9-2011

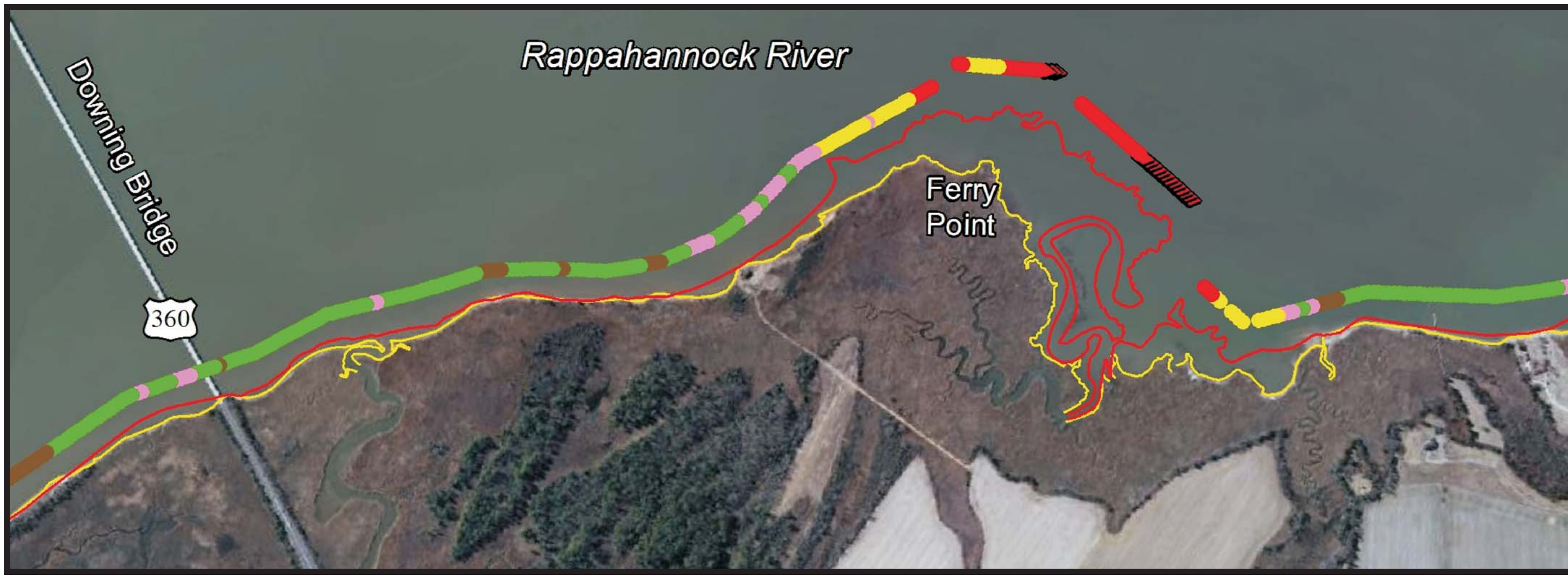
Shoreline Evolution: Richmond County, Virginia Rappahannock River Shorelines

Donna A. Milligan
Virginia Institute of Marine Science

Christine Wilcox
Virginia Institute of Marine Science

C. Scott Hardaway Jr.
Virginia Institute of Marine Science

Shoreline Evolution: Richmond County, Virginia Rappahannock River Shorelines



Virginia Institute of Marine Science
College of William & Mary
Gloucester Point, Virginia

September 2011

Shoreline Evolution:
Richmond County, Virginia
Rappahannock River Shorelines

Data Summary Report

Donna A. Milligan
Christine Wilcox
C. Scott Hardaway, Jr.

Shoreline Studies
Department of Physical Sciences
Virginia Institute of Marine Science
College of William & Mary
Gloucester Point, Virginia

This project was funded by the Virginia Coastal Zone Management Program at the Department of Environmental Quality through Grant #NA10NOS4190205 of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, under the Coastal Zone Management Act of 1972, as amended. The views expressed herein are those of the authors and do not necessarily reflect the views of the U.S. Department of Commerce, NOAA, or any of its subagencies.

September 2011

Table of Contents

List of Figures

List of Tables

1 Introduction

Richmond County is situated on the Northern Neck Peninsula in the eastern portion of Virginia (Figure 1). The Rappahannock River forms the southern boundary of this 192 square mile community. The County has 149 miles of shoreline on the Rappahannock River and Cat Point and Totuskey Creeks. Through time, the County's shoreline has evolved, and determining the rates and patterns of shore change provides the basis to know how a particular coast has changed through time and how it might proceed in the future. Along Chesapeake Bay's estuarine shores, winds, waves, tides and currents shape and modify coastlines by eroding, transporting and depositing sediments.

The purpose of this report is to document how the shore zone of Richmond County has evolved since 1937. Aerial imagery was taken for most of the Bay region beginning that year and can be used to assess the geomorphic nature of shore change. Aerial photos show how the coast has changed, how beaches, dunes, bars, and spits have grown or decayed, how barriers have breached, how inlets have changed course, and how one shore type has displaced another or has not changed at all. Shore change is a natural process but, quite often, the impacts of man, through shore hardening or inlet stabilization, come to dominate a given shore reach. In addition to documenting historical shorelines, the change in shore positions along the rivers and larger creeks in Richmond County will be quantified in this report. The shorelines of very irregular coasts, small creeks around inlets, and other complicated areas, will be shown but not quantified.

2 Methods

2.1 Photo Rectification and Shoreline Digitizing

An analysis of aerial photographs provides the historical data necessary to understand the suite of processes that work to alter a shoreline. Images of the Richmond County Shoreline from 1937, 1953, 1969, 1994, 2002, 2007 and 2009 were used in the analysis. The 1994, 2002, 2007 and 2009 images were available from other sources. The 1994 imagery was orthorectified by the U.S. Geological Survey (USGS) and the 2002, 2007 and 2009 imagery was orthorectified by the Virginia Base Mapping Program (VBMP). The 1937, 1953, and 1969 photos were a part of the VIMS Shoreline Studies Program archives. The historical aerial images acquired to cover the entire shoreline were not always flown on the same day. The dates for each year are: *1937* - April 1, 6,7 and 17; *1953* - October 2, 3, and November 27; *1969* - December 5 and 11. The exact dates the 1994 images were flown could not be determined, and the 2002, 2007, and 2009 were all flown in February and March of their respective years.

The 1937, 1953, and 1969 images were scanned as tiffs at 600 dpi and converted to ERDAS IMAGINE (.img) format. These aerial photographs were orthographically corrected to produce a seamless series of aerial mosaics following a set of standard operating procedures. The 1994 Digital Orthophoto Quarter Quadrangles (DOQQ) from USGS were used as the reference images. The 1994 photos are used rather than higher quality, more recent aerials because of the difficulty in finding control points that match the earliest 1937 and 1953 images.

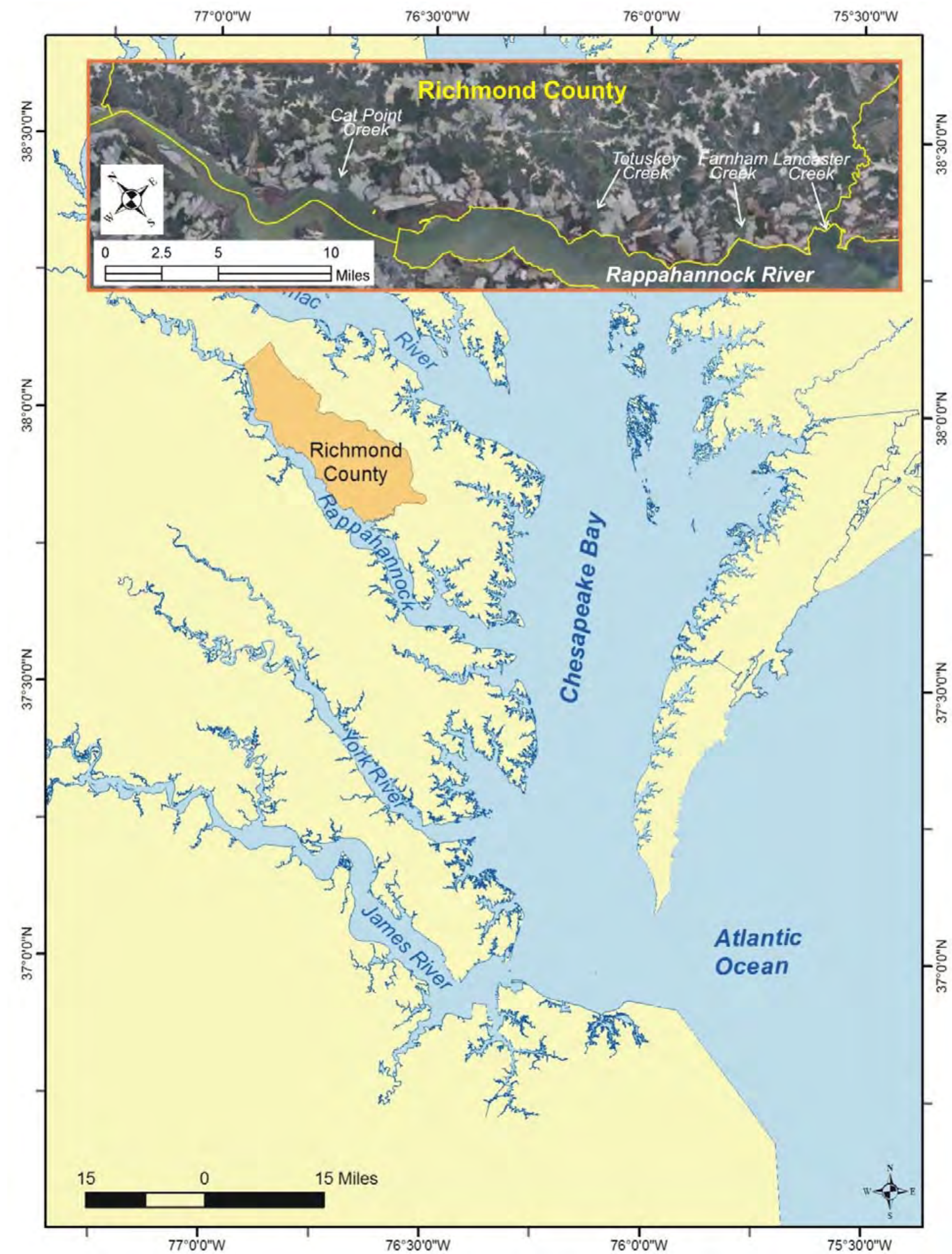


Figure 1. Location of Richmond County within the Chesapeake Bay estuarine system.

ERDAS Orthobase image processing software was used to orthographically correct the individual flight lines using a bundle block solution. Camera lens calibration data were matched to the image location of fiducial points to define the interior camera model. Control points from 1994 USGS DOQQ images provide the exterior control, which is enhanced by a large number of image-matching tie points produced automatically by the software. The exterior and interior models were combined with a digital elevation model (DEM) from the USGS National Elevation Dataset to produce an orthophoto for each aerial photograph. The orthophotographs were adjusted to approximately uniform brightness and contrast and were mosaicked together using the ERDAS Imagine mosaic tool to produce a one-meter resolution mosaic .img format. To maintain an accurate match with the reference images, it is necessary to distribute the control points evenly, when possible. This can be challenging in areas with lack of ground features, poor photo quality and lack of control points. Good examples of control points were manmade features such as road intersections and stable natural landmarks such as ponds and creeks that have not changed much over time. The base of tall features such as buildings, poles. or trees can be used, but the base can be obscured by other features or shadows making these locations difficult to use accurately. Most areas of the county were particularly difficult to rectify, either due to the lack of development when compared to the reference images or due to no development in the historical and the reference images.

Once the aerial photos were orthorectified and mosaicked, the shorelines were digitized in ArcMap with the mosaics in the background. The morphologic toe of the beach or edge of marsh was used to approximate low water. High water limit of runup can be difficult to determine on the shoreline due to narrow or non-existent beaches against upland banks or vegetated cover. In areas where the shoreline was not clearly identifiable on the aerial photography, the location was estimated based on the experience of the digitizer. The displayed shorelines are in shapefile format. One shapefile was produced for each year that was mosaicked.

Horizontal positional accuracy is based upon orthorectification of scanned aerial photography against the USGS digital orthophoto quadrangles. To get vertical control, the USGS 30m DEM data was used. The 1994 USGS reference images were developed in accordance with National Map Accuracy Standards (NMAS) for Spatial Data Accuracy at the 1:12,000 scale. The 2002, 2007, and 2009 Virginia Base Mapping Program's orthophotography were developed in accordance with the National Standard for Spatial Data Accuracy (NSSDA). Horizontal root mean square error (RMSE) for historical mosaics was held to less than 20 ft.

Using methodology reported in Morton *et al.* (2004) and National Spatial Data Infrastructure (1998), estimates of error in orthorectification, control source, DEM and digitizing were combined to provide an estimate of total maximum shoreline position error. The data sets that were orthorectified (1937, 1953, and 1969) have an estimated total maximum shoreline position error of ±20.0 ft, while the total maximum shoreline error for the four existing datasets are estimated at 18.3 ft for USGS and 10.2 ft for VBMP. The maximum annualized error for the shoreline data is ±0.7 ft/yr. The smaller rivers and creeks are more prone to error due to their lack of good control points for photo rectification, narrower shore features, tree and ground cover and overall smaller rates of change. These areas are digitized but due to the higher potential for error, rates of change analyses are not calculated.

The Richmond County shoreline was divided into 21 plates (Figure 2) in order to display that data in Appendices A and B. In Appendix A, all of the digtized shorelines are shown, and the 2009 image is shown with only the 1937 and 2009 shorelines to show the long-term trends. In Appendix B, two photo dates and their associated shoreline are shown on each plate.

2.2 Rate of Change Analysis

The Digital Shoreline Analysis System (DSAS) was used to determine the rate of change for the County's shoreline (Himmelstoss, 2009). All DSAS input data must be managed within a personal geodatabase, which includes all the baselines created for Richmond County and the digitized shorelines for 1937, 1953, 1969, 1994, 2002, 2007, and 2009. Baselines were created about 200 feet seaward of the 1937 shoreline and encompassed most of the County's main shorelines but generally did not include the smaller creeks. It also did not include areas that have unique shoreline morphology such as creek mouths and spits. DSAS generated transects perpendicular to the baseline about 33 ft apart , which were manually checked and cleaned up. For Richmond County, this method represented about 43 miles of shoreline along 6937 transects. The End Point Rate (EPR) is calculated by determining the distance between the oldest and most recent shoreline in the data and dividing it by the number of years between them. This method provides an accurate net rate of change over the long term and is relatively easy to apply to most shorelines since it only requires two dates. This method does not use the intervening shorelines so it may not account for changes in accretion or erosion rates that may occur through time. However, Milligan *et al.* (2010a, 2010b, 2010c, 2010d) found that in several localities within the bay, EPR is a reliable indicator of shore change even when intermediate dates exist. Average rates were calculated along selected areas of the shore; segments are labeled in Appendix A and shown in Table 1.

3 Summary

The rates of change shown in Table 1 are averaged across large sections of shoreline and may not be indicative of rates at specific sites within the reach. Along many segments, rate of change is very low. Most change occurs at headlands, marshes or southwest or southeast-facing shorelines. The largest average rates occur on the Rappahannock River while the more fetch limited creeks have smaller average erosion rates. Segment L has the highest rate of change due to the loss of land at Waverly Point at the mouthof Totusky Creek and the barrier across Richardson Creek.

Table 1. Average end point rate of change (ft/yr) between 1937 and 2009 for segments along Richmond's shoreline. Segment locations are shown on maps in Appendix A.

Segment Name	Location	Average Rate of Change (ft/yr)
A	Rappahannock River	-0.4
B	Rappahannock River	-0.7
C	Rappahannock River - Mulberry Island	-0.6
D	Rappahannock River	-0.5
E	Cat Point Creek	-0.6
F	Rappahannock River	-0.5
G	Rappahannock River	-2.1
H	Rappahannock River	-1.5
I	Rappahannock River	-0.7
J	Rappahannock River	-0.8
K	Totuskey Creek	-0.5
L	Rappahannock River - Richardson Creek	-3.1
M	Rappahannock River	-0.4
N	Rappahannock River	-0.4
O	Farnham Creek	-0.4
P	Rappahannock River	-1.0
Q	Lancaster Creek	-0.8
R	Morattico Creek	-0.4

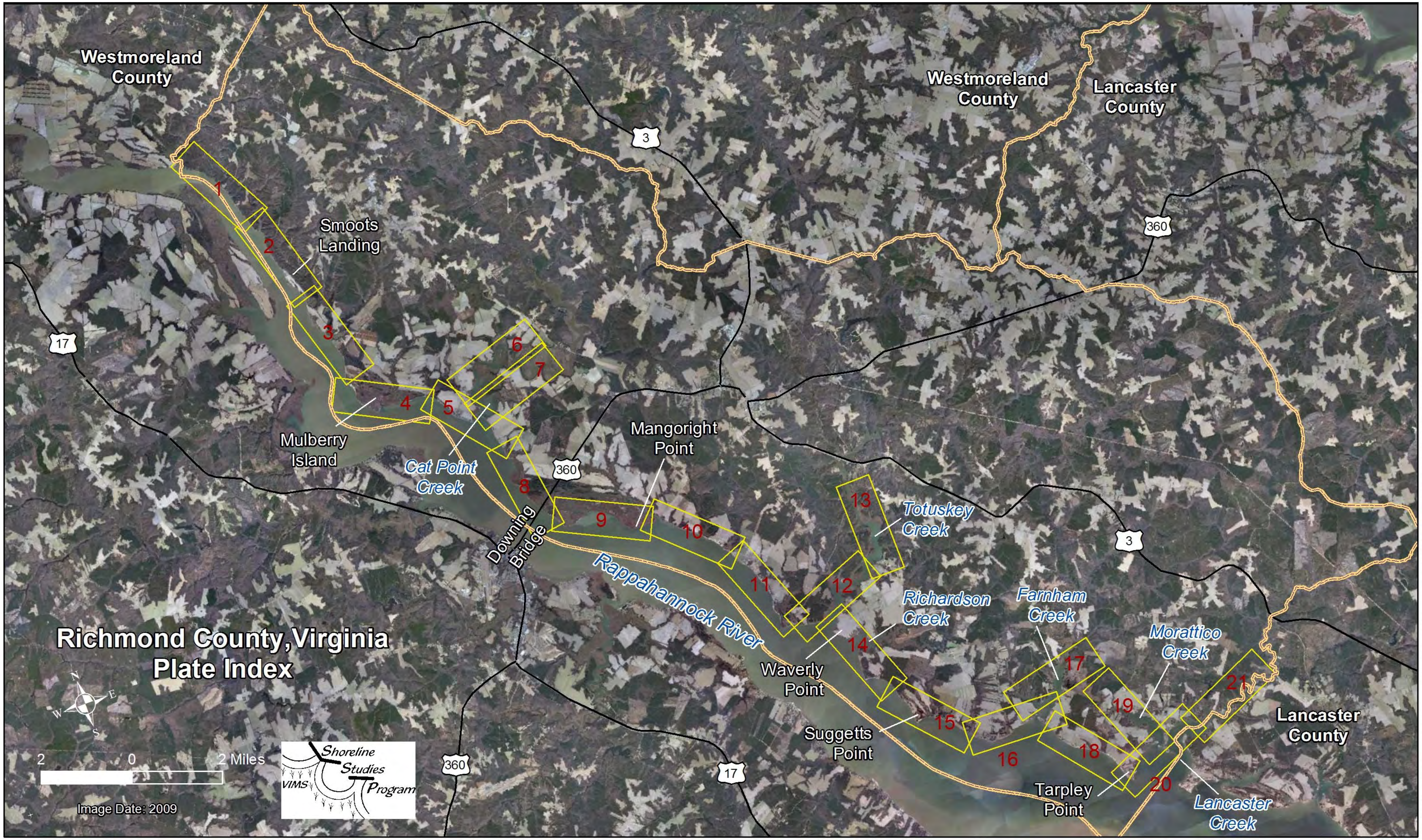


Figure 2. Index of shoreline plates.

4 References

Himmelstoss, E.A., 2009. "DSAS 4.0 Installation Instructions and User Guide" in: Thieler, E.R., Himmelstoss, E.A., Zichichi, J.L., and Ergul, Ayhan. 2009 Digital Shoreline Analysis System (DSAS) version 4.0 — An ArcGIS extension for calculating shoreline change: U.S. Geological Survey Open-File Report 2008-1278.

Milligan, D. A., K.P. O'Brien, C. Wilcox, C. S. Hardaway, JR, 2010a. Shoreline Evolution: City of Newport News, Virginia James River and Hampton Roads Shorelines**.** Virginia Institute of Marine Science. College of William & Mary, Gloucester Point, VA. http://web.vims.edu/physical/research/shoreline/docs/dune_evolution/NewportNews/1NewportNews_Shore_Evolve.pdf

Milligan, D. A., K.P. O'Brien, C. Wilcox, C. S. Hardaway, JR, 2010b. Shoreline Evolution: City of Poquoson, Virginia, Poquoson River, Chesapeake Bay, and Back River Shorelines. Virginia Institute of Marine Science. College of William & Mary, Gloucester Point, VA. http://web.vims.edu/physical/research/shoreline/docs/dune_evolution/Poquoson/1Poquoson_Shore_Evolve.pdf

Milligan, D. A., K.P. O'Brien, C. Wilcox, C. S. Hardaway, JR, 2010c. Gloucester County, Virginia York River, Mobjack Bay, and Piankatank River Shorelines. Virginia Institute of Marine Science. College of William & Mary, Gloucester Point, VA. http://web.vims.edu/physical/research/shoreline/docs/dune_evolution/Gloucester/1Gloucester_Shore_Evolve.pdf

Milligan, D. A., K.P. O'Brien, C. Wilcox, C. S. Hardaway, JR, 2010d. Shoreline Evolution: York County, Virginia York River, Chesapeake Bay and Poquoson River Shorelines. Virginia Institute of Marine Science. College of William & Mary, Gloucester Point, VA. http://web.vims.edu/physical/research/shoreline/docs/dune_evolution/York/1York_Shore_Evolve.pdf

Morton, R.A., T.L. Miller, and L.J. Moore, 2004. National Assessment of Shoreline Change: Part 1 Historical Shoreline Change and Associated Coastal Land Loss along the U.S. Gulf of Mexico. U.S. Department of the Interior, U.S. Geological Survey Open-File Report 2004-1043, 45 p.

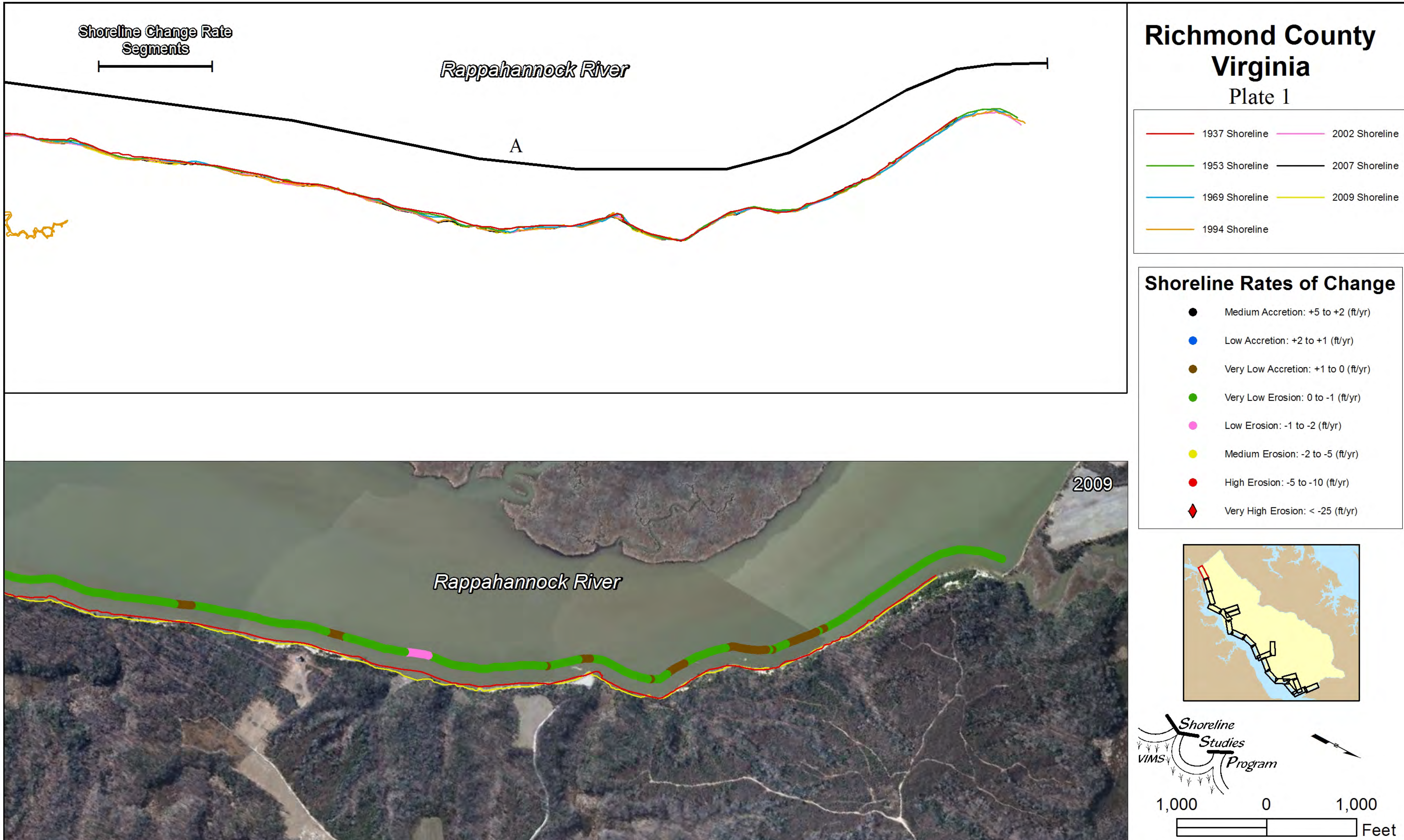
National Spatial Data Infrastructure, 1998. Geospatial Positional Accuracy Standards, Part 3: National Standard for Spatial Data Accuracy. Subcommittee for Base Cartographic Data. Federal Geographic Data Committee. Reston, VA.

Appendix A

End Point Rate of Shoreline Change Maps

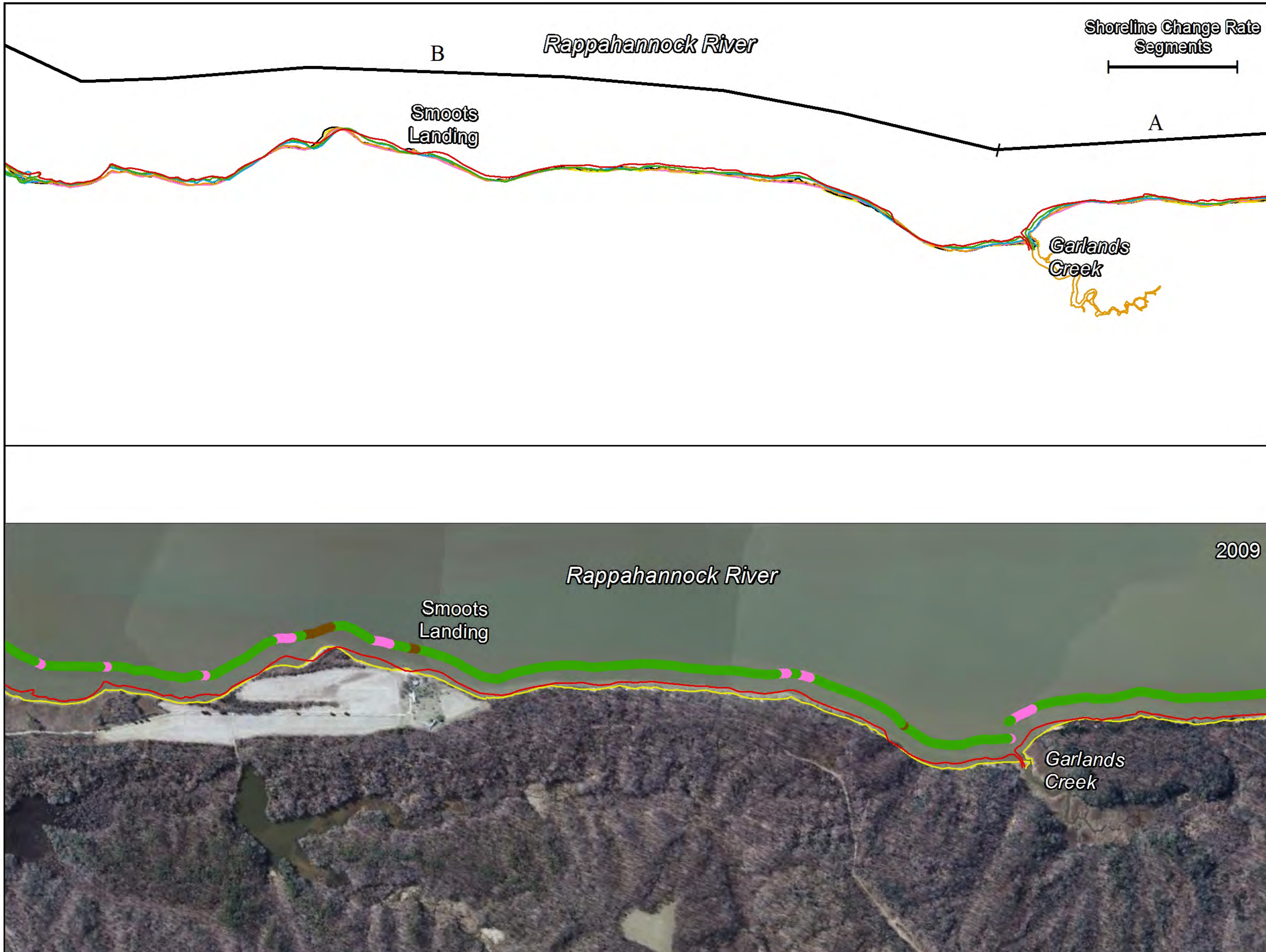
Shoreline change rate segments are shown on the top map. The calculated rates of change for each transect within the segment were averaged to determine an average rate of change as shown in Table 1 of the report.

Note: The location labels on the plates come from U.S. Geological Survey topographic maps, Google Earth, and other map sources and may not be accurate for the historical or even more recent images. They are for reference only.


Richmond County
Virginia
Plate 1
Shoreline Change Rate Segments
Rappahannock River
A
1937 Shoreline
2002 Shoreline
1953 Shoreline
2007 Shoreline
1969 Shoreline
2009 Shoreline
1994 Shoreline
Shoreline Rates of Change
Medium Accretion: +5 to +2 (ft/yr)
Low Accretion: +2 to +1 (ft/yr)
Very Low Accretion: +1 to 0 (ft/yr)
Very Low Erosion: 0 to -1 (ft/yr)
Low Erosion: -1 to -2 (ft/yr)
Medium Erosion: -2 to -5 (ft/yr)
High Erosion: -5 to -10 (ft/yr)
Very High Erosion: < -25 (ft/yr)
2009
Rappahannock River
Shoreline Studies Program
VIMS
1,000 0 1,000
Feet

Richmond County Virginia

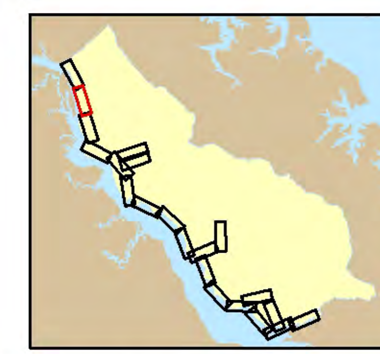
Plate 2



- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline

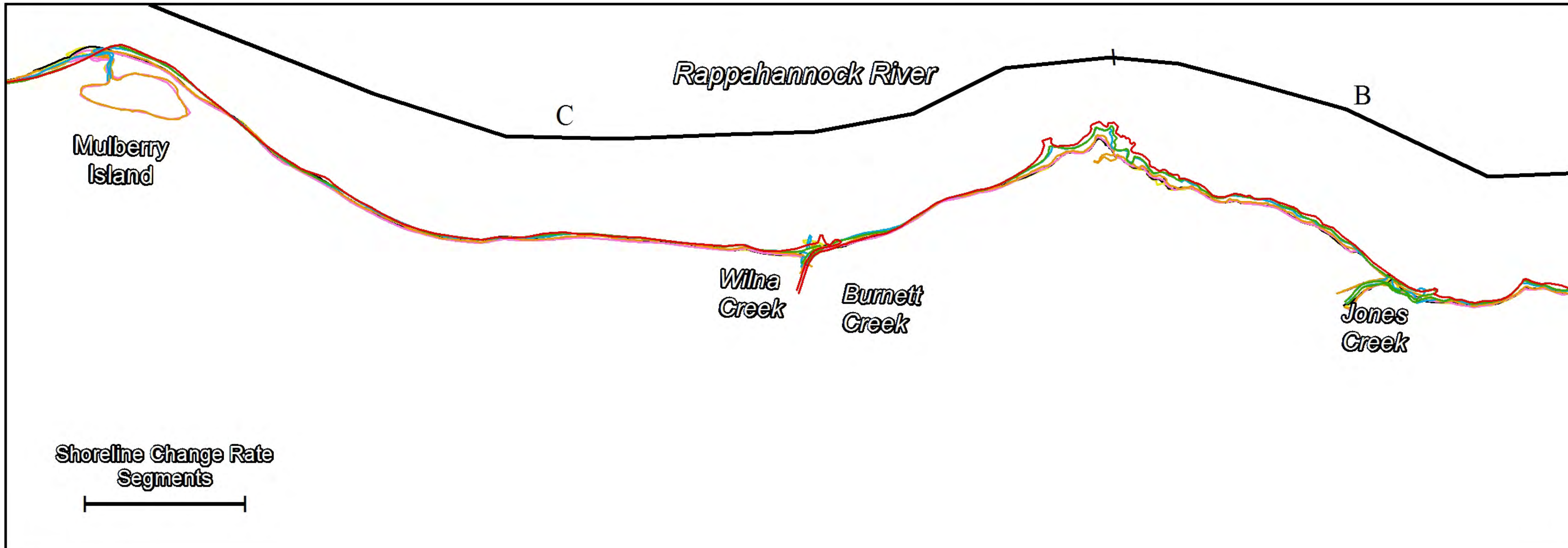
Shoreline Rates of Change

- Medium Accretion: +5 to +2 (ft/yr)
- Low Accretion: +2 to +1 (ft/yr)
- Very Low Accretion: +1 to 0 (ft/yr)
- Very Low Erosion: 0 to -1 (ft/yr)
- Low Erosion: -1 to -2 (ft/yr)
- Medium Erosion: -2 to -5 (ft/yr)
- High Erosion: -5 to -10 (ft/yr)
- Very High Erosion: < -25 (ft/yr)



Shoreline Studies Program VIMS

1,000 0 1,000 Feet



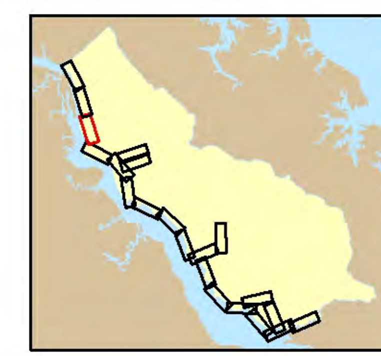
Richmond County Virginia

Plate 3

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline

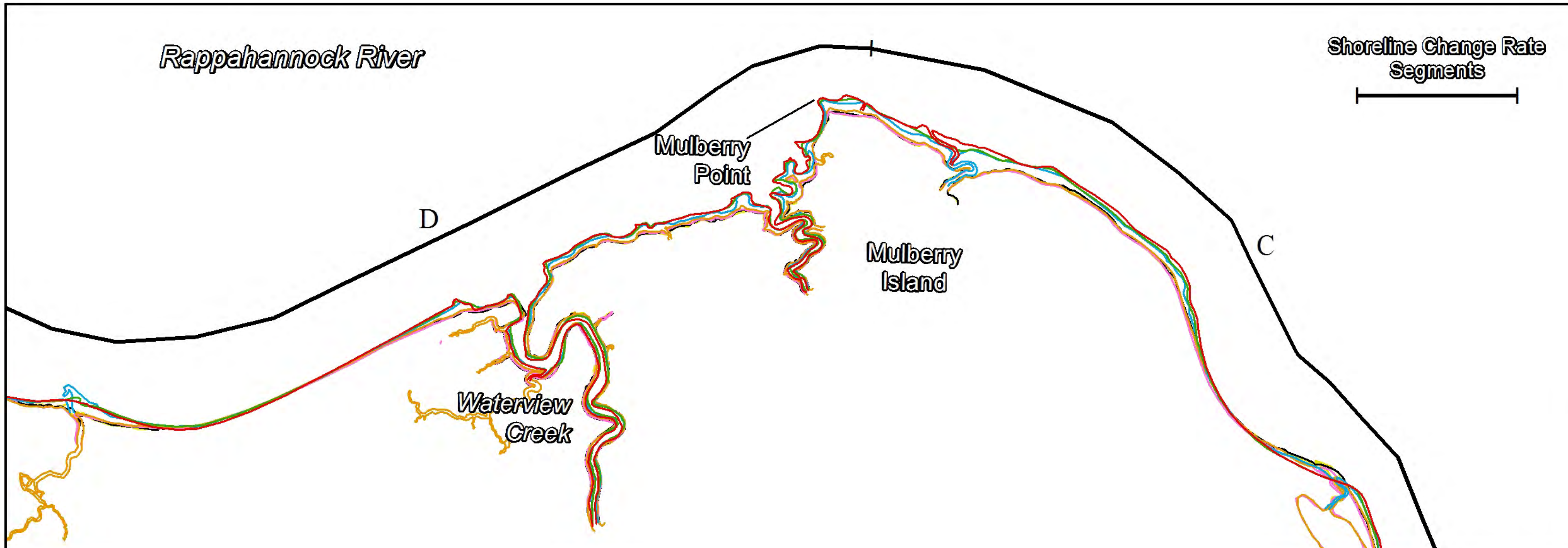
Shoreline Rates of Change

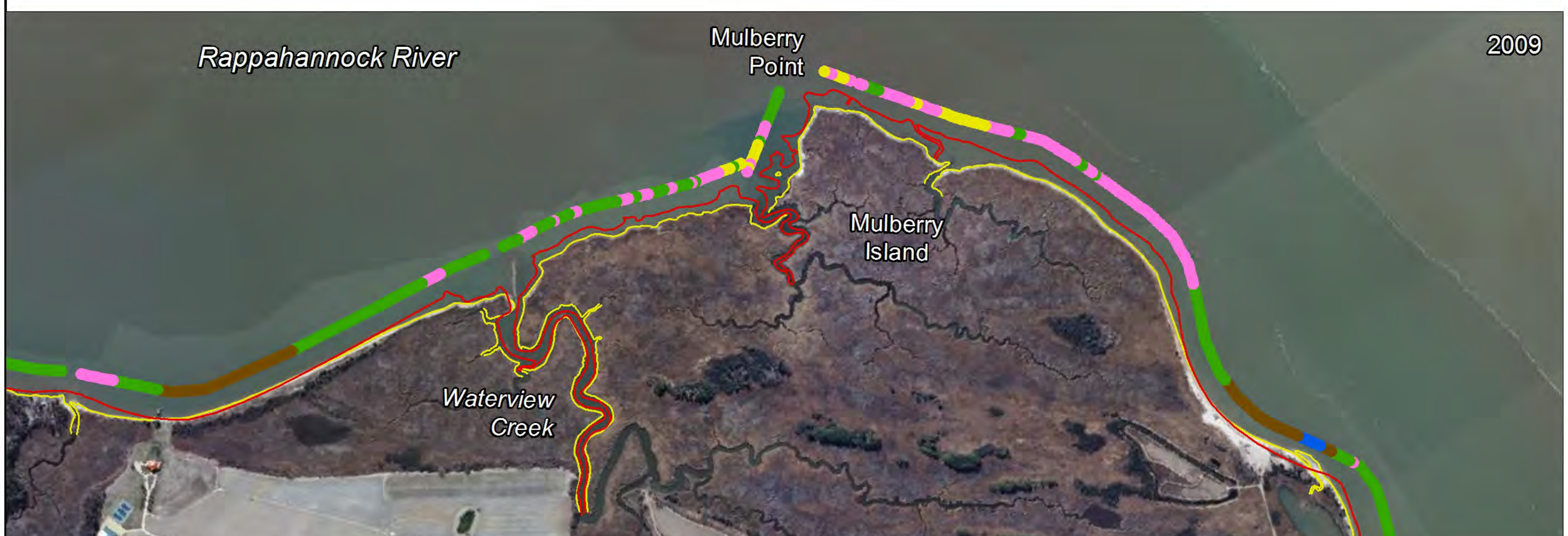
- Medium Accretion: +5 to +2 (ft/yr)
- Low Accretion: +2 to +1 (ft/yr)
- Very Low Accretion: +1 to 0 (ft/yr)
- Very Low Erosion: 0 to -1 (ft/yr)
- Low Erosion: -1 to -2 (ft/yr)
- Medium Erosion: -2 to -5 (ft/yr)
- High Erosion: -5 to -10 (ft/yr)
- Very High Erosion: < -25 (ft/yr)



Shoreline Studies Program
VIMS

1,000 0 1,000
Feet





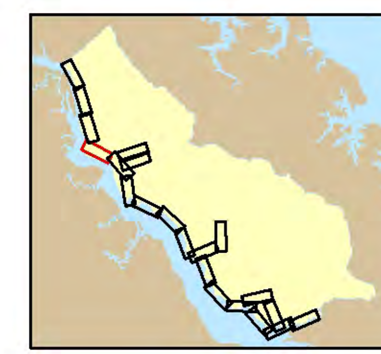
Richmond County Virginia

Plate 4

1937 Shoreline	2002 Shoreline
1953 Shoreline	2007 Shoreline
1969 Shoreline	2009 Shoreline
1994 Shoreline	

Shoreline Rates of Change

- Medium Accretion: +5 to +2 (ft/yr)
- Low Accretion: +2 to +1 (ft/yr)
- Very Low Accretion: +1 to 0 (ft/yr)
- Very Low Erosion: 0 to -1 (ft/yr)
- Low Erosion: -1 to -2 (ft/yr)
- Medium Erosion: -2 to -5 (ft/yr)
- High Erosion: -5 to -10 (ft/yr)
- Very High Erosion: < -25 (ft/yr)

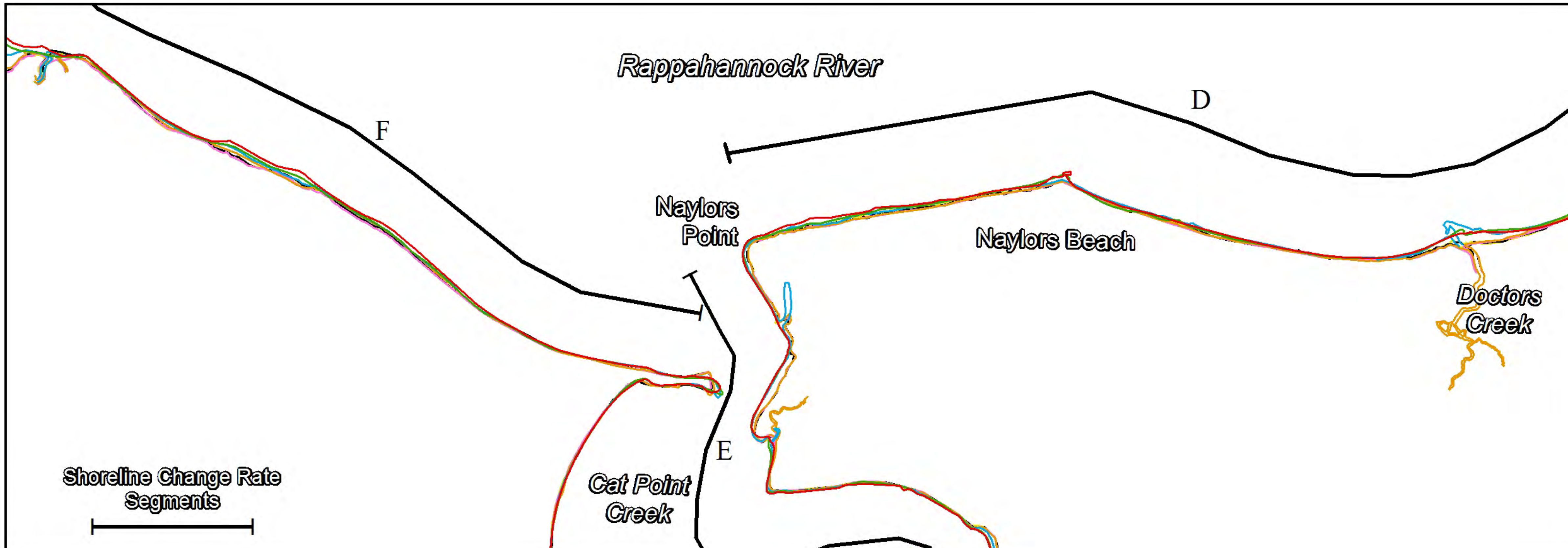


VIMS Shoreline Studies Program

1,000 0 1,000 Feet

Richmond County Virginia

Plate 5



1937 Shoreline
2002 Shoreline
1953 Shoreline
2007 Shoreline
1969 Shoreline
2009 Shoreline
1994 Shoreline

Shoreline Rates of Change

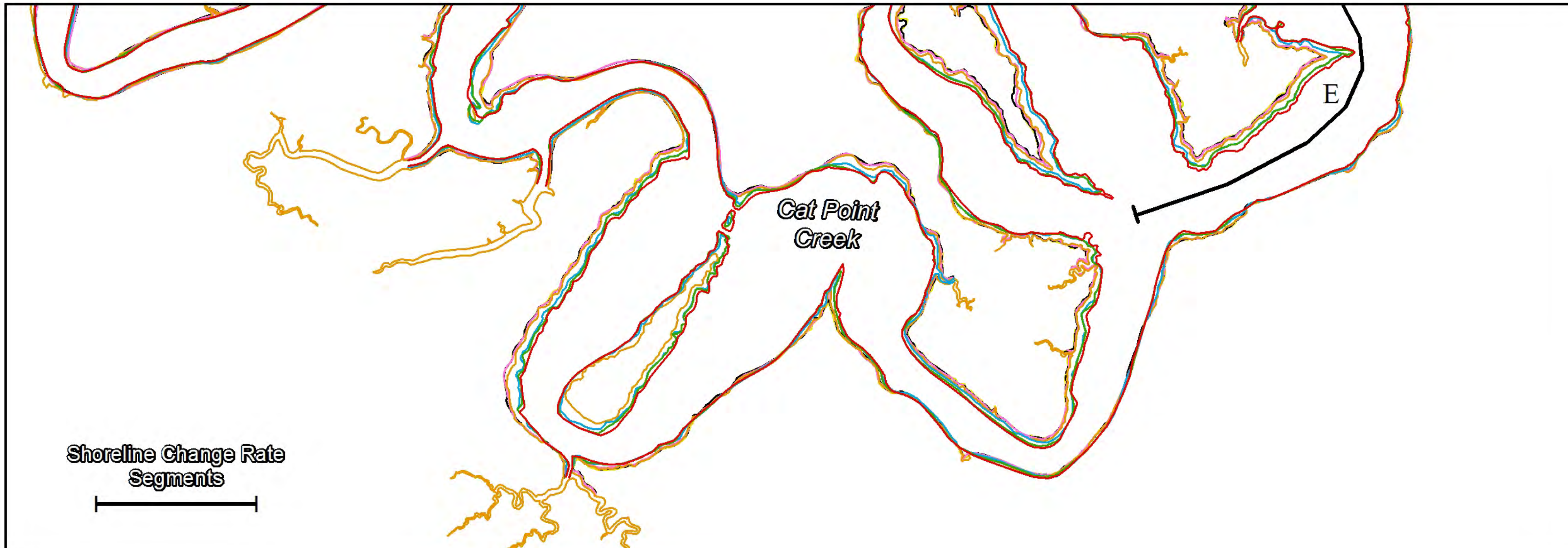
- Medium Accretion: +5 to +2 (ft/yr)
- Low Accretion: +2 to +1 (ft/yr)
- Very Low Accretion: +1 to 0 (ft/yr)
- Very Low Erosion: 0 to -1 (ft/yr)
- Low Erosion: -1 to -2 (ft/yr)
- Medium Erosion: -2 to -5 (ft/yr)
- High Erosion: -5 to -10 (ft/yr)
- Very High Erosion: < -25 (ft/yr)

