			0	ma	ns	0.7 - 1			None

Remarks: Profile description by D.M. Balduff; 21 July 2005 at 11:47 am.
Sampled using a McCauley sampler.
Worm tubes on surface.
Oab1 contained 1 cm bands of 10Y 3.5/1 sediment layers.

Sample CB102

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 09' 20.2" N, 75˚ 14' 45.2" W
Water Depth 240 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	2	a	C	10Y 3/1			0	ma	ms	> 1			None
Cg1	51	c	C	10Y 3/1			0	ma	ms	> 1		15	Strong
Cg2	114	a	SiC	10Y 3/1			0	ma	ms	> 1			Strong
Oab	134	c	Mk	2.5Y 2.5/1	50	10YR 5/6							Strong
Ab	143	c	Mk L	5Y 3/1	30	10YR 5/6	0	ma	ms	0.7 - 1			Strong
Cgb1	165	c	SL	10Y 4/1	7	10YR 5/6	0	ma	ss	0.7 - 1			Weak
Cgb2	177	-	SL	10Y 5/1			0	ma	ss	< 0.7			Weak

Remarks: Profile description by D.M. Balduff; 21 July 2005 at 12:23 pm.
Sampled using a McCauley sampler.
Worm tubes on surface.

Sample CB103

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 06' 54.9" N, 75˚ 16' 27.1" W
Water Depth 230 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	4	a	SiC	5Y 3/1			0	ma	ss	>> 1			Strong
Cg1	70	c	SiC	10Y 2.5/1			0	ma	vs	> 1		1	Strong
Cg2	109	c	C	10Y 3/1			0	ma	ms	> 1		3	Strong
Cg3	117	-	C	10Y 3/1			0	ma	ms	> 1		10	Strong

Remarks: Profile description by D.M. Balduff; 22 July 2005 at 8:27 am.
Sampled using a McCauley sampler.

Sample CB104

Fine-loamy, Haplic Sulfaquents (Fine-loamy, Haplic Sulfiwassents)
38˚ 11' 0.2" N, 75˚ 14' 28.3" W
Water Depth 225 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	6	a	SL	5Y 4/1			0	ma	ns	0.7 - 1			None
A2	18	c	SL	N 3			0	ma	ns	0.7 - 1		10	None
Cg1	40	c	SL	N 3.5			0	ma	ns	0.7 - 1		2	Weak
2Cg2	87	c	SiC	10Y 3/1			0	ma	ms	> 1		2	Strong
2Cg3	134	c	SiC	10Y 3/1			0	ma	ms	> 1		3	Strong
2Cg4	153	a	SiC	10Y 3/1			0	ma	ms	> 1		1	Strong
2Oab1	161	a	Mk	10YR 2/2	2	5Y 5/6							Strong
2Oab2	168	-	Mk	7.5YR 2.5/1									Strong

Remarks: Profile description by D.M. Balduff; 22 July 2005 at 9:35 am.
Sampled using a McCauley sampler.

Sample CB105

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 11' 15.0" N, 75˚ 15' 1.1" W
Water Depth 230 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	2	a	SiC	5Y 3/1			0	ma	ss	> 1			None
A2	19	c	L	5GY 3.5/1	5	2.5Y 5/6	0	ma	ss	0.7 - 1			None
Cg	63	c	SiC	10Y 3/1	20	2.5Y 5/6	0	ma	ms	> 1			Strong
Oab	78	c	Mk	10YR 2/1	50	2.5Y 5/6							Strong
Ab	85	c	L	5Y 4/1	3	2.5Y 5/6	0	ma	ss	0.7 - 1			Strong
Cgb	105	-	SiC	10Y 5/1			0	ma	ms	< 0.7			Strong

Remarks: Profile description by D.M. Balduff; 22 July 2005 at 10:28 am.
Sampled using a McCauley sampler.

Sample CB106

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 02' 48.6" N, 75˚ 18' 7.1" W
Water Depth 230 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	3	a	SiL	5Y 3/1			0	ma	ss	> 1			None
A2	16	c	SL	N 3			0	ma	ss	0.7 - 1		2	None
2Cg1	53	c	SiC	10Y 3/1			0	ma	ms	> 1		1	Strong
2Cg2	69	c	SiC	10Y 3.5/1	10	10YR 4/4	0	ma	ss	> 1			Strong
2Cg3	165	c	SiC	10Y 3.5/1	40	10YR 4/4	0	ma	ss	> 1			Strong
2Cg4	210	-	SiC	N 4	15	2.5Y 5/6	0	ma	ms	> 1		1	Strong

Remarks: Profile description by D.M. Balduff; 26 July 2005 at 8:33 am.
Sampled using a McCauley sampler.
Worm tubes on surface.

Sample CB107

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 01’ 56.7” N, 75˚ 18’ 23.7” W
Water Depth 240 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	6	a	SiL	5Y 3/2			0	ma	ns	> 1			None
Cg1	49	c	SiCL	10Y 3/1			0	ma	ms	> 1		2	None
Cg2	105	c	SiC	10Y 3/1	25	2.5Y 5/6	0	ma	ss	> 1			Strong
Cg3	165	g	SiC	10Y 3.5/1	15	2.5Y 5/6	0	ma	ms	> 1			Strong
Cg4	200	-	SiC	10Y 3.5/1	7	2.5Y 5/6	0	ma	ss	> 1			Strong

Remarks: Profile description by D.M. Balduff; 26 July 2005 at 9:28 am.
Sampled using a McCauley sampler.

Sample CB108

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 02’ 3.0” N, 75˚ 18’ 55.8” W
Water Depth 220 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	2	a	L	10Y 2.5/1			0	ma	ss	0.7 - 1			None
A2	17	c	L	10Y 3/1			0	ma	ms	0.7 - 1		3	None
Cg1	57	c	SiC	10Y 3/1			0	ma	ss	> 1			Weak
Cg2	84	c	SiC	10Y 3.5/1			0	ma	ms	> 1			Strong
Cg3	97	-	SiC	10Y 3.5/1			0	ma	ss	> 1		10	Strong

Remarks: Profile description by D.M. Balduff; 26 July 2005 at 10:00 am.
Sampled using a McCauley sampler.

Sample CB109

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 02' 9.0" N, 75˚ 19' 29.7" W
Water Depth 230 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	3	a	SL	5Y 4/1			0	ma	ns	> 1			None
A2	15	c	SiCL	10Y 3/1			0	ma	ss	> 1		5	Strong
Cg1	71	c	SiC	10Y 3/1	7	5Y 5/6	0	ma	ss	> 1		2	Strong
Cg2	120	-	SiC	10Y 3/1	5	5Y 5/6	0	ma	ss	> 1			Strong

Remarks: Profile description by D.M. Balduff; 26 July 2005 at 10:22 am.
Sampled using a McCauley sampler.

Sample CB110

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 02' 9.4" N, 75˚ 19' 53.6" W
Water Depth 240 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	2	a	SiC	10Y 2.5/1			0	ma	ms	> 1			Strong
Cg1	69	g	SiC	10Y 3/1			0	ma	ms	> 1			Strong
Cg2	100	a	C	10Y 2.5/1			0	ma	ms	> 1		2	Strong
Cg3	103	-	SiC	10Y 3/1			0	ma	ss	> 1		15	Strong

Remarks: Profile description by D.M. Balduff; 26 July 2005 at 10:47 am.
Sampled using a McCauley sampler.

Sample CB111

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 02' 13.4" N, 75˚ 20' 30.1" W
Water Depth 160 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	3	a	SiL	5Y 4/2			0	ma	ss	>> 1			
A2	20	c	SiC	10Y 2.5/1			0	ma	ms	> 1			Strong
Cg1	42	g	SiC	10Y 3/1			0	ma	ms	> 1		2	Strong
Cg2	200	-	SiC	10Y 3/1			0	ma	ms	> 1			Strong

Remarks: Profile description by D.M. Balduff; 26 July 2005 at 11:14 am.
Sampled using a McCauley sampler.
Surface was extremely shelly.

Sample CB112

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 04' 52.6" N, 75˚ 17' 36.7" W
Water Depth 180 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	4	a	SiCL	5Y 4/2			0	ma	ss	> 1			
A2	21	c	CL	10Y 2.5/1	7	5Y 5/6	0	ma	ms	> 1		2	
Cg1	54	c	SiC	10Y 3.5/1	20	5Y 5/6	0	ma	ss	> 1			Strong
Cg2	138	c	SiC	10Y 3/1			0	ma	ms	> 1		1	Strong
Cg3	184	-	SiC	10Y 3.5/1			0	ma	ms	> 1			Strong

Remarks: Profile description by D.M. Balduff; 27 July 2005 at 8:43 am.
Sampled using a McCauley sampler.
Clam shell in horizon A2.

Sample CB113

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 05' 7.7" N, 75˚ 17' 55.5" W
Water Depth 160 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	4	a	SiL	5Y 4/2			0	ma	ss	> 1			Strong
A2	25	c	SL	10Y 3/1			0	ma	ss	0.7 - 1			Strong
Cg1	46	c	SiC	10Y 3/1			0	ma	ms	> 1			Strong
Cg2	148	c	SiC	5GY 4/1	20	2.5Y 5/6	0	ma	ms	> 1			Strong
Cg3	199	-	SiC	10Y 3/1	25	2.5Y 5/6	0	ma	ms	> 1			Strong

Remarks: Profile description by D.M. Balduff; 27 July 2005 at 9:16 am.
Sampled using a McCauley sampler.

Sample CB114

Fine-loamy, Typic Sulfaquents (Fine-loamy, Fluvic Sulfiwassents)
38˚ 05’ 21.5” N, 75˚ 18’ 9.3” W
Water Depth 150 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	6	a	SiL	5Y 4/2			0	ma	ss	> 1			
A2	23	c	SL	10Y 2.5/1			0	ma	ss	0.7 - 1			Strong
Cg1	63	c	SiC	10Y 3/1			0	ma	ms	> 1		3	Strong
Cg2	80	c	SL	10Y 3/1			0	ma	ss	0.7 - 1			Strong
Cg3	210	-	SiC	10Y 3/1			0	ma	ms	> 1		1	Strong

Remarks: Profile description by D.M. Balduff; 27 July 2005 at 9:50 am.
Sampled using a McCauley sampler.

Sample CB115

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 05' 28.2" N, 75˚ 18' 38.9" W
Water Depth 120 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Redoximorphic Features		Organic Fragments		Structure		Moist Const.	n value	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Abun. %	Color	Gr.	Shape				
A1	2	a	SL	5Y 4/1					0	ma	ss	> 1		Strong
A2	15	c	SL	10Y 3/1	1	10YR 4/4			0	ma	ms	0.7 - 1	1	Strong
2Cg1	50	c	SiC	10Y 3/1					0	ma	ms	> 1	2	Strong
2Cg2	99	c	SiC	5Y 4/1	15 10	10Y 5/1 2.5Y 4/1	10	2.5Y 5/6	0	ma	ms	> 1		Strong
2Cg3	159	c	SiC	5Y 5/1	15	5Y 5/4	15	2.5Y 5/6	0	ma	ms	> 1		Strong
2Cg4	198	-	SiC				2	2.5Y 5/6	0	ma	ms	> 1	2	Strong

Remarks: Profile description by D.M. Balduff; 27 July 2005 at 10:15 am.
Sampled using a McCauley sampler.

Sample CB116

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 05' 21.2" N, 75˚ 17' 25.6" W
Water Depth 200 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	3	a	SL	5Y 4/1			0	ma	ns	> 1			
A2	18	c	SL	10Y 2.5/1			0	ma	ss	0.7 - 1			Strong
2Cg1	62	c	SiC	10Y 2.5/1			0	ma	ss	> 1			Faint
2Cg2	78	c	SiC	10Y 3/1	3	2.5Y 3/3	0	ma	ss	> 1			Faint
2Cg3	103	-	SiC	10Y 3/1			0	ma	ss	> 1		15	Strong

Remarks: Profile description by D.M. Balduff; 27 July 2005 at 12:15 pm.
Sampled using a McCauley sampler.

Sample CB117

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38° 01' 34.8" N, 75° 19' 48.1" W
Water Depth 240 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	16	c	L	10Y 2.5/1			0	ma	ss	0.7 - 1		7	None
Cg1	34	c	SiC	10Y 3/1			0	ma	ms	> 1		3	Strong
Cg2	97	c	SiC	10Y 3/1			0	ma	ss	> 1		1	Strong
Cg3	163	c	CL	10Y 3/1			0	ma	ms	> 1		1	Strong
Cg4	211	-	L	10Y 3/1			0	ma	ss	0.7 - 1		2	Strong

Remarks: Profile description by D.M. Balduff; 11 August 2005 at 8:10 am.
Sampled using a McCauley sampler.

Sample CB118

Fine-silty, Typic Sulfaquent (Fine-silty, Fluvic Sulfiwassents)
38º 01' 9.3" N, 75º 21' 12.2" W
Water Depth 220 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	9	c	SiC		N 3			0	ma	ms	> 1			Faint
Cg1	19	c	SiC		10Y 3/1			0	ma	ms	> 1			Faint
Cg2	117	c	SiC	CL	10Y 3/1			0	ma	ss	> 1			Strong
Cg3	148	c	SiC		10Y 3/1	10	2.5Y 3/3	0	ma	ss	> 1		1	Strong
Cg4	191	c	SiC		10Y 3/1	3	2.5Y 3/3	0	ma	ss	> 1		1	Strong
Cg5	205	-	SiC		10Y 3/1			0	ma	ss	> 1			Strong

Remarks: Profile described by D. Balduff, 11 August 2005 at 9:21 am.
Sampled using McCauley peat auger.
Worm tubes on surface.

Sample CB119

Coarse-loamy, Typic Sulfaquents (Coarse-loamy, Fluvic Sulfiwassents)
38˚ 01' 1.8" N, 75˚ 22' 37.3" W
Water Depth 220 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	17	c	C	10Y 3/1			0	ma	ms	> 1			None
Cg1	44	c	CL	10Y 3/1			0	ma	ms	> 1		1	Strong
Cg2	73	c	L	10Y 3/1			0	ma	ss	0.7 - 1		1	None
2Cg3	99	-	SL	10Y 3/1 N 3 (2)			0	ma	ss	0.7 - 1			None

Remarks: Profile description by D.M. Balduff; 11 August 2005 at 9:54 am.
Sampled using a McCauley sampler.

Sample CB120

Coarse-loamy, Typic Sulfaquents (Coarse-loamy, Fluvic Sulfiwassents)
38˚ 01' 34.1" N, 75˚ 22' 8.7" W
Water Depth 160 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	12	c	C	5Y 3/1 10YR 4/4 (2)			0	ma	ss	> 1			None
Cg1	31	c	CL	10Y 3/1			0	ma	ss	0.7 - 1			None
2Cg2	56	c	SL	10Y 3/1	7	10YR 3/3	0	ma	ss	0.7 - 1			None
2Cg3	81	c	SL	10Y 4/1	3	10YR 3/3	0	ma	ss	0.7 - 1			Strong
2Cg4	102	-	SL	10Y 4/1 5Y 4/6 (2)			0	ma	ss	0.7 - 1			None

Remarks: Profile description by D.M. Balduff; 11 August 2005 at 10:35 am.
Sampled using a McCauley sampler.

Sample CB121

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38˚ 02' 0.5" N, 75˚ 22' 12.7" W
Water Depth 140 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	12	c	SiC	N 3			0	ma	ms	> 1		2	Strong
Cg1	52	c	SiC	10Y 3/1 N 3 (15)			0	ma	ms	> 1			Strong
Cg2	89	c	SiC	10Y 3.5/1			0	ma	ss	> 1			Strong
Cg3	197	c	SiC	10Y 3/1	15	5Y 4/4	0	ma	ss	> 1			Strong
Cg/Oa	204	a	Mk SiC	10Y 3/1	25	5Y 4/4	0	ma	ss	> 1			Strong
Oab	213	c	Mk	10YR 2/2	45	5Y 4/4							Strong
Cgb	216	-	SiC	10Y 3/1			0	ma	ns	> 1			Strong

Remarks: Profile description by D.M. Balduff; 11 August 2005 at 11:14 am.
Sampled using a McCauley sampler.

Sample CB122

Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)
38° 00’ 58.1” N, 75° 21’ 35.5” W
Water Depth 220 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	4	a	SiC	5Y 3.5/1			0	ma	ss	> 1			Strong
Cg1	31	c	SiC	10Y 2.5/1 N 2.5 (2) 2.5Y 3/3 (3)			0	ma	ms	> 1			Strong
Cg2	132	c	SiC	10Y 3/1	2	2.5Y 4/4	0	ma	ss	> 1		3	Strong
Cg3	203	-	SiC	10Y 3/1	20	2.5Y 4/4	0	ma	ms	> 1			Strong

Remarks: Profile description by D.M. Balduff; 11 August 2005 at 12:09 pm.
Sampled using a McCauley sampler.
Worm tubes on surface.

Sample CB123

Sandy, Haplic Sulfaquent (Sulfic Psammowassents)
38º 11' 34.4" N, 75º 12' 52.5" W
Water Depth 130 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	4	a	fS		5Y 4/1			0	sg	ns	< 0.7			
A2	24	c	fS		N 3			0	sg	ns	< 0.7		2	Strong
Cg1	47	c	LfS	fS	10Y 3/1			0	sg	ns	< 0.7		5	Strong
Cg2	109	c	LfS	LfS	10Y 3.5/1	2	2.5Y 3/1	0	sg	ns	< 0.7			Strong
Cg3	148	c	LfS		N 3.5			0	sg	ns	< 0.7		10	Strong
2Cg4	160	-	SC		10Y 2.5/1			0	ma	ms	> 1		3	Strong

Remarks: Profile described by D. Balduff, 12 August 2005 at 10:48 am.
Sampled using a vibracorer; depth inside core 69 cm, depth outside core 70 cm.

Sample CB124

Coarse-loamy, Haplic Sulfaquent (Coarse-loamy, Haplic Sulfiwassents)
38º 12' 42.6" N, 75º 11' 58.0" W
Water Depth 100 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	6	c	fS	fS	10Y 3.5/1			0	sg	sg	< 0.7		2	None
Cg1	48	c	fS	fS	10Y 3/1			0	sg	sg	< 0.7		2	None
2Cg2	70	a	SiC	SiCL	10Y 3/1	15	2.5Y 3/3	0	ma	ms	> 1			Strong
2Oab1	116	c	Mk		10YR 2/2		2.5Y 6/6							Strong
2Oab2	130	c	Mk		10YR 2/1		2.5Y 6/6							Strong
3Ab	136	c	Mk L	fSL	5Y 3/1	7	10YR 3/4	0	ma	ms	0.7 - 1			Strong
3Cgb	157	-	L	fSL	10Y 3.5/1	5	2.5Y 5/4	0	ma	ms	0.7 - 1			Strong

Remarks: Profile described by D. Balduff, 12 August 2005 at 10:48 am.
Sampled using a vibracorer; depth inside core 64 cm, depth outside core 65 cm.

Sample CB125

Sandy, Haplic Sulfaquent (Sulfic Psammowassents)
38º 10’ 22.0” N, 75º 13’ 25.6” W
Water Depth 150 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	2	a	S	5Y 4/1			0	sg	ns	< 0.7			None
A2	11	c	S	N 3			0	sg	ns	< 0.7			None
Cg1	35	c	SL	10Y 3/1			0	ma	ss	0.7 - 1		3	None
Cg2	65	c	LS	10Y 3/1	1	2.5Y 5/6	0	sg	ns	< 0.7			Faint
Cg3	98	c	SL	10Y 3/1	3	2.5Y 5/6	0	ma	ns	0.7 - 1		2	Faint
Cg4	126	-	LcS	5GY 4/1				sg	ns	< 0.7		10	Strong

Remarks: Profile described by D. Balduff, 15 August 2005 at 9:25 am.
Sampled using a vibracorer; depth inside core 152 cm, depth outside core 154 cm.

Sample CB126

Fine-silty, Typic Sulfaquent (Fine-silty, Fluvic Sulfiwassents)
38º 10' 51.8" N, 75º 15' 4.0" W
Water Depth 210 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	2	a	L	5Y 4/1			0	ma	ns	0.7 - 1			None
A2	36	c	L	10Y 2.5/1			0	ma	ss	0.7 - 1		2	Faint
Cg1	120	c	SiC	10Y 3/1			0	ma	ss	> 1			Strong
Cg2	166	c	SiC	10Y 3/1	7	2.5Y 2.5/1	0	ma	ss	> 1			Strong
Oab	177	a	Mk	10YR 2/1									Strong
Ab	181	a	Mk SiL	10YR 3/1			0	ma	ss	> 1			Strong
Cgb	192	-	SiC	N 4	3	2.5Y 5/4	0	ma	ms	> 1			Faint

Remarks: Profile described by D. Balduff, 15 August 2005 at 11:05 am.
Sampled using a McCauley peat sampler.
Worm tubes on surface.

Sample CB127

Fine-silty, Typic Sulfaquent (Fine-silty, Fluvic Sulfiwassents)
38º 11' 42.5" N, 75º 15' 10.1" W
Water Depth 180 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	22	c	SiC		10Y 3/1			0	ma	ms	> 1		1	None
Cg1	51	c	SiC	SiCL	5Y 4/1			0	ma	ss	>> 1			None
Cg2	102	c	SiC	SiCL	10Y 3/1			0	ma	ss	> 1			Strong
Cg3	169	c	SiC		10Y 3/1	3	2.5Y 3/1	0	ma	ss	> 1		2	Strong
Cg4	186	c	Mk SiC		10Y 3/1	30	10YR 5/4	0	ma	ms	> 1			Strong
Oab1	201	c	Mk		10YR 2/1									Strong
Oab2	224	c	Mk		2.5Y 2.5/1									Strong
Ab	230	a	Mk L		10YR 2/1	10	2.5Y 6/6	0	ma	ss	> 1			
Cgb	236	-	L		10YR 3/1	7	10YR 2/1	0	ma	ss	> 1			

Remarks: Profile described by D. Balduff, 12 August 2005 at 10:48 am.
Sampled using a McCauley peat sampler.
Worm tubes on surface.

Sample CB128

Fine-silty, Typic Sulfaquent (Fine-silty, Fluvic Sulfiwassents)
38º 11' 36.1" N, 75º 14' 38.4" W
Water Depth 220 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	4	a	SL	5Y 4/1			0	ma	ss	> 1			Strong
A2	14	c	SiCL	N 3			0	ma	ms	> 1			Strong
Cg1	26	c	SiCL	10Y 3/1	3	10YR 3/4	0	ma	ss	> 1		5	Strong
Cg2	69	c	SiC	10Y 3/1	20	5Y 5/4	0	ma	ss	> 1			Strong
Cg3	218	c	SiC	10Y 3/1	15	2.5Y 5/6	0	ma	ms	> 1			Strong
Cg4	247	a	SiC	10Y 3/1	3	5Y 5/6	0	ma	ms	> 1		1	Strong
Cg5	250	-	Mk SiC	10YR 3/2			0	ma	ms	> 1			Strong

Remarks: Profile described by D. Balduff, 19 August 2005 at 9:30 am.
Sampled using a McCauley peat sampler.

Sample CB129

Fine-silty, Typic Sulfaquent (Fine-silty, Fluvic Sulfiwassents)
38º 08’ 48.2” N, 75º 14’ 27.8” W
Water Depth 300 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	3	a	SiC	5Y 4/1			0	ma	ss	> 1			None
A2	33	c	SiC	10Y 2.5/1			0	ma	ss	> 1			Strong
Cg1	137	g	SiC	10Y 3/1			0	ma	ss	> 1			Strong
Cg2	194	c	SiC	10Y 3.5/1			0	ma	ss	> 1		2	Strong
2Cg3	219	-	SL	5GY 3.5/1			0	ma	ns	0.7 - 1		10	Strong

Remarks: Profile described by D. Balduff, 19 August 2005 at 10:47 am.
Sampled using a McCauley peat sampler.

Sample CB130

Fine-silty, Typic Sulfaquent (Fine-silty, Fluvic Sulfiwassents)
38º 04’ 6.4” N, 75º 21’ 22.0” W
Water Depth 150 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	4	a	SiC		5Y 4/1			0	ma	ms	> 1			None
A2	21	c	SiC	SiCL	10Y 2.5/1			0	ma	ms	> 1		1	None
Cg1	58	c	SiC	CL	10Y 3/1	3	2.5Y 5/4	0	ma	ms	> 1		3	None
Cg2	125			SiCL										
Cg2	199	g	SiC	SiCL	10Y 3/1			0	ma	vs	> 1		1	Strong
Cg3	275			CL										
Cg3	340	-	SiC	SiCL	10Y 3/1			0	ma	ms	> 1		2	Strong

Remarks: Profile described by D. Balduff, 20 August 2005 at 10:12 am.
Sampled using a McCauley peat sampler.
Gastropod located at 201 cm.

Sample CB131

Sandy, Haplic Sulfaquent (Sandy, Haplic Sulfiwassents)
38º 10’ 16.2” N, 75º 12’ 33.9” W
Water Depth 110 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	2	a	LfS	5Y 4/1			0	sg	ns	< 0.7			None
A2	9	c	fS	N 3			0	sg	ns	< 0.7			None
Cg1	39	c	fSL	10Y 3.5/1			0	ma	ns	0.7 - 1			None
Cg2	73	c	fSl	10Y 3.5/1	3	10YR 2/1	0	ma	ns	0.7 - 1			Strong
Cg3	123	c	L	5GY 3.5/1	5	10YR 2/1	0	ma	ms	> 1			Strong
2Cg4	161	-	LfS	5GY 4/1			0	sg	ns	< 0.7		5	Strong

Remarks: Profile described by D. Balduff, 22 August 2005 at 8:40 am.
Sampled using a vibracorer; depth inside core 62 cm, depth outside core 60 cm.

Sample CB132

Sandy, Haplic Sulfaquent (Sulfic Psammowassents)
38º 10’ 51.2” N, 75º 12’ 16.6” W
Water Depth 110 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	2	a	LfS	5Y 4/1			0	sg	ns	< 0.7	15		Strong
A2	10	c	LfS	N 3			0	sg	ns	< 0.7	15		Strong
Cg1	22	c	fS	10Y 2.5/1			0	sg	ns	< 0.7		1	Strong
Cg2	77	c	LfS	10Y 3.5/1			0	sg	ns	< 0.7		1	Strong
Cg3	90	c	LfS	5GY 4/1	3	10YR 3/1	0	sg	ns	< 0.7		3	Strong
2Cg4	155	-	S	N 4			0	sg	ns	< 0.7			Strong

Remarks: Profile described by D. Balduff, 22 August 2005 at 10:00 am.
Sampled using a vibracorer; depth inside core 76 cm, depth outside core 52 cm.

Sample CB133

Sandy, Haplic Sulfaquent (Sulfic Psammowassents)
38º 11’ 36.3” N, 75º 11’ 39.9” W
Water Depth 125 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	10	a	L	N 2.5			0	ma	ns	>> 1			Strong
A2	23	c	SL	N 3			0	ma	ns	< 0.7			Strong
Cg1	56	c	LS	10Y 3/1	15	10YR 3/2	0	sg	ns	< 0.7		7	Strong
Cg2	122	c	S	10Y 4/1	2	10YR 3/2	0	sg	ns	< 0.7		3	Strong
Cg3	183	c	SL	10Y 3.5/1	2	10YR 3/2	0	ma	ns	< 0.7		2	Strong
Cg4	196	-	S	5GY 4/1			0	sg	ns	< 0.7		2	Strong

Remarks: Profile described by D. Balduff, 22 August 2005 at 10:50 am.
Sampled using a vibracorer; depth inside core 47 cm, depth outside core 36 cm.

