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Shoreline Evolution: City of Chesapeake, Virginia Elizabeth River Shorelines Data Summary Report

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Shoreline Evolution: City of Chesapeake, Virginia Elizabeth River Shorelines



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

September 2016

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Data Summary Report

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September 2016

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1 Introduction

City of Chesapeake is situated between the Cities of Norfolk and Portsmouth along several branches of the Elizabeth River (Figure 1). Because the City's shoreline is continually changing, determining where the shoreline was in the past, how far and how fast it is moving, and what factors drive shoreline change will help define where the shoreline will be going in the future. These rates and patterns of shore change along Chesapeake Bay's estuarine shores will differ through time as 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 City of Chesapeake 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 larger creeks of City of Chesapeake will be quantified in this report. The shorelines of very irregular coasts, small creeks and around inlets, and other complicated areas will be shown but not quantified.

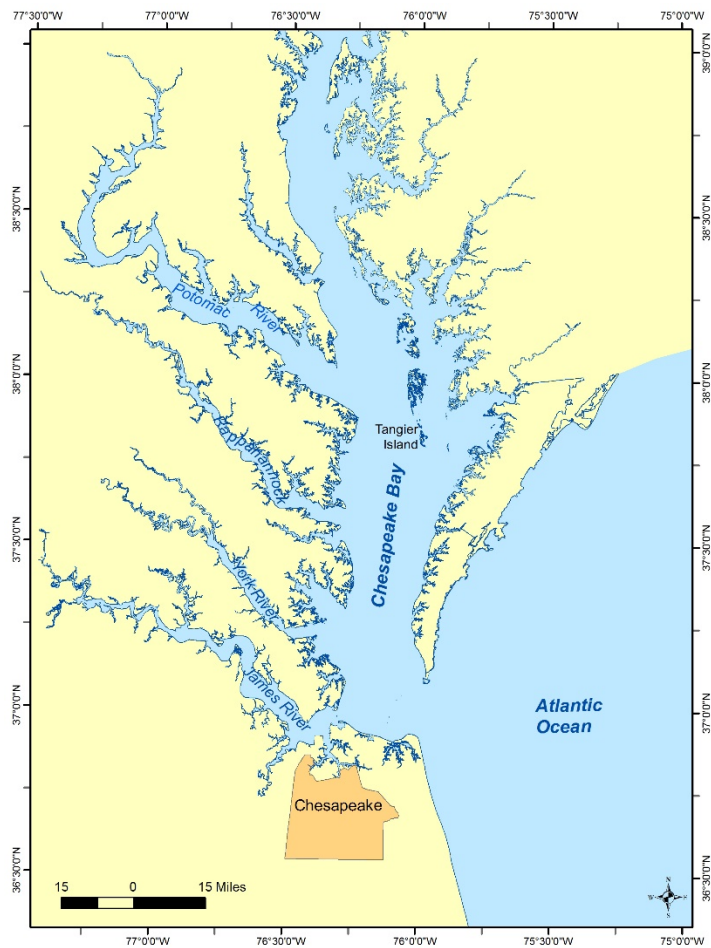


Figure 1. Location of City of Chesapeake within the Chesapeake Bay estuarine system.

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 City of Chesapeake Shoreline from 1937, 1954, 1963, 1994, 2002, 2009, and 2013 were used in the analysis. The 1994, 2002, 2009, and 2013 images were available from other sources. The 1994 imagery was orthorectified by the U.S. Geological Survey (USGS) and the 2002, 2009, and 2013 imagery was orthorectified by the Virginia Base Mapping Program (VBMP). The 1937, 1954, and 1963 photos are part of the VIMS Shoreline Studies Program archives. The historical aerial images used to analyze the City's shoreline were not always flown on the same day. The exact dates that the 1994 images were flown could not be ascertained; however, the dates for the other years are as follows:

1937 – April 12, May 20, September 4
1954 – October 11 and 16, November 7
1963 – February 6 and 18
2002 – February 18, 19 and 22
2009 – February 17, 20, and 23, March 24
2013 – March 15, 27 and 30, April 6

The 1937, 1954, and 1963 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 aeriels because of the difficulty in finding control points that match the earliest 1937 images.

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 given the lack of ground features and poor photo quality on the earliest photos. 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. Some areas of the City of Chesapeake were difficult to rectify, either due to the lack of development when compared to the reference images or due to changing development between 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 feature digitized is noted in the shoreline attributes for the 2009 photos. For City of Chesapeake, the high water line was approximated. High water limit of run-up can be difficult to determine on some shorelines due to narrow or non-existent beaches against upland banks, vegetated cover, or man-made vertical structures. In addition, tide levels at the time the photos were taken and amount of development throughout the years were particularly noticeable between photo dates. These type of conditions required us to approximate the high water line (Figure 2).

Nearly 109 miles of shoreline were digitized from the 2009 photos. However, not all tidal shoreline was digitized inside very small creeks and marshes. Poor quality photos in some areas made rectifying and digitizing images difficult. Environmental conditions along the shoreline made it difficult to delineate the shoreline even on the latest photos. In some areas trees can obscure the true shoreline locations due to overhanging branches, leaning trees or a slight angle on the aerials. 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. For 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 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.



Figure 2. Variable tide level and development complicated shoreline locations (Left: 1937 and right: 2009).

2.2 Rate of Change Analysis

The Digital Shoreline Analysis System (DSAS) was used to determine the rate of change for the City of Chesapeake's shoreline (Himmelstoss, 2009). All DSAS input data must be managed within a personal geodatabase, which includes all the baselines created for the City of Chesapeake and the digitized shorelines for 1937, 1954, 1963, 1994, 2002 and 2009. Baselines were digitized about 200 feet, more or less, depending on features and space, seaward of the 1937 shoreline and encompassed the City's main shorelines as well as most of the smaller creeks. It did not include areas that have unique shoreline morphology such as creek mouths and spits. DSAS generated transects perpendicular to the baseline about 30 feet apart, which were manually checked and cleaned up before running the End Point Rate (EPR) calculations. Forty four miles of baselines and 7015 transects were used.

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.

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, 1954, and 1963) have an estimated total maximum shoreline position error of 20.0 feet, while the total maximum shoreline error for the three existing datasets are estimated at 18.3 feet for USGS and 10.2 feet for VBMP. The maximum annualized error for the shoreline data is ± 0.6 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 analysis are not calculated. Many areas of City of Chesapeake have shore change rates that fall within the calculated error. Some of the areas that show very low accretion or very low erosion can be due to errors within the method as described above.

The City of Chesapeake shoreline was divided into 8 plates (Figure 3) in order to display the shoreline data. In Appendix A, the 2009 image is shown with the 1937 and 2009 shorelines and the calculated EPR. In Appendix B, one photo date and the associated shoreline is shown on each map for each year. These include the photos taken in 1937, 1954, 1963, 1994, 2002, 2009, and 2013.

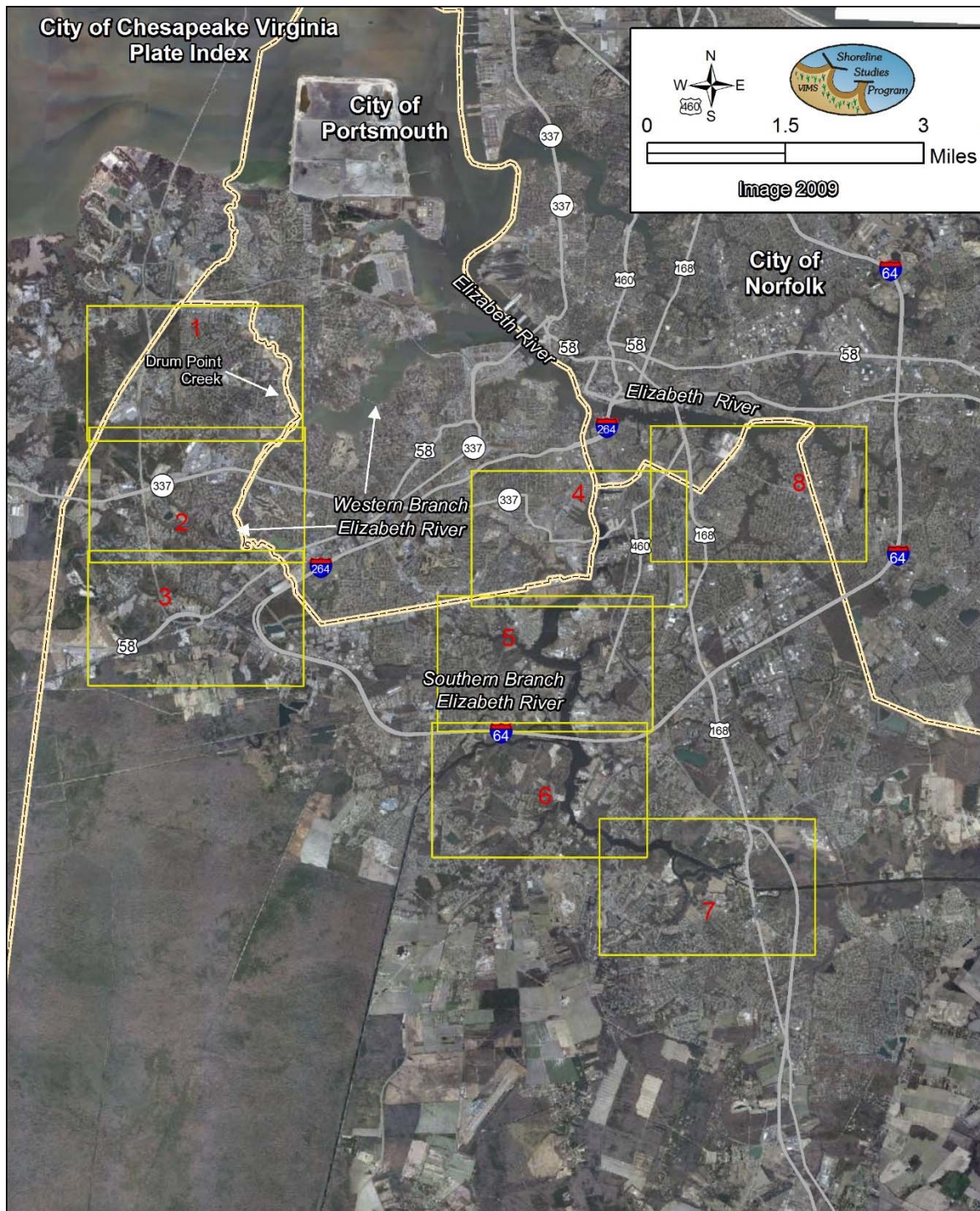


Figure 3. Plate index for City of Chesapeake shorelines.

3 Results and Discussion

Three separate areas of shoreline occur within the City of Chesapeake: on the Western Branch of the Elizabeth River (Plates 1-3), on the Southern Branch of the Elizabeth River (Plates 4-7), and on the Eastern Branch of the Elizabeth River (Plate 8). All three areas have minimal fetch and most of the rivers and creeks are experiencing very low erosion (<1 ft/yr). Table 1 shows the average EPR of change for sections of the City based on the digitized shorelines.

The shorelines along the Western Branch and the Eastern Branch and those creeks and rivers that feed into them are similar. They generally are low, residential properties fronted by marsh shorelines. These shorelines are either natural or have shore protection structures on individual properties (Appendix A1-A3). One area along the main Eastern Branch of the Elizabeth River shows more and variable change (Appendix A-8). In 1957 (Appendix B-51), the shoreline showed no small creeks feeding directly into the Elizabeth River. However, by 1963 (Appendix A-52), seven creeks had been created/enlarged and the farm fields converted to residential properties. It is likely that marsh was dredged to create water access for the properties.

The Southern Branch of the Elizabeth River is a highly industrialized shoreline. Even in 1937, many industries were located directly adjacent to the shoreline (Appendix B-24 and B-29). Over time, the shoreline has become mostly man-made and includes manipulated and hardened areas for railroad docks, military bases, and channels for shipping docks. Marshes have been filled in for land expansion and the building over smaller creeks, or marshes have been removed to create water access leading to some areas of low to medium accretion and erosion (Appendix A-8). The shoreline change data is available for viewing online at www.vims.edu/research/departments/physical/programs/ssp/gis_maps.

Table 1. Average end point rates of shoreline change (1937-2009) in feet per year along sections of City of Chesapeake's coast.

| Reach Name | Plate Number | Avg EPR (ft/yr) | Category |
|---------------------------------|--------------|-----------------|------------------|
| Elizabeth River Western Branch | 1,2 and 3 | -0.55 | Very Low Erosion |
| Elizabeth River Southern Branch | 4,5,6, and 7 | -0.46 | Very Low Erosion |
| Elizabeth River Eastern Branch | 8 | -0.26 | Very Low Erosion |

4 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. Some areas of the City, where the shoreline change rates are categorized as accretion, have structures along the shoreline which results in a positive long-term rate of change due to the structures themselves. Some of the areas with very low accretion, particularly in the smaller creeks and rivers, may be the result of errors within photo rectification and digitizing wooded shorelines.

5 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/Cascade/Shoreline_Evolution/Newport_News_ShoreEvolve-lr.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/Cascade/Shoreline_Evolution/Poquoson_ShoreEvolve-lr.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/Cascade/Shoreline_Evolution/Gloucester_ShoreEvolve-lr.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/Cascade/Shoreline_Evolution/York_ShoreEvolve-lr.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.

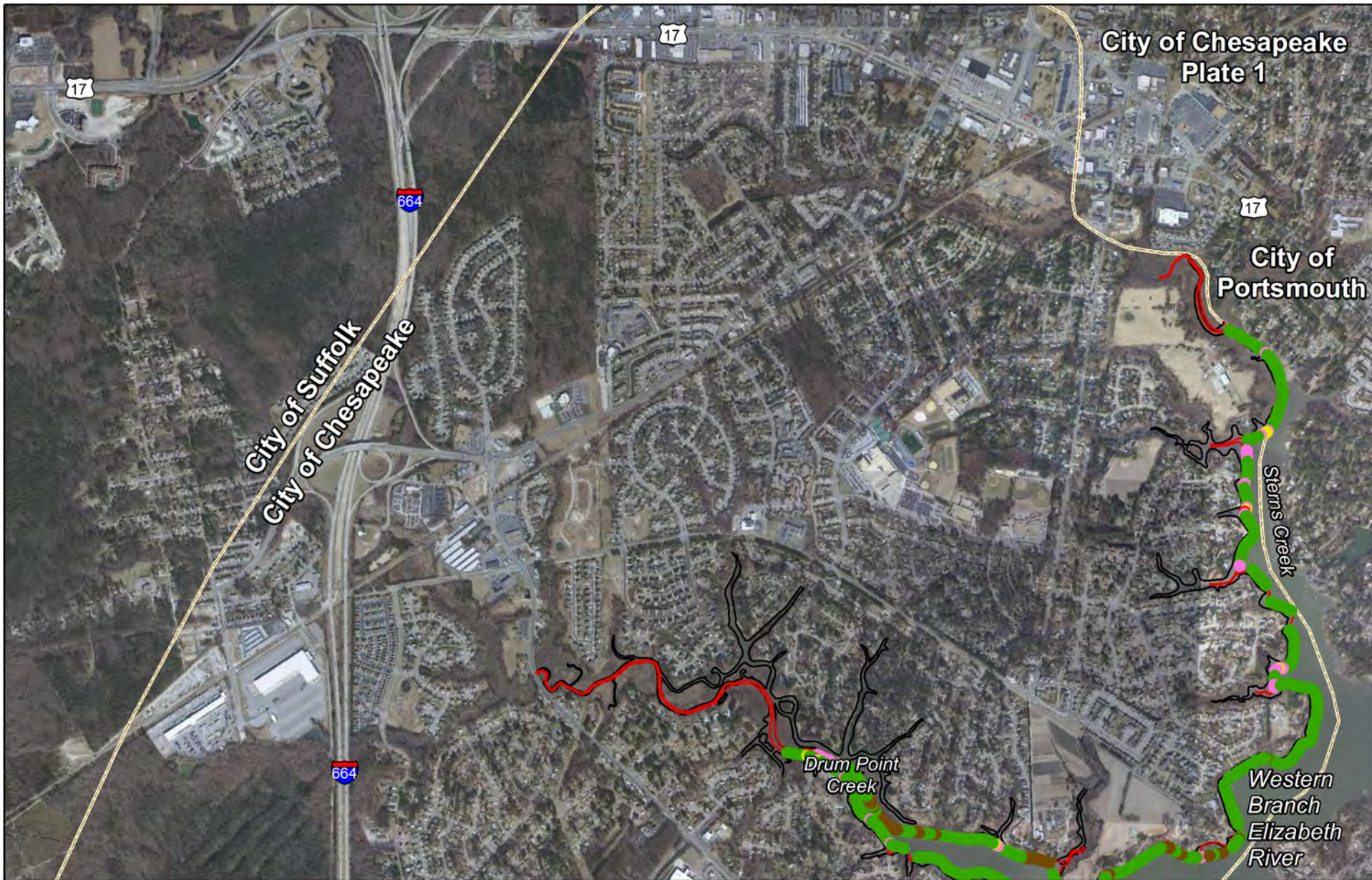
Appendix A

End Point Rate of Shoreline Change Maps

Shoreline change rates calculated between 1937 and 2009 are shown on a 2009 VBMP aerial photo. The calculated rates of change were averaged to determine an average rate of change for sections of shoreline 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.

| | | |
|----------------|--|----------------|
| Plate 1 | | Plate 5 |
| Plate 2 | | Plate 6 |
| Plate 3 | | Plate 7 |
| Plate 4 | | Plate 8 |