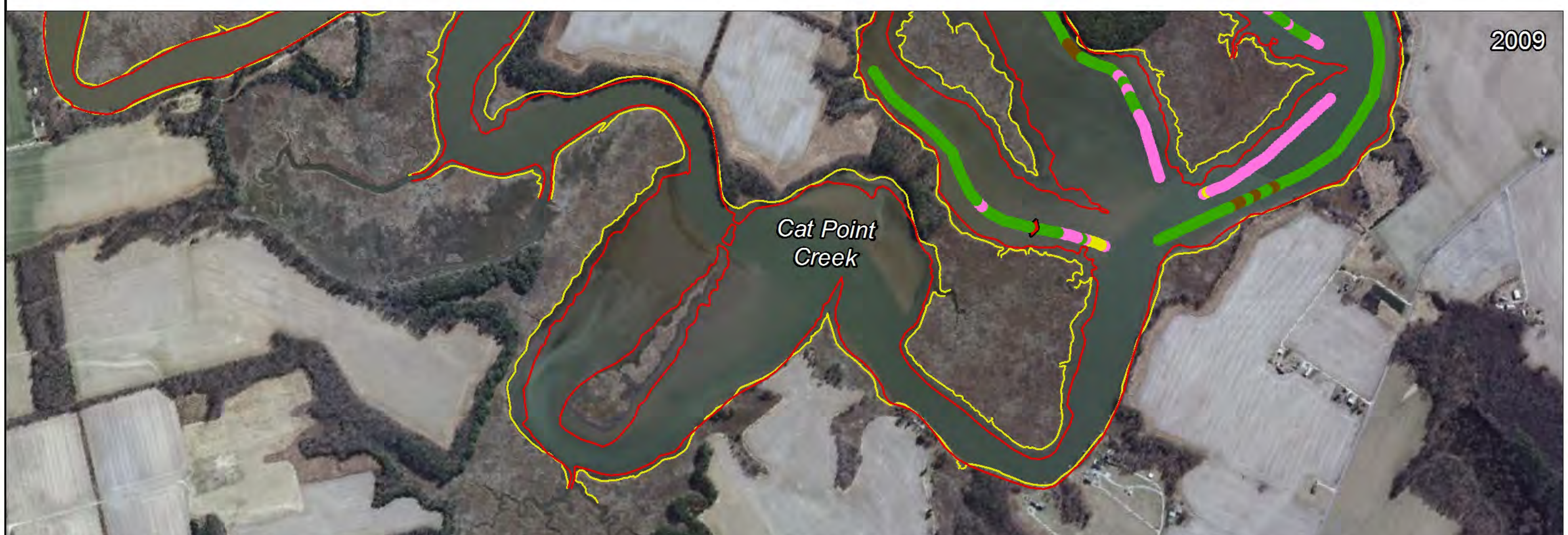
Shoreline Studies Program VIMS

1,000 0 1,000 Feet

Richmond County Virginia

Plate 6





1937 Shoreline
1953 Shoreline
1969 Shoreline
1994 Shoreline
2002 Shoreline
2007 Shoreline
2009 Shoreline

Shoreline Rates of Change

- Medium Accretion: +5 to +2 (ft/yr)
- Low Accretion: +2 to +1 (ft/yr)
- Very Low Accretion: +1 to 0 (ft/yr)
- Very Low Erosion: 0 to -1 (ft/yr)
- Low Erosion: -1 to -2 (ft/yr)
- Medium Erosion: -2 to -5 (ft/yr)
- High Erosion: -5 to -10 (ft/yr)
- Very High Erosion: < -25 (ft/yr)

Shoreline Studies Program VIMS

1,000 0 1,000 Feet

Richmond County Virginia

Plate 7

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline

Shoreline Rates of Change

- Medium Accretion: +5 to +2 (ft/yr)
- Low Accretion: +2 to +1 (ft/yr)
- Very Low Accretion: +1 to 0 (ft/yr)
- Very Low Erosion: 0 to -1 (ft/yr)
- Low Erosion: -1 to -2 (ft/yr)
- Medium Erosion: -2 to -5 (ft/yr)
- High Erosion: -5 to -10 (ft/yr)
- Very High Erosion: < -25 (ft/yr)

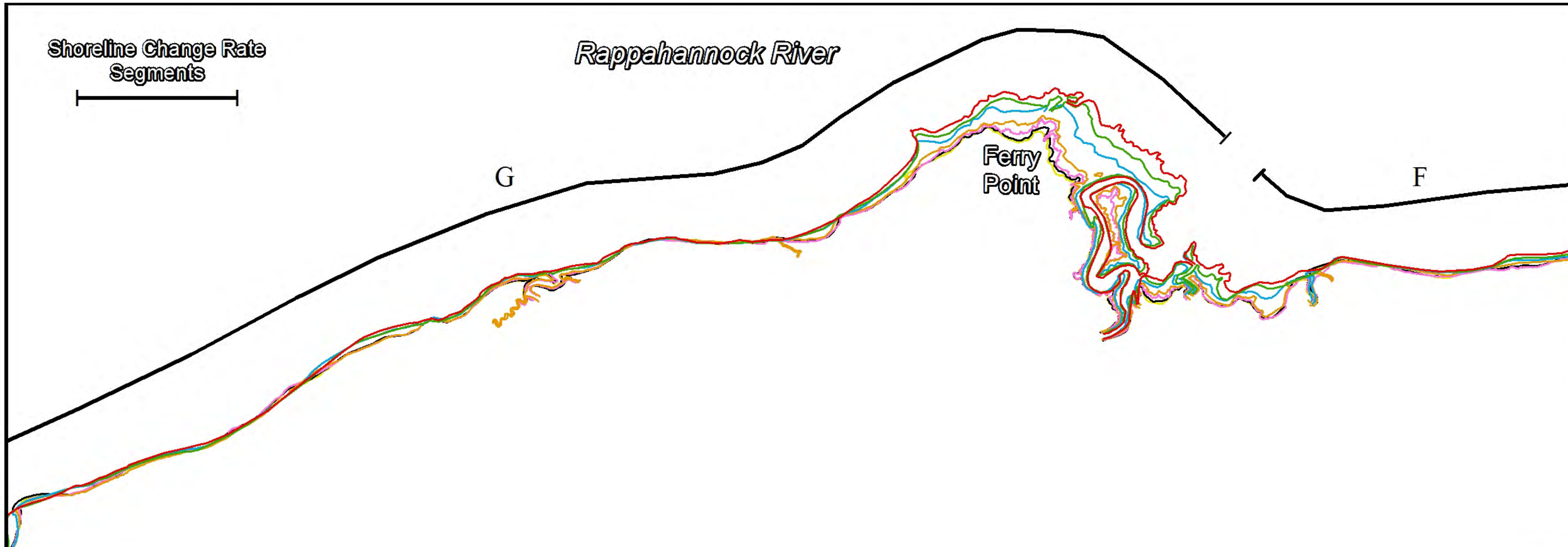
VIMS Shoreline Studies Program

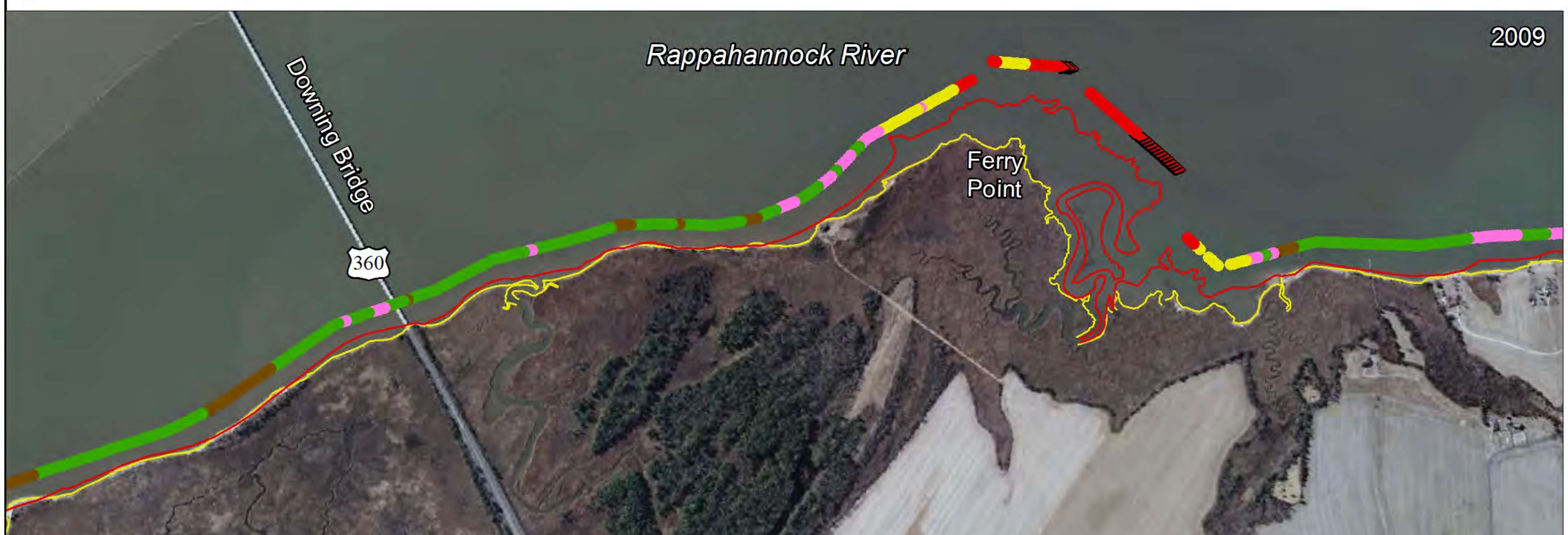
1,000 0 1,000

Feet

Richmond County Virginia

Plate 8





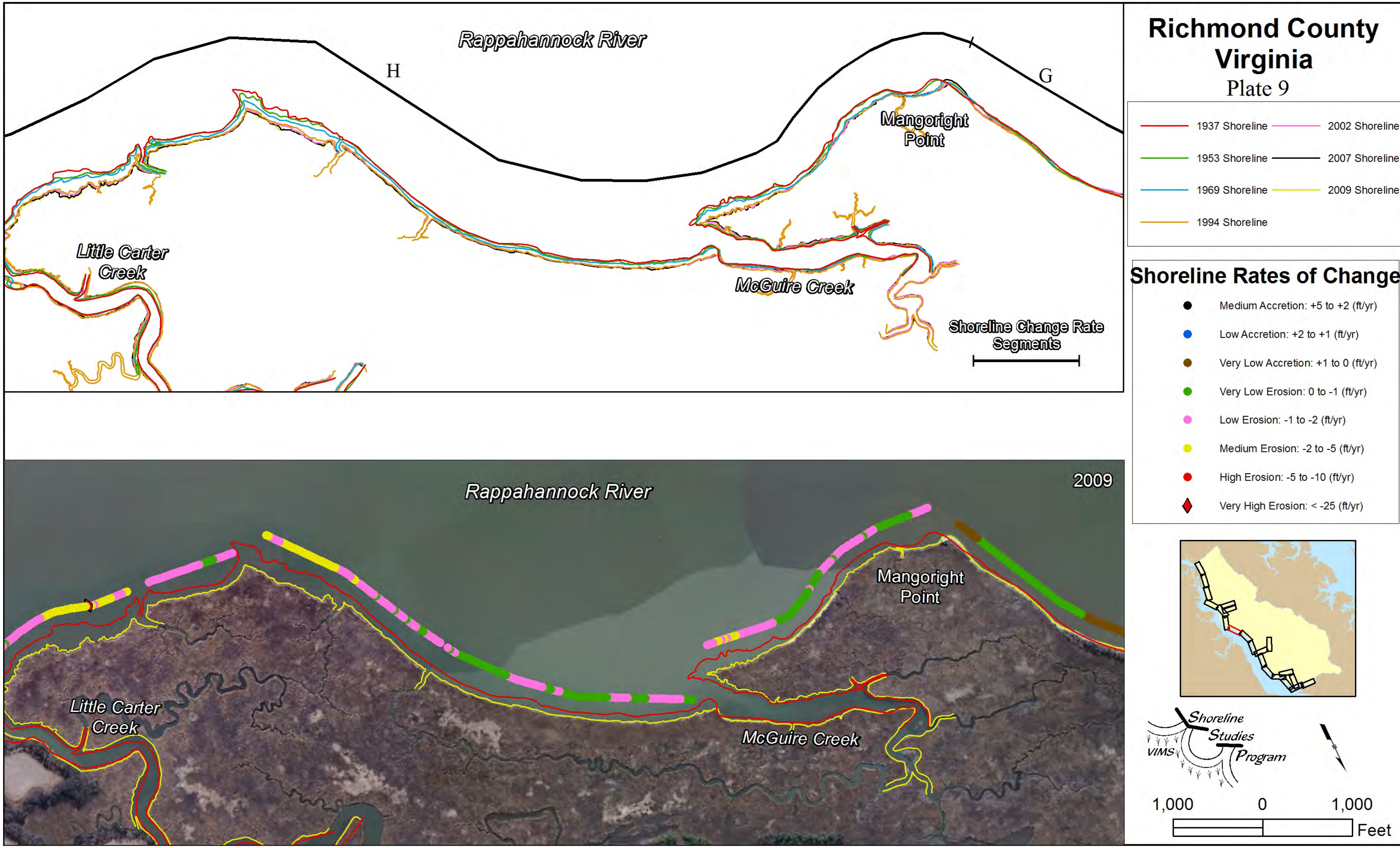
1937 Shoreline	2002 Shoreline
1953 Shoreline	2007 Shoreline
1969 Shoreline	2009 Shoreline
1994 Shoreline	

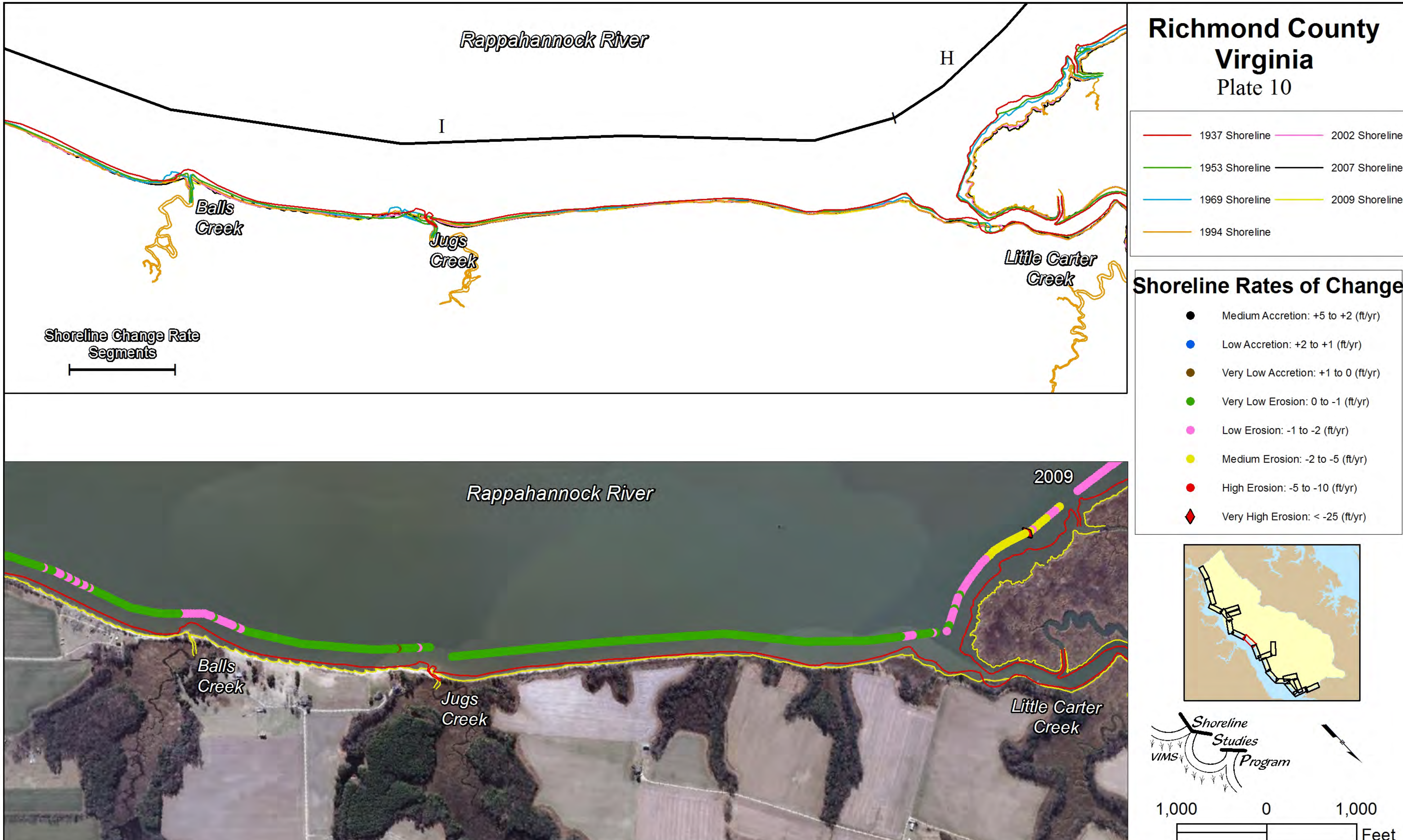
Shoreline Rates of Change

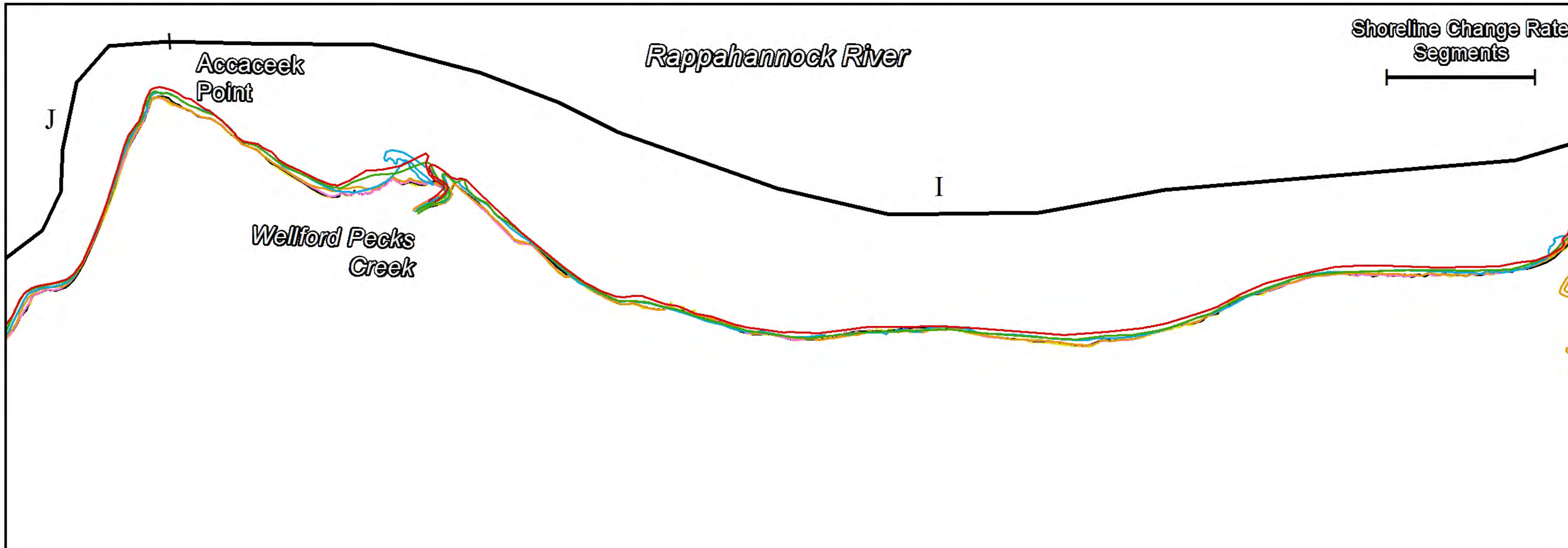
- Medium Accretion: +5 to +2 (ft/yr)
- Low Accretion: +2 to +1 (ft/yr)
- Very Low Accretion: +1 to 0 (ft/yr)
- Very Low Erosion: 0 to -1 (ft/yr)
- Low Erosion: -1 to -2 (ft/yr)
- Medium Erosion: -2 to -5 (ft/yr)
- High Erosion: -5 to -10 (ft/yr)
- Very High Erosion: < -25 (ft/yr)

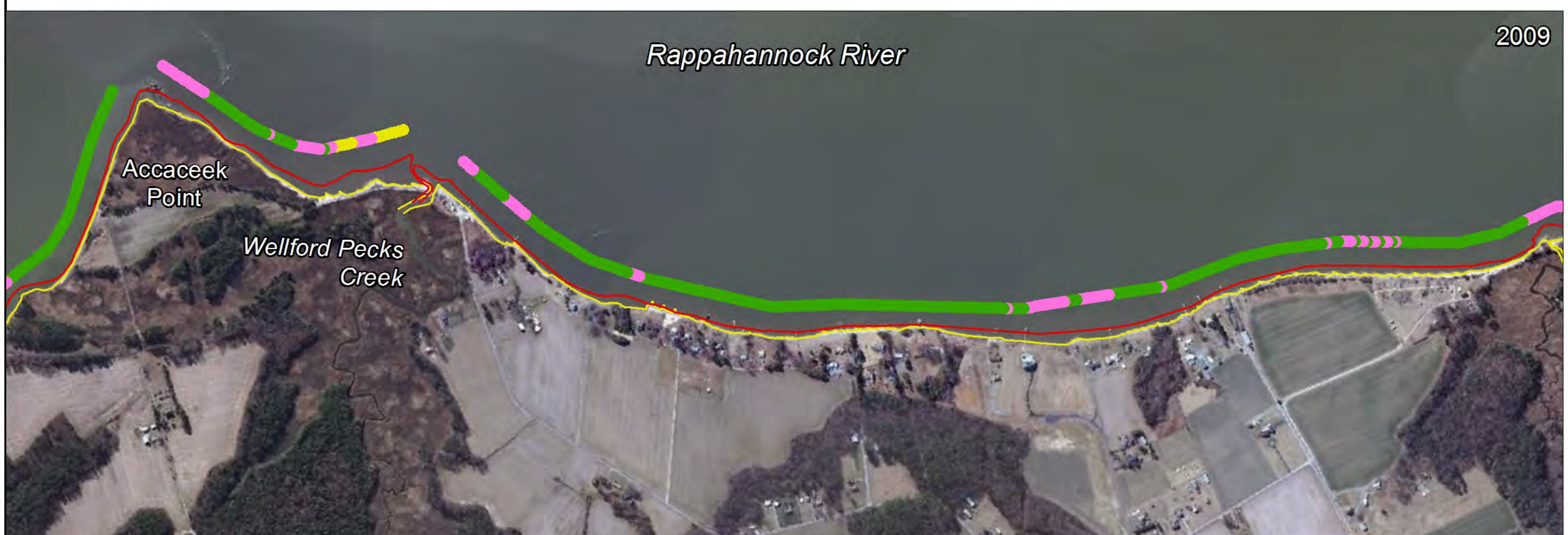
Shoreline Studies Program
VIMS

1,000 0 1,000
Feet


Richmond County
Virginia
Plate 9
1937 Shoreline
1953 Shoreline
1969 Shoreline
1994 Shoreline
2002 Shoreline
2007 Shoreline
2009 Shoreline
Shoreline Rates of Change
Medium Accretion: +5 to +2 (ft/yr)
Low Accretion: +2 to +1 (ft/yr)
Very Low Accretion: +1 to 0 (ft/yr)
Very Low Erosion: 0 to -1 (ft/yr)
Low Erosion: -1 to -2 (ft/yr)
Medium Erosion: -2 to -5 (ft/yr)
High Erosion: -5 to -10 (ft/yr)
Very High Erosion: < -25 (ft/yr)
Rappahannock River
H
G
Mangoright Point
Little Carter Creek
McGuire Creek
Shoreline Change Rate Segments
2009
Shoreline Studies Program
VIMS
1,000
0
1,000
Feet


Richmond County
Virginia
Plate 10
Rappahannock River
H
I
Balls Creek
Jugs Creek
Little Carter Creek
Shoreline Change Rate Segments
1937 Shoreline
1953 Shoreline
1969 Shoreline
1994 Shoreline
2002 Shoreline
2007 Shoreline
2009 Shoreline
Shoreline Rates of Change
Medium Accretion: +5 to +2 (ft/yr)
Low Accretion: +2 to +1 (ft/yr)
Very Low Accretion: +1 to 0 (ft/yr)
Very Low Erosion: 0 to -1 (ft/yr)
Low Erosion: -1 to -2 (ft/yr)
Medium Erosion: -2 to -5 (ft/yr)
High Erosion: -5 to -10 (ft/yr)
Very High Erosion: < -25 (ft/yr)
2009
Rappahannock River
Balls Creek
Jugs Creek
Little Carter Creek
Shoreline Studies Program
VIMS
1,000 0 1,000
Feet





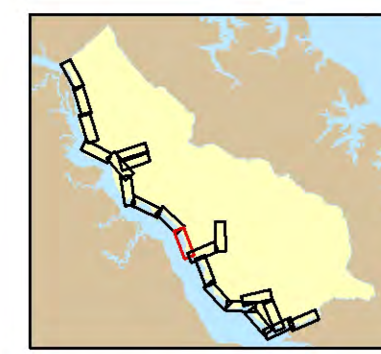
Richmond County Virginia

Plate 11

1937 Shoreline	2002 Shoreline
1953 Shoreline	2007 Shoreline
1969 Shoreline	2009 Shoreline
1994 Shoreline	

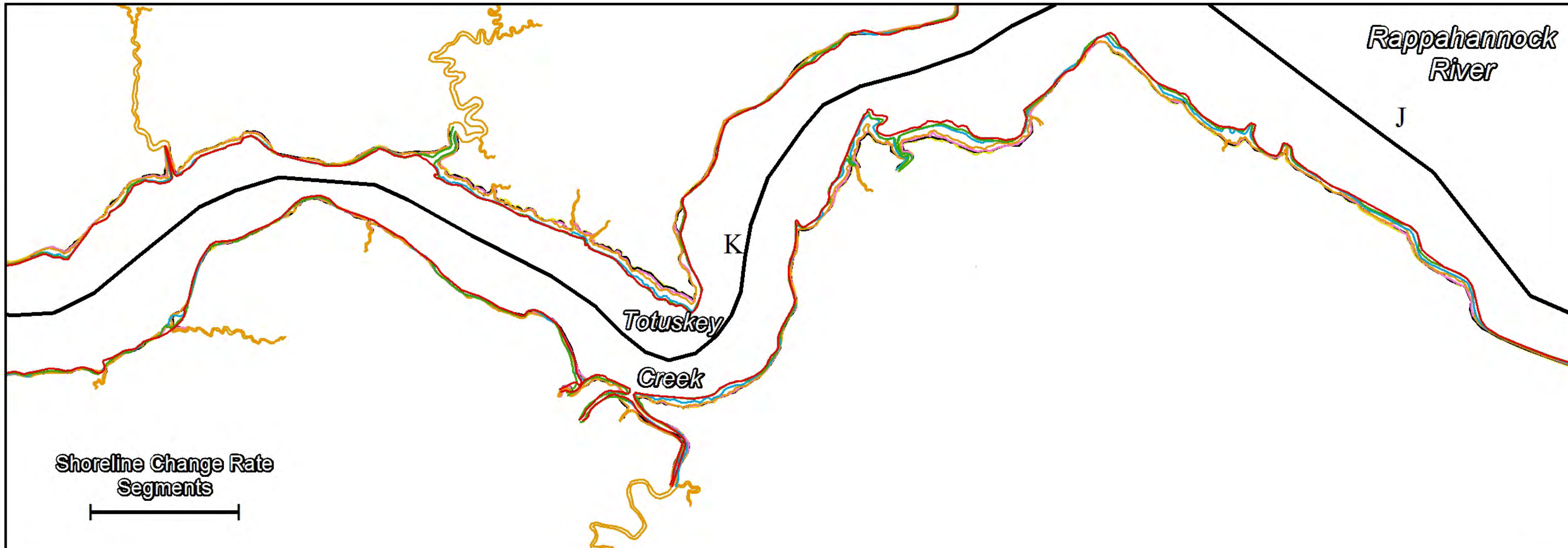
Shoreline Rates of Change

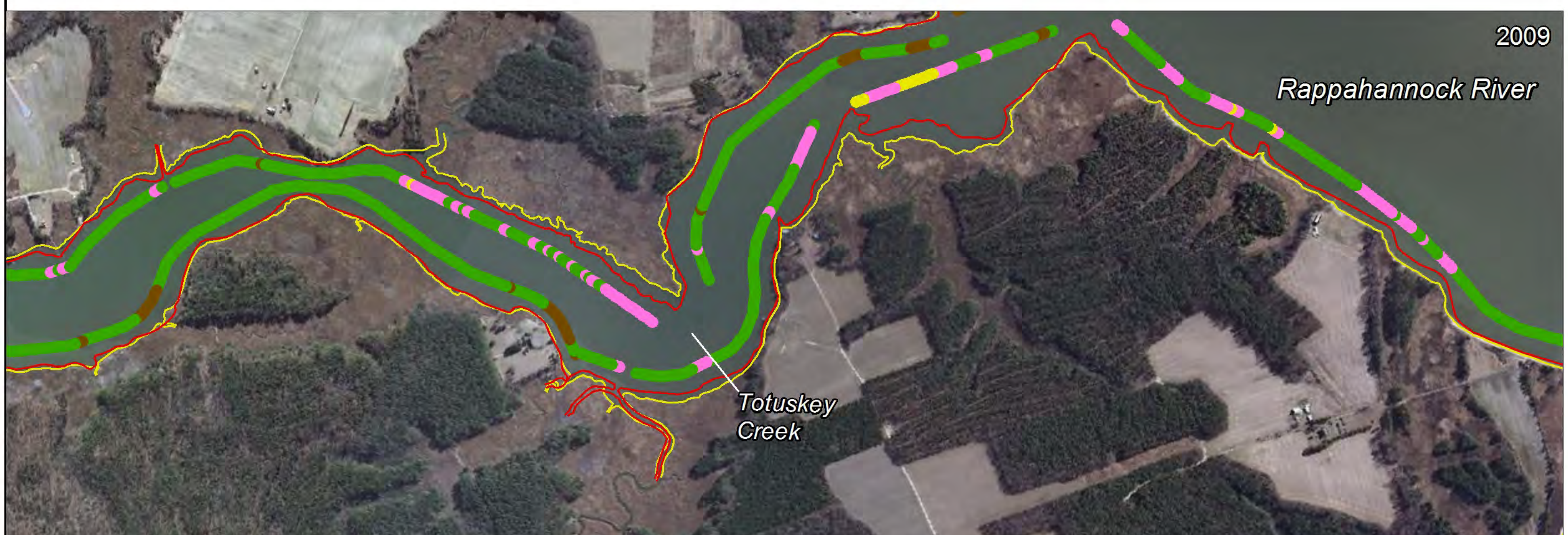
- Medium Accretion: +5 to +2 (ft/yr)
- Low Accretion: +2 to +1 (ft/yr)
- Very Low Accretion: +1 to 0 (ft/yr)
- Very Low Erosion: 0 to -1 (ft/yr)
- Low Erosion: -1 to -2 (ft/yr)
- Medium Erosion: -2 to -5 (ft/yr)
- High Erosion: -5 to -10 (ft/yr)
- Very High Erosion: < -25 (ft/yr)



Shoreline Studies Program
VIMS

1,000 0 1,000
Feet





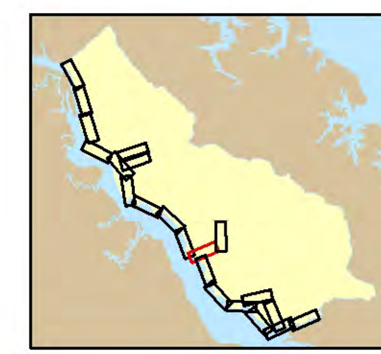
Richmond County Virginia

Plate 12

1937 Shoreline	2002 Shoreline
1953 Shoreline	2007 Shoreline
1969 Shoreline	2009 Shoreline
1994 Shoreline	

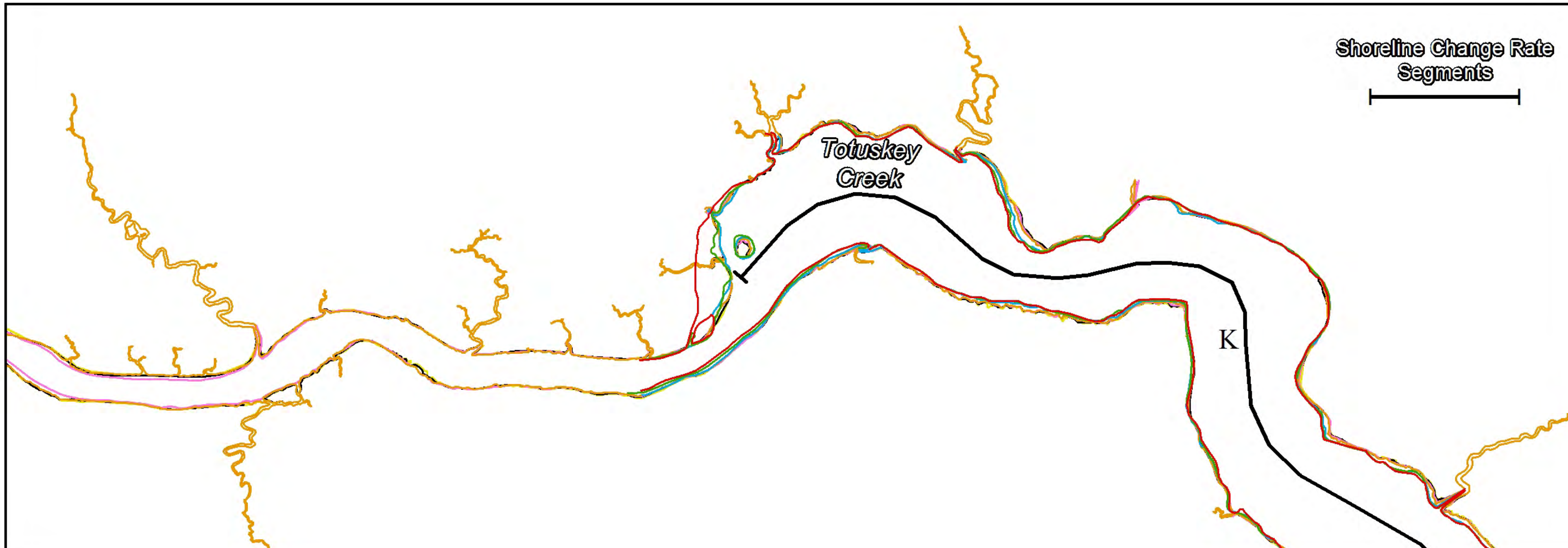
Shoreline Rates of Change

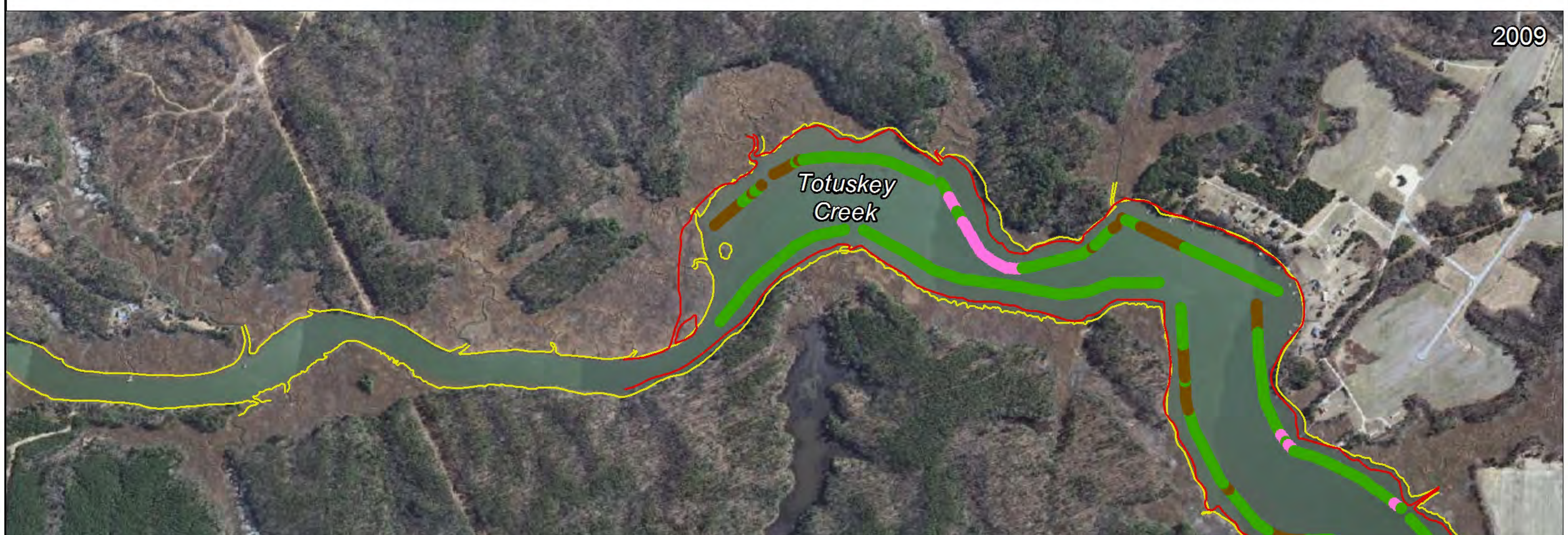
- Medium Accretion: +5 to +2 (ft/yr)
- Low Accretion: +2 to +1 (ft/yr)
- Very Low Accretion: +1 to 0 (ft/yr)
- Very Low Erosion: 0 to -1 (ft/yr)
- Low Erosion: -1 to -2 (ft/yr)
- Medium Erosion: -2 to -5 (ft/yr)
- High Erosion: -5 to -10 (ft/yr)
- Very High Erosion: < -25 (ft/yr)



Shoreline Studies Program VIMS

1,000 0 1,000 Feet





Richmond County Virginia

Plate 13

1937 Shoreline	2002 Shoreline
1953 Shoreline	2007 Shoreline
1969 Shoreline	2009 Shoreline
1994 Shoreline	

Shoreline Rates of Change

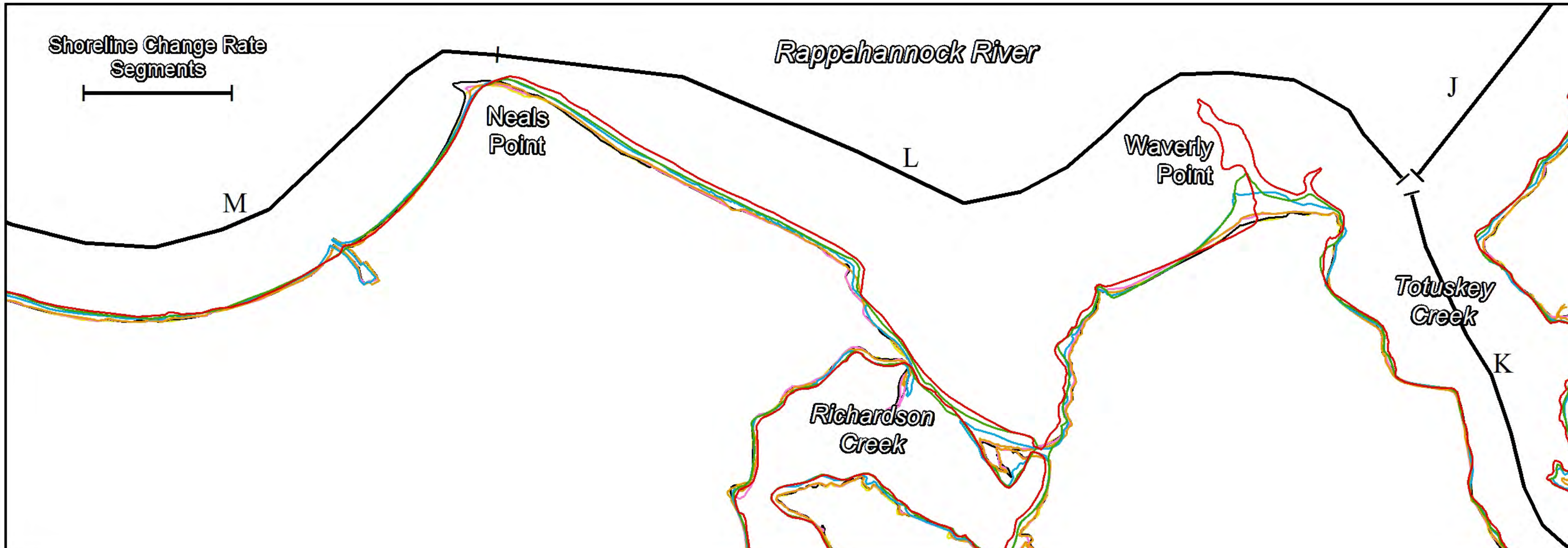
- Medium Accretion: +5 to +2 (ft/yr)
- Low Accretion: +2 to +1 (ft/yr)
- Very Low Accretion: +1 to 0 (ft/yr)
- Very Low Erosion: 0 to -1 (ft/yr)
- Low Erosion: -1 to -2 (ft/yr)
- Medium Erosion: -2 to -5 (ft/yr)
- High Erosion: -5 to -10 (ft/yr)
- Very High Erosion: < -25 (ft/yr)

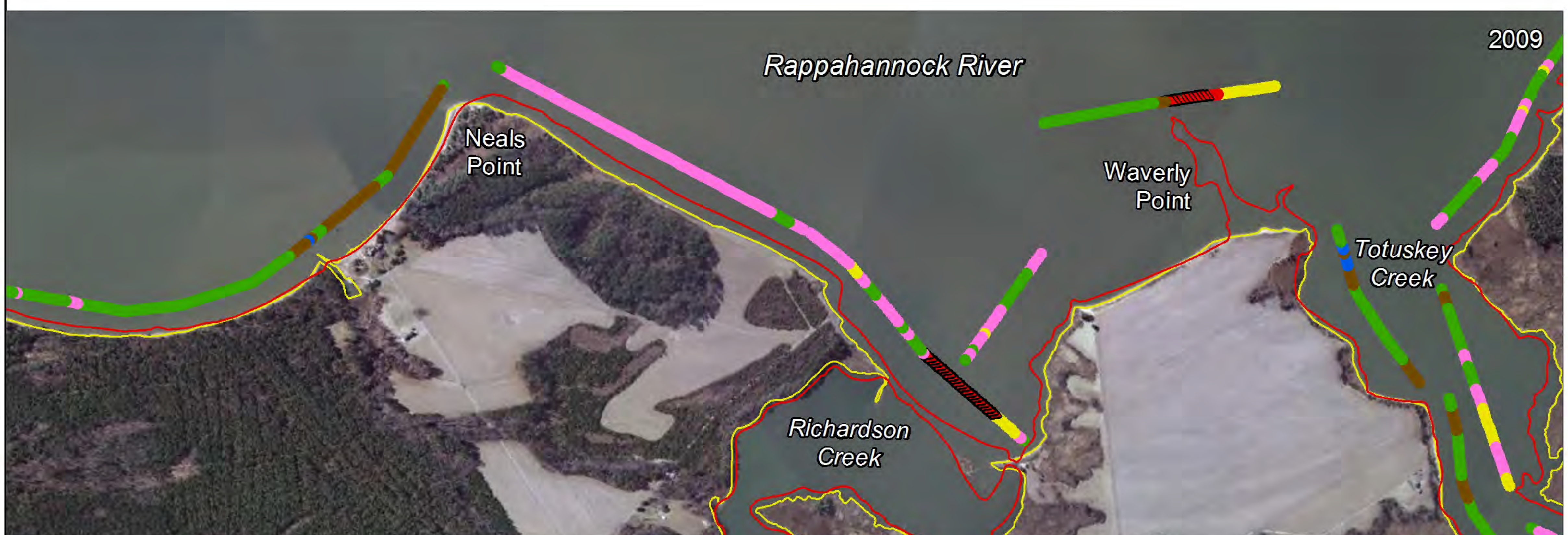
Shoreline Studies Program VIMS

1,000 0 1,000 Feet

Richmond County Virginia

Plate 14

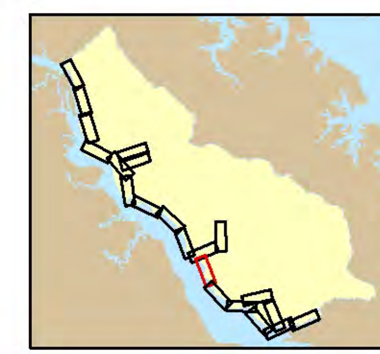




1937 Shoreline
2002 Shoreline
1953 Shoreline
2007 Shoreline
1969 Shoreline
2009 Shoreline
1994 Shoreline

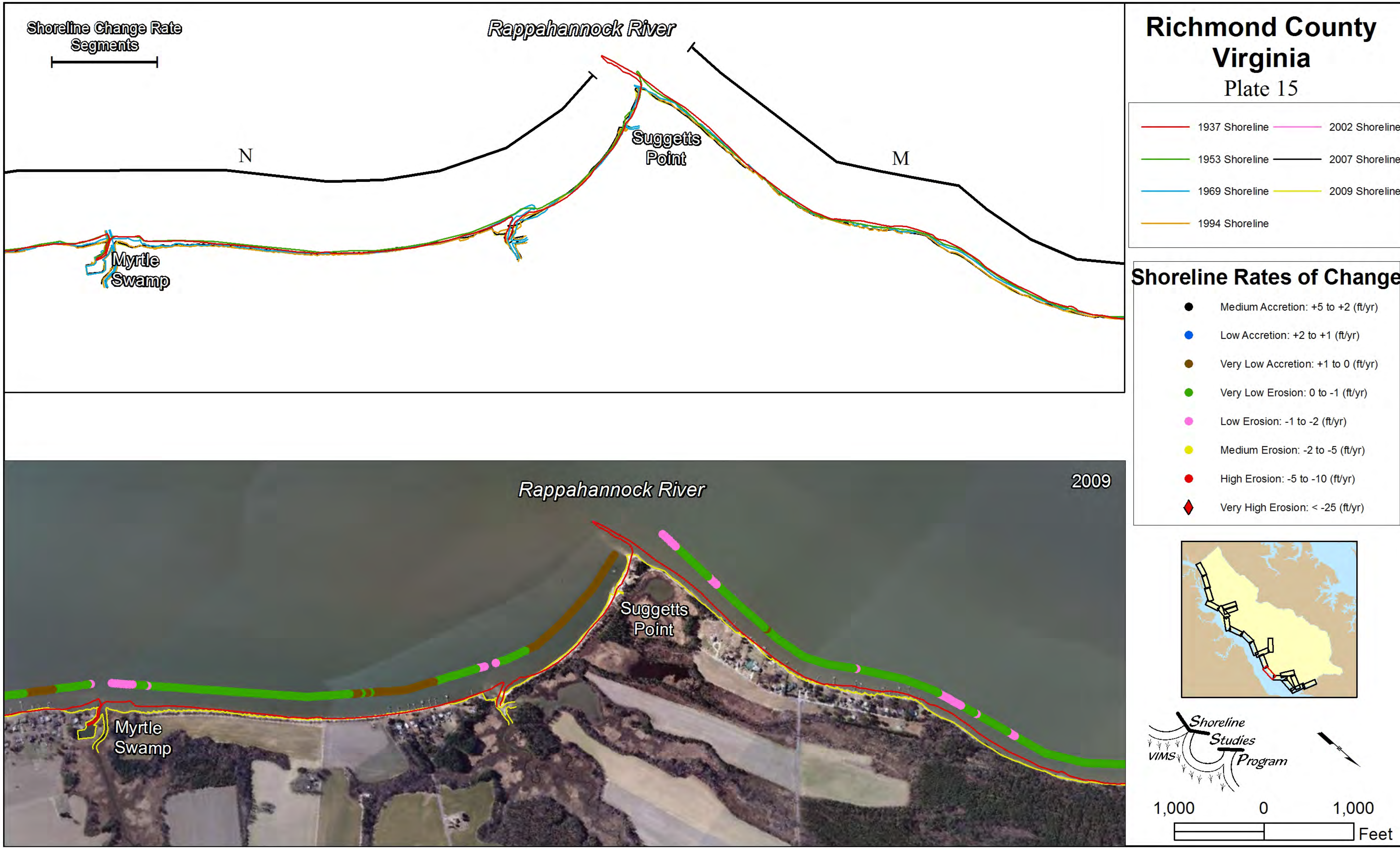
Shoreline Rates of Change

- Medium Accretion: +5 to +2 (ft/yr)
- Low Accretion: +2 to +1 (ft/yr)
- Very Low Accretion: +1 to 0 (ft/yr)
- Very Low Erosion: 0 to -1 (ft/yr)
- Low Erosion: -1 to -2 (ft/yr)
- Medium Erosion: -2 to -5 (ft/yr)
- High Erosion: -5 to -10 (ft/yr)
- Very High Erosion: < -25 (ft/yr)