Sample CB134

Fine-silty, Typic Sulfaquent (Fine-silty, Fluvic Sulfiwassents)
38º 12' 10.6" N, 75º 14' 53.0" W
Water Depth 200 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	4	a	SiL	5Y 4/1			0	ma	ns	> 1		3	None
A2	23	c	SiL	10Y 2.5/1			0	ma	ss	> 1		2	None
Cg1	92	c	SiCL	10Y 4/1			0	ma	ms	> 1			None
Cg2	109	c	SiC	10Y 4/1	10	2.5Y 4/4	0	ma	ss	> 1			None
Oab	118	c	Mk	10YR 2/1									Strong
2Ab	134	c	SL	5Y 4/1	15	5Y 5/4	0	ma	ns	0.7 - 1			None
2Cgb1	162	c	SL	10Y 5/1	2	5Y 5/4	0	ma	ns	< 0.7			None
2Cgb2	179	-	LS	10Y 5/1			0	sg	ns	< 0.7			None

Remarks: Profile described by D. Balduff, 23 August 2005 at 8:08 am.
Sampled using a McCauley peat sampler.
Worm tubes and bivalve shells on surface.

Sample CB135

Sandy, Haplic Sulfaquent (Sulfic Psammowassents)
38º 12’ 19.6” N, 75º 14’ 59.1” W
Water Depth 150 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	4	a	LfS	5Y 4/2			0	sg	ns	< 0.7			None
A2	19	c	S	N 3			0	sg	ns	< 0.7		7	None
Cg1	61	c	LS	2.5Y 4/2	10	10YR 4/6	0	sg	ns	< 0.7		7	None
Cg2	98	c	LS	5Y 5/1	7	2.5Y 5/4	0	sg	ns	< 0.7			None
Cg3	126	c	S	5Y 5/1	2	2.5Y 5/4	0	sg	ns	< 0.7			None
2Cg4	174	-	cS	10Y 6/1			0	sg	ns	< 0.7			Strong

Remarks: Profile described by D. Balduff, 23 August 2005 at 8:08 am.
Sampled using a vibracorer; depth inside core 86 cm, depth outside core 70 cm.
Worm tubes on surface.

Sample CB136

Fine-silty, Typic Sulfaquent (Fine-silty, Fluvic Sulfiwassents)
38º 12' 16.1" N, 75º 14' 56.2" W
Water Depth 165 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	2	a	fSl		5Y 4/1			0	ma	ns	< 0.7			None
A2	18	c	LS	LfS	10Y 2.5/1			0	ma	ns	< 0.7		2	None
Cg1	37	c	SL	L	10Y 3/1			0	ma	ns	0.7 - 1		3	None
2Cg2	93	c	SiC	SiCL	10Y 3/1			0	ma	ss	> 1		2	Strong
2Cg3	146	c	SiC	SiCL	10Y 3/1			0	ma	ms	> 1		1	Strong
2Cg4	161	a	SiC	SiC	10Y 3/1	20	5Y 5/6	0	ma	ss	> 1			Strong
2Oab1	187	c	Mk		10YR 3/2									Strong
2Oab2	205	c	Mk		10YR 2/1									Strong
3Ab	211	-	SL	SL	2.5Y 3/1			0	ma	ns	0.7 - 1			Strong

Remarks: Profile described by D. Balduff, 23 August 2005 at 10:20 am.
Sampled using a McCauley peat sampler.

Sample CB137

Fine-silty, Typic Sulfaquent (Fine-silty, Fluvic Sulfiwassents)
38º 11’ 37.1” N, 75º 14’ 31.8” W
Water Depth 225 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	3	a	SiL	5Y 4/1			0	ma	ns	>> 1			None
A2	10	c	SiL	N 3			0	ma	ss	> 1			None
Cg1	64	c	SiC	10Y 4/1	10	10YR 3/3	0	ma	ms	> 1			Strong
Cg2	106	c	SiC	10Y 3.5/1	15	2.5Y 6/8	0	ma	ss	> 1			Strong
Cg3	174	c	SiC	10Y 3.5/1	7	2.5Y 6/8	0	ma	ss	> 1			Strong
Cg4	210	-	SiC	10Y 3.5/1	3	2.5Y 5/4	0	ma	ms	> 1			Strong

Remarks: Profile described by D. Balduff, 23 August 2005 at 10:59 am.
Sampled using a McCauley peat sampler.

Sample CB138

Sandy, Haplic Sulfaquent (Sulfic Psammowassents)
38º 11' 22.9" N, 75º 10' 39.3" W
Water Depth 120 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	23	c	fS	N 3			0	sg	ns	< 0.7		1	None
Cg1	47	c	S	N 4.5			0	sg	ns	< 0.7		2	None
Cg2	130	c	S	N 5			0	sg	ns	< 0.7			Strong
Cg3	149	-	S	N 4.5			0	sg	ns	< 0.7			Strong

Remarks: Profile described by D. Balduff, 24 August 2005 at 8:40 am.
Sampled using a vibracorer; depth inside core 79 cm, depth outside core 63 cm.

Sample CB139

Sandy, Haplic Sulfaquent (Sulfic Psammowassents)
38º 11' 27.7" N, 75º 11' 18.9" W
Water Depth 165 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	2	a	fS	5Y 4/1			0	sg	ns	< 0.7			None
A2	10	c	fS	N 3	3	10YR 2/1	0	sg	ns	< 0.7			None
A3	21	c	fS	N 4	2	10YR 3/2	0	sg	ns	< 0.7		1	None
Cg1	52	c	fS	N 4.5	1	10YR 5/6	0	sg	ns	< 0.7		2	Strong
Cg2	67	c	S	N 5			0	sg	ns	< 0.7			Strong
Cg3	87	c	S	N 5			0	sg	ns	< 0.7		7	Strong
Cg4	144	-	S	N 5.5			0	sg	ns	< 0.7		1	Strong

Remarks: Profile described by D. Balduff, 24 August 2005 at 9:22 am.
Sampled using a vibracorer; depth inside core 70 cm, depth outside core 50 cm.
Worm tubes on surface. Clam shell in Cg3 horizon.

Sample CB140

Sandy, Haplic Sulfaquent (Sulfic Psammowassents)
38º 10’ 55.7” N, 75º 13’ 23.0” W
Water Depth 160 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	2	a	fS	5Y 4/1			0	sg	ns	< 0.7		1	None
A2	15	c	fS	N 2.5			0	sg	ns	< 0.7		2	Strong
Cg1	36	c	fS	10Y 3/1			0	sg	ns	< 0.7			Strong
Cg2	96	c	LfS	5GY 3.5/1	3	10YR 3/3	0	sg	ns	< 0.7		3	Strong
Cg3	123	c	LfS	10Y 3/1			0	sg	ns	< 0.7		3	Strong
2Cg4	147	c	L	10Y 3/1			0	ma	ss	> 1		2	Strong
2Cg5	192	-	fSL	10Y 3/1			0	ma	ss	0.7 - 1		5	Strong

Remarks: Profile described by D. Balduff, 24 August 2005 at 10:40 am.
Sampled using a vibracorer; depth inside core 70 cm, depth outside core 42 cm.

Sample CB141

Fine-silty, Typic Sulfaquent (Fine-silty, Fluvic Sulfiwassents)
38º 11' 38.8" N, 75º 13' 47.7" W
Water Depth 220 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A1	4	a	SiL		5Y 3/1			0	ma	ns	> 1		2	None
A2	13	c	SiL	SL	10Y 2.5/1			0	ma	ss	> 1		10	None
Cg1	23	c	SiCL	SL	10Y 3/1			0	ma	ss	> 1		25	None
Cg2	46	c	SiC	CL	10Y 3/1		2.5Y 4/4	0	ma	ms	> 1		25	Strong
Cg3	123	g	SiC	SiCL	10Y 3/1			0	ma	ss	> 1			Strong
Cg4	174	-	SiC	SiC	10Y 3/1			0	ma	ss	> 1		2	Strong

Remarks: Profile described by D. Balduff, 24 August 2005 at 12:00 pm.
Sampled using a McCauley peat sampler.
Worm tubes on surface.

Sample CB142

Fine-silty, Typic Sulfaquent (Fine-silty, Fluvic Sulfiwassents)
38º 08' 52.7" N, 75º 16' 35.6" W
Water Depth 200 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	3	a	SiL		5GY 4/1			0	ma	ms	> 1		1	Strong
Cg1	36	g	SiCL	SiL	5GY 3/1			0	ma	ms	> 1			Strong
Cg2	100	c	SiCL	SiCL	10Y 3/1	3	10YR 3/4	0	ma	ms	> 1		1	Strong
Oab	131	c	Mk		10YR 3/1									Strong
Ab	134	c	Mk L		N 3			0	ma	ms	0.7 - 1			Strong
Bab	142	c	L	L	5Y 4/1			0	ma	ms	0.7 - 1			Strong
Cgb	149	-	CL	L	10Y 5/1			0	ma	ss	0.7 - 1			Strong

Remarks: Profile described by D. Balduff, 1 October 2005 at 1:54 pm.
Sampled using a McCauley peat sampler.

Sample CB143

Fine-silty, Typic Sulfaquent (Fine-silty, Fluvic Sulfiwassents)
38º 09’ 4.8” N, 75º 16’ 39.2” W
Water Depth 185 cm

Horiz.	Boundary		USDA Texture		Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field	Lab		Abun. %	Color	Gr.	Shape					
A	3	a	SiCL		N 2.5			0	ma	ss	> 1			None
Cg1	61	c	SiCL	L	10Y 3/1			0	ma	ss	> 1			Strong
Cg2	95	c	L	L	10Y 3/1	2	2.5Y 3/1	0	ma	ms	> 1			Strong
Cg3	108	a	L	L	10Y 3.5/1			0	ma	ms	0.7 - 1			Strong
2Cg4	137	-	C	SiL	5GY 5/1			0	ma	vs	< 0.7			None

Remarks: Profile described by D. Balduff, 1 October 2005 at 2:37 pm.
Sampled using a McCauley peat sampler.

Sample CB144

Fine-loamy, Typic Sulfaquent (Fine-loamy, Fluvic Sulfiwassents)
38º 09’ 8.0” N, 75º 16’ 38.1” W
Water Depth 175 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A1	2	a	fS	5Y 4/1			0	sg	ns	< 0.7		1	None
A2	15	c	fS	N 2.5			0	sg	ns	< 0.7		2	Strong
Cg1	36	c	fS	10Y 3/1			0	sg	ns	< 0.7			Strong
Cg2	96	c	LfS	5GY 3.5/1	3	10YR 3/3	0	sg	ns	< 0.7		3	Strong
Cg3	123	c	LfS	10Y 3/1			0	sg	ns	< 0.7		3	Strong
2Cg4	147	c	L	10Y 3/1			0	ma	ss	> 1		2	Strong
2Cg5	192	-	fSL	10Y 3/1			0	ma	ss	0.7 - 1		5	Strong

Remarks: Profile described by D. Balduff, 1 October 2005 at 3:07 pm.
Sampled using a McCauley peat sampler.

Sample CB145

Fine-silty, Terric Sulfisaprists (Sapric Sulfiwassists)
38º 09' 16.2" N, 75º 16' 40.0" W
Water Depth 20 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	6	c	Mk SiC	5Y 4/1			0	ma	ss	> 1			Strong
Oa	34	c	Mk	10YR 3/3									Strong
Cg	51	a	Mk SiC	2.5Y 4/2			0	ma	ms	> 1			Strong
O'a	69	a	Mk	10YR 2/1									Strong
Cg1	106	c	Mk SiC	5GY 3.5/1	4	10YR 4/4	0	ma	ss	> 1			Strong
Cg2	143	a	SiC	5GY 3/1	20	10YR 4/6	0	ma	ss	> 1			Strong
Oab	162	-	Mk	10YR 2/1									Strong

Remarks: Profile described by D. Balduff, 17 August 2005 at 12:03 pm.
Sampled using a vibracorer.

Sample CB146

Fine-silty, Terric Sulfisaprists (Sapric Sulfiwassists)
38º 12' 25.10" N, 75º 15' 2.50" W
Water Depth 40 cm

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
A	2	a	SL	5Y 4/1			0	ma	ss	<0.7			Strong
Cg	6	c	SiC	10Y 3.5/1	10	2.5Y 5/6	0	ma	ss	>1			Strong
Oa	24	c	Mk	5Y 3/2									Strong
C'g	39	c	MkSiCL	10Y 3.5/1			0	ma	ss	>1			Strong
Oab1	71	c	Mk	5Y 3/2									Strong
Oab2	103	c	Mk	10YR 2/1									Strong
C"g	160	c	SiC	5GY 3.5/1	25	5Y 6/6	0	ma	ss	>1			Strong
Oab	210	c	Mk	10YR 2/2									Strong
2Ab	220	c	L	10YR 2/1	7	2.5Y 4/4	0	ma	ss	0.7-1			Strong
2Cgb	229	-	SL	10Y 3/1	3	2.5Y 4/4	0	ma	ss	<0.7			Strong

Remarks: Profile described by D. Balduff, 18 August 2005 at 10:57 am.
Sampled using McCauley peat sampler.
Worm tubes on surface.

Sample M01

38º 09’ 16.6” N, 75º 16’ 40.2” W

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
Oa	5	a	Mk	2.5Y 3/2									None
Oe	31	c	Mp	10YR 3/3									Strong
Oa1	53	c	Mk	2.5Y 2.5/1									Strong
Oa2	72	c	Mk	10YR 2/1									Strong
Oa3	104	c	Mk	2.5YR 3/4									None
Cg	127	c	Mk SiL	5Y 3/1	20	10YR 3/2	0	ma	ss	> 1			Strong
Oab	146	c	Mk	5Y 4/2									Strong
Ab	151	a	Mk SiL	5Y 3/2	20	10YR 3/2	0	ma	ss	> 1			Strong
Cgb	193	c	Mk SiCL	10Y 3/1	10	2.5Y 5/4	0	ma	ms	> 1			Strong
A'b	203	c	Mk SiCL	10Y 3/1	20	2.5Y 5/4	0	ma	ss	> 1			Strong
Cgb1	225	a	SiCL	10Y 3/1	5	2.5Y 6/6	0	ma	ss	> 1			None
2Cgb2	243	-	SCL	10Y 4/1	3	2.5Y 5/4	0	ma	ms	< 0.7			None

Remarks: Profile described by D. Balduff, 17 August 2005 at 8:30 am.
Sampled using McCauley peat sampler and bucket auger.
Marsh grass on surface.

Sample M02

38º 09’ 17.9” N, 75º 16’ 40.3” W

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
Oe	30	c	Mp	2.5Y 3/1			0						Strong
Oa1	46	c	Mk	10YR 3/2			0						Strong
Oa2	70	c	Mk	5Y 4/1			0						Strong
Oa3	84	c	Mk	10Y 2/1			0						Strong
Oa4	91	c	Mk	N 2.5			0						Strong
Cg1	117	c	SiCL	10YR 2.5/1	25	2.5Y 6/4	0	ma	ss	> 1			Strong
Cg2	158	c	Mk SiCL	5Y 4/2	20	2.5Y 6/4	0	ma	ss	> 1			Strong
2Cg3	164	a	SL	5Y 5/2	5	2.5Y 6/4	0	ma	ss	0.7 - 1			Strong
2Cg4	234	c	SCL	N 5	5	2.5Y 6/4	0	ma	ss	< 0.7			None
2Cg5	238	-	LS	N 5			0	sg	ns	< 0.7			None

Remarks: Profile described by D. Balduff, 17 August 2005 at 9:45 am.
Sampled using McCauley peat sampler and bucket auger.
Marsh grass on surface.

Sample M03

38º 09’ 19.5” N, 75º 16’ 41.2” W

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape				
Oe	50	c	Mp	10YR 3/2								Strong
Oa1	90	c	Mk	10YR 4/3								Strong
Oa2	108	c	Mk	10Y 3/1	tree	10YR 4/6						Strong
Oa3	130	c	Mk	10Y 3.5/1								Strong
Oa4	149	a	Mk	N 2.5								Strong
2Cg	170	-	SL/SCL	10Y 6/1 10GY 5/1 (5)			0	ma	ms	< 0.7		Strong

Remarks: Profile described by D. Balduff, 17 August 2005 at 10:40 am.
Sampled using McCauley peat sampler and bucket auger.
Marsh grass on surface.

Sample M04

38º 09' 21.5" N, 75º 16' 42.1" W

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
Oe	42	c	Mp	2.5Y 3/3									Strong
Oa1	55	c	Mk	5Y 3/1									Strong
Oa2	80	c	Mk	2.5Y 2.5/1									Strong
A	98	a	Mk L	5Y 3/1	20	2.5Y 5/4	0	ma	ss	0.7 - 1			Strong
Cg	143	-	SCL	10Y 5/1	7	5Y 7/6	0	ma	ss	< 0.7			Strong

Remarks: Profile described by D. Balduff, 17 August 2005 at 11:00 am.
Sampled using McCauley peat sampler and bucket auger.
Marsh grass on surface.

Sample M07

38º 12’ 27.4” N, 75º 15’ 4.4” W

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
Oe1	15	c	Mp	2.5Y 3/1									Strong
Oe2	51	c	Mp	2.5Y 3/1									Strong
Oa	83	c	Mk	2.5Y 4/2									Strong
Oe	116	a	Mp	10YR 2/1									Strong
A	127	a	Mk SiL	10YR 2/1			0	ma	ss	> 1			Strong
Cg1	155	c	SiL	5Y 4/2	15	10YR 3/4	0	ma	ss	> 1			Strong
Cg2	177	c	Mk SiL	10YR 3/2			0	ma	ss	> 1			Strong
Oab	193	c	Mk	10YR 2/1									Strong
2Ab	200	c	L	5Y 2.5/2			0	ma	ss	0.7 - 1			Strong
2Cgb1	240	c	SL	10Y 4/1	5	2.5Y 5/4	0	ma	ss	0.7 - 1			Strong
2Cgb2	268	-	SL	10Y 5/1	2	10YR 3/4	0	ma	ns	0.7 - 1			Strong

Remarks: Profile described by D. Balduff, 18 August 2005 at 8:24 am.
Sampled using McCauley peat sampler and bucket auger.
Marsh grass on surface.

Sample M08
38º 12' 29.6" N, 75º 15' 6.0" W

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
Oe	25	c	Mp	2.5Y 3/2									Strong
A	39	c	Mk SiCL	10Y 4/1			0	ma	ss	> 1			Strong
Cg	52	c	Mk SiC	5Y 3/2			0	ma	ss	> 1			Strong
O'e	82	c	Mp	10YR 2/1									Strong
C'g	177	c	SiC	5GY 4/1	20	2.5Y 5/6	0	ma	ss	> 1			Strong
Oa	192	c	Mk	2.5Y 3/3									Strong
Ab	203	c	Mk SiCL	5Y 4/2			0	ma	ss	> 1			Strong
Oab	242	c	Mk	10YR 2/1									Strong
Cgb	258	c	SiL	5Y 3/2			0	ma	ss	0.7 - 1			Strong
A'b	271	c	Mk L	10YR 2/1			0	ma	ss	0.7 - 1			Strong
2C'gb	295	-	SL	10YR 2/2			0	ma	ns	0.7 - 1			Strong

Remarks: Profile described by D. Balduff, 18 August 2005 at 9:06 am.
Sampled using McCauley peat sampler and bucket auger.
Marsh grass on surface.

Sample M09

38º 12’ 31.9” N, 75º 15’ 8.8” W

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
Oe	4	a	Mp	2.5Y 4/2									Strong
Oa	15	c	Mk	2.5Y 4/2									Strong
Cg	75	c	Mk SiCL	5Y 3/1			0	ma	ss	> 1			Strong
O'a	102	c	Mk	10YR 2/1									Strong
C'g	187	c	Mk SiC	5Y 4/2			0	ma	ss	> 1			Strong
Oab	224	c	Mk	10YR 2/1									Strong
2Ab	237	c	Mk L	10YR 2/2			0	ma	ss	0.7 - 1			Strong
2Cgb1	244	a	SL	2.5Y 2.5/1			0	ma	ns	0.7 - 1			Strong
2Cgb2	284	-	SL	5Y 5/1			0	ma	ns	< 0.7			Strong

Remarks: Profile described by D. Balduff, 18 August 2005 at 9:46 am.
Sampled using McCauley peat sampler and bucket auger.
Marsh grass on surface.

Sample M10

38º 12’ 25.8” N, 75º 15’ 3.0” W

Horiz.	Boundary		USDA Texture	Matrix Color	Organic Fragments		Structure		Wet Const.	n value	Roots %	Shells %	Intensity of H_2S
	Depth	Dist.	Field		Abun. %	Color	Gr.	Shape					
Oe	6	a	Mk	5Y 3/2									Strong
Cg	31	c	C	10Y 3/1	15	10YR 3/4	0	ma	ss	0.7 - 1			Strong
Oa1	66	c	Mk	2.5Y 5/3									Strong
Oa2	97	a	Mk	10YR 4/3									Strong
Oa3	125	a	Mk	10YR 2/1									Strong
C'g	166	a	SiC	5GY 4/1	15	2.5Y 5/6	0	ma	ss	> 1			Strong
Oab1	183	c	Mk	2.5Y 2.5/1									Strong
Oab2	203	c	Mk	10YR 3/2									Strong
Oab3	220	c	Mk	10YR 2/2									Strong
2Cgb1	261	c	SL	5GY 4/1			0	ma	ss	< 0.7			Strong
2Cgb2	300	-	SCL	5Y 5/2 5Y 5/4 (3)			0	ma	ss	< 0.7			Strong

Remarks: Profile described by D. Balduff, 18 August 2005 at 10:32 am.
Sampled using McCauley peat sampler and bucket auger.
Marsh grass on surface.

Observation O01 21 September 2004
38˚ 08' 4.67" N, 75˚ 14' 5.15" W
Water Depth 220 cm

0-8 cm – n value >1
8-20 cm – n value <0.7

Observation O02 21 September 2004
38˚ 08' 9.49" N, 75˚ 14' 13.38" W
Water Depth 280 cm

0-40 cm – n value >1
40-50 cm – sand, n value <0.7

Observation O03 22 September 2004
38˚ 09' 11.9" N, 75˚ 16' 47.59" W

0-90 cm –sample did not contain an organic horizon, clam shell at 15 cm, organic fragments located at bottom of sample
90 cm – sandy loam

Observation O04 7 June 2005
38˚ 07' 3.06" N, 75˚ 17' 28.92" W
Water Depth 150 cm

A1 – 0-4 cm – oxidized surface
Cg – 4-16 cm
Oab – 16-60 cm
Ab – 60-69 cm

Observation O05 7 June 2005
38˚ 07' 6.9" N, 75˚ 17' 39.6" W
Water Depth 30 cm

A – 0-25 cm – coarse sand with 15% coarse fragments, light brownish gray (2.5Y 6/2)
Cg1 – 25-40 cm – medium sand, gray (2.5Y 6/1)
Cg2 – 40-51 cm – medium sand, gray (2.5Y 5/1)
Cg3 – 51-62 cm – loamy sand with 5% coarse fragments, very dark gray (2.5Y 3/1)

Observation O06 8 June 2005
38˚ 09' 35.04" N, 75˚ 13' 53.88" W

A – 0-30 cm – loam, black (N 2.5/)
Cg – 30-50 – sandy loam with some shells

Observation O07 30 June 2005
38˚ 04' 47.0" N, 75˚ 19' 44.2" W

A1 – 0-13 cm – loamy sand, olive gray (5Y 4/2)
A2 – 13-26 cm – loamy sand, greenish black (10Y 2.5/1)
Cg1 – 26-36 cm – loamy sand, greenish black (10Y 2.5/1) with 30% dark gray (5Y4/1) and pale olive (5Y 6/4) redoximorphic features
Cg2 – 36-56 cm – sandy loam, 60% pale olive (5Y 6/3) and 40% very dark greenish gray (10Y 3/1)

Observation O08 11 August 2005
38˚ 01' 39.3" N, 75˚ 20' 51.1" W

0-50 cm – sandy loam, very dark greenish gray (10Y 3/1), 10% large shells
50 cm – sand

Observation O09 11 August 2005
38˚ 01' 41.9" N, 75˚ 20' 10.5" W

0-50 cm – sandy loam, very dark greenish gray (10Y 3/1), 10% large shells
50 cm – sand

Observation O10 11 August 2005
38˚ 01' 21.8" N, 75˚ 22' 9.6" W

0-50 cm – silty clay, very dark greenish gray (10Y 3/1)
50 cm – very shelly horizon

Observation O11 22 August 2005
38˚ 07' 1.7" N, 75˚ 17' 1.0" W

A1 – 0-2 cm
Cg1 – 2-47 cm – silty clay, very dark greenish gray (10Y 3/1)
2Cg2 – 47-57 cm – sandy loam, very dark greenish gray (10Y 3/1), 3% shells

Observation O12 11 August 2005
38˚ 01' 38.2" N, 75˚ 20' 34.0" W
Water Depth 210 cm

Surface horizon – sand, very shelly surface

Observation O13 12 August 2005
38˚ 10' 21.9" N, 75˚ 14' 9.8" W
Water Depth 210 cm

Surface horizon – sand

Observation O14 19 August 2005
38˚ 07’ 37.0” N, 75˚ 14’ 39.0” W
Water Depth 280 cm
0-20 cm – silty clay
20 cm – sand, n value <0.7

Observation O15 19 August 2005
38˚ 08’ 49.7” N, 75˚ 14’ 51.2” W
Water Depth 270 cm
Worm tubes on surface
A1 – 0-2 cm – fine sandy loam, black (N 2.5/)
A2 – 2-12 cm – fine sandy loam, greenish black (10Y 2.5/1), 1% shells
Cg – 12-30 cm – sandy loam, very dark greenish gray (10Y 3/1), 3% shells

Observation O16 23 August 2005
38˚ 11’ 39.9” N, 75˚ 10’ 33.7” W
Water Depth 120 cm
A – 0-2 cm – fine sandy loam, black (N 2.5/), no odor
Cg1 – 2-40 cm – loamy fine sand, very dark gray (N 3/), 3% shells, no odor
Cg2 – 40-60 cm – sand, gray (N 5/), 1% shells, faint odor

Observation O17 23 August 2005
38˚ 12’ 23.7” N, 75˚ 15’ 1.0” W
Water Depth 140 cm
A – 0-2 cm – sandy loam, dark gray (5Y 4/1), no odor
Cg – 2-30 cm – loamy sand, very dark greenish gray (10Y 3/1), no odor

Appendix D: Total Carbon, Organic Carbon, and Calcium Carbonate Data

Pedon	Sample	Effervescence	Total C			Organic C			CO_3-C	Calcium Carbonate	
			g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	Avg. g kg^{-1}	±2 sd* g kg^{-1}
CB01	A, 0-14 cm	VS	0.85	0.16	0.76	0.76	0.14	0.74	0.09	0.8	0.4-1.1
CB01	Cg1, 14-76 cm	NE	0.44	0.34		0.44	0.34				
CB01	Cg2, 76-103 cm	NE	0.82	0.29		0.82	0.29				
CB01	Cg3, 103-170 cm	NE	1.56	1.36		1.56	1.36				
CB01	Cg4, 170-210 cm	NE	3.09	1.11		3.09	1.11				
CB04	A, 0-6 cm	SL	11.04	0.65	11.51	10.52	0.62	11.47	0.52	4.4	0.0-9.5
CB04	Cg1, 6-32 cm	NE	11.66	2.62		11.66	2.62				
CB04	Cg2, 32-111 cm	NE	11.34	9.57		11.34	9.57				
CB04	Cg3, 111-149 cm	NE	9.64	3.99		9.64	3.99				
CB06	A, 0-3 cm	NE	13.99	0.18	5.19	13.99	0.18	5.19			
CB06	Cg1, 3-59 cm	NE	14.11	3.97		14.11	3.97				
CB06	2Cg2, 59-81 cm	NE	2.59	0.54		2.59	0.54				
CB06	2Cg3, 81-107 cm	NE	2.55	0.68		2.55	0.68				
CB09	A1, 0-2 cm	NE	-	-	3.82	-	-	3.82			
CB09	A2, 2-16 cm	NE	5.22	1.02		5.22	1.02				
CB09	Cg1, 16-22 cm	NE	4.64	0.41		4.64	0.41				
CB09	Cg2, 22-42 cm	NE	2.46	0.92		2.46	0.92				
CB09	Cg/Bgb, 42-53 cm	NE	1.40	0.29		1.40	0.29				
CB09	2Bgb, 53-76 cm	NE	1.81	0.74		1.81	0.74				
CB09	2Bwb1, 76-98 cm	NE	1.16	0.43		1.16	0.43				
CB09	2Bwb2, 98-108 cm	NE	0.30	0.06		0.30	0.06				
CB09	2BCgb, 108-118 cm	NE	0.33	0.06		0.33	0.06				
CB09	2Cgb1, 118-133 cm	NE	0.32	0.09		0.32	0.09				
CB09	2Cgb2, 133-151 cm	NE	0.16	0.04		0.16	0.04				

* Range in calcium carbonate calculated due to uncertainty in the amount of organic carbon oxidized by H_2SO_3 treatment.