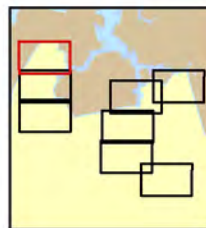
Shoreline Rates of Change

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

Legend

- Shoreline 1937
- Shoreline 2009

2009 VBMP Photo

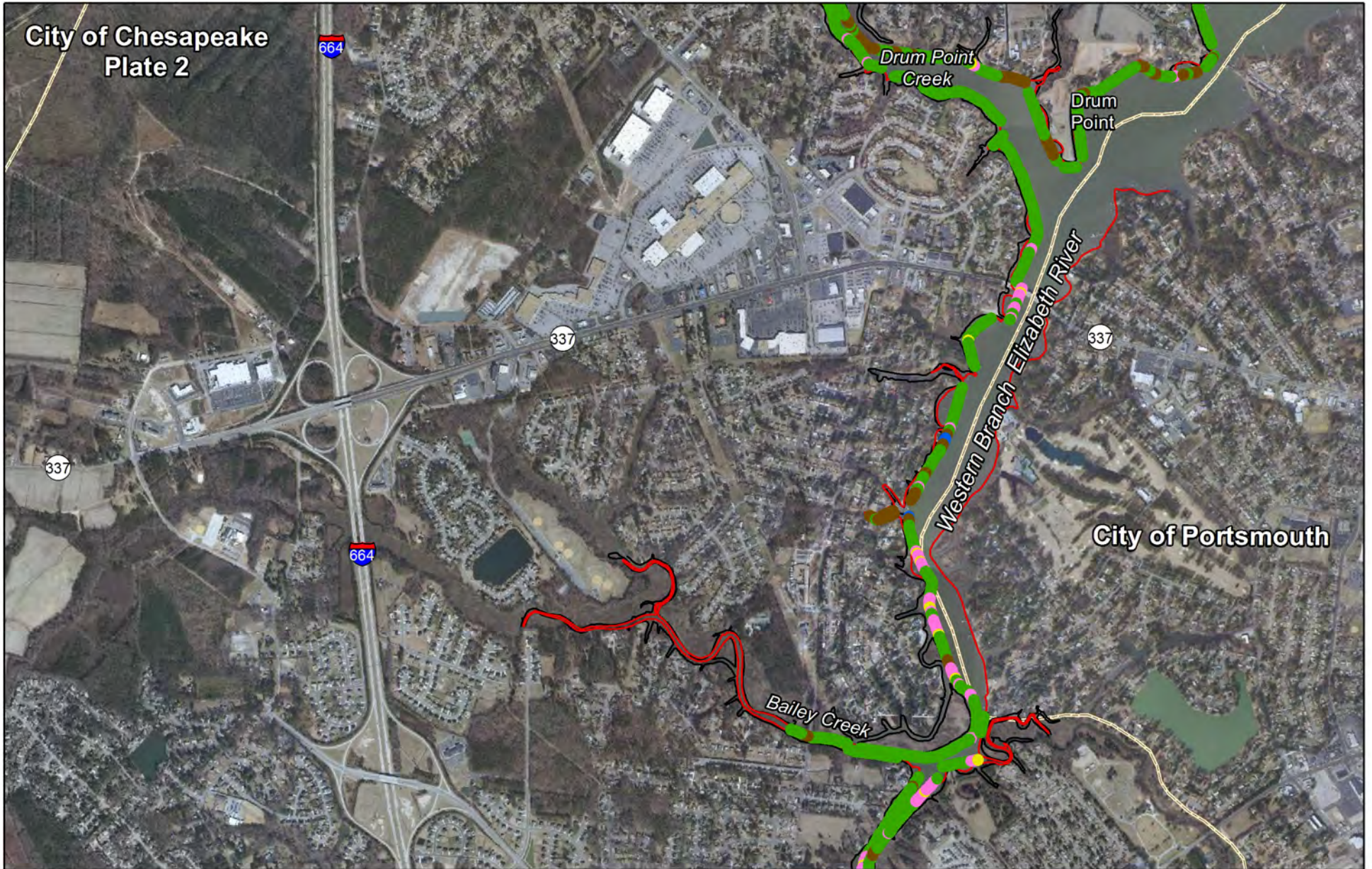


0 2,000 4,000

Feet

A-1

**City of Chesapeake
Plate 2**



Shoreline Rates of Change

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

Legend

- Shoreline 1937
- Shoreline 2009

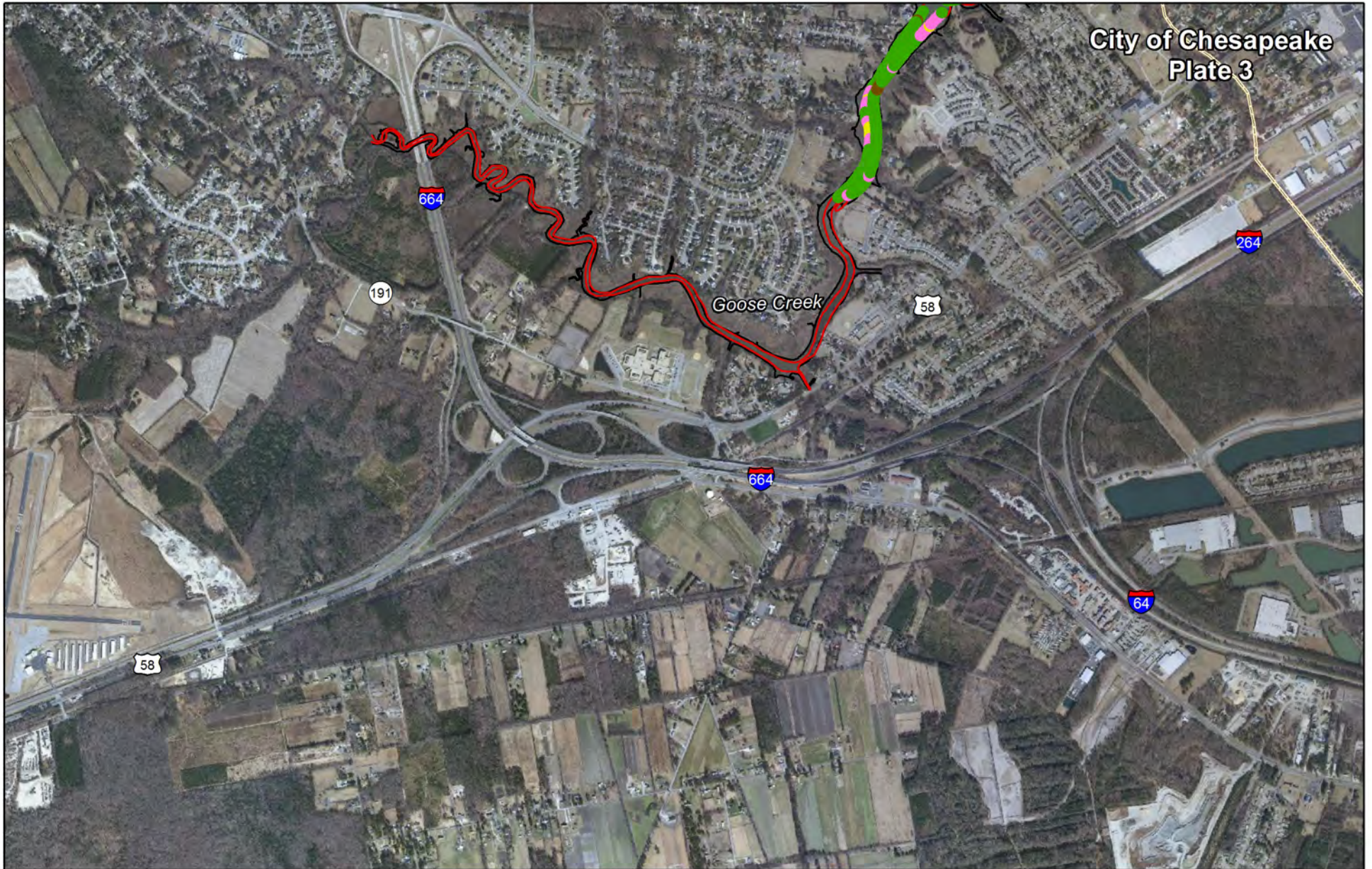
2009 VBMP Photo



0 2,000 4,000

Feet

A-2



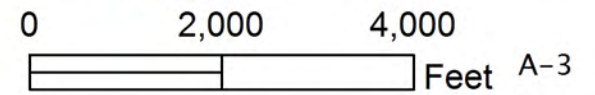
Shoreline Rates of Change

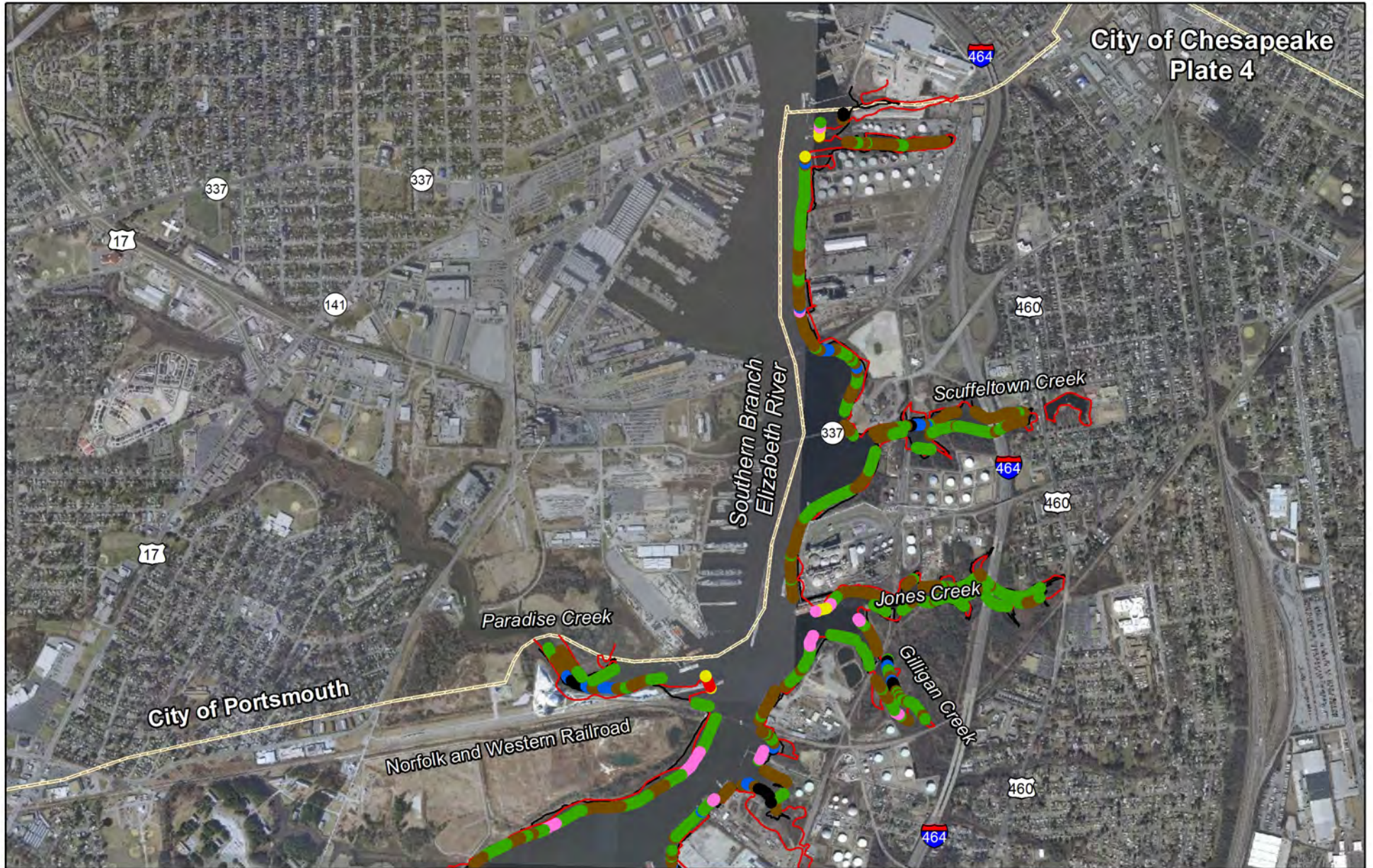
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| ● High Accretion: +10 to +5 (ft/yr) | ● Low Erosion: -1 to -2 (ft/yr) |
| ● Medium Accretion: +5 to +2 (ft/yr) | ● Medium Erosion: -2 to -5 (ft/yr) |
| ● Low Accretion: +2 to +1 (ft/yr) | ● High Erosion: -5 to -10 (ft/yr) |
| ● Very Low Accretion: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

Legend

- Shoreline 1937
- Shoreline 2009

2009 VBMP Photo





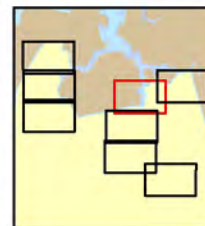
Shoreline Rates of Change

- | | |
|---------------------------------------|-------------------------------------|
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| ● Very Low Accretion: +1 to 0 (ft/yr) | ◆ Very High Erosion: < -10 (ft/yr) |

Legend

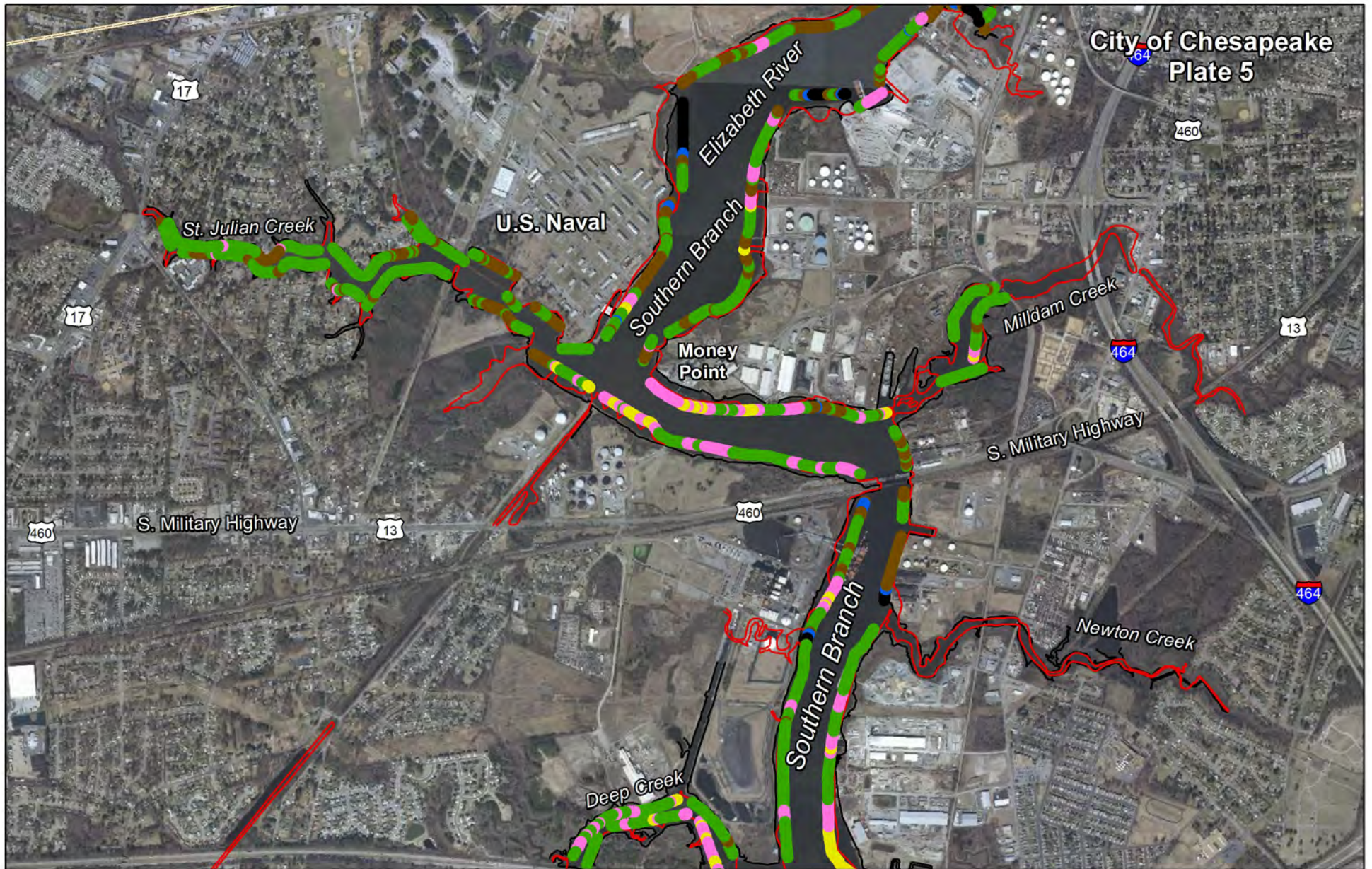
- Shoreline 1937
- Shoreline 2009

2009 VBMP Photo



0 2,000 4,000

Feet



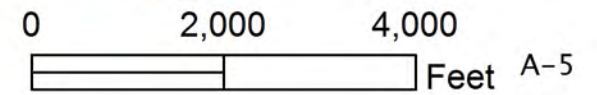
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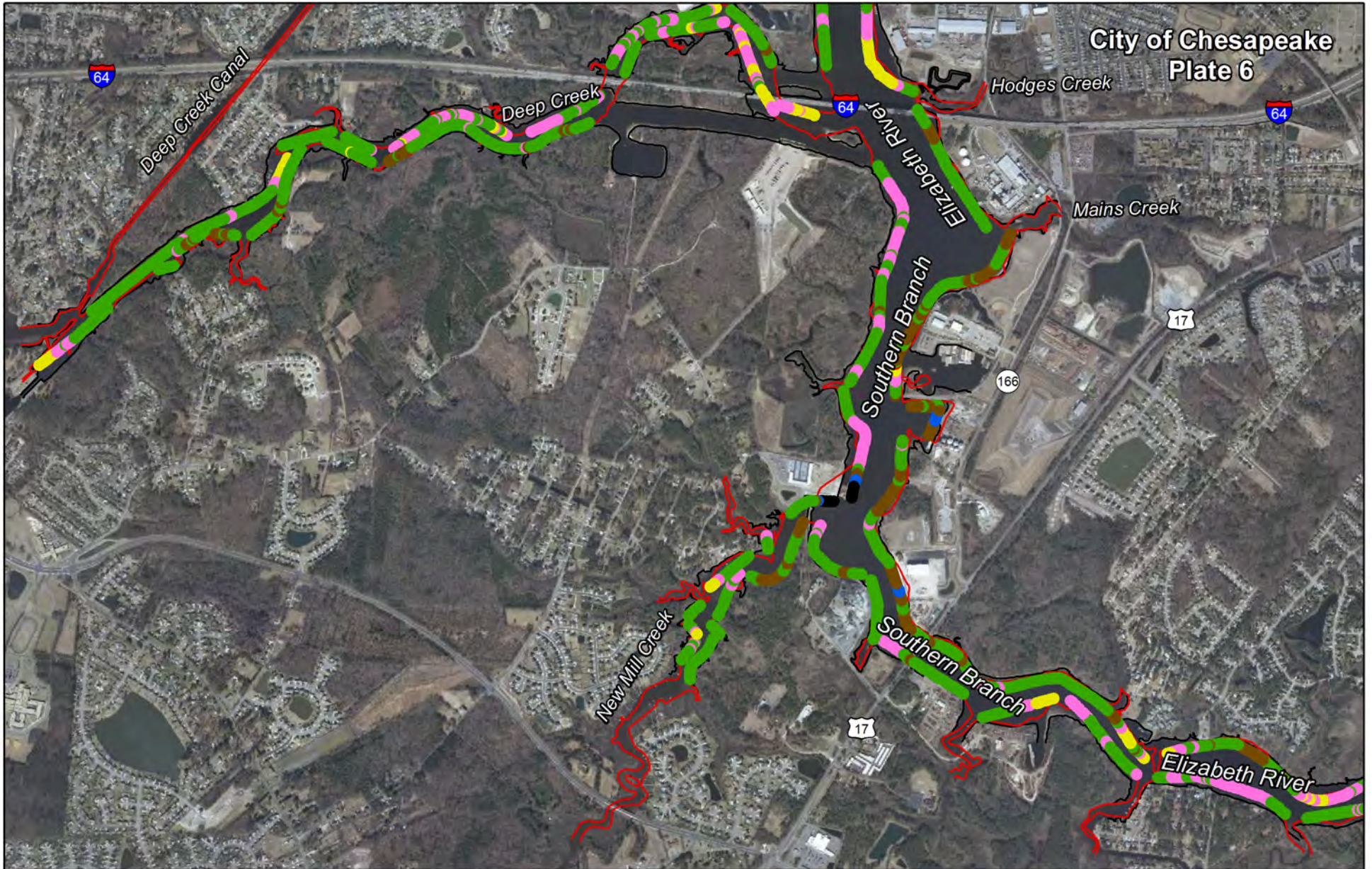
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|---------------------------------------|-------------------------------------|
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| ● Very Low Accretion: +1 to 0 (ft/yr) | ◆ Very High Erosion: < -10 (ft/yr) |

Legend

- Shoreline 1937
- Shoreline 2009

2009 VBMP Photo





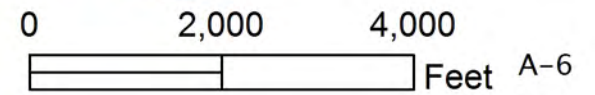
Shoreline Rates of Change

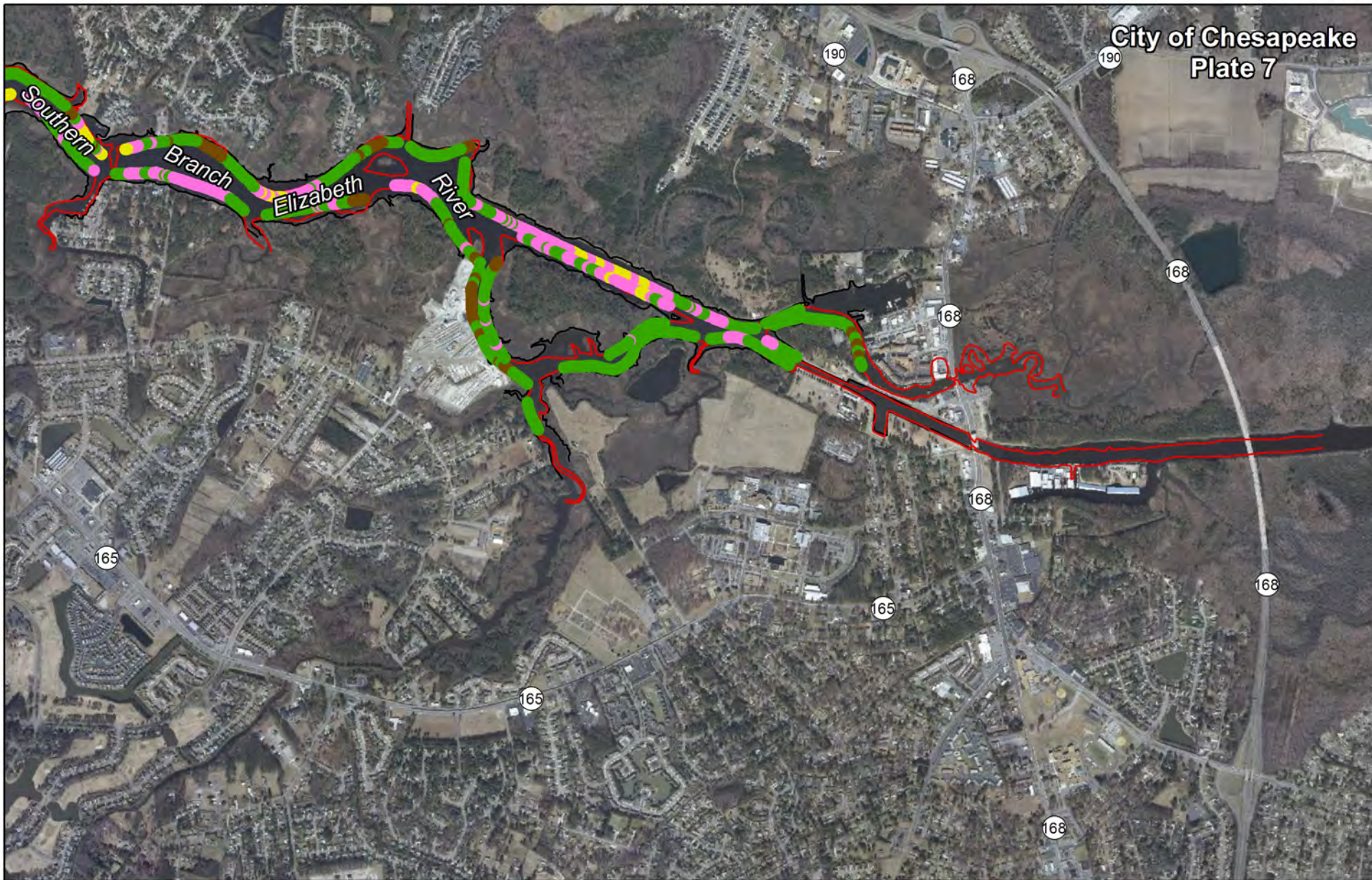
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| ● Medium Accretion: +5 to +2 (ft/yr) | ● Medium Erosion: -2 to -5 (ft/yr) |
| ● Low Accretion: +2 to +1 (ft/yr) | ● High Erosion: -5 to -10 (ft/yr) |
| ● Very Low Accretion: +1 to 0 (ft/yr) | ◆ Very High Erosion: < -10 (ft/yr) |