Shoreline Studies Program
VIMS

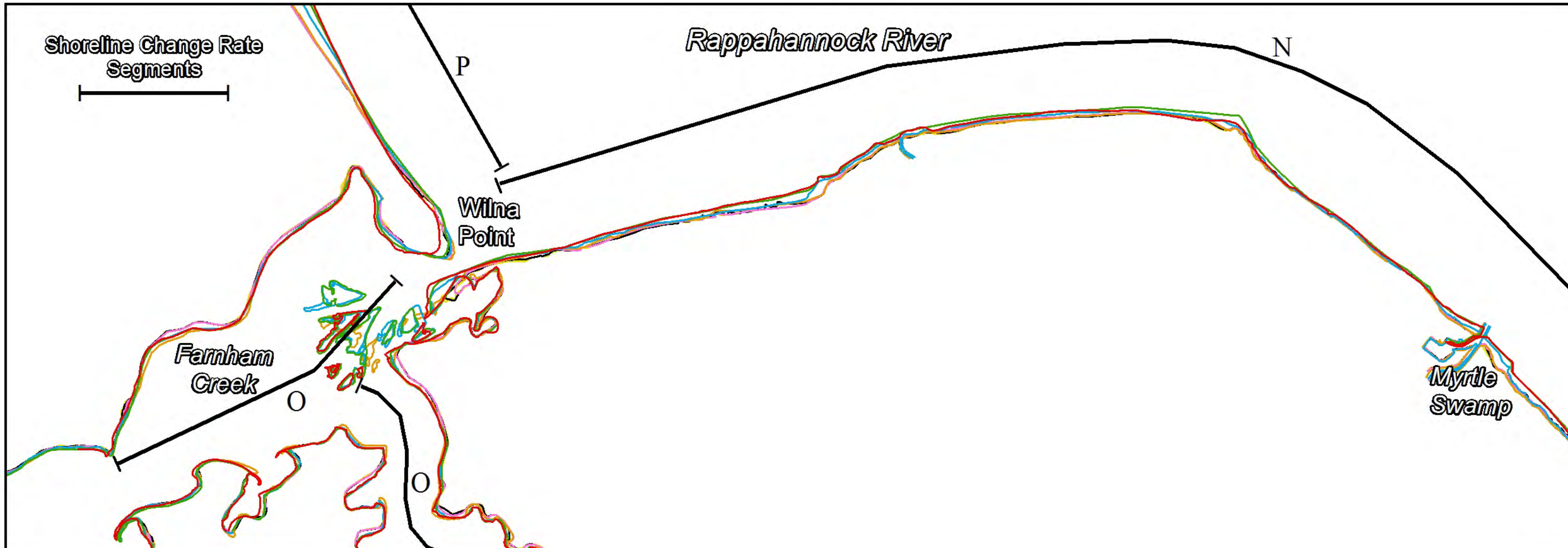
1,000 0 1,000
Feet

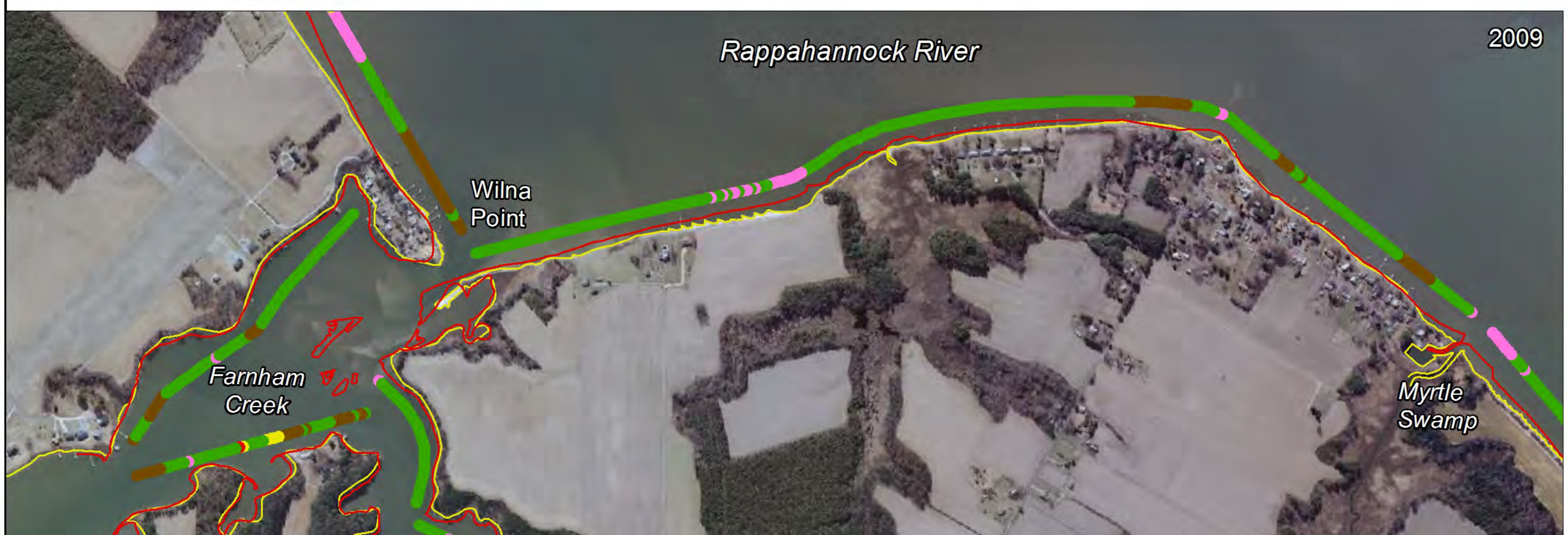


Shoreline Change Rate Segments
Rappahannock River
N
M
Suggetts Point
Myrtle Swamp
Richmond County Virginia
Plate 15
1937 Shoreline
2002 Shoreline
1953 Shoreline
2007 Shoreline
1969 Shoreline
2009 Shoreline
1994 Shoreline
Shoreline Rates of Change
Medium Accretion: +5 to +2 (ft/yr)
Low Accretion: +2 to +1 (ft/yr)
Very Low Accretion: +1 to 0 (ft/yr)
Very Low Erosion: 0 to -1 (ft/yr)
Low Erosion: -1 to -2 (ft/yr)
Medium Erosion: -2 to -5 (ft/yr)
High Erosion: -5 to -10 (ft/yr)
Very High Erosion: < -25 (ft/yr)
Rappahannock River
2009
Suggetts Point
Myrtle Swamp
Shoreline Studies Program
VIMS
1,000
0
1,000
Feet

Richmond County Virginia

Plate 16

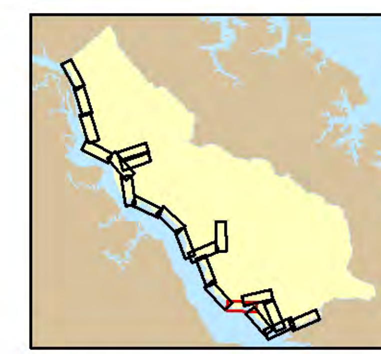




1937 Shoreline	2002 Shoreline
1953 Shoreline	2007 Shoreline
1969 Shoreline	2009 Shoreline
1994 Shoreline	

Shoreline Rates of Change

- Medium Accretion: +5 to +2 (ft/yr)
- Low Accretion: +2 to +1 (ft/yr)
- Very Low Accretion: +1 to 0 (ft/yr)
- Very Low Erosion: 0 to -1 (ft/yr)
- Low Erosion: -1 to -2 (ft/yr)
- Medium Erosion: -2 to -5 (ft/yr)
- High Erosion: -5 to -10 (ft/yr)
- Very High Erosion: < -25 (ft/yr)

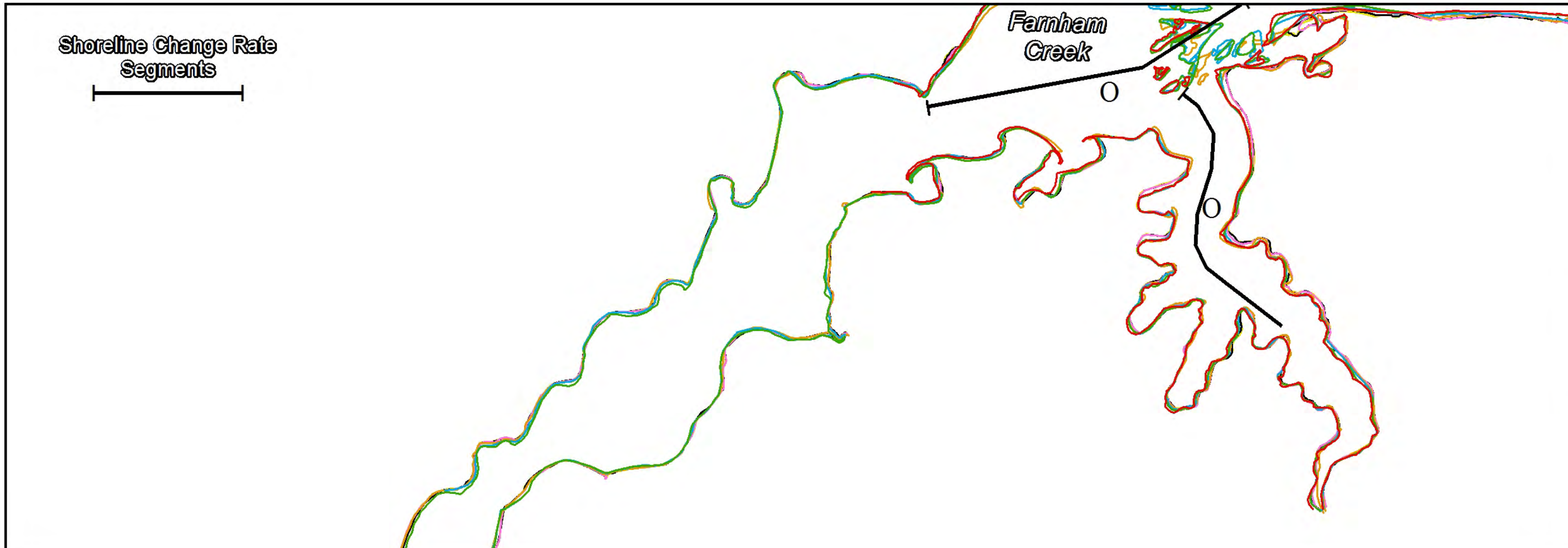


Shoreline Studies Program VIMS

1,000 0 1,000 Feet

Richmond County Virginia

Plate 17



1937 Shoreline	2002 Shoreline
1953 Shoreline	2007 Shoreline
1969 Shoreline	2009 Shoreline
1994 Shoreline	

Shoreline Rates of Change

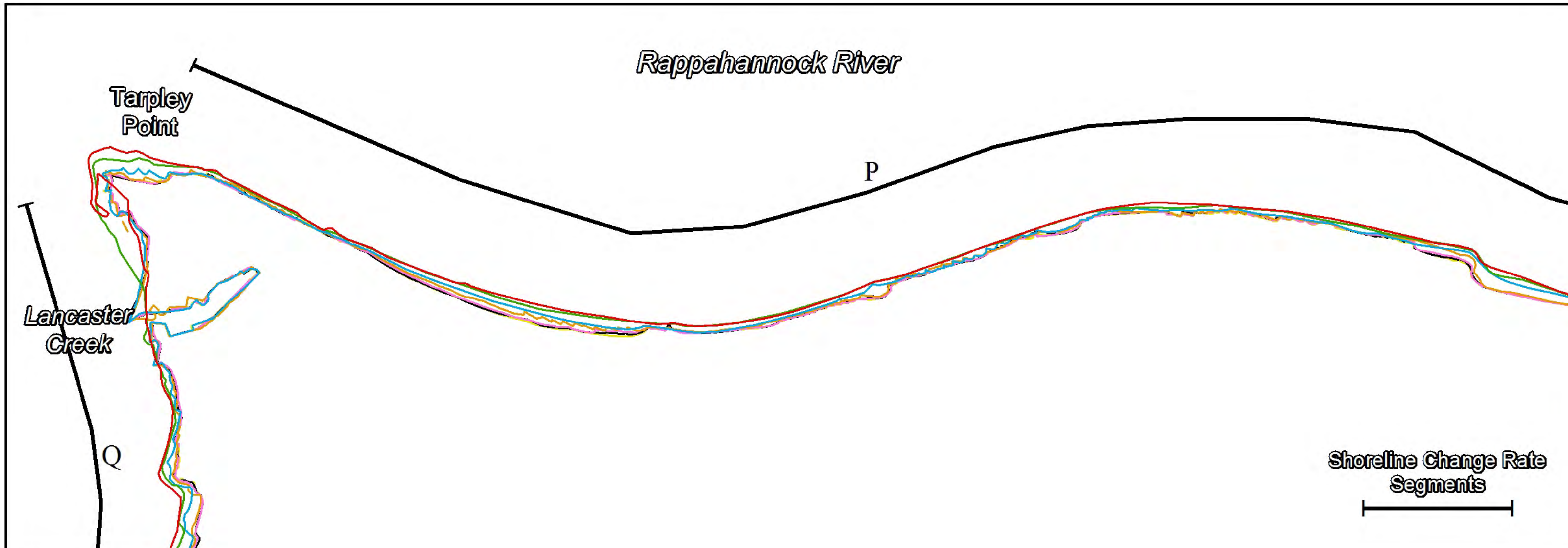
- Medium Accretion: +5 to +2 (ft/yr)
- Low Accretion: +2 to +1 (ft/yr)
- Very Low Accretion: +1 to 0 (ft/yr)
- Very Low Erosion: 0 to -1 (ft/yr)
- Low Erosion: -1 to -2 (ft/yr)
- Medium Erosion: -2 to -5 (ft/yr)
- High Erosion: -5 to -10 (ft/yr)
- Very High Erosion: < -25 (ft/yr)

VIMS Shoreline Studies Program

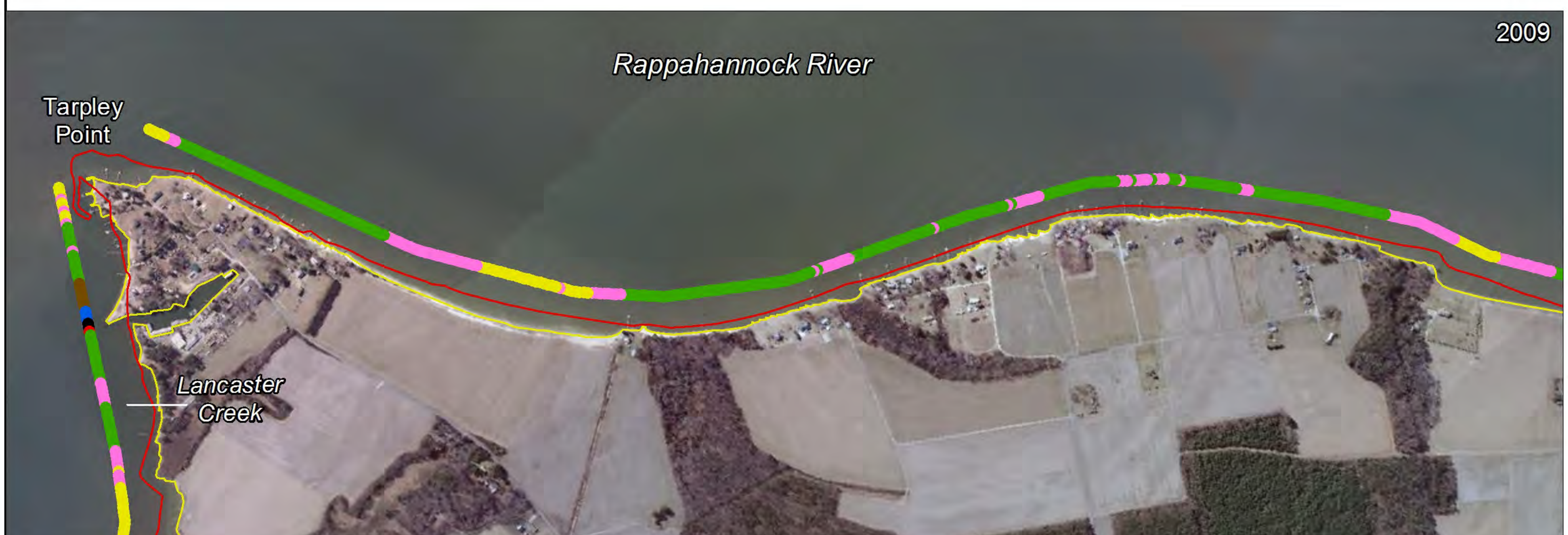
1,000 0 1,000 Feet

Richmond County Virginia

Plate 18



1937 Shoreline
1953 Shoreline
1969 Shoreline
1994 Shoreline
2002 Shoreline
2007 Shoreline
2009 Shoreline

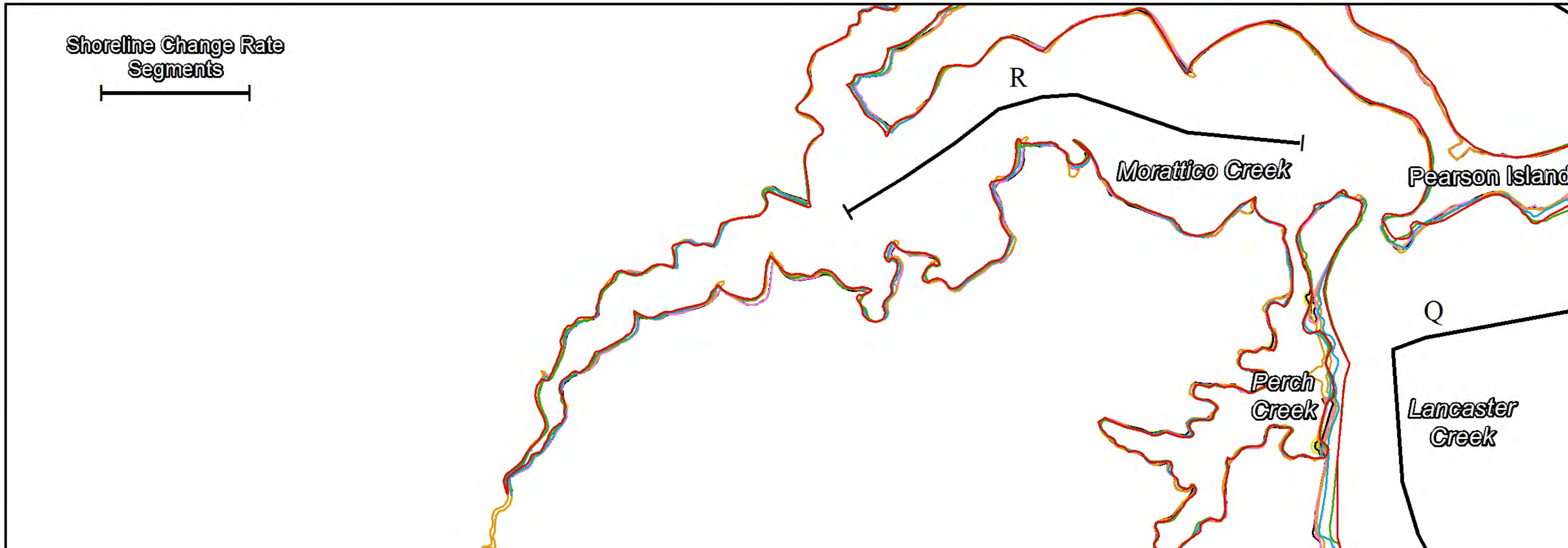


Shoreline Rates of Change

- Medium Accretion: +5 to +2 (ft/yr)
- Low Accretion: +2 to +1 (ft/yr)
- Very Low Accretion: +1 to 0 (ft/yr)
- Very Low Erosion: 0 to -1 (ft/yr)
- Low Erosion: -1 to -2 (ft/yr)
- Medium Erosion: -2 to -5 (ft/yr)
- High Erosion: -5 to -10 (ft/yr)
- Very High Erosion: < -25 (ft/yr)

Shoreline Studies Program VIMS

1,000 0 1,000 Feet



Richmond County Virginia

Plate 19

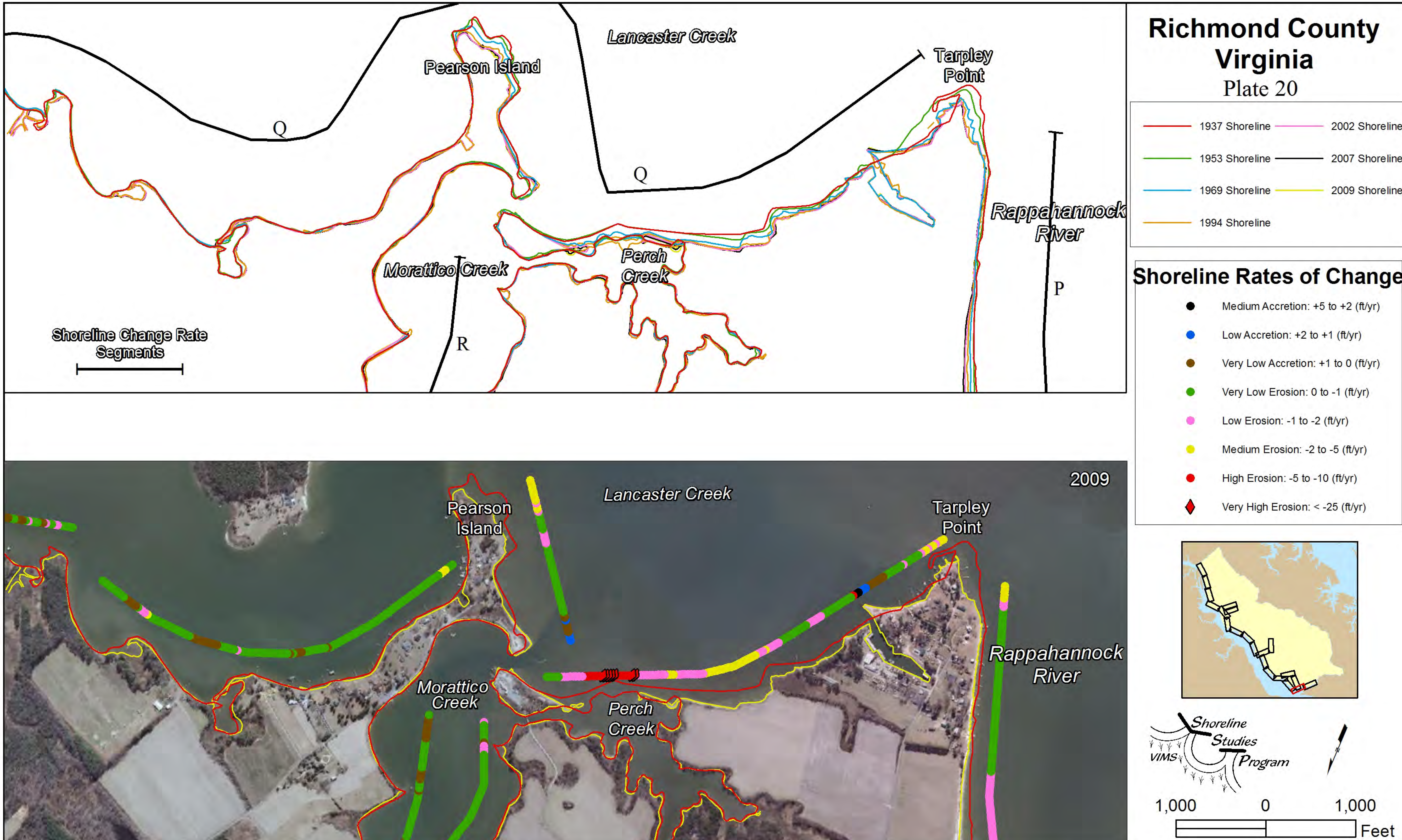
1937 Shoreline	2002 Shoreline
1953 Shoreline	2007 Shoreline
1969 Shoreline	2009 Shoreline
1994 Shoreline	

Shoreline Rates of Change

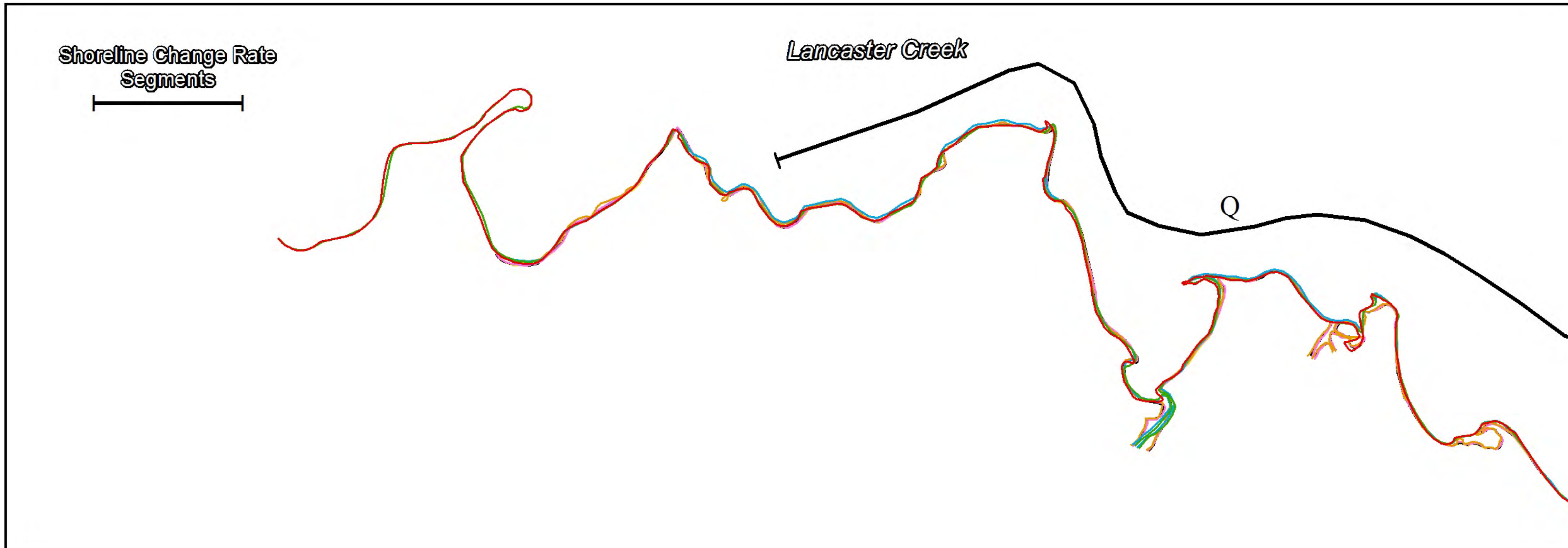
- Medium Accretion: +5 to +2 (ft/yr)
- Low Accretion: +2 to +1 (ft/yr)
- Very Low Accretion: +1 to 0 (ft/yr)
- Very Low Erosion: 0 to -1 (ft/yr)
- Low Erosion: -1 to -2 (ft/yr)
- Medium Erosion: -2 to -5 (ft/yr)
- High Erosion: -5 to -10 (ft/yr)
- Very High Erosion: < -25 (ft/yr)

Shoreline Studies Program VIMS

1,000 0 1,000 Feet



Richmond County
Virginia
Plate 20
1937 Shoreline
2002 Shoreline
1953 Shoreline
2007 Shoreline
1969 Shoreline
2009 Shoreline
1994 Shoreline
Shoreline Rates of Change
Medium Accretion: +5 to +2 (ft/yr)
Low Accretion: +2 to +1 (ft/yr)
Very Low Accretion: +1 to 0 (ft/yr)
Very Low Erosion: 0 to -1 (ft/yr)
Low Erosion: -1 to -2 (ft/yr)
Medium Erosion: -2 to -5 (ft/yr)
High Erosion: -5 to -10 (ft/yr)
Very High Erosion: < -25 (ft/yr)
Lancaster Creek
Pearson Island
Tarpley Point
Q
Q
R
P
Rappahannock River
Moratico Creek
Perch Creek
Shoreline Change Rate Segments
2009
Shoreline Studies Program
VIMS
1,000
0
1,000
Feet



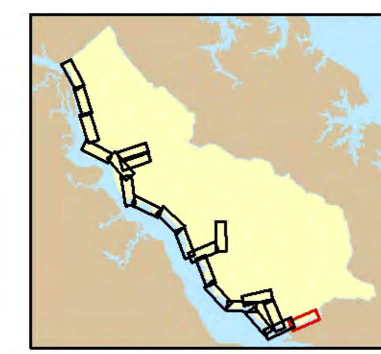
Richmond County Virginia

Plate 21

1937 Shoreline	2002 Shoreline
1953 Shoreline	2007 Shoreline
1969 Shoreline	2009 Shoreline
1994 Shoreline	

Shoreline Rates of Change

- Medium Accretion: +5 to +2 (ft/yr)
- Low Accretion: +2 to +1 (ft/yr)
- Very Low Accretion: +1 to 0 (ft/yr)
- Very Low Erosion: 0 to -1 (ft/yr)
- Low Erosion: -1 to -2 (ft/yr)
- Medium Erosion: -2 to -5 (ft/yr)
- High Erosion: -5 to -10 (ft/yr)
- Very High Erosion: < -25 (ft/yr)



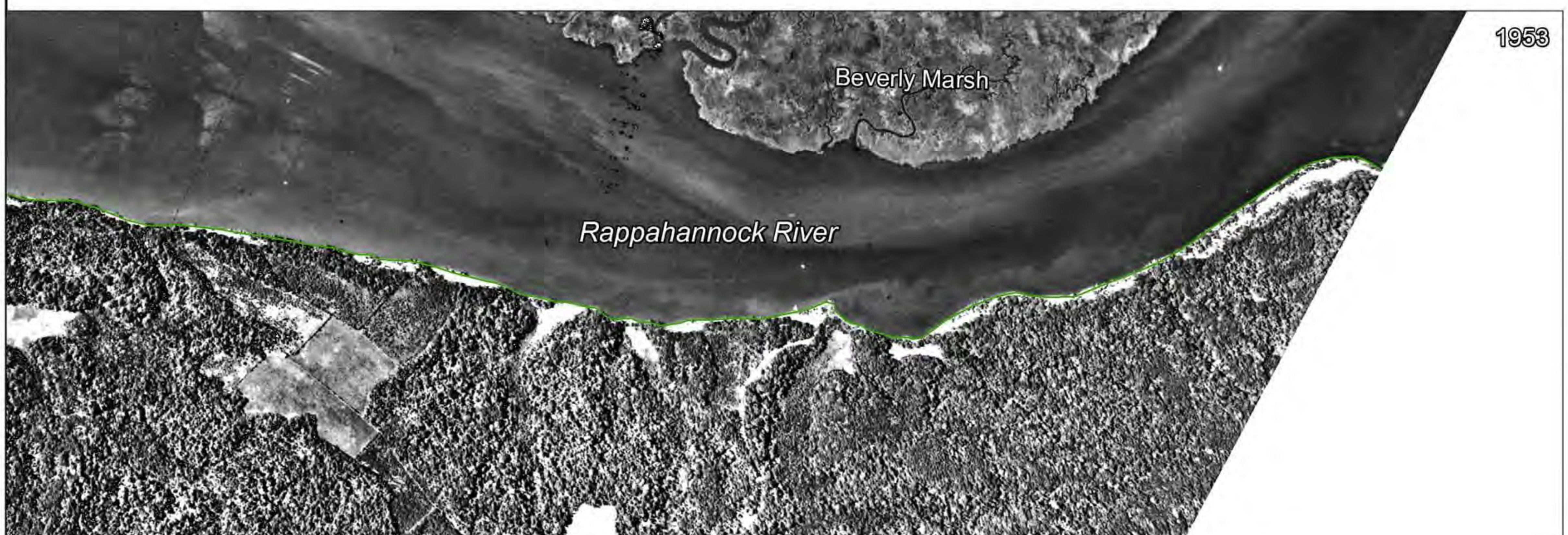
Shoreline Studies Program
VIMS

1,000 0 1,000
Feet

Appendix B

Historical Shoreline Photo Maps

Note: The location labels on the plates come from U.S. Geological Survey topographic maps, Google Earth, and other map sources and may not be accurate for the historical or even more recent images. They are for reference only.



Richmond County Virginia

Plate 1

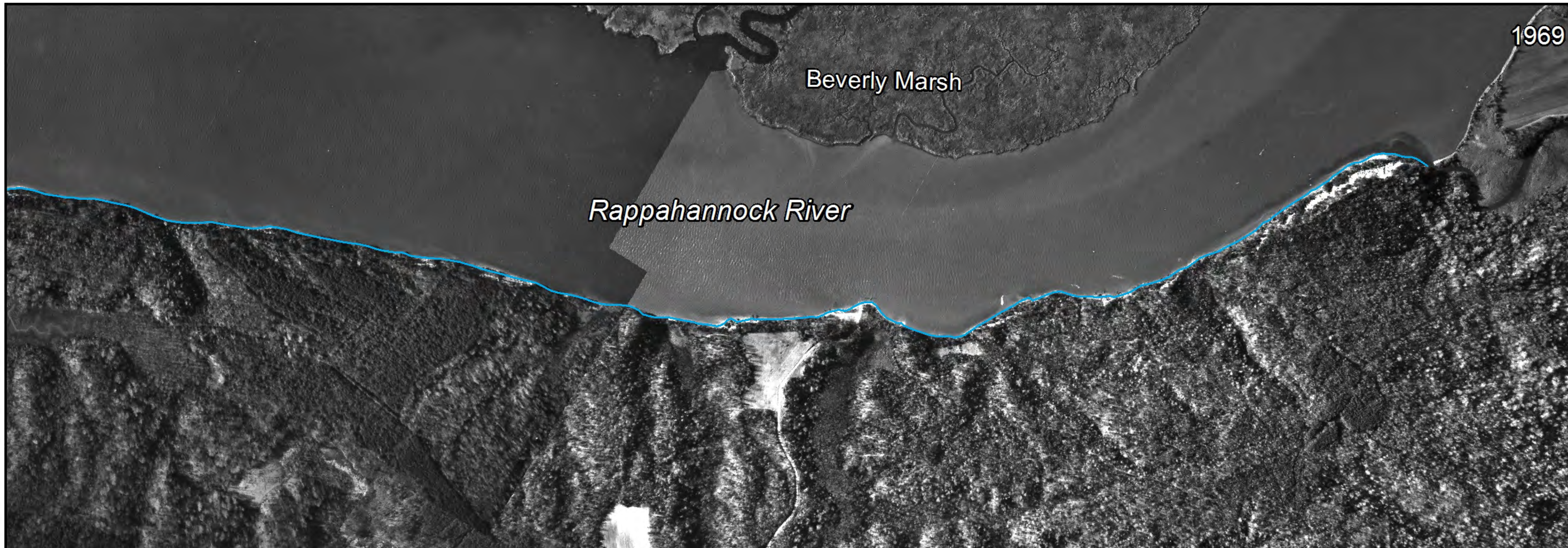
Legend

1937 Shoreline

1953 Shoreline

Shoreline Studies Program VIMS

1,000 0 1,000 Feet



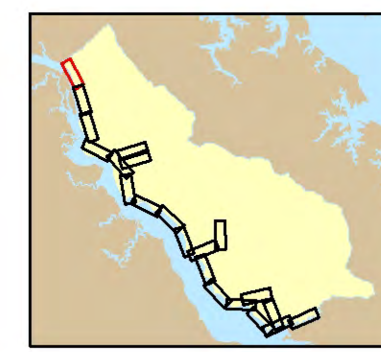
Richmond County Virginia

Plate 1

Legend

1969 Shoreline

1994 Shoreline



VIMS Shoreline Studies Program

1,000 0 1,000 Feet

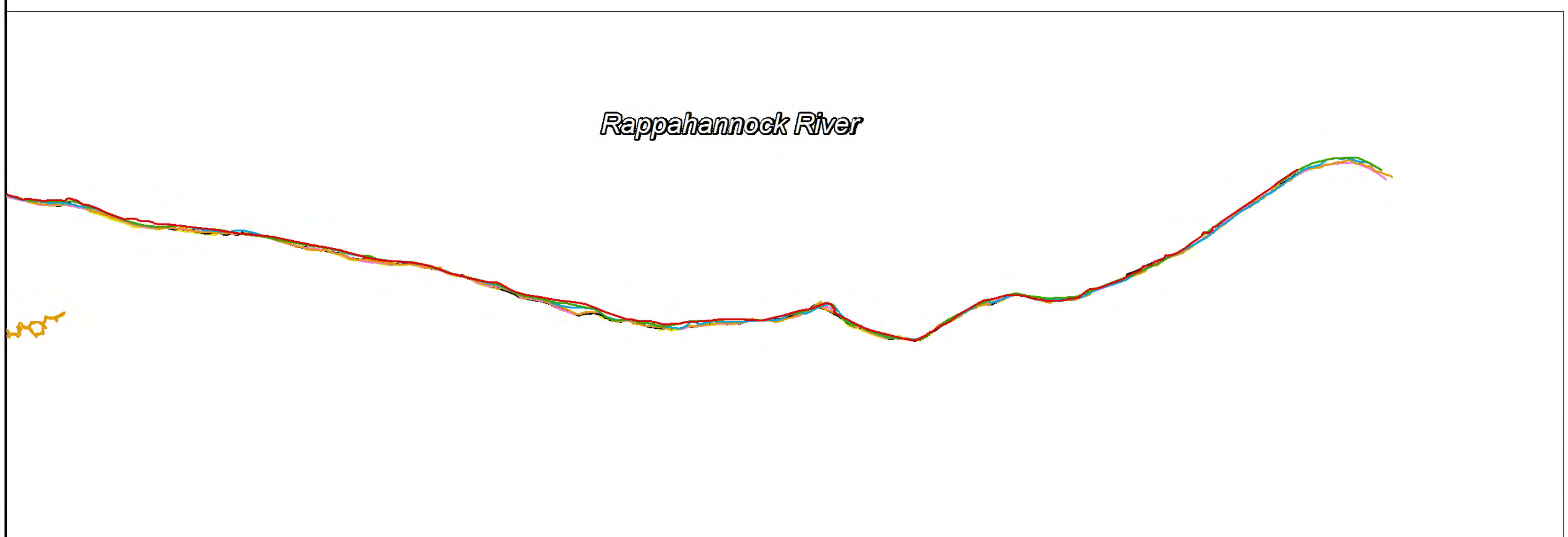

Richmond County
Virginia
Plate 1
2002
Beverly Marsh
Rappahannock River
2007
Beverly Marsh
Rappahannock River
Legend
2002 Shoreline
2007 Shoreline
Shoreline
Studies
Program
VIMS
1,000
0
1,000
Feet