Appendix D: Continued.

Pedon	Sample	Effervescence	Total C			Organic C			CO_3-C	Calcium Carbonate	
			g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	Avg. g kg^{-1}	±2 sd* g kg^{-1}
CB10	A, 0-17 cm	NE	1.89	0.40	4.42	1.89	0.40	3.99			
CB10	Cg1, 17-51 cm	NE	2.24	0.96		2.24	0.96				
CB10	Cg2, 51- 64 cm	ST	7.90	1.19		5.07	0.77		2.83	23.6	21.1-26.1
CB10	2Cg3, 64-84 cm	NE	5.98	1.61		5.98	1.61				
CB10	3Cg4, 84-89 cm	NE	3.21	0.22		3.21	0.22				
CB10	3Cg5, 89-134 cm	NE	0.17	0.10		0.17	0.10				
CB11	A1, 0-2 cm	-	-	-	30.19	-	-	30.09			
CB11	A2, 2-12 cm	VS	7.87	0.97		7.02	0.86		0.85	7.0	3.6-10.4
CB11	Cg1, 12-36 cm	NE	19.56	4.62		19.56	4.62				
CB11	Cg2, 36-56 cm	NE	42.17	4.87		42.17	4.87				
CB11	Oab1, 56-83 cm	NE	157.00	12.28		157.00	12.28				
CB11	Oab2, 83-109 cm	NE	212.20	11.39		212.20	11.39				
CB11	2Ab, 109-115 cm	NE	71.30	3.10		71.30	3.10				
CB11	2Cgb, 115-122 cm	NE	22.32	2.30		22.32	2.30				
CB16	A1, 0-2 cm	VS	1.11	0.03	2.20	0.87	0.02	2.13	0.24	2.0	1.6-2.4
CB16	A2, 2-22 cm	SL	1.05	0.19		0.69	0.03		0.09	0.8	0.5-1.1
CB16	Cg1, 22-37 cm	NE	2.17	0.42		2.17	0.17				
CB16	Cg2, 37-67 cm	NE	2.78	1.23		2.78	1.23				
CB16	Cg3, 67- 80 cm	NE	1.04	0.19		1.04	0.19				
CB16	Cg4, 80-114 cm	SL	0.49	0.22		0.35	0.15		0.14	1.2	1.0-1.4
CB16	Cg5, 114-187 cm	NE	1.39	1.52		1.39	1.52				
CB16	Cg6, 187-215 cm	VS	0.41	0.15		0.39	0.14		0.02	0.1	0.0-0.3

* Range in calcium carbonate calculated due to uncertainty in the amount of organic carbon oxidized by H_2SO_3 treatment.

Appendix D: Continued.

Pedon	Sample	Effervescence	Total C			Organic C			CO_3-C	Calcium Carbonate	
			g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	Avg. g kg^{-1}	±2 sd* g kg^{-1}
CB17	A, 0-8 cm	NE	2.69	0.32	3.68	2.69	0.32	3.49			
CB17	Cg/A, 8-32 cm	VS	1.46	0.54		1.35	0.50		0.11	0.9	0.3-1.6
CB17	Cg1, 32-54 cm	NE	6.21	1.50		6.21	1.50				
CB17	Cg2, 54-77 cm	VS	4.43	1.19		3.91	1.04		0.52	4.4	2.5-6.3
CB17	2Cg3, 77-102 cm	NE	0.42	0.14		0.42	0.14				
CB17	2Cg4, 102-148 cm	NE	0.23	0.14		0.23	0.14				
CB18	A, 0-8 cm	-	-	-		-	-	11.63			
CB18	Cg, 8-50 cm	NE	15.23	5.54	11.63	15.23	5.54				
CB18	Cg, 50-100 cm	NE	12.37	6.09		12.37	6.09				
CB18	Cg, 100-150 cm	NE	13.89	4.83		13.89	4.83				
CB18	Cg, 150-200 cm	VS	12.56	6.28		11.30	5.65		1.26	10.4	4.9-15.9
CB18	Cg, 200-250 cm	SL	13.09	6.68		13.09	6.68		0.00	0.0	2.0-13.8
CB20	A, 0-8 cm	NE	12.79	0.65	8.50	12.79	0.65	8.13			
CB20	Cg1, 8-32 cm	NE	9.59	4.33		9.59	4.33				
CB20	Cg2, 32-60 cm	VS	5.39	2.06		4.75	1.81		0.64	5.4	3.0-7.7
CB20	Cg3, 60-115 cm	VS	4.10	2.01		3.76	1.84		0.34	2.8	1.0-4.6
CB21	A1, 0-2 cm	SL	-	-	22.60	-	-	22.49			
CB21	A2, 2-18 cm	SL	22.19	2.66		21.26	2.54		0.93	7.7	0.0-18.1
CB21	Oab, 18-58 cm	NE	201.60	16.65		201.60	16.65				
CB21	Ab, 58-62 cm	NE	25.87	0.81		25.87	0.81				
CB21	BAgb, 62-71 cm	NE	10.43	1.32		10.43	1.32				
CB21	Btgb, 71-96 cm	NE	3.23	1.17		3.23	1.17				
CB21	Cgb, 96-134 cm	NE	0.17	0.09		0.17	0.09				

* Range in calcium carbonate calculated due to uncertainty in the amount of organic carbon oxidized by H_2SO_3 treatment.

Appendix D: Continued.

Pedon	Sample	Effervescence	Total C			Organic C			CO_3-C	Calcium Carbonate	
			g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	Avg. g kg^{-1}	±2 sd* g kg^{-1}
CB24	Oa/Cg	NE	104.80			104.80					
CB24	Cg/Oa	NE	92.51			92.51					
CB26	A, 0-2 cm	NE	0.93	0.03	34.16	0.93	0.03	34.16			
CB26	Cg, 2-28 cm	NE	1.91	0.80		1.91	0.80				
CB26	A', 28-50 cm	NE	71.83	6.05		71.83	6.05				
CB26	C'g, 50-70 cm	NE	45.70	5.28		45.70	5.28				
CB26	Cg/Oab, 70-103 cm	NE	186.20	24.21		186.20	24.21				
CB26	Oab, 103-132 cm	NE	188.40	26.21		188.40	26.21				
CB26	Ab, 132-137 cm	NE	43.63	1.18		43.63	1.18				
CB26	Btgb, 137-150 cm	NE	15.71	3.15		15.71	3.15				
CB31	A2, 4-22 cm	ST	22.86	3.06	9.06	13.11	1.75	5.25	9.75	81.3	74.9-87.6
CB31	Cg1, 22-62 cm	VE	22.30	4.36		10.55	2.06		11.75	97.9	92.8-103.1
CB31	Cg2, 62-112 cm	SL	13.32	2.15		11.66	1.88		1.66	13.9	8.2-19.5
CB39	A1, 0-1 cm		-	-	6.82			6.79			
CB39	A2, 1-12 cm	VS	18.47	0.97		17.91	0.94		0.56	4.7	0.0-13.4
CB39	Cg1, 12-43 cm	NE	13.17	3.45		13.17	3.45				
CB39	Cg2, 43-57 cm	NE	14.08	1.05		14.08	1.05				
CB39	Cg3, 57-126 cm	NE	9.71	2.17		9.71	2.17				
CB39	2Cg4, 126-161 cm	NE	3.89	1.14		3.89	1.14				
CB39	2Cg5, 161-198 cm	NE	1.89	1.01		1.89	1.01				

* Range in calcium carbonate calculated due to uncertainty in the amount of organic carbon oxidized by H_2SO_3 treatment.

Appendix D: Continued.

Pedon	Sample	Effervescence	Total C			Organic C			CO_3-C	Calcium Carbonate	
			g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	Avg. g kg^{-1}	±2 sd* g kg^{-1}
CB41	A2, 3-17 cm	SL	6.76	1.24	9.94	5.66	1.04	6.89	1.10	9.1	6.4-11.9
CB41	Cg1, 17-52 cm	ST	16.62	6.66		10.13	4.06		6.49	54.0	49.1-59.0
CB41	Cg2, 52-143 cm	SL	11.26	3.87		9.87	3.39		1.39	11.6	6.8-16.4
CB45	A, 0-6 cm	VS	2.26	0.18	1.86	2.06	0.17	1.73	0.20	1.6	0.6-2.6
CB45	Cg/A, 6-33 cm	VS	0.70	0.26		0.62	0.24		0.08	0.6	0.3-0.9
CB45	Cg1, 33-88 cm	VS	1.22	0.83		1.16	0.79		0.06	0.5	0.0-1.1
CB45	Cg2, 88-99 cm	VS	3.18	0.43		2.93	0.40		0.25	2.1	0.7-3.5
CB45	2Cg3, 99-142 cm	VS	18.38	6.67		17.48	6.35		0.90	7.4	0.0-15.9
CB45	2Cg4, 142-186 cm	VS	32.27	8.93		31.65	8.76		0.62	5.2	0.0-20.6
CB46	A, 0-5 cm	-	-	-	24.85	-	-	21.70			
CB46	Cg1, 5-19 cm	NE	12.17	6.79		12.17	6.79				
CB46	Cg2, 19-40 cm	VS	11.55	5.39		10.98	5.12		0.57	4.8	0.0-10.1
CB46	Cg3, 40-82 cm	NE	11.61	8.10		11.61	8.10				
CB46	Cg4, 82-126 cm	ST	22.22	11.16		8.18	4.11		14.04	117.0	113.0-120.9
CB50	A1, 0-3 cm	-	-	-	11.36	-	-	6.28			
CB50	A2, 3-21 cm	VE	15.59	2.83		5.95	1.08		9.64	8.03	77.4-83.2
CB50	Cg/A, 21-45 cm	ST	14.03	3.60		6.17	1.58		7.86	65.5	62.5-68.5
CB50	Cg1, 45-60 cm	ST	10.82	1.94		6.55	1.17		4.27	35.6	32.4-38.8
CB50	Cg2, 60-92 cm	SL	6.25	2.52		5.10	2.06		1.15	9.6	7.1-12.1
CB50	Cg3, 92-160 cm	SL	4.44	3.98		3.64	3.26		0.08	6.7	4.9-8.5

* Range in calcium carbonate calculated due to uncertainty in the amount of organic carbon oxidized by H_2SO_3 treatment.

Appendix D: Continued.

Pedon	**Sample**	**Effervescence**	**Total C**			**Organic C**			**CO_3-C**	**Calcium Carbonate**	
			g kg^{-1}	**kg m^{-2}**	**kg m^{-2} upper 1 m**	**g kg^{-1}**	**kg m^{-2}**	**kg m^{-2} upper 1 m**	**g kg^{-1}**	**Avg. g kg^{-1}**	**±2 sd* g kg^{-1}**
CB52	A1 & A2 0-10 cm	VS	7.22	0.40	9.26	6.46	0.35	8.56	0.76	6.3	3.2-9.5
CB52	Cg1, 10-21 cm	VS	9.56	0.86		9.04	0.81		0.52	4.4	0.0-8.8
CB52	2Cg2, 21-39 cm	SL	12.51	1.62		11.57	1.49		0.94	7.8	2.2-13.5
CB52	2Cg3, 39-59 cm	SL	15.67	2.28		14.14	2.06		1.53	12.7	5.9-19.6
CB52	2Cg4, 59-86 cm	VS	18.17	2.94		16.95	2.74		1.22	10.2	2.0-18.4
CB52	2Cg5, 86-115 cm	SL	10.43	2.43		9.77	2.27		0.66	5.5	0.7-10.2
CB52	2Cg6, 115-138 cm	VS	6.75	1.30		6.13	1.18		0.62	5.2	2.2-8.2
CB55	A1, 0-3 cm	-	-	-	4.03	-	-	3.44			
CB55	A2, 3-12 cm	SL	3.38	0.37		2.24	0.25		1.14	9.5	8.4-10.6
CB55	Cg1, 12-41 cm	VS	3.99	1.39		3.71	1.29		0.28	2.4	0.6-4.2
CB55	Cg2, 41-90 cm	VS	2.87	1.68		2.40	1.40		0.47	3.9	2.7-5.1
CB55	2Cg3, 90-143 cm	SL	5.24	3.16		4.40	2.65		0.84	7.1	4.9-9.2
CB55	2Cg4, 143-162 cm	NE	9.65	2.46		9.65	2.46				
CB55	2Cg5, 162-198 cm	NE	9.86	4.41		9.86	4.41				
CB56	A1, 0-2 cm	-	-	-	2.98	-	-	2.66			
CB56	A2, 2-10 cm	VS	2.79	0.27		2.72	0.27		0.07	0.6	0.0-1.9
CB56	Cg1, 10-31 cm	VS	1.38	0.40		1.26	0.36		0.12	0.9	0.3-1.6
CB56	Cg2, 31-49 cm	VS	1.93	0.53		0.92	0.25		1.01	8.4	8.0-8.9
CB56	Cg3, 49-72 cm	NE	3.49	1.07		3.49	1.07				
CB56	Cg4, 72-90 cm	NE	2.50	0.60		2.50	0.60				
CB56	Cg5, 90-122 cm	NE	0.87	0.36		0.87	0.36				
CB56	Cg6, 122-137 cm	NE	2.69	0.57		2.69	0.57				
CB56	2Ab, 137-154 cm	ST	16.34	2.54		11.17	1.73		5.18	43.1	37.7-48.6

* Range in calcium carbonate calculated due to uncertainty in the amount of organic carbon oxidized by H_2SO_3 treatment.

Appendix D: Continued.

Pedon	Sample	Effervescence	Total C			Organic C			CO_3-C	Calcium Carbonate	
			g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	Avg. g kg^{-1}	±2 sd* g kg^{-1}
CB58	A1, 0-3 cm	-	-	-	4.56	-	-	3.48			
CB58	A2, 3-14 cm	VS	4.22	0.68		2.18	0.35		2.04	17.0	16.0-18.1
CB58	Cg1, 14-37 cm	SL	4.98	1.76		3.96	1.40		1.02	8.5	6.6-10.4
CB58	Cg2, 37-106 cm	VS	4.14	2.32		3.38	1.89		0.76	6.4	4.7-8.0
CB58	2Cg3, 106-162 cm	NE	10.31	6.84		10.31	6.84				
CB59	A1, 0-5 cm	VS	25.28	0.34	16.76	24.39	0.33	16.75	0.89	7.5	0.0-19.3
CB59	A2, 5-24 cm	NE	28.29	2.74		28.29	2.74				
CB59	Cg1, 24-35 cm	NE	62.23	2.28		62.23	2.28				
CB59	Cg2, 35-74 cm	NE	57.11	9.03		57.11	9.03				
CB59	Cg3, 74-86 cm	NE	24.37	1.43		24.37	1.43				
CB59	Cg4, 86-127 cm	NE	11.74	2.76		11.74	2.76				
CB67	A1, 0-2 cm	-	-	-	15.91	-	-	15.64			
CB67	A2, 2-13 cm	SL	9.19	0.90		8.00	0.78		1.19	9.9	6.0-13.8
CB67	Cg/A, 13-35 cm	SL	12.13	4.24		11.88	4.16		0.25	2.1	0.0-7.8
CB67	2Cg1, 35-73 cm	NE	23.09	7.90		23.09	7.90				
CB67	2Cg2, 73-135 cm	VS	13.96	6.61		13.63	6.45		0.33	2.7	0.0-9.4
CB70	A1, 0-5 cm	-	-	-	10.03	-	-	10.08			
CB70	A2, 5-19 cm	SL	10.24	1.02		9.72	0.97		0.52	4.3	0.0-9.0
CB70	2Cg1, 19-44 cm	SL	11.92	2.16		11.30	2.05		0.62	5.1	0.0-10.6
CB70	2Cg2, 44-78 cm	VS	15.36	4.24		15.12	4.18		0.24	2.0	0.0-9.4
CB70	2Cg3, 78-92 cm	NE	18.46	1.86		18.46	1.86				
CB70	2Cg4, 92-127 cm	NE	13.70	3.24		13.70	3.24				

* Range in calcium carbonate calculated due to uncertainty in the amount of organic carbon oxidized by H_2SO_3 treatment.

Appendix D: Continued.

Pedon	Sample	Effervescence	Total C			Organic C			CO_3-C	Calcium Carbonate	
			g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	Avg. g kg^{-1}	±2 sd* g kg^{-1}
CB72	A1, 0-2 cm	-	-	-	12.63	-	-	12.04			
CB72	A2, 2-13 cm	VS	11.14	1.65		10.61	1.58		0.53	4.4	0.0-9.6
CB72	Cg1, 13-48 cm	VS	11.93	7.73		11.42	7.40		0.51	4.3	0.0-9.8
CB72	Cg2, 48-69 cm	VS	9.06	1.30		8.91	1.28		0.15	1.2	0.0-5.6
CB72	Cg3, 69-107	VS	7.46	2.39		6.86	2.20		0.60	4.9	1.6-8.3
CB74	A1, 0-2 cm	-	-	-	3.72	-	-	3.56			
CB74	A2, 2-19 cm	VS	8.01	1.25		7.51	1.17		0.50	4.2	0.5-7.8
CB74	Cg1, 19-55 cm	SL	2.46	1.02		2.36	0.98		0.10	0.8	0.0-2.0
CB74	Cg2, 55-89 cm	VS	2.41	1.04		2.36	1.02		0.05	0.5	0.0-1.6
CB74	Cg3, 89-109 cm	VS	3.45	0.75		3.32	0.72		0.13	1.1	0.0-2.7
CB74	2Cg4, 109-142 cm	VS	2.61	1.27		2.34	1.14		0.27	2.3	1.1-3.4
CB74	2Cg5, 142-174 cm	VS	0.80	0.39		0.82	0.38		0.00	0.0	0.0-0.3
CB79	A1, 0-3 cm	-	-	-	4.38	-	-	3.47			
CB79	A2, 3-10 cm	VE	7.21	0.79		1.54	0.17		5.67	47.2	46.5-48.0
CB79	Cg1, 10-50 cm	VS	3.67	1.94		3.40	1.80		0.27	2.2	0.6-3.9
CB79	Cg2, 50-86 cm	VS	2.81	1.55		2.54	1.40		0.27	2.3	1.0-3.5
CB79	Cg3, 86-123 cm	VS	0.51	0.28		0.49	0.27		0.02	0.2	0.0-0.4
CB81	A1, 0-2 cm	-	-	-	4.47	-	-	4.47			
CB81	A2, 2-18 cm	NE	13.42	1.98		13.42	1.98				
CB81	Cg1, 18-154 cm	NE	10.49	4.13		10.49	4.13				

* Range in calcium carbonate calculated due to uncertainty in the amount of organic carbon oxidized by H_2SO_3 treatment.

Appendix D: Continued.

Pedon	Sample	Effervescence	Total C			Organic C			CO_3-C	Calcium Carbonate	
			g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	Avg. g kg^{-1}	±2 sd* g kg^{-1}
CB84	A, 0-6 cm	-	-	-	8.18	-	-	7.64			
CB84	Cg1, 6-72 cm	NE	14.65	6.20		14.65	6.20				
CB84	Cg2, 72-138 cm	SL	13.37	4.65		9.72	3.38		3.65	30.4	25.6-35.1
CB86	A, 0-3 cm	-	-	-	10.61	-	-	10.61			
CB86	Cg1, 3-35 cm	NE	18.59	5.09		18.59	5.09				
CB86	Cg2, 35-93 cm	NE	15.26	4.21		15.26	4.21				
CB86	Cg3, 93-105 cm	NE	22.77	2.24		22.77	2.24				
CB90	A, 0-2 cm	-	-	-	14.50	-	-	14.18			
CB90	Cg1, 2-32 cm	VS	16.87	6.05		16.44	5.90		0.43	3.6	0.0-11.6
CB90	Cg2, 32-42 cm	NE	21.71	1.72		21.71	1.72				
CB90	Cg3, 42-72 cm	VS	18.63	2.99		18.13	2.91		0.40	4.2	0.0-13.0
CB90	Cg4, 72-95 cm	VS	12.20	3.36		11.97	3.29		0.23	2.0	0.0-7.8
CB90	Cg5, 95-114 cm	VS	10.97	1.45		10.21	1.35		0.76	6.3	1.4-11.3
CB91	A, 0-3 cm	-	-	-	6.11	-	-	5.81			
CB91	Cg1, 3-54 cm	VS	10.24	3.79		9.82	3.63		0.42	3.5	0.0-8.2
CB91	Cg2, 54-61 cm	VS	6.73	0.59		6.44	0.56		0.29	2.5	0.0-5.6
CB91	Cg3, 61-139 cm	VS	12.10	3.47		11.27	3.23		0.83	6.9	1.4-12.4
CB91	Cg4, 139-169 cm	SL	10.27	1.39		9.17	1.24		1.10	9.2	4.7-13.7
CB91	Cg5, 169-191 cm	VE	8.55	1.22		5.12	0.73		3.43	28.6	26.1-31.1

* Range in calcium carbonate calculated due to uncertainty in the amount of organic carbon oxidized by H_2SO_3 treatment.

Appendix D: Continued.

Pedon	Sample	Effervescence	Total C			Organic C			CO_3-C	Calcium Carbonate	
			g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	Avg. g kg^{-1}	±2 sd* g kg^{-1}
CB93	A1, 0-4 cm	-	-	-	10.00	-	-	9.74			
CB93	A2, 4-15 cm	VS	14.54	1.78		14.06	1.72		0.48	4.0	0.0-10.8
CB93	Cg1, 15-42 cm	VS	9.95	3.96		9.75	3.88		0.20	1.7	0.0-6.4
CB93	Cg2, 42-81 cm	VS	14.04	3.65		13.71	3.57		0.33	2.7	0.0-9.4
CB93	Cg3, 81-210 cm	VS	11.73	4.17		11.04	3.93		0.69	5.7	0.3-11.1
CB94	A1, 0-1 cm	-	-	-	11.12	-	-	10.71			
CB94	A2, 1-12 cm	VS	1.41	0.22		1.22	0.19		0.19	1.5	0.9-2.1
CB94	2Cg1, 12-33 cm	VS	15.88	2.28		15.88	2.28		0.00	0.0	0.0-7.8
CB94	2Cg2, 33-94 cm	VS	16.19	7.54		16.13	7.51		0.06	0.5	0.0-8.4
CB94	2Cg3, 94-107 cm	VE	20.78	2.35		14.04	1.59		6.74	56.2	49.4-63.0
CB94	2Cg4, 107-145 cm	VS	15.11	3.73		15.06	3.72		0.05	0.4	0.0-7.7
CB97	A, 0-2 cm	-	-	-	5.75	-	-	5.75			
CB97	Cg1, 2-76 cm	NE	10.69	4.31		10.69	4.31				
CB97	Cg2, 76-95 cm	NE	11.04	1.28		11.04	1.28				
CB97	Cg3, 95-131 cm	NE	13.32	3.21		13.32	3.21				
CB97	Cg4, 131-145 cm	NE	19.63	1.96		19.63	1.96				
CB97	Cg5, 145-168 cm	SL	37.84	3.70		38.03	3.72		0.00	0.0	0.0-17.0
CB97	Oab/Cg, 168-195 cm	NE	42.48	7.64		42.48	7.64				
CB97	Oab1, 195-213 cm	NE	162.40	6.05		162.40	6.05				
CB97	Oab2, 213-224 cm	NE	111.50	2.54		111.50	2.54				
CB97	Ab, 224-245 cm	NE	28.76	3.97		28.76	3.97				
CB97	Cgb1, 245-260 cm	NE	3.33	0.45		3.33	0.45				
CB97	Cgb2, 260-266 cm	NE	2.48	0.10		2.48	0.10				

* Range in calcium carbonate calculated due to uncertainty in the amount of organic carbon oxidized by H_2SO_3 treatment.

Appendix D: Continued.

Pedon	Sample	Effervescence	Total C			Organic C			CO_3-C	Calcium Carbonate	
			g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	Avg. g kg^{-1}	±2 sd* g kg^{-1}
CB100	A, 0-3 cm	-	-	-	9.94	-	-	9.35			
CB100	Cg1, 3-53 cm	VS	14.05	4.80		13.77	4.70		0.28	2.3	0.0-9.0
CB100	Cg2, 53-80 cm	SL	10.58	2.70		10.02	2.56		0.56	4.6	0.0-9.5
CB100	Ab, 80-100 cm	ST	14.87	2.45		12.68	2.09		2.19	18.3	12.1-24.5
CB106	A1, 0-3 cm	-	-	-	12.67	-	-	11.81			
CB106	A2, 3-16 cm	SL	8.72	2.12		7.92	1.93		0.80	6.7	2.8-10.5
CB106	Cg1, 16-53 cm	SL	10.75	4.28		9.02	3.59		1.73	14.5	10.1-18.8
CB106	Cg2, 53-69 cm	VS	20.58	5.29		20.58	5.29		0.00	0.0	0.0-11.6
CB106	Cg3, 69-165 cm	VS	32.14	3.11		32.89	3.04		0.00	0.0	0.0-9.8
CB111	A1, 0-3 cm	-	-	-	6.42	-	-	6.18			
CB111	A2, 3-20 cm	VS	17.88	1.92		17.43	1.87		0.45	3.7	0.0-12.2
CB111	Cg1, 20-42 cm	NE	13.13	2.32		13.13	2.32				
CB111	Cg2, 42-200 cm	VS	14.30	5.93		13.07	5.42		1.23	10.2	3.9-16.6
CB117	A, 0-16 cm	VS	24.30	4.39	10.92	5.29	0.96	6.93	19.01	158.4	155.8-160.9
CB117	Cg1,16-34 cm	ST	13.08	2.65		9.96	2.02		3.12	26.0	21.2-30.8
CB117	Cg2, 34-97 cm	SL	11.15	3.71		9.83	3.27		1.32	11.0	6.2-15.8
CB117	Cg3, 97-163 cm	SL	8.33	3.73		7.29	3.27		1.04	8.7	5.1-12.2
CB118	A, 0-9 cm	VS	15.06	1.56	6.80	14.53	1.51	6.43	0.53	4.4	0.0-11.5
CB118	Cg1, 9-19 cm	VS	14.01	1.01		13.42	0.79		0.59	4.8	0.0-11.4
CB118	Cg2, 19-117 cm	SL	10.40	5.12		9.74	4.79		0.66	5.5	0.7-10.2

* Range in calcium carbonate calculated due to uncertainty in the amount of organic carbon oxidized by H_2SO_3 treatment.

Appendix D: Continued.

Pedon	Sample	Effervescence	Total C			Organic C			CO_3-C	Calcium Carbonate	
			g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	Avg. g kg^{-1}	±2 sd* g kg^{-1}
CB119	A, 0-17 cm	VS	14.43	1.77	5.54	14.34	1.75	8.43	0.09	0.7	0.0-7.7
CB119	Cg1, 17-44 cm	VS	11.85	2.92		11.50	2.83		0.35	3.0	0.0-8.6
CB119	Cg2, 44-73 cm	VS	9.33	2.53		8.80	2.39		0.53	4.4	0.1-8.7
CB119	Cg3, 73-99 cm	NE	4.21	1.46		4.21	1.46				
CB120	A, 0-12 cm	VS	15.90	0.39	9.03	15.57	0.39	5.45	0.33	2.8	0.0-10.4
CB120	Cg1, 12-31 cm	NE	11.90	1.79		11.90	1.79				
CB120	2Cg2, 31-56 cm	VS	9.89	2.15		9.67	2.10		0.22	1.8	0.0-6.5
CB120	2Cg3, 56-81 cm	VS	2.01	0.69		1.98	0.68		0.03	0.2	0.0-1.2
CB120	2Cg4, 81-102 cm	VS	2.20	0.57		2.12	0.55		0.08	0.7	0.0-1.7
CB121	A, 0-12 cm	VS	23.60	1.73	16.92	23.48	1.72	9.05	0.12	1.0	0.0-12.5
CB121	Cg1, 12-52 cm	VS	14.83	2.80		14.85	2.80		0.00	0.0	0.0-7.0
CB121	Cg2, 52-89 cm	NE	14.00	3.38		14.00	3.38				
CB121	Cg3, 89-197 cm	VS	22.40	10.99		22.04	11.17		0.00	0.0	0.0-7.9
CB124	A, 0-6 cm	VS	1.07	0.08	16.92	0.93	0.07	16.84	0.14	1.2	0.7-1.6
CB124	Cg1, 6-48 cm	VS	0.88	0.50		0.75	0.42		0.13	1.1	0.7-1.4
CB124	2Cg2, 48-70 cm	NE	36.43	4.04		36.43	4.04				
CB124	2Oab1, 70-116 cm	NE	186.75	18.87		186.75	18.87				
CB124	2Oab2, 116-130 cm	NE	189.50	7.69		189.50	7.69				
CB124	3Ab, 130-136 cm	NE	32.38	2.23		32.38	2.23				
CB124	3Cgb, 136-157 cm	NE	11.39	2.84		11.39	2.84				

* Range in calcium carbonate calculated due to uncertainty in the amount of organic carbon oxidized by H_2SO_3 treatment.