Legend

- Shoreline 1937
- Shoreline 2009

2009 VBMP Photo





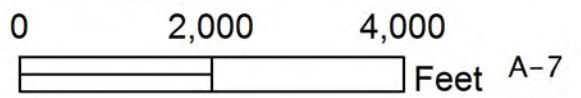
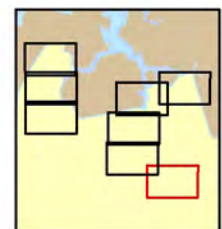
Shoreline Rates of Change

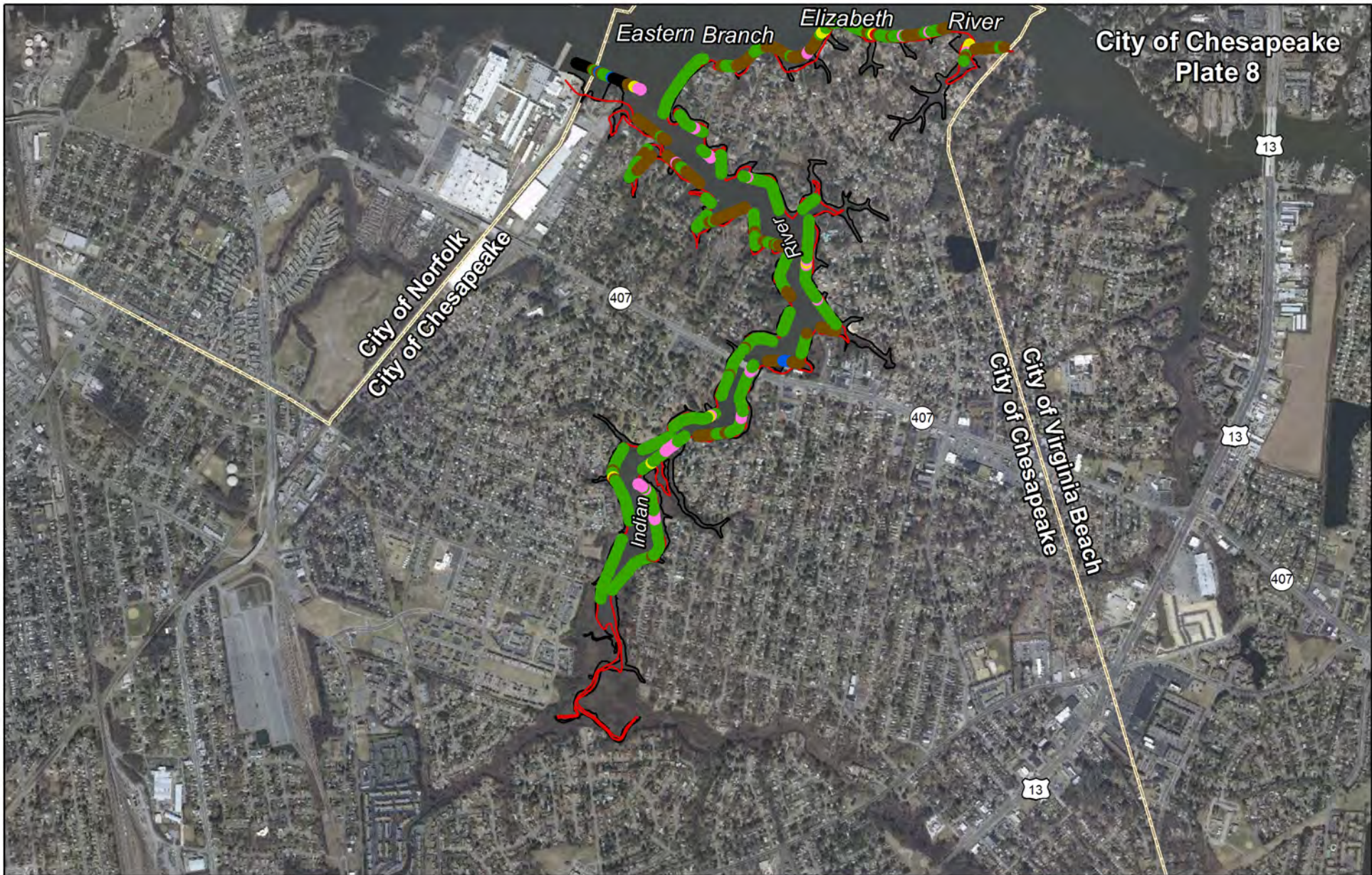
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| ● Very Low Accretion: +1 to 0 (ft/yr) | ◆ Very High Erosion: < -10 (ft/yr) |

Legend

- Shoreline 1937
- Shoreline 2009

2009 VBMP Photo





City of Chesapeake
Plate 8

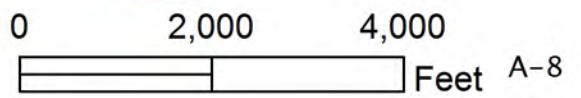
Shoreline Rates of Change

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

Legend

- Shoreline 1937
- Shoreline 2009

2009 VBMP Photo



Appendix B

Historical Photo and Digitized Shoreline 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.

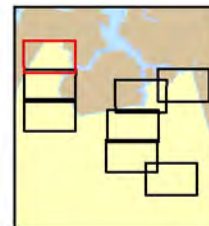
| | | |
|----------------|--|----------------|
| Plate 1 | | Plate 5 |
| Plate 2 | | Plate 6 |
| Plate 3 | | Plate 7 |
| Plate 4 | | Plate 8 |



Legend
 — Shoreline 1937

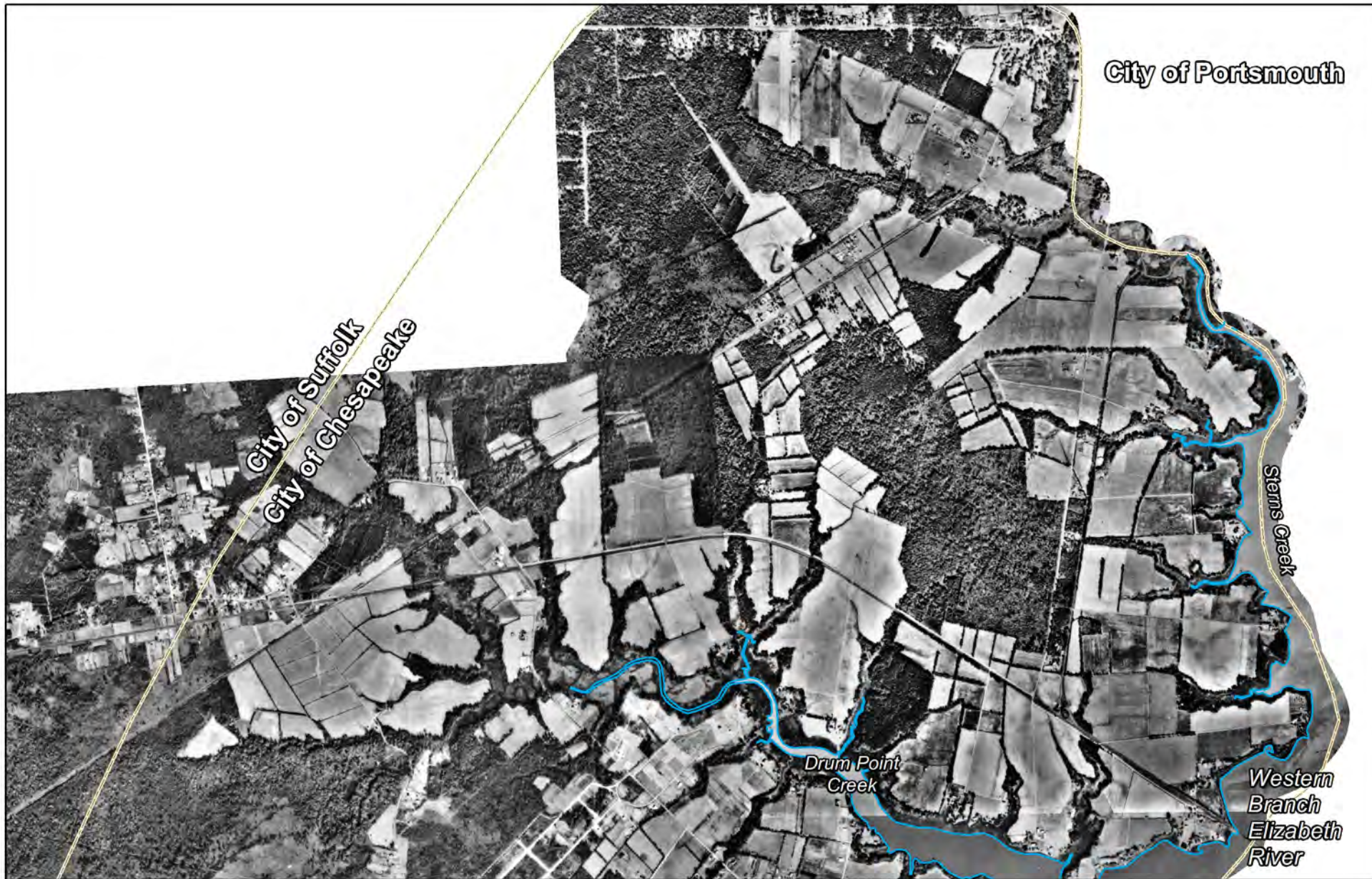


**City of Chesapeake, Virginia
 Plate 1**



0 2,000 4,000
 Feet

Photo Date: 1937



Legend
 — Shoreline 1954



**City of Chesapeake, Virginia
 Plate 1**

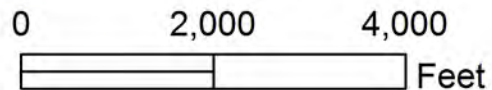
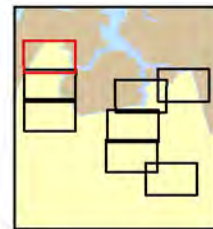


Photo Date: 1954



Legend
 — Shoreline 1963



**City of Chesapeake, Virginia
 Plate 1**

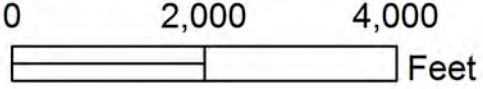
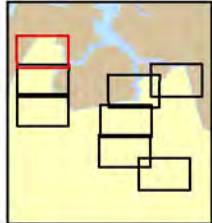


Photo Date: 1963



Legend
 — Shoreline 1994

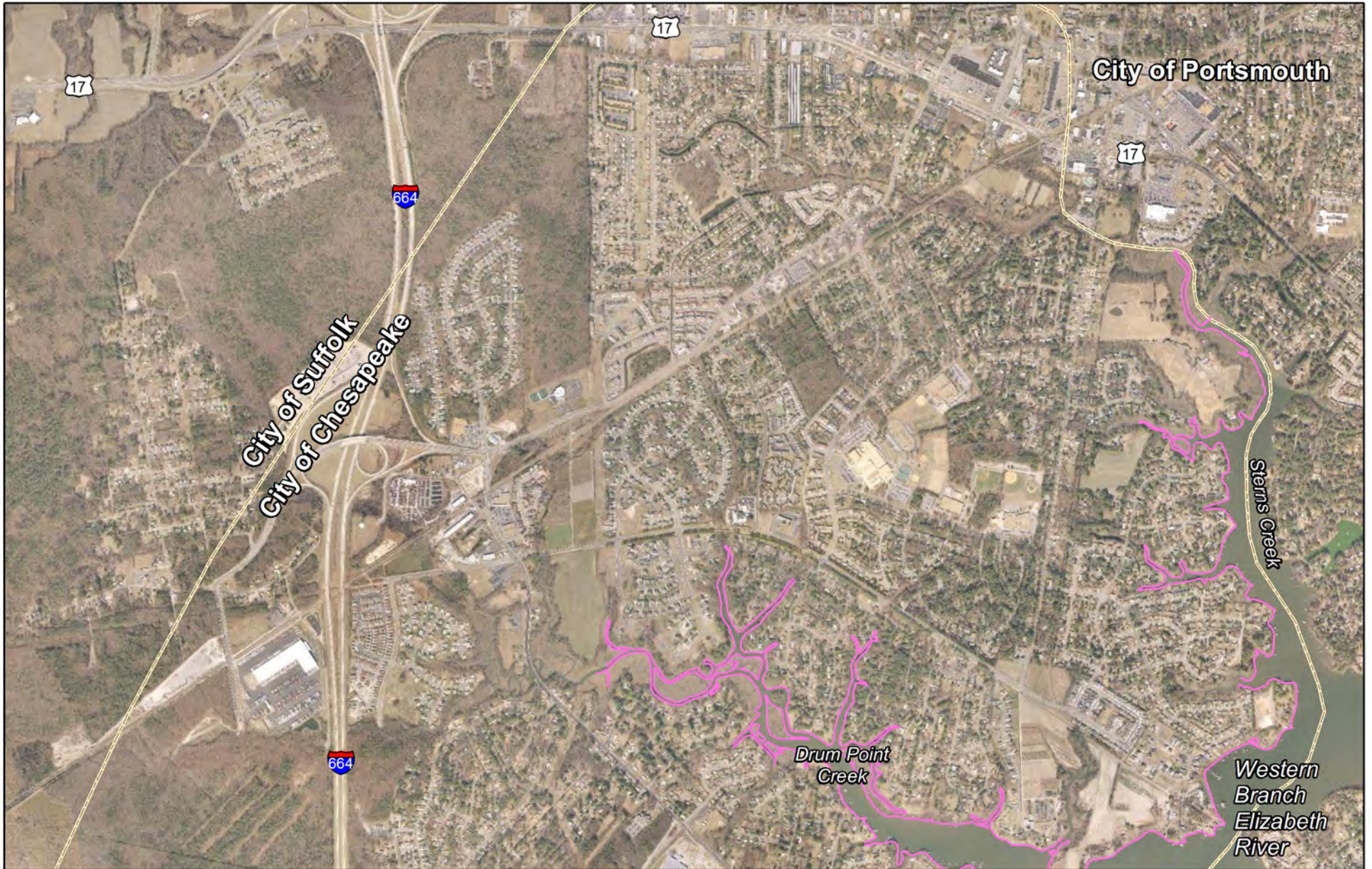


**City of Chesapeake, Virginia
 Plate 1**



0 2,000 4,000
 Feet

Photo Date: 1994



Legend
 — Shoreline 2002

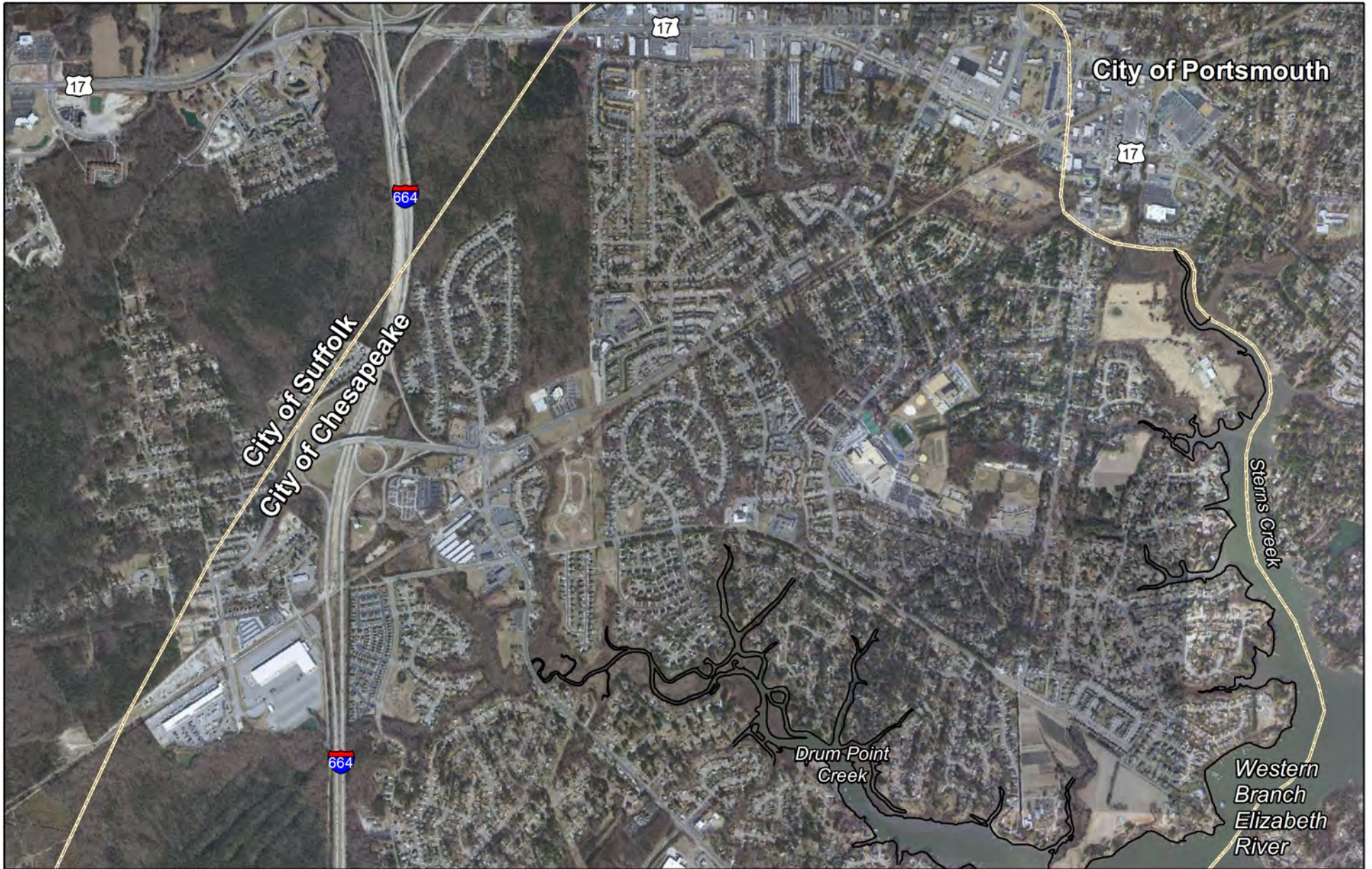


0 2,000 4,000
 Feet

**City of Chesapeake, Virginia
 Plate 1**

Photo Date: 2002





Legend
 — Shoreline 2009



**City of Chesapeake, Virginia
 Plate 1**

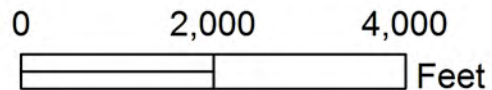
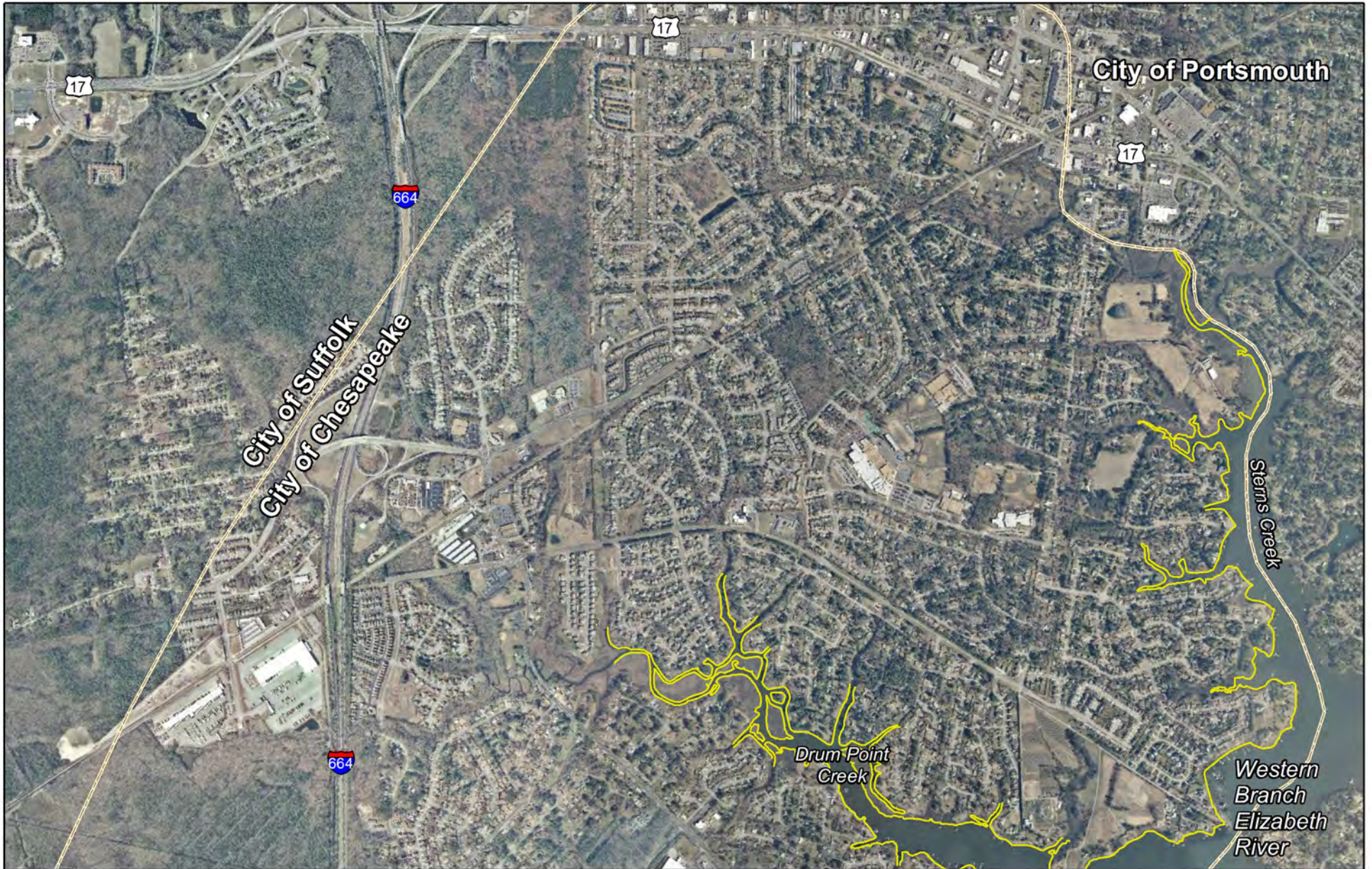