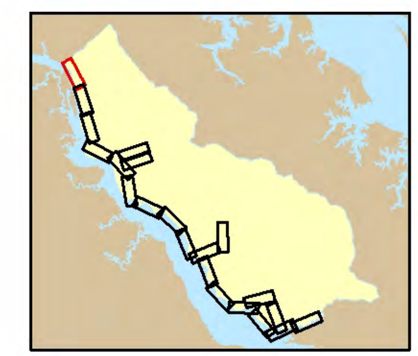
Richmond County Virginia

Plate 1

Legend

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline



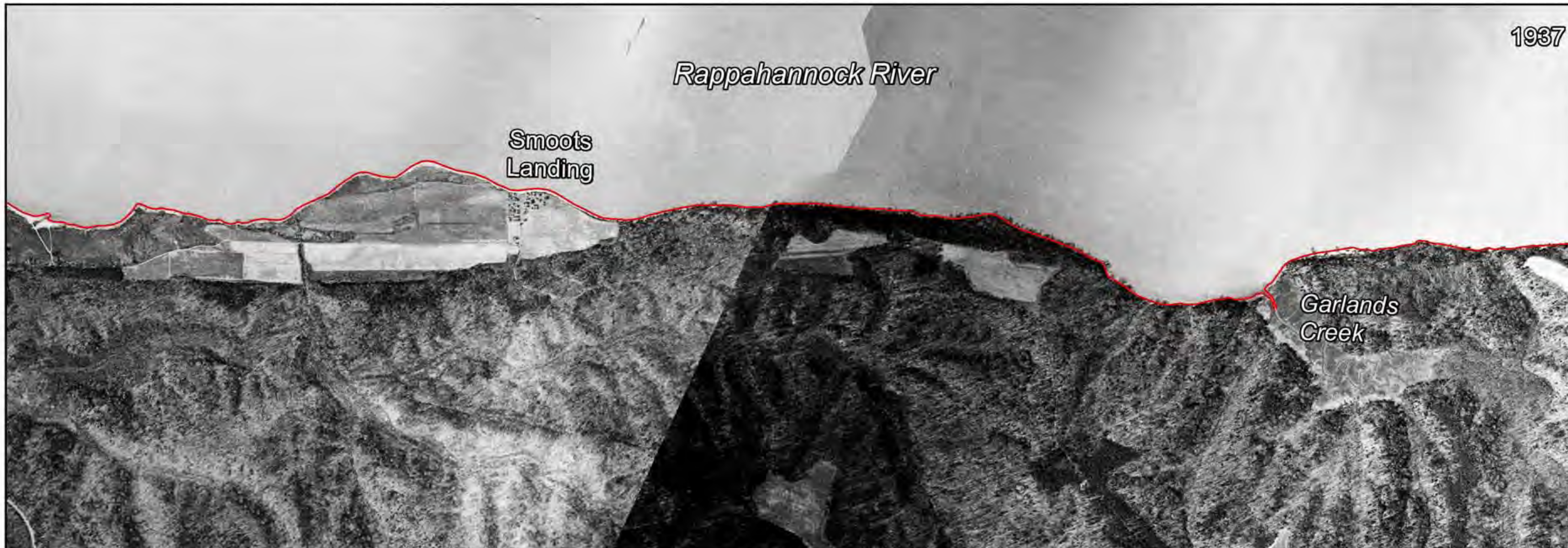


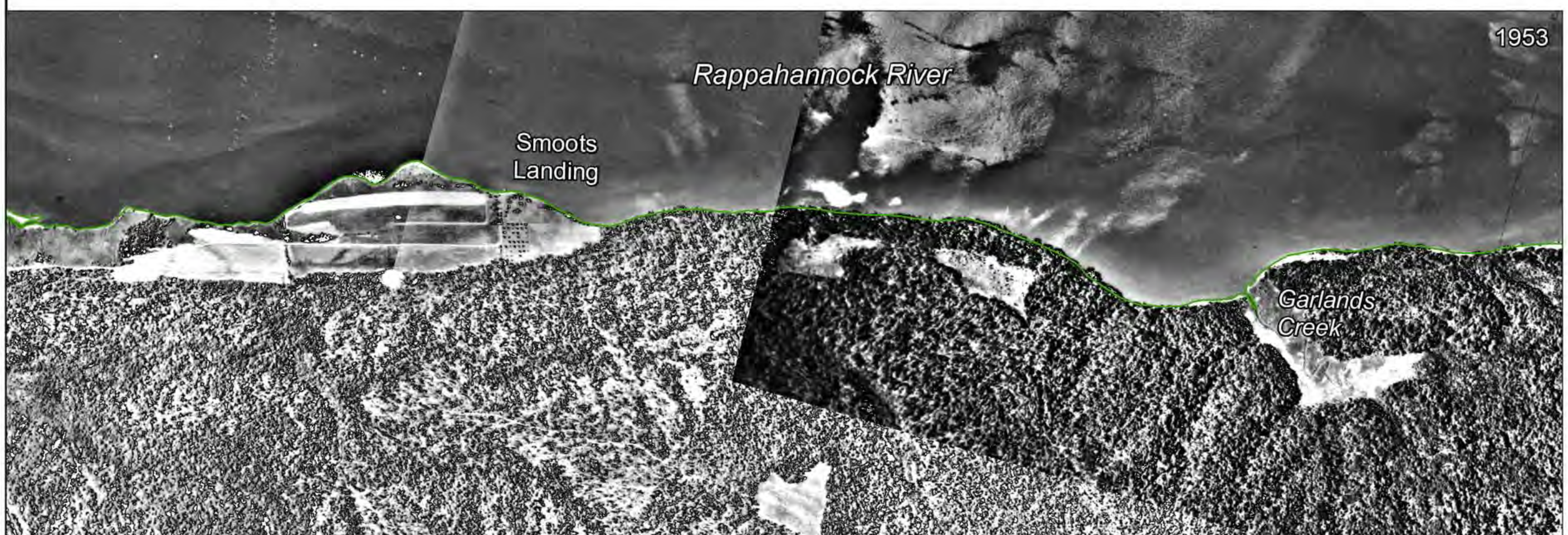
Shoreline Studies Program
VIMS

1,000 0 1,000
Feet

Richmond County Virginia

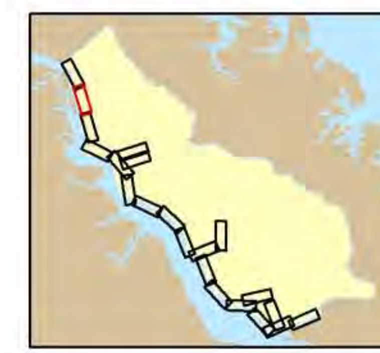
Plate 2





Legend

- 1937 Shoreline
- 1953 Shoreline

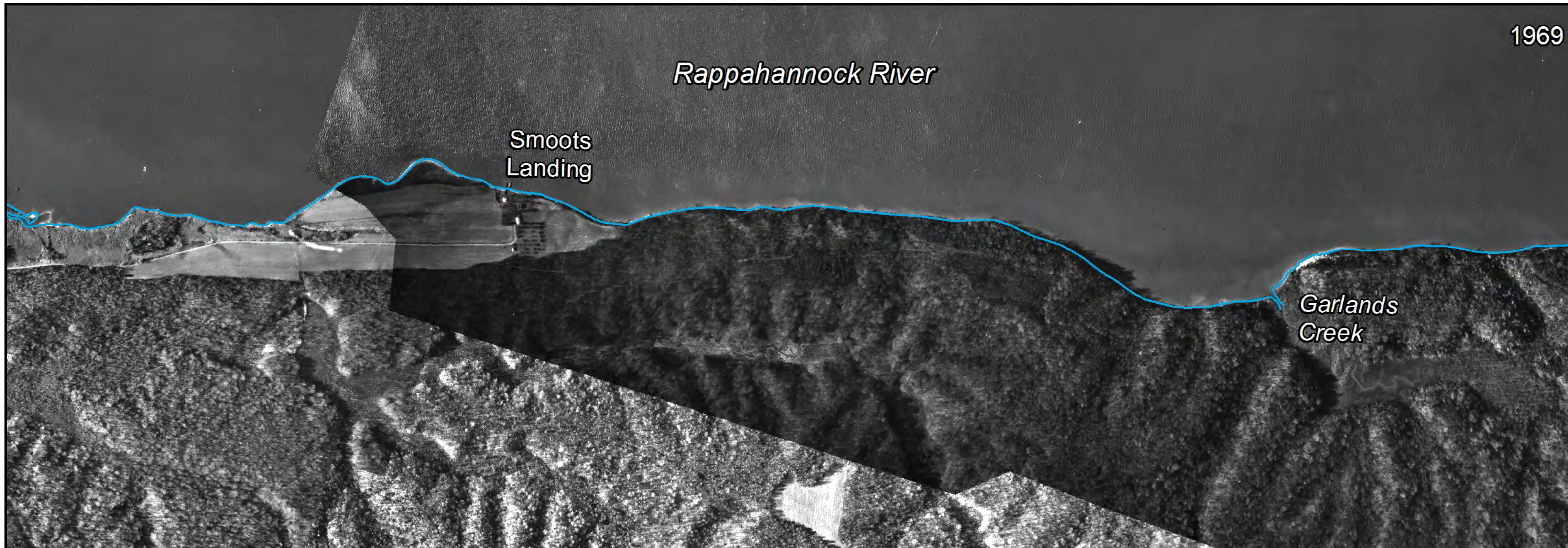


Shoreline Studies Program
VIMS

1,000 0 1,000 Feet

Richmond County
Virginia

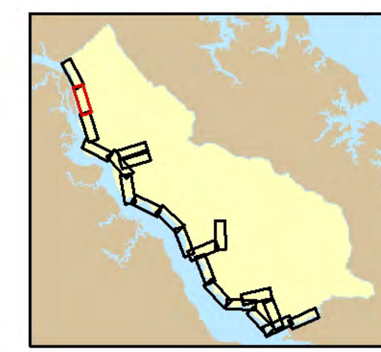
Plate 2



Legend

1969 Shoreline

1994 Shoreline

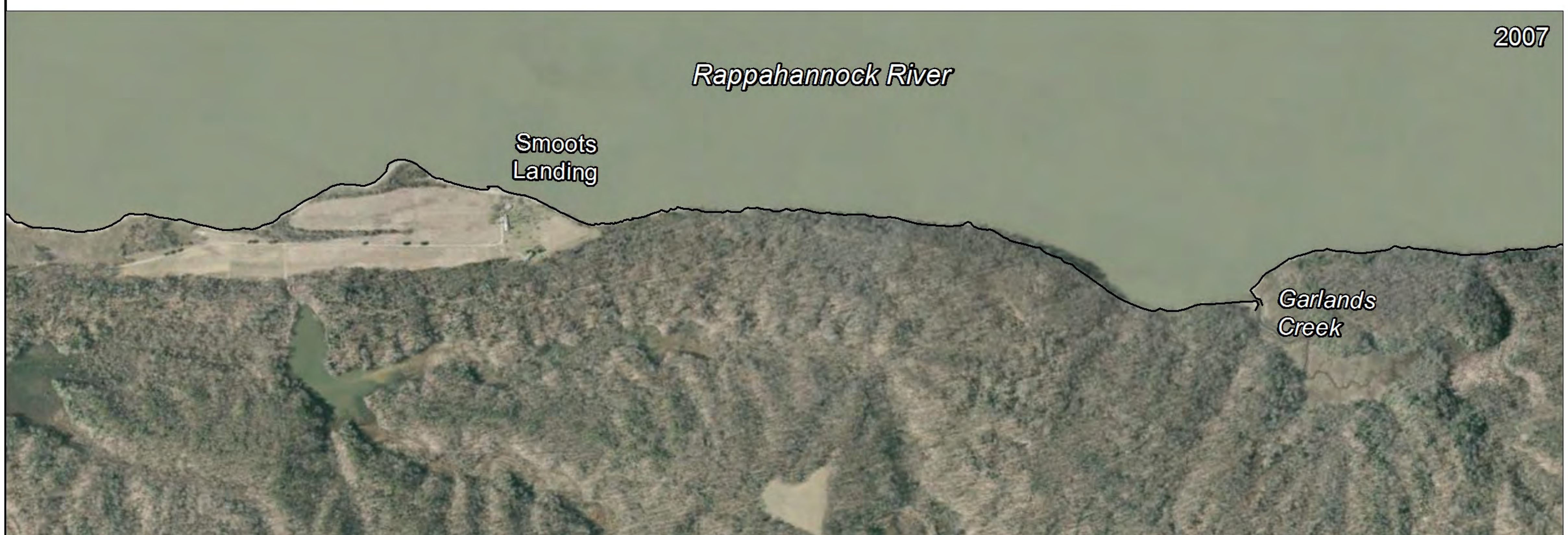


Shoreline Studies Program

VIMS

1,000 0 1,000

Feet



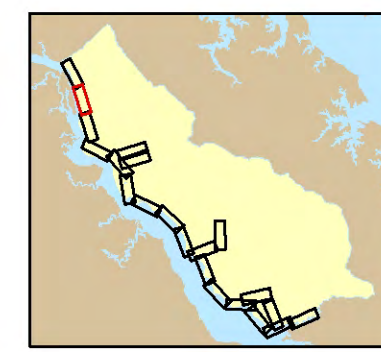
Richmond County Virginia

Plate 2

Legend

2002 Shoreline

2007 Shoreline



Shoreline Studies Program
VIMS

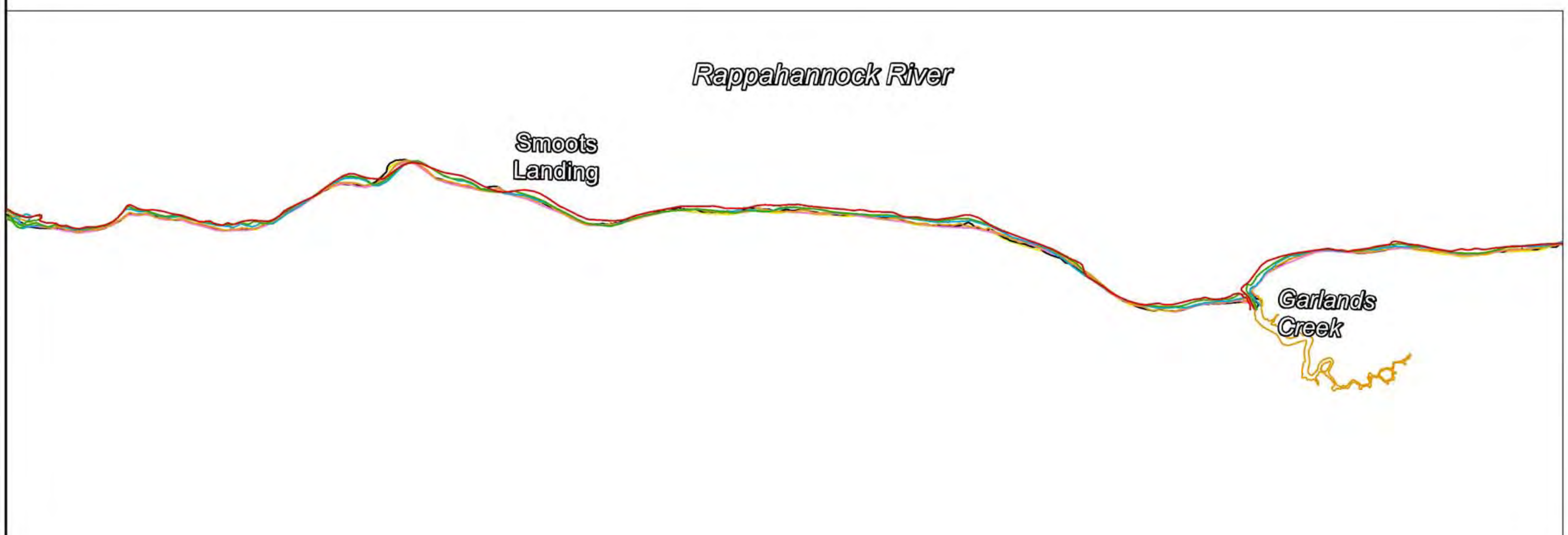
1,000 0 1,000 Feet

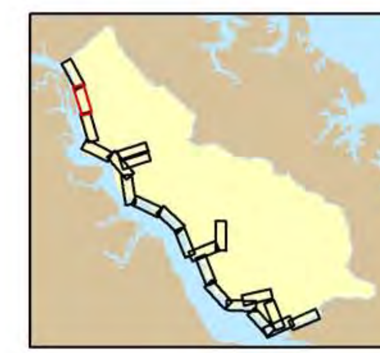
Richmond County Virginia

Plate 2

Legend

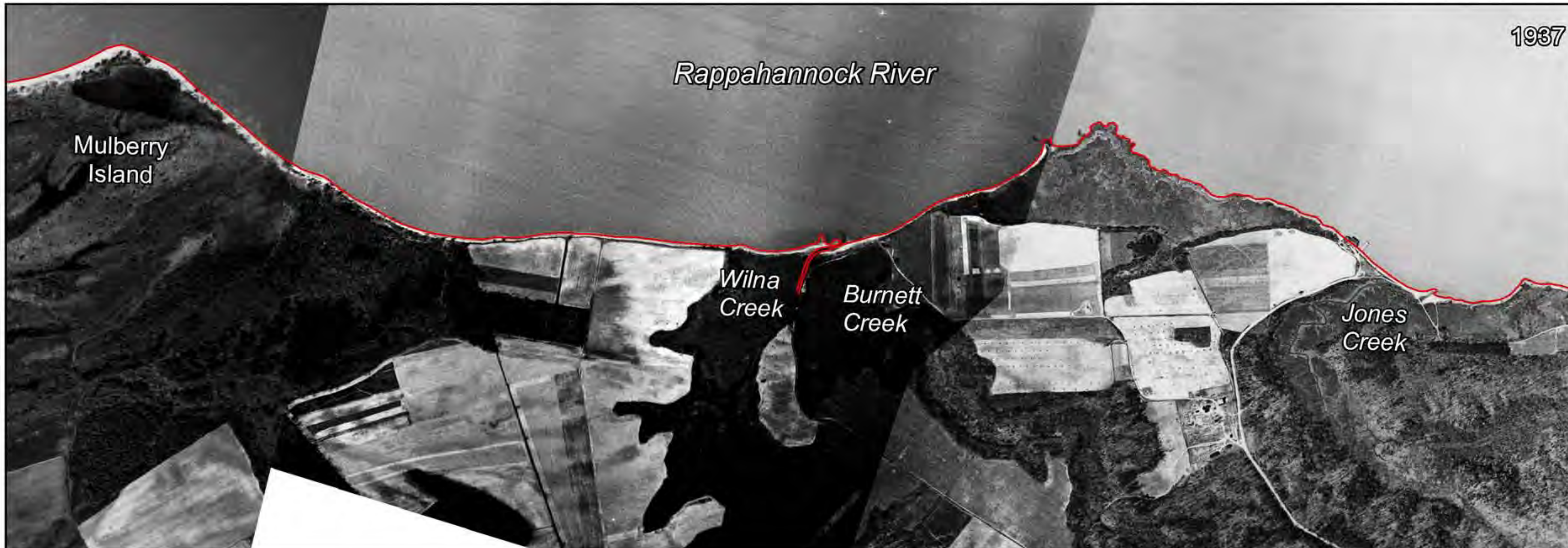
- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline





Shoreline Studies Program
VIMS

1,000 0 1,000
Feet



Richmond County Virginia

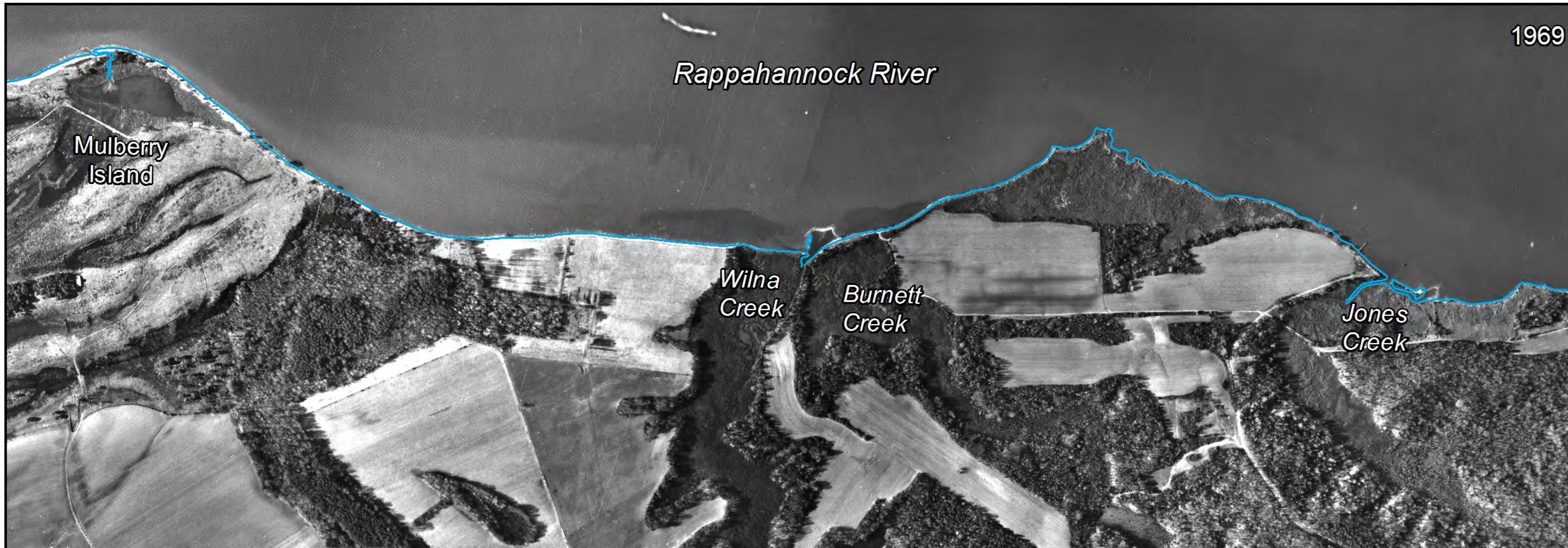
Plate 3

Legend

- 1937 Shoreline
- 1953 Shoreline

Shoreline Studies Program
VIMS

1,000 0 1,000
Feet



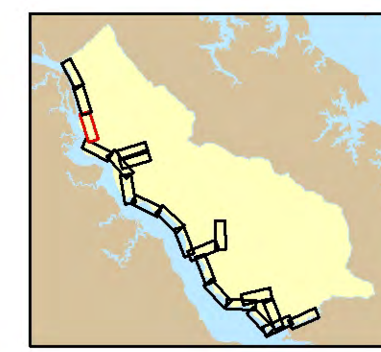
Richmond County Virginia

Plate 3

Legend

1969 Shoreline

1994 Shoreline



Shoreline Studies Program VIMS

1,000 0 1,000

Feet

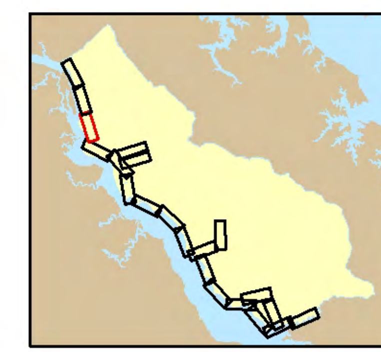
Richmond County Virginia

Plate 3

Legend

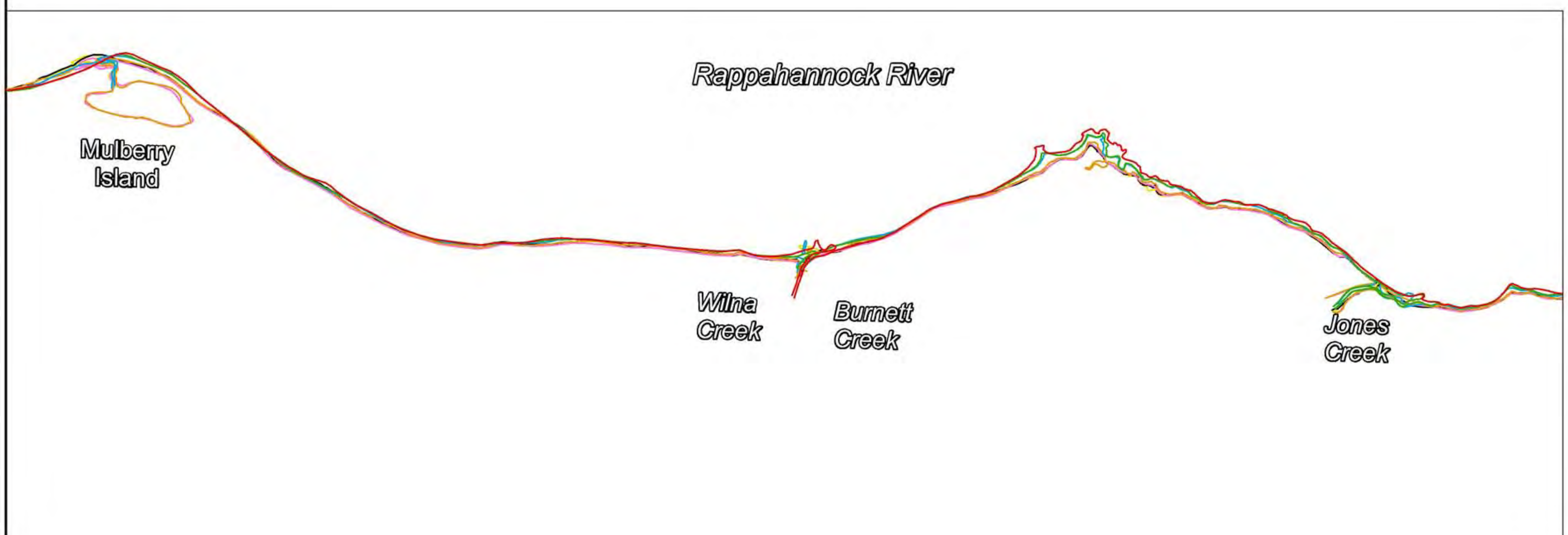
2002 Shoreline

2007 Shoreline



Shoreline Studies Program VIMS

1,000 0 1,000 Feet



Richmond County Virginia

Plate 3

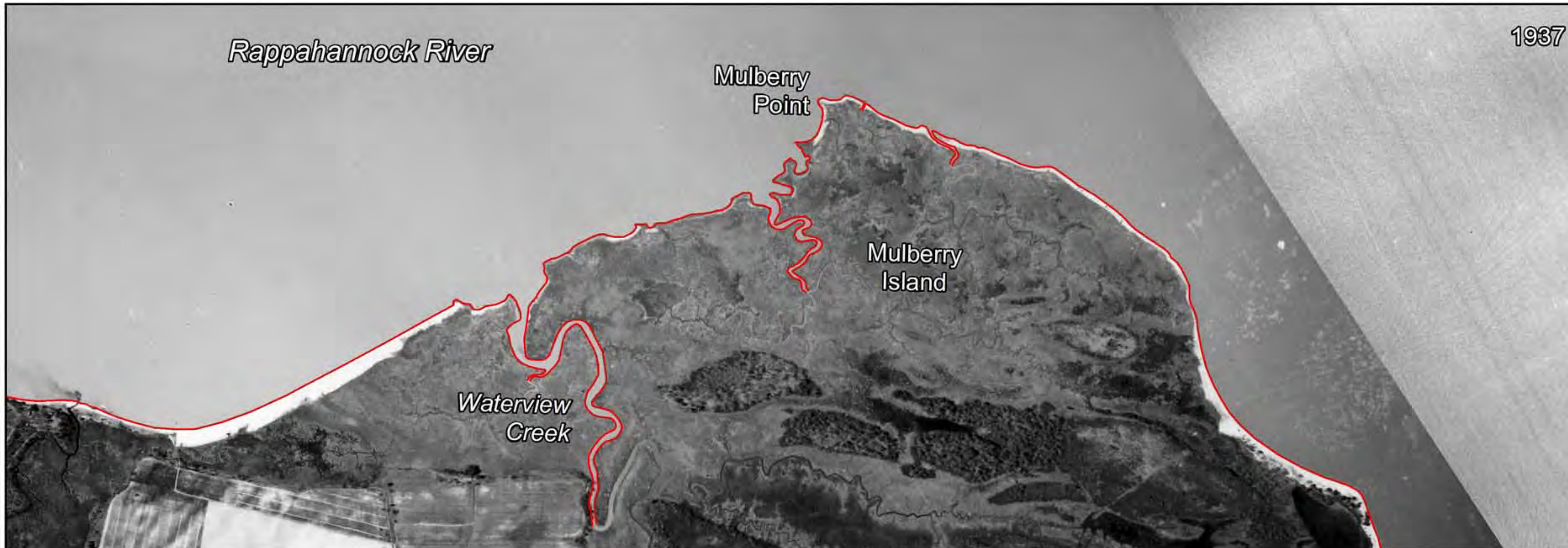
Legend

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline

Shoreline Studies Program VIMS

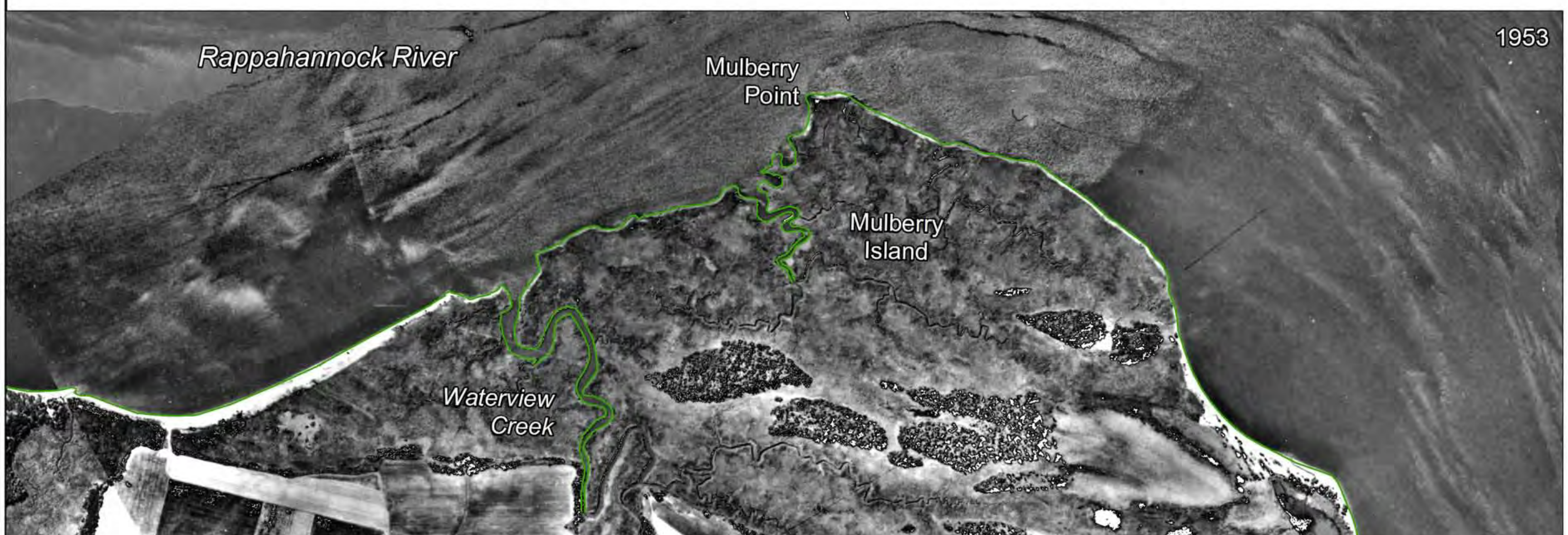
1,000 0 1,000

Feet



Richmond County Virginia

Plate 4

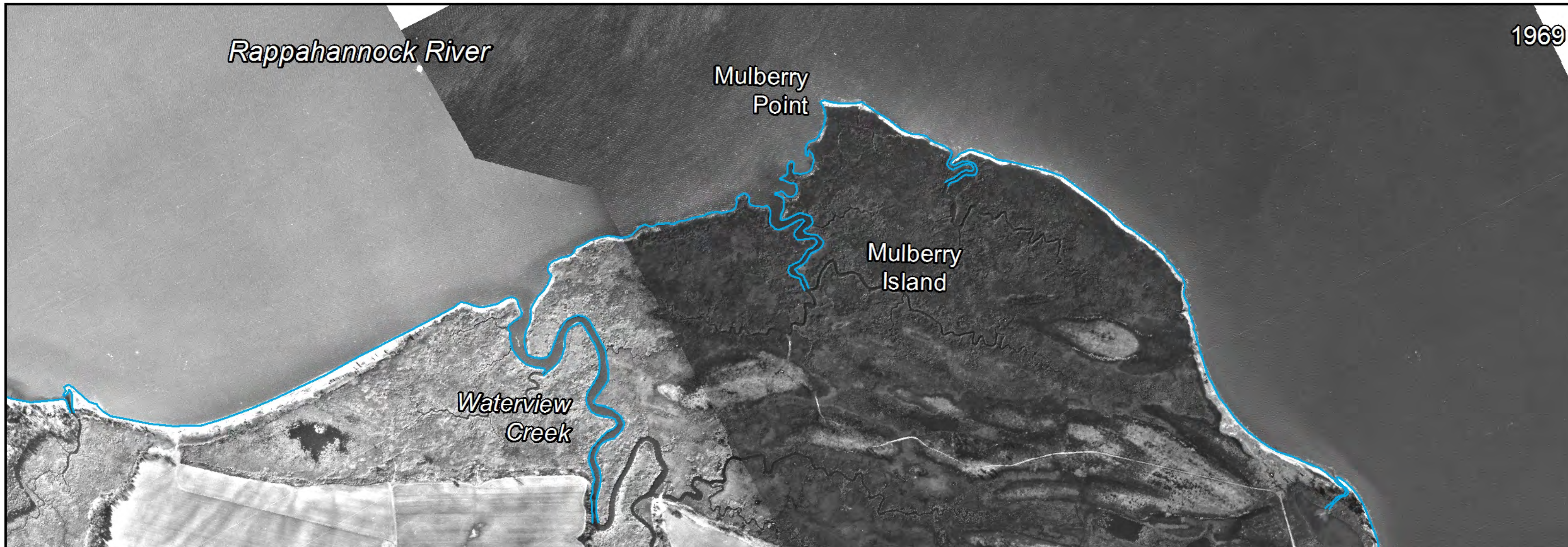


Shoreline Studies Program
VIMS

1,000 0 1,000
Feet

Richmond County Virginia

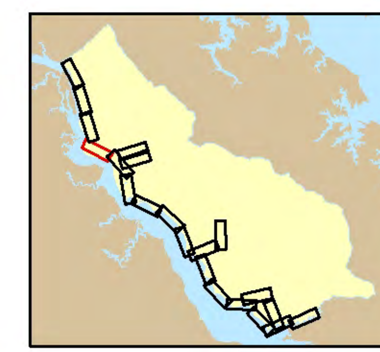
Plate 4



Legend

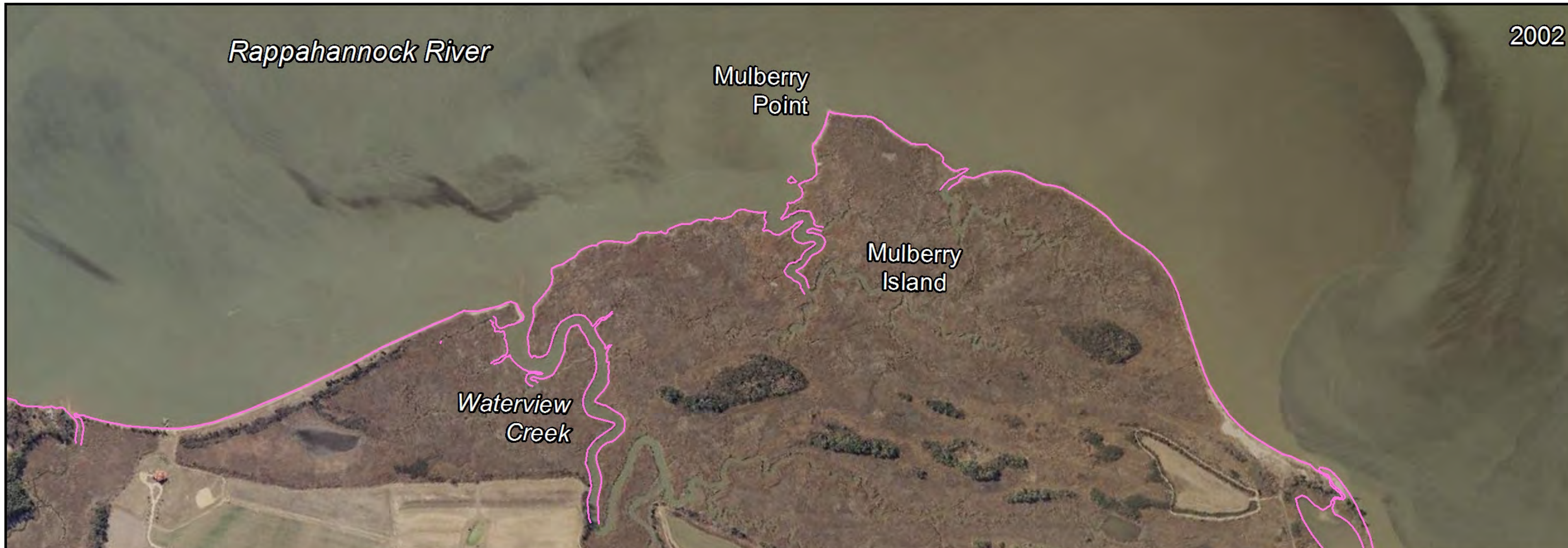
1969 Shoreline

1994 Shoreline



Shoreline Studies Program VIMS

1,000 0 1,000 Feet



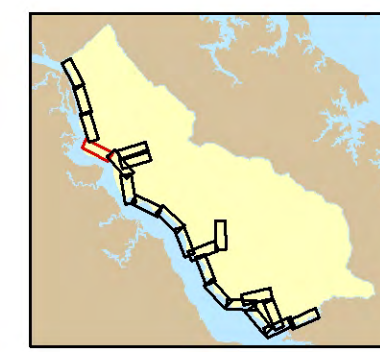
Richmond County Virginia

Plate 4

Legend

2002 Shoreline

2007 Shoreline



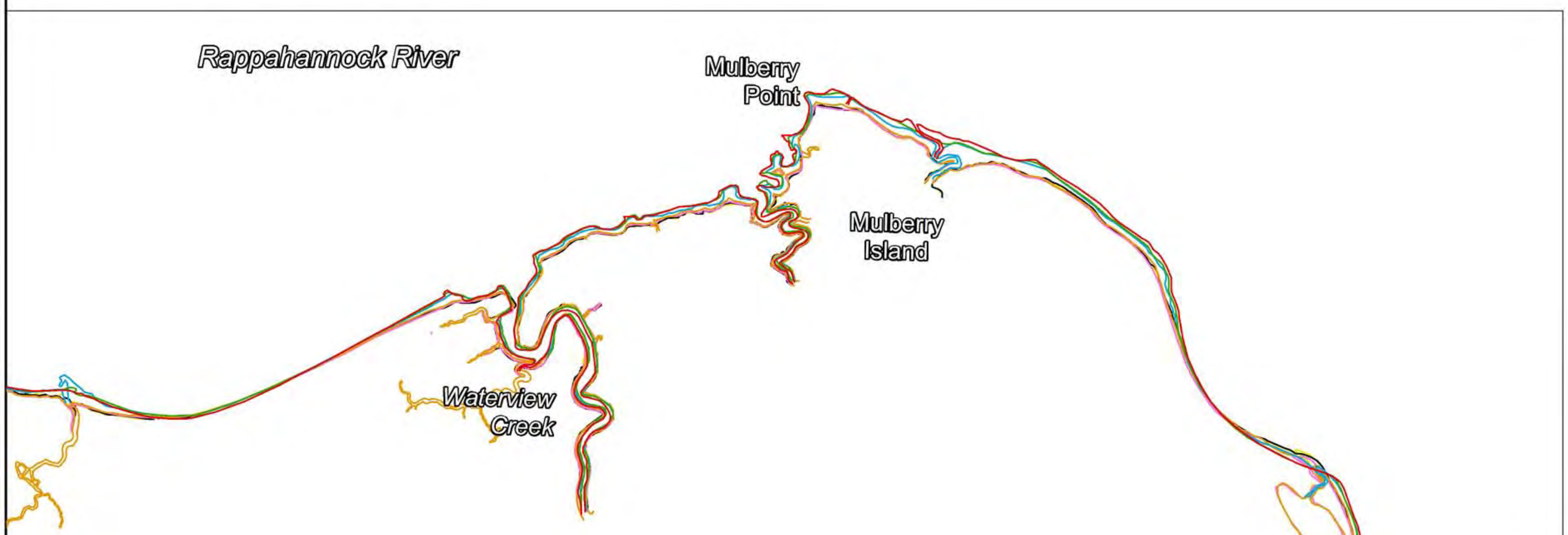
Shoreline Studies Program VIMS

1,000 0 1,000

Feet

Richmond County Virginia

Plate 4



Legend

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline

Shoreline Studies Program VIMS

1,000 0 1,000 Feet

Richmond County Virginia

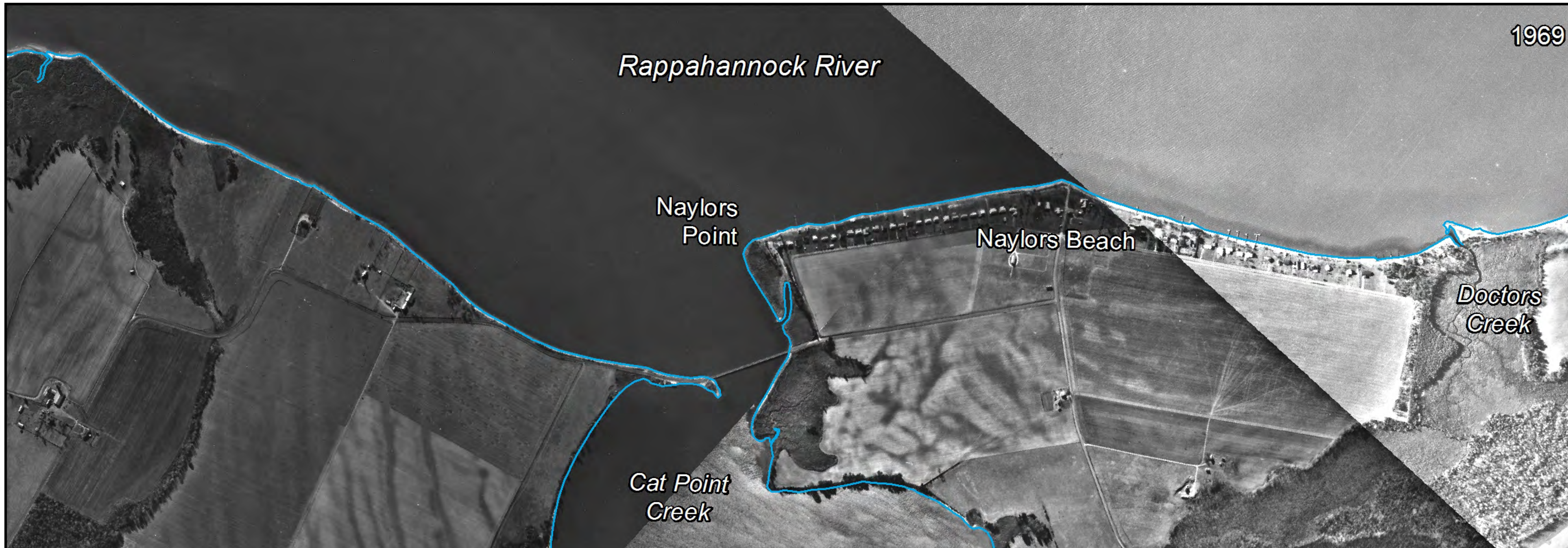
Plate 5

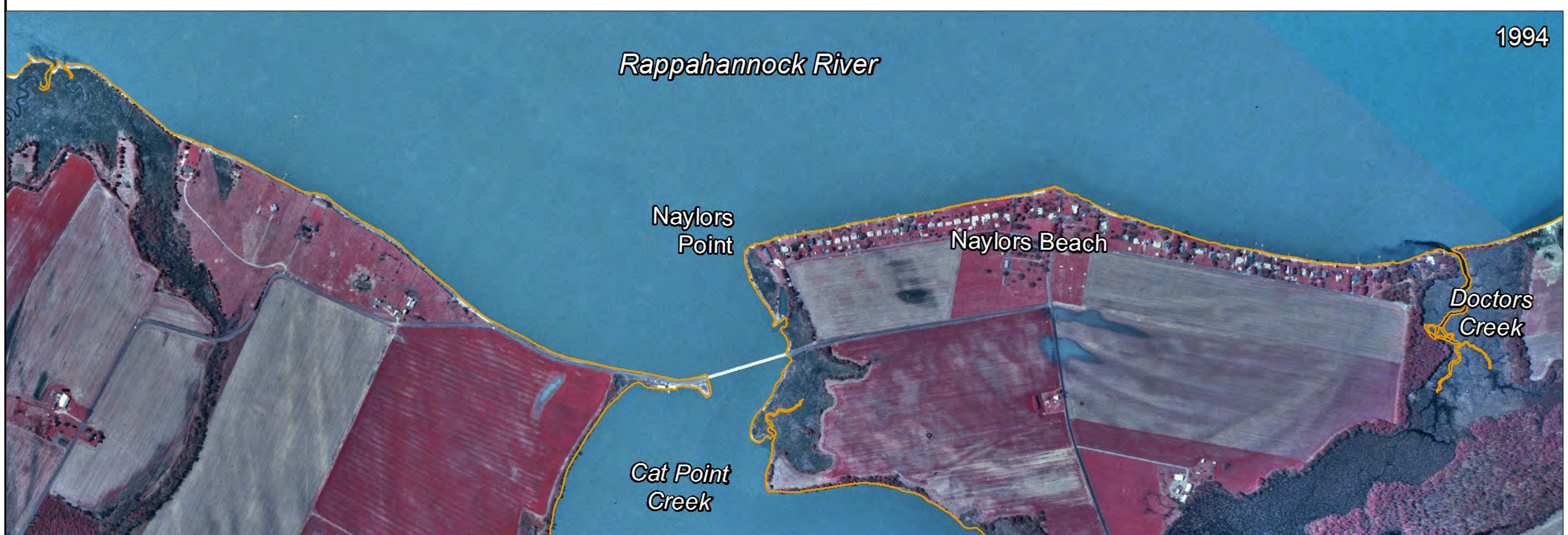
Legend

- 1937 Shoreline
- 1953 Shoreline

Shoreline Studies Program VIMS

1,000 0 1,000 Feet



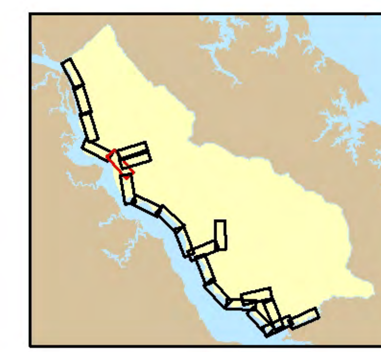


Richmond County Virginia

Plate 5

Legend

- 1969 Shoreline
- 1994 Shoreline



Shoreline Studies Program VIMS

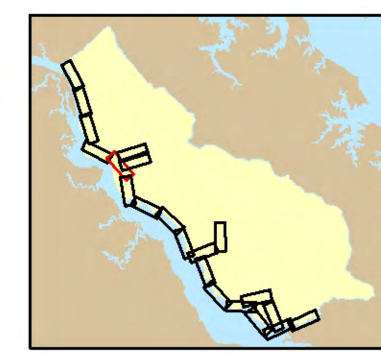
1,000 0 1,000 Feet

Richmond County Virginia

Plate 5

Legend

- 2002 Shoreline
- 2007 Shoreline

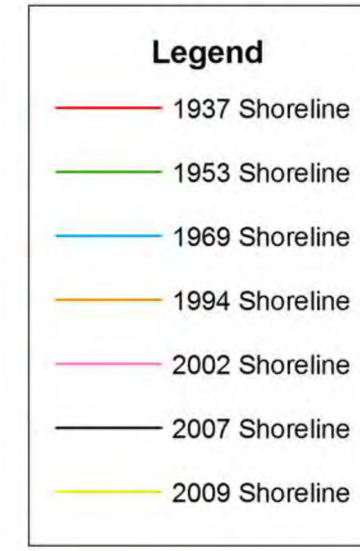


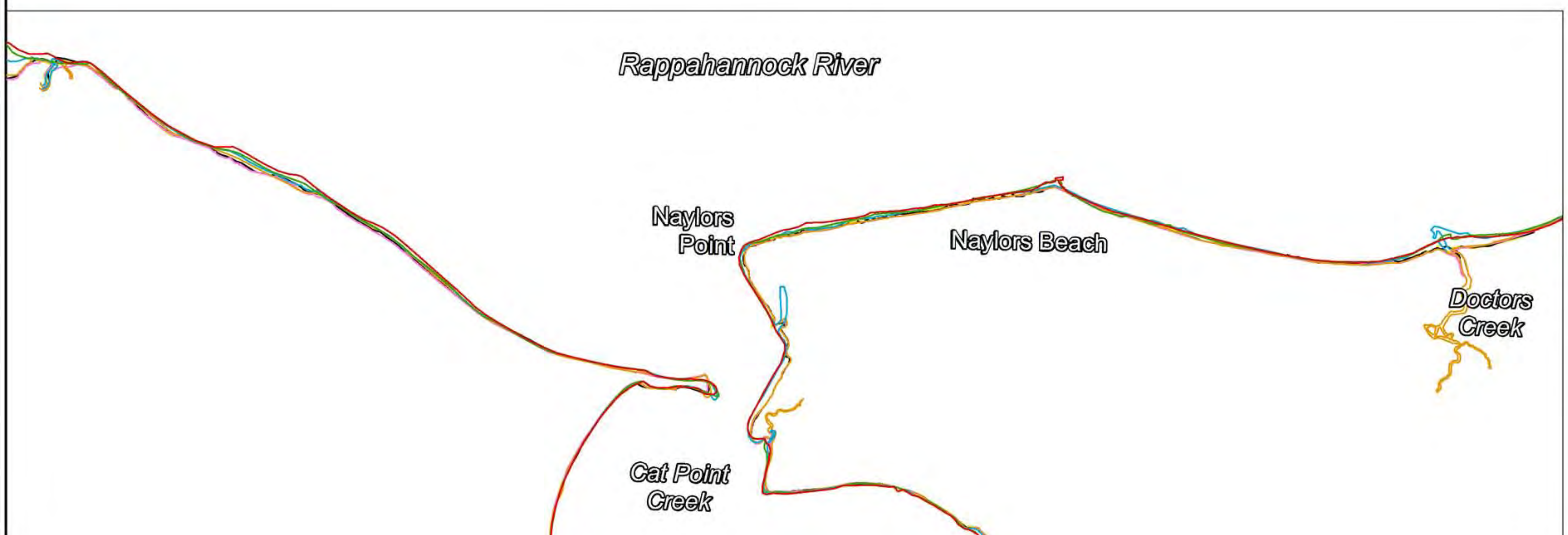
Shoreline Studies Program VIMS

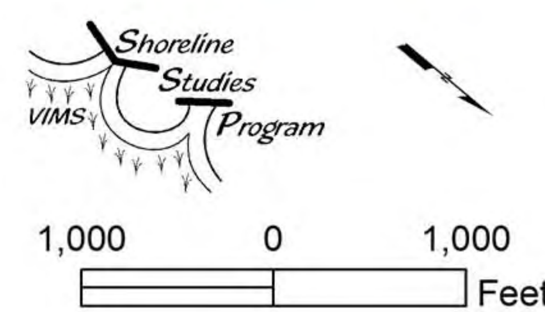
1,000 0 1,000 Feet

Richmond County Virginia

Plate 5

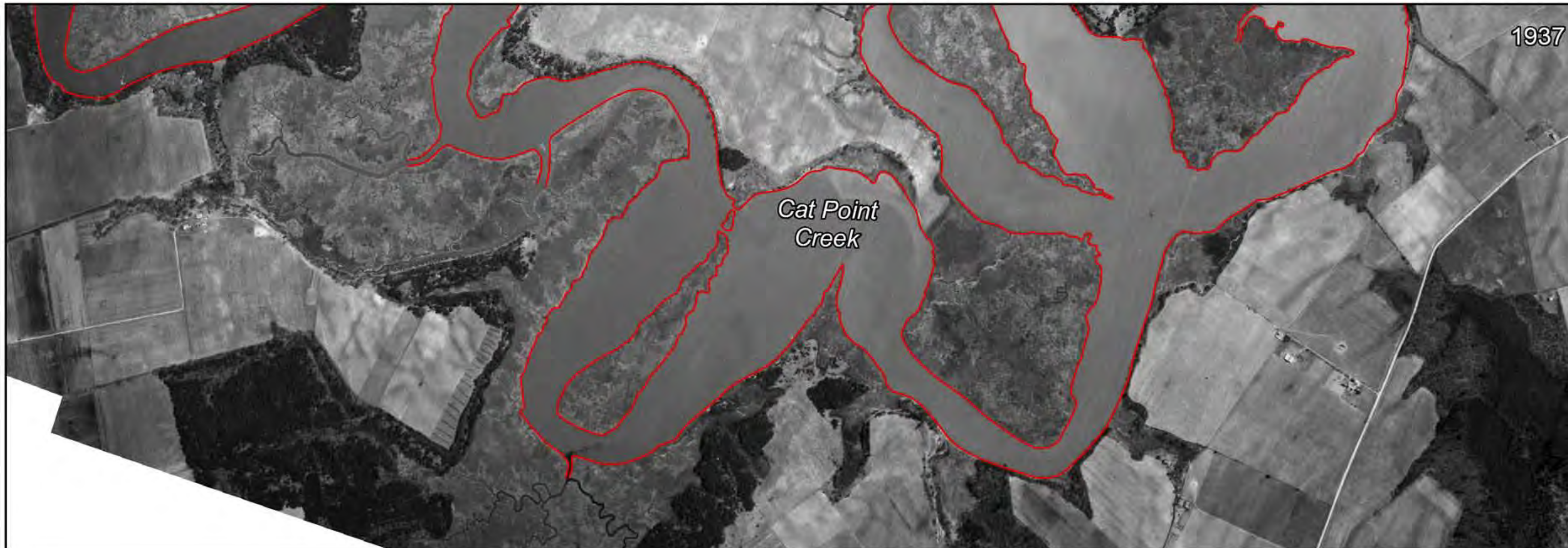






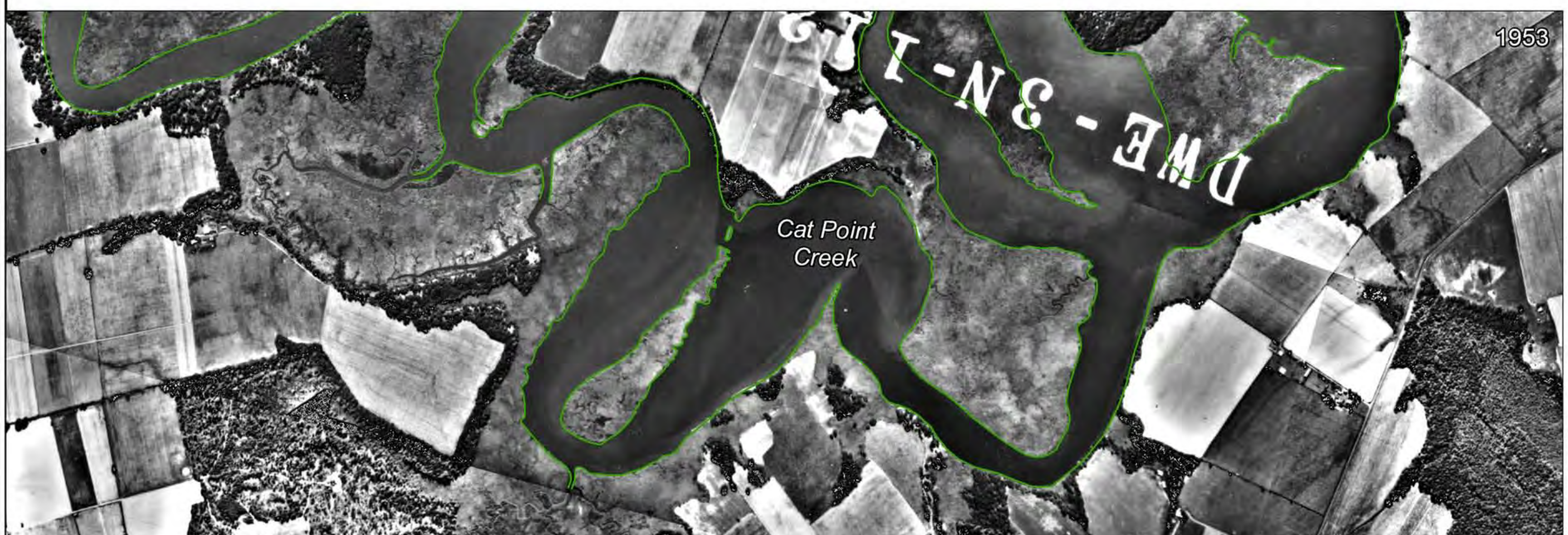
Richmond County Virginia

Plate 6



Legend

- 1937 Shoreline
- 1953 Shoreline

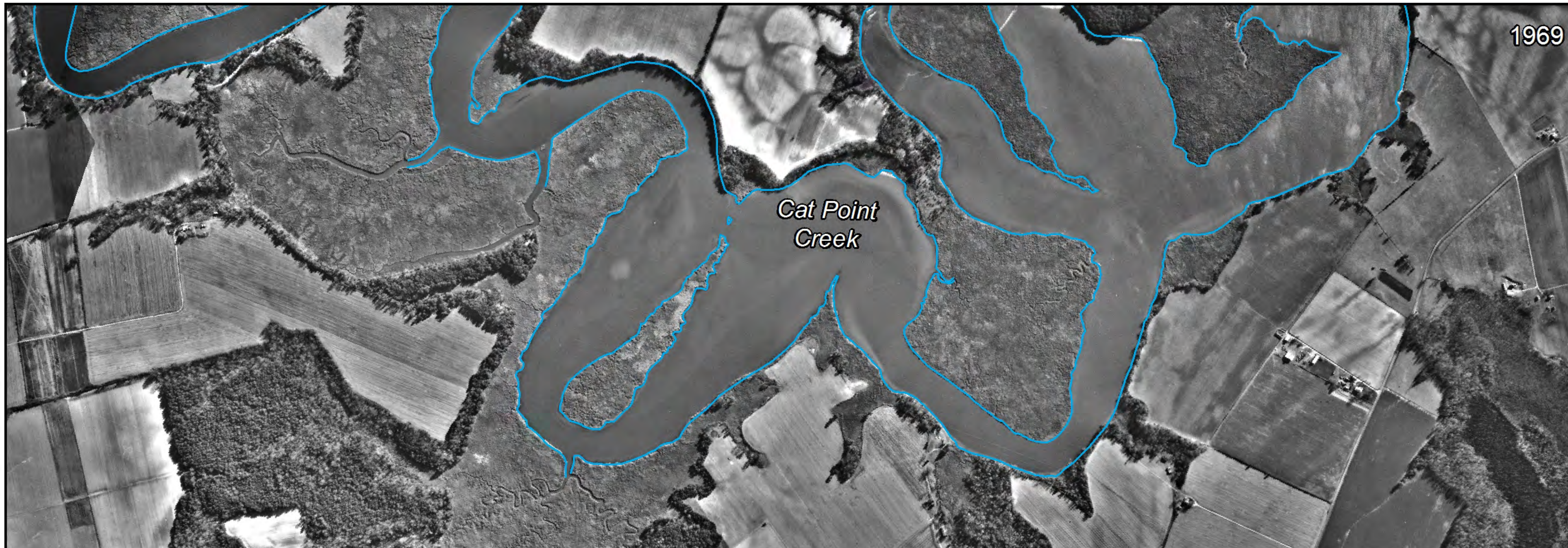


Shoreline Studies Program
VIMS

1,000 0 1,000 Feet

Richmond County Virginia

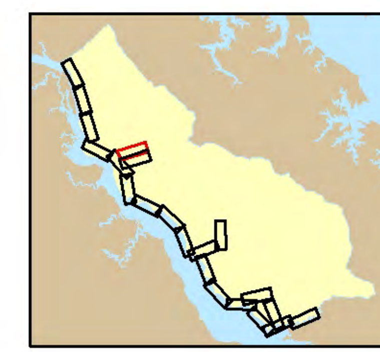
Plate 6



Legend

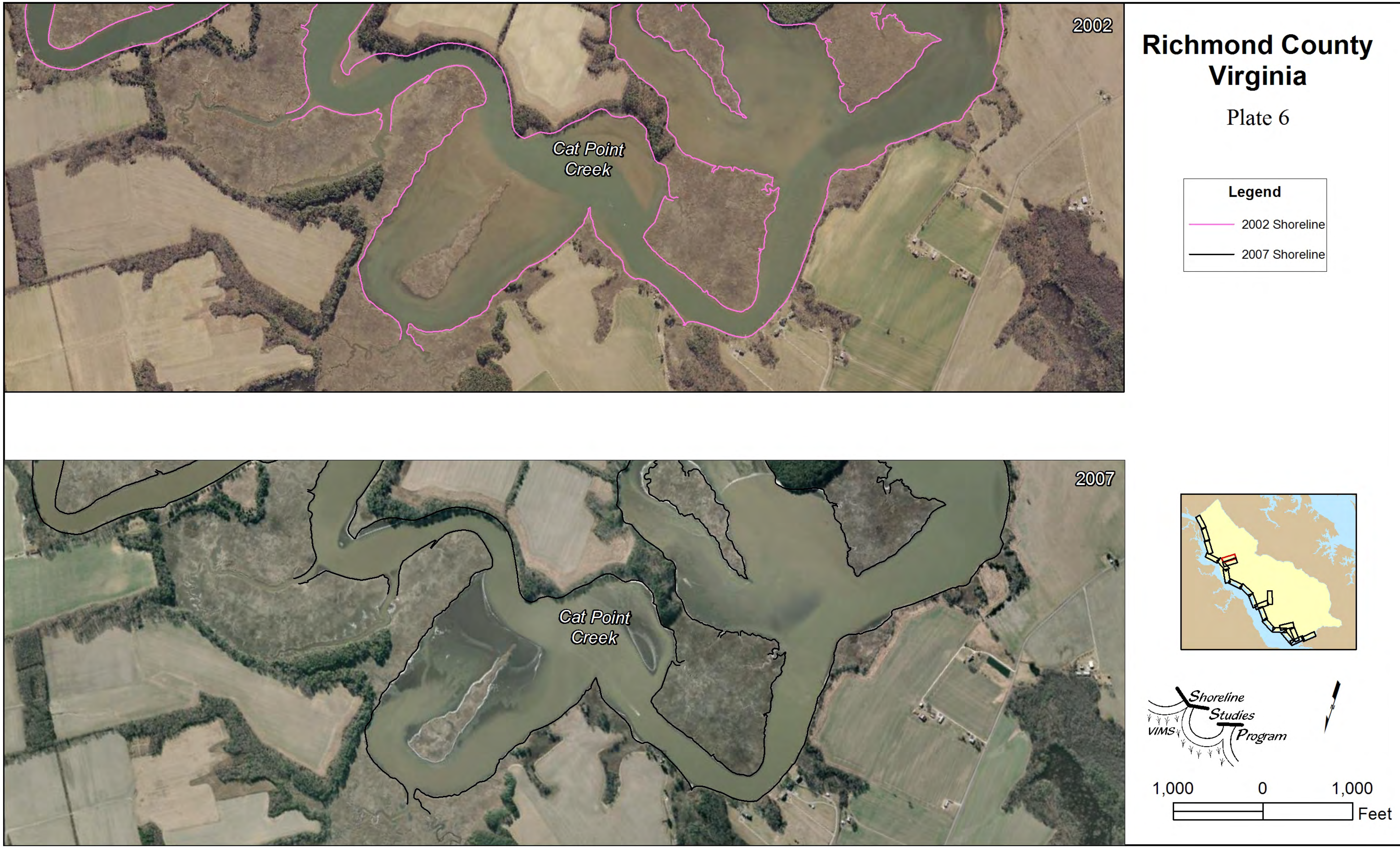
1969 Shoreline

1994 Shoreline



Shoreline Studies Program VIMS

1,000 0 1,000 Feet

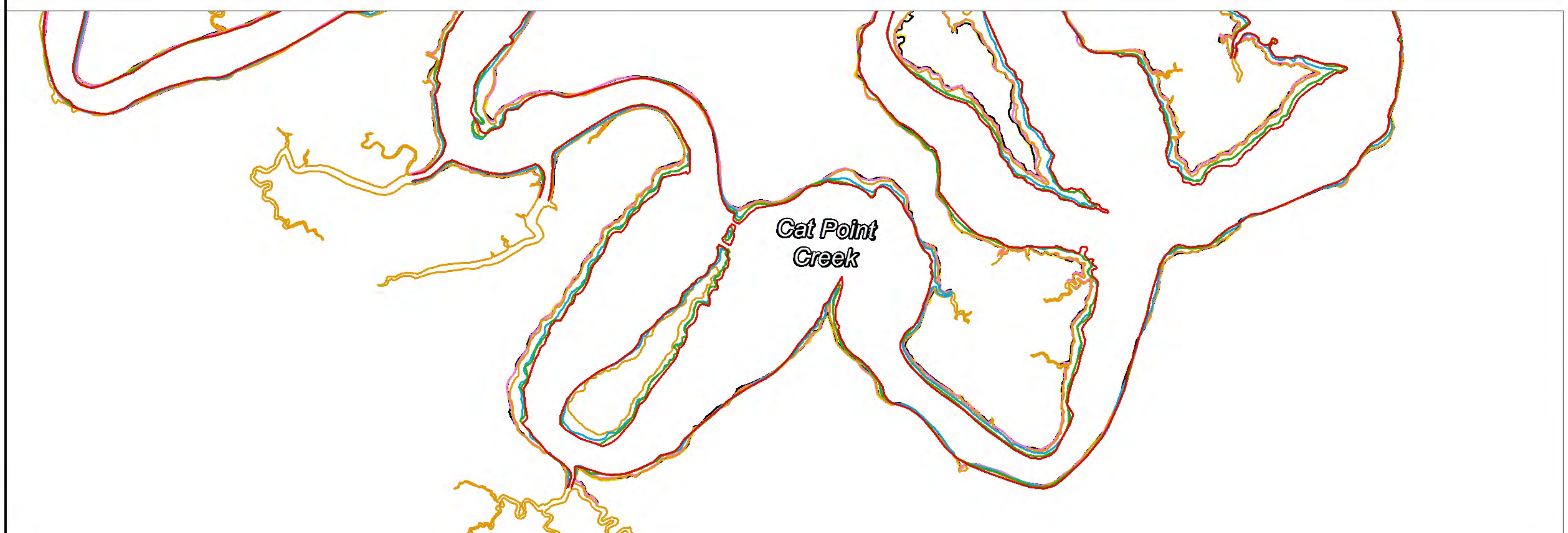

2002
Cat Point Creek
2007
Cat Point Creek
Richmond County Virginia
Plate 6
Legend
2002 Shoreline
2007 Shoreline
Shoreline Studies Program
VIMS
1,000 0 1,000
Feet