Appendix D: Continued.

Pedon	Sample	Effervescence	Total C			Organic C			CO_3-C	Calcium Carbonate	
			g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	Avg. g kg^{-1}	±2 sd* g kg^{-1}
CB127	A, 0-22 cm	VS	12.99	3.50	9.14	12.40	3.34	8.91	0.59	5.0	0.0-11.0
CB127	Cg1, 22-51 cm	VS	12.55	1.97		12.60	1.96		0.00	0.0	0.0-5.6
CB127	Cg2, 51-102 cm	VS	9.99	3.82		9.78	3.74		0.21	1.7	0.0-6.5
CB130	A1, 0-4 cm	-	-	-	9.56	-	-	9.30			
CB130	A2, 4-21 cm	VS	17.18	1.48		16.76	1.45		0.42	3.5	0.0-11.6
CB130	Cg1, 21-58 cm	VS	9.60	3.31		9.31	3.21		0.29	2.5	0.0-7.0
CB130	Cg2, 58-125 cm	VS	10.25	7.60		9.98	7.40		0.27	2.2	0.0-7.1
CB130	Cg2, 125-199 cm	VS	10.74	6.51		10.53	6.38		0.21	1.7	0.0-6.9
CB130	Cg3, 199-275 cm	SL	9.62	7.45		8.98	6.96		0.64	5.3	1.0-9.7
CB130	Cg3, 275-340 cm	VS	11.94	6.67		11.51	6.43		0.43	3.5	0.0-9.1
CB136	A1, 0-2 cm	-	-	-	7.71	-	-	7.41			
CB136	A2, 2-18 cm	VS	3.13	0.08		2.89	0.07		0.24	2.0	0.6-3.4
CB136	Cg1, 18-37 cm	VS	10.32	2.77		10.13	2.72		0.19	1.6	0.0-6.5
CB136	2Cg2, 37-93 cm	SL	11.98	4.43		11.36	4.21		0.32	5.1	0.0-10.6
CB136	2Cg3, 93-146 cm	VS	10.91	6.14		10.38	5.85		0.53	4.4	0.0-9.4
CB136	2Cg4, 146-161 cm	NE	53.57	3.96		53.57	3.96				
CB136	2Oab1, 161-187 cm	NE	271.70	15.52		271.70	15.52				
CB136	2Oab2, 187-205 cm	NE	164.25	6.50		164.25	6.50				
CB136	3Ab, 205-211 cm	NE	44.63	1.76		44.63	1.76				

* Range in calcium carbonate calculated due to uncertainty in the amount of organic carbon oxidized by H_2SO_3 treatment.

Appendix D: Continued.

Pedon	Sample	Effervescence	Total C			Organic C			CO_3-C	Calcium Carbonate	
			g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	Avg. g kg^{-1}	±2 sd* g kg^{-1}
CB141	A1, 0-4 cm	-	-	-	17.26	-	-	6.67			
CB141	A2, 4-13	VE	17.75	1.12		5.30	0.33		12.45	103.7	101.1-106.3
CB141	Cg1, 13-23 cm	VE	51.07	5.06		6.67	0.66		44.40	370.0	366.7-373.2
CB141	Cg2, 23-46 cm	VE	33.34	6.78		8.58	1.74		24.76	206.3	202.1-210.5
CB141	Cg3, 46-123 cm	SL	13.04	6.14		11.89	5.60		1.15	9.6	3.8-15.4
CB141	Cg4, 123-174 cm	VS	14.83	5.64		13.45	5.12		1.38	11.5	5.0-18.0
CB142	A, 0-3 cm	-	-	-	8.91	-	-	8.49			
CB142	Cg1, 3-36 cm	VS	12.55	4.00		11.87	3.78		0.68	5.6	0.0-11.4
CB142	Cg2, 36-100 cm	SL	14.34	4.92		13.74	4.71		0.60	5.0	0.0-11.7
CB142	Oab, 100-131 cm	NE	230.70	15.71		230.70	15.71				
CB142	Ab, 131-134 cm	NE	46.04	1.19		46.04	1.19				
CB142	BAgb, 134-142 cm	NE	21.73	2.70		21.73	2.70				
CB142	Cgb, 142-149 cm	NE	5.87	0.91		5.87	0.91				
CB143	A, 0-3 cm	-	-	-	8.84	-	-	8.84			
CB143	Cg1, 3-61 cm	NE	13.98	5.39		13.98	5.39				
CB143	Cg2, 61-95 cm	NE	8.60	2.25		8.60	2.25				
CB143	Cg3, 95-108 cm	NE	12.44	3.13		12.44	3.13				
CB143	2Cg4, 108-137 cm	VS	2.53	0.78		2.63	0.77		0.00	0.0	0.0-0.4
CB144	A, 0-29 cm	VS	16.17	3.21	10.85	15.88	3.15	10.59	0.29	2.4	0.0-10.2
CB144	Cg1, 29-51 cm	VS	19.47	3.78		18.67	3.63		0.80	6.6	0.0-15.7
CB144	2Cg2, 51-75 cm	VS	17.11	2.57		16.80	2.53		0.31	2.6	0.0-10.7
CB144	2Cg3, 75-104 cm	NE	6.01	1.49		6.01	1.49				

* Range in calcium carbonate calculated due to uncertainty in the amount of organic carbon oxidized by H_2SO_3 treatment.

Appendix D: Continued.

Pedon	Sample	Effervescence	Total C			Organic C			CO_3-C	Calcium Carbonate	
			g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	kg m^{-2}	kg m^{-2} upper 1 m	g kg^{-1}	Avg. g kg^{-1}	±2 sd* g kg^{-1}
M06	Oab	NE	212.00								
M08	Oab, 200 cm	NE	220.94								
M08	Oab, 230 cm	NE	182.33								
M10	Oab1	NE	107.10								
M10	Oab2	NE	221.16								
M10	Oab3	NE	304.87								

* Range in calcium carbonate calculated due to uncertainty in the amount of organic carbon oxidized by H_2SO_3 treatment.

Appendix E: Moist Incubation pH Data

Pedon	Horizon, Depth (cm)	Intensity of H_2S in the field	pH											
			WK 0	WK 1	WK 2	WK 3	WK 4	WK 5	WK 6	WK 7	WK 8	WK 9	WK 11	WK 13
CB01	A, 0-14	None	6.28	6.00	4.81	5.12	6.11	5.26	6.38	6.12	5.85	6.20	5.30	4.81
CB01	Cg1, 14-76	Strong	6.61	5.27	3.89	3.57	3.00	3.10	3.28	3.25	3.36	3.33	3.39	3.31
CB01	Cg2, 76-103	Strong	6.87	5.97	3.99	3.79	3.32	3.03	3.03	2.95	3.00	2.96	3.04	3.07
CB01	Cg3, 103-170	Strong	7.12	6.60	5.23	5.07	5.37	4.35	3.86	3.65	3.50	3.10	2.99	2.86
CB01	Cg4, 170-210	Strong	7.48	6.65	5.35	5.29	4.85	3.75	3.41	3.12	2.99	2.58	2.76	2.80
CB04	A, 0-6	---	---	---	---	---	---	---	---	---	---	---	---	---
CB04	Cg1, 6-32	Strong	6.47	6.49	5.78	6.13	5.65	4.47	3.59	3.55	3.33	2.96	2.97	2.70
CB04	Cg2, 32-111	Strong	7.55	7.13	6.26	7.41	7.11	7.37	7.29	7.08	7.00	6.31	6.71	5.75
CB04	Cg3, 111- 149	Strong	7.45	7.15	6.54	6.24	4.75	3.69	2.97	3.09	2.93	2.55	2.48	2.51
CB10	A, 0-17	Strong	7.26	6.30	5.37	4.41	3.45	3.40	3.56	3.54	3.52	3.56	3.59	3.44
CB10	Cg1, 17-51	Strong	7.10	3.92	3.60	3.09	2.93	2.79	2.79	2.71	2.87	2.84	3.04	2.98
CB10	Cg2, 51-64	Strong	6.48	6.14	4.34	4.84	4.18	3.66	2.97	2.84	2.71	2.55	2.70	2.80
CB10	2Cg3, 64-84	Strong	6.84	6.80	5.89	5.57	4.82	4.45	3.26	3.22	3.08	2.74	2.72	2.73
CB10	3Cg4, 84-89	Strong	6.88	6.83	5.96	5.88	5.44	4.60	4.34	3.82	3.50	2.95	3.81	3.58
CB10	3Cg5, 89-134	Strong	7.32	7.07	6.31	6.74	6.86	6.37	6.75	6.82	6.48	6.03	6.66	6.01
CB11	A1, 0-2	Strong	---	---	---	---	---	---	---	---	---	---	---	---
CB11	A2, 2-12	Strong	7.65	6.85	6.55	6.71	6.80	6.57	5.38	5.65	5.29	3.69	3.22	3.05
CB11	Cg1, 12-36	Strong	7.51	6.59	6.35	5.40	4.06	3.63	3.04	2.96	2.68	2.37	2.43	2.61
CB11	Cg2, 36-56	Strong	6.47	6.61	6.18	4.89	4.27	3.44	3.05	2.97	2.88	2.60	2.58	2.53
CB11	Oab1, 56-83	Strong	6.70	6.21	4.88	3.67	3.26	3.04	2.69	2.72	2.74	2.36	2.36	2.30
CB11	Oab2, 83-109	Strong	7.00	6.38	5.48	5.23	4.89	4.63	3.62	3.29	3.17	2.90	2.71	2.61
CB11	2Ab, 109-115	Strong	6.91	7.01	6.11	6.39	6.39	6.44	6.28	6.10	5.63	5.39	5.46	5.19
CB11	2Cgb, 115-122	Strong	7.00	7.04	6.76	6.82	7.00	6.75	7.08	6.98	6.60	6.68	6.72	6.15
CB16	A1, 0-2	---	---	---	---	---	---	---	---	---	---	---	---	---
CB16	A2, 2-22	Strong	6.58	5.06	6.19	4.80	3.81	3.30	3.25	3.27	3.28	3.39	3.51	3.43
CB16	Cg1, 22-37	Strong	6.69	5.67	6.25	5.78	5.63	4.75	3.98	3.60	3.16	2.90	3.03	3.12
CB16	Cg2, 37-67	Strong	6.93	6.23	5.94	4.69	4.57	4.04	3.47	3.42	3.12	2.95	2.78	2.76
CB16	Cg3, 67- 80	Strong	7.00	6.12	6.02	4.79	4.16	3.99	3.44	3.38	3.21	2.79	3.00	3.09
CB16	Cg4, 80-114	Strong	7.16	6.21	6.15	5.22	5.89	5.07	4.07	3.98	3.76	3.48	3.62	3.61
CB16	Cg5, 114-187	Strong	7.29	6.97	6.18	5.85	6.40	5.81	4.61	4.72	4.33	3.61	3.59	3.31
CB16	Cg6, 187-215	Strong	7.38	7.33	6.14	6.14	6.49	5.96	4.63	4.74	3.80	3.21	3.22	3.27

Appendix E: Continued.

Pedon	Horizon, Depth (cm)	Intensity of H_2S in the field	pH											
			WK 0	WK 1	WK 2	WK 3	WK 4	WK 5	WK 6	WK 7	WK 8	WK 9	WK 11	WK 13
CB17	A, 0-8	None	7.28	7.06	6.34	6.42	6.23	6.31	5.79	5.79	5.22	4.78	4.45	4.30
CB17	Cg/A, 8-32	Strong	7.27	6.77	5.86	5.35	4.96	4.57	3.35	3.31	3.25	3.09	2.98	2.91
CB17	Cg1, 32-54	Strong	7.36	6.76	6.35	6.47	6.19	5.81	5.36	5.10	5.18	3.74	3.32	3.00
CB17	Cg2, 54-77	Strong	7.51	6.79	5.66	4.00	3.31	3.30	2.95	2.94	2.85	2.72	2.66	2.57
CB17	Cg3, 77-102	Strong	7.09	4.12	4.27	2.72	2.61	2.68	2.81	2.70	2.85	3.11	3.20	3.29
CB17	Cg4, 102-148	Strong	6.54	3.91	3.84	2.96	2.53	2.69	2.67	2.76	2.70	2.79	2.77	3.03
CB18	A, 0-8	None	---	---	---	---	---	---	---	---	---	---	---	---
CB18	Cg, 8-50	Strong	7.08	6.55	5.73	6.45	6.37	5.80	5.63	5.17	5.00	4.17	4.17	3.21
CB18	Cg, 50-100	Strong	7.66	7.00	6.74	7.33	6.91	6.72	7.07	6.90	6.29	6.09	6.09	3.16
CB18	Cg, 100-150	Strong	7.77	7.70	6.97	7.37	7.21	7.03	7.17	6.83	6.33	6.28	6.28	4.76
CB18	Cg, 150-200	Strong	7.93	7.89	7.06	6.99	7.13	6.91	6.26	5.99	5.19	3.92	3.92	3.13
CB18	Cg, 200-250	Strong	7.94	7.87	7.08	7.47	7.20	6.97	6.94	7.09	5.80	3.75	3.75	2.89
CB26	A, 0-2	Strong	---	---	---	---	---	---	---	---	---	---	---	---
CB26	Cg, 2-28	Strong	7.45	6.89	4.00	2.98	2.69	2.56	2.62	2.61	2.71	2.76	2.77	2.78
CB26	A', 28-50	Strong	5.38	4.95	3.65	3.11	2.94	2.92	2.69	2.75	2.66	2.43	2.42	2.43
CB26	C'g, 50-70	Strong	7.10	6.32	4.36	3.74	3.34	2.88	2.66	2.54	2.41	2.24	2.27	2.43
CB26	Cg/Oa, 70-103	Strong	7.34	6.22	5.29	5.37	5.08	3.92	3.28	3.09	2.90	2.53	2.50	2.43
CB26	Oab, 103-132	Strong	7.03	6.33	5.27	4.97	4.25	3.38	2.63	2.62	2.53	2.30	2.35	2.29
CB26	Ab, 132-137	Strong	6.77	6.43	5.65	5.85	5.69	5.20	4.62	4.50	4.27	3.70	3.50	3.34
CB26	Btgb, 137-150	Strong	6.87	6.63	5.67	4.97	4.63	4.28	3.20	3.12	3.19	3.03	3.06	3.04

Appendix E: Continued.

Pedon	Horizon, Depth (cm)	Intensity of H_2S in the field	pH																
			WK 0	WK 1	WK 2	WK 3	WK 4	WK 5	WK 6	WK 7	WK 8	WK 9	WK 11	WK 13	WK 16	WK 18	WK 20	WK 22	WK 25
CB09	A1, 0-2	None																	
CB09	A2, 2-16	None	7.32	6.65	6.52	6.38	6.43	6.06	5.90	6.42	6.04	5.77	5.56	5.02	4.37	3.51	3.34	---	---
CB09	Cg1, 16-22	None	6.85	6.50	5.44	4.15	3.79	3.84	3.63	3.61	3.34	3.30	2.40	2.53	2.53	---	---	---	---
CB09	Cg2, 22-42	None	6.28	6.33	5.00	4.11	3.45	3.56	3.26	3.16	2.65	2.68	2.55	2.45	2.43	---	---	---	---
CB09	Cg/Bgb, 42-53	None	6.35	6.32	5.51	4.80	4.17	4.01	3.74	3.56	3.05	3.10	2.42	2.50	2.43	---	---	---	---
CB09	2Bgb, 53-76	None	5.90	6.04	5.55	4.97	4.33	4.16	4.03	3.77	2.91	3.15	2.65	2.73	2.89	---	---	---	---
CB09	2Bwb1, 76-98	None	5.92	6.08	5.81	5.36	5.45	5.24	5.15	5.21	5.55	5.57	5.46	5.49	5.36	5.36	5.38	5.21	5.38
CB09	2Bwb2, 98-108	None	5.61	5.92	6.03	5.62	5.57	5.58	5.34	5.55	5.45	5.47	5.40	5.51	5.43	5.31	5.32	5.30	5.37
CB09	2BCgb, 108-118	None	5.58	6.22	5.95	5.21	5.45	5.69	5.23	5.54	5.49	5.56	5.48	5.59	5.57	5.62	5.43	5.42	5.57
CB09	2Cgb1, 118-133	None	5.47	5.94	5.93	5.56	5.74	5.71	5.29	5.58	5.29	5.35	5.32	5.42	5.32	5.47	5.37	5.36	5.48
CB09	2Cgb2, 133-151	None	5.67	6.07	6.12	5.96	5.91	5.82	5.71	5.89	5.59	5.59	5.61	5.60	5.47	5.51	5.54	5.41	5.43
CB21	A1, 0-2	None	7.18	7.15	7.03	6.45	6.97	6.67	6.76	7.11	7.16	7.01	6.83	6.86	6.61	6.61	6.38	5.92	5.55
CB21	A2, 2-18	None	7.39	6.88	6.71	6.05	6.47	6.14	6.14	6.49	6.47	6.04	5.70	5.22	4.48	4.24	3.36	3.18	
CB21	Oa, 18-58	Weak	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB21	Ab, 58-62	None	6.98	7.29	6.75	6.24	5.19	4.86	4.22	3.78	3.70	2.72	2.23	2.16	2.09	---	---	---	---
CB21	BAgb, 62-71	None	7.31	7.52	6.58	5.65	5.07	4.29	3.87	3.45	3.14	3.06	2.39	2.48	2.34	---	---	---	---
CB21	Btgb, 71-96	None	7.22	7.32	6.76	5.42	5.05	3.98	3.56	3.33	3.26	2.86	2.54	2.47	2.49	---	---	---	---
CB21	2Cgb, 96-134	None	7.96	7.42	6.70	5.61	4.92	4.43	4.10	3.79	3.32	3.30	3.41	3.39	3.55	---	---	---	---
CB24	Oa/Cg, 22-50	Strong	7.25	6.94	6.33	5.51	5.20	4.71	4.50	4.36	4.20	3.74	2.76	2.56					
CB24	Cg/Oa, 50-71	Strong	7.26	7.14	5.80	4.60	4.34	3.81	3.65	3.54	3.16	2.41	2.39	2.44					
CB39	A1, 0-1	Weak	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB39	A2, 1-12	None	7.50	7.72	7.63	7.06	6.79	6.17	6.01	7.21	7.00	7.00	6.88	6.41	5.85	5.59	5.27	5.02	4.08
CB39	Cg1, 12-43	None	7.98	8.11	7.70	7.07	6.98	6.60	6.35	7.22	7.23	6.94	6.73	6.24	5.33	4.84	4.29	3.67	2.93
CB39	Cg2, 43-57	None	8.14	7.98	7.53	7.05	7.03	6.62	6.50	7.02	7.02	6.65	5.83	4.89	3.85	---	---	---	---
CB39	Cg3, 57-126	None	7.89	8.02	7.02	6.51	6.10	5.51	4.67	4.34	3.86	3.65	2.68	2.35	2.29	---	---	---	---
CB39	2Cg4, 126-161	None	6.46	6.86	6.57	5.47	4.10	4.07	3.58	3.62	3.23	2.85	2.30	2.50	2.40	---	---	---	---
CB39	2Cg5, 161-198	None	6.41	6.95	6.33	5.37	3.89	3.84	3.67	3.72	3.38	3.25	2.59	2.92	2.69	---	---	---	---

Appendix E: Continued.

Pedon	Horizon, Depth (cm)	Intensity of H_2S in the field	pH																
			WK 0	WK 1	WK 2	WK 3	WK 4	WK 5	WK 6	WK 7	WK 8	WK 9	WK 11	WK 13	WK 16	WK 18	WK 20	WK 22	WK 25
CB45	A, 0-6	Strong	7.30	6.68	6.26	5.40	4.59	4.40	4.28	4.44	4.28	4.08	3.58	3.53	3.79	---	---	---	---
CB45	Cg/A, 6-33	Strong	7.57	6.54	5.46	4.28	3.54	3.79	3.72	3.85	3.04	3.02	3.24	3.31	3.45	---	---	---	---
CB45	Cg1, 33-88	Strong	7.95	6.64	4.38	3.81	3.04	3.51	3.41	3.49	2.62	2.66	2.68	2.85	2.88	---	---	---	---
CB45	Cg2, 88-99	Strong	8.06	7.96	6.02	5.46	4.13	5.08	4.60	4.81	4.50	4.22	2.46	2.68	2.83	---	---	---	---
CB45	2Cg3, 99-142	Strong	8.10	8.25	7.52	6.57	6.03	6.22	6.20	6.87	6.69	6.13	5.12	4.19	2.73	---	---	---	---
CB45	2Cg4, 142-186	Strong	8.33	8.53	7.98	7.29	6.96	6.73	6.87	7.29	7.02	6.53	5.88	4.89	3.72	---	---	---	---
CB50	A1, 0-3	None	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB50	A2, 3-21	None	7.86	7.72	8.15	7.46	7.14	7.10	7.25	7.99	7.96	7.98	7.95	7.88	8.00	7.92	8.03	7.97	7.91
CB50	Cg/A, 21-45	None	7.83	8.06	8.00	7.68	7.36	7.29	6.98	7.62	8.02	7.95	7.85	7.89	8.07	7.96	8.06	7.90	7.89
CB50	Cg1, 45-60	None	7.80	8.24	7.99	7.56	7.35	7.33	7.17	7.75	7.39	7.78	7.71	7.83	7.81	7.66	7.88	7.96	7.92
CB50	Cg2, 60-92	Strong	7.74	8.03	7.95	7.59	7.12	7.09	6.92	6.83	6.60	6.18	6.20	5.14	4.37	3.61	2.87	---	---
CB50	Cg3, 92-160	Strong	8.15	8.40	7.79	7.53	6.69	7.13	6.87	6.87	6.76	6.57	6.19	5.96	5.45	5.49	5.09	4.43	3.45
CB52	A1 & A2 0-10	Strong	7.50	7.38	6.54	5.96	6.76	7.12	6.91	6.84	6.75	6.47	6.14	5.68	4.66	4.38	4.13	4.01	3.70
CB52	Cg1, 10-21	Strong	7.78	7.76	6.88	6.36	6.30	6.28	5.82	5.25	4.68	4.41	2.92	2.54	2.63	---	---	---	---
CB52	2Cg2, 21-39	Strong	7.58	7.84	7.14	6.46	6.34	5.65	5.28	4.92	4.73	4.21	2.88	2.63	2.60	---	---	---	---
CB52	2Cg3, 39-59	Strong	7.62	7.83	7.08	6.44	6.20	4.77	4.58	4.58	4.67	3.86	3.03	2.99	3.03	---	---	---	---
CB52	2Cg4, 59-86	Strong	7.60	7.99	7.10	6.35	6.23	4.89	4.61	4.54	4.43	4.21	3.21	2.81	2.80	---	---	---	---
CB52	2Cg5, 86-115	Strong	7.68	8.22	7.58	6.83	6.69	6.24	6.07	6.69	6.40	6.30	5.59	4.99	3.60	---	---	---	---
CB52	2Cg6, 115-138	Strong	7.65	7.85	7.53	7.09	7.02	6.61	6.55	7.37	7.09	7.06	6.81	6.62	6.32	5.86	5.41	4.94	4.15
CB56	A1, 0-2	Strong	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB56	A2, 2-10	Strong	7.67	7.68	7.07	6.51	4.50	4.53	4.37	4.21	3.74	3.56	2.64	2.87	3.01	---	---	---	---
CB56	Cg1, 10-31	Strong	7.88	7.56	6.53	5.46	4.30	4.15	4.08	4.05	3.72	3.54	2.64	2.89	3.03	---	---	---	---
CB56	Cg2, 31-49	Strong	7.66	7.61	7.36	6.58	7.38	6.79	6.85	8.08	7.76	8.13	7.79	7.78	7.78	7.81	7.83	7.49	7.74
CB56	Cg3, 49-72	Strong	7.74	8.08	7.32	6.32	4.55	3.91	3.87	3.83	3.85	3.78	2.54	2.73	2.80	---	---	---	---
CB56	Cg4, 72-90	Strong	7.82	8.12	7.23	5.67	3.89	3.66	3.67	3.65	3.50	3.44	2.34	2.53	2.55	---	---	---	---
CB56	Cg5, 90-122	Strong	8.26	8.23	6.43	4.92	3.86	3.87	3.90	3.86	3.62	3.64	2.67	2.74	2.92	---	---	---	---
CB56	Cg6, 122-137	Strong	7.40	8.48	7.45	7.23	7.29	7.41	7.35	7.93	7.84	8.09	7.69	7.68	7.87	7.92	8.02	7.92	7.86
CB56	2Ab, 137-154	Strong	7.73	8.12	7.88	7.34	7.37	7.37	7.38	7.68	7.53	7.62	7.36	7.31	7.15	6.97	7.12	7.28	7.07

Appendix E: Continued.