Photo Date: 2009



Legend
 — Shoreline 2013



0 2,000 4,000
 Feet

**City of Chesapeake, Virginia
 Plate 1**

Photo Date: 2013



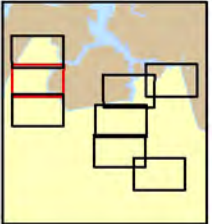
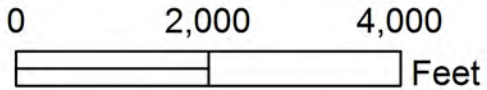


Legend
 — Shoreline 1937



**City of Chesapeake, Virginia
 Plate 2**

Photo Date: 1937





Legend
 — Shoreline 1954



**City of Chesapeake, Virginia
 Plate 2**

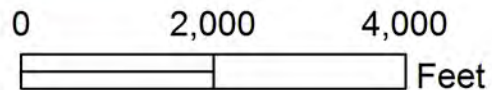


Photo Date: 1954



City of Chesapeake

Drum Point
Creek

Drum
Point

Western Branch Elizabeth River

City of Portsmouth

Bailey Creek

Legend
 Shoreline 1963



**City of Chesapeake, Virginia
Plate 2**

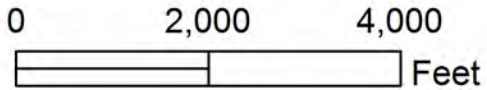
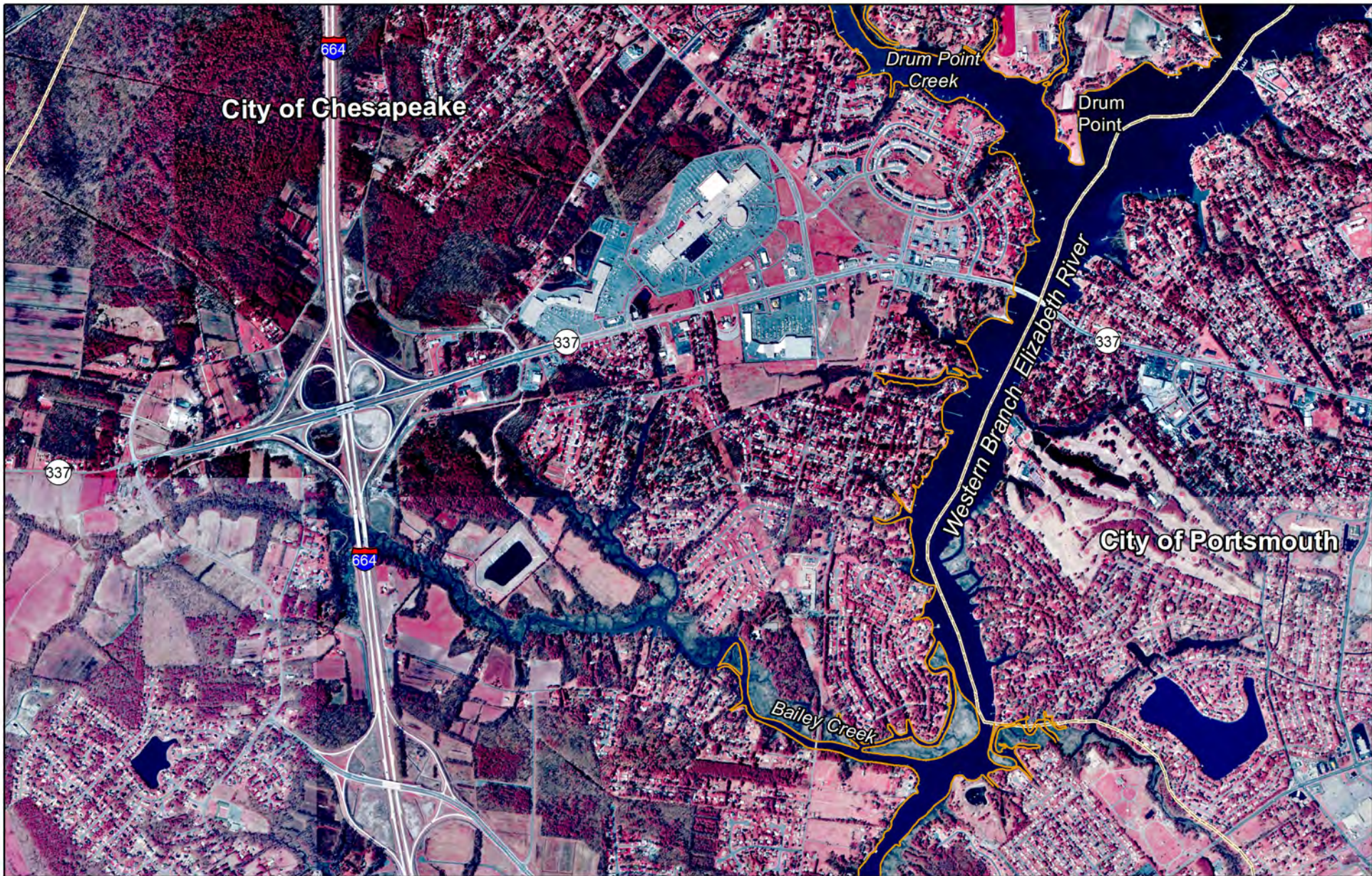


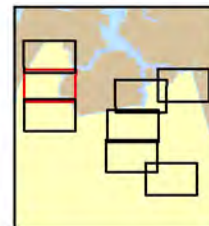
Photo Date: 1963



Legend
 — Shoreline 1994

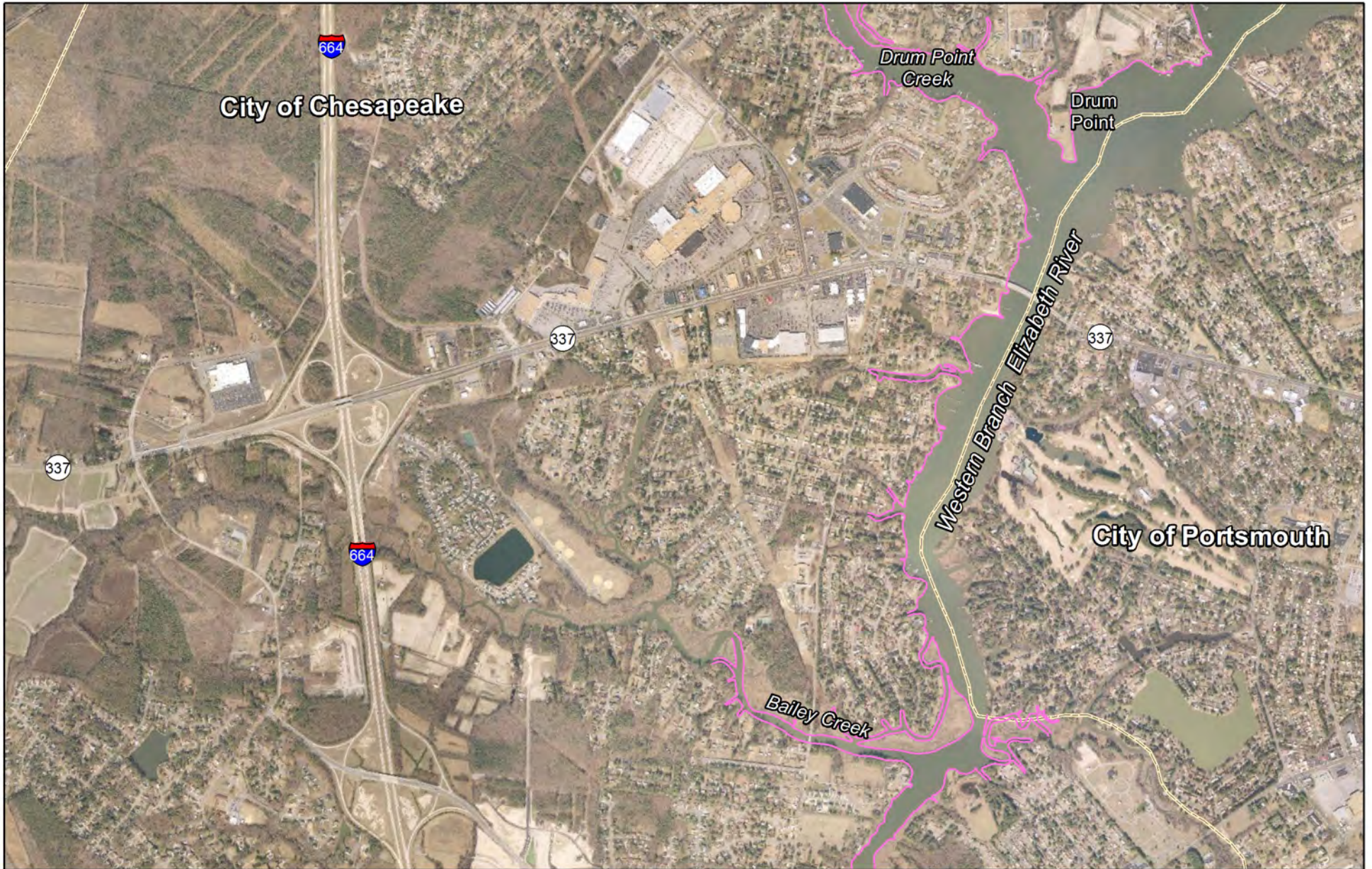


**City of Chesapeake, Virginia
 Plate 2**



0 2,000 4,000
 Feet

Photo Date: 1994



Legend
 — Shoreline 2002

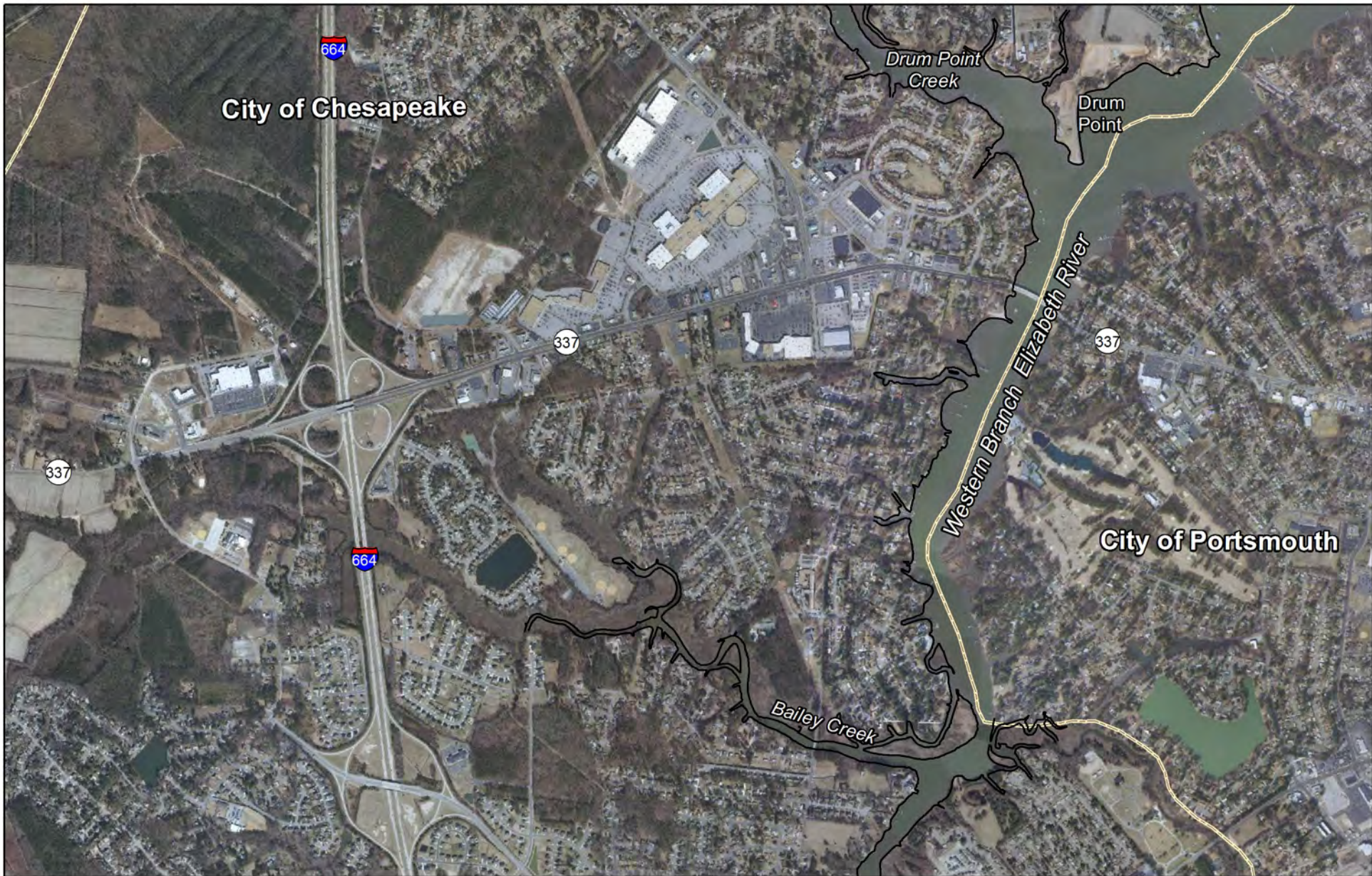


0 2,000 4,000
 Feet

**City of Chesapeake, Virginia
 Plate 2**

Photo Date: 2002





Legend
 — Shoreline 2009

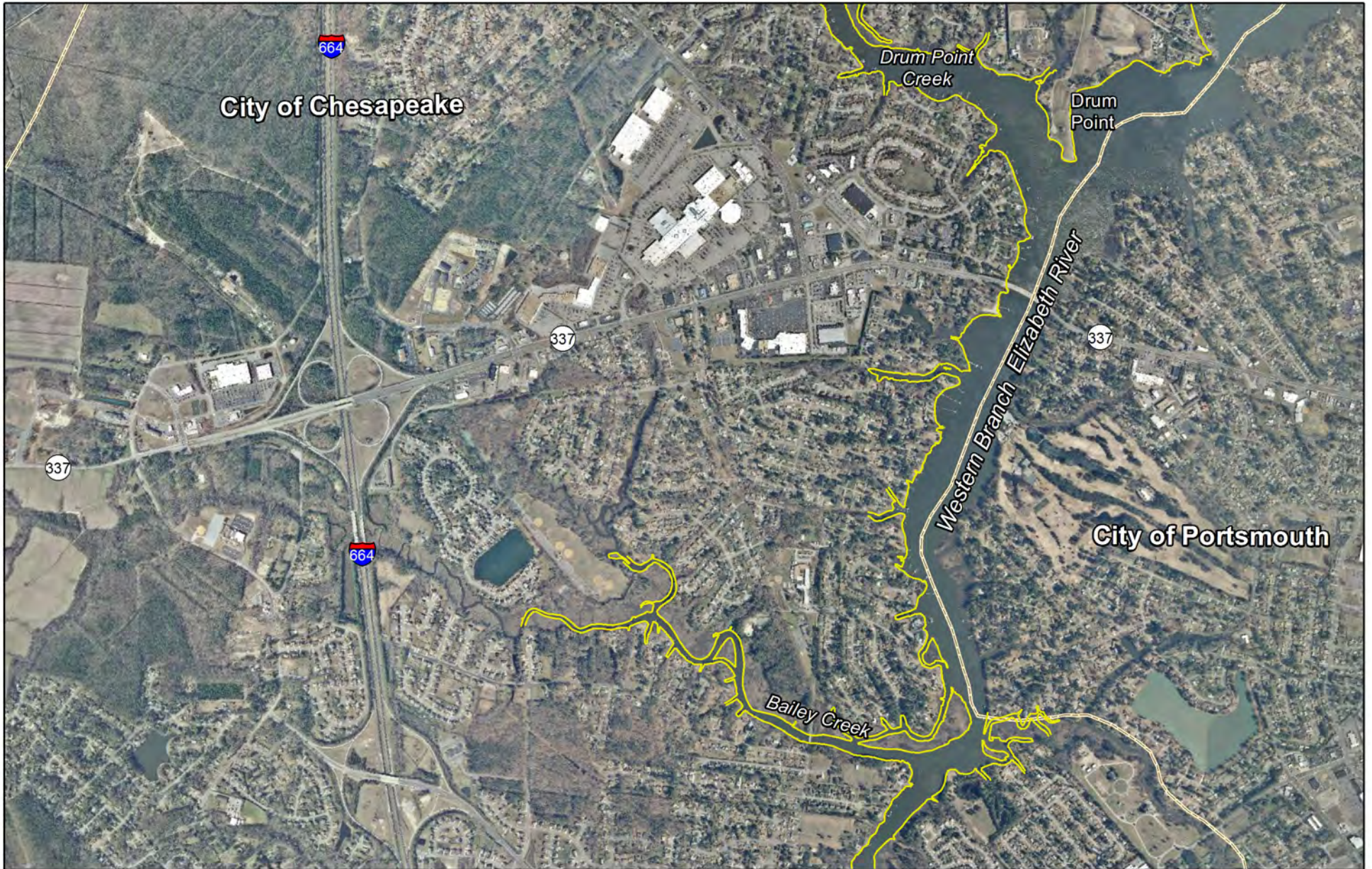



0 2,000 4,000
 Feet

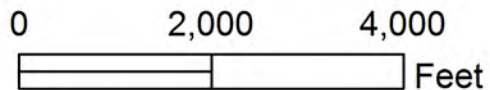
**City of Chesapeake, Virginia
 Plate 2**

Photo Date: 2009





Legend
 Shoreline 2013



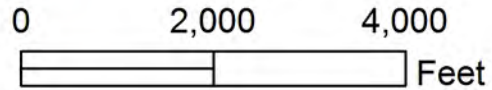
**City of Chesapeake, Virginia
 Plate 2**