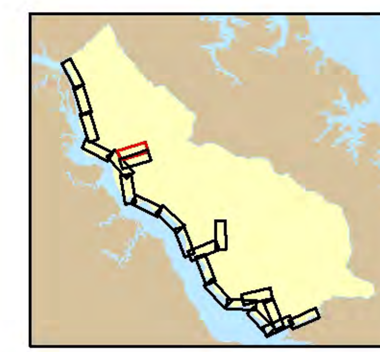
Richmond County Virginia

Plate 6

Legend

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline





VIMS Shoreline Studies Program

1,000 0 1,000 Feet

Richmond County Virginia

Plate 7

Legend

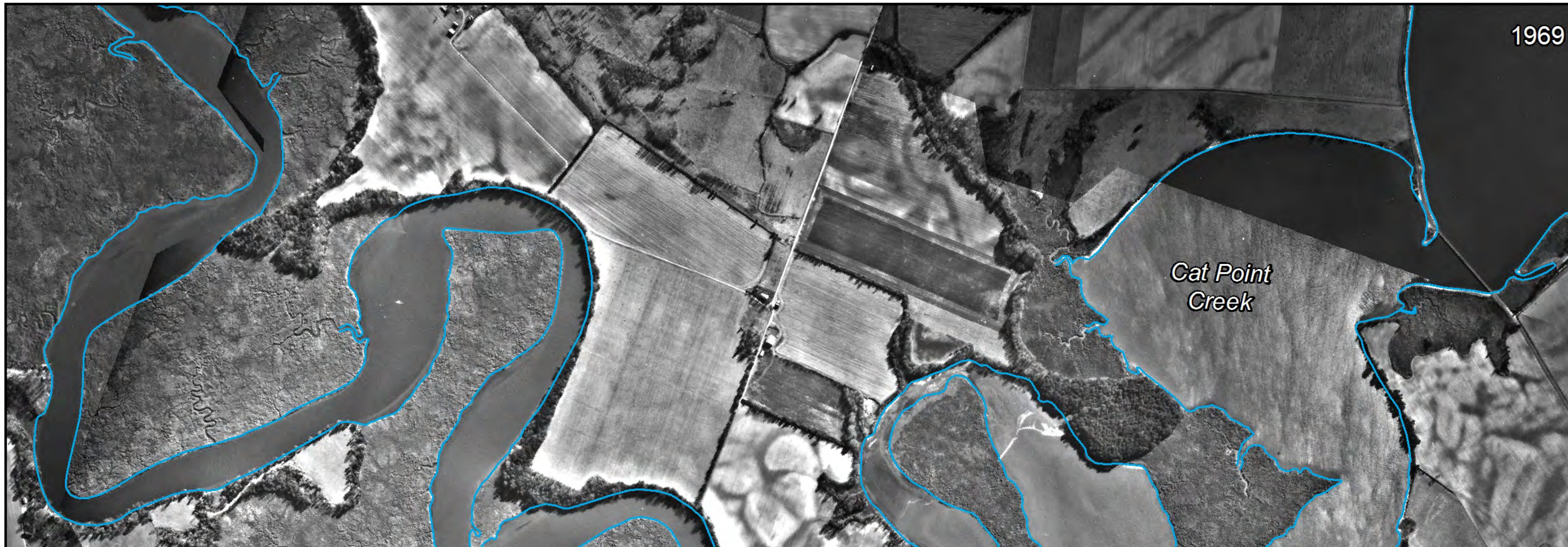
- 1937 Shoreline
- 1953 Shoreline

Shoreline Studies Program VIMS

1,000 0 1,000 Feet

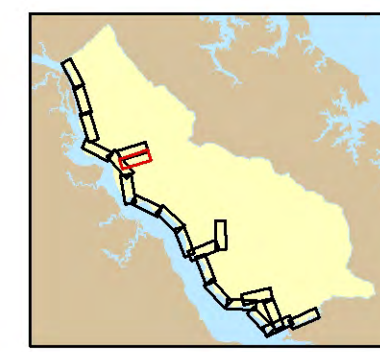
Richmond County Virginia

Plate 7



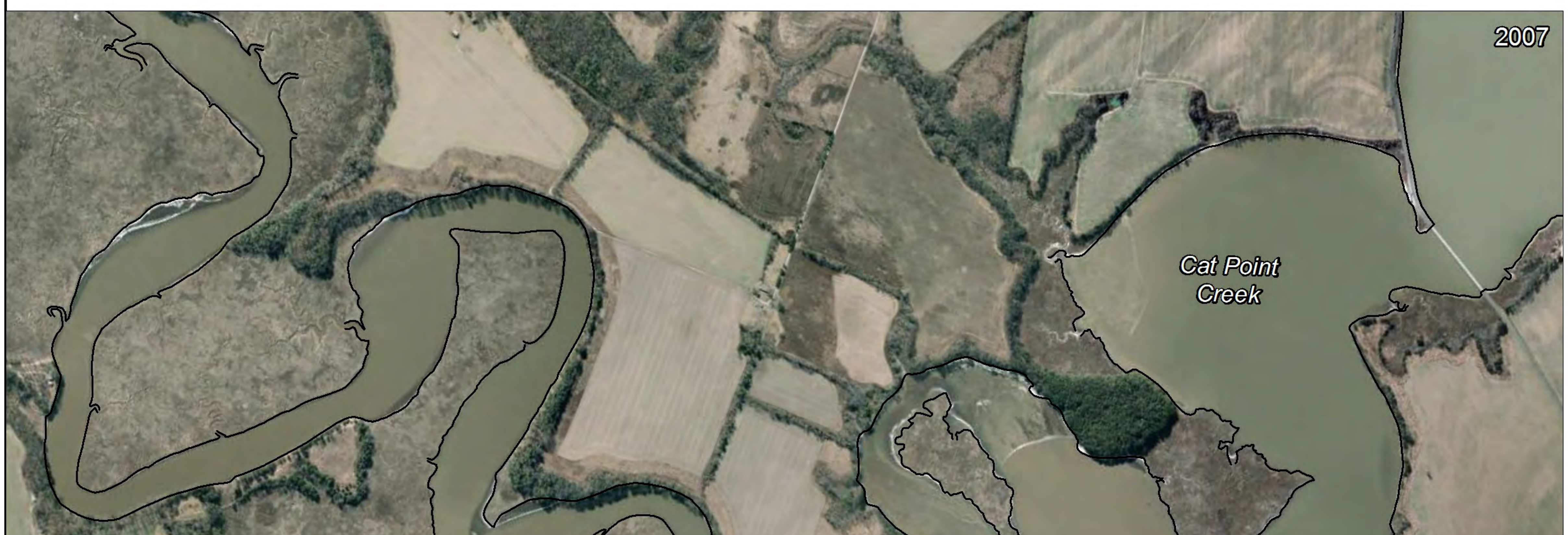
Legend

- 1969 Shoreline
- 1994 Shoreline



Shoreline Studies Program
VIMS

1,000 0 1,000
Feet



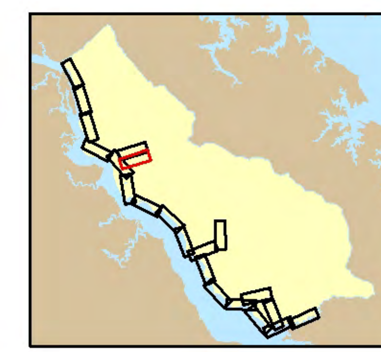
Richmond County
Virginia

Plate 7

Legend

2002 Shoreline

2007 Shoreline



Shoreline Studies Program

VIMS

1,000 0 1,000

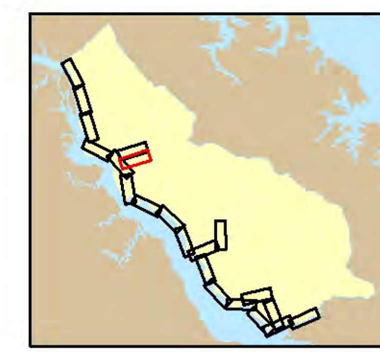
Feet

Richmond County Virginia

Plate 7

Legend

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline

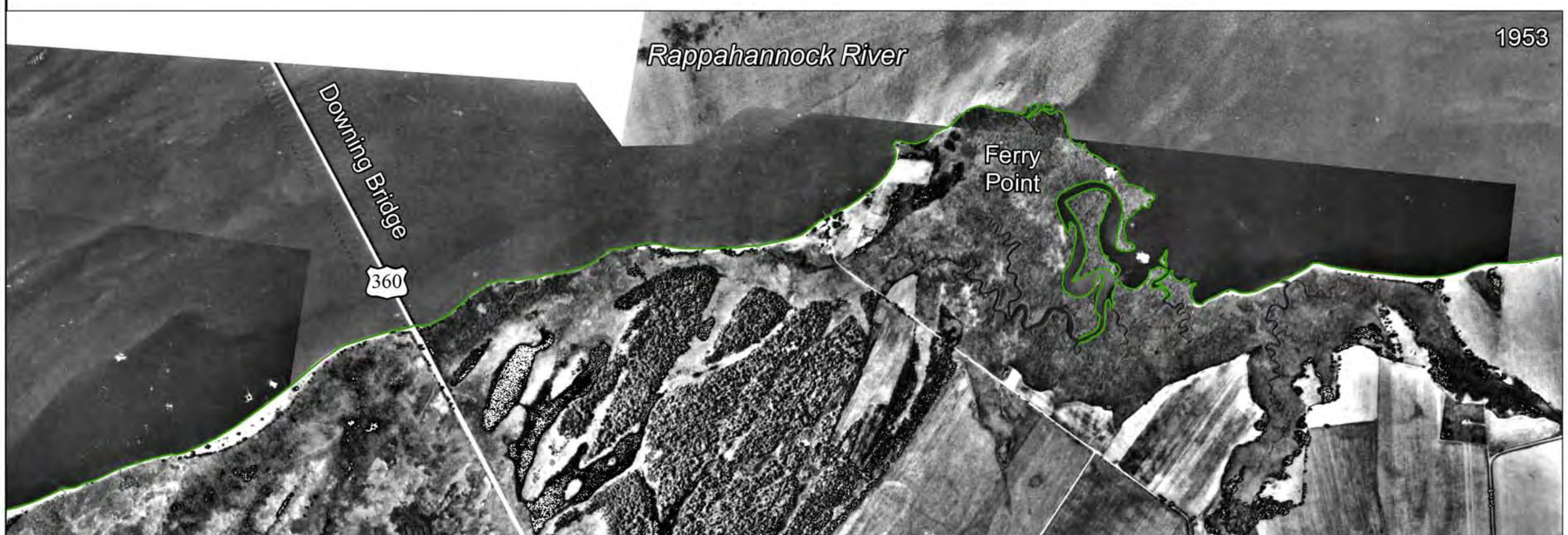


Shoreline Studies Program
VIMS

1,000 0 1,000
Feet

Richmond County Virginia

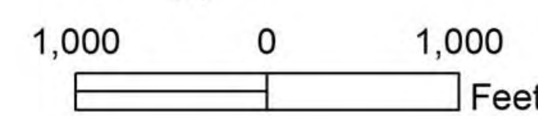
Plate 8

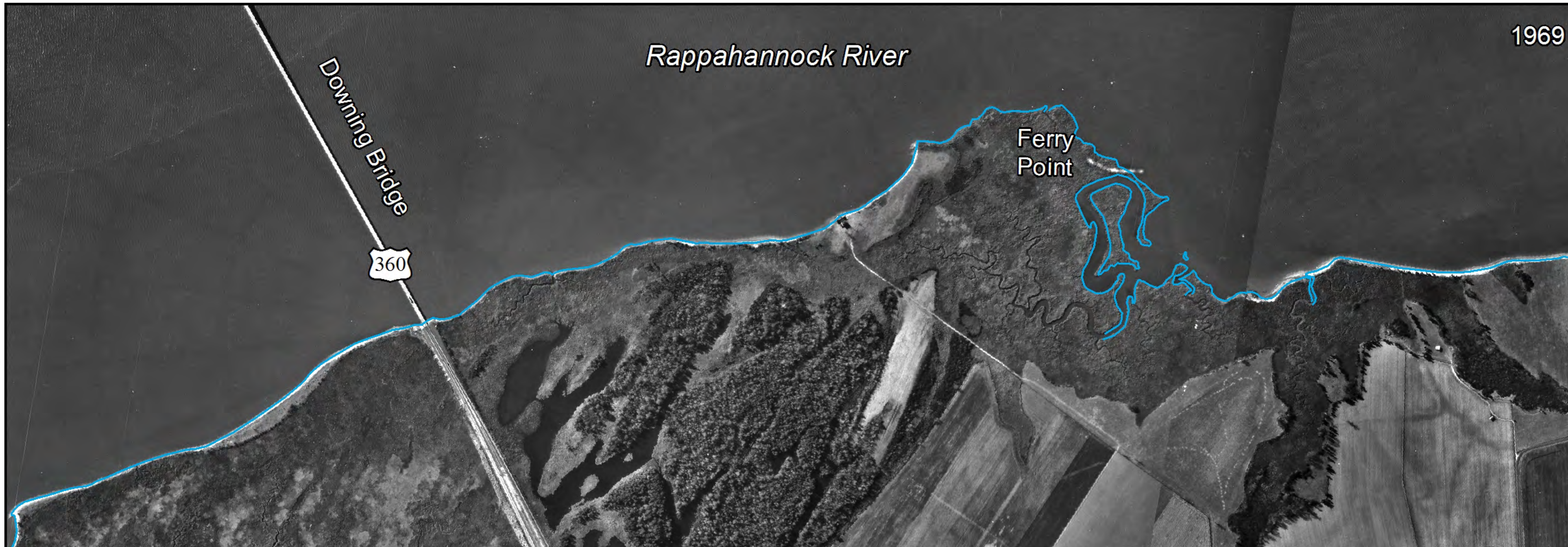


Legend

1937 Shoreline

1953 Shoreline





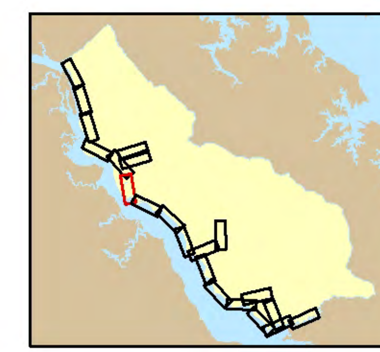
Richmond County Virginia

Plate 8

Legend

1969 Shoreline

1994 Shoreline

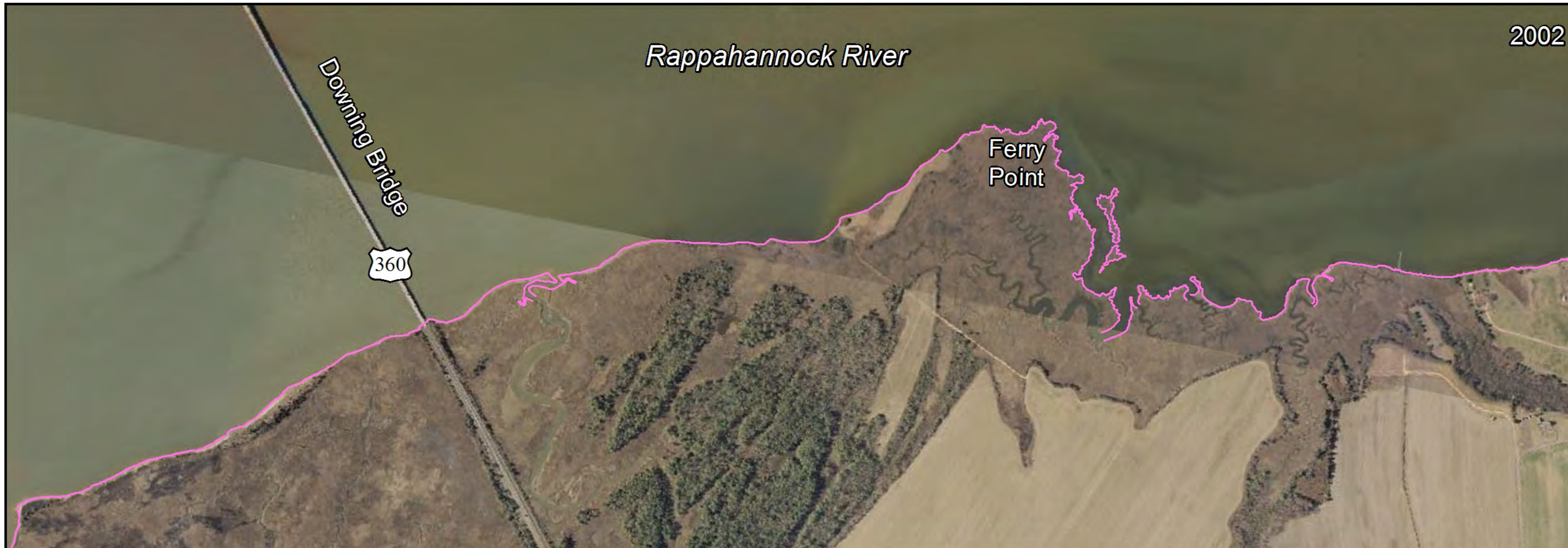


Shoreline Studies Program VIMS

1,000 0 1,000 Feet

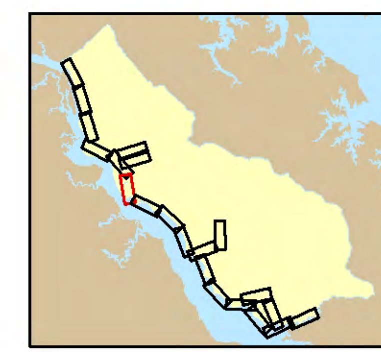
Richmond County Virginia

Plate 8



Legend

- 2002 Shoreline
- 2007 Shoreline



Shoreline Studies Program
VIMS

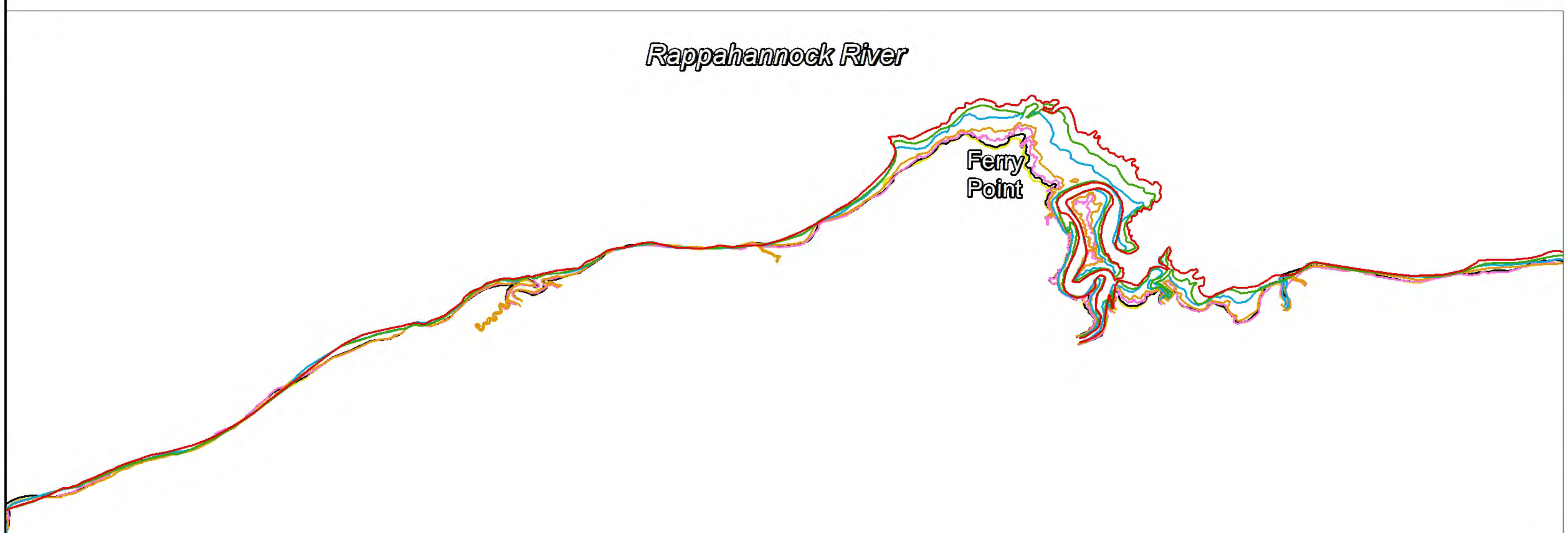
1,000 0 1,000
Feet

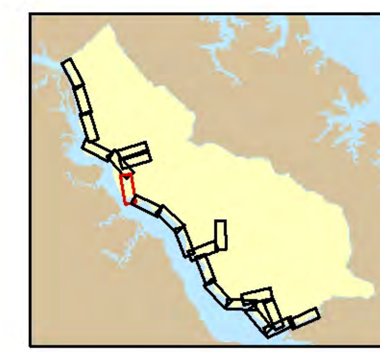
Richmond County Virginia

Plate 8

Legend

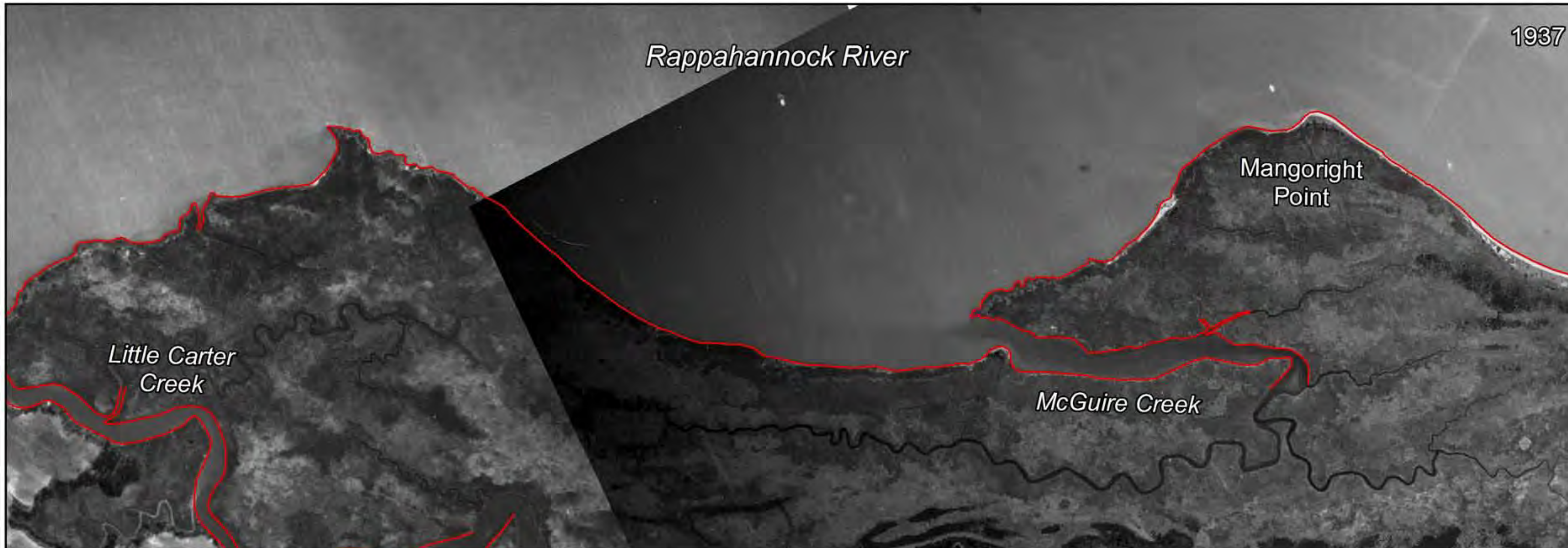
- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline





Shoreline Studies Program
VIMS

1,000 0 1,000
Feet



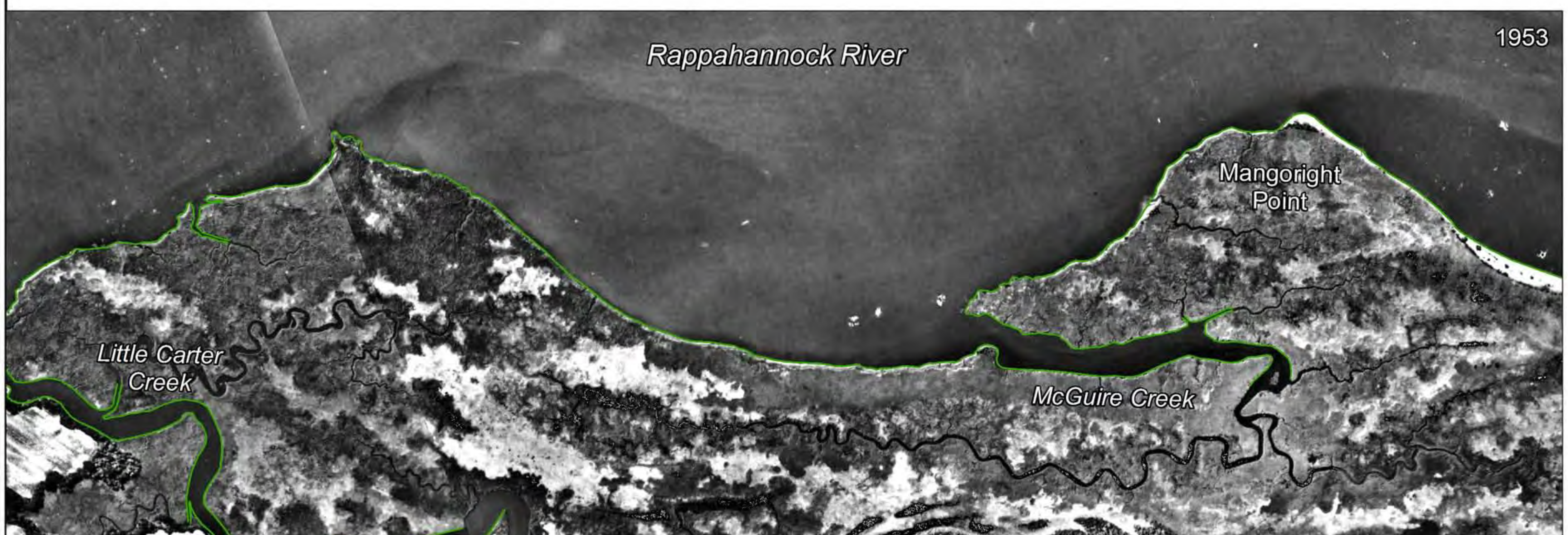
Richmond County Virginia

Plate 9

Legend

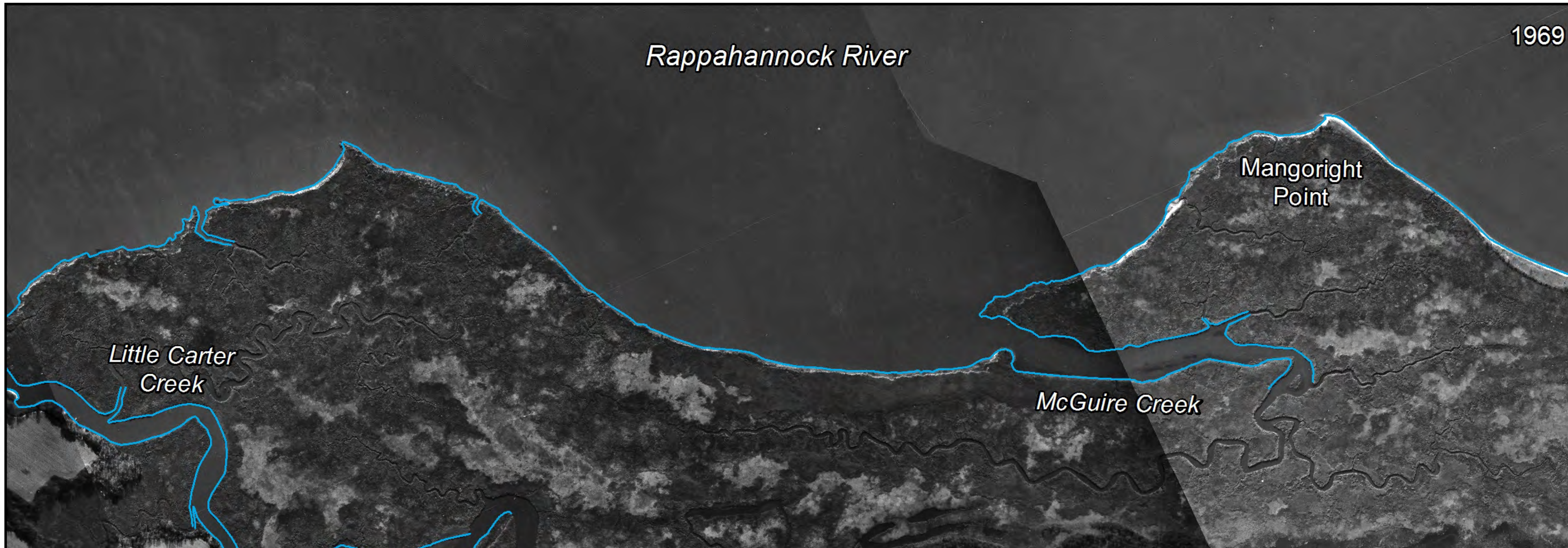
1937 Shoreline

1953 Shoreline



Shoreline Studies Program
VIMS

1,000 0 1,000
Feet



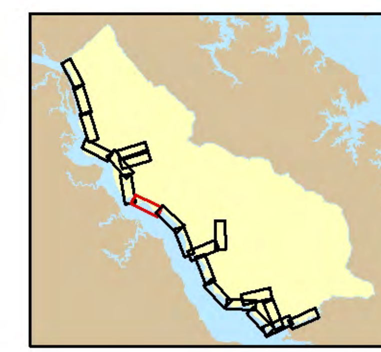
Richmond County Virginia

Plate 9

Legend

1969 Shoreline

1994 Shoreline



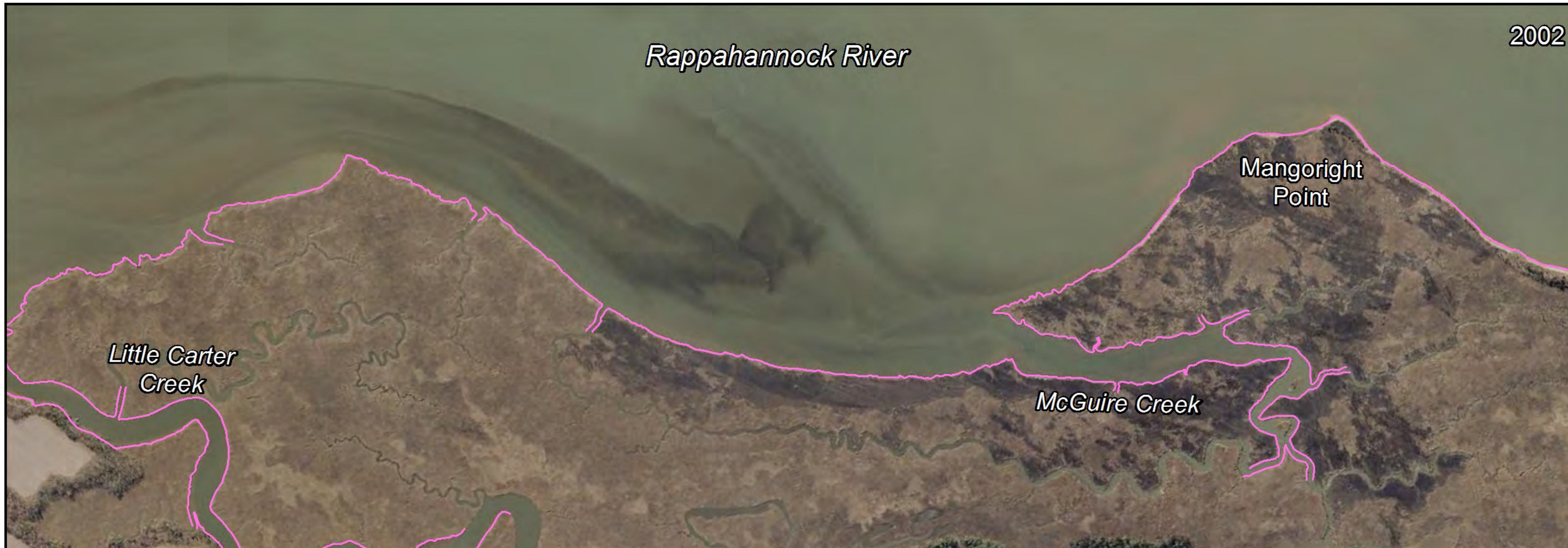
Shoreline Studies Program VIMS

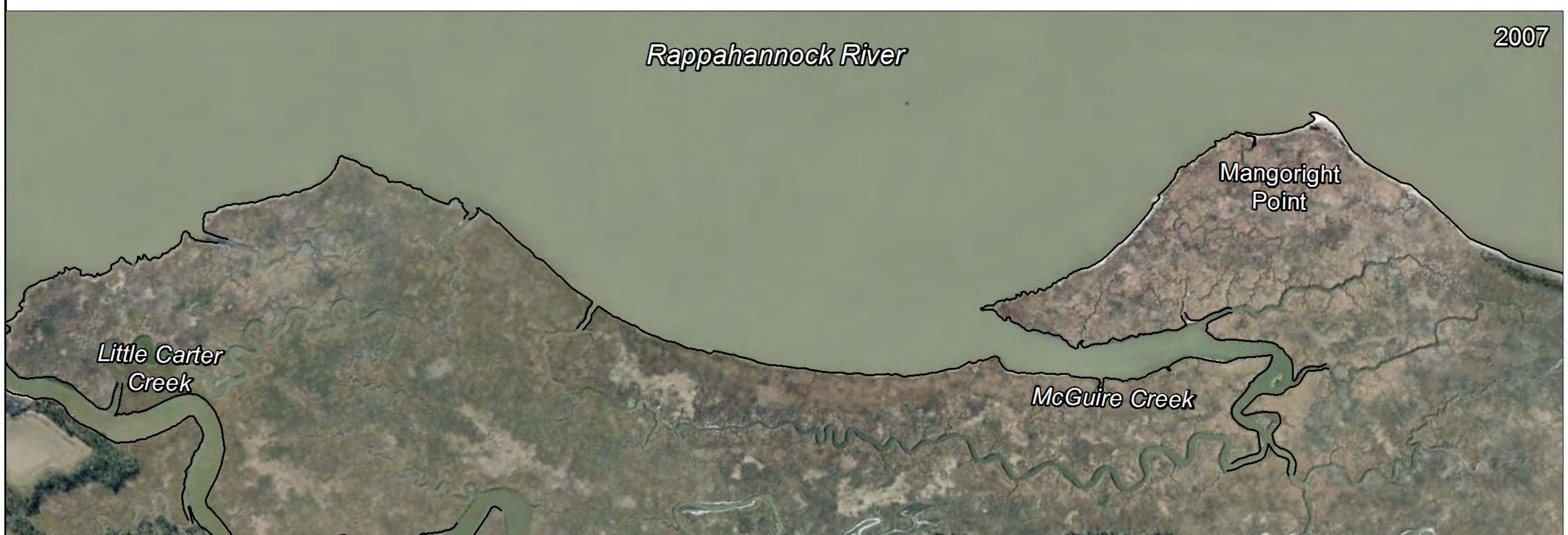
1,000 0 1,000

Feet

Richmond County Virginia

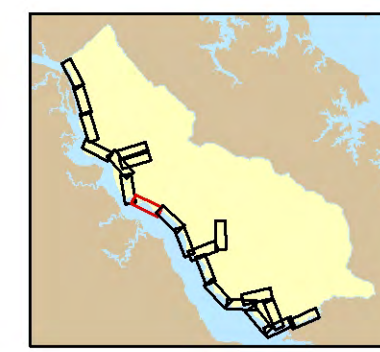
Plate 9





Legend

- 2002 Shoreline
- 2007 Shoreline



Shoreline Studies Program VIMS

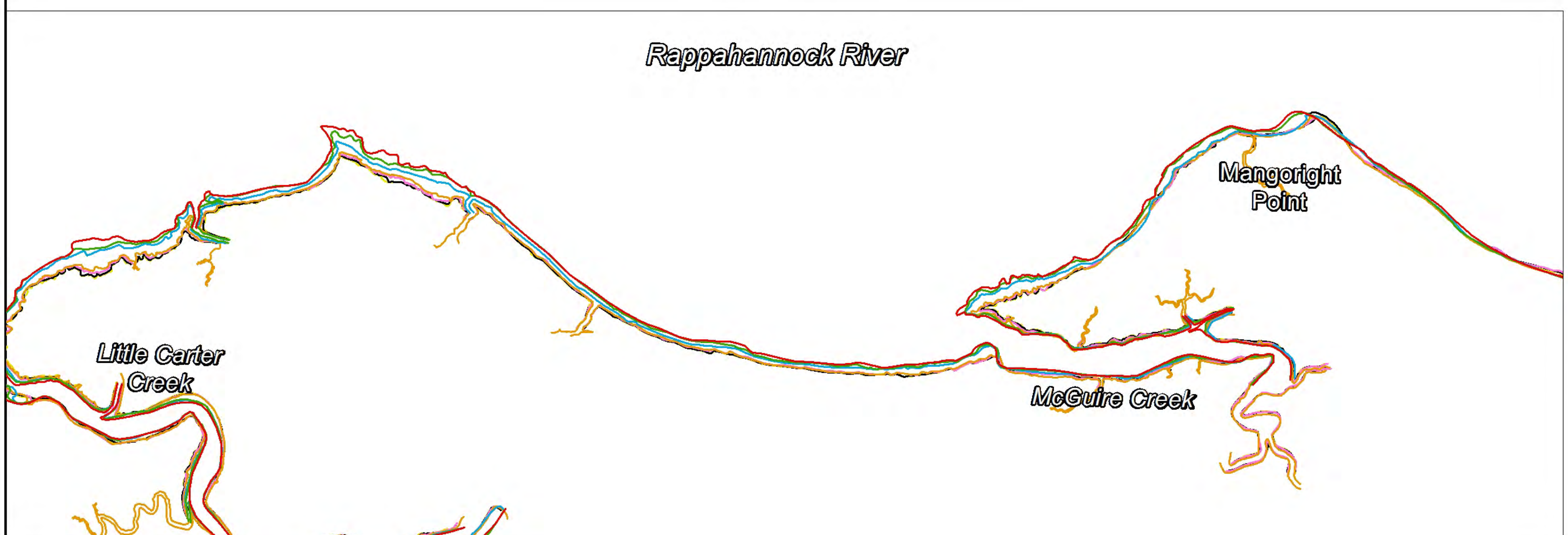
1,000 0 1,000 Feet

Richmond County Virginia

Plate 9

Legend

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline



Shoreline Studies Program
VIMS

1,000 0 1,000
Feet

Richmond County Virginia

Plate 10

Legend

1937 Shoreline

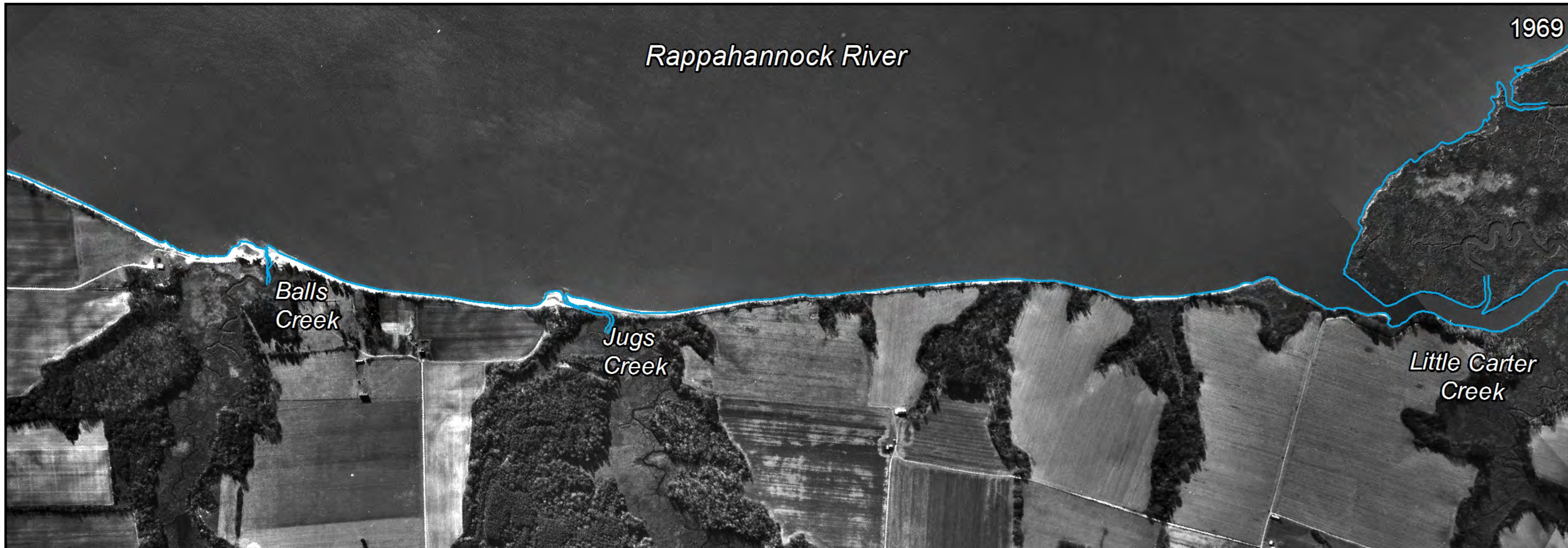
1953 Shoreline

Shoreline Studies Program
VIMS

1,000 0 1,000
Feet

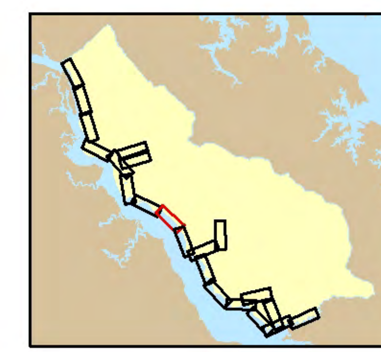
Richmond County Virginia

Plate 10



Legend

- 1969 Shoreline
- 1994 Shoreline

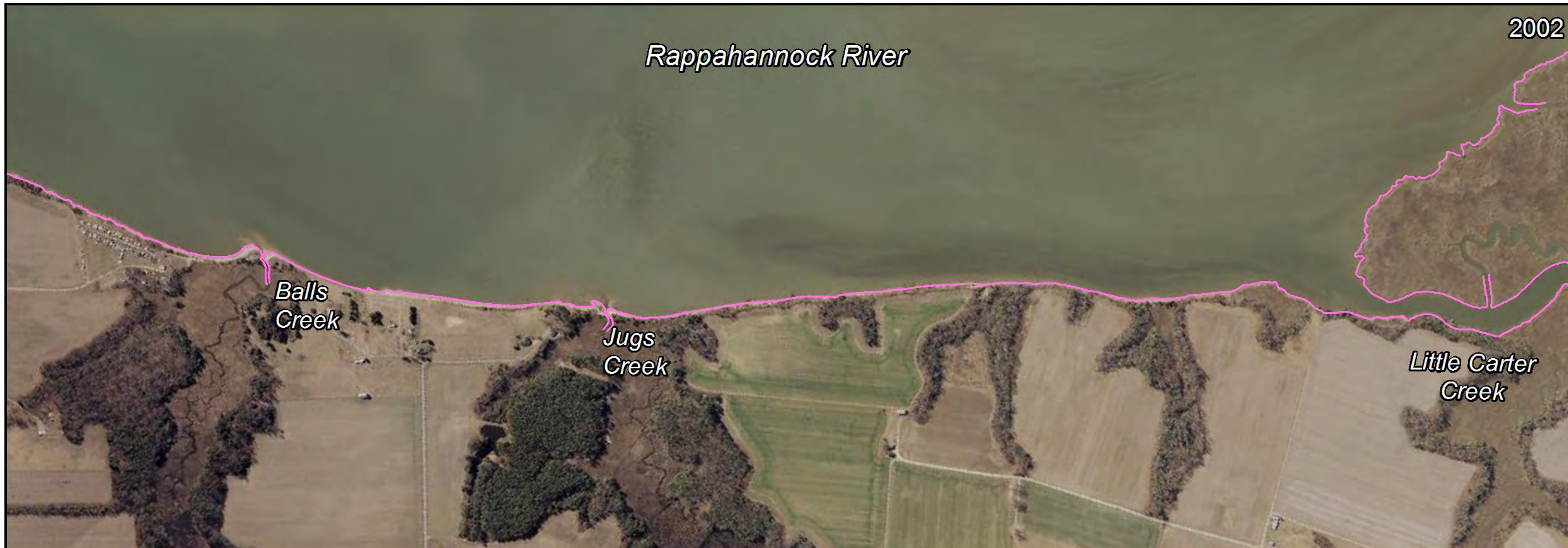


Shoreline Studies Program VIMS

1,000 0 1,000 Feet

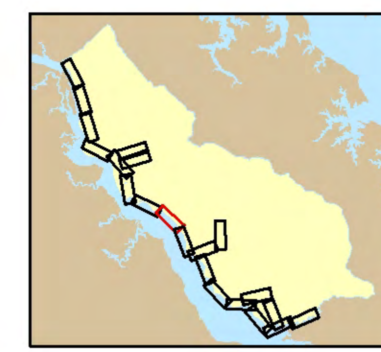
Richmond County Virginia

Plate 10



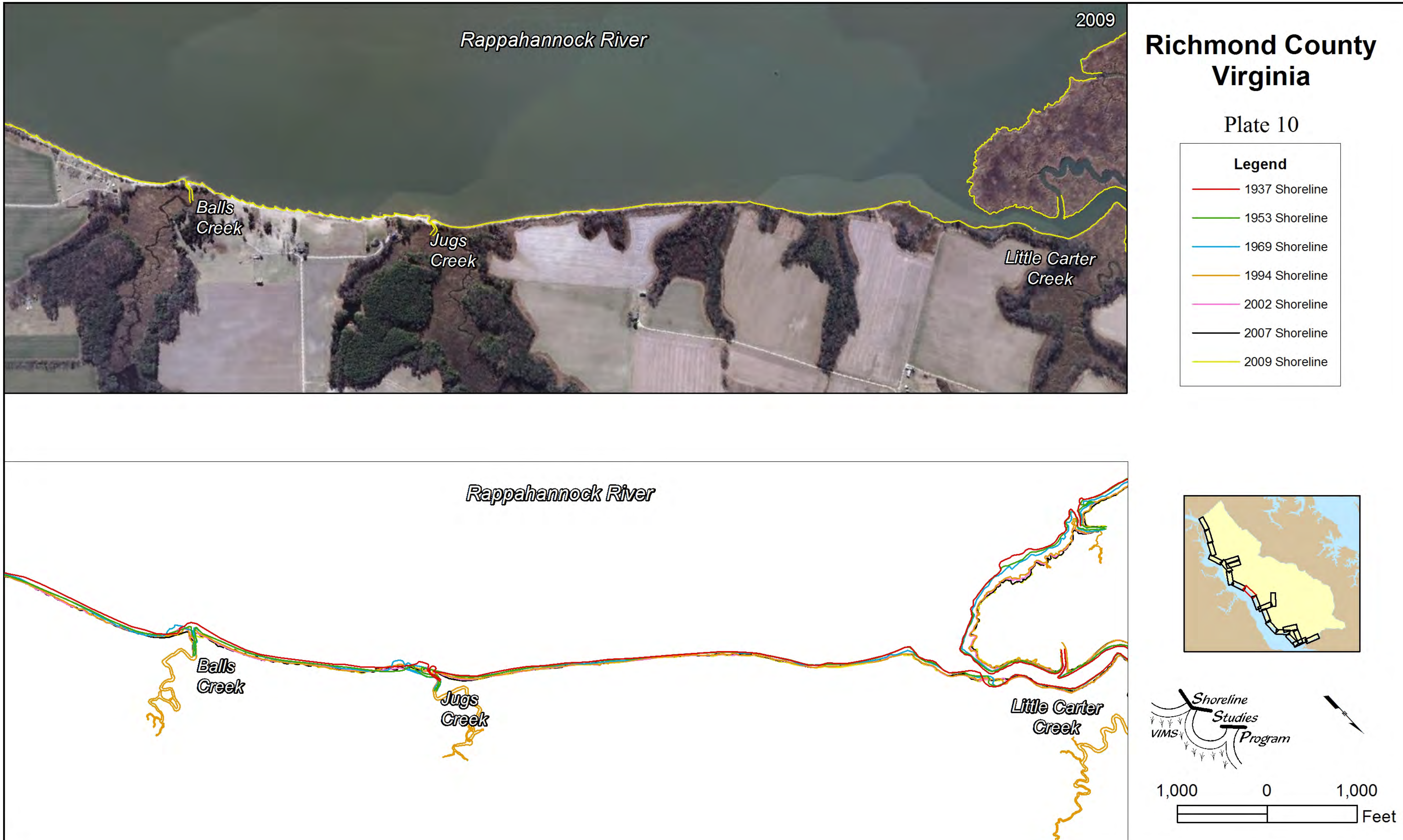
Legend

- 2002 Shoreline
- 2007 Shoreline



Shoreline Studies Program
VIMS

1,000 0 1,000
Feet



Richmond County
Virginia
Plate 10
2009
Rappahannock River
Balls Creek
Jugs Creek
Little Carter Creek
Legend
1937 Shoreline
1953 Shoreline
1969 Shoreline
1994 Shoreline
2002 Shoreline
2007 Shoreline
2009 Shoreline
Rappahannock River
Balls Creek
Jugs Creek
Little Carter Creek
Shoreline Studies Program
VIMS
1,000 0 1,000
Feet