Pedon	Horizon, Depth (cm)	Intensity of H_2S in the field	pH																
			WK 0	WK 1	WK 2	WK 3	WK 4	WK 5	WK 6	WK 7	WK 8	WK 9	WK 11	WK 13	WK 16	WK 18	WK 20	WK 22	WK 25
CB58	A1, 0-3	Strong	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB58	A2, 3-14	Strong	7.72	7.91	7.96	7.41	7.51	7.41	7.42	7.68	7.62	7.69	7.60	7.63	7.61	7.58	7.81	7.73	7.59
CB58	Cg1, 14-37	Strong	7.90	8.09	7.78	7.38	6.28	7.11	7.10	6.66	6.71	6.07	6.15	5.34	3.75	---	---	---	---
CB58	Cg2, 37-106	Strong	7.58	7.91	7.79	7.36	6.70	6.43	6.45	6.81	6.62	5.88	6.29	6.03	5.10	4.24	3.66	3.11	---
CB58	2Cg3, 106-162	Strong	7.54	7.82	7.81	7.25	6.90	6.71	6.62	6.51	6.36	5.92	5.18	4.28	3.12	---	---	---	---
CB74	A1, 0-2	None	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB74	A2, 2-19	None	7.56	6.64	7.61	6.95	5.53	5.26	4.91	4.65	4.33	4.10	3.15	2.56	2.70	---	---	---	---
CB74	Cg1, 19-55	None	7.66	6.39	6.36	5.88	4.35	4.09	3.96	3.91	3.51	3.29	2.40	2.48	2.50	---	---	---	---
CB74	Cg2, 55-89	None	7.63	6.92	5.74	4.60	3.46	3.56	3.56	3.47	3.26	2.66	2.41	2.49	2.56	---	---	---	---
CB74	Cg3, 89-109	Weak	7.50	7.22	5.96	4.38	3.96	3.53	3.38	3.29	3.20	3.12	2.61	2.38	2.40	---	---	---	---
CB74	2Cg4, 109-142	Weak	7.53	7.59	7.09	6.60	6.65	7.20	7.20	7.89	7.75	8.03	7.96	7.88	7.80	7.98	8.03	7.97	8.24
CB74	2Cg5, 142-174	None	7.61	7.56	5.43	3.78	3.04	3.75	3.55	3.57	3.47	3.46	3.41	3.38	3.42	---	---	---	---
CB79	A1, 0-3	None	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB79	A2, 3-10	None	7.73	7.60	6.65	6.31	6.58	6.59	6.75	8.17	7.83	8.18	7.85	7.99	8.00	8.06	8.05	7.96	8.03
CB79	Cg1, 10-50	Strong	7.65	7.96	6.87	6.37	6.61	6.46	6.27	6.17	5.52	4.86	4.20	3.63	3.20	---	---	---	---
CB79	Cg2, 50-86	Strong	7.82	8.08	6.86	6.68	6.70	6.52	6.54	6.86	6.60	6.20	5.69	5.19	4.82	4.33	3.40	2.88	---
CB79	Cg3, 86-123	Strong	8.04	7.16	6.98	6.60	6.58	6.53	6.45	6.38	5.53	5.10	4.15	3.69	3.49				
CB91	A, 0-3	Weak	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB91	Cg1, 3-54	Weak	7.59	8.06	7.48	7.03	7.16	6.85	6.81	7.04	6.88	6.61	6.18	5.64	4.87	4.12	3.22	3.00	---
CB91	Cg2, 54-61	None	7.73	8.17	7.49	7.07	6.35	6.74	6.75	6.87	6.19	5.20	3.92	2.98	2.57	---	---	---	---
CB91	Cg3, 61-139	Weak	7.58	8.31	7.62	7.11	7.03	6.82	6.54	6.98	6.82	6.45	6.25	5.25	4.23	3.87	3.08	---	---
CB91	Cg4, 139-169	None	7.35	8.27	7.49	7.12	7.06	6.73	6.52	6.58	6.61	5.38	5.25	4.00	3.29	---	---	---	---
CB91	Cg5, 169-191	Weak	7.30	8.11	7.73	7.50	5.00	4.47	3.90	3.45	3.52	3.18	3.09	2.77	2.47	---	---	---	---
CB94	A1, 0-1	None	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB94	A2, 1-12	None	7.21	7.17	5.96	5.49	3.99	3.97	4.15	4.08	4.16	3.97	3.67	3.70	3.87	---	---	---	---
CB94	2Cg1, 12-33	Strong	7.34	7.20	6.12	5.43	4.42	3.74	3.35	3.33	3.30	3.19	3.08	2.51	2.43	---	---	---	---
CB94	2Cg2, 33-94	Strong	7.54	7.52	6.40	5.58	4.62	3.94	3.60	3.59	3.45	3.32	2.77	2.43	2.39	---	---	---	---
CB94	2Cg3, 94-107	Strong	7.56	7.82	7.14	6.60	6.77	6.58	6.57	7.16	7.25	7.32	7.16	7.14	6.54	6.59	6.25	6.25	5.31
CB94	2Cg4, 107-145	Strong	7.50	7.96	6.06	6.21	4.64	3.72	3.43	3.27	3.36	3.12	2.75	2.49	2.39	---	---	---	---

Appendix E: Continued.

Pedon	Horizon, Depth (cm)	Intensity of H_2S in the field	pH																
			WK 0	WK 1	WK 2	WK 3	WK 4	WK 5	WK 6	WK 7	WK 8	WK 9	WK 11	WK 13	WK 16	WK 18	WK 20	WK 22	WK 25
CB97	A, 0-2	Strong	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB97	Cg1, 2-76	Strong	7.59	8.23	6.72	5.88	6.32	6.19	6.23	6.85	6.71	6.39	5.04	3.99	2.70	---	---	---	---
CB97	Cg2, 76-95	Strong	7.79	8.38	7.14	6.57	6.72	6.39	6.38	6.61	6.53	5.76	4.81	4.16	2.85	---	---	---	---
CB97	Cg3, 95-131	Strong	7.51	7.90	7.27	6.81	6.93	6.39	6.34	6.13	6.42	5.29	5.59	3.69	3.03	---	---	---	---
CB97	Cg4, 131-145	Strong	7.62	8.36	7.20	6.75	6.74	5.93	5.60	5.21	4.95	4.37	4.14	3.11	2.71	---	---	---	---
CB97	Cg5, 145-168	Strong	7.35	8.31	7.22	6.64	5.56	5.55	5.30	5.01	4.84	4.65	4.10	3.28	2.94	---	---	---	---
CB97	Oa/Cg, 168-195	Strong	7.47	8.34	7.07	6.31	4.99	4.58	4.27	4.08	3.77	3.36	2.90	2.69	2.56	---	---	---	---
CB97	Oab1, 195-213	Strong	7.64	7.70	6.91	5.68	4.98	4.21	4.04	3.91	3.88	3.43	2.60	2.46	2.30	---	---	---	---
CB97	Oab2, 213-224	Strong	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB97	2Ab, 224-245	Strong	6.87	7.29	6.77	5.95	4.93	5.95	3.53	3.19	3.01	2.78	2.51	2.37	2.25	---	---	---	---
CB97	2Cgb1, 245-260	None	6.76	7.39	5.65	4.14	3.07	3.87	2.85	2.66	2.77	2.40	2.46	2.31	2.33	---	---	---	---
CB97	2Cgb2, 260-266	None	6.38	7.31	5.67	4.30	3.69	3.05	2.99	2.85	2.78	2.40	2.52	2.25	2.10	---	---	---	---
CB124	A, 0-6	None	7.67	7.23	6.68	5.48	5.72	5.21	5.70	6.37	6.35	6.05	5.79	5.62	4.51	4.20	4.28	4.56	4.39
CB124	Cg1, 6-48	None	7.80	7.22	6.79	5.87	6.47	6.29	6.58	7.45	7.46	7.68	7.18	7.55	7.61	7.59	7.73	7.08	7.52
CB124	2Cg2, 48-70	Strong	7.49	7.64	6.90	6.10	5.19	4.04	3.40	3.17	3.34	2.85	2.58	2.40	2.36	---	---	---	---
CB124	2Oab1, 70-116	Strong	7.84	7.63	7.26	6.52	5.88	4.36	3.83	3.81	3.89	3.32	2.88	2.62	2.45	---	---	---	---
CB124	2Oab2, 116-130	Strong	7.59	7.84	7.49	6.25	6.31	5.95	5.89	6.01	5.73	5.43	5.22	4.91	4.71	4.60	4.44	4.38	4.13
CB124	3Ab, 130-136	Strong	7.12	7.41	7.55	6.72	5.51	4.90	4.73	4.56	4.25	3.92	3.75	3.28	3.25	---	---	---	---
CB124	3Cgb, 136-157	Strong	7.37	7.82	7.58	6.44	4.68	4.02	3.78	3.60	3.59	3.36	3.03	3.06	3.02	---	---	---	---
CB130	A1, 0-4	None	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB130	A2, 4-21	None	7.09	7.29	6.67	6.23	6.46	5.88	6.32	7.01	6.94	6.63	6.53	6.22	5.61	5.39	4.99	4.98	4.16
CB130	Cg1, 21-58	None	7.63	7.75	6.98	6.38	6.16	5.64	5.72	5.61	4.69	4.02	3.23	2.55	2.59	---	---	---	---
CB130	Cg2, 58-125	Strong	7.72	8.04	7.25	6.43	6.38	5.75	5.46	5.26	4.45	4.05	3.76	2.86	2.56	---	---	---	---
CB130	Cg2, 125-199	Strong	7.78	8.30	7.62	6.77	6.51	5.90	6.07	6.36	6.23	5.54	4.71	4.11	3.20	---	---	---	---
CB130	Cg3, 199-275	Strong	7.95	8.10	7.76	6.97	6.59	6.51	6.53	6.46	5.89	5.39	4.79	4.12	3.24	---	---	---	---
CB130	Cg3, 275-340	Strong	7.89	8.32	7.38	6.63	6.81	6.16	6.18	6.21	5.79	4.62	3.68	2.91	2.53	---	---	---	---

Appendix E: Continued.

Pedon	Horizon, Depth (cm)	Intensity of H_2S in the field	pH																
			WK 0	WK 1	WK 2	WK 3	WK 4	WK 5	WK 6	WK 7	WK 8	WK 9	WK 11	WK 13	WK 16	WK 18	WK 20	WK 22	WK 25
CB136	A1, 0-2	None	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB136	A2, 2-18	None	7.80	8.25	7.61	6.91	7.43	6.80	7.45	8.03	7.86	7.90	7.87	7.87	7.96	8.06	8.17	7.94	7.92
CB136	Cg1, 18-37	None	7.61	8.18	7.60	6.79	7.19	6.66	6.40	6.07	5.79	4.57	4.20	2.83	2.52	---	---	---	---
CB136	2Cg2, 37-93	Strong	7.42	7.34	7.64	7.00	7.26	6.69	6.89	6.87	7.02	6.46	6.48	6.17	5.16	4.25	3.43	3.08	---
CB136	2Cg3, 93-146	Strong	7.46	7.77	7.66	6.64	6.12	4.98	4.54	4.12	3.87	3.36	2.50	2.45	2.45	---	---	---	---
CB136	2Cg4, 146-161	Strong	7.44	7.64	6.93	6.48	4.82	3.38	3.31	3.03	3.16	2.96	2.39	2.22	2.21	---	---	---	---
CB136	2Oab1, 161-187	Strong	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB136	2Oab2, 187-205	Strong	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB136	3Ab, 205-211	Strong	6.93	7.10	6.73	6.27	5.58	4.77	4.45	4.16	4.05	3.45	2.67	2.47	2.46	---	---	---	---
CB141	A1, 0-4	None	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB141	A2, 4-13	None	7.62	7.72	7.24	6.99	6.96	6.92	7.29	7.96	7.73	7.98	7.72	7.86	7.96	7.88	8.05	7.94	7.98
CB141	Cg1, 13-23	None	7.71	8.06	7.50	7.31	7.19	7.32	7.75	8.00	7.91	8.03	7.80	7.94	7.94	7.96	7.96	8.05	8.10
CB141	Cg2, 23-46	Strong	7.66	8.30	7.74	7.51	7.67	7.37	7.74	8.00	7.86	7.96	7.85	7.94	7.95	7.95	7.89	7.97	7.97
CB141	Cg3, 46-123	Strong	7.62	8.59	8.01	7.62	7.74	7.29	7.27	7.10	6.95	6.74	6.30	5.87	4.30	3.81	2.97	---	---
CB141	Cg4, 123-174	Strong	7.76	8.39	7.89	7.60	7.84	7.36	7.56	7.57	7.35	7.32	7.09	6.96	6.81	6.82	6.96	7.12	6.05
CB142	A, 0-3	Strong	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB142	Cg1, 3-36	Strong	8.13	8.50	7.97	7.43	7.46	7.22	6.10	6.48	6.38	5.44	4.36	3.12	2.79	---	---	---	---
CB142	Cg2, 36-100	Strong	7.64	8.21	7.85	7.43	7.00	6.43	5.41	5.10	4.34	3.63	3.25	3.03	2.83	---	---	---	---
CB142	Oab, 100-131	Strong	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB142	Ab, 131-134	Strong	7.46	7.91	7.30	6.41	5.27	4.31	3.94	3.70	3.51	3.21	2.40	2.32	2.20	---	---	---	---
CB142	BAgb, 134-142	Strong	7.67	8.29	7.69	6.27	4.27	3.64	3.83	3.12	3.12	2.91	2.57	2.21	2.12	---	---	---	---
CB142	Cgb, 142-149	Strong	7.65	7.85	7.40	6.20	3.96	3.61	3.50	3.41	3.06	2.83	2.54	2.29	2.18	---	---	---	---
CB143	A, 0-3	None	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CB143	Cg1, 3-61	Strong	7.78	7.94	7.50	6.68	5.97	5.60	5.58	5.55	4.67	4.12	3.24	2.88	2.88	---	---	---	---
CB143	Cg2, 61-95	Strong	7.82	8.11	7.39	6.39	4.53	3.95	3.62	3.45	3.33	3.02	2.31	2.23	2.45	---	---	---	---
CB143	Cg3, 95-108	Weak	7.58	8.10	7.33	6.05	3.79	3.36	3.26	3.15	2.89	2.72	2.24	2.19	2.16	---	---	---	---
CB143	2Cg4, 108-137	None	6.51	7.31	7.31	6.54	6.36	6.37	6.89	7.64	7.49	7.52	7.47	7.82	7.70	7.81	7.90	7.77	7.71

Appendix F: Salinity Data

Sample	Moisture content g kg^{-1}	Salinity 1:5 by volume dS m^{-1}	mg L^{-1}	ppt in original soil solution	mg g^{-1} dry soil
CB01 A, 0-14 cm	269	2.38	1523	19.2	6.2
CB01 Cg1, 14-76 cm	228	3.28	2099	27.0	9.1
CB01 Cg2, 76-103 cm	311	3.84	2458	30.9	10.4
CB01 Cg3, 103-170 cm	285	4.04	2586	34.0	10.7
CB01 Cg4, 170-210 cm	482	4.72	3021	30.1	18.6
CB04 Cg1, 6-32 cm	662	5.39	3450	33.5	22.2
CB04 Cg2, 32-111 cm	438	2.55	1632	19.0	8.3
CB04 Cg3, 111-149 cm	579	1.71	1094	9.8	5.6
CB09 A2, 2-16 cm	323	4.55	2912	35.0	11.3
CB09 Cg1, 16-22 cm	232	3.60	2304	35.8	8.3
CB09 Cg2, 22-42 cm	142	2.26	1446	28.5	4.0
CB09 Cg/Bwb 42-53 cm	166	1.85	1184	19.9	3.3
CB09 2Bgb, 53-76 cm	196	1.19	762	11.7	2.3
CB09 2Bwb1, 76-98 cm	134	0.97	623	14.4	1.9
CB09 2Bwb2, 98-108 cm	249	0.54	344	6.3	0.9
CB09 2BCgb, 108-118 cm	120	0.55	353	8.9	1.1
CB09 2Cgb1, 118-133 cm	141	0.31	195	4.1	0.6
CB09 2Cgb2, 133-151 cm	126	0.11	67	1.9	0.2
CB10 A, 0-17 cm	313	2.92	1869	25.5	8.0
CB10 Cg1, 17-51 cm	228	2.23	1427	26.2	6.0
CB10 2Cg2, 51-64 cm	370	4.43	2835	35.7	13.2
CB10 2Cg3, 64-84 cm	373	4.58	2931	32.0	11.9
CB10 3Cg4, 84-89 cm	276	4.13	2643	38.4	10.4
CB10 3Cg5, 89-134 cm	245	3.53	2259	38.3	9.4
CB11 A2, 2-12 cm	406	4.00	2559	28.1	11.4
CB11 Cg1, 12-36 cm	635	4.30	2752	24.7	15.7
CB11 Cg2, 36-56 cm	1361	6.85	4384	32.2	43.8
CB11 Oab1, 56-83 cm	3163	5.40	3456	22.3	70.5
CB11 Oab2, 83-109 cm	3991	4.14	2650	18.7	74.6
CB11 2Ab, 109-115 cm	1003	3.20	2048	16.1	16.1
CB11 2Cgb, 115-122 cm	288	2.33	1491	19.0	5.5

Appendix F: Continued.

Sample	Moisture content g kg^{-1}	Salinity 1:5 by volume dS m^{-1}	mg L^{-1}	ppt in original soil solution	mg g^{-1} dry soil
CB16 A2, 2-22 cm	243	3.14	2010	31.4	8.9
CB16 Cg1, 22-37 cm	291	3.26	2086	28.9	8.6
CB16 Cg2, 37-67 cm	259	3.28	2099	29.5	7.6
CB16 Cg3, 67-80 cm	227	3.44	2201	31.4	8.3
CB16 Cg4, 80-114 cm	258	3.38	2163	34.2	8.8
CB16 Cg5, 114-187 cm	188	3.40	2176	31.4	7.8
CB16 Cg6, 187-215 cm	258	3.25	2080	33.2	8.4
CB17 A, 0-8 cm	269	3.75	2400	32.7	8.8
CB17 Cg/A 8-32 cm	264	3.47	2221	29.4	7.8
CB17 Cg1, 32-54 cm	449	4.45	2848	33.0	14.8
CB17 Cg2, 54-77 cm	428	4.32	2765	30.5	13.0
CB17 2Cg3, 77-102 cm	205	3.91	2502	47.7	9.8
CB17 2Cg4, 102-148 cm	205	2.99	1914	36.2	7.4
CB18 Cg, 8-50 cm	757	5.35	3424	29.5	22.3
CB18 Cg, 50-100 cm	581	5.35	3424	33.3	19.3
CB18 Cg, 100-150 cm	714	6.42	4109	45.4	32.4
CB18 Cg, 150-200 cm	538	5.61	3590	36.9	19.8
CB18 Cg, 200-250 cm	590	5.45	3488	32.4	19.1
CB21 A1, 0-2 cm		ND			30.8
CB21 A2, 2-18 cm	815	6.42	4109	37.7	9.3
CB21 Ab, 58-62 cm	697	2.04	1306	13.3	4.0
CB21 BAgb, 62-71 cm	341	1.59	1018	11.7	2.1
CB21 Btg, 71-96 cm	284	0.89	568	7.5	0.3
CB21 2Cgb, 96-134 cm	195	0.12	76	1.4	
CB26 A 0-2 cm	237	4.19	2682	37.0	8.8
CB26 Cg, 2-28 cm	226	5.81	3718	54.7	12.4
CB26 A', 28-50 cm	2203	7.23	4627	32.0	70.6
CB26 C'g, 50-70 cm	1603	4.98	3187	20.4	32.6
CB26 Cg/Oa, 71-103 cm	2394	5.50	3520	22.1	53.0
CB26 Oab, 103-132 cm	2494	3.05	1952	10.1	25.2
CB26 Ab, 132-137 cm	1214	2.01	1286	11.1	13.5
CB26 Btgb, 137-150 cm	229	1.57	1005	15.2	3.5

Appendix F: Continued.

Sample	Moisture content g kg^{-1}	Salinity 1:5 by volume dS m^{-1}	mg L^{-1}	ppt in original soil solution	mg g^{-1} dry soil
CB39 A2, 1-12 cm	751	3.75	2400	23.8	15.8
CB39 Cg1, 12-43 cm	629	4.11	2630	21.0	15.4
CB39 Cg2, 43-57 cm	943	3.18	2035	14.7	15.5
CB39 Cg3, 57-126 cm	649	1.07	685	6.4	3.5
CB39 2Cg4, 126-161 cm	253	0.50	323	4.4	1.1
CB39, 2Cg5, 161-198 cm	182	0.20	128	2.0	0.4
CB45 A, 0-6 cm	251	2.93	1875	45.6	11.9
CB45 Cg/A, 6-33 cm	240	3.67	2349	50.0	8.8
CB45 Cg1, 33-88 cm	252	3.96	2534	40.7	10.9
CB45 Cg2, 88-99 cm	301	5.94	3802	78.6	26.6
CB45 2Cg3, 99-142 cm	566	6.06	3878	34.5	25.8
CB45 2Cg4, 142-186 cm	607	5.81	3718	33.5	33.2
CB50 A2, 3-21 cm	448	4.69	3002	36.7	16.2
CB50 Cg/A, 21-45 cm	365	5.30	3392	46.8	17.1
CB50 Cg1, 45-60 cm	391	4.80	3072	36.0	14.0
CB50 Cg2, 60-92 cm	324	4.06	2598	34.3	11.1
CB50 Cg3, 92-160 cm	317	4.30	2752	35.7	11.3
CB52 A1/A2, 0-10 cm	434	4.95	3168	40.0	15.8
CB52 Cg1, 10-21 cm	417	4.72	3021	34.3	14.2
CB52 2Cg2, 21-39 cm	579	6.54	4186	39.5	33.5
CB52 2Cg3, 39-59 cm	598	5.26	3366	30.2	28.5
CB52 2Cg4, 59-86 cm	863	6.13	3923	32.2	32.4
CB52 2Cg5, 86-115 cm	621	6.03	3859	39.3	18.2
CB52 2Cg6, 115-138 cm	631	5.54	3546	34.5	14.5
CB55 A2, 3-12 cm	273	2.12	1357	21.7	5.9
CB55 Cg1, 12-41 cm	390	3.53	2259	26.4	10.3
CB55 Cg2, 41-90 cm	316	3.40	2176	31.0	9.8
CB55 2Cg3, 90-143 cm	413	3.01	1926	22.4	9.2
CB55 2Cg4, 143-162 cm	307	3.21	2054	27.0	8.3
CB55 2Cg5, 162-198 cm	361	3.73	2387	28.9	10.5

Appendix F: Continued.

Sample	Moisture content g kg^{-1}	Salinity 1:5 by volume dS m^{-1}	mg L^{-1}	ppt in original soil solution	mg g^{-1} dry soil
CB56 A2, 2-10 cm	387	4.52	2893	33.3	12.9
CB56 Cg1, 10-31 cm	288	3.33	2131	29.0	8.4
CB56 Cg2, 31-49 cm	273	4.66	2982	39.0	10.6
CB56 Cg3, 49-72 cm	304	3.74	2394	31.9	9.7
CB56 Cg4, 72-90 cm	284	2.81	1798	25.6	7.3
CB56 Cg5, 90-122 cm	263	3.53	2259	36.3	9.4
CB56 Cg6, 122-137 cm	361	3.78	2419	26.0	9.4
CB56 2Ab, 137-156 cm	601	3.69	2362	23.2	14.0
CB58 A2, 3-14 cm	310	3.36	2150	25.8	8.0
CB58 Cg1, 14-37 cm	311	2.45	1568	18.0	5.6
CB58 Cg2, 37-106 cm	622	4.91	3142	34.2	21.3
CB58 2Cg3, 106-162 cm	382	3.41	2182	26.2	10.0
CB74 A2, 2-19 cm	523	3.53	2259	25.9	13.5
CB74 Cg1, 19-55 cm	335	2.20	1408	22.1	6.5
CB74 Cg2, 55-89 cm	282	2.92	1869	27.4	7.9
CB74 Cg3, 89-109 cm	358	4.13	2643	29.4	13.4
CB74 2Cg4, 109-142 cm	204	3.06	1958	27.8	7.1
CB74 2Cg5, 142-174 cm	237	1.71	1094	16.8	3.9
CB79 A2, 3-10 cm	276	4.80	3072	38.6	10.7
CB79 Cg1, 10-50 cm	313	3.68	2355	30.7	9.6
CB79 Cg2, 50-86 cm	261	3.54	2266	30.7	8.0
CB79 Cg3, 86-123 cm	236	2.96	1894	29.3	6.9
CB91 Cg1, 3-54 cm	430	3.91	2502	20.1	12.6
CB91 Cg2, 54-61 cm	780	4.32	2765	29.0	15.0
CB91 Cg3, 61-139 cm	804	3.76	2406	19.2	15.6
CB91 Cg4, 139-169 cm	649	3.48	2227	20.5	13.7
CB91 Cg5, 169-191 cm	446	3.10	1984	20.1	7.6
CB94 A2, 1-12 cm	276	4.30	2752	37.8	10.4
CB94 Cg1, 12-33 cm	1119	7.56	4838	36.4	40.7
CB94 2Cg2, 33-94 cm	778	4.74	3034	27.2	22.3
CB94 2Cg3, 94-107 cm	926	4.50	2880	20.7	19.2
CB94 2Cg4, 107-145 cm	994	5.35	3424	29.9	29.7

Appendix F: Continued.

Sample	Moisture content g kg^{-1}	Salinity 1:5 by volume dS m^{-1}	mg L^{-1}	ppt in original soil solution	mg g^{-1} dry soil
CB97 Cg1, 2-76 cm	557	4.39	2810	32.7	22.8
CB97 Cg2, 76-95 cm	470	4.04	2586	26.0	12.4
CB97 Cg3, 95-131 cm	628	3.94	2522	18.8	15.3
CB97 Cg4, 131-145 cm	727	4.28	2739	24.3	20.5
CB97 Cg5, 145-168 cm	800	4.23	2707	19.5	23.7
CB97 Cg/Oa, 168-195 cm	1078	4.78	3059	24.2	32.5
CB 97 Oab1, 195-213 cm	2351	4.18	2675	20.9	51.8
CB97 Oab2, 213-224 cm		ND			
CB97 Ab, 224-245 cm	280	1.09	698	7.2	3.4
CB97 Cgb1, 245-260 cm	253	0.71	451	6.4	1.5
CB97 Cgb2, 260-266 cm		ND			
CB124 A, 0-6 cm	267	2.64	1690	26.3	7.0
CB124 Cg1, 6-48 cm	274	2.58	1651	24.1	6.6
CB124 2Cg2, 48-70 cm	1124	4.54	2906	28.5	32.0
CB124 2Oab1, 70-116 cm	3397	4.97	3181	24.5	83.1
CB124 2Oab2, 116-130 cm	2497	5.61	3590	28.4	70.8
CB124 2Ab, 130-136 cm	451	3.78	2419	25.8	11.6
CB124 2Cgb, 136-157 cm	362	3.57	2285	28.8	10.4
CB130 A2, 4-21 cm	626	5.01	3206	27.9	19.0
CB130 Cg1, 21-58 cm	475	5.13	3283	25.6	16.4
CB130 Cg2, 58-125 cm	509	4.86	3110	28.1	17.6
CB130 Cg2, 125-199 cm	548	5.85	3744	38.2	19.8
CB130 Cg3, 199-275 cm	377	4.68	2995	27.8	15.4
CB130 Cg3, 275-340 cm	546	3.88	2483	17.4	12.4
CB136 A2, 2-18 cm	222	3.77	2413	33.4	9.4
CB136 Cg1, 18-37 cm	459	4.52	2893	29.4	16.1
CB136 2Cg2, 37-93 cm	669	4.45	2848	27.0	15.4
CB136 2Cg3, 93-146 cm	640	4.20	2688	22.8	15.1
CB136 2Cg4, 146-161 cm	651	4.27	2733	23.5	24.8
CB136 2Oab1, 161-187 cm		ND			
CB136 2Oab2, 187-205 cm		ND			
CB136 3Ab, 205-211 cm	562	2.77	1773	29.1	16.0

Appendix F: Continued.

Sample	Moisture content g kg^{-1}	Salinity 1:5 by volume dS m^{-1}	mg L^{-1}	ppt in original soil solution	mg g^{-1} dry soil
CB141 A2, 4-13 cm	415	4.25	2720	31.2	12.9
CB141 Cg1, 13-23 cm	341	4.75	3040	20.2	7.9
CB141 Cg2, 23-46 cm	796	5.22	3341	32.6	24.3
CB141 Cg3, 46-123 cm	971	5.20	3328	24.8	21.0
CB141 Cg4, 123-174 cm	787	5.51	3526	28.0	22.5
CB142 Cg1, 3-36 cm	553	3.37	2157	18.8	10.3
CB142 Cg2, 36-100 cm	744	3.20	2048	18.5	12.6
CB142 Oab, 100-131 cm		ND			
CB142 Ab, 131-134 cm	942	1.45	928	6.5	14.9
CB142 BAgb, 134-142 cm	548	0.70	445	3.4	3.5
CB142 Cgb, 142-149 cm	308	0.63	405	5.6	1.4
CB143 Cg1, 3-61 cm	638	2.92	1869	16.2	11.4
CB143 Cg2, 61-95 cm	495	1.27	813	6.6	4.0
CB143 Cg3, 95-108 cm	590	0.78	498	4.5	2.1
CB143 2Cg4, 108-137 cm	450	0.26	168	1.9	0.6

Appendix G: Moisture Content and Bulk Density Data

Pedon	Sample	Moisture Content g kg^{-1}	Bulk Density g cm^{-3}
CB01	A, 0-14 cm	322*	1.34
CB01	Cg1, 14-76 cm	255*	1.25
CB01	Cg2, 76-103 cm	336*	1.29
CB01	Cg3, 103-170 cm	315*	1.30
CB01	Cg4, 170-210 cm	619*	0.90
CB04	A, 0-6 cm	546	0.98
CB04	Cg1, 6-32 cm	662	0.86
CB04	Cg2, 32-111 cm	438	1.07
CB04	Cg3, 111-149 cm	579	1.09
CB06	A, 0-3 cm	633	0.43
CB06	Cg1, 3-59 cm	772	0.50
CB06	2Cg2, 59-81 cm	342	0.96
CB06	2Cg3, 81-107 cm	210	1.02
CB09	A1, 0-2 cm		
CB09	A2, 2-16 cm	323	1.40
CB09	Cg1, 16-22 cm	232	1.48
CB09	Cg2, 22-42 cm	142	1.88
CB09	Cg/Bgb, 42-53 cm	166	1.91
CB09	2Bgb, 53-76 cm	196	1.78
CB09	2Bwb1, 76-98 cm	134	1.68
CB09	2Bwb2, 98-108 cm	249	1.92
CB09	2BCgb, 108-118 cm	120	1.73
CB09	2Cgb1, 118-133 cm	141	1.77
CB09	2Cgb2, 133-151 cm	126	1.47
CB10	A, 0-17 cm	313	1.26
CB10	Cg1, 17-51 cm	228	1.26
CB10	Cg2, 51- 64 cm	370	1.16
CB10	2Cg3, 64-84 cm	373	1.35
CB10	3Cg4, 84-89 cm	272	1.36
CB10	3Cg5, 89-134 cm	245	1.27
CB11	A1, 0-2 cm		
CB11	A2, 2-12 cm	406	1.23
CB11	Cg1, 12-36 cm	635	0.98
CB11	Cg2, 36-56 cm	1361	0.58
CB11	Oab1, 56-83 cm	3163	0.29
CB11	Oab2, 83-109 cm	3991	0.21
CB11	2Ab, 109-115 cm	1003	0.73
CB11	2Cgb, 115-122 cm	288	1.47

[*] These moisture contents were remeasured for bulk density calculations and differ from those used in salinity measurements.