Photo Date: 2013



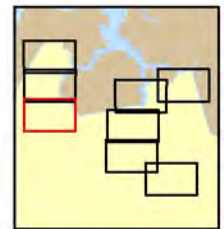


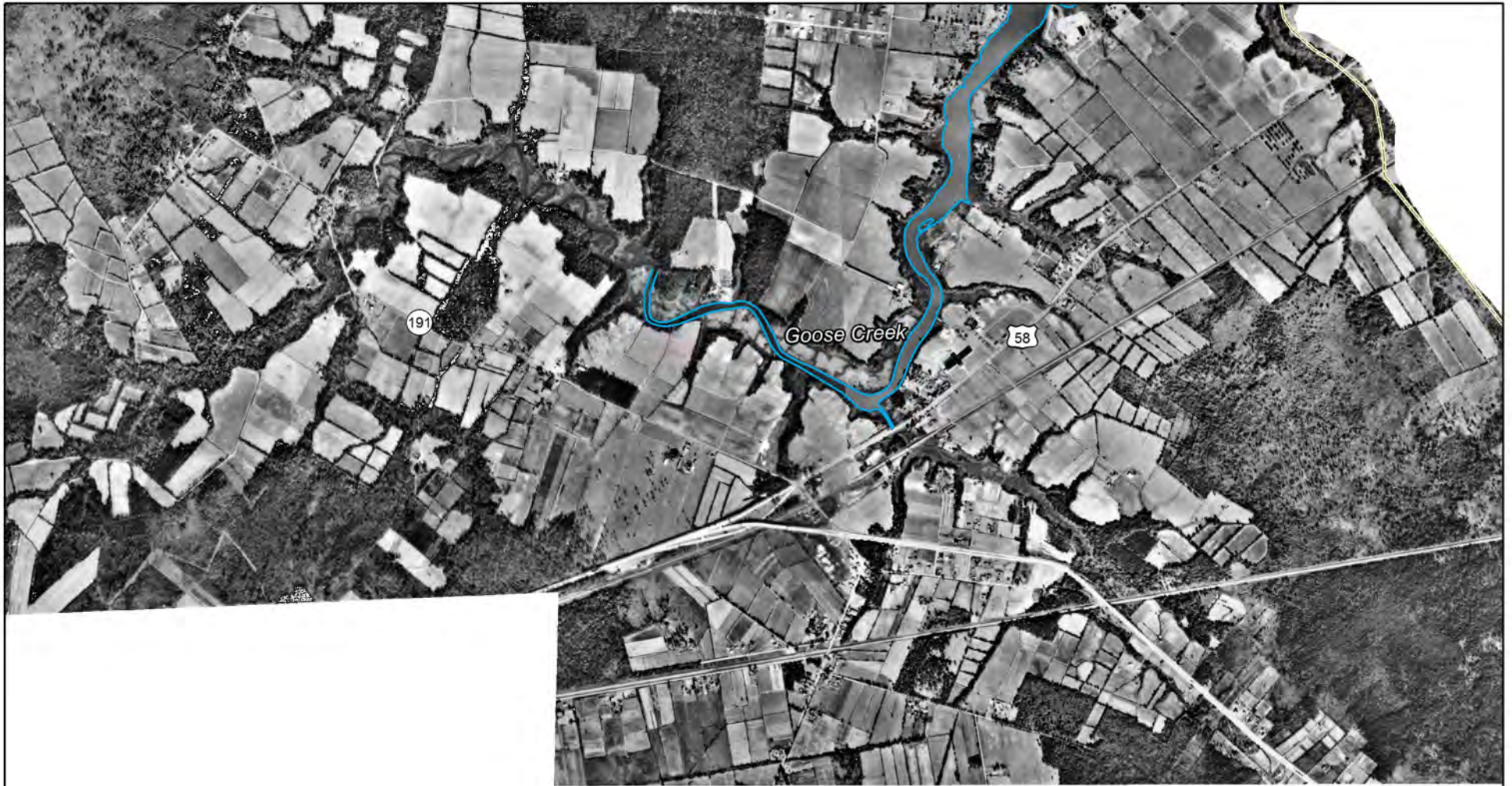
Legend
— Shoreline 1937



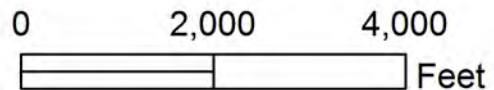
City of Chesapeake, Virginia Plate 3

Photo Date: 1937





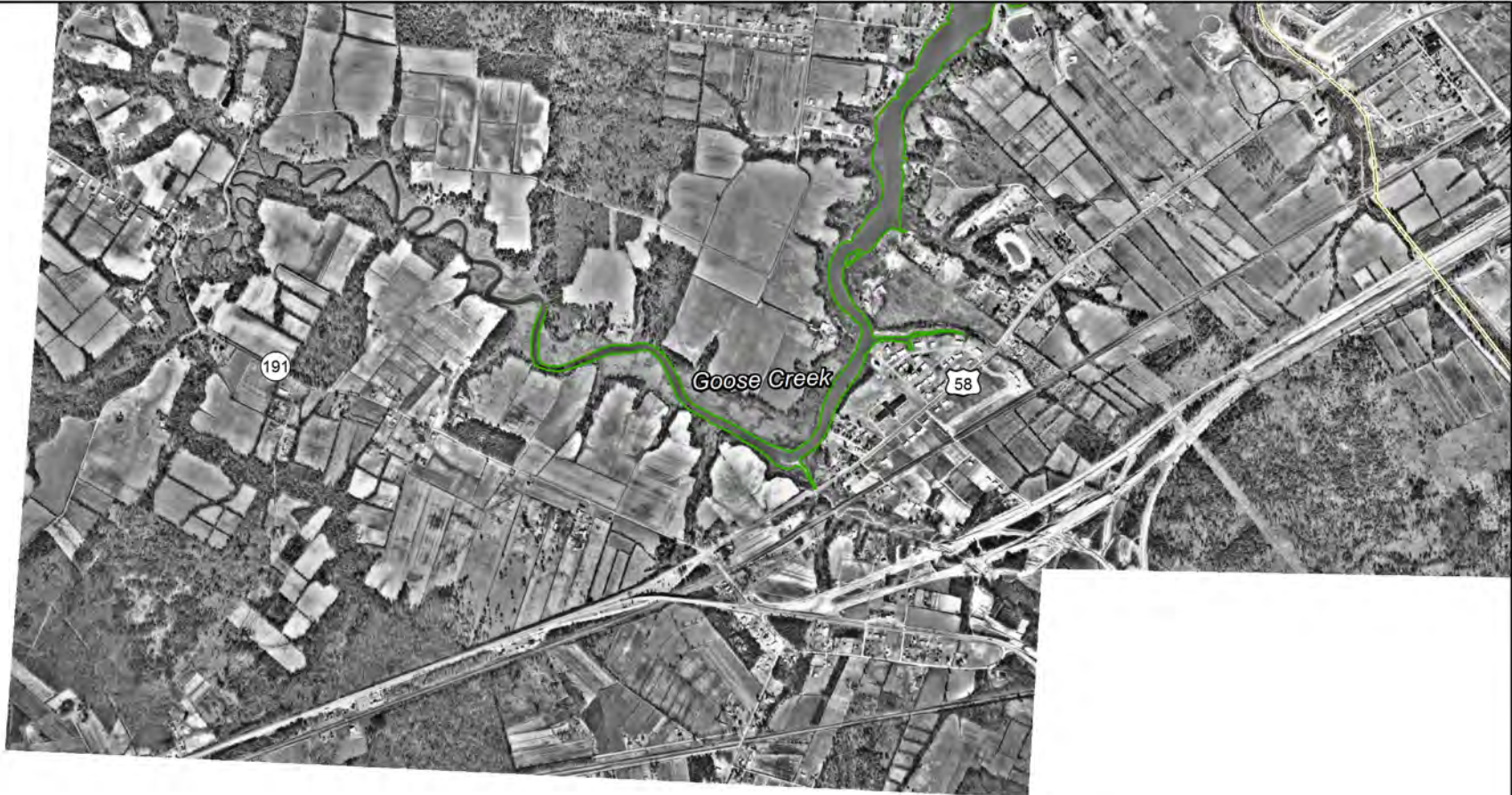
Legend
— Shoreline 1954



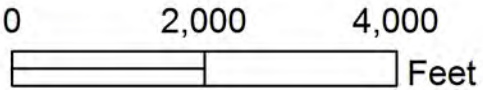
City of Chesapeake, Virginia Plate 3

Photo Date: 1954



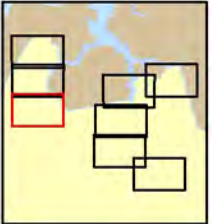


Legend
— Shoreline 1963



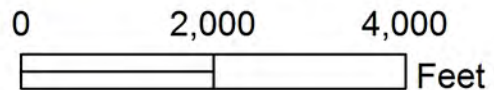
City of Chesapeake, Virginia Plate 3

Photo Date: 1963





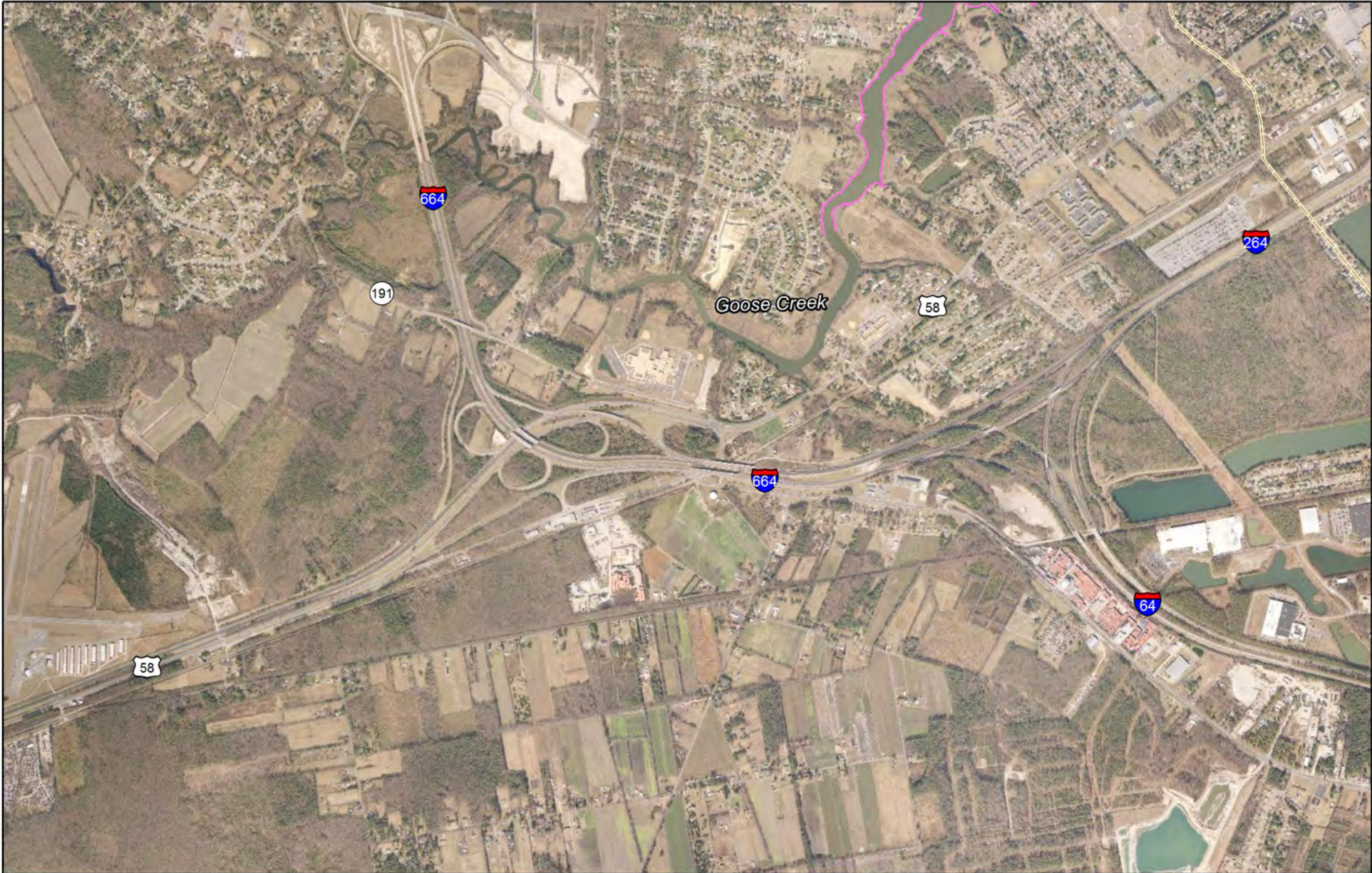
Legend
 — Shoreline 1994



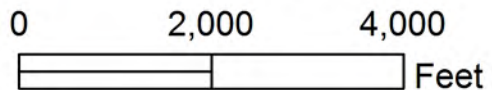
**City of Chesapeake, Virginia
 Plate 3**

Photo Date: 1994





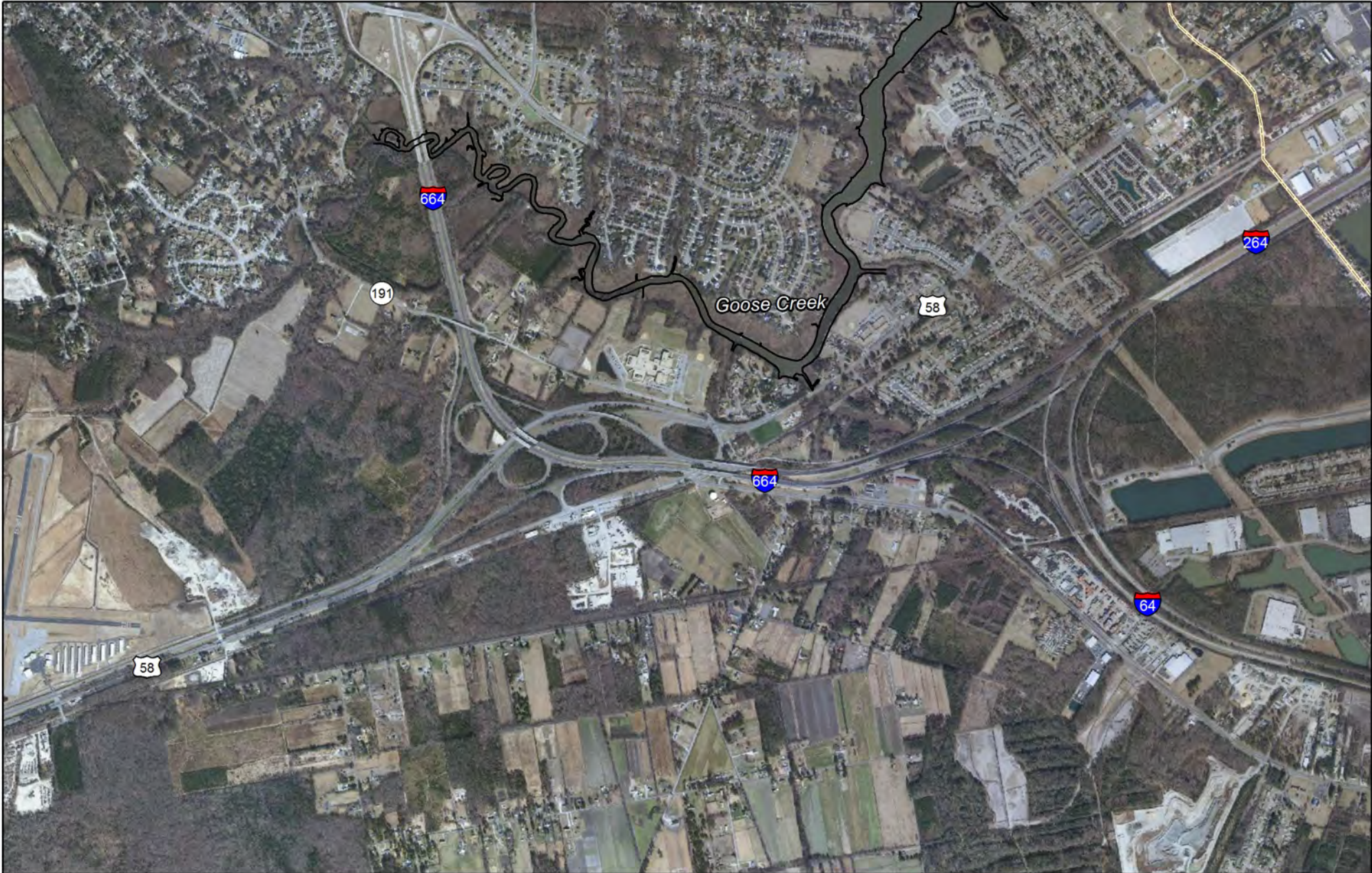
Legend
— Shoreline 2002



City of Chesapeake, Virginia Plate 3

Photo Date: 2002





Legend
 — Shoreline 2009



**City of Chesapeake, Virginia
 Plate 3**

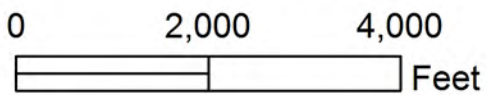
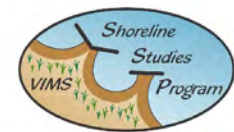
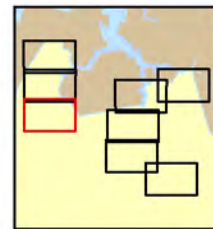
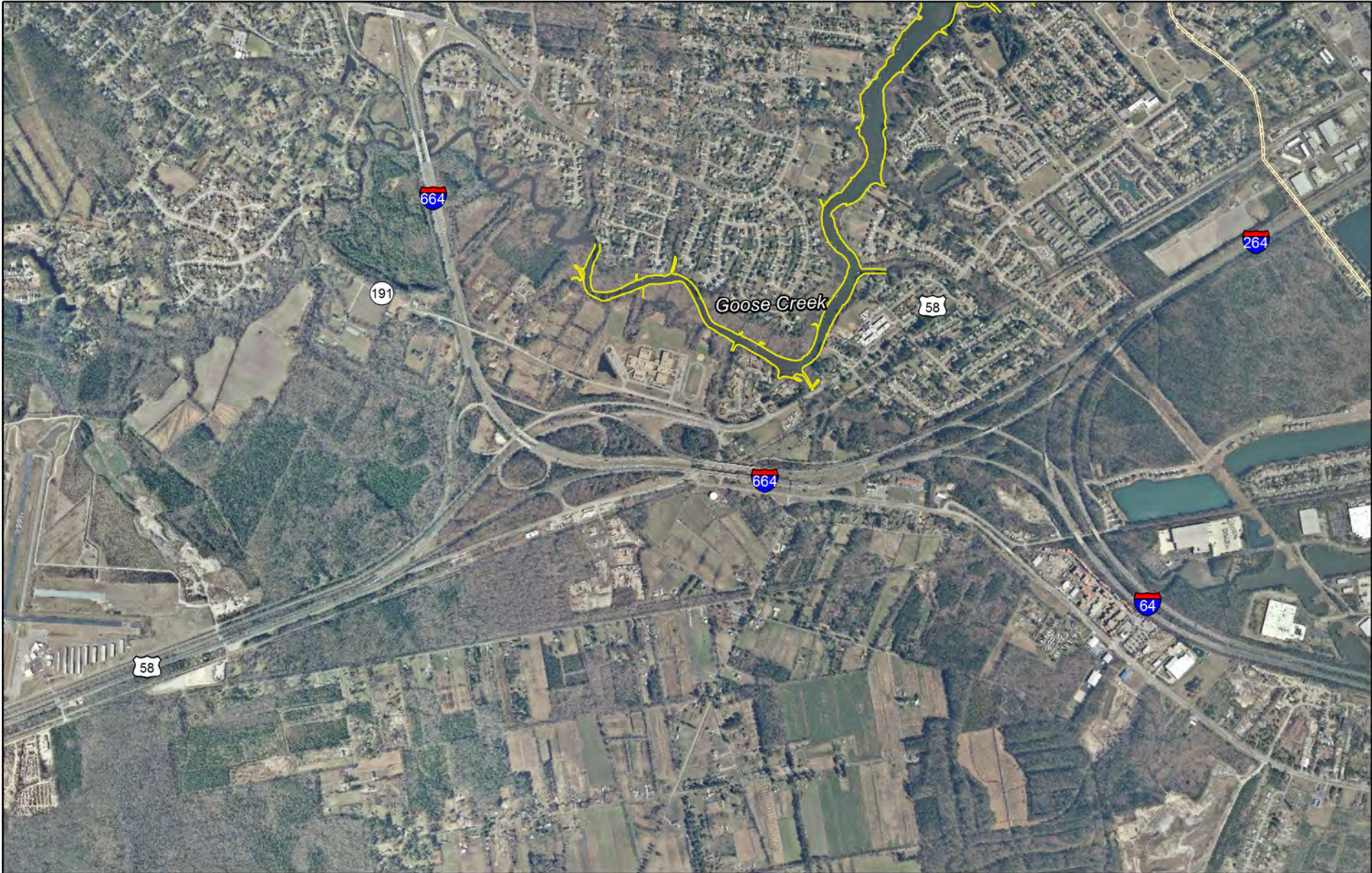

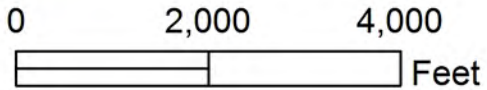


Photo Date: 2009

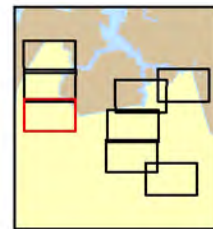


Legend
 Shoreline 2013



**City of Chesapeake, Virginia
 Plate 3**

Photo Date: 2013





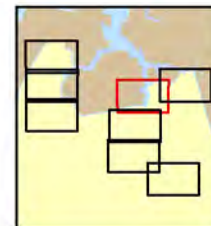
Legend
 — Shoreline 1937



0 2,000 4,000
 Feet

**City of Chesapeake, Virginia
 Plate 4**

Photo Date: 1937





Legend
 — Shoreline 1954



0 2,000 4,000
 Feet

**City of Chesapeake, Virginia
 Plate 4**

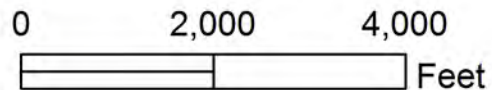
Photo Date: 1954





Legend

— Shoreline 1963




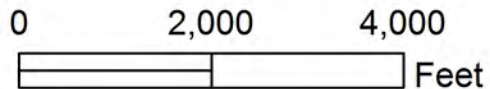
**City of Chesapeake, Virginia
Plate 4**