Richmond County Virginia

Plate 11

Legend

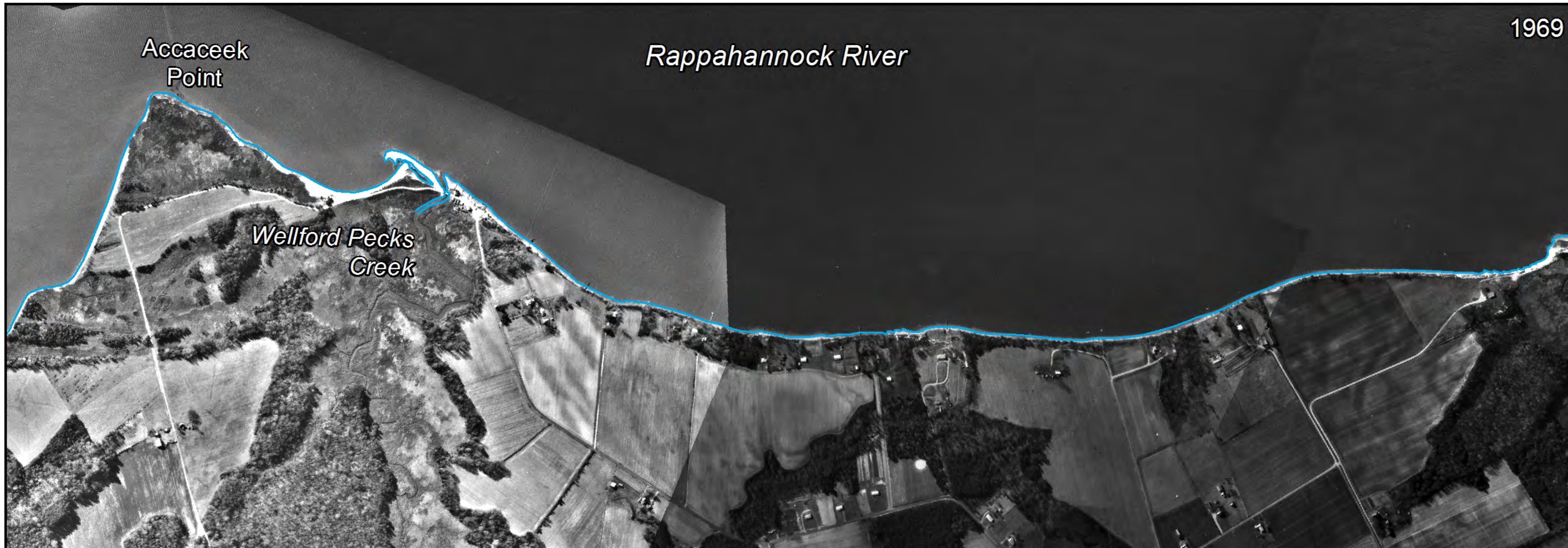
- 1937 Shoreline
- 1953 Shoreline

Shoreline Studies Program
VIMS

1,000 0 1,000
Feet

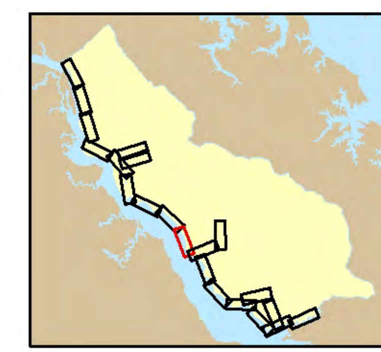
Richmond County Virginia

Plate 11



Legend

- 1969 Shoreline
- 1994 Shoreline



Shoreline Studies Program
VIMS

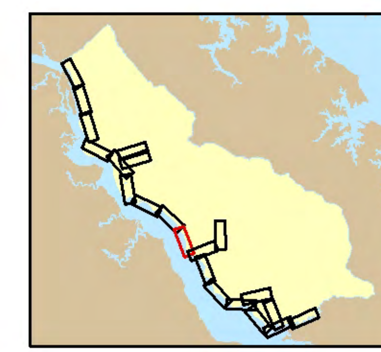
1,000 0 1,000
Feet

Richmond County Virginia

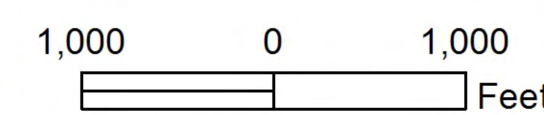
Plate 11

Legend

- 2002 Shoreline
- 2007 Shoreline



Shoreline Studies Program
VIMS

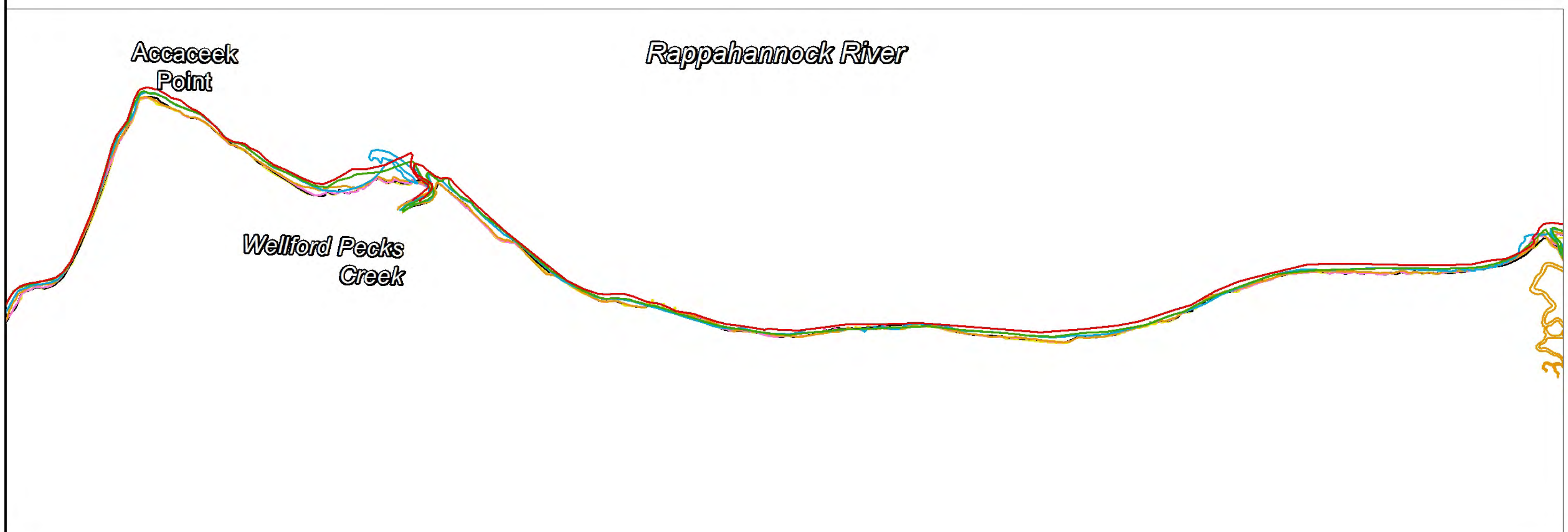


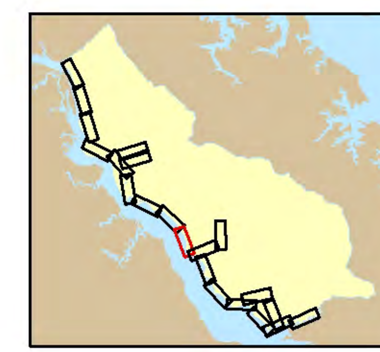
Richmond County Virginia

Plate 11

Legend

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline





Shoreline Studies Program
VIMS

1,000 0 1,000
Feet

Richmond County Virginia

Plate 12

Legend

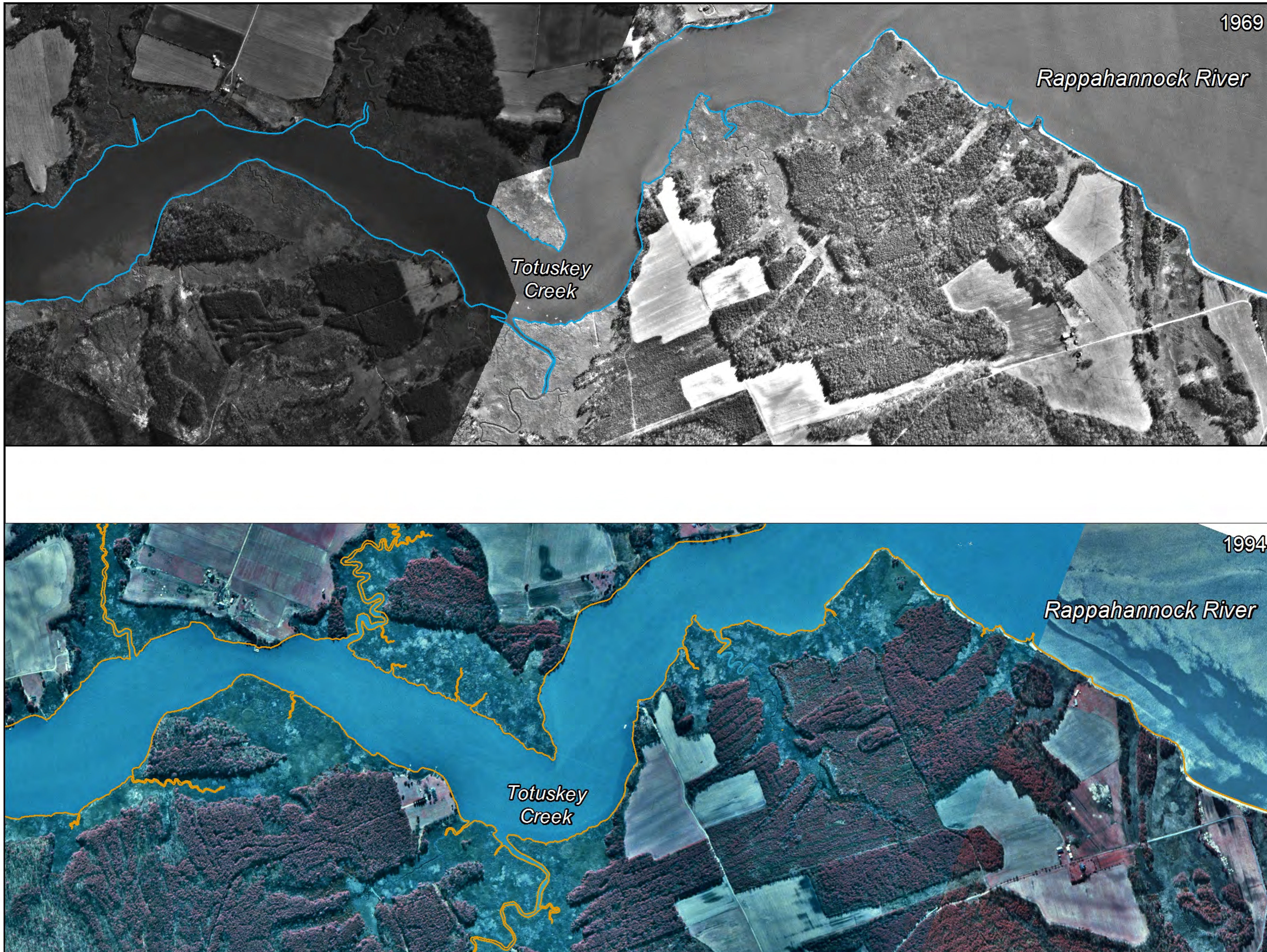
- 1937 Shoreline
- 1953 Shoreline

VIMS Shoreline Studies Program

1,000 0 1,000 Feet

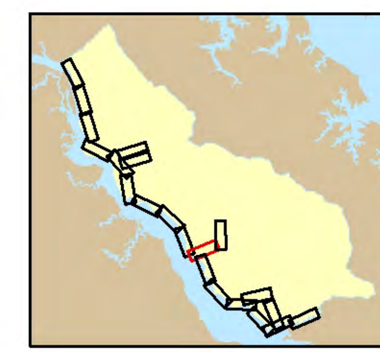
Richmond County Virginia

Plate 12



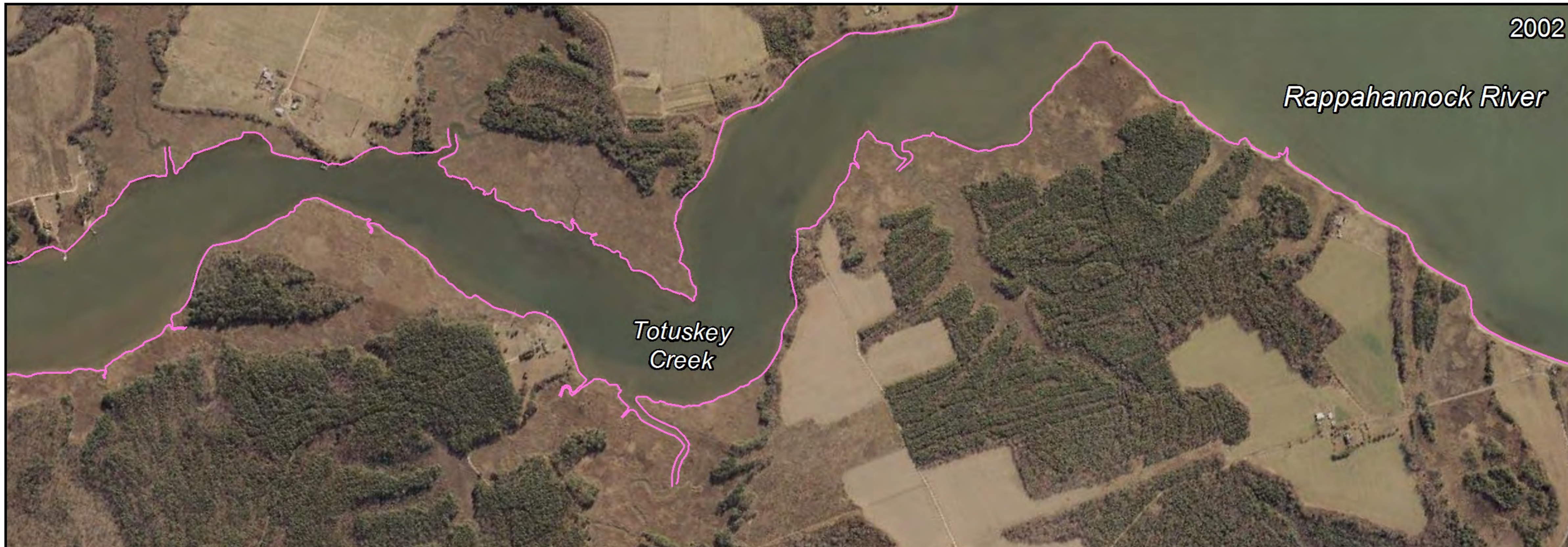
Legend

- 1969 Shoreline
- 1994 Shoreline



Shoreline Studies Program
VIMS

1,000 0 1,000 Feet



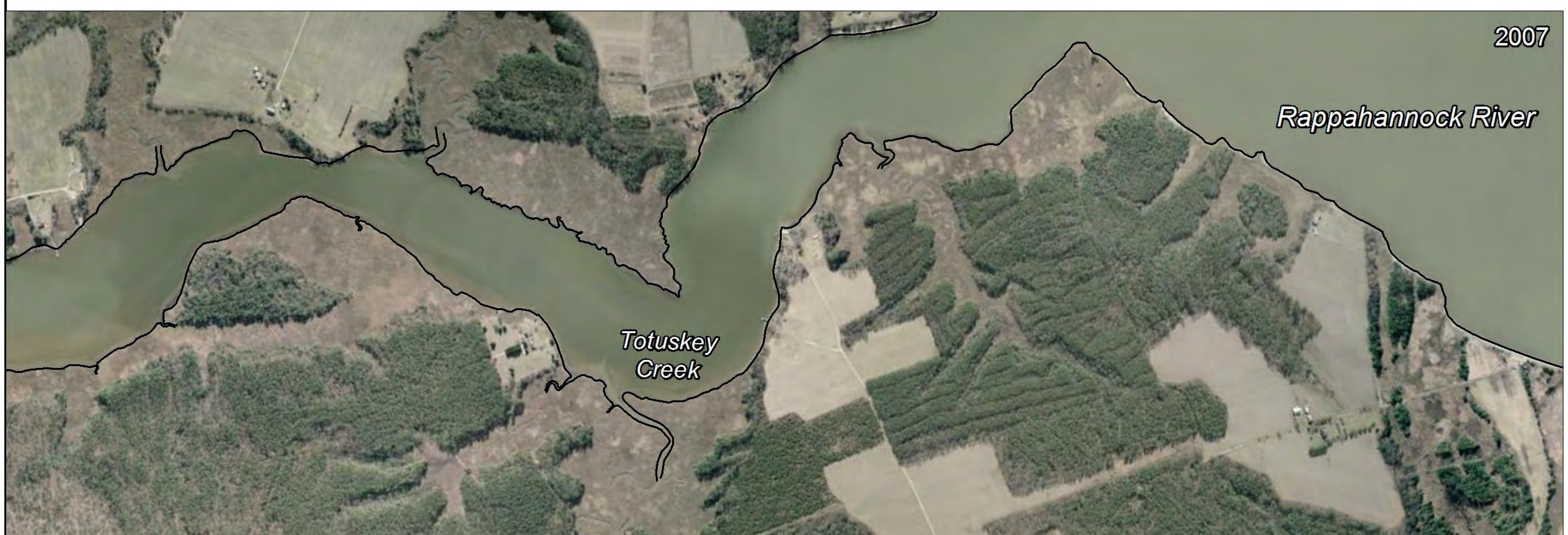
Richmond County Virginia

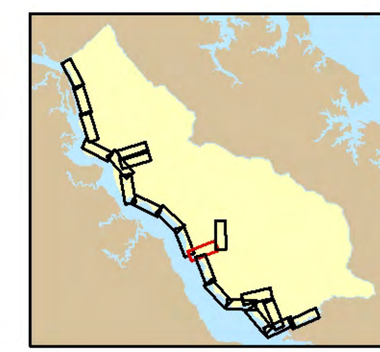
Plate 12

Legend

2002 Shoreline

2007 Shoreline





Shoreline Studies Program
VIMS

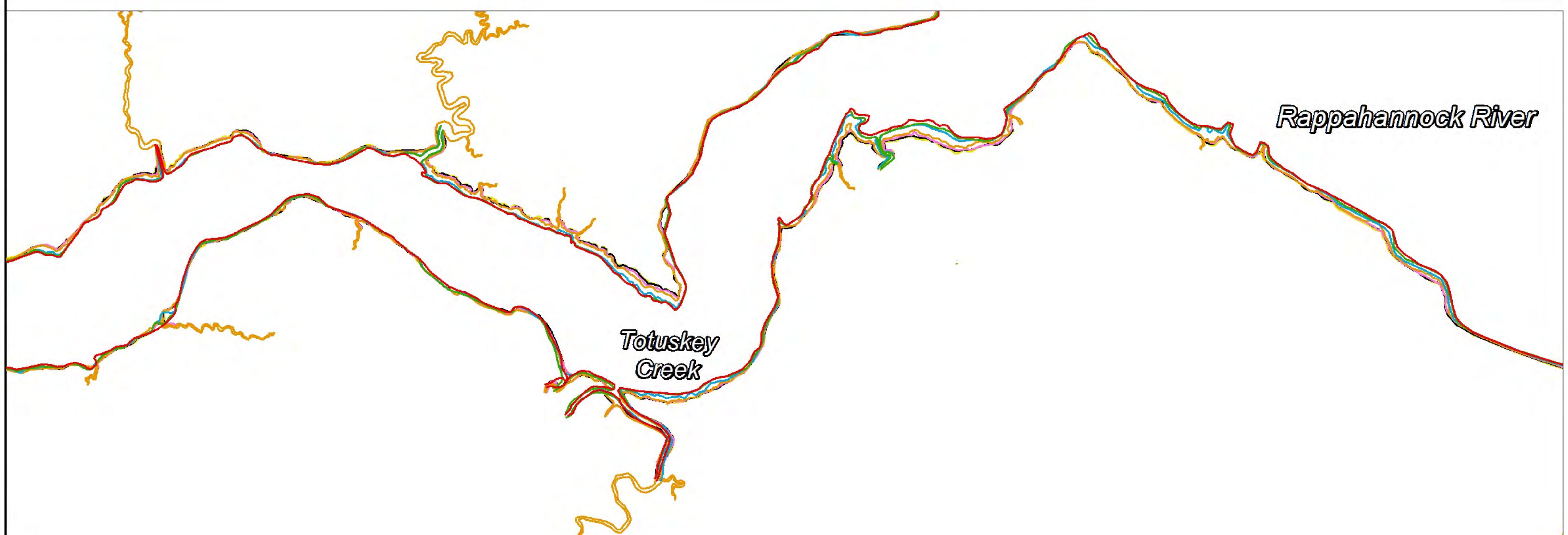
1,000 0 1,000
Feet

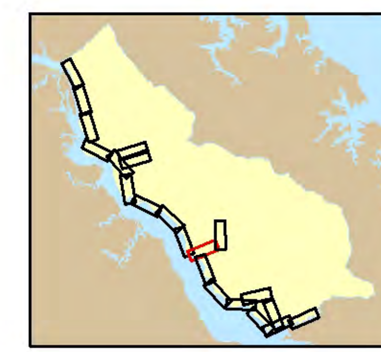
Richmond County Virginia

Plate 12

Legend

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline





1,000 0 1,000 Feet

Richmond County Virginia

Plate 13

Legend

(red line)	1937 Shoreline
(green line)	1953 Shoreline

Shoreline Studies Program VIMS

1,000 0 1,000 Feet

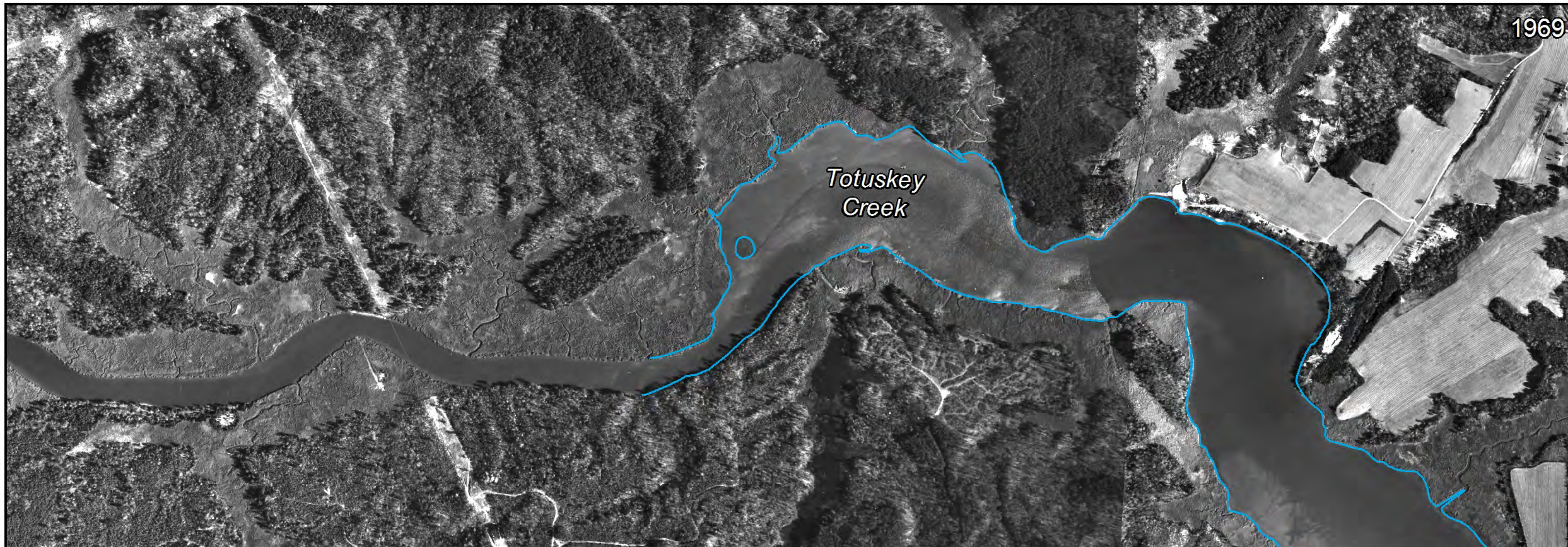
Richmond County Virginia

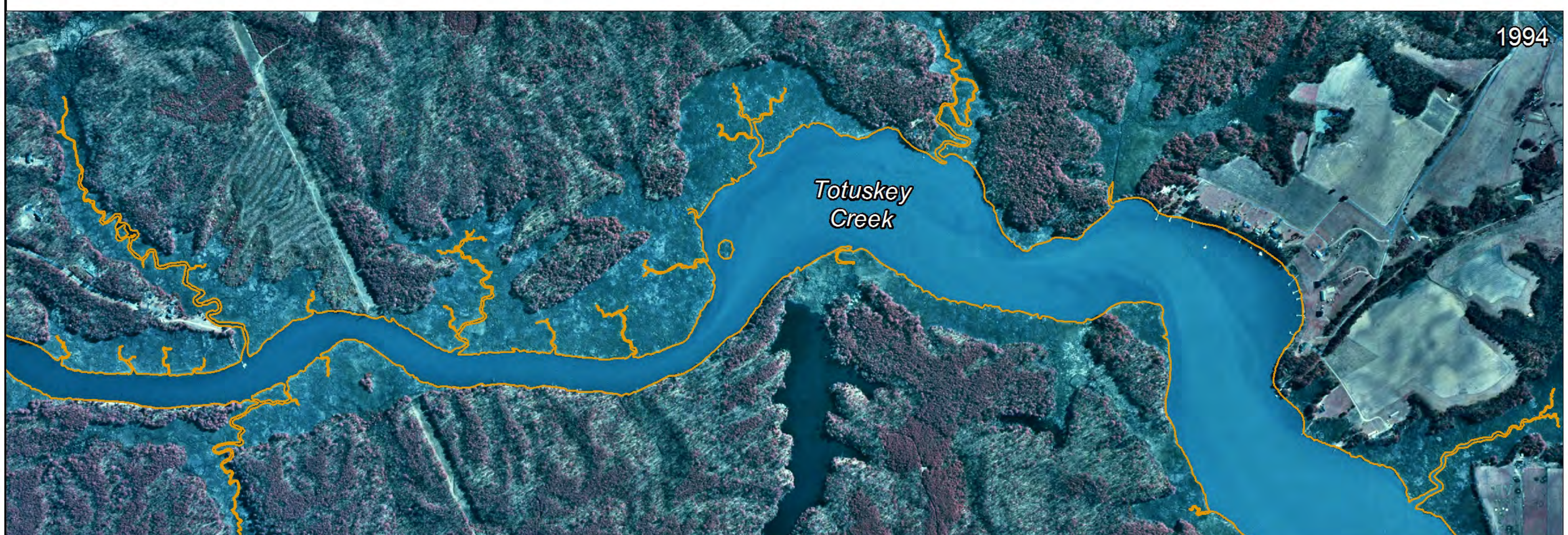
Plate 13

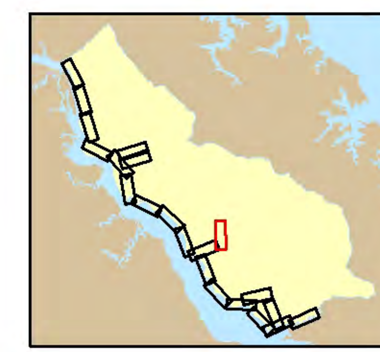
Legend

1969 Shoreline

1994 Shoreline





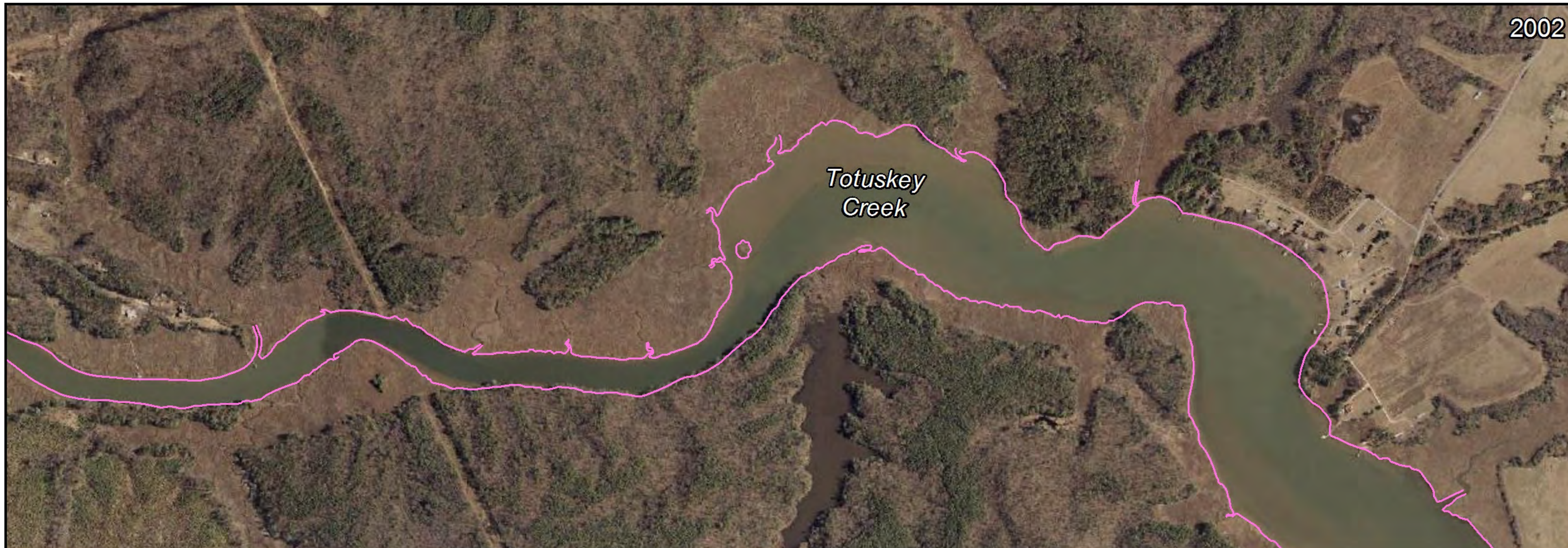


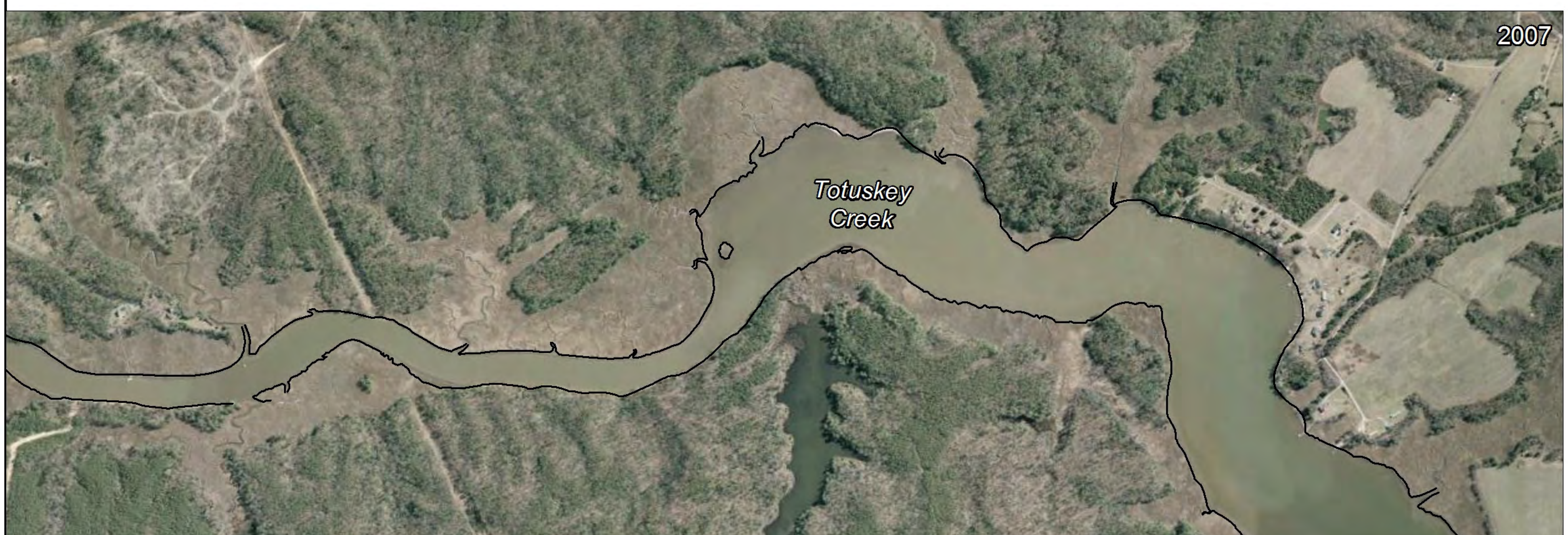
Shoreline Studies Program
VIMS

1,000 0 1,000
Feet

Richmond County Virginia

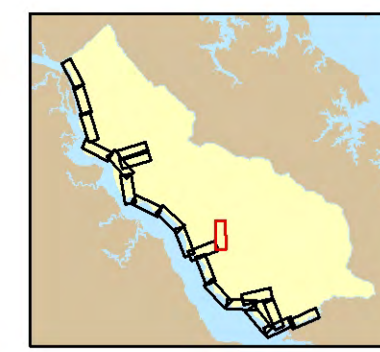
Plate 13

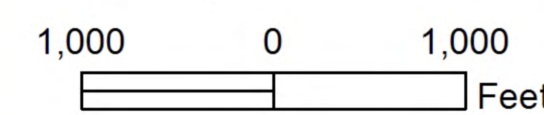


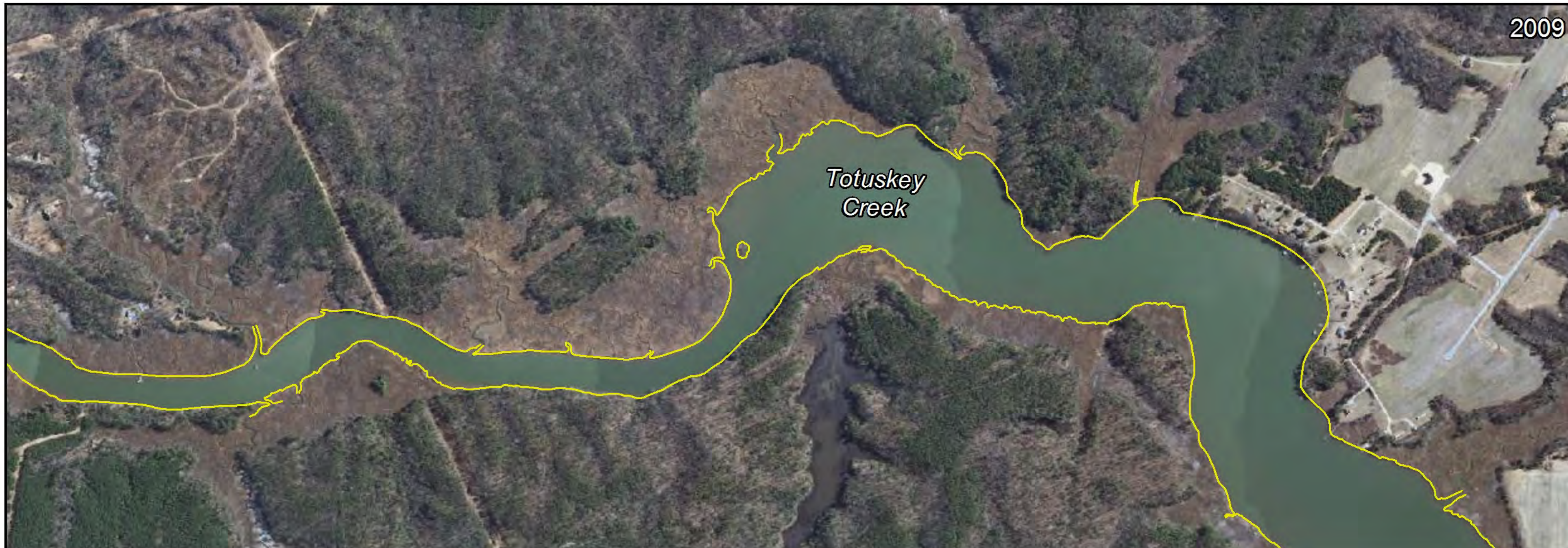


Legend

- 2002 Shoreline
- 2007 Shoreline





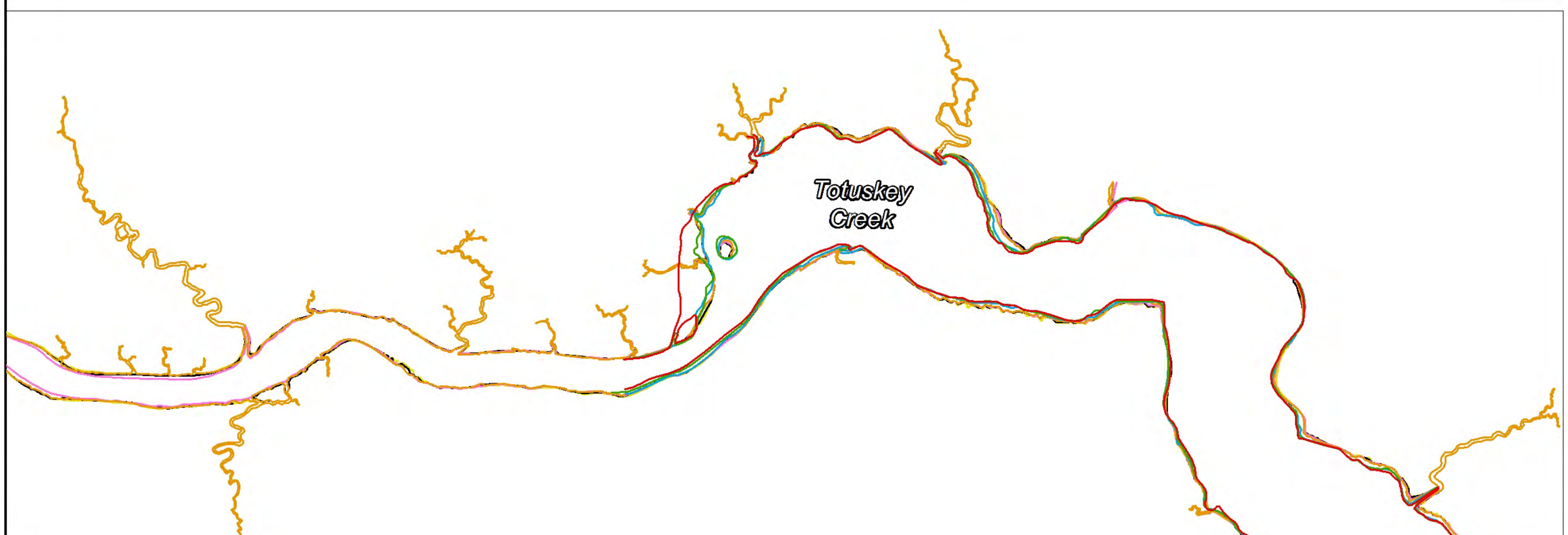


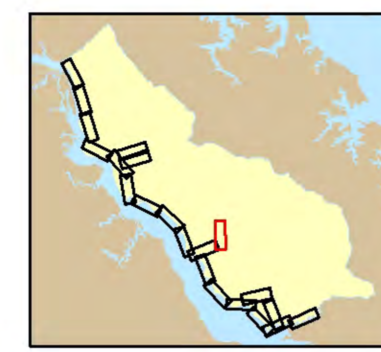
Richmond County Virginia

Plate 13

Legend

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline



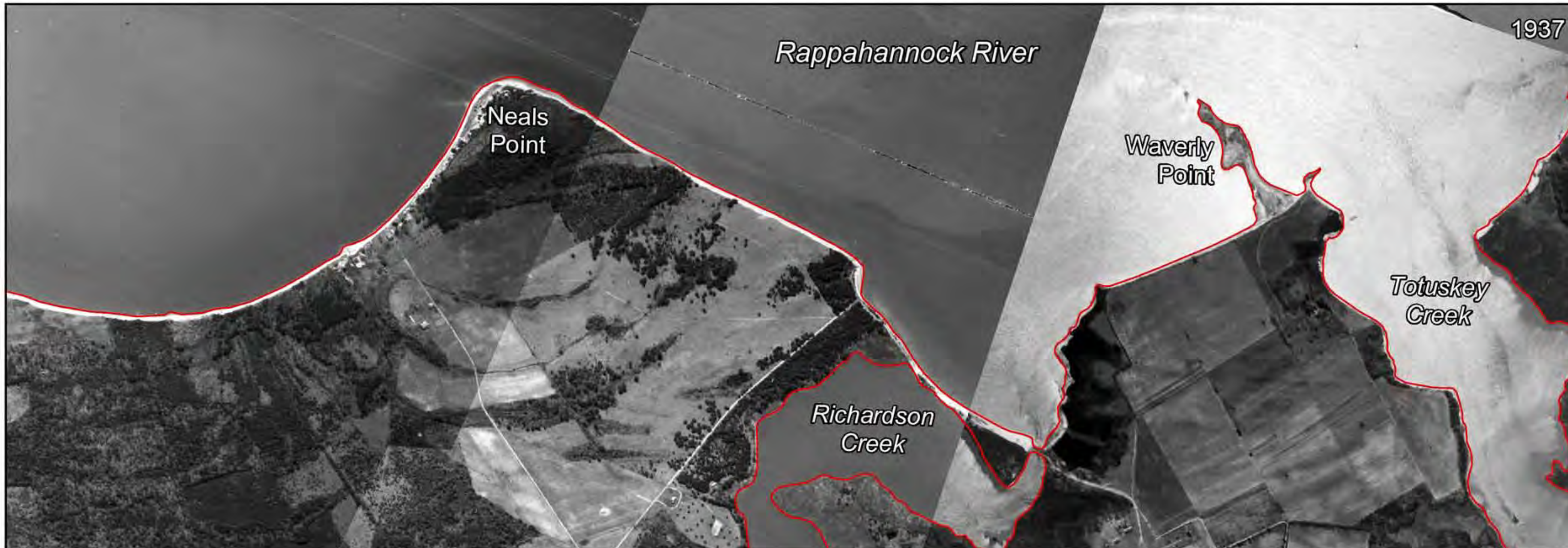


VIMS Shoreline Studies Program

1,000 0 1,000
Feet

Richmond County Virginia

Plate 14



Legend

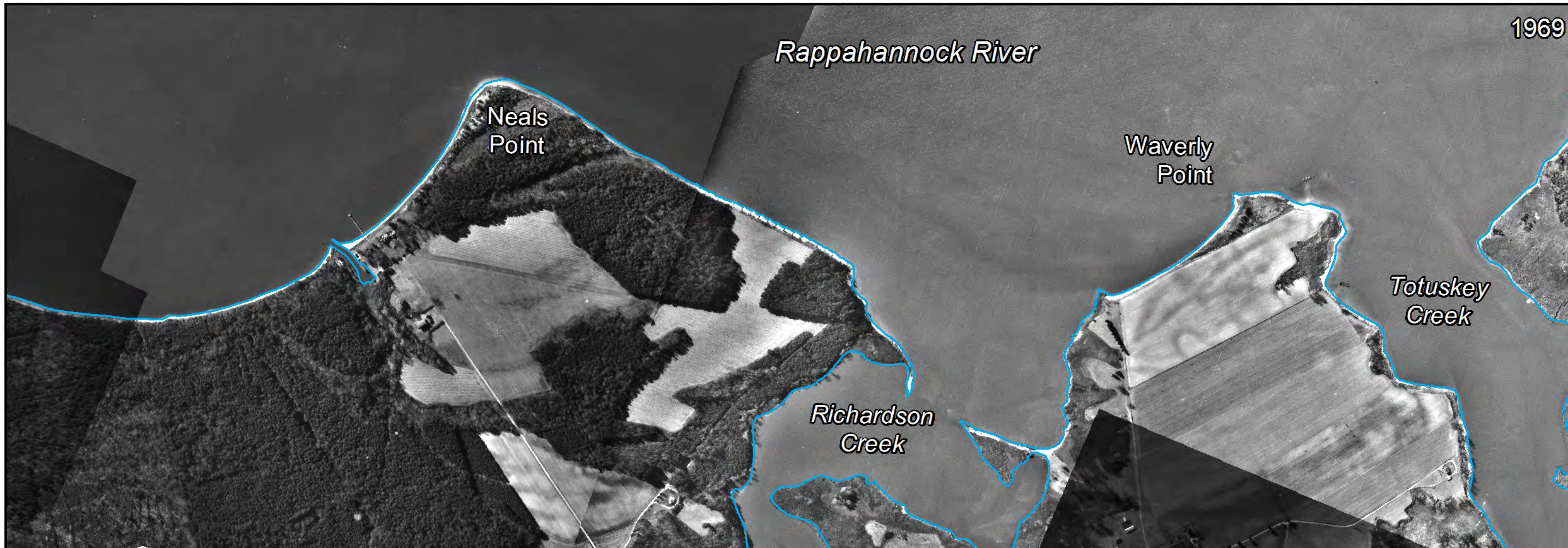
- 1937 Shoreline
- 1953 Shoreline

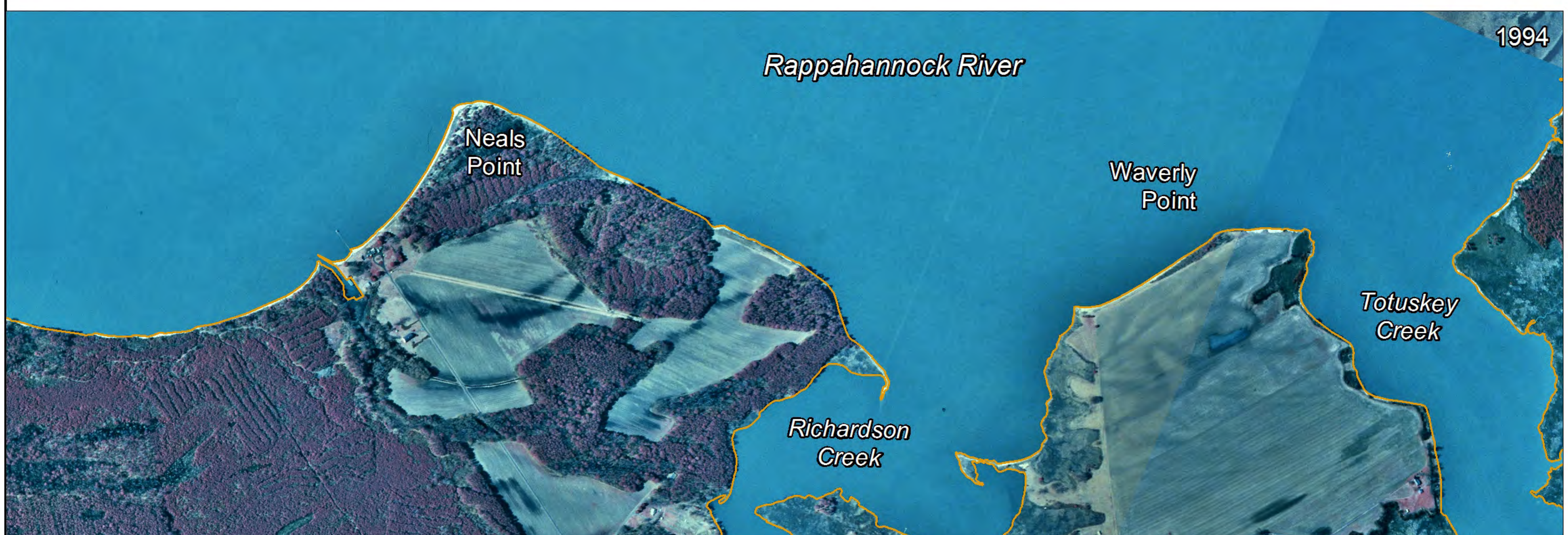
Shoreline Studies Program
VIMS

1,000 0 1,000
Feet

Richmond County Virginia

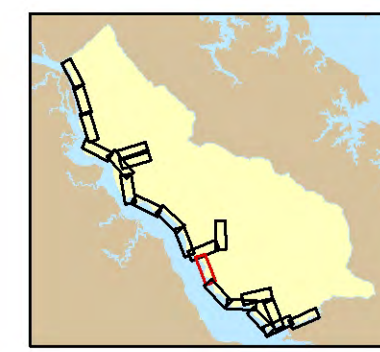
Plate 14





Legend

- 1969 Shoreline
- 1994 Shoreline

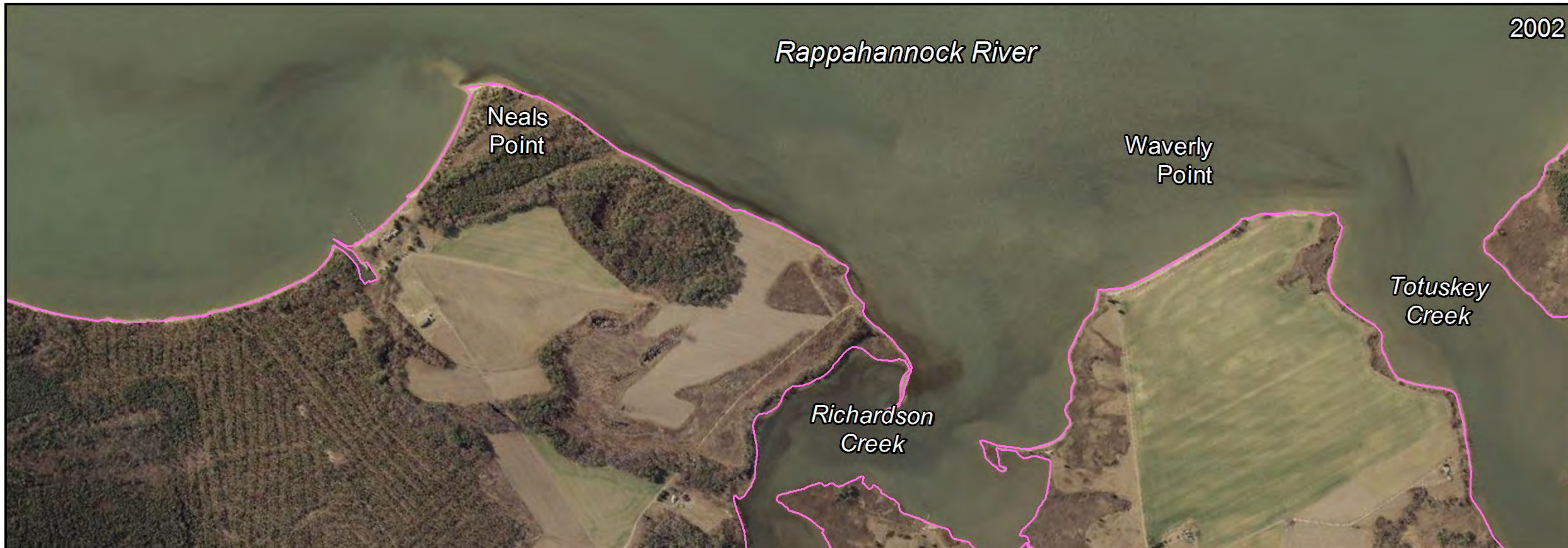


Shoreline Studies Program
VIMS

1,000 0 1,000
Feet

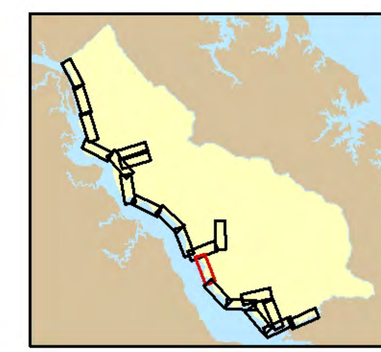
Richmond County Virginia

Plate 14