Appendix G: Continued.

Pedon	Sample	Moisture Content g kg^{-1}	Bulk Density g cm^{-3}
CB16	A1, 0-2 cm	242*	1.28
CB16	A2, 2-22 cm	282*	1.21
CB16	Cg1, 22-37 cm	297*	1.31
CB16	Cg2, 37-67 cm	259*	1.48
CB16	Cg3, 67- 80 cm	265*	1.42
CB16	Cg4, 80-114 cm	259*	1.30
CB16	Cg5, 114-187 cm	249*	1.49
CB16	Cg6, 187-215 cm	253*	1.32
CB17	A, 0-8 cm	269	1.47
CB17	Cg/A, 8-32 cm	264	1.54
CB17	Cg1, 32-54 cm	449	1.05
CB17	Cg2, 54-77 cm	428	1.16
CB17	2Cg3, 77-102 cm	205	1.35
CB17	2Cg4, 102-148 cm	205	1.36
CB18	A, 0-8 cm		
CB18	Cg, 8-50 cm	757	0.87
CB18	Cg, 50-100 cm	581	0.98
CB18	Cg, 100-150 cm	714	0.70
CB18	Cg, 150-200 cm	538	1.00
CB18	Cg, 200-250 cm	590	1.02
CB20	A, 0-8 cm	671	0.64
CB20	Cg1, 8-32 cm	411	1.88
CB20	Cg2, 32-60 cm	377	1.36
CB20	Cg3, 60-115 cm	313	0.89
CB21	A1, 0-2 cm		
CB21	A2, 2-18 cm	815	0.75
CB21	Oab, 18-58 cm		
CB21	Ab, 58-62 cm	697	0.78
CB21	BAgb, 62-71 cm	341	1.40
CB21	Btgb, 71-96 cm	284	1.45
CB21	Cgb, 96-134 cm	195	1.41

* These moisture contents were remeasured for bulk density calculations and differ from those used in salinity measurements.

Appendix G: Continued.

Pedon	Sample	Moisture Content g kg^{-1}	Bulk Density g cm^{-3}
CB26	A, 0-2 cm	237	1.65
CB26	Cg, 2-28 cm	226	1.61
CB26	A’, 28-50 cm	2203	0.38
CB26	C’g, 50-70 cm	1603	0.58
CB26	Cg/Oab, 70-103 cm	2395	0.39
CB26	Oab, 103-132 cm	2494	0.48
CB26	Ab, 132-137 cm	1214	0.54
CB26	Btgb, 137-150 cm	229	1.54
CB31	A2, 4-22 cm	592	074
CB31	Cg1, 22-62 cm	601	0.49
CB31	Cg2, 62-112 cm	592	0.32
CB39	A1, 0-1 cm		
CB39	A2, 1-12 cm	751	0.48
CB39	Cg1, 12-43 cm	629	0.85
CB39	Cg2, 43-57 cm	943	0.53
CB39	Cg3, 57-126 cm	649	0.32
CB39	2Cg4, 126-161 cm	253	0.84
CB39	2Cg5, 161-198 cm	182	1.44
CB41	A2, 3-17 cm	429	1.31
CB41	Cg1, 17-52 cm	434	1.15
CB41	Cg2, 52-143 cm	542	0.38
CB45	A, 0-6 cm	261*	1.35
CB45	Cg/A, 6-33 cm	176*	1.40
CB45	Cg1, 33-88 cm	268*	1.24
CB45	Cg2, 88-99 cm	339*	1.23
CB45	2Cg3, 99-142 cm	750*	0.84
CB45	2Cg4, 142-186 cm	991*	0.63
CB50	A1, 0-3 cm		
CB50	A2, 3-21 cm	442	1.01
CB50	Cg/A, 21-45 cm	365	1.07
CB50	Cg1, 45-60 cm	391	1.19
CB50	Cg2, 60-92 cm	324	1.26
CB50	Cg3, 92-160 cm	317	1.32

* These moisture contents were remeasured for bulk density calculations and differ from those used in salinity measurements.

Appendix G: Continued.

Pedon	Sample	Moisture Content g kg^{-1}	Bulk Density g cm^{-3}
CB52	A1 & A2 0-10 cm	434	0.55
CB52	Cg1, 10-21 cm	417	0.82
CB52	2Cg2, 21-39 cm	579	0.72
CB52	2Cg3, 39-59 cm	598	0.73
CB52	2Cg4, 59-86 cm	863	0.60
CB52	2Cg5, 86-115 cm	621	0.80
CB52	2Cg6, 115-138 cm	631	0.84
CB55	A1, 0-3 cm		
CB55	A2, 3-12 cm	273	1.22
CB55	Cg1, 12-41 cm	390	1.20
CB55	Cg2, 41-90 cm	316	1.19
CB55	2Cg3, 90-143 cm	413	1.14
CB55	2Cg4, 143-162 cm	307	1.34
CB55	2Cg5, 162-198 cm	361	1.24
CB56	A1, 0-2 cm		
CB56	A2, 2-10 cm	387	1.23
CB56	Cg1, 10-31 cm	288	1.37
CB56	Cg2, 31-49 cm	273	1.52
CB56	Cg3, 49-72 cm	304	1.34
CB56	Cg4, 72-90 cm	284	1.33
CB56	Cg5, 90-122 cm	263	1.27
CB56	Cg6, 122-137 cm	361	1.42
CB56	2Ab, 137-154 cm	546*	0.91
CB58	A1, 0-3 cm		
CB58	A2, 3-14 cm	310	1.47
CB58	Cg1, 14-37 cm	311	1.53
CB58	Cg2, 37-106 cm	622	0.81
CB58	2Cg3, 106-162 cm	382	1.19
CB59	A1, 0-5 cm	954	0.27
CB59	A2, 5-24 cm	982	0.51
CB59	Cg1, 24-35 cm	1765	0.33
CB59	Cg2, 35-74 cm	1691	0.41
CB59	Cg3, 74-86 cm	1046	0.49
CB59	Cg4, 86-127 cm	966	0.57

* These moisture contents were remeasured for bulk density calculations and differ from those used in salinity measurements.

Appendix G: Continued.

Pedon	Sample	Moisture Content g kg^{-1}	Bulk Density g cm^{-3}
CB67	A1, 0-2 cm		
CB67	A2, 2-13 cm	429	0.89
CB67	Cg/A, 13-35 cm	582	1.59
CB67	2Cg1, 35-73 cm	747	0.90
CB67	2Cg2, 73-135 cm	747	0.76
CB67	2Cg3, 135- cm	482	0.89
CB70	A1, 0-5 cm		
CB70	A2, 5-19 cm	487	0.71
CB70	2Cg1, 19-44 cm	521	0.73
CB70	2Cg2, 44-78 cm	686	0.81
CB70	2Cg3, 78-92 cm	758	0.72
CB70	2Cg4, 92-127 cm	803	0.68
CB72	A1, 0-2 cm		
CB72	A2, 2-13 cm	570	1.35
CB72	Cg1, 13-48 cm	495	1.85
CB72	Cg2, 48-69 cm	690	0.68
CB72	Cg3, 69-107	505	0.84
CB74	A1, 0-2 cm		
CB74	A2, 2-19 cm	522[*]	0.91
CB74	Cg1, 19-55 cm	294[*]	1.15
CB74	Cg2, 55-89 cm	288[*]	1.27
CB74	Cg3, 89-109 cm	455[*]	1.08
CB74	2Cg4, 109-142 cm	257[*]	1.48
CB74	2Cg5, 142-174 cm	235[*]	1.48
CB79	A1, 0-3 cm		
CB79	A2, 3-10 cm	276	1.56
CB79	Cg1, 10-50 cm	313	1.33
CB79	Cg2, 50-86 cm	261	1.53
CB79	Cg3, 86-123 cm	236	1.46
CB81	A1, 0-2 cm	586	0.92
CB81	A2, 2-18 cm	478	0.29
CB81	Cg1, 18-154 cm	562	0.66

[*] These moisture contents were remeasured for bulk density calculations and differ from those used in salinity measurements.

Appendix G: Continued.

Pedon	Sample	Moisture Content g kg^{-1}	Bulk Density g cm^{-3}
CB86	A, 0-3 cm		
CB86	Cg1, 3-35 cm	668	0.86
CB86	Cg2, 35-93 cm	958	0.48
CB86	Cg3, 93-105 cm	700	0.80
CB90	A, 0-2 cm		
CB90	Cg1, 2-32 cm	629	1.20
CB90	Cg2, 32-42 cm	904	0.79
CB90	Cg3, 42-72 cm	1142	0.54
CB90	Cg4, 72-95 cm	775	1.20
CB90	Cg5, 95-114 cm	788	0.70
CB91	A, 0-3 cm		
CB91	Cg1, 3-54 cm	430	0.72
CB91	Cg2, 54-61 cm	780	1.24
CB91	Cg3, 61-139 cm	804	0.37
CB91	Cg4, 139-169 cm	649	0.45
CB91	Cg5, 169-191 cm	446	0.65
CB93	A1, 0-4 cm		
CB93	A2, 4-15 cm	543	1.11
CB93	Cg1, 15-42 cm	548	1.47
CB93	Cg2, 42-81 cm	826	0.67
CB93	Cg3, 81-210 cm	655	0.28
CB94	A1, 0-1 cm		
CB94	A2, 1-12 cm	276	1.42
CB94	2Cg1, 12-33 cm	1119	0.68
CB94	2Cg2, 33-94 cm	777	0.76
CB94	2Cg3, 94-107 cm	926	0.87
CB94	2Cg4, 107-145 cm	994	0.65
CB97	A, 0-2 cm		
CB97	Cg1, 2-76 cm	557	0.54
CB97	Cg2, 76-95 cm	470	0.61
CB97	Cg3, 95-131 cm	628	0.67
CB97	Cg4, 131-145 cm	727	0.71
CB97	Cg5, 145-168 cm	800	0.43
CB97	Oab/Cg, 168-195 cm	1078	0.67
CB97	Oab1, 195-213 cm	2351	0.21
CB97	Oab2, 213-224 cm		
CB97	Ab, 224-245 cm	280	0.66
CB97	Cgb1, 245-260 cm	253	0.91
CB97	Cgb2, 260-266 cm	436	0.69

Appendix G: Continued.

Pedon	Sample	Moisture Content g kg^{-1}	Bulk Density g cm^{-3}
CB100	A, 0-3 cm		
CB100	Cg1, 3-53 cm	915	0.67
CB100	Cg2, 53-80 cm	521	1.13
CB100	Cg3, 80-100 cm	874	0.81
CB106	A1, 0-3 cm		
CB106	A2, 3-16 cm	450	1.87
CB106	Cg1, 16-53 cm	492	1.08
CB106	Cg2, 53-69 cm	811	1.61
CB106	Cg3, 69-165 cm	1121	0.10
CB111	A1, 0-3 cm		
CB111	A2, 3-20 cm	653	0.63
CB111	Cg1, 20-42 cm	592	0.80
CB111	Cg2, 42-200 cm	839	0.26
CB117	A, 0-16 cm	270	1.13
CB117	Cg1,16-34 cm	732	1.12
CB117	Cg2, 34-97 cm	823	0.53
CB117	Cg3, 97-163 cm	534	0.68
CB118	A, 0-9 cm	587	1.15
CB118	Cg1, 9-19 cm	634	0.72
CB118	Cg2, 19-117 cm	677	0.50
CB119	A, 0-17 cm	600	0.72
CB119	Cg1, 17-44 cm	550	0.91
CB119	Cg2, 44-73 cm	536	0.94
CB119	Cg3, 73-99 cm	277	1.34
CB120	A, 0-12 cm	570	0.21
CB120	Cg1, 12-31 cm	432	0.79
CB120	2Cg2, 31-56 cm	474	0.87
CB120	2Cg3, 56-81 cm	192	1.37
CB120	2Cg4, 81-102 cm	260	1.23
CB121	A, 0-12 cm	711	0.61
CB121	Cg1, 12-52 cm	939	0.47
CB121	Cg2, 52-89 cm	848	0.65
CB121	Cg3, 89-197 cm	890	0.46

Appendix G: Continued.

Pedon	Sample	Moisture Content g kg^{-1}	Bulk Density g cm^{-3}
CB124	A, 0-6 cm	267	1.28
CB124	Cg1, 6-48 cm	274	1.34
CB124	2Cg2, 48-70 cm	1124	0.50
CB124	2Oab1, 70-116 cm	3397	0.22
CB124	2Oab2, 116-130 cm	2497	0.29
CB124	3Ab, 130-136 cm	451	1.15
CB124	3Cgb, 136-157 cm	362	1.19
CB127	A, 0-22 cm	726	1.23
CB127	Cg1, 22-51 cm	946	0.54
CB127	Cg2, 51-102 cm	544	0.75
CB130	A1, 0-4 cm		
CB130	A2, 4-21 cm	626	0.51
CB130	Cg1, 21-58 cm	475	0.93
CB130	Cg2, 58-125 cm	509	1.11
CB130	Cg2, 125-199 cm	548	0.82
CB130	Cg3, 199-275 cm	377	1.02
CB130	Cg3, 275-340 cm	546	0.86
CB136	A1, 0-2 cm		
CB136	A2, 2-18 cm	222	0.16
CB136	Cg1, 18-37 cm	459	1.41
CB136	2Cg2, 37-93 cm	669	0.66
CB136	2Cg3, 93-146 cm	640	1.06
CB136	2Cg4, 146-161 cm	651	0.49
CB136	2Oab1, 161-187 cm		
CB136	2Oab2, 187-205 cm		
CB136	3Ab, 205-211 cm	562	0.66
CB141	A1, 0-4 cm		
CB141	A2, 4-13	415	0.70
CB141	Cg1, 13-23 cm	341	0.99
CB141	Cg2, 23-46 cm	796	0.88
CB141	Cg3, 46-123 cm	971	0.61
CB141	Cg4, 123-174 cm	787	0.75
CB142	A, 0-3 cm		
CB142	Cg1, 3-36 cm	553	0.97
CB142	Cg2, 36-100 cm	744	0.54
CB142	Oab, 100-131 cm		
CB142	Ab, 131-134 cm	942	0.86
CB142	BAgb, 134-142 cm	548	1.56
CB142	Cgb, 142-149 cm	308	2.21

Appendix G: Continued.

Pedon	Sample	Moisture Content g kg^{-1}	Bulk Density g cm^{-3}
CB143	A, 0-3 cm		
CB143	Cg1, 3-61 cm	638	0.66
CB143	Cg2, 61-95 cm	495	0.77
CB143	Cg3, 95-108 cm	590	1.94
CB143	2Cg4, 108-137 cm	450	1.06
CB144	A, 0-29 cm	643	0.68
CB144	Cg1, 29-51 cm	737	0.88
CB144	2Cg2, 51-75 cm	558	0.63
CB144	2Cg3, 75-104 cm	445	0.85

Appendix H: Particle-Size Data

Pedon	Sample	Texture Class	% sand	% silt	% clay	% vcos	% cos	% ms	% fs	%vfs
CB01	A, 0-14 cm	Fine Sand	99.5	0.2	0.3	0.0	6.2	34.4	58.3	0.6
CB01	Cg1, 14-76 cm	Fine Sand	99.1	0.5	0.4	0.3	7.3	34.0	56.6	0.8
CB01	Cg2, 76-103 cm	Fine Sand	98.0	1.2	0.8	0.0	0.7	3.1	83.9	10.2
CB01	Cg3, 103-170 cm	Fine Sand	91.6	4.9	3.6	0.0	0.2	1.4	74.1	15.8
CB01	Cg4, 170-210 cm	Loamy Fine Sand	81.0	10.8	8.2	0.1	0.1	0.3	57.3	23.2
CB04	A, 0-6 cm	---	---	---	---	---	---	---	---	---
CB04	Cg1, 6-32 cm	Silt Loam	18.9	57.6	23.5	0.1	0.2	0.2	1.3	17.0
CB04	Cg2, 32-111 cm	Silty Clay Loam	27.7	45.4	27.0	0.1	0.3	1.2	7.6	18.4
CB04	Cg3, 111-149 cm	Silty Clay Loam	13.7	53.1	33.2	0.0	0.5	2.0	7.1	4.1
CB06	Cg1, 3-59 cm	Silty Clay Loam	12.7	58.0	29.3	0.0	0.3	0.7	3.6	8.0
CB06	2Cg2, 59-81 cm	Fine Sandy Loam	64.5	24.5	11.0	0.4	2.5	10.7	43.9	7.0
CB06	2Cg3, 81-107 cm	Fine Sandy Loam	69.0	19.1	11.9	0.2	1.5	9.5	49.4	8.3
CB09	A1, 0-2 cm	---	---	---	---	---	---	---	---	---
CB09	A2, 2-16 cm	Loamy Fine Sand	81.0	10.8	8.3	0.6	4.8	14.8	52.8	7.9
CB09	Cg1, 16-22 cm	Loamy Fine Sand	84.9	9.2	5.9	1.4	7.2	17.5	53.2	5.7
CB09	Cg2, 22-42 cm	Fine Sandy Loam	69.5	23.9	6.6	0.7	3.1	16.1	44.2	5.5
CB09	Cg/Bgb, 42-53 cm	Fine Sandy Loam	74.0	19.2	6.8	0.5	3.5	16.7	47.9	5.3
CB09	2Bgb, 53-76 cm	Fine Sandy Loam	69.7	19.5	10.8	0.7	3.4	15.7	44.2	5.7
CB09	2Bwb1, 76-98 cm	Loamy Fine Sand	84.9	5.5	9.6	0.4	3.7	12.1	60.4	8.2
CB09	2Bwb2, 98-108 cm	Sandy Loam	72.7	18.0	9.2	0.9	5.4	17.1	38.9	10.4
CB09	2BCgb, 108-118 cm	Loamy Fine Sand	77.5	14.0	8.4	0.1	3.3	15.2	51.1	7.8
CB09	2Cgb1, 118-133 cm	Fine Sandy Loam	62.2	30.5	7.3	0.1	1.9	5.0	44.4	10.8
CB09	2Cgb2, 133-151 cm	Loamy Fine Sand	86.4	7.4	6.2	0.1	1.5	9.4	69.0	6.5

Appendix H: Continued.

Pedon	Sample	Texture Class	% sand	% silt	% clay	% vcos	% cos	% ms	% fs	%vfs
CB10	A, 0-17 cm	Fine Sand	97.2	0.9	1.9	0.1	0.8	12.5	79.6	4.2
CB10	Cg1, 17-51 cm	Fine Sand	92.3	5.4	2.3	0.0	0.6	2.5	68.4	20.8
CB10	2Cg2, 51- 64 cm	Loamy Fine Sand	80.0	13.3	6.7	0.2	0.3	2.1	58.3	19.1
CB10	2Cg3, 64-84 cm	Fine Sandy Loam	68.2	21.2	10.6	0.0	0.1	0.8	51.1	16.2
CB10	3Cg4, 84-89 cm	Loamy Fine Sand	86.2	10.2	3.5	0.0	0.4	1.7	72.5	11.6
CB10	3Cg5, 89-134 cm	Fine Sand	99.6	0.3	0.0	0.1	0.0	0.5	97.1	1.9
CB11	A1, 0-2 cm	---	---	---	---	---	---	---	---	---
CB11	A2, 2-12 cm	Loamy Fine Sand	77.3	13.7	9.0	0.1	0.9	5.6	55.7	15.1
CB11	Cg1, 12-36 cm	Silty Clay Loam	11.2	51.3	37.5	0.1	0.4	1.0	6.5	3.2
CB11	Cg2, 36-56 cm	Silty Clay Loam	6.5	56.1	37.4	0.2	0.9	0.9	2.8	1.7
CB11	Oab1, 56-83 cm	Muck	---	---	---	---	---	---	---	---
CB11	Oab2, 83-109 cm	Muck	---	---	---	---	---	---	---	---
CB11	2Ab, 109-115 cm	Clay Loam	28.9	41.7	29.3	0.1	1.7	8.1	14.6	4.3
CB11	2Cgb, 115-122 cm	Loam	38.7	44.1	17.2	0.6	4.7	11.7	18.2	3.5
CB16	A1, 0-2 cm	---	---	---	---	---	---	---	---	---
CB16	A2, 2-22 cm	Fine Sand	97.8	0.2	2.0	0.0	0.1	0.7	91.9	5.0
CB16	Cg1, 22-37 cm	Fine Sand	95.5	3.0	1.5	0.2	0.6	1.2	79.3	14.2
CB16	Cg2, 37-67 cm	Loamy Fine Sand	82.0	10.1	7.9	0.0	0.1	1.0	68.5	12.5
CB16	Cg3, 67- 80 cm	Fine Sand	94.0	3.8	2.2	0.1	0.2	1.1	84.7	7.9
CB16	Cg4, 80-114 cm	Fine Sand	97.1	1.8	1.1	0.1	0.2	1.0	80.0	15.7
CB16	Cg5, 114-187 cm	Fine Sand	88.6	7.8	3.6	0.0	0.2	1.1	70.6	16.7
CB16	Cg6, 187-215 cm	Fine Sand	97.9	0.2	1.9	0.1	0.1	0.5	92.7	4.4

Appendix H: Continued.

Pedon	Sample	Texture Class	% sand	% silt	% clay	% vcos	% cos	% ms	% fs	%vfs
CB17	A, 0-8 cm	Fine Sand	96.5	2.8	0.6	0.1	1.0	17.5	68.7	9.2
CB17	Cg/A, 8-32 cm	Fine Sand	96.4	2.7	0.8	0.1	1.2	12.7	73.9	8.5
CB17	Cg1, 32-54 cm	Fine Sandy Loam	73.9	17.6	8.5	0.1	0.1	0.8	51.1	21.8
CB17	Cg2, 54-77 cm	Loamy Fine Sand	81.5	12.0	6.5	0.0	0.4	4.3	66.2	10.5
CB17	Cg3, 77-102 cm	Fine Sand	99.1	0.1	0.7	0.2	1.5	6.1	87.8	3.5
CB17	Cg4, 102-148 cm	Fine Sand	99.1	0.0	0.9	0.0	0.2	1.4	89.8	6.7
CB18	A, 0-8 cm	---	---	---	---	---	---	---	---	---
CB18	Cg, 8-50 cm	Silty Clay Loam	18.9	47.1	34.1	0.0	0.1	0.1	8.2	10.4
CB18	Cg, 50-100 cm	Clay Loam	23.3	47.7	29.0	0.0	0.2	0.1	8.9	14.1
CB18	Cg, 100-150 cm	Silty Clay Loam	10.7	53.1	36.2	0.0	0.1	0.0	1.3	9.3
CB18	Cg, 150-200 cm	Silty Clay Loam	19.7	47.0	33.3	0.0	0.0	0.1	3.8	15.8
CB18	Cg, 200-250 cm	Clay Loam	29.5	38.8	31.8	0.0	0.1	0.3	13.2	15.8
CB21	A1, 0-2 cm	Clay Loam	24.0	48.0	28.0	0.0	0.3	0.9	3.7	19.1
CB21	A2, 2-18 cm	Clay Loam	28.1	44.9	27.0	0.1	0.6	1.5	5.0	20.9
CB21	Oa, 18-58 cm	Muck	Muck	---	---	---	---	---	---	---
CB21	Ab, 58-62 cm	Loam	30.4	45.4	24.3	0.2	2.2	6.7	15.5	5.8
CB21	BAgb, 62-71 cm	Loam	38.9	44.2	16.9	0.2	2.5	8.9	20.2	7.1
CB21	Btgb, 71-96 cm	Clay	27.7	25.5	46.9	0.4	1.1	3.2	15.2	7.7
CB21	2Cgb, 96-134 cm	Loamy Fine Sand	88.7	5.4	5.8	0.3	4.2	22.8	54.2	7.3

Appendix H: Continued.

Pedon	Sample	Texture Class	% sand	% silt	% clay	% vcos	% cos	% ms	% fs	%vfs
CB26	A, 0-2 cm	---	---	---	---	---	---	---	---	---
CB26	Cg, 2-28 cm	Fine Sand	95.5	2.0	2.4	2.8	3.8	14.0	72.9	2.0
CB26	A', 28-50 cm	Silty Clay	7.3	46.3	46.4	0.3	1.5	1.2	2.7	1.7
CB26	C'g, 50-70 cm	Silty Clay	3.0	53.3	437	0.2	0.5	0.7	0.9	0.8
CB26	Cg/Oab, 70-103 cm	---	---	---	---	---	---	---	---	---
CB26	Oab, 103-132 cm	Muck	---	---	---	---	---	---	---	---
CB26	Ab, 132-137 cm	Clay Loam	33.6	28.5	37.9	1.3	0.6	0.7	22.7	8.2
CB26	Btgb, 137-150 cm	Clay Loam	43.1	29.6	27.3	1.1	0.9	0.9	30.5	9.8
CB29	Cg3, 24-89 cm	Loamy Fine Sand	79.6	13.4	7.1	0.1	0.7	3.2	48.5	27.0
CB29	2Ab, 89-111 cm	Fine Sand	93.9	3.5	2.6	2.8	7.0	20.0	55.8	8.3
CB31	Cg1, 22-62 cm	Clay Loam	20.2	45.7	34.1	1.2	0.1	0.2	8.7	10.0
CB31	Cg2, 62-112 cm	Clay Loam	22.1	42.8	35.0	0.0	0.2	1.0	15.9	5.0
CB39	A1, 0-1 cm	---	---	---	---	---	---	---	---	---
CB39	A2, 1-12 cm	Silty Clay Loam	6.0	57.3	36.7	0.0	0.1	0.3	1.2	4.4
CB39	Cg1, 12-43 cm	Silty Clay Loam	7.9	53.7	38.4	0.0	0.3	0.7	1.8	5.0
CB39	Cg2, 43-57 cm	Silty Clay	4.0	53.2	42.8	0.0	0.1	0.3	0.9	2.7
CB39	Cg3, 57-126 cm	Silt Loam	20.2	53.3	26.5	0.2	1.5	4.5	10.4	3.6
CB39	2Cg4, 126-161 cm	Fine Sandy Loam	73.8	15.8	10.4	0.7	5.9	17.4	44.4	5.4
CB39	2Cg5, 161-198 cm	Fine Sandy Loam	75.9	17.5	6.5	0.8	5.8	17.2	44.2	8.0
CB41	A2, 3-17 cm	Fine Sandy Loam	69.2	19.7	11.1	0.2	0.1	0.1	57.0	11.8
CB41	Cg1, 17-52 cm	Clay Loam	34.8	38.0	27.2	4.3	0.8	0.2	15.2	14.3
CB41	Cg2, 52-143 cm	Clay Loam	27.2	42.8	30.0	0.0	0.0	0.0	14.4	12.8

Appendix H: Continued.