Photo Date: 1963





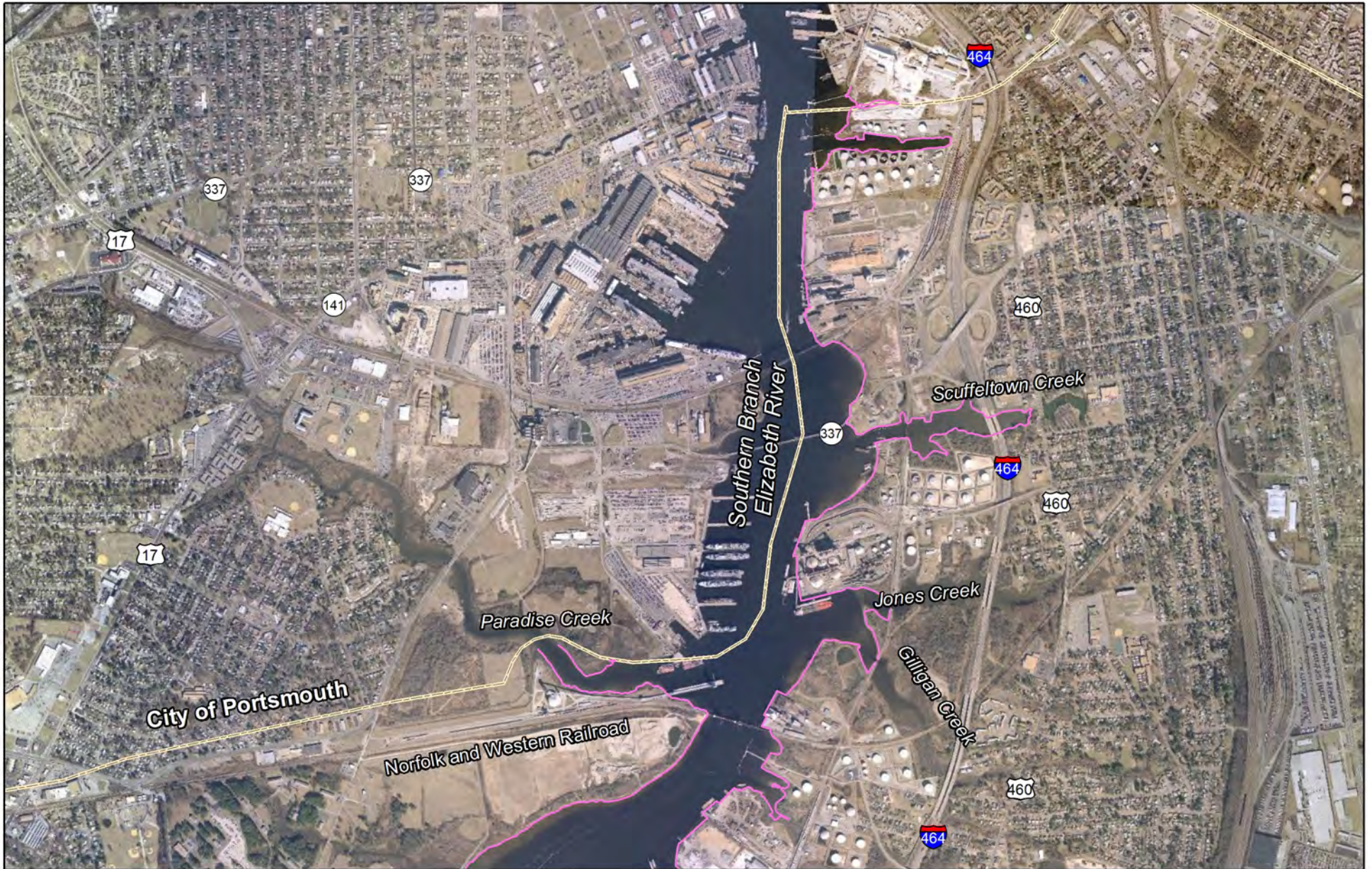
Legend
 Shoreline 1994



City of Chesapeake, Virginia Plate 4

Photo Date: 1994





Legend
 — Shoreline 2002

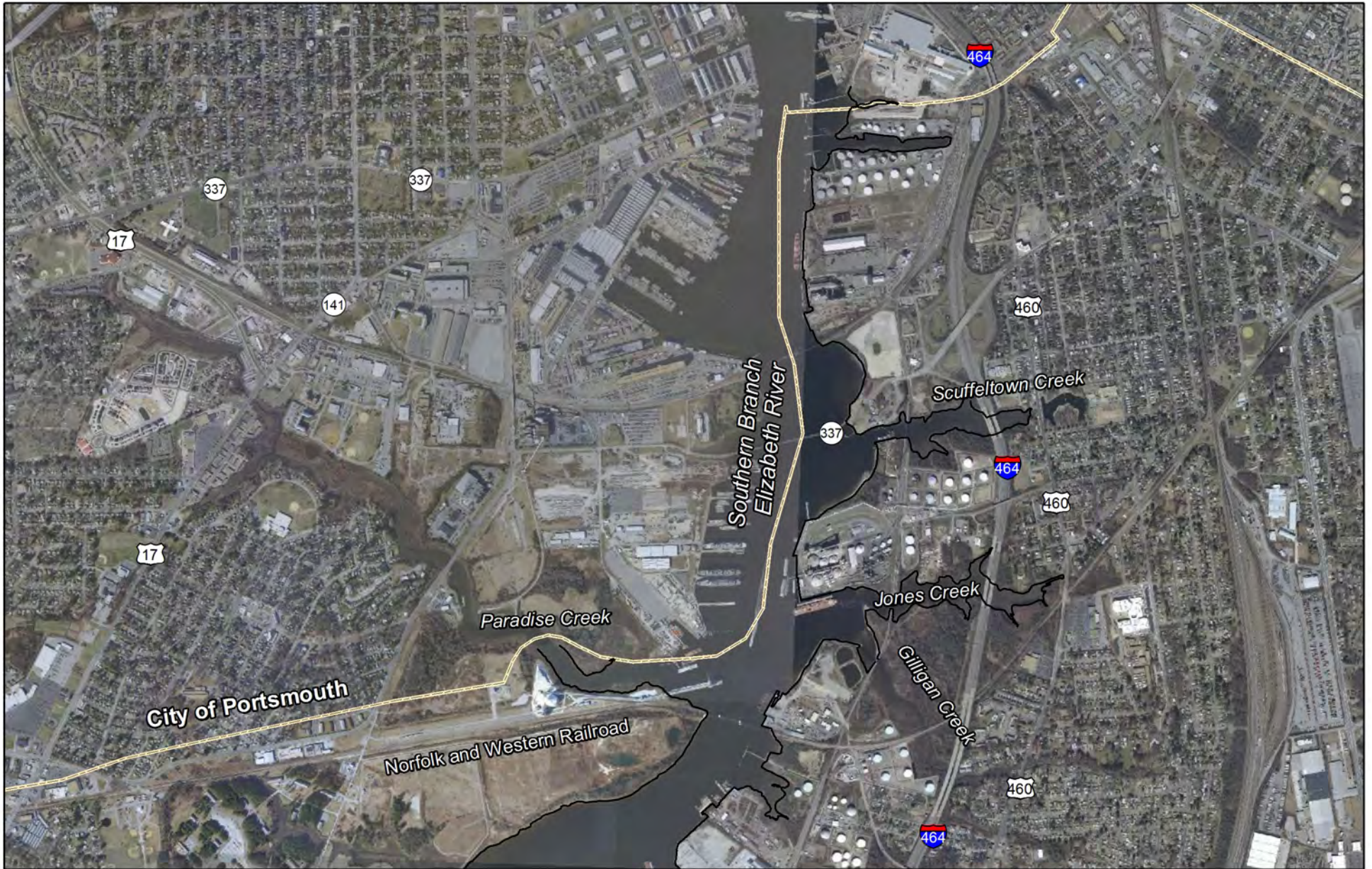


0 2,000 4,000
 Feet

City of Chesapeake, Virginia Plate 4

Photo Date: 2002





Legend
 — Shoreline 2009

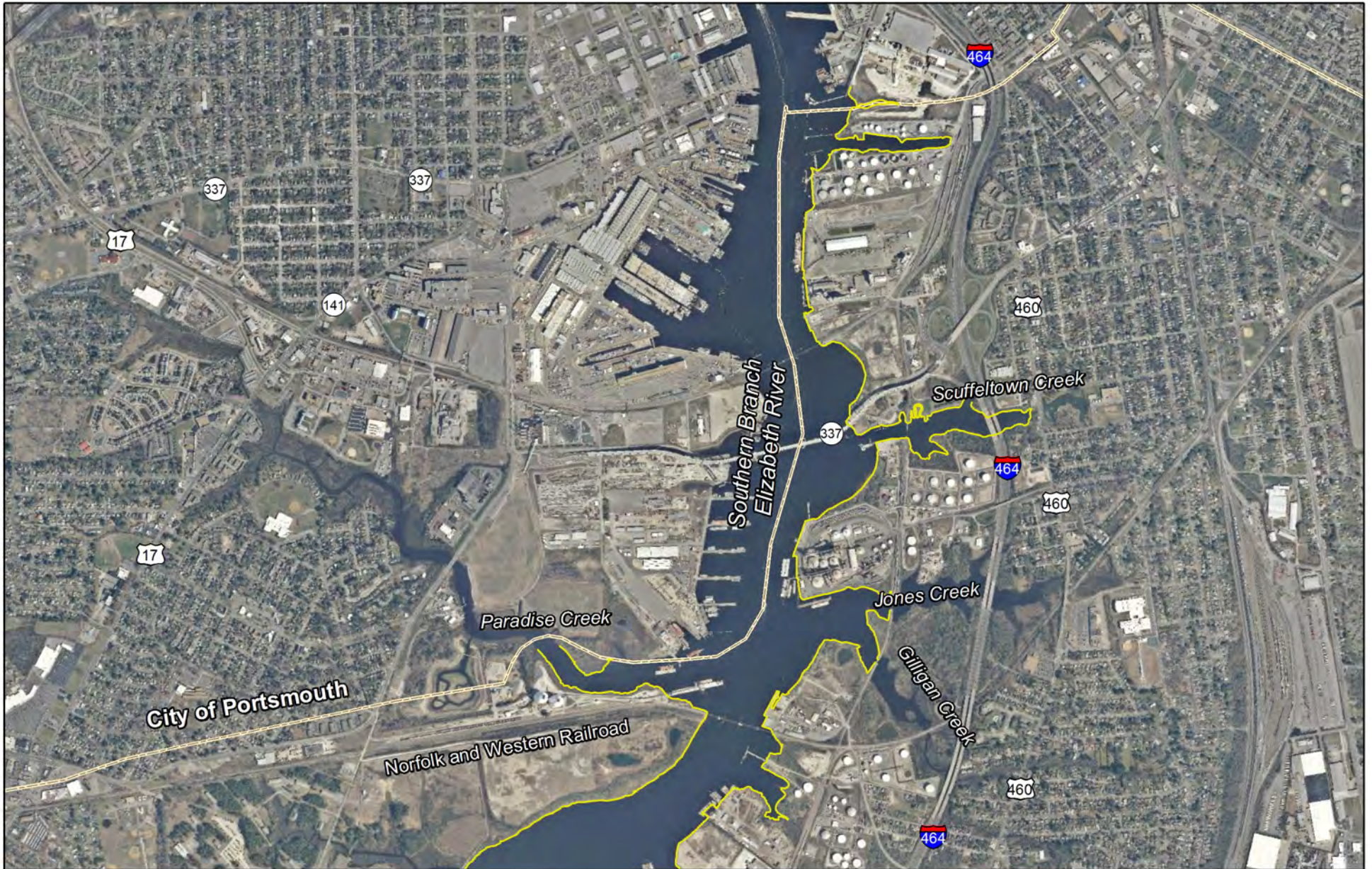


0 2,000 4,000
 Feet

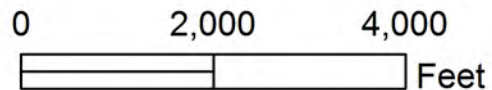
**City of Chesapeake, Virginia
 Plate 4**

Photo Date: 2009





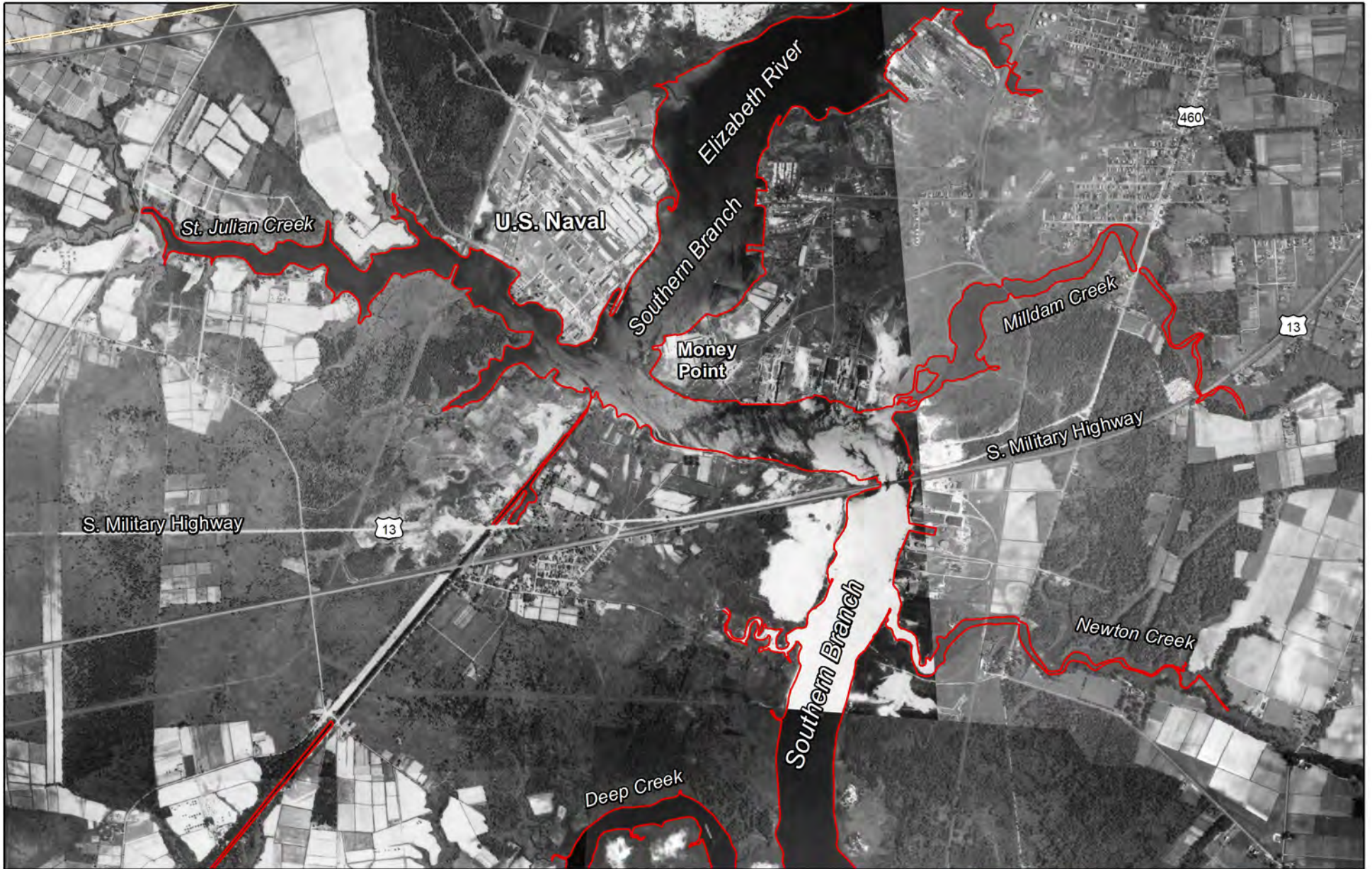
Legend
 Shoreline 2013



City of Chesapeake, Virginia Plate 4

Photo Date: 2013





Legend
 — Shoreline 1937

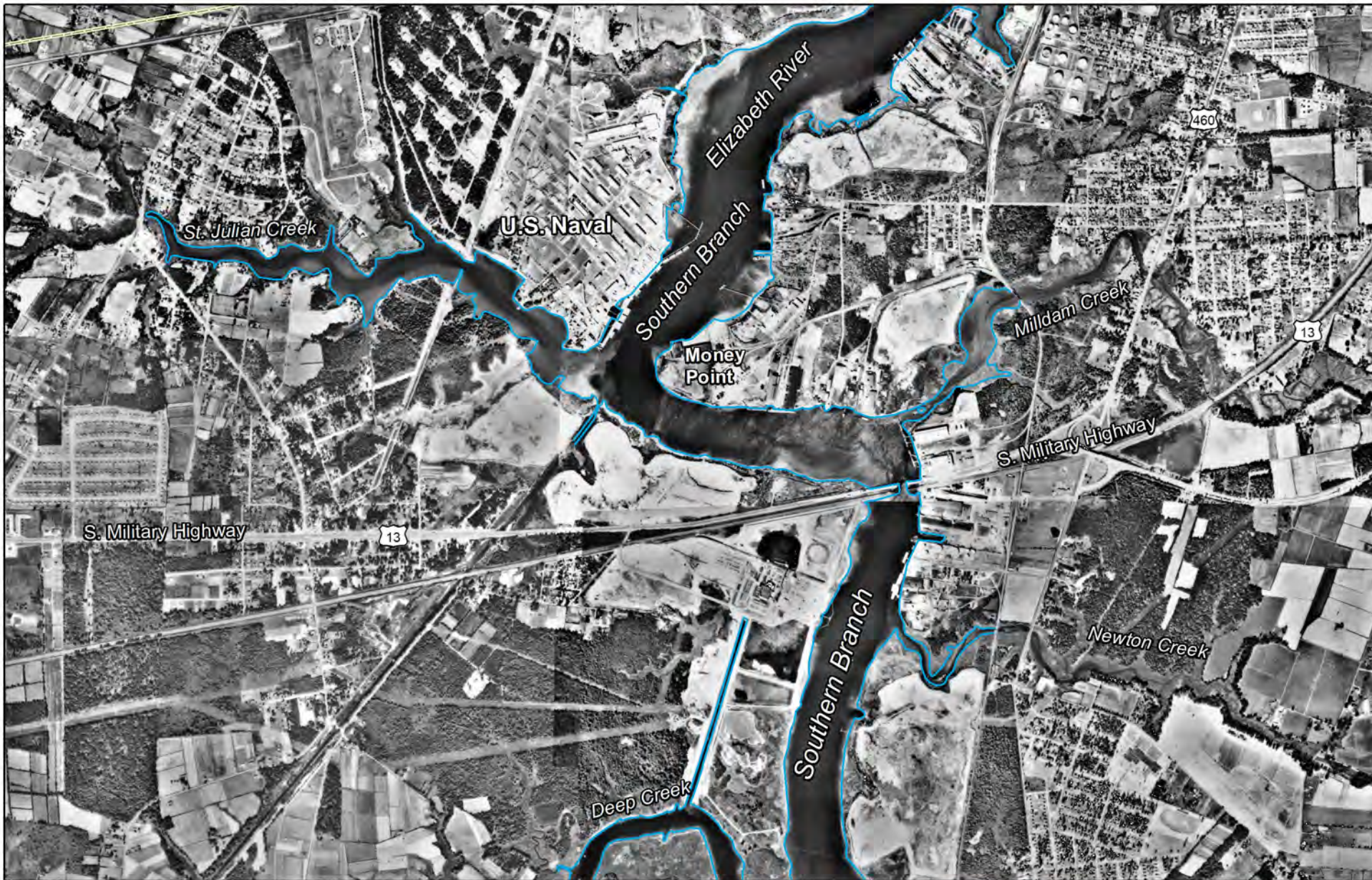


0 2,000 4,000
 Feet

**City of Chesapeake, Virginia
 Plate 5**

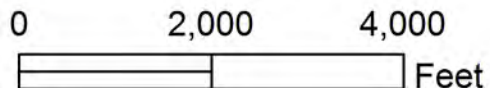
Photo Date: 1937





Legend

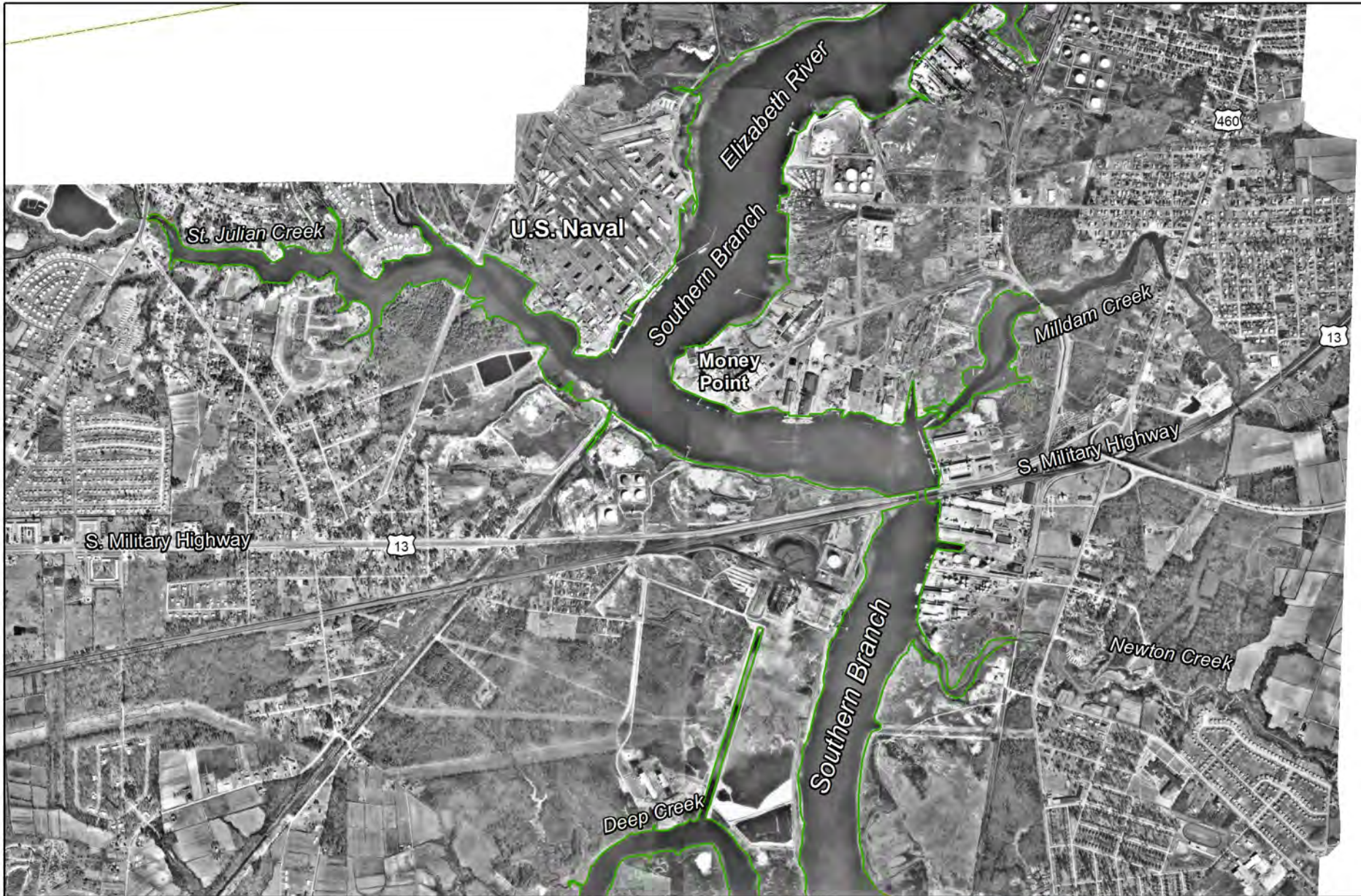
— Shoreline 1954



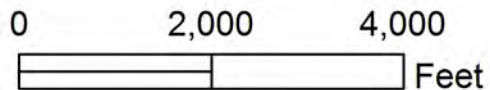
**City of Chesapeake, Virginia
Plate 5**