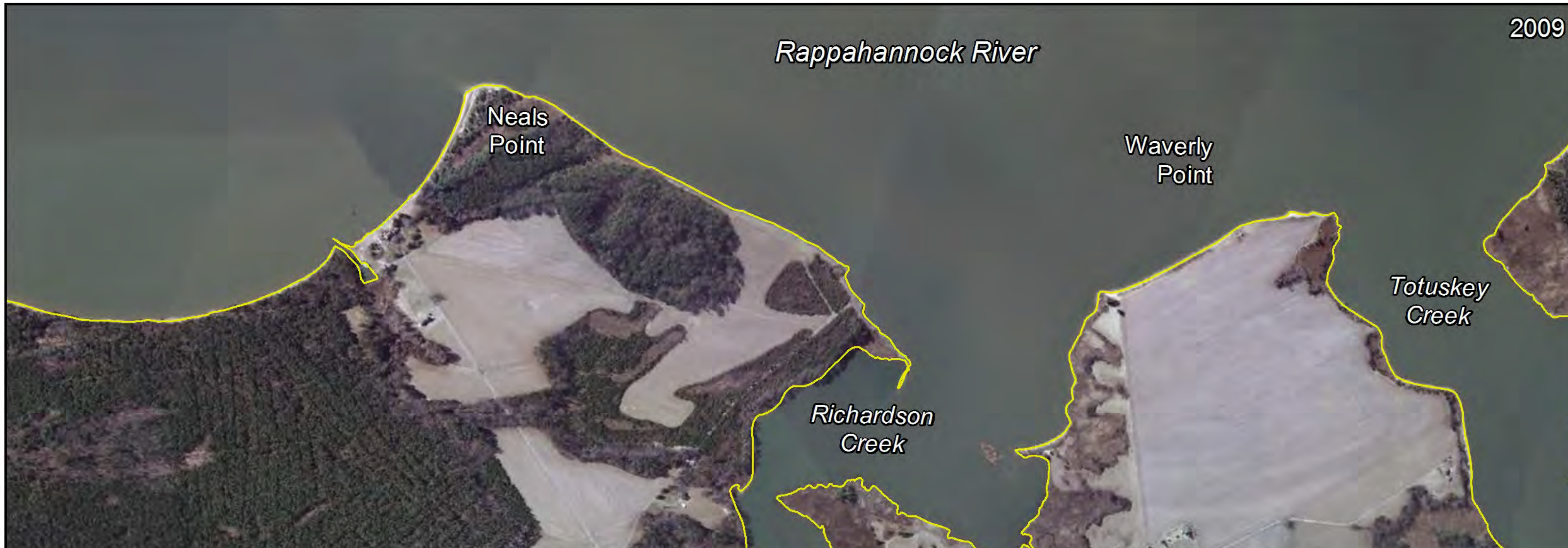
Legend

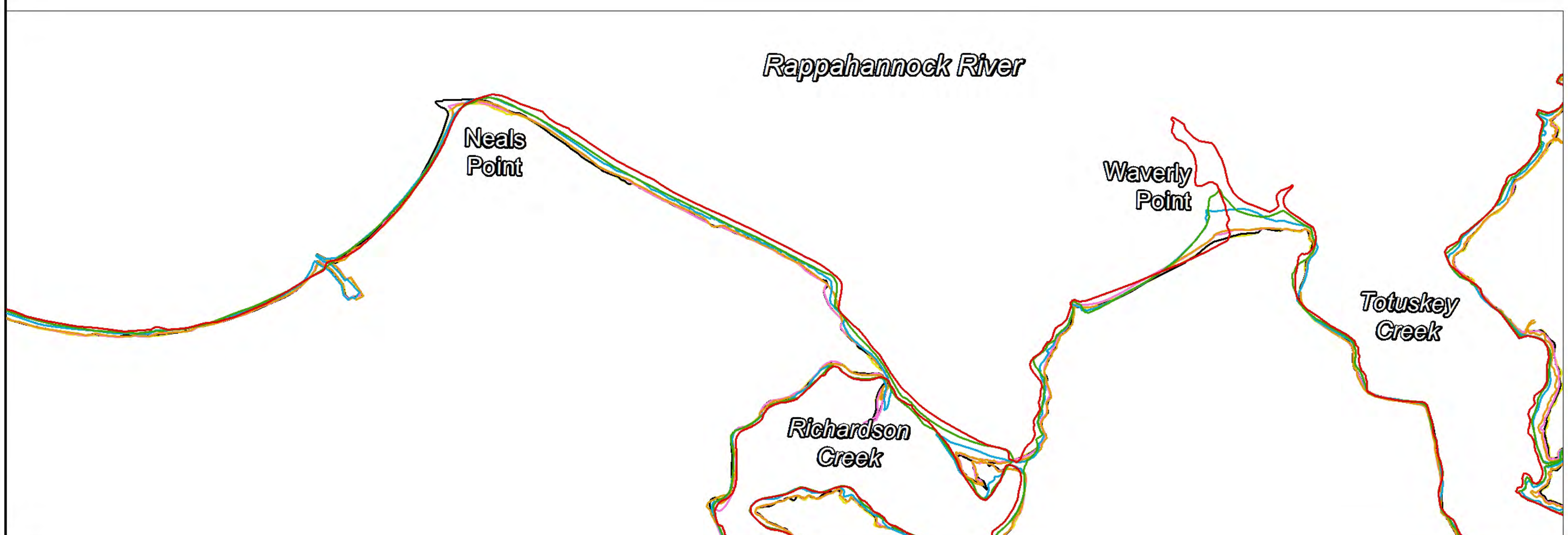
- 2002 Shoreline
- 2007 Shoreline



Shoreline Studies Program VIMS

1,000 0 1,000 Feet



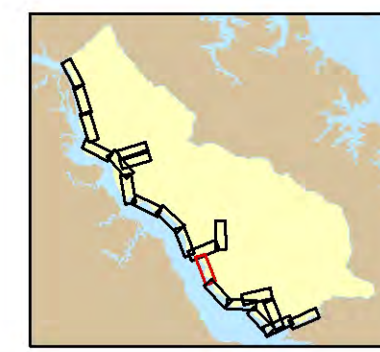


Richmond County Virginia

Plate 14

Legend

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline



Shoreline Studies Program
VIMS

1,000 0 1,000 Feet

Richmond County Virginia

Plate 15

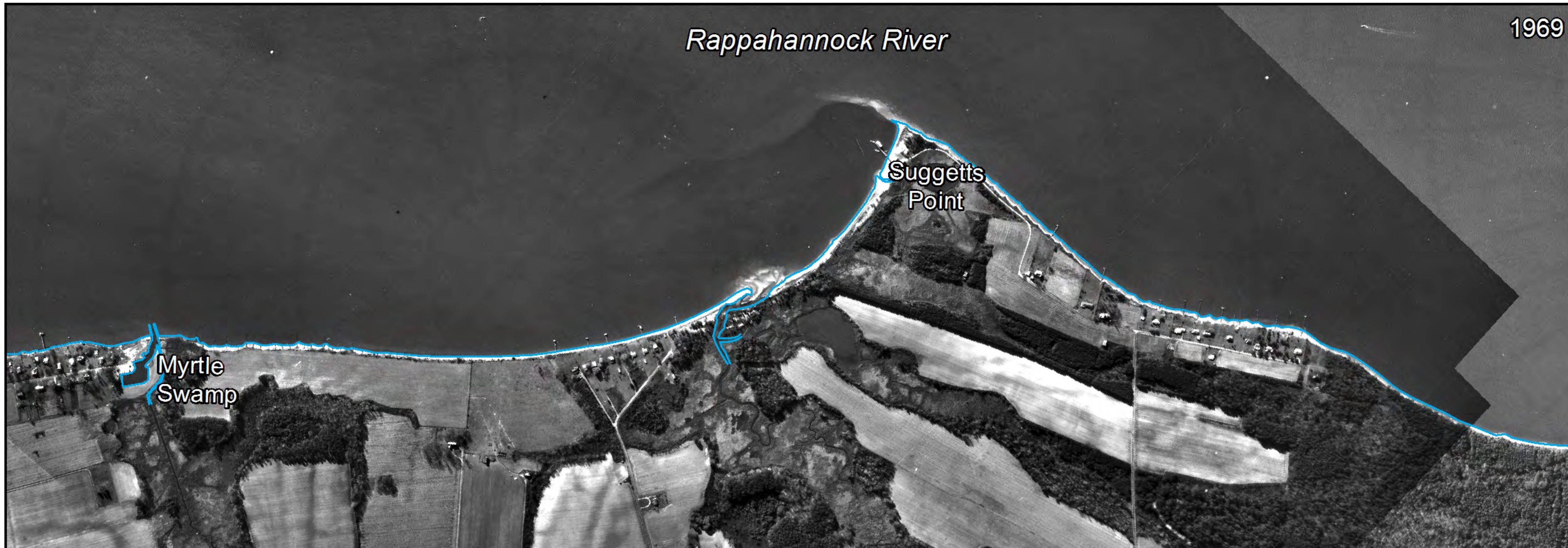
Legend

1937 Shoreline

1953 Shoreline

Shoreline Studies Program VIMS

1,000 0 1,000 Feet

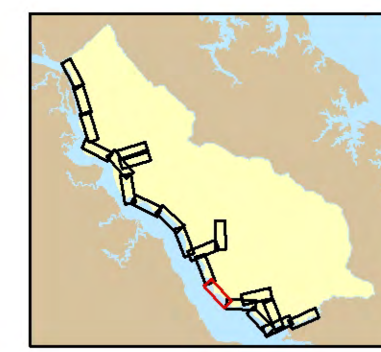


Richmond County Virginia

Plate 15

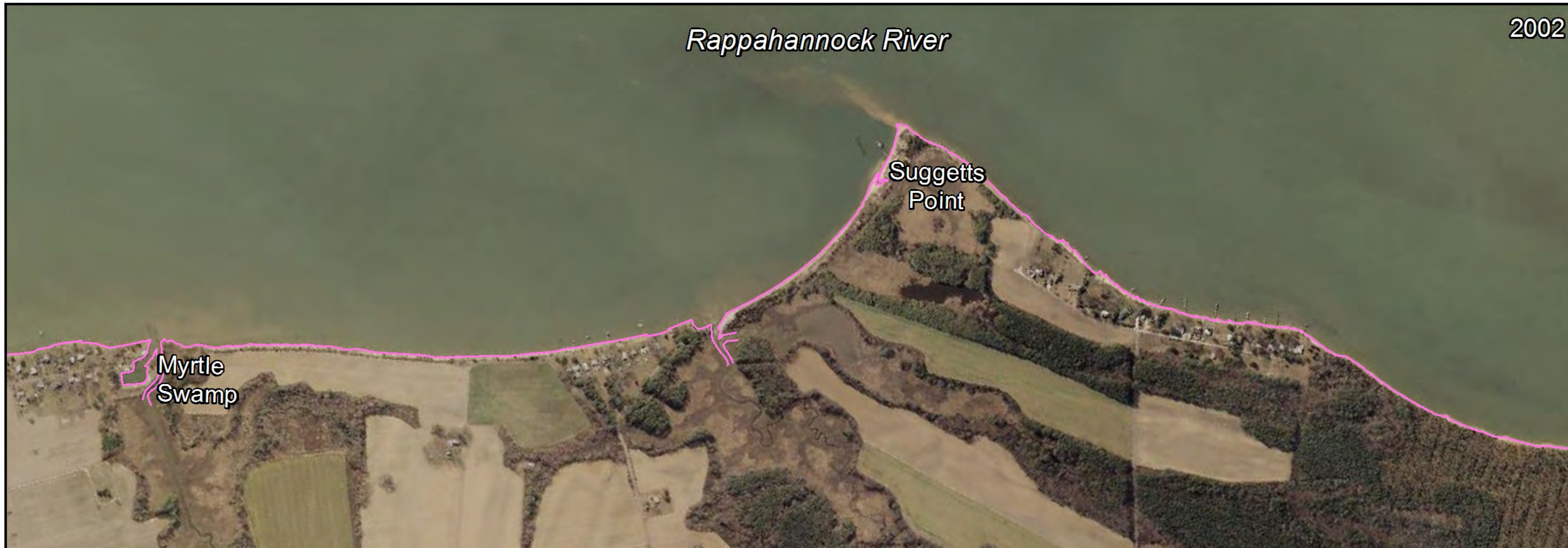
Legend

- 1969 Shoreline
- 1994 Shoreline



Shoreline Studies Program
VIMS

1,000 0 1,000
Feet

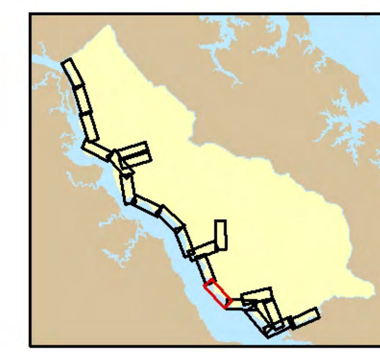


Richmond County Virginia

Plate 15

Legend

- 2002 Shoreline
- 2007 Shoreline



Shoreline Studies Program
VIMS

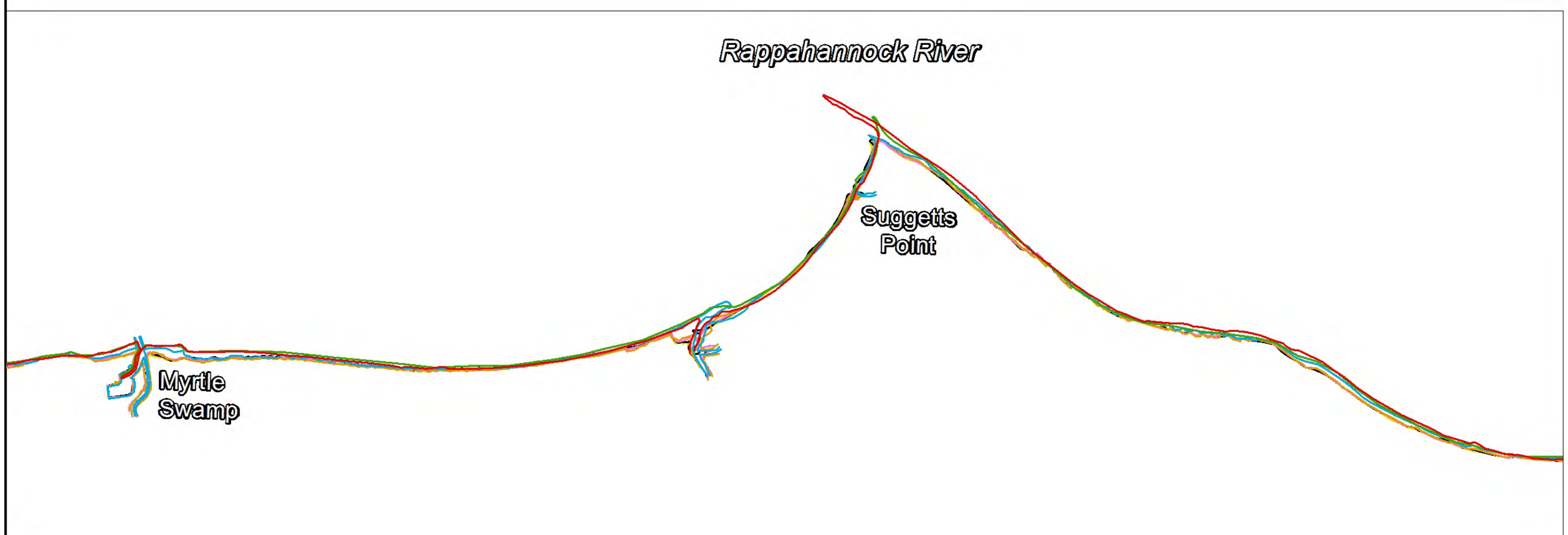
1,000 0 1,000 Feet

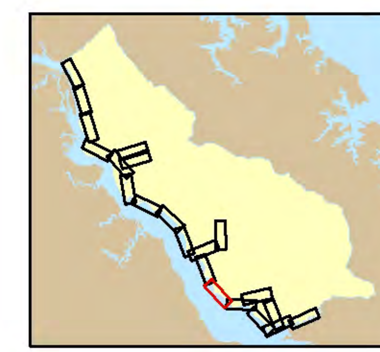
Richmond County Virginia

Plate 15

Legend

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline





Shoreline Studies Program VIMS

1,000 0 1,000 Feet

Richmond County Virginia

Plate 16

Legend

1937 Shoreline

1953 Shoreline

Shoreline Studies Program

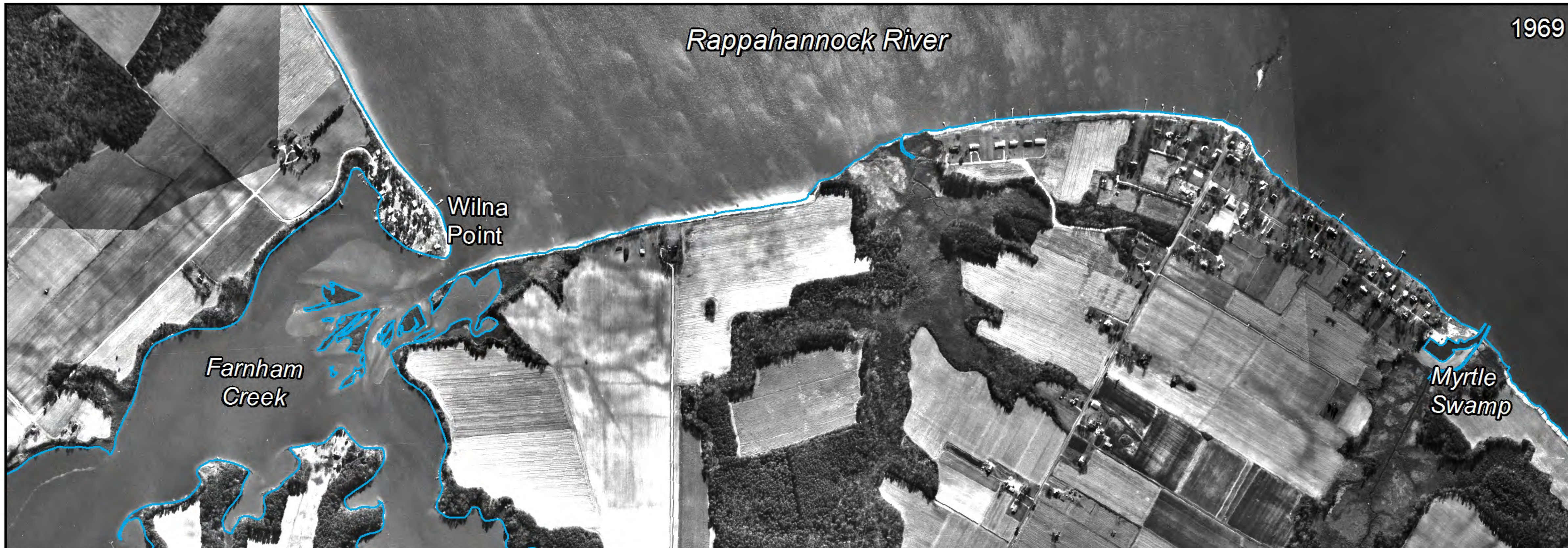
VIMS

1,000 0 1,000

Feet

Richmond County Virginia

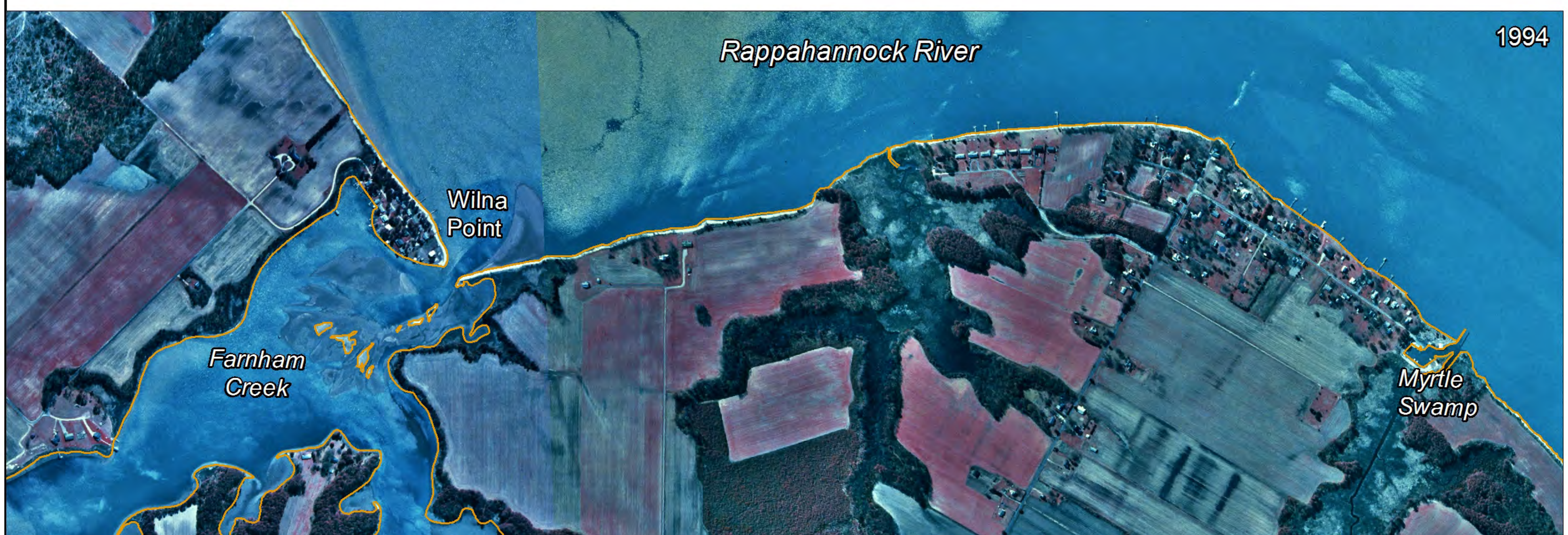
Plate 16

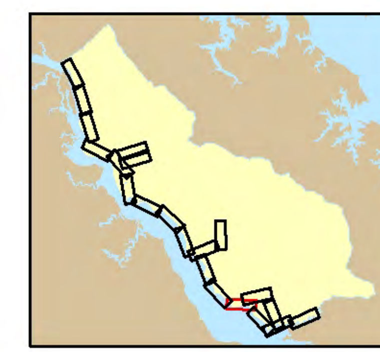


Legend

1969 Shoreline

1994 Shoreline





Shoreline Studies Program

VIMS

1,000 0 1,000

Feet

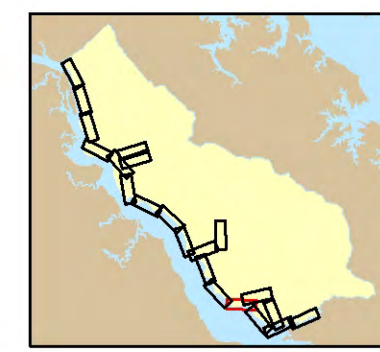
Richmond County Virginia

Plate 16

Legend

2002 Shoreline

2007 Shoreline

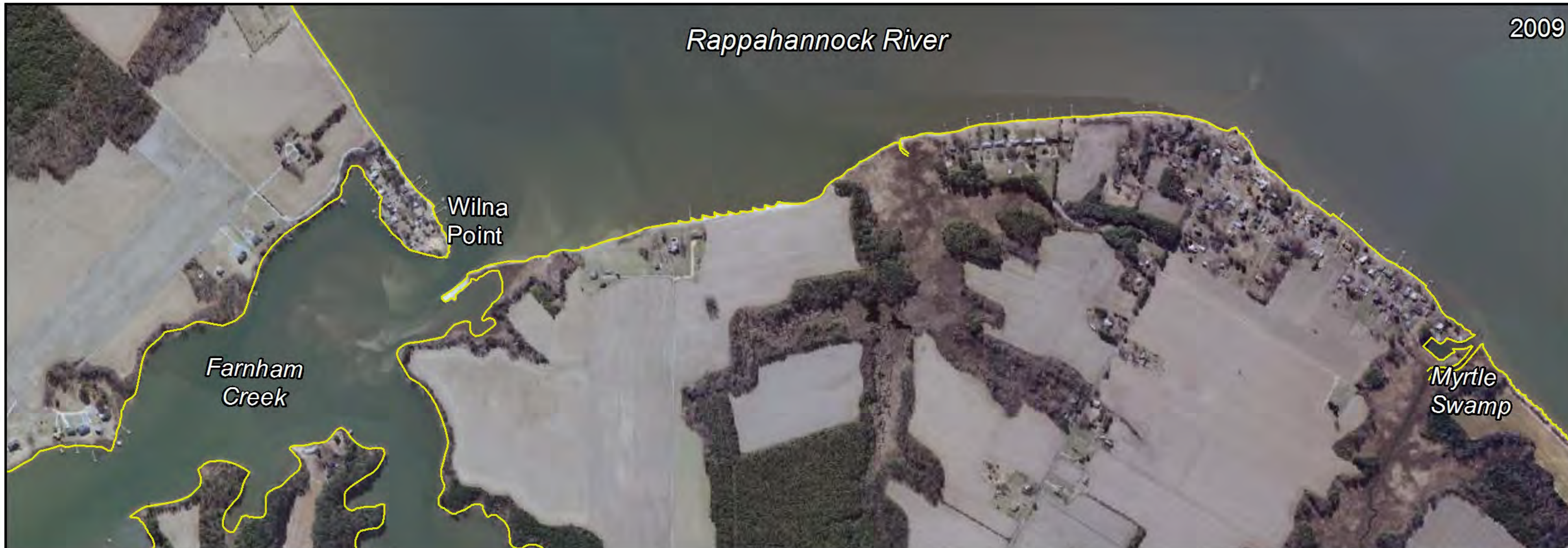


VIMS Shoreline Studies Program

1,000 0 1,000 Feet

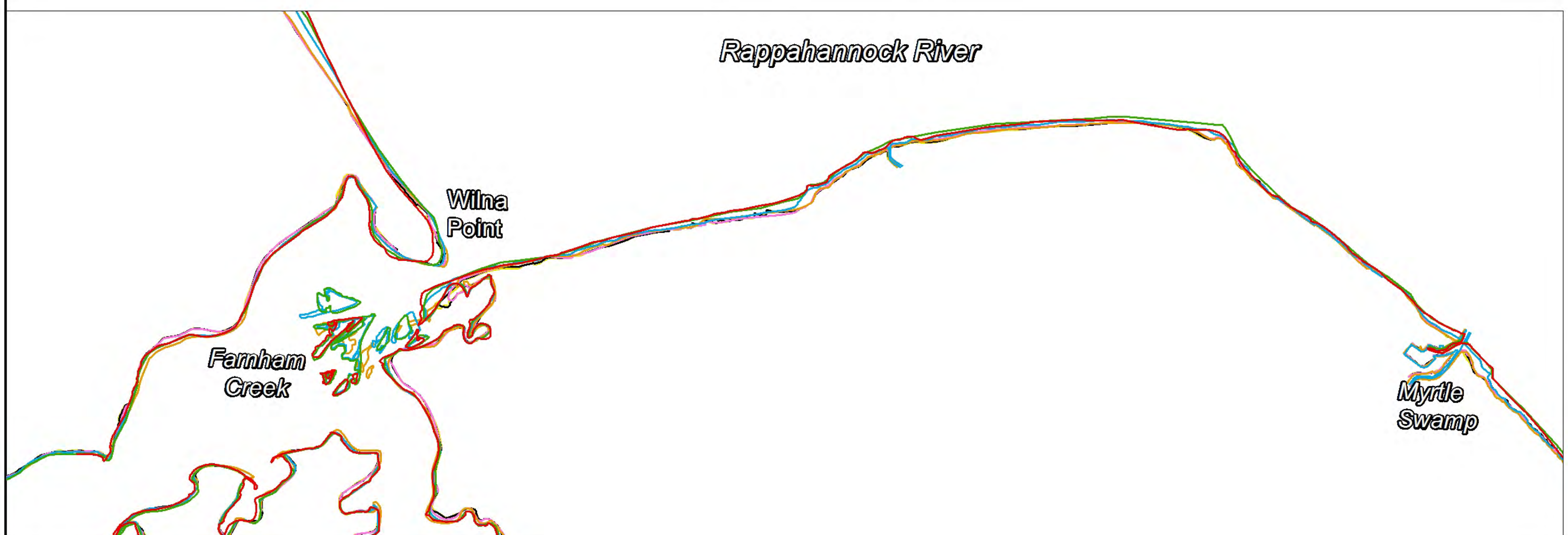
Richmond County Virginia

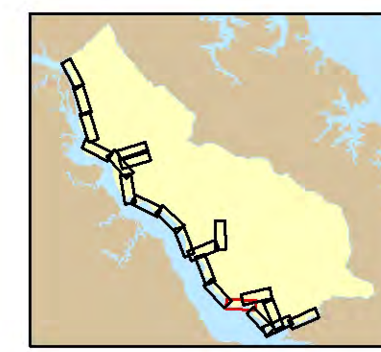
Plate 16



Legend

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline





Shoreline Studies Program
VIMS

1,000 0 1,000
Feet

Richmond County Virginia

Plate 17

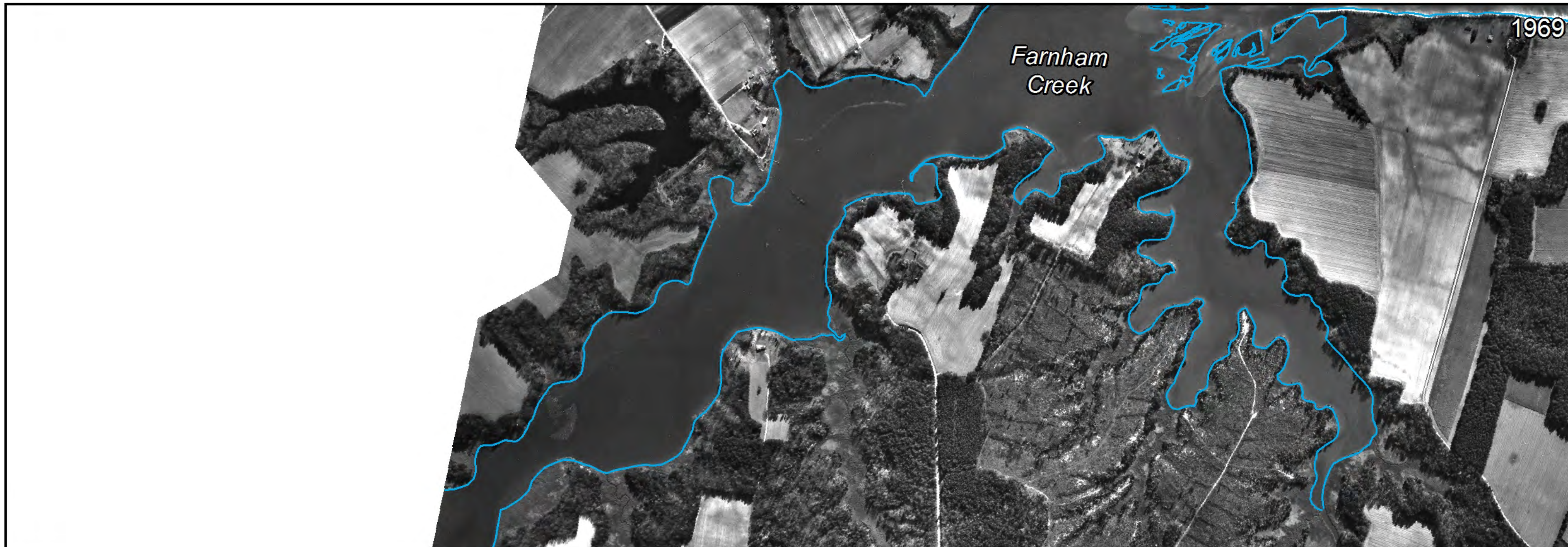
Legend

1937 Shoreline

1953 Shoreline

Shoreline Studies Program
VIMS

1,000 0 1,000
Feet



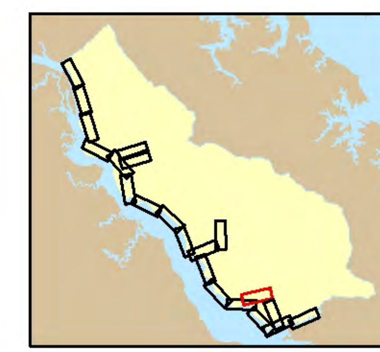
Richmond County Virginia

Plate 17

Legend

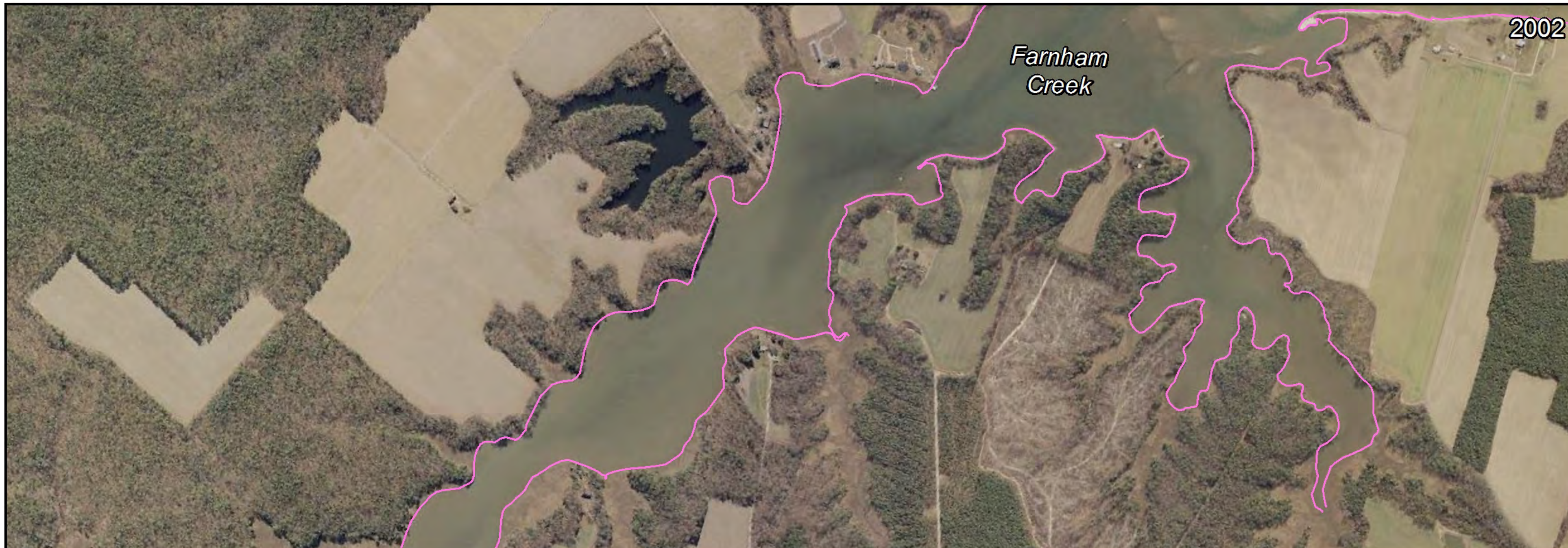
1969 Shoreline

1994 Shoreline



Shoreline Studies Program
VIMS

1,000 0 1,000
Feet



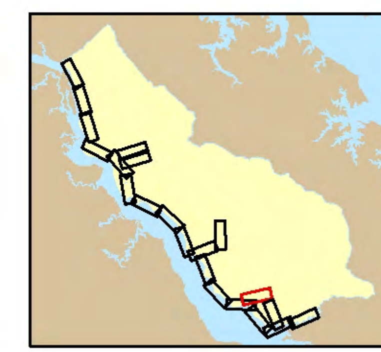
Richmond County Virginia

Plate 17

Legend

2002 Shoreline

2007 Shoreline

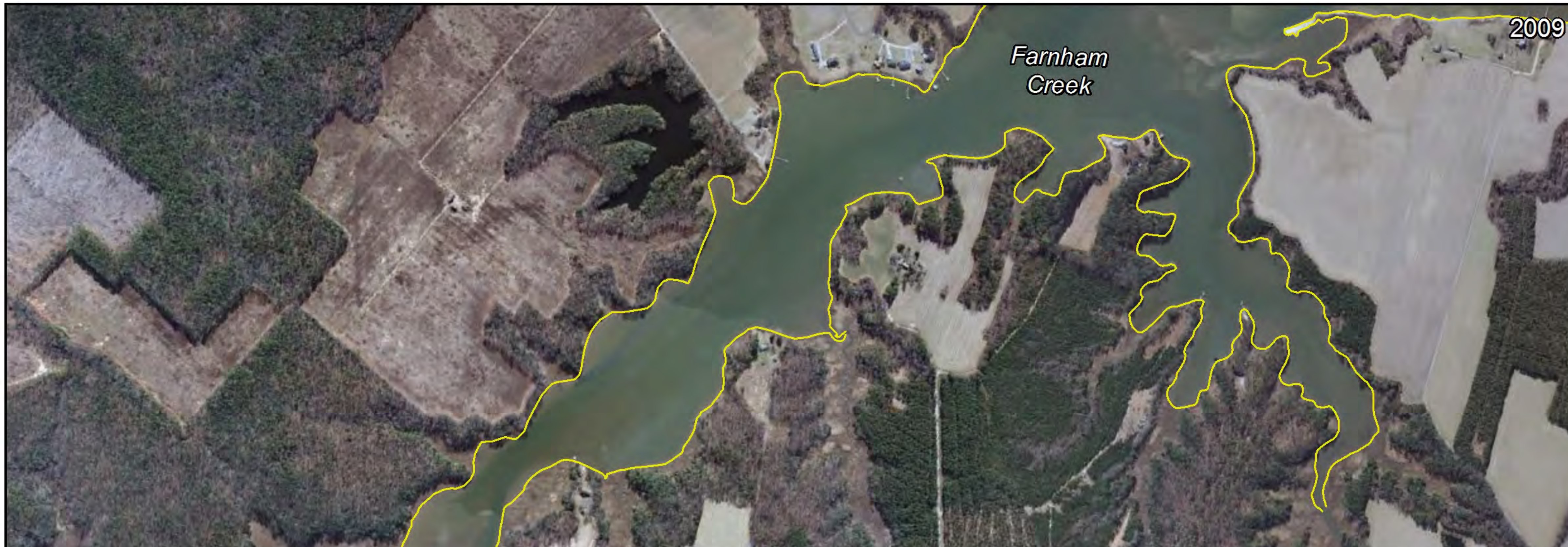


Shoreline Studies Program

VIMS

1,000 0 1,000

Feet

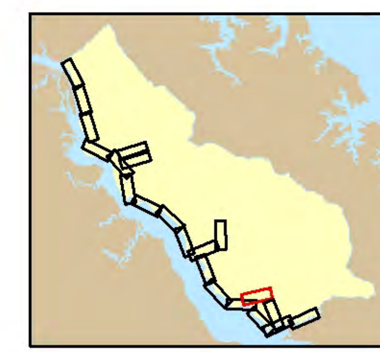


Richmond County Virginia

Plate 17

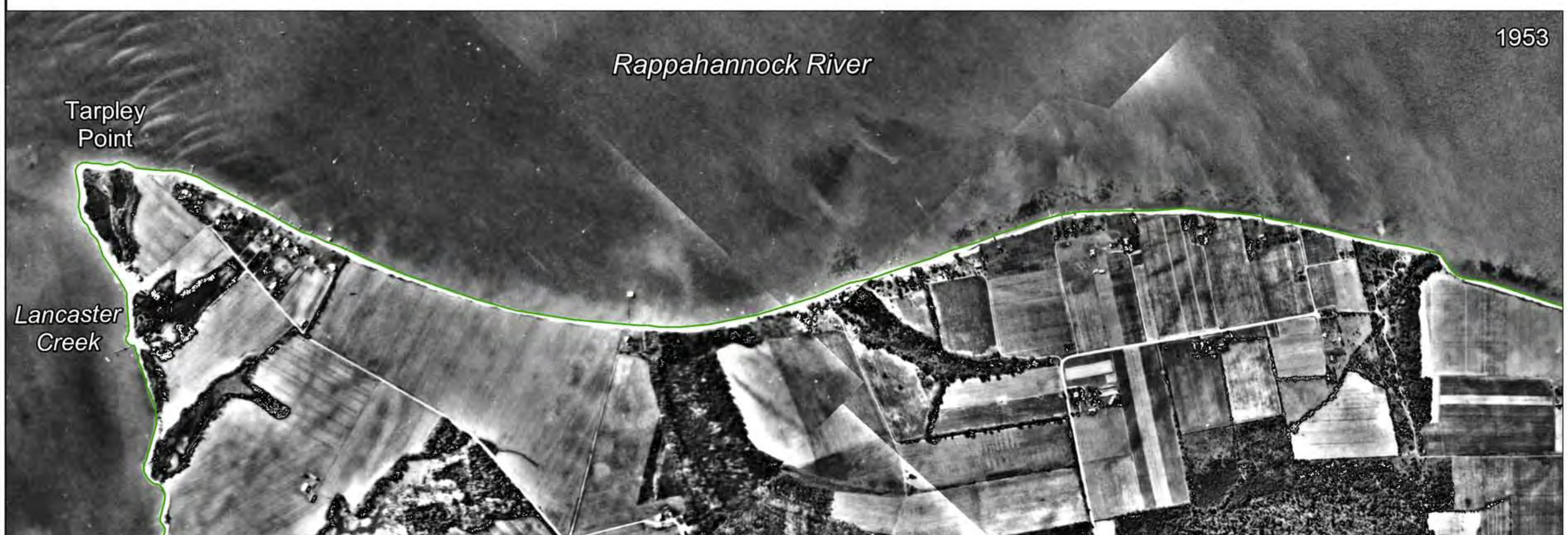
Legend

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline



Shoreline Studies Program VIMS

1,000 0 1,000 Feet



Richmond County Virginia

Plate 18

Legend

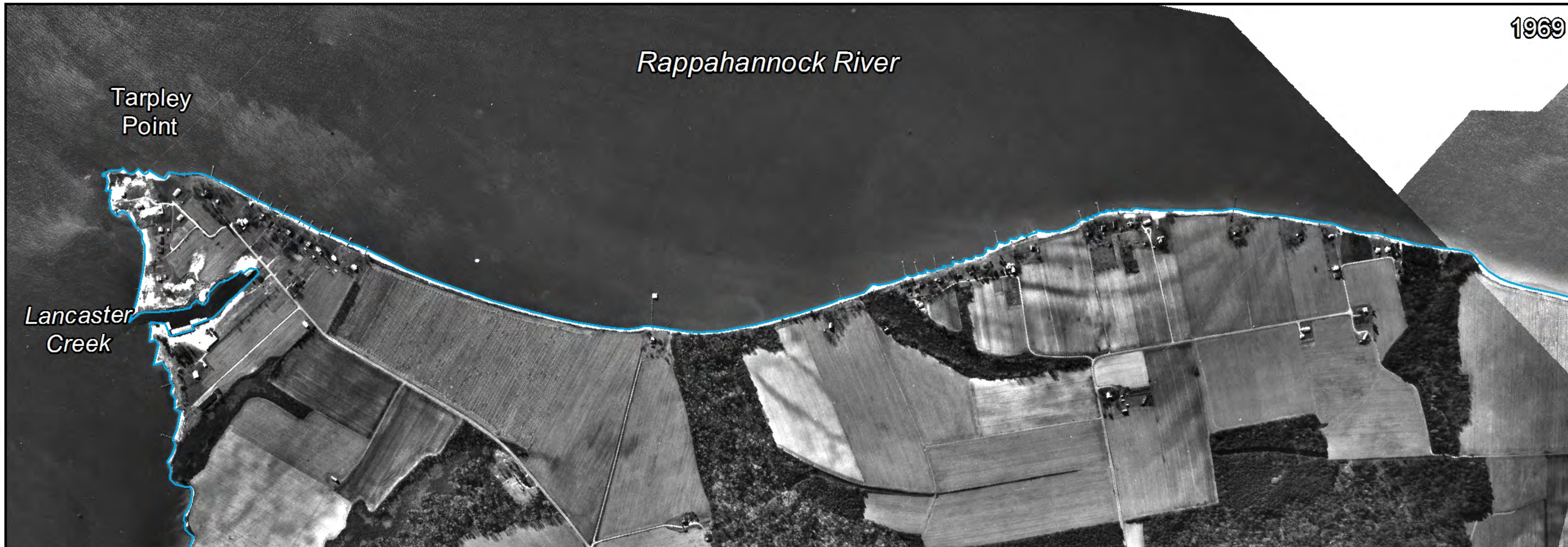
- 1937 Shoreline
- 1953 Shoreline

Shoreline Studies Program VIMS

1,000 0 1,000 Feet

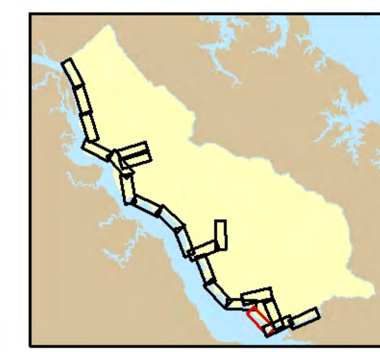
Richmond County Virginia