Pedon	Sample	Texture Class	% sand	% silt	% clay	% vcos	% cos	% ms	% fs	%vfs
CB45	A, 0-6 cm	Fine Sand	97.2	1.2	1.7	0.0	0.0	5.2	89.4	2.5
CB45	Cg/A, 6-33 cm	Fine Sand	98.6	0.3	1.1	0.0	0.1	3.9	93.1	1.5
CB45	Cg1, 33-88 cm	Fine Sand	94.8	2.3	2.9	0.0	0.1	1.7	88.1	4.9
CB45	Cg2, 88-99 cm	Loamy Fine Sand	83.2	11.0	5.8	0.0	0.1	0.9	61.7	20.5
CB45	2Cg3, 99-142 cm	Loam	28.2	47.1	24.7	0.0	0.1	0.1	7.4	20.6
CB45	2Cg4, 142-186 cm	Silty Clay Loam	14.7	46.6	38.7	0.0	0.1	0.1	5.5	9.0
CB49	Cg1, 10-42 cm	Loam	30.1	44.9	25.0	0.1	0.0	0.0	4.6	25.4
CB49	Cg2, 42-80 cm	Sandy Loam	62.4	23.0	14.6	0.5	0.2	0.1	21.7	39.9
CB49	Ab, 80-105 cm	Very fine Sandy Loam	57.5	27.8	14.7	0.0	0.9	0.9	11.0	44.6
CB50	A1, 0-3 cm	---	---	---	---	---	---	---	---	---
CB50	A2, 3-21 cm	Sandy Loam	61.0	25.5	13.5	11.5	3.2	1.5	16.7	28.1
CB50	Cg/A, 21-45 cm	Loam	50.9	32.9	16.2	12.0	2.2	1.1	10.6	25.1
CB50	Cg1, 45-60 cm	Loam	42.7	35.5	21.8	0.0	0.0	0.1	5.8	36.7
CB50	Cg2, 60-92 cm	Loam	49.7	33.3	17.0	0.1	0.3	0.4	8.8	40.1
CB50	Cg3, 92-160 cm	Very Fine Sandy Loam	60.3	25.7	14.0	0.0	0.1	0.1	15.1	45.0
CB52	A1 & A2 0-10 cm	Sandy Loam	72.3	18.1	9.6	0.0	0.0	0.1	33.6	38.6
CB52	Cg1, 10-21 cm	Loam	52.0	31.6	16.5	0.0	0.1	0.1	18.3	33.4
CB52	2Cg2, 21-39 cm	Loam	32.2	43.8	24.0	0.0	0.2	0.1	11.3	20.6
CB52	2Cg3, 39-59 cm	Loam	42.4	35.9	21.7	0.0	0.0	0.2	18.1	24.1
CB52	2Cg4, 59-86 cm	Clay Loam	28.7	41.9	29.4	0.0	0.1	0.2	10.5	17.9
CB52	2Cg5, 86-115 cm	Loam	42.6	35.0	22.4	0.0	0.1	0.1	18.7	23.7
CB52	2Cg6, 115-138 cm	Sandy Loam	59.1	25.7	15.2	0.0	0.2	0.2	29.3	29.3

Appendix H: Continued.

Pedon	Sample	Texture Class	% sand	% silt	% clay	% vcos	% cos	% ms	% fs	%vfs
CB55	A1, 0-3 cm	---	---	---	---	---	---	---	---	---
CB55	A2, 3-12 cm	Fine Sand	90.1	6.1	3.8	0.1	0.0	0.1	66.9	23.0
CB55	Cg1, 12-41 cm	Loamy Fine Sand	80.9	10.5	8.6	0.1	0.2	0.1	62.0	18.9
CB55	Cg2, 41-90 cm	Loamy Fine Sand	80.7	10.9	8.3	0.0	0.1	0.1	53.0	27.5
CB55	2Cg3, 90-143 cm	Loam	53.4	29.6	17.0	0.0	0.0	0.2	10.9	42.3
CB55	2Cg4, 143-162 cm	Sandy Loam	62.9	23.4	13.8	0.0	0.1	0.2	20.9	41.6
CB55	2Cg5, 162-198 cm	Loam	35.6	40.1	24.2	0.0	0.0	0.2	5.4	30.1
CB56	A1, 0-2 cm	---	---	---	---	---	---	---	---	---
CB56	A2, 2-10 cm	Fine Sand	94.6	3.2	2.2	0.0	0.1	0.7	87.1	6.7
CB56	Cg1, 10-31 cm	Fine Sand	95.5	2.4	2.1	0.2	0.5	1.6	89.2	4.0
CB56	Cg2, 31-49 cm	Fine Sand	97.4	0.7	1.9	0.2	0.3	2.4	91.8	2.7
CB56	Cg3, 49-72 cm	Loamy Fine Sand	79.2	13.7	7.1	0.0	0.0	0.3	57.4	21.5
CB56	Cg4, 72-90 cm	Fine Sand	88.7	6.4	4.9	0.3	0.5	0.5	70.1	17.4
CB56	Cg5, 90-122 cm	Fine Sand	95.4	2.2	2.4	0.0	0.2	0.3	84.2	10.7
CB56	Cg6, 122-137 cm	Fine Sand	88.7	6.4	5.0	0.6	0.8	0.3	74.0	13.0
CB56	2Ab, 137-154 cm	Loamy Fine Sand	80.7	12.6	6.7	0.0	0.1	0.4	56.2	23.9
CB58	A1, 0-3 cm	---	---	---	---	---	---	---	---	---
CB58	A2, 3-14 cm	Loamy Fine Sand	81.5	15.5	3.0	0.2	0.1	0.2	52.7	28.3
CB58	Cg1, 14-37 cm	Fine Sandy Loam	75.8	14.8	9.4	0.1	0.1	0.2	49.7	25.7
CB58	Cg2, 37-106 cm	Fine Sandy Loam	67.8	20.4	11.8	0.0	0.2	0.2	21.3	46.0
CB58	2Cg3, 106-162 cm	Silty Clay Loam	19.2	48.5	32.3	0.0	0.0	0.0	1.5	17.7

Appendix H: Continued.

Pedon	Sample	Texture Class	% sand	% silt	% clay	% vcos	% cos	% ms	% fs	%vfs
CB74	A1, 0-2 cm	---	---	---	---	---	---	---	---	---
CB74	A2, 2-19 cm	Sandy Loam	67.4	22.5	10.1	0.1	0.1	0.1	36.1	31.0
CB74	Cg1, 19-55 cm	Loamy Fine Sand	82.9	11.8	5.3	0.0	0.1	0.3	56.9	25.6
CB74	Cg2, 55-89 cm	Loamy Fine Sand	87.9	7.5	4.6	0.0	0.0	0.6	72.0	15.3
CB74	Cg3, 89-109 cm	Loamy Fine Sand	77.9	13.4	8.7	0.2	0.8	9.6	55.0	12.2
CB74	2Cg4, 109-142 cm	Loamy Fine Sand	85.4	7.9	6.7	0.0	1.2	9.9	68.4	5.9
CB74	2Cg5, 142-174 cm	Fine Sand	94.5	2.5	3.0	0.0	1.0	9.8	80.9	2.8
CB79	A1, 0-3 cm	---	---	---	---	---	---	---	---	---
CB79	A2, 3-10 cm	Fine Sand	94.9	2.8	2.3	2.2	0.6	0.9	73.6	17.7
CB79	Cg1, 10-50 cm	Fine Sandy Loam	74.8	15.3	9.9	0.0	0.0	0.2	57.7	16.9
CB79	Cg2, 50-86 cm	Loamy Fine Sand	80.4	12.0	7.6	0.0	0.1	2.1	57.6	20.6
CB79	Cg3, 86-123 cm	Fine Sand	98.2	0.4	1.4	0.0	0.6	5.2	87.5	4.9
CB85	Cg1, 21-33 cm	Clay Loam	23.8	44.4	31.7	1.0	1.9	4.9	12.5	3.6
CB85	Cg2, 33-57 cm	Clay Loam	26.2	41.5	32.3	0.5	2.3	5.7	14.3	3.4
CB85	2Cg3, 57-92 cm	Sandy Loam	74.7	14.7	10.6	10.1	8.7	10.3	40.5	5.0
CB85	2Cg4, 92-120 cm	Loamy Fine Sand	87.6	2.7	9.7	18.6	8.6	6.6	50.0	3.8
CB91	A, 0-3 cm	---	---	---	---	---	---	---	---	---
CB91	Cg1, 3-54 cm	Loam	34.0	41.1	24.9	0.3	1.8	3.7	17.3	10.9
CB91	Cg2, 54-61 cm	Sandy Loam	65.2	20.0	14.8	0.3	1.7	18.6	38.7	5.9
CB91	Cg3, 61-139 cm	Silty Clay Loam	16.4	48.5	35.1	0.3	0.4	0.7	2.7	12.2
CB91	Cg4, 139-169 cm	Loam	42.4	33.2	24.4	0.7	1.9	4.7	23.0	12.2
CB91	Cg5, 169-191 cm	Sandy Loam	65.1	19.8	15.1	1.1	4.8	17.7	34.8	6.6

Appendix H: Continued.

Pedon	Sample	Texture Class	% sand	% silt	% clay	% vcos	% cos	% ms	% fs	%vfs
CB93	A1, 0-4 cm	---	---	---	---	---	---	---	---	---
CB93	A2, 4-15 cm	Silt Loam	24.7	51.6	23.7	0.0	0.1	0.0	4.8	19.9
CB93	Cg1, 15-42 cm	Silt Loam	25.9	51.7	22.4	0.3	0.2	0.2	2.6	19.0
CB93	Cg2, 42-81 cm	Silty Clay Loam	5.4	56.0	38.5	0.0	0.1	0.0	0.3	5.0
CB93	Cg3, 81-210 cm	Silty Clay Loam	9.7	53.9	36.3	0.1	0.1	0.1	0.4	9.0
CB94	A1, 0-1 cm	---	---	---	---	---	---	---	---	---
CB94	A2, 1-12 cm	Fine Sand	96.0	1.8	2.2	0.6	4.8	30.5	55.9	4.1
CB94	2Cg1, 12-33 cm	Silty Clay	8.4	50.0	41.5	0.2	1.0	3.0	3.3	1.0
CB94	2Cg2, 33-94 cm	Silty Clay	4.7	53.5	41.8	0.2	0.5	0.4	1.2	2.4
CB94	2Cg3, 94-107 cm	Silty Clay	3.7	51.7	44.5	0.4	0.3	0.2	0.5	2.2
CB94	2Cg4, 107-145 cm	Silty Clay	4.9	53.3	41.8	0.0	0.5	0.2	1.0	3.2
CB97	A, 0-2 cm	---	---	---	---	---	---	---	---	---
CB97	Cg1, 2-76 cm	Silt Loam	23.5	52.9	23.6	0.1	0.1	0.2	2.1	21.0
CB97	Cg2, 76-95 cm	Loam	31.9	46.1	21.9	0.0	0.2	0.2	13.7	17.8
CB97	Cg3, 95-131 cm	Silty Clay Loam	17.2	47.4	35.4	0.0	0.1	0.1	7.2	9.8
CB97	Cg4, 131-145 cm	Silty Clay Loam	19.8	45.9	34.3	0.1	0.3	0.4	8.3	10.7
CB97	Cg5, 145-168 cm	Silty Clay	12.0	43.9	44.1	0.0	0.1	0.1	4.5	7.3
CB97	Oa/Cg, 168-195 cm	---	---	---	---	---	---	---	---	---
CB97	Oab1, 195-213 cm	Muck	---	---	---	---	---	---	---	---
CB97	Oab2, 213-224 cm	Muck	---	---	---	---	---	---	---	---
CB97	2Ab, 224-245 cm	Loam	43.9	36.0	20.1	0.8	3.6	8.6	16.2	14.7
CB97	2Cgb1, 245-260 cm	Loam	53.8	31.6	14.6	1.3	3.7	8.2	22.7	17.9
CB97	2Cgb2, 245-260 cm	Sandy Loam	56.8	23.5	19.6	1.2	2.9	3.6	25.9	23.1

Appendix H: Continued.

Pedon	Sample	Texture Class	% sand	% silt	% clay	% vcos	% cos	% ms	% fs	%vfs
CB100	Cg1, 3-53 cm	Silty Clay Loam	17.7	49.8	32.5	0.0	0.0	0.0	3.4	14.3
CB100	Cg2, 53-80 cm	Loam	29.9	44.3	25.8	0.0	0.1	0.3	8.7	20.8
CB100	Cg3, 80-100 cm	Silty Clay Loam	16.5	50.3	33.2	1.6	0.0	0.2	2.5	12.3
CB118	Cg2, 19-117 cm	Clay Loam	26.1	45.4	28.5	0.0	0.1	0.1	5.6	20.2
CB123	Cg1, 24-47 cm	Fine Sand	96.6	2.3	1.0	0.3	0.9	3.8	77.5	14.1
CB123	Cg2, 47-109 cm	Loamy Fine Sand	76.2	15.9	7.9	0.0	0.1	0.1	47.3	28.8
CB123	Cg3, 109-148 cm	---	---	---	---	---	---	---	---	---
CB123	2Cg4, 148-160 cm	Sandy Loam	75.8	17.1	7.1	0.2	0.2	0.9	23.3	51.2
CB124	A, 0-6 cm	Fine Sand	98.3	0.1	1.6	0.0	0.1	0.7	89.5	8.0
CB124	Cg1, 6-48 cm	Fine Sand	97.7	0.7	1.7	0.0	0.1	1.1	84.6	11.9
CB124	2Cg2, 48-70 cm	Silty Clay Loam	15.0	50.1	34.9	0.1	0.4	0.5	7.4	6.7
CB124	2Oab1, 70-116 cm	Muck	---	---	---	---	---	---	---	---
CB124	2Oab2, 116-130 cm	Muck	---	---	---	---	---	---	---	---
CB124	3Ab, 130-136 cm	Fine Sandy Loam	63.3	26.5	10.2	2.0	4.3	5.7	44.2	7.1
CB124	3Cgb, 136-157 cm	Fine Sandy Loam	63.9	27.1	9.0	0.9	4.5	8.2	43.5	6.8
CB127	Cg1, 22-51 cm	Silty Clay Loam	15.6	55.1	29.3	0.0	0.2	0.4	1.3	3.7
CB127	Cg2, 51-102 cm	Silty Clay Loam	12.6	57.5	29.8	0.1	0.2	0.1	0.8	11.4
CB130	A1, 0-4 cm	---	---	---	---	---	---	---	---	---
CB130	A2, 4-21 cm	Silty Clay Loam	11.8	54.9	33.3	0.1	0.2	0.3	3.2	7.9
CB130	Cg1, 21-58 cm	Clay Loam	22.9	47.3	29.8	0.0	0.1	0.2	2.7	19.9
CB130	Cg2, 58-125 cm	Silty Clay Loam	16.6	47.3	36.0	0.0	0.0	0.0	1.7	15.0
CB130	Cg2, 125-199 cm	Silty Clay Loam	17.7	48.1	34.3	0.2	0.3	0.5	1.2	15.4
CB130	Cg3, 199-275 cm	Clay Loam	27.4	43.3	29.3	0.2	0.2	0.3	2.9	23.7
CB130	Cg3, 275-340 cm	Silty Clay Loam	17.6	45.9	36.5	0.1	0.4	1.2	2.6	13.3

Appendix H: Continued.

Pedon	Sample	Texture Class	% sand	% silt	% clay	% vcos	% cos	% ms	% fs	%vfs
CB136	A1, 0-2 cm	---	---	---	---	---	---	---	---	---
CB136	A2, 2-18 cm	Loamy Fine Sand	89.6	5.5	5.0	0.4	4.8	28.4	54.8	1.1
CB136	Cg1, 18-37 cm	Loam	35.8	38..0	26.2	0.2	2.3	8.8	21.0	3.4
CB136	2Cg2, 37-93 cm	Silty Clay Loam	10.2	59.2	30.6	0.0	0.2	0.5	0.8	8.8
CB136	2Cg3, 93-146 cm	Silty Clay Loam	8.0	62.8	29.2	0.1	0.2	0.2	0.5	6.9
CB136	2Cg4, 146-161 cm	Silty Clay	5.2	51.6	43.2	0.4	0.6	0.3	1.0	2.9
CB136	2Oab1, 161-187 cm	Muck	---	---	---	---	---	---	---	---
CB136	2Oab2, 187-205 cm	Muck	---	---	---	---	---	---	---	---
CB136	3Ab, 205-211 cm	Sandy Loam	69.3	22.3	8.4	0.7	3.8	18.4	32.3	14.1
CB141	A1, 0-4	---	---	---	---	---	---	---	---	---
CB141	A2, 4-13	Sandy Loam	76.5	14.9	8.6	10.9	1.2	0.8	24.7	38.9
CB141	Cg1, 13-23 cm	Sandy Loam	66.2	21.0	12.8	0.1	4.7	2.8	21.7	37.0
CB141	Cg2, 23-46 cm	Clay Loam	23.3	47.7	29.0	0.1	0.6	0.4	3.2	18.9
CB141	Cg3, 46-123 cm	Silty Clay Loam	7.8	54.1	38.1	0.0	0.1	0.2	0.9	6.6
CB141	Cg4, 123-174 cm	Silty Clay	6.6	52.3	41.1	0.0	0.0	0.0	0.3	6.3
CB142	A, 0-3 cm	---	---	---	---	---	---	---	---	---
CB142	Cg1, 3-36 cm	Silt Loam	19.1	56.4	24.5	0.0	0.0	0.2	1.0	17.9
CB142	Cg2, 36-100 cm	Silty Clay Loam	17.7	51.2	31.1	0.0	0.3	0.3	3.7	13.3
CB142	Oab, 100-131 cm	Muck	---	---	---	---	---	---	---	---
CB142	Ab, 131-134 cm	---	---	---	---	---	---	---	---	---
CB142	BAgb, 134-142 cm	Loam	43.5	40.8	15.7	0.0	0.4	1.0	23.8	18.2
CB142	Cgb, 142-149 cm	Loam	41.6	42.3	16.1	0.2	0.7	0.6	23.8	16.2

Appendix H: Continued.

Pedon	Sample	Texture Class	% sand	% silt	% clay	% vcos	% cos	% ms	% fs	%vfs
CB143	A, 0-3 cm	---	---	---	---	---	---	---	---	---
CB143	Cg1, 3-61 cm	Loam	27.0	48.3	24.7	0.1	0.2	0.4	2.9	23.3
CB143	Cg2, 61-95 cm	Loam	37.3	43.2	19.6	0.1	1.3	4.0	10.3	21.6
CB143	Cg3, 95-108 cm	Loam	40.3	42.2	17.5	0.2	2.3	8.4	19.5	10.0
CB143	2Cg4, 108-137 cm	Silt Loam	23.5	54.6	21.9	0.1	1.0	4.2	11.8	6.4

References

Anderson, R.R. 1970. The submerged vegetation of Chincoteague Bay. p. 136–155. *In* Assateague ecological studies final report: Part1. Environmental information. Nat. Resources Inst. Univ. of Maryland. Contrib. No. 446.

Anderson, R.R. 1972. Submersed vascular plants of the Chesapeake Bay and tributaries. Chesapeake Sci. 13:S87-S89.

Aston, S.R. 1980. Nutrients, dissolved gases, and general biogeochemistry in estuaries. p. 233-295. *In* E. Olausson et al. (ed.) Chemistry and biogeochemistry of estuaries. John Wiley, New York.

Balduff, D.M., and M.C. Rabenhorst. 2007. Grain counting strategies for a more accurate assessment of soil mineralogy. Soil Survey Horiz. 48:xxx-xxx.

Barko, J.W., and R.M. Smart. 1983. Effects of organic matter additions to sediment on the growth of aquatic plants. J. Ecol. 71:161-175.

Barko, J.W., and R.M. Smart. 1986. Sediment-related mechanisms of growth limitation in submersed macrophytes. Ecology 67:1328-1340.

Barko, J.W., D. Gunnison, and S.R. Carpenter. 1991. Sediment interactions with submersed macrophyte growth and community dynamics. Aquatic Botany 41:41-65.

Bartberger, C.E. 1976. Sediment sources and sedimentation rates, Chincoteague Bay, Maryland and Virginia. Sedimentary Petrology. 46:326-336.

Bartberger, C.E., and R.B. Biggs. 1970. Sedimentation in Chincoteague Bay. p. 70–89. *In* Assateague ecological studies final report: Part1. Environmental information. Nat. Resources Inst. Univ. of Maryland. Contrib. No. 446.

Bates, R.L., and J.A. Jackson (ed.). 1987. Glossary of geology. 3rd ed. Am. Geol. Inst. Alexandria, VA.

Batiuk, R., P. Bergstrom, M. Kemp, E. Koch, L. Murray, J.C. Stevenson, R. Bartleson, V. Carter, N.B. Rybicki, J.M. Landwehr, C. Gallegos, L. Karrh, M. Naylor, D. Wilcox, K.A. Moore, S. Ailstock, and M. Teichberg. 2000. Chesapeake Bay submerged aquatic vegetation water quality and habitat-based requirements and restoration targets: A second synthesis. Chesapeake Bay Program, Annapolis, MD.

Batiuk, R., R. Orth, K. Moore, J. C. Stevenson, W. Dennison, L. Staver, V. Carter, N Rybicki, R. Hickman, S. Kollar and S. Bieber. 1992. Chesapeake Bay submerged aquatic vegetation habitat requirements and restoration targets: A technical synthesis. Chesapeake Bay Program, Annapolis, MD.

Biggs, R.B. 1970. The origin and geological history of Assateague Island, Maryland and Virginia. p. 9–42. *In* Assateague ecological studies final report: Part1. Environmental information. Nat. Resources Inst. Univ. of Maryland. Contrib. No. 446.

Bloom, A.L. and M. Stuvier. 1963. Submergence of the Connecticut coast. Science 139:332-334.

Bockheim, J.G. 1997. Properties and classification of cold desert soils from Antarctica. Soil Sci. Soc. Am. J. 61:224-231.

Bradley, M.P. 2001. Subaqueous soils and subtidal wetlands in Rhode Island. M.S. thesis. Univ. of Rhode Island, Kingston.

Bradley, M.P., and M.H. Stolt. 2002. Evaluating methods to create a base map for a subaqueous soil inventory. Soil Sci. 167: 222-228.

Bradley, M.P., and M.H. Stolt. 2003. Subaqueous soil-landscape relationships in a Rhode Island estuary. Soil Sci. Soc. Amer. J. 67:1487-1495.

Bradley, M.P., and M.H. Stolt. 2006. Landscape-level seagrass – sediment relations in a coastal lagoon. Aquatic Botany. 84:121-128.

Burt, R. (ed.) 2004. Soil survey laboratory methods manual. Soil Survey Invest. Rep. 42. Version 4.0. Natl. Soil Survey Cent., Lincoln, NE.

Carey, J.B., R.L. Cunningham, and E.G. Williams. 1976. Loess identification in soils of Southeastern Pennsylvania. Soil Sci. Soc. Am. J. 40:745-750.

Carlson, P.R., L.A. Yarbro, and T.R. Barber. 1994. Relationship of sediment sulfide to mortality of *Thalassia testudinum* in Florida Bay. Bull. Of Mar. Sci. 54:733-746.

Chaillou, J.C., S.B. Weisberg, F.W. Kutz, T.E. DeMoss, L. Mangiaracina, R. Magnien, R. Eskin, J. Maxted, K.S. Price, and L.K. Summers. 1996. Assessment of the ecological condition of the Delaware and Maryland coastal bays. EPA, Annapolis, MD.

Chesapeake Bay Program. 1991. Habitat requirements for Chesapeake Bay living resources. 2nd Ed. USEPA, Chesapeake Bay Program, Annapolis, Maryland.

Colman, S. M., J. F. Bratton, and P. C. Baucom. 2000. Radiocarbon dating of Marion-Dufresne cores MD99-2204, -2207, -2209, Chesapeake Bay. *In* T.M. Cronin (ed.)

Initial report on the IMAGES V Cruise of the Marion-Dufresne to the Chesapeake Bay June 20 - 22, 1999. U.S. Geological Survey, Open-File Report 00-306.

Coppock, C. R., M.C. Rabenhorst, and B.A. Needelman. 2004. Rehoboth Bay, Delaware: Subaqueous soils of an Atlantic coastal lagoon. *In* Annual meetings abstracts [CD-ROM]. ASA, CSSA, SSSA, Madison, WI.

Coppock, C.R., M.C. Rabenhorst, and B.A. Needelman. 2003. Subaqueous soil landscape models in a coastal lagoon. *In* Annual meeting abstracts [CD-ROM]. ASA, CSSA, and SSSA, Madison, WI.

Cornwell, J.C. and J.W. Morse. 1987. The characterization of iron sulfide minerals in anoxic sediments. Marine Chem. 22:193-206.

Daddario, J.J. 1961. A lagoon deposit profile near Atlantic City, New Jersey. Bull. N.J. Acad. Sci. 6:7-14.

Darmody, R.G., and D.S. Fanning. 1977. Whiffing sulfur levels of tidal marsh soils. Soil Survey Horizons 18:16-17.

Darmody, R.G., D.S. Fanning, W.J. Drummond, Jr., and J.E. Foss. 1977. Determination of total sulfur in tidal marsh soils by x-ray spectroscopy. Soil Sci. Soc. Am. J. 41:761-765.

Davis, Jr. , R.A. 1994. Barrier island systems: A geological overview. p. 1-46. *In* R.A. Davis, Jr. (ed.) Geology of Holocene barrier island systems. Springer-Verlag, New York.

De Beaumont, E. 1845. Lecons de geologie pratique. p. 5-43. *In* M.L. Schwartz (ed.) Barrier islands. Benchmark Papers in Geology vol. 8. Hutchinson and Ross, Stroudsburg.

Demas, G.P. 1998. Subaqueous soils of Sinepuxent Bay, MD. Ph.D. diss. Univ. of Maryland, College Park.

Demas, G.P., 1993. Submerged soils: A new frontier in soil survey. Soil Surv. Horiz. 34:44-46.

Demas, G.P., and M.C. Rabenhorst. 1998. Subaqueous soils: a resource inventory protocol. Proc. 16th World Congress of Soil Science, Montpelier, France. August 20-26, 1998. Symp. 7, on CD.

Demas, G.P., and M.C. Rabenhorst. 1999. Subaqueous soils: pedogenesis in a submerged environment. Soil Sci. Soc. Amer. J. 63:1250-1257.

Demas, G.P., and M.C. Rabenhorst. 2001. Factors of subaqueous soil formation: a system of quantitative pedology for submerged environments. Geoderma. 102:189-204.

Demas, G.P., J.C. Stevenson, and M.C. Rabenhorst. 1996. Subaqueous soils: a pedological approach to the study of shallow water habitats. Estuaries. 19:229-237.

Dillow, J.J.A., W.S.L. Banks, and M.J. Smigaj. 2002. Ground-water quality and discharge to Chincoteague and Sinepuxent Bays adjacent to Assateague Island National Seashore, Maryland. USGS Water-Resources Investigations Rep. 02-4029.

Drobeck, K., H. Hidu, J.M. Odell, and W. Boynton. 1970. Chincoteague and Sinepuxent Bay benthos. p. 175–243. *In* Assateague ecological studies final report: Part1. Environmental information. Nat. Resources Inst. Univ. of Maryland. Contrib. No. 446.

Duarte, C.M. 1991. Seagrass depth limits. Aquatic Bot. 40:363-377.

Duinker, J.C. 1980. Suspended matter in estuaries: adsorption and desorption processes. p. 121-151. *In* E. Olausson and I. Cato (ed.) Chemistry and biogeochemistry of estuaries. John Wiley and Sons, New York.

Saffland, A.B.W., and W.R. Effland. 1992. Soil geomorphology studies in the US soil survey program. Agric. Hist. 66:189-212.

Emery, K.O. 1967. Freshwater peat on the continental shelf. Science. 158: 1301-1307.

Enriquez, S., N. Marba, C.M. Duarte, B.I. van Tussenbroek, G. Reyes-Zavala. 2001. Effects of seagrass *Thalassia testudinum* on sediment redox. Mar. Ecology Prog. Ser. 219:149-158.

Environmental Systems Research Institute (ESRI), Inc. 2005. ArcGIS user's manual. ver. 9.0. Redfield, CA.

Fairbanks, R. G. 1989. A 17,000-year glacio-eustatic sea level record: influence of glacial melting rates on the Younger Dryas event and deep-ocean circulation. Nature 342:637-642.