Photo Date: 1954





Legend
 — Shoreline 1963



**City of Chesapeake, Virginia
 Plate 5**

Photo Date: 1963





Legend
 — Shoreline 1994

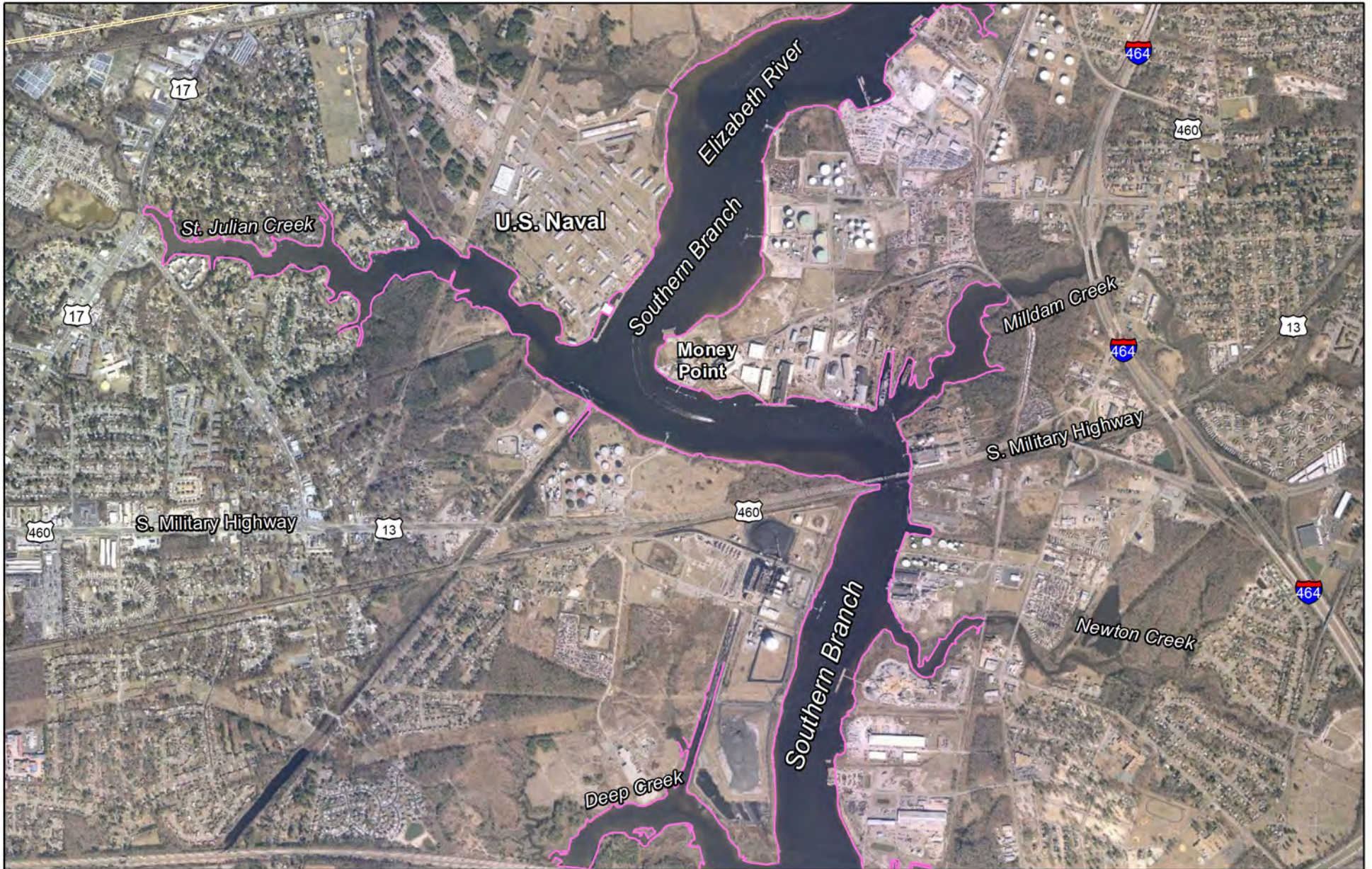


0 2,000 4,000
 Feet

**City of Chesapeake, Virginia
 Plate 5**

Photo Date: 1994





Legend
 — Shoreline 2002



0 2,000 4,000
 Feet

**City of Chesapeake, Virginia
 Plate 5**

Photo Date: 2002





Legend
 — Shoreline 2009

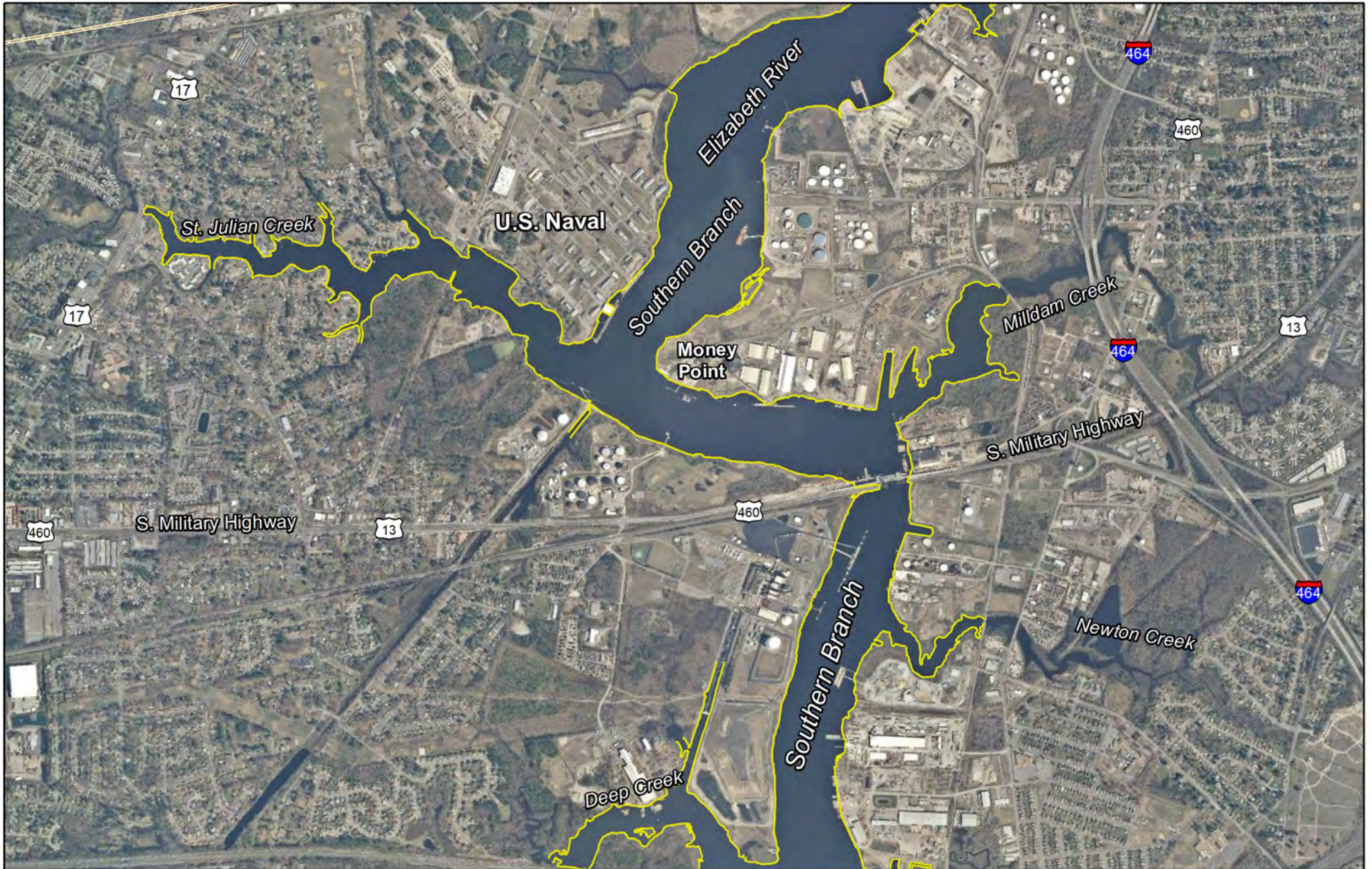


0 2,000 4,000
 Feet

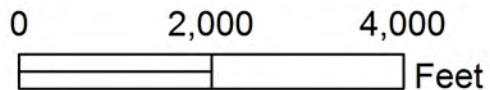
**City of Chesapeake, Virginia
 Plate 5**

Photo Date: 2009





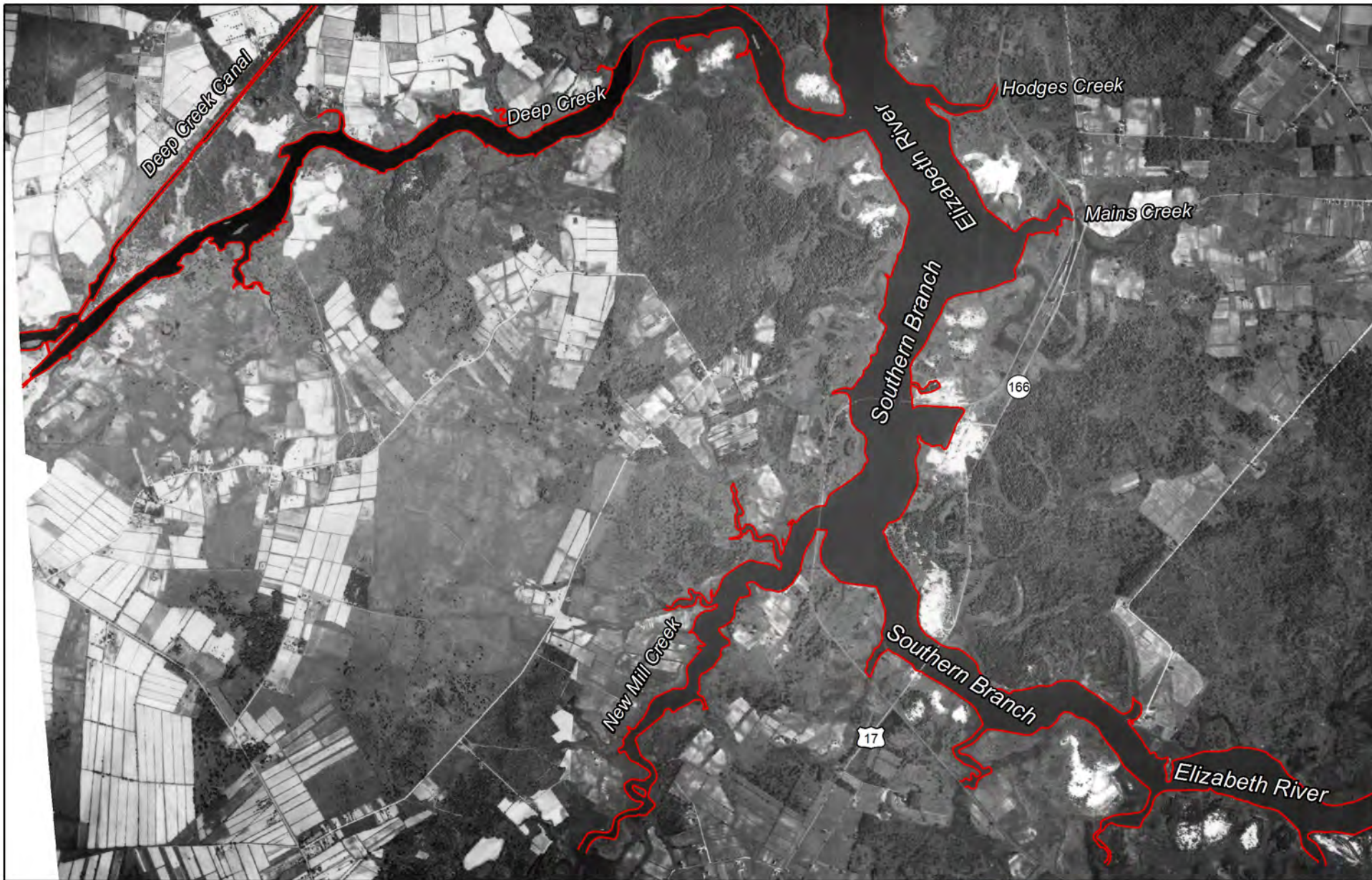
Legend
 — Shoreline 2013



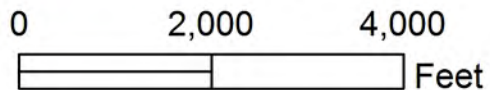
**City of Chesapeake, Virginia
 Plate 5**

Photo Date: 2013





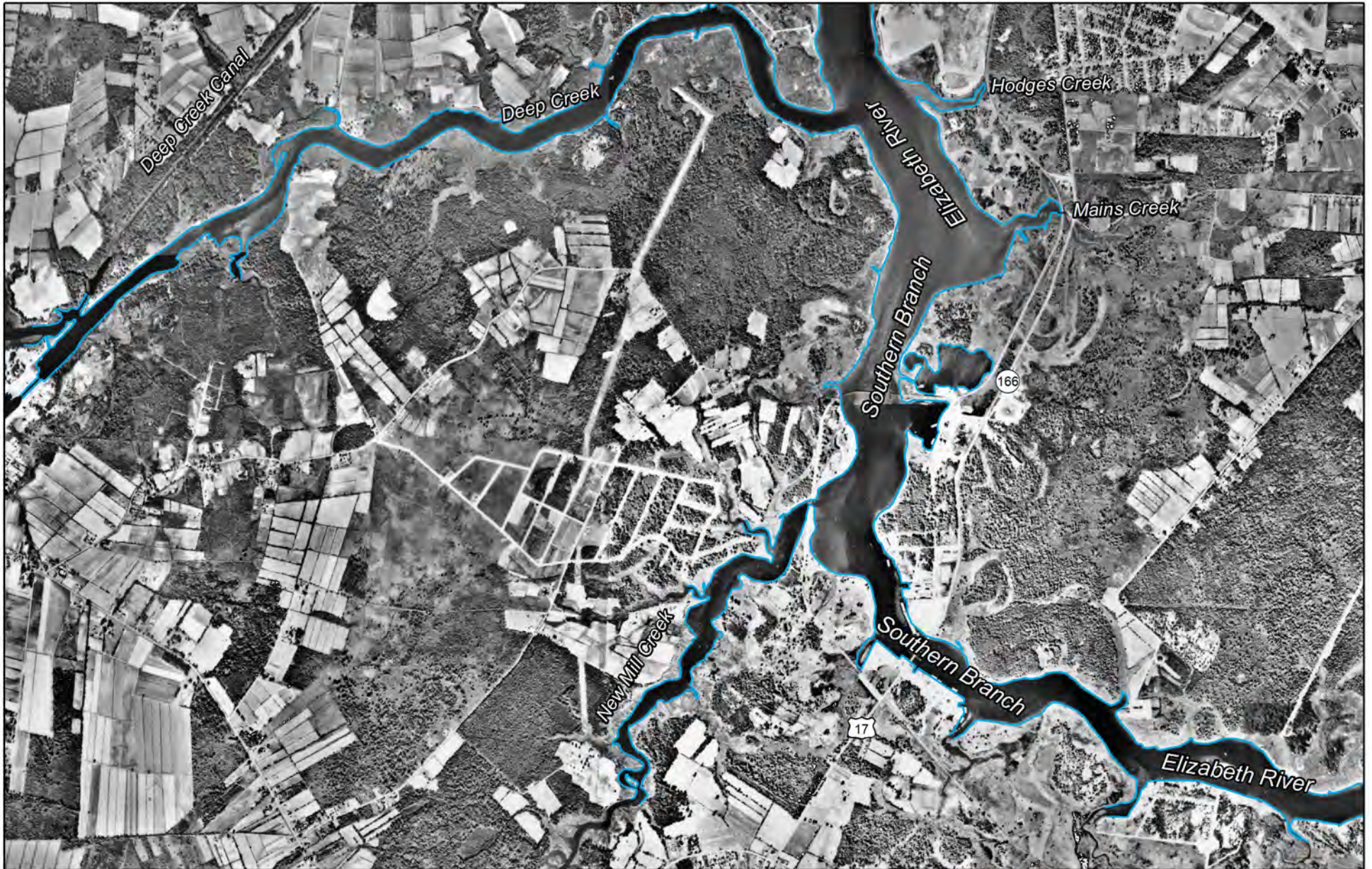
Legend
 — Shoreline 1937



**City of Chesapeake, Virginia
 Plate 6**

Photo Date: 1937





Legend
 — Shoreline 1954



0 2,000 4,000
 Feet

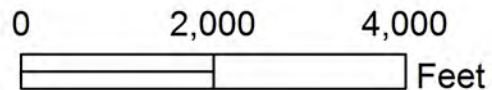
**City of Chesapeake, Virginia
 Plate 6**

Photo Date: 1954





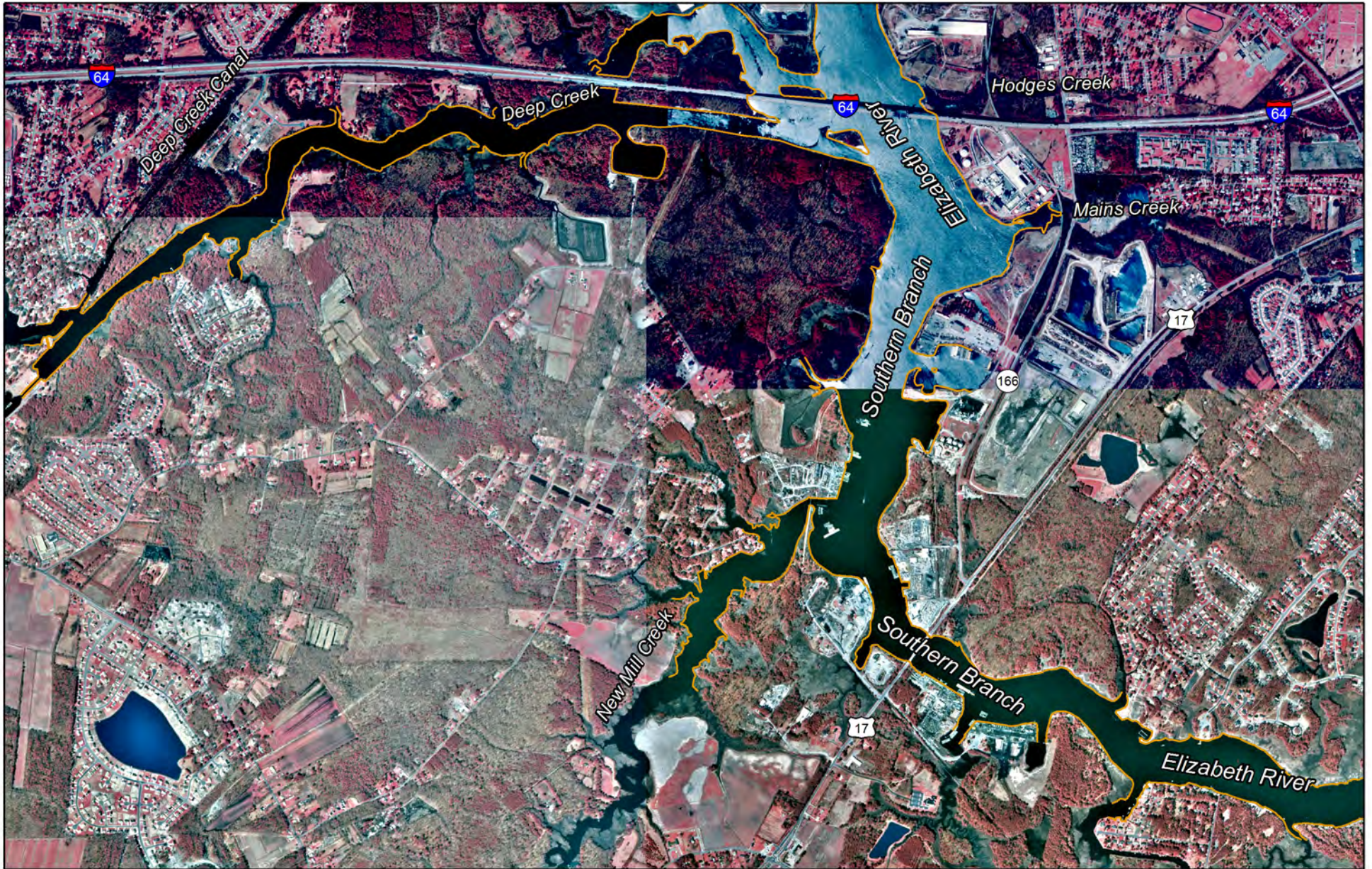
Legend
 — Shoreline 1963




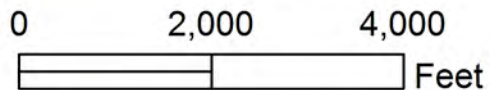
**City of Chesapeake, Virginia
 Plate 6**