Plate 18



Legend

- 1969 Shoreline
- 1994 Shoreline



Shoreline Studies Program VIMS

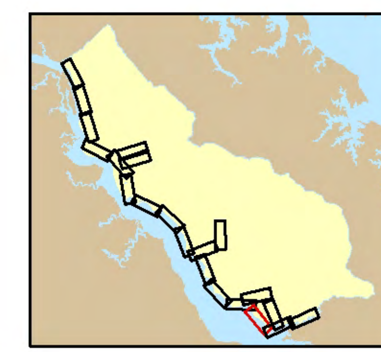
1,000 0 1,000 Feet

Richmond County Virginia

Plate 18

Legend

- 2002 Shoreline
- 2007 Shoreline

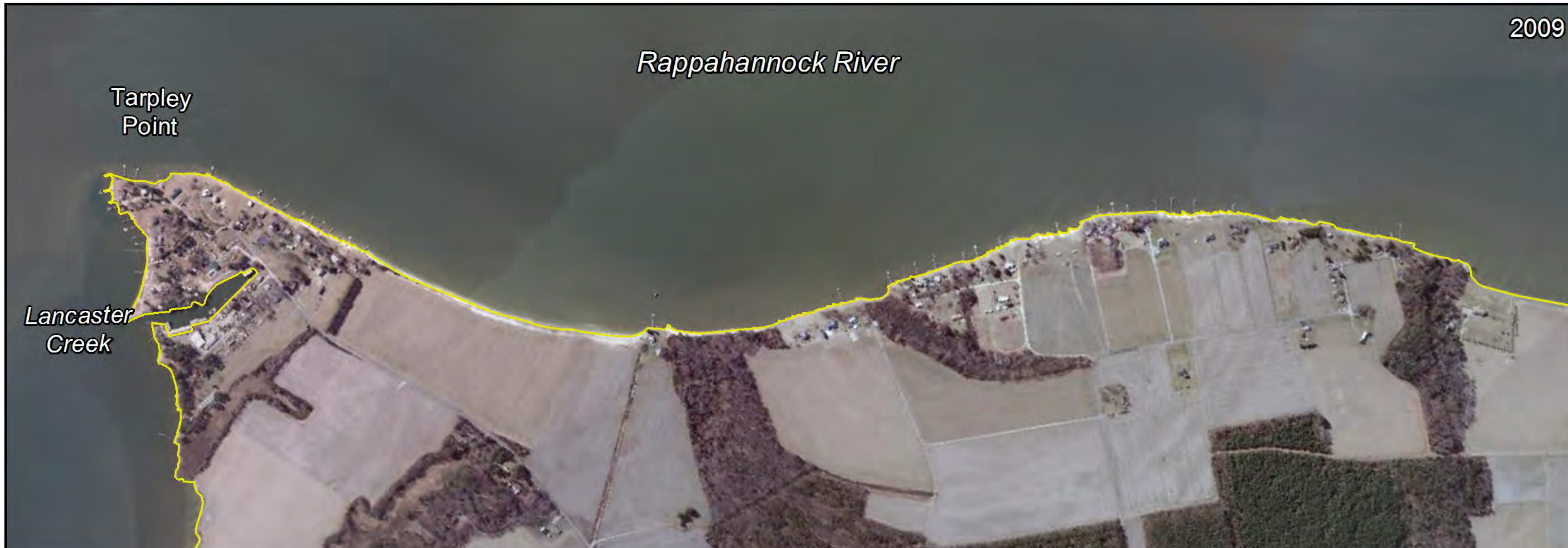


Shoreline Studies Program
VIMS

1,000 0 1,000
Feet

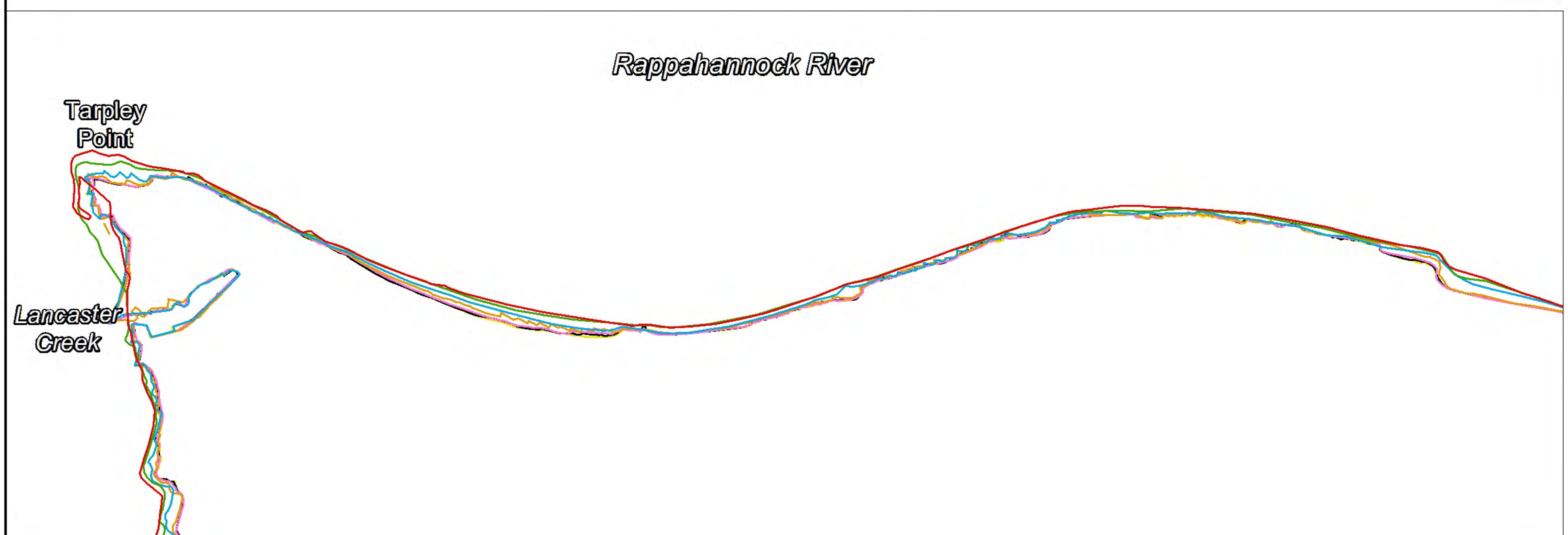
Richmond County Virginia

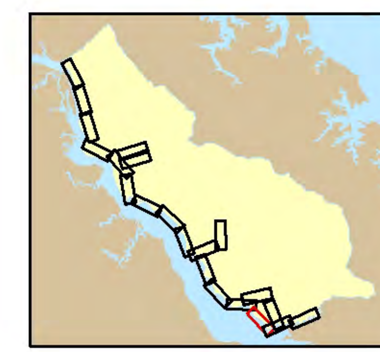
Plate 18



Legend

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline





Shoreline Studies Program
VIMS

1,000 0 1,000
Feet

Richmond County Virginia

Plate 19

Legend

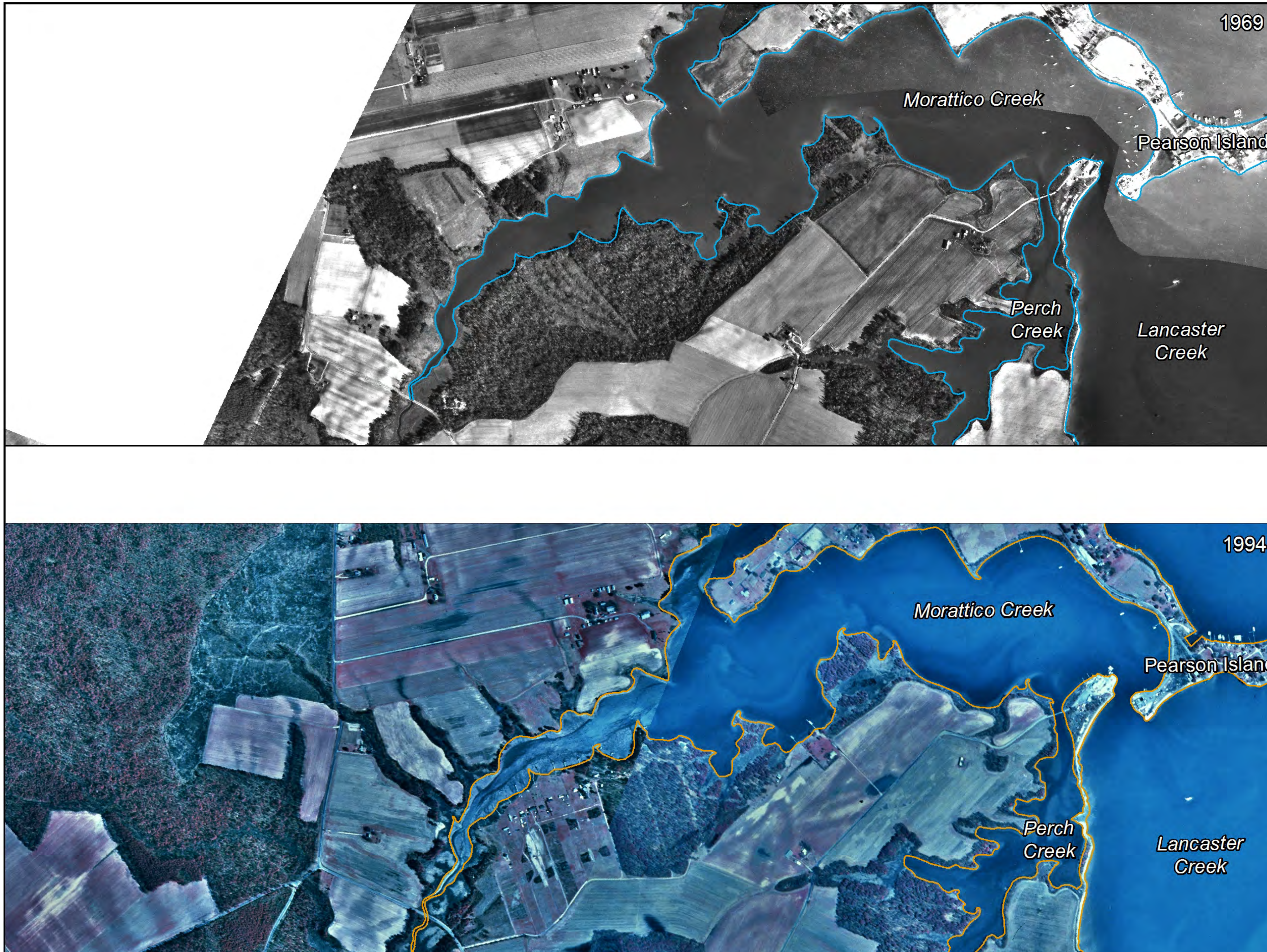
- 1937 Shoreline
- 1953 Shoreline

Shoreline Studies Program
VIMS

1,000 0 1,000 Feet

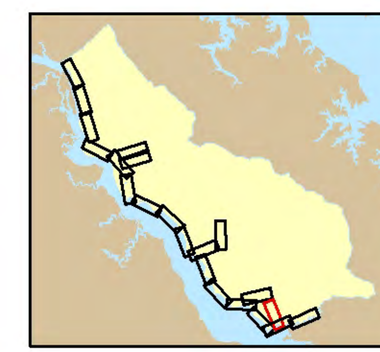
Richmond County Virginia

Plate 19



Legend

- 1969 Shoreline
- 1994 Shoreline

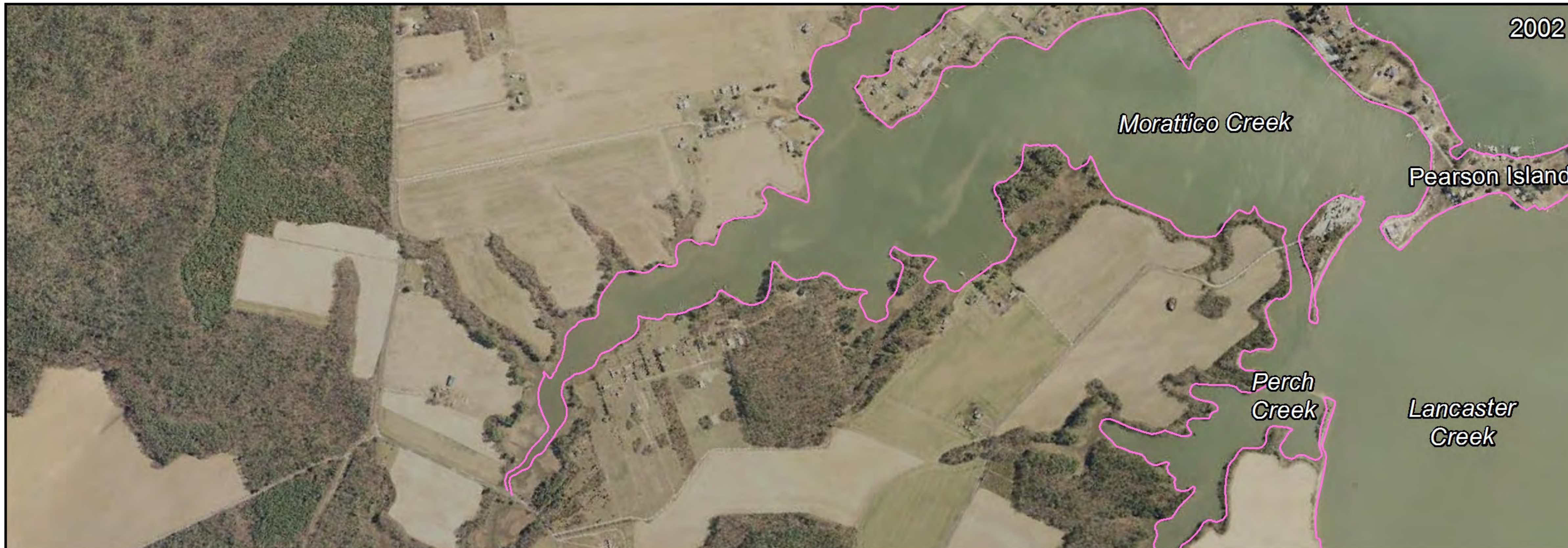


Shoreline Studies Program
VIMS

1,000 0 1,000 Feet

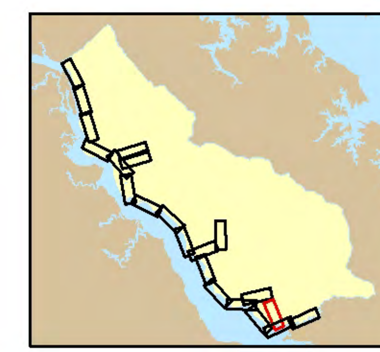
Richmond County Virginia

Plate 19



Legend

- 2002 Shoreline
- 2007 Shoreline



Shoreline Studies Program
VIMS

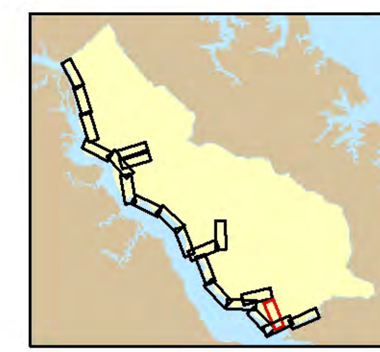
1,000 0 1,000 Feet

Richmond County Virginia

Plate 19

Legend

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline



Shoreline Studies Program
VIMS

1,000 0 1,000
Feet

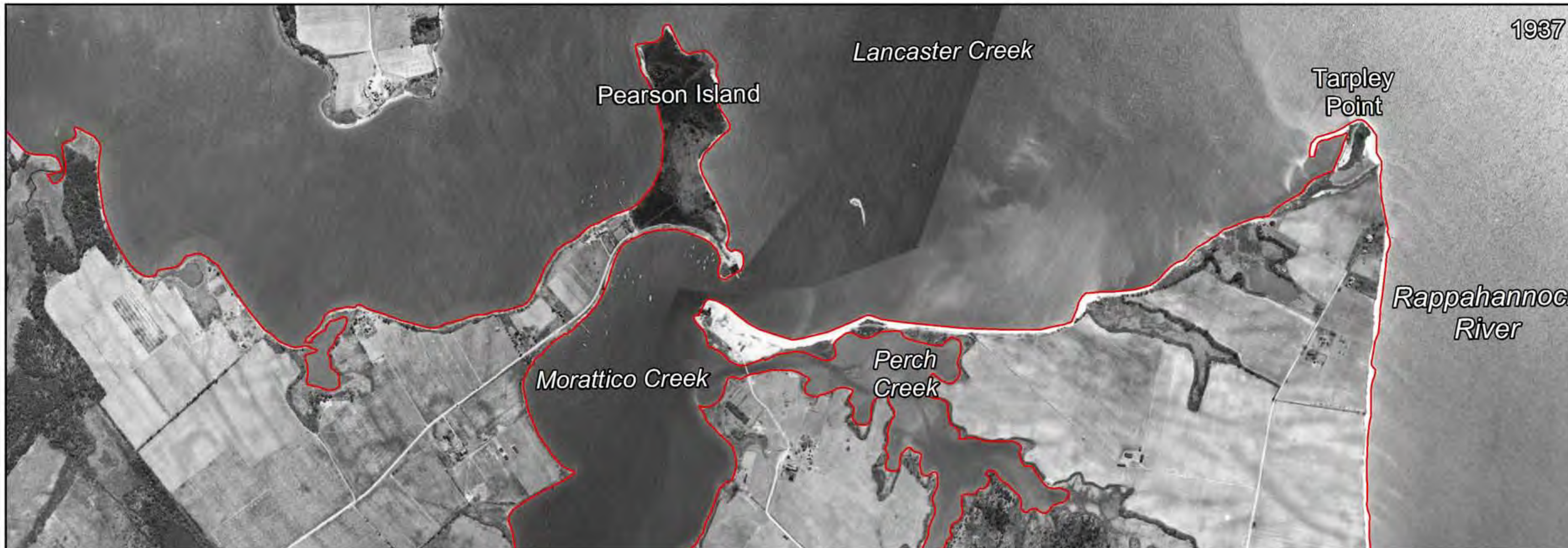
Richmond County Virginia

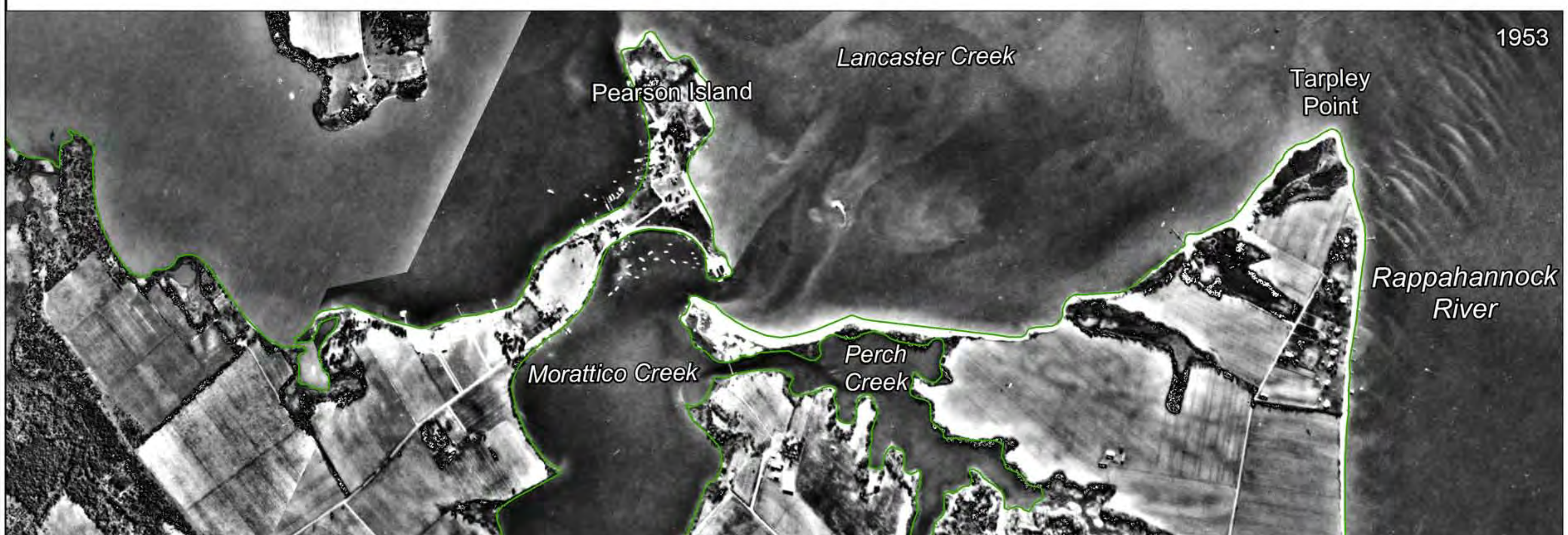
Plate 20

Legend

1937 Shoreline

1953 Shoreline



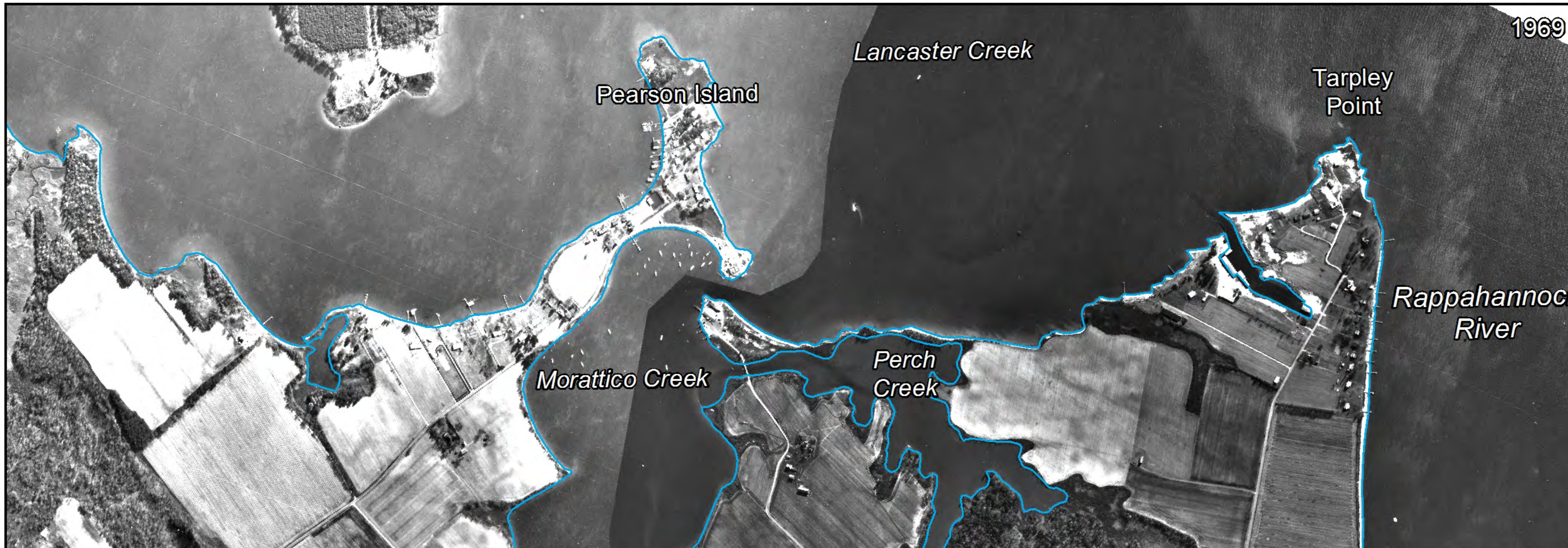


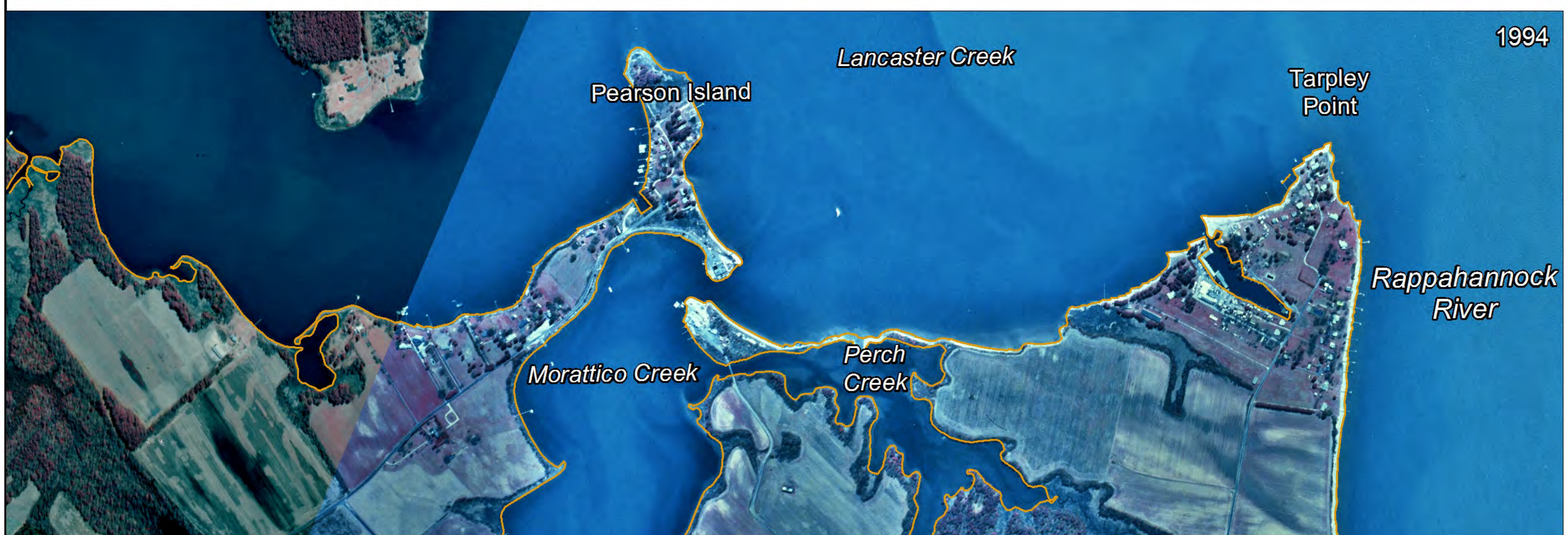
Shoreline Studies Program
VIMS

1,000 0 1,000
Feet

Richmond County Virginia

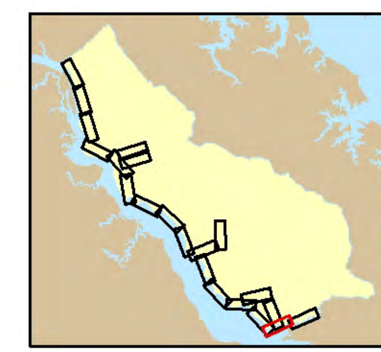
Plate 20





Legend

- 1969 Shoreline
- 1994 Shoreline



Shoreline Studies Program
VIMS

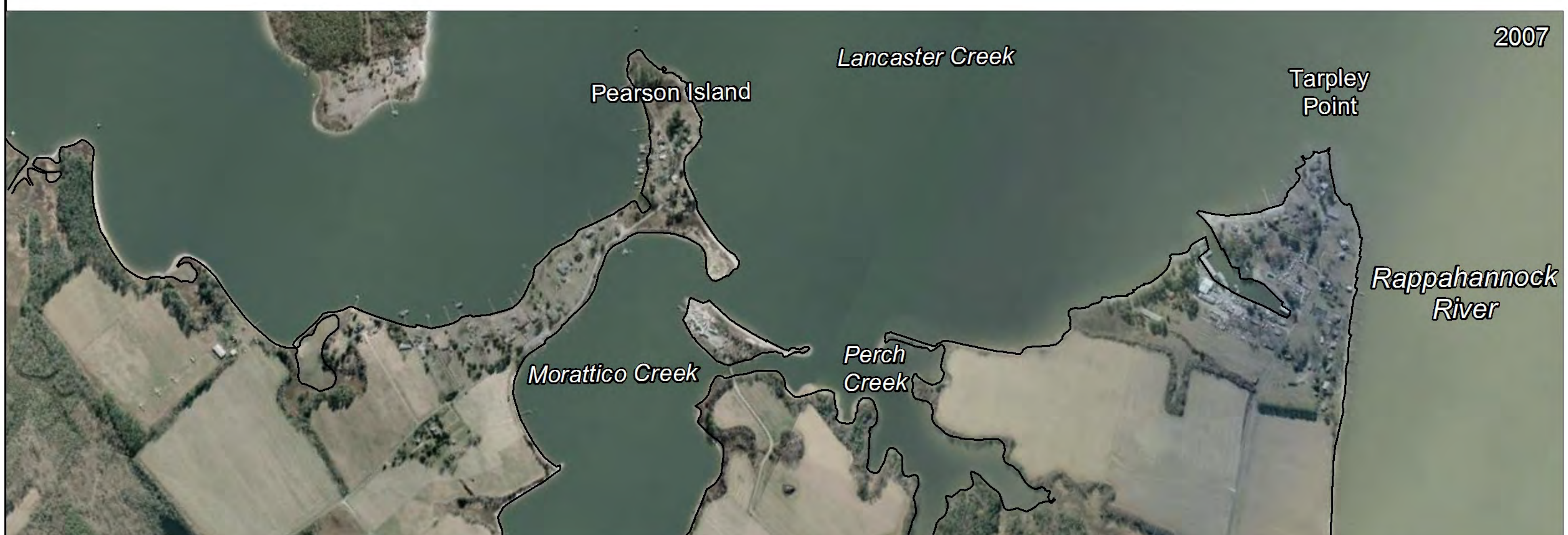
1,000 0 1,000
Feet

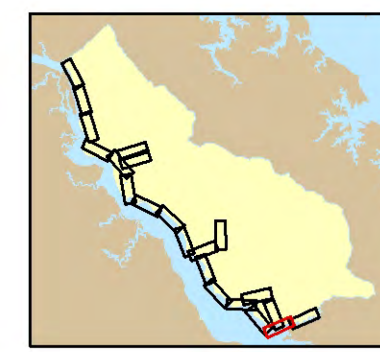
Richmond County Virginia

Plate 20

Legend

- 2002 Shoreline
- 2007 Shoreline





VIMS Shoreline Studies Program

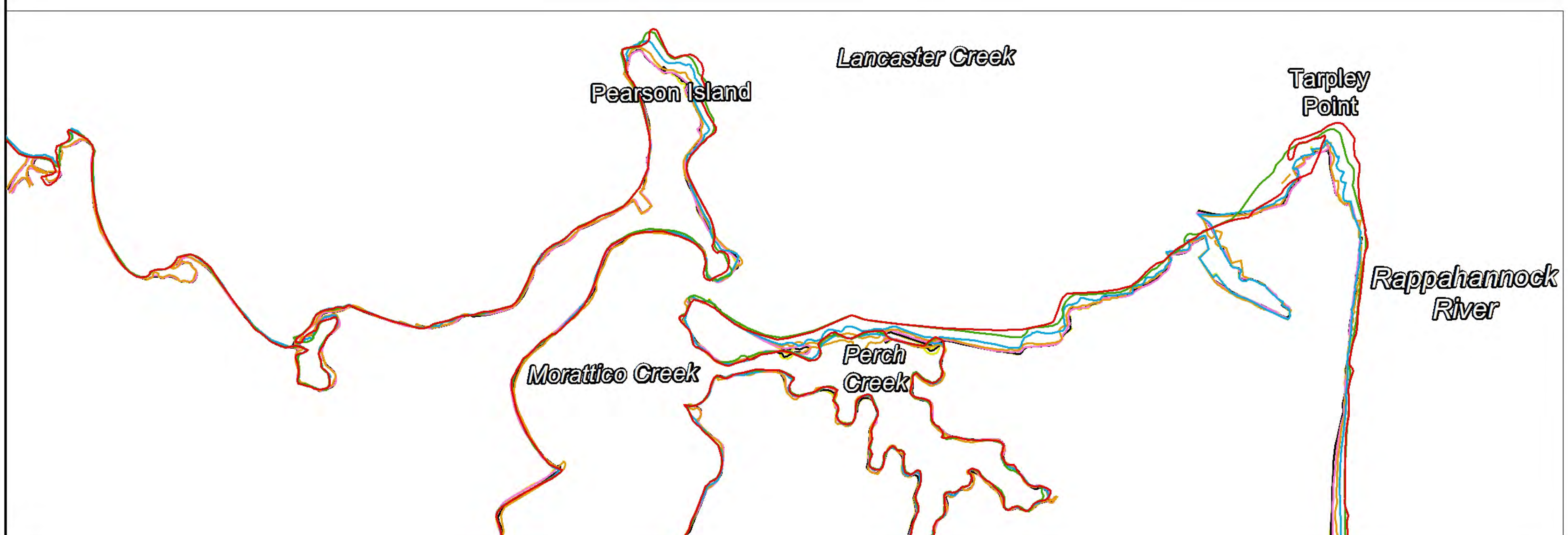
1,000 0 1,000 Feet

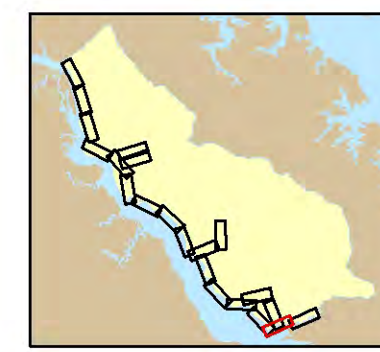
Richmond County Virginia

Plate 20

Legend

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline





Shoreline Studies Program
VIMS

1,000 0 1,000
Feet

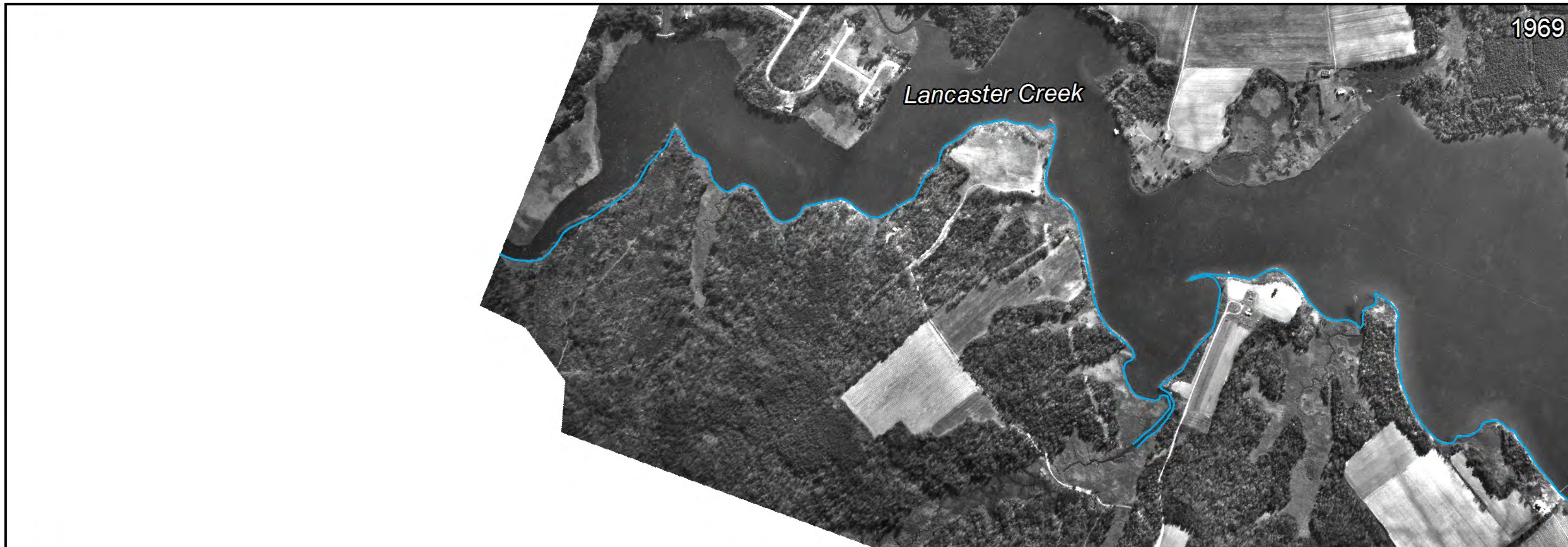
Richmond County Virginia

Plate 21

Legend

- 1937 Shoreline
- 1953 Shoreline

1,000 0 1,000 Feet



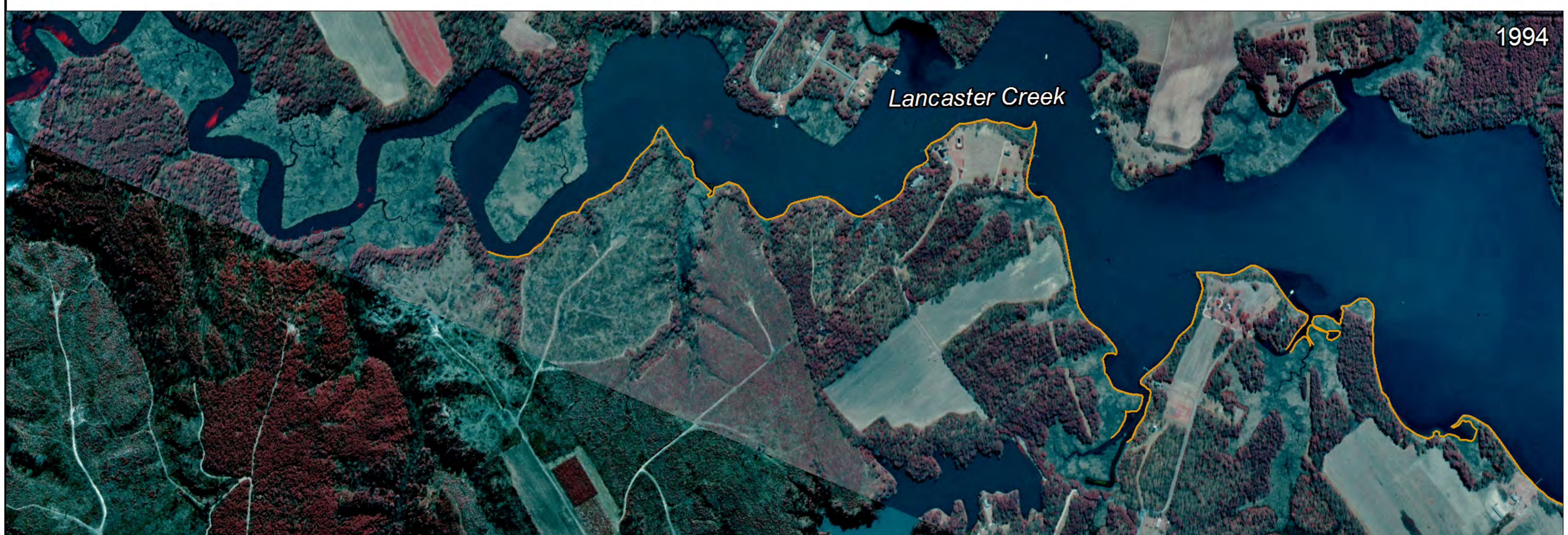
Richmond County Virginia

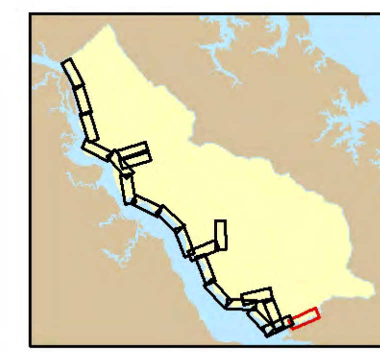
Plate 21

Legend

1969 Shoreline

1994 Shoreline





Shoreline Studies Program
VIMS

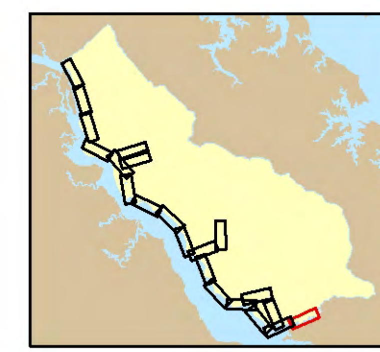
1,000 0 1,000
Feet

Richmond County Virginia

Plate 21

Legend

- 2002 Shoreline
- 2007 Shoreline



Shoreline Studies Program
VIMS

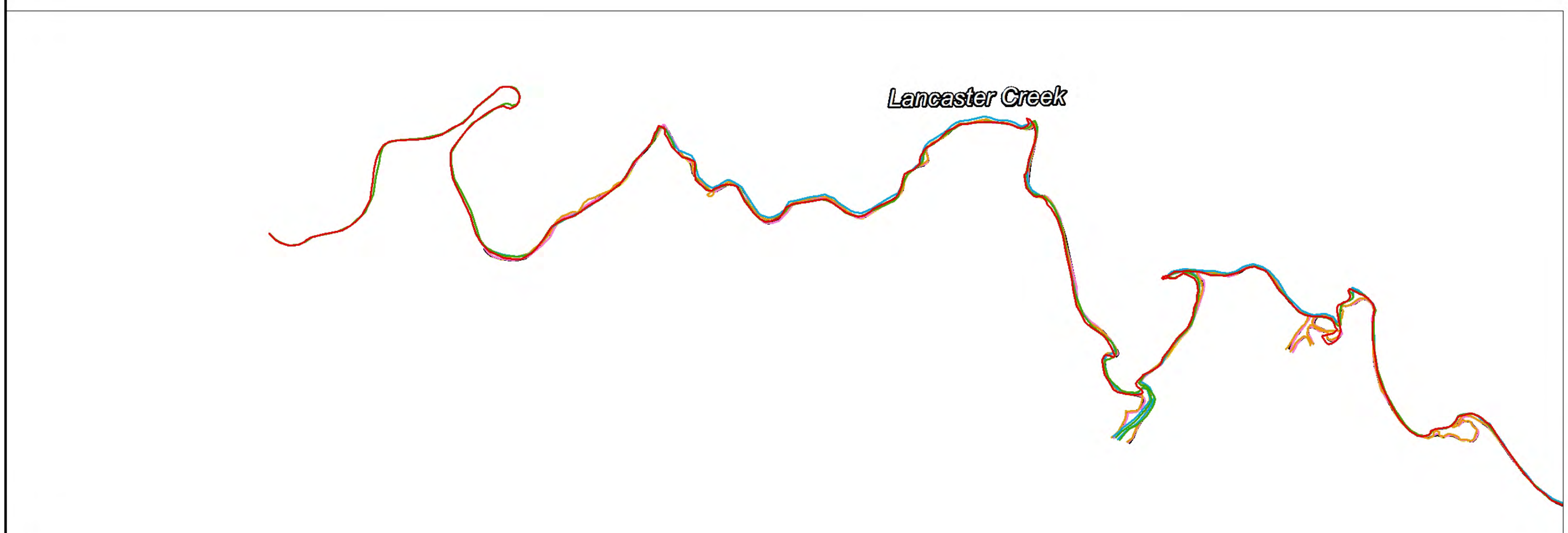
1,000 0 1,000 Feet

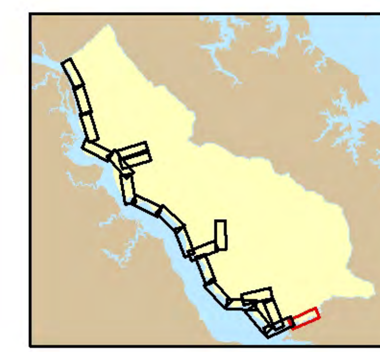
Richmond County Virginia

Plate 21

Legend

- 1937 Shoreline
- 1953 Shoreline
- 1969 Shoreline
- 1994 Shoreline
- 2002 Shoreline
- 2007 Shoreline
- 2009 Shoreline





Shoreline Studies Program VIMS

1,000 0 1,000 Feet