Flannagan, C. 2005. Soil/landscape relationships in submerged soils of Taunton Bay, Maine. M.S. Thesis, University of Maine, Orono.

Flemming, B.W. 2000. A revised textural classification of gravel-free muddy sediments on the basis of ternary diagrams. Cont. Shelf Res. 20:1125-1137.

Folger, D.W. 1972. Characteristics of estuarine sediments of the United States. Geologic Survey Professional Paper 742. United States Department of the Interior, Washington, D.C.

Folk, R.L. 1974. Petrology of sedimentary rocks. Hemphill's, Austin, TX.

Fonseca, M.S., and S.S. Bell. 1998. Influence of physical setting on seagrass landscapes near Beaufort, North Carolina, USA. Mar. Ecology Prog. Ser. 171:109-121.

Fox, R.S., and E.E. Ruppert. 1985. Shallow-water marine benthic macroinvertebrates of South Carolina. Univ. of South Carolina Press, Columbia, South Carolina.

Gawne, C.E. 1966. Shore changes on Fenwick and Assateague Islands Maryland and Virginia. Unpub. Bachelors Thesis, Univ. of Illinois, Champaign-Urbana.

Gilbert, G.K. 1885. The topographic feature of lake shores. U.S. Geol. Surv. 5th Annual Rep. p. 69-123.

Goodman, J.L., K.A. Moore, and W.C. Dennison. 1995. Photosynthetic responses of eelgrass (*Zostera marina*) to light and sediment sulfide in a shallow barrier lagoon. Aquatic Bot. 50:37-48.

Goodman, P.J., and W.T. Williams. 1961. Investigations into 'die-back'. J. Ecol. 49:391-398.

Griffin, T.M., and M.C. Rabenhorst. 1989. Processes and rates of pedogenesis in some Maryland tidal marsh soils. Soil Sci. Soc. Am. J. 53:862-870.

Halsey, S.D. 1978. Late Quaternary geologic history and morphologic development of the barrier island system along the Delmarva Peninsula of the Mid-Atlantic Bight. Ph.D. diss. Univ. of Delaware, Lewes.

Hansen, J.W., and B.A. Lomstein. 1999. Leakage of ammonium, urea, and dissolved organic nitrogen and carbon from eelgrass *Zostera marina* roots and rhizomes during sediment handling. Aquatic Microbial Ecology. 16:303-307.

Hansen, K. 1959. The terms gyttja and dy. Hydrobiologia. 13:309-315.

Hayes, M.O. 1979. Barrier island morphology as a function of tidal and wave regime. p. 3-22. *In* S.P. Leatherman (ed.) Barrier islands. Academic Press, New York.

Hayes, M.O. 1980. General morphology and sediment patterns in tidal inlets. Sedimentary Geol. 26:139-156.

Hicks, S.D., H.A. Debaugh, and L.E. Hickman. 1983. Sea level variations for the United States 1955-1980. U.S. Dep. of Commerce, NOAA, Rockville, MD.

Holmer, M., M.S. Frederiksen, and H. Møllegaard. 2005. Sulfur accumulation in eelgrass (*Zostera marina*) and effect of sulfur on eelgrass growth. Aquatic Bot. 81:367-379.

Holmer, M., and L. Laursen. 2002. Effect of shading of *Zostera marina* (eelgrass) on sulfur cycling in sediments with contrasting organic matter and sulfide pools. J. Exp. Mar. Biol. Ecol. 270:25-37.

Holmer, M., and S.L. Nielsen. 1997. Sediment sulfur dynamics related to biomass-density patterns in *Zostera marina* (eelgrass) beds. Mar. Ecology Prog. Ser. 146:163-171.

Hoyt, J.H. 1967. Barrier island formation. Geol. Soc. Am. Bull. 78:1125-1135.

Hubbard, D.K., G. Oertel, and D. Nummedal. 1979. The role of waves and tidal currents in the development of tidal-inlet sedimentary structures and sand body geometry: examples from North Carolina, South Carolina, and Georgia. J. Sediment. Petrol. 49:1073-1092.

Hudson, B.D. 1990. Concepts of soil mapping and interpretation. Soil Surv. Horizons. 31:63-73.

Hudson, B.D. 1992. The soil survey as a paradigm-based science. Soil Sci. Soc. Amer. J. 56: 836-841.

Huettel, M., and G. Gust. 1992. Impact of bioroughness on interfacial solute exchange in permeable sediments. Mar. Ecology Prog. Ser. 89:253-267.

Hussein, A.H. 1996. Soil chronofunctions in submerging coastal areas of Chesapeake Bay. Ph. D. diss. Univ. of Maryland, College Park.

Hurley, L.M. 1990. Field guide to the submerged aquatic vegetation of Chesapeake Bay. U.S. Fish and Wildlife Species, Chesapeake Bay Estuary Program.

Idestam-Almquist, J., and L. Kautsky. 1995. Plastic responses in morphology of *Potamogeton pectinalus* to sediment and above sediment conditions at two sites in the northern Baltic proper. Aquatic Bot. 52:205-216.

Inman, D.L., and C.E. Nordstrom. 1971. On the tectonic and morphological classification of coasts. J. Geol. 79:1-21.

Integration and Application Network. 2006. Maryland coastal bays. [Online]. Available at http://ian.umces.edu/mcb (verified 6 Dec. 2006).

International Society of Soil Science. 1998. World reference base for soil resources. 84 World Soil Resources Rep. Food and Agricultural Organization of the United Nations, Rome.

International Union of Soil Science Working Group WRB. 2006. World reference base for soil resources 2006. World Soil Resources Rep. No. 103. Food and Agricultural Organization of the United Nations, Rome.

Isaken, M.F., and K. Finster. 1996. Sulphate reduction in the root zone of the seagrass *Zostera noltii* on the intertidal flats of a coastal lagoon (Arcachon, France). Mar. Ecol. Prog. Ser. 137:187-194.

Jenny, H. 1941. Factors of Soil Formation: A System of Quantitative Pedology. McGraw-Hill, New York, 281 pp.

Jespersen, J.L., and L.J. Osher. 2007. Carbon storage in the soils of a mesotidal gulf of Maine estuary. Soil Sci. Soc. Am. J. 71: .

Kearney, M.S., and J.C. Stevenson. 1991. Island land loss and marsh vertical accretion rate evidence for historical sea-level changes in Chesapeake Bay. J. Coastal Res. 7:403-415.

Kearney, M.S., and J.C. Stevenson. 2005. Ecology of North American coasts. *In* M. L. Schwartz (ed.) Encyclopedia of coastal science. Springer, Dordrecht, Netherlands.

Kemp, W.M., R. Batiuk, R. Bartleson, P. Bergstrom, V. Carter, C.L. Gallegos, W. Hurley, L. Karrh, E.W. Koch, J.M. Landwehr, K.A. Moore, L. Murray, M. Naylor, N.B. Rybicki, J.C. Stevenson, and D.J. Wilcox. 2004. Habitat requirements for submerged aquatic vegetation in Chesapeake Bay: Water quality, light regime, and physical-chemical factors. Estuaries 27:363-377.

Kemp, W.M., W.R. Boynton, J.C. Stevenson, R.R. Twilley, and J.C. Means. 1983. The decline of submerged vascular plants in upper Chesapeake Bay: Summary of the results concerning possible causes. Mar. Tech. Soc. J. 17:78-89.

Kemp, W.M., W.R. Boynton, R.R. Twilley, J.C. Stevenson, and L.G. Ward. 1984. Influences of submerged vascular plants on ecological processes in the upper

Chesapeake Bay. *In* V.S. Kennedy (ed.) The estuary as a filter. p. 367-394. Acad. Press, New York.

Kenworthy, W.J., J.C. Zieman, and G.W. Thayer. 1982. Evidence for the influence of seagrasses on the benthic nitrogen cycle in a coastal plain estuary near Beaufort, North Carolina (USA). Oecologia 54:152-158.

Kilmer, V.J. and L.T. Alexander. 1949. Methods of making mechanical analysis of soils. Soil Sci. 68:15-24.

Koch, E.W. 1999. Preliminary evidence on the interdependent effect of currents and porewater geochemistry on Thalassia testudinum Banks ex König seedlings. Aquatic Botany 63:95-102.

Koch, E.W. 2001. Beyond light: Physical, geological, and geochemical parameters as possible submersed aquatic vegetation habitat requirements. Estuaries 24:1-17.

Koch, E.W., and S. Beer. 1996. Tides, light and the distribution of Zostera marina in Long Island Sound, USA. Aquatic Botany 53:97-107.

Koch, M.S., and I.A. Mendelssohn. 1989. Sulphide as a soil phytotoxin: differential responses in two marsh species. J. Ecol. 77:565-578.

Kraft, J. C., M. J. Chrzastowski, D. F. Belknap, M. A. Tuscano, and C. H. Fletcher. 1987. The transgressive barrier-lagoon coast of Delaware: Morphostratigraphy, sedimentary sequences and responses to relative rise in sea level. p. 129-143. *In* D. Nummedal et al. (ed.) Sea-level fluctuation and coastal evolution. Society of Economic Paleontologists and Mineralogists, Tulsa, OK.

Kraft, J.C. 1976. Radiocarbon dates in the Delaware coastal zone. Delaware Sea Grant Rep. DEL-SG-19-76. Univ. Delaware, Newark, DE.

Krumbein, W.C. 1939. Tidal lagoon sediments on the Mississippi delta. p. 178-194. *In* P.D. Trask (ed.) Recent marine sediments. Dover Publications, Inc. New York.

Kubiena, W.M. 1953. The soils of Europe. T. Murby, London.

Leber III, K.M., and R.L. Lippson. 1970. Identity and distribution of decapod crustaceans in relation to environmental factors in Chincoteague Bay. p. 245–294. *In* Assateague ecological studies final report: Part1. Environmental information. Nat. Resources Inst. Univ. of Maryland. Contrib. No. 446.

LECO Corporation. 2005. Carbon and nitrogen in soil and sediment. LECO Corp., St. Joseph, MI.

Lee, K., and K.H. Dunton. 2000. Diurnal changes in pore water sulfide concentrations in the seagrass *Thalassia testudinum* beds: the effects of seagrasses on sulfide dynamics. J. Exp. Mar. Biol. and Ecol. 25:201-214.

Leeder, M.R. 1982. Sedimentary: Process and products. G. Allen & Unwin, London.

Levin, D.R. 1993. Tidal inlet evolution in the Mississippi River delta plain. J. Coastal Res. 9:462-480.

Livingston, R.J., S.E. McGlynn, and X. Niu. 1998. Factors controlling seagrass growth in a gulf coastal system: water and sediment quality and light. Aquatic Botany 60:135-159.

Marshall, N., and K. Lukas. 1970. Preliminary observations on the properties of bottom sediments with and without eelgrass, *Zostera marina*, cover. Proc. of the Natl. Shellfish Assoc. 60:107-111.

Maryland Department of Natural Resources. 2007. Underwater grasses decline in Maryland's coastal bays. [Online]. Available at http://www.dnr.state.md.us/dnrnews/pressrelease2007/050307.html (accessed 30 June 2007; verified 30 July 2007).

Merrell, K.C., J.C. Stevenson, G.P. Demas, and M.C. Rabenhorst. 1997. Seagrass production in relation to soil-landscape units: A pedological approach to understanding seagrass distributions. Abstract. 14th Biennial Estuarine Research Foundation International Meeting: The State of Our Estuaries, Providence, Rhode Island.

Miller, T.J., S.J.D. Martell, D.B. Burnell, G. Davis, L.Fergley, A. Sharov, C. Bonzek, D. Hewitt, J. Hoenig, R.N. Lipcius. 2005. Stock assessment of blue crabs in Chesapeake Bay 2005 Final Report. Univ. Maryland Cent. for Environ. Sci. Tech. Rep. Ser. No. TS-487-05.

Milne, G. 1936. Normal erosion as a factor in soil profile development. Nature. 136:548-549.

Moore, I.D., P.E. Gessler, and G.A. Nielsen. 1993. Soil attribute prediction using terrain analysis. Soil Sci. Soc. Am. J. 57:443-452.

Moore, K.A., R.J. Orth, and J.F. Nowak. 1993. Environmental regulation of seed germination in *Zostera marina* L. (eelgrass) in Chesapeake Bay: effects of light, oxygen, and sediment burial. Aquatic Bot. 45:79-91.

Muckenhausen, E. 1965. The soil classification system of the Federal Republic of Germany. Pedoligie (Belgium) Special Issue 3:57-74.

Nelson, D.W., and L.E. Sommers. 1982. Total carbon, organic carbon, and organic matter. *In* Page et al. (ed.) Methods of soil analysis: Part 2- chemical and microbiological properties. 2nd ed. ASA and SSSA, Madison, WI.

Newman, W.S., and C.A. Munsart. 1968. Holocene geology of the Wachapreague lagoon, eastern shore peninsula, Virginia. Mar. Geol. 6:81-105.

Nienhus, P.H. 1983. Temporal and spatial patterns of eelgrass (Zostera marina L.) in a former estuary in the Netherlands dominated by human activity. Mar. Technol. Soc. J. 17:69-77.

Northeast Regional Cooperative Soil Survey Subaqueous Soils Committee. 2007. Proposed Amendments to *Soil Taxonomy* to Accommodate Subaqueous Soils. [Online]. Available at http://nesoil.com/sas/Subaqueoustaxonomy.htm (verified 17 May 2007).

Norton, A.N., and D.E. Krantz. 2004. Saline and hypersaline groundwater under Assateague Island, Maryland. *In* Abstracts, Annu. Meet., Geol. Soc. Am. Denver, CO. 7-10 Nov. 2004.

Oertel, G.F., and J.C. Kraft. 1994. New Jersey and Delmarva barrier islands. p. 207-232. *In* R.A. Davis, Jr. (ed.) Geology of Holocene barrier island systems. Springer-Verlag, New York.

Okajima, H., and S. Takagi. 1956. Effects of hydrogen sulfide on the distribution of radioactive ^{32}P in the rice plant. Part IV Physiological behavior of hydrogen sulfide in the rice plant. Sci.Rep. Res. Inst. Tohoku Univ. Japan.

Orth, R.J. 1977. The importance of sediment stability in seagrass communities. p. 281-300. *In* B.C. Coull (ed.) Ecology of marine benthos. Univ. of South Carolina Press, Columbia, S.C.

Orth, R.J., M. Luckenbach, and K.A. Moore. 1994. Seed dispersal in a marine macrophyte: implications for colonization and restoration. Ecology 75:1927-1939.

Orth, R.J., and K.A. Moore. 1983. Chesapeake Bay: An unprecedented decline in submerged aquatic vegetation. Science 222:51-53.

Orth, R.J., and K.A. Moore. 1983. Seed germination and seedling growth of *Zostera marina* L. (eelgrass) in the Chesapeake Bay. Aquatic Bot. 15:117-131.

Orth, R.J., D.J. Wilcox, L.S. Nagey, A.L. Owens, J.R. Whiting, A.K. Kenne. 2005. 2004 distribution of submerged aquatic vegetation in Chesapeake Bay and coastal bays. Virginia Inst. of Mar. Sci. Spec. Sci. Rep. No. 146.

Osher, L.J., and C.T. Flannagan. 2007. Soil/landscape relationships in a mesotidal Maine Estuary. Soil Sci. Soc. Am. J. 71:1323-1334.

Osher, L.J., and J. Jespersen. 2006. Carbon storage in estuarine soils of Downeast Maine. *In* Abstracts. 18th World Congress of Soil Science. Philadelphia, PA. 9-15 July 2006.

Otvos, E.G. 1977. Development and migration of barrier islands, Northern Gulf of Mexico. Geol. Soc. Am. Bull. 81:241-246.

Pastor, J., and J.G. Bockheim. Soil development on moraines of Taylor Glacier, Lower Taylor Valley, Antarctica. Soil Sci. Soc. Am. J. 44:341-348.

Payne, M.K., and M.H. Stolt. 2006. Subaqueous landscapes and soils within Southern New England open embayments. *In* Annual meeting abstracts [CD-ROM]. ASA, CSSA, and SSSA, Madison, WI.

Pielou, E.C. 1991. After the ice age: the return of life to glaciated North America. The Univ. of Chicago Press, Chicago, IL.

Pilkey, O.H. 2003. A celebration of the world's barrier islands. p. 27-60. Columbia University Press, New York.

Piper, C.S. 1942. Organic matter. p. 213. *In* Soil and plant analysis. Interscience Publishers Inc., New York.

Ponnamperuma, F.N. 1972. The chemistry of submerged soils. Adv. Agron. 24:29-96.

Pons, L.J, N. Van Breeman, and P.M. Driessen. 1982. Physiography of coastal sediments and development of potential soil acidity. p. 1-18. In J.A. Kittrick et al. (ed.) Acid sulfate weathering. SSSA Spec. Publ. 10. ASA, Madison, WI.

Pritchard, D.W. 1960. Salt balance and exchange rate for Chincoteague Bay. Chesapeake Sci. 1:48-57.

Pritchard, D. 1967. Observations of circulation in coastal plain estuaries. p. 37-44. *In:* G. Lauff (ed), Estuaries. American Association for the Advancement of Science. Publ. No 83, Washington, D.C.

Prothero, D.R., and F. Schwab. 2004. Sedimentary geology: An introduction to sedimentary rocks and stratigraphy. 2nd ed. W.H. Freeman and Company, New York.

Rabenhorst, M.C. 1995. Carbon storage in tidal marsh soils. p. 93-103. *In* R. Lal et al. (ed.) Soils and global change. Lewis Publ. Boca Raton, FL.

Rasmussen, W.C., and T.H. Slaughter. 1955. The ground-water resources. *In* The water resources of Somerset, Wicomico, and Worcester counties. Maryland Dep. Geol., Mines, and Water Res. Bull. 16.

Raytheon Marine Co. Staff. 1986. Instruction manual for DE-719C fathometer precision survey recorder. Document No. 1035188, Revision E, Raytheon Marine Co., Hudson, New Hampshire.

Redfield, A.C. 1972. Development of a New England salt marsh. Ecol. Monogr. 42:201-237.

Redfield, A.C., and M. Rubin. 1962. The age of salt marsh peat and its relation to recent changes in sea level at Barnstable, Massachusetts. Proc. of the Natl. Acad. of Sci. 48:1728-1735.

Remote Data Systems Staff. 1994. WL40 series operation manual. Remote Data Systems Inc., Whiteville, North Carolina.

Rhoads, D.C., and D.K. Young. 1970. The influence of deposit-feeding organisms on sediment stability and community trophic structure. J. of Marine Sci. 28:150-178.

Rickard, D.T. 1973. Sedimentary iron sulfide formation. p. 28-65. *In* H. Dost (ed.) Acid sulphate soils Vol. 1. Int. Land Reclamation Inst. Publ. No. 18. Wageningen, Netherlands.

Rockwell Corp. Staff. 1994. Operations and maintenance manual: precision lightweight GPS receiver (PLGR+). Rockwell International Corporation, Cedar Rapids, Iowa.

Sand-Jensen, K., and M. Søndergaard. 1979. Distribution and quantitative development of aquatic macrophytes in relation to sediment characteristics in oligotrophic Lake Kalgaard, Denmark. Freshwater Biol. 9:1-11.

Schaetzl, R., and S. Anderson. 2005. Soils: genesis and geomorphology. University Press, Cambridge, United Kingdom.

Schoenberger, P.J., D.A. Wysocki, E.C. Benham, and W.D. Broderson (ed.) 2002. Field book for describing and sampling soils, Version 2.0. USDA-NRCS Natl. Soil Survey Cent., Lincoln, NE.

Shanks, K.E. 2005. Characterization of the Chincoteague Bay watershed in Worcester County, Maryland. Maryland Dep. of Nat. Res. Watershed Serv.

Shepard, F.P. 1954. Nomenclature based on sand-silt-clay ratios. Journal of Sedimentary Petrology. 24:151-158.

Shepard, F.P., and H.R. Wanless. 1971. Barriers and estuaries: New York to Chesapeake Bay. p. 87-99. *In* Our changing coastlines. McGraw-Hill Inc. New York.

Short, F.T. 1987. Effects of sediment nutrients on seagrasses: literature review and mesocosm experiment. Aquatic Bot. 27:41-57.

Short, F.T., D.M. Burdick, S.W. Wolf, and G.E. Jones. 1993. Eelgrass in estuarine research reserves along the East Coast, U.S.A. Part I. Declines from pollution and disease. NOAA Coastal Ocean Program Publ.

Short, F.T., R.C. Davis, B.S. Kopp, C.A. Short, and D.M. Burdick. 2002. Site-selection model for optimal transplantation of eelgrass *Zostera marina* in the northeastern US. Mar. Ecology Prog. Ser. 227:253-267.

Simjouw, J., M. R. Mulholland, and E. C. Minor. 2004. Changes in dissolved organic matter characteristics in Chincoteague Bay during a bloom of the pelagophyte *Aureococcus anophagefferens*. Estuaries 27:986-998.

Simonson, R.W. 1959. Outline of a generalized theory of soil genesis. Soil Sci. Soc. Amer. Proc. 23:152- 156.

Soil Survey Division Staff. 1993. Soil Survey Manual. USDA Handb. 1B 3rd ed. U.S. Government Printing Office, Washington, D.C.

Soil Survey Staff. 1975. *Soil Taxonomy*: A basic system of soil classification for making and interpretation soil surveys. SCS-USDA Agric. Handb. No. 436. U.S. Gov. Printing Office, Washington D.C.

Soil Survey Staff. 1999. *Soil Taxonomy*: A basic system of soil classification for making and interpretation soil surveys. 2nd ed. USDA-NRCS Agric. Handb. No. 436. U.S. Gov. Printing Office, Washington D.C.

Soil Survey Staff. 2006. Keys to *Soil Taxonomy*. 10th ed. USDA-NRCS US Government Printing Office, Washington D.C.

Soil, Water, and Agricultural Testing Laboratory. SWAT laboratory conversion factors. [Online]. Available at http:// swatlab.nmsu.edu/conv.html (verified 24 August 2007).

Stevenson, J.C., C.B. Piper, and N. Confer. 1979. Summary of available information on Chesapeake Bay submerged vegetation. Univ. of Maryland Laboratory Cent. for Environ. Estuarine Stud., Horn Point, Maryland.

Subaqueous Soils Subcommittee. 2005. Glossary of terms for subaqueous soils, landscapes, landforms, and parent materials of estuaries and lagoons [Online]. Available at http://nesoil.com/sas/glossary.htm (verified 27 June 2006). Natl. Cooperative Soil Survey Conf., Corpus Christi, TX. 21–26 May 2005.

Sugarman, P. 1998. Sea level rise in New Jersey. New Jersey Geol. Survey. Information Circular.

Taylor, D.I., S.W. Nixon, S.L. Granger, and B.A. Buckley. 1995. Nutrient limitation and the eutrophication of coastal lagoons. Mar. Ecological Prog. Ser. 127:235-244.

Terrados, J., C.M. Duarte, M.D. Fortes, J. Borum, N.S.R. Agawin, S. Bach, U. Thampanya, L. Kamp-Nielsen, W.J. Kenworthy, O. Geertz-Hansen, and J. Vermaat. 1998. Changes in community structure and biomass communities along gradients of siltation in SE Asia. Estuarine Coastal and Shelf Sci. 46:757-768.

Terrados, J., C.M. Duarte, L. Kamp-Nielsen, N.S.R. Agawin, E. Gacia, D. Lacap, M.D. Fortes, J. Borum, M. Lubanski, and T.M. Greve. 1999. Are seagrass growth and survival constrained by the reducing conditions of the sediments? Aquatic Botany 65:175-197.

Toscano, M.A., R.T. Kerhin, L.L. York, T.M. Cronin, and S.J. Williams. 1989. Quaternary stratigraphy of the inner continental shelf of Maryland. Maryland Geol. Survey Rep. of Invest. 50.

Trask, P.D. 1932. Origin and environment of source sediments of petroleum. Houston Gulf Publishing Co.

United States Department of Agricultural, Natural Resources Conservation Service. 2001. Orthophoto mosaic for Worcester County, MD. USDA-NRCS Geospatial Data Branch. Fort Worth, TX.

U.S. Department of Agriculture, Natural Resources Conservation Service, 2005. National Soil Survey Handbook, title 430-VI. [Online] Available: http://soils.usda.gov/technical/handbook/ (verified 10 May 2006).

v. Post, H. 1862. Studier ofver nutidans kopregena jordbildningar, gytta, torf, mylla. Klg. Sv. Vetensk. Akad. Handl. 4. Stockholm.

Van Wijck, C., C. de Groot, and P. Grillas. The effect of anaerobic sediment on the growth of Potamogeton pectinatus L.: the role of organic matter, sulphide and ferrous iron. Aquatic Bot. 44:31-49.

Valdes-Murtha, L.M. 1997. Analysis of critical habitat requirements for restoration and growth of submerged vascular plants in the Delaware and Maryland coastal bays. M.S. Thesis Univ. of Delaware, Lewes.

Ward, L.G., W.M. Kemp, and W.R. Boynton. 1984. The influence of waves and seagrass communities on suspended particulates in an estuarine embayment. Marine Geol. 59:85-103.

Ward, L.G., P.S. Rosen, W.J. Neal, O.H. Pilkey, Jr., O.H. Pilkey, Sr., G.L. Anderson, and S.J. Howie. 1989. Living with Chesapeake Bay and Virginia's ocean shores. Duke University Press, Durham, NC.

Wazniak, C., M. Hall, C. Cain, D.Wilson, R. Jesien, J.Thomas,T. Carruthers, and W. Dennison. 2004. State of the Maryland Coastal Bays. Maryland Department of Natural Resources, Maryland Coastal Bays Program, and University of Maryland Center for Environmental Science.

Wazniak, C.E., and M.R. Hall (ed.). 2005. Maryland's coastal bays: Ecosystem health assessment 2004. DNR 12-1202-0009. Maryland Dep. of Nat. Resources. Tidewater Ecosystem Assessment, Annapolis, MD.

Wazniak, C.E., L.Karrh, T. Parham, M. Naylor, M. Hall, T. Carruthers, and R. Orth. 2005. Seagrass abundance and habitat criteria in the Maryland coastal bays. *In* Wazniak, C.E., and M.R. Hall (ed.). Maryland's coastal bays: Ecosystem health assessment 2004. DNR 12-1202-0009. Maryland Dep. of Nat. Resources. Tidewater Ecosystem Assessment, Annapolis, MD.

Wells, D.V., and R.D. Conkwright. 1999. The Maryland coastal bays sediment mapping project. Physical and chemical characteristics of the shallow sediments: Synthesis Report and Atlas. Coastal and Estuarine Geology File Report 99-5. Maryland Natural Resources Resource Assessment Service Maryland Geological Survey, Baltimore, MD.

Wells, D.V., R.D. Conkwright, J.M Hill, and M.J. Park. 1994. The surficial sediments of Assawoman Bay and Isle of Wight Bay in Maryland: physical and chemical characteristics. Coastal and Estuarine Geology File Report 94-2, Maryland Geological Survey, Baltimore, MD.

Wells, D.V., R.A. Ortt, Jr., S. Van Ryswick, R.D. Conckwright, and K.A. Offerman. 2004. Bathymetric survey of the Maryland portion of Chincoteague Bay. Coastal and Estuarine Geol. File Rep. No. 04-04, Maryland Geol. Surv., Baltimore, Maryland.

Wentworth, C.K. 1922. A scale of grade and class terms for clastic sediments. Journal of Geology. 30:377-392.

Wilding, L.P., and L.R. Drees. 1983. Spatial variability and pedology. p. 83-116. *In*: Wilding, L.P., Smeck, N.E, and Hall, G.F. (Eds.), Pedogenesis and *Soil Taxonomy*. Concepts and Interactions, vol 1, Elsevier, Amsterdam.

Wright, W.R., and J.E. Foss. 1972. Contributions of clay and organic matter to the cation exchange capacity of Maryland soils. Soil Sci. Soc. Am. Proc. 36:115-119.

Yellow Springs Instrument Co., Inc. 1987. Instruction manualYSI model 32 conductance meter. Yellow Springs Instrument Co., Inc, Yellow Springs, OH.