Photo Date: 1963





Legend
 Shoreline 1994



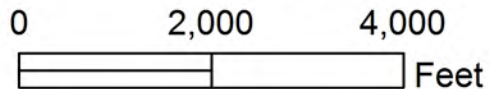
**City of Chesapeake, Virginia
 Plate 6**

Photo Date: 1994





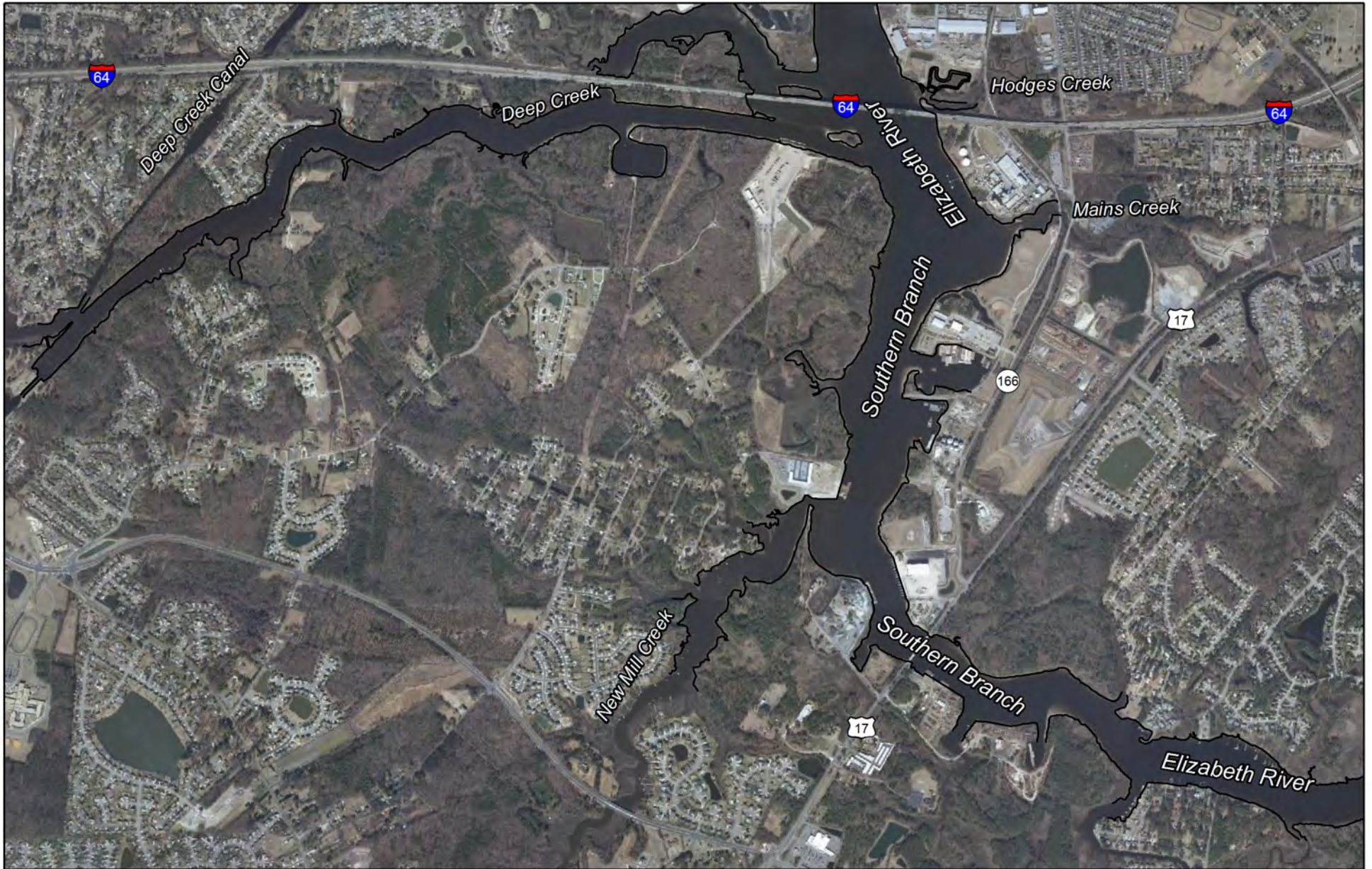
Legend
 — Shoreline 2002



**City of Chesapeake, Virginia
 Plate 6**

Photo Date: 2002





Legend
 — Shoreline 2009

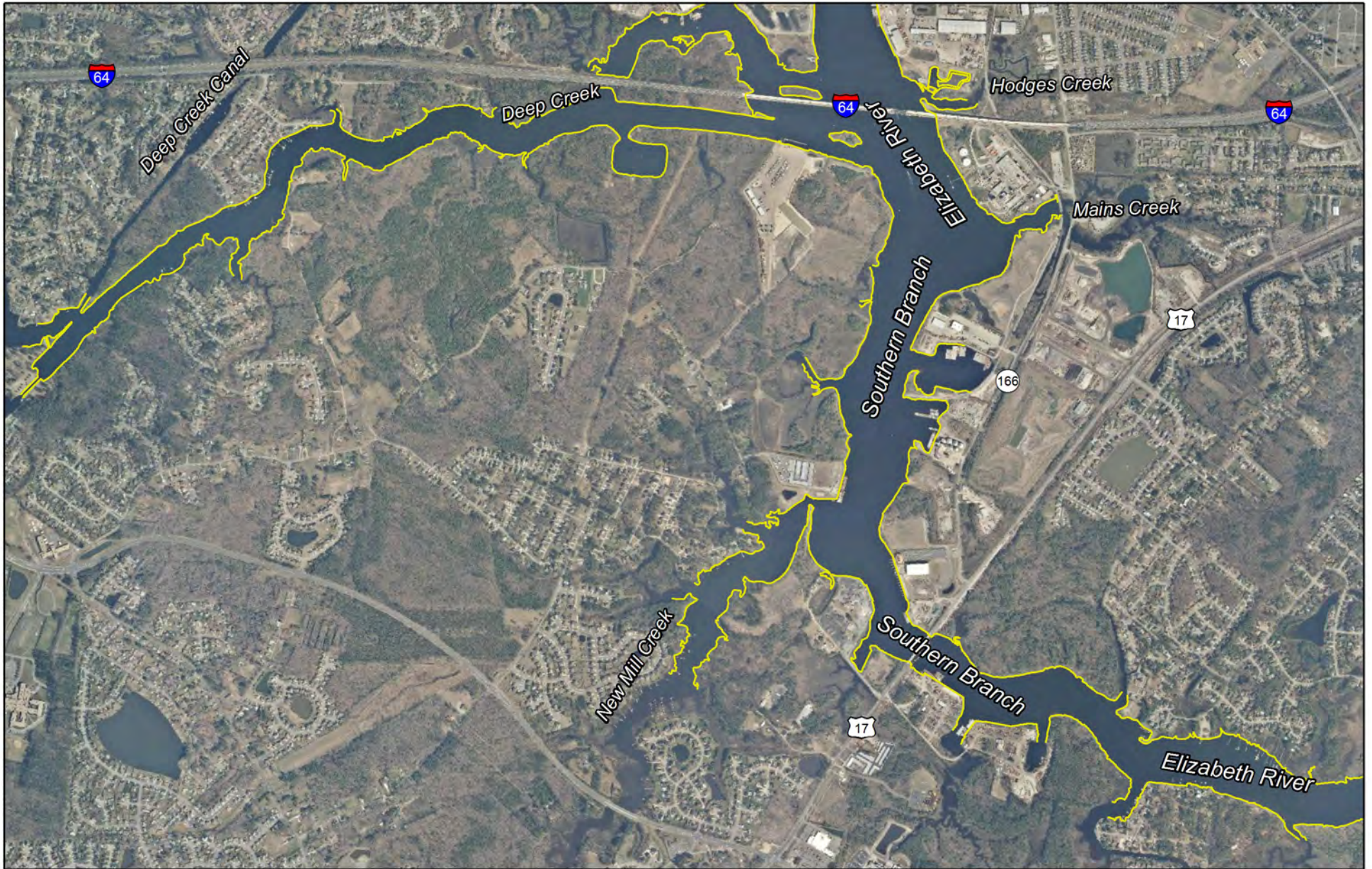


0 2,000 4,000
 Feet

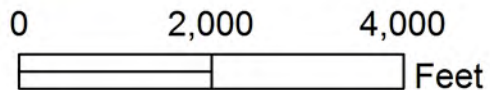
**City of Chesapeake, Virginia
 Plate 6**

Photo Date: 2009





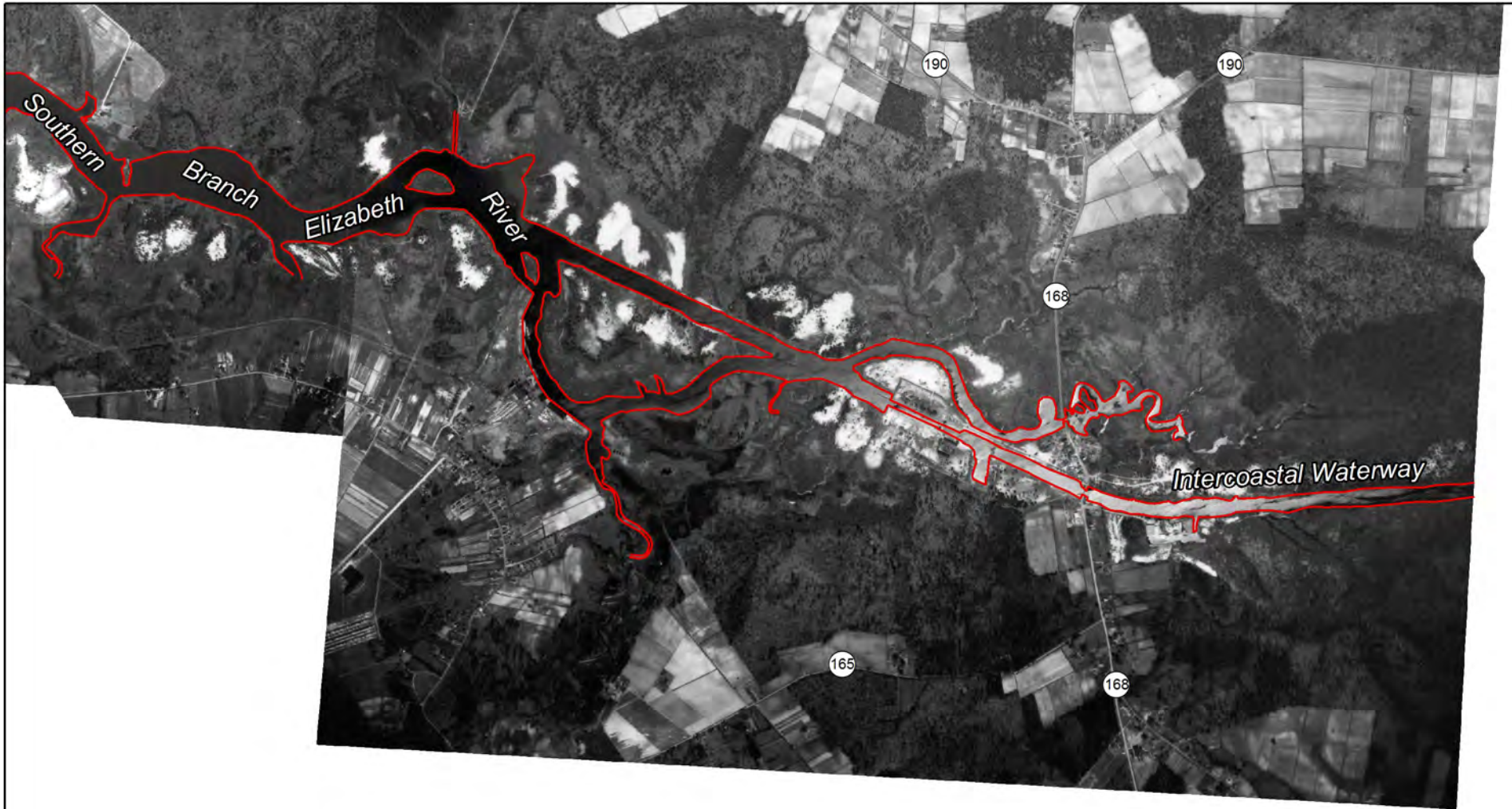
Legend
 Shoreline 2013



**City of Chesapeake, Virginia
 Plate 6**

Photo Date: 2013





Legend
 — Shoreline 1937

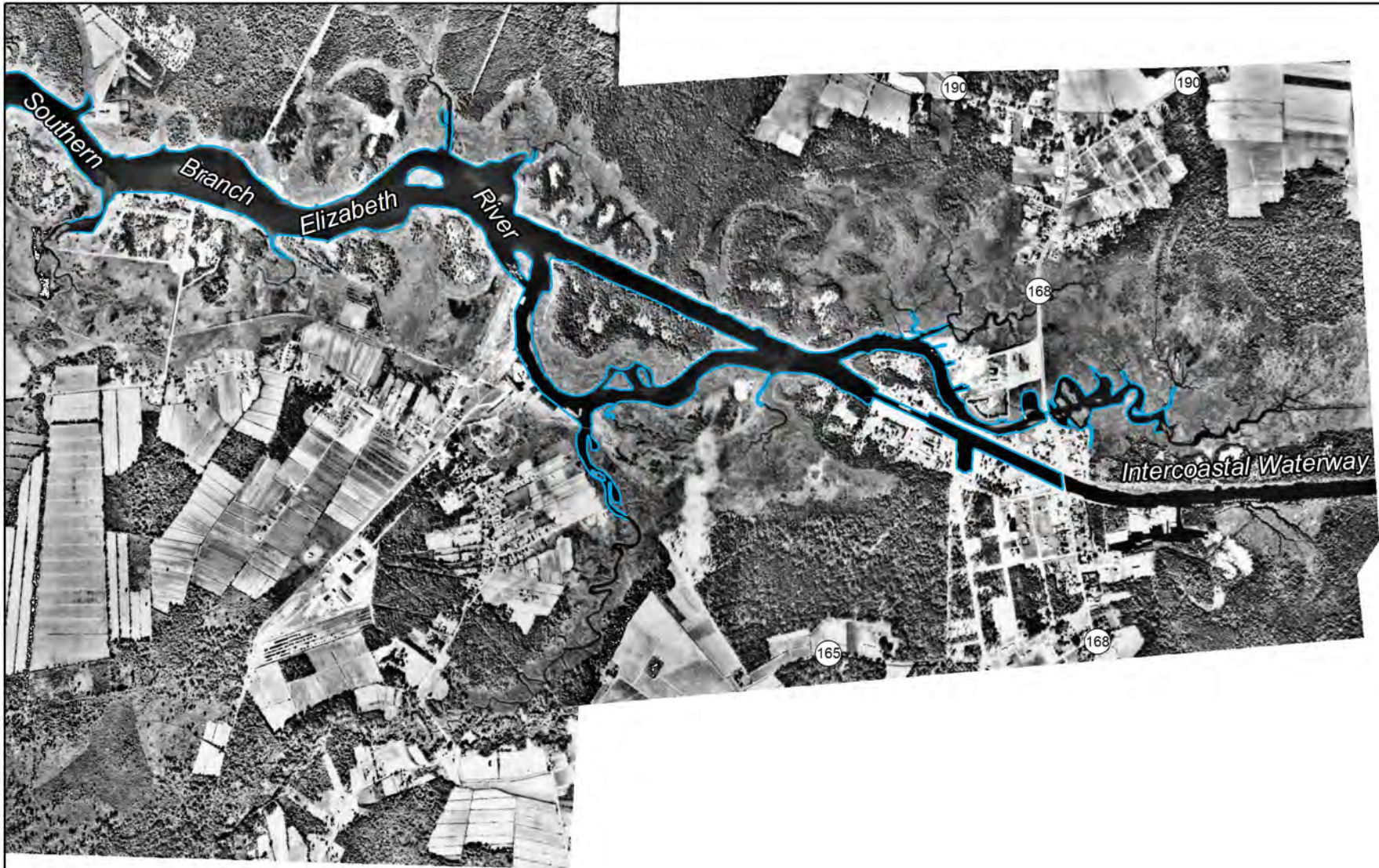


0 2,000 4,000
 Feet

**City of Chesapeake, Virginia
 Plate 7**

Photo Date: 1937





Legend
 — Shoreline 1954

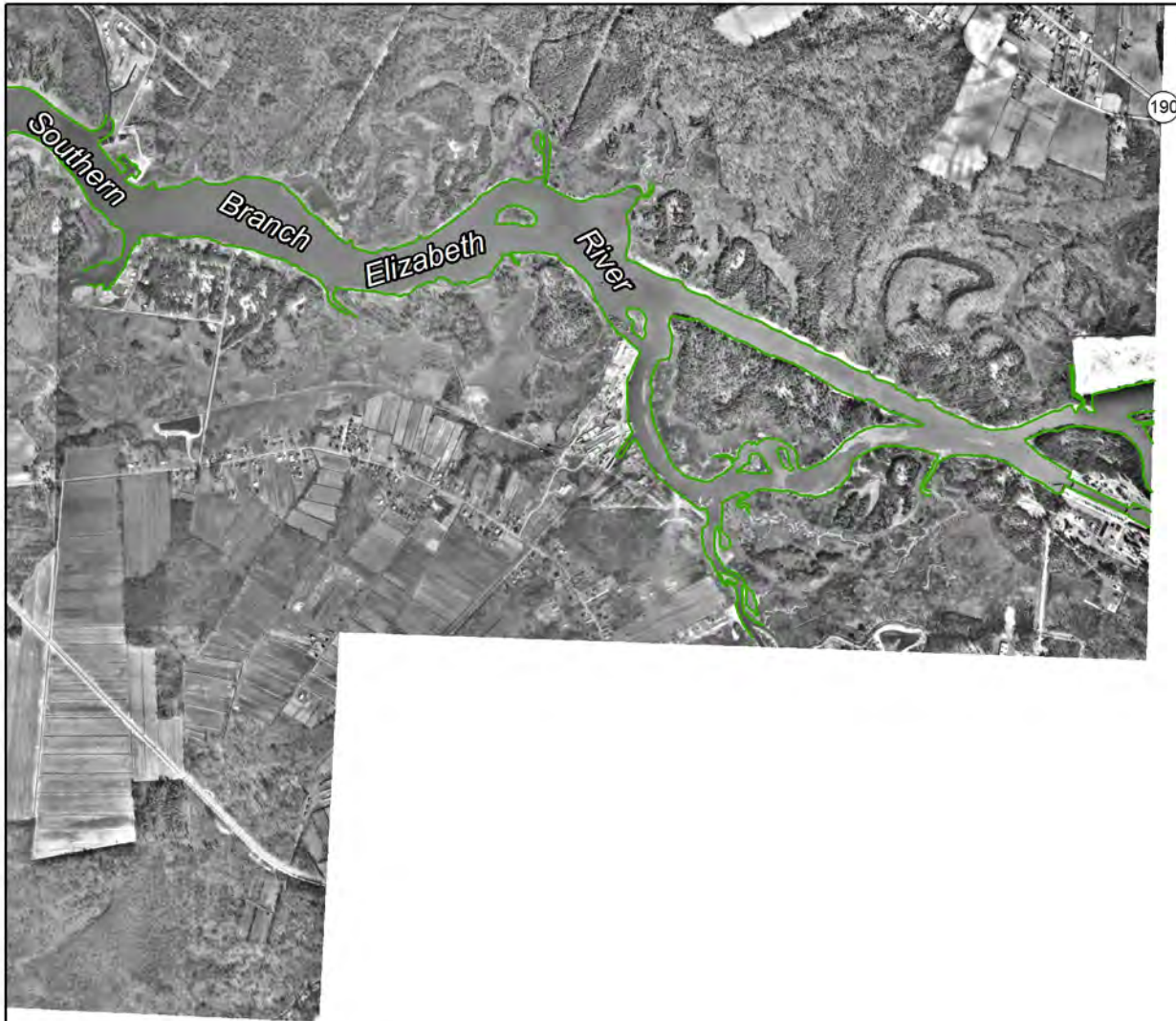


0 2,000 4,000
 Feet

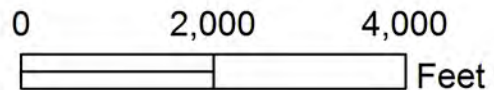
City of Chesapeake, Virginia Plate 7

Photo Date: 1954



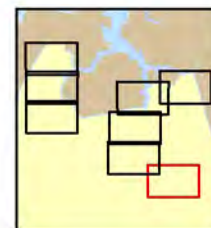


Legend
— Shoreline 1963




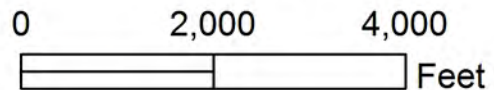
City of Chesapeake, Virginia Plate 7

Photo Date: 1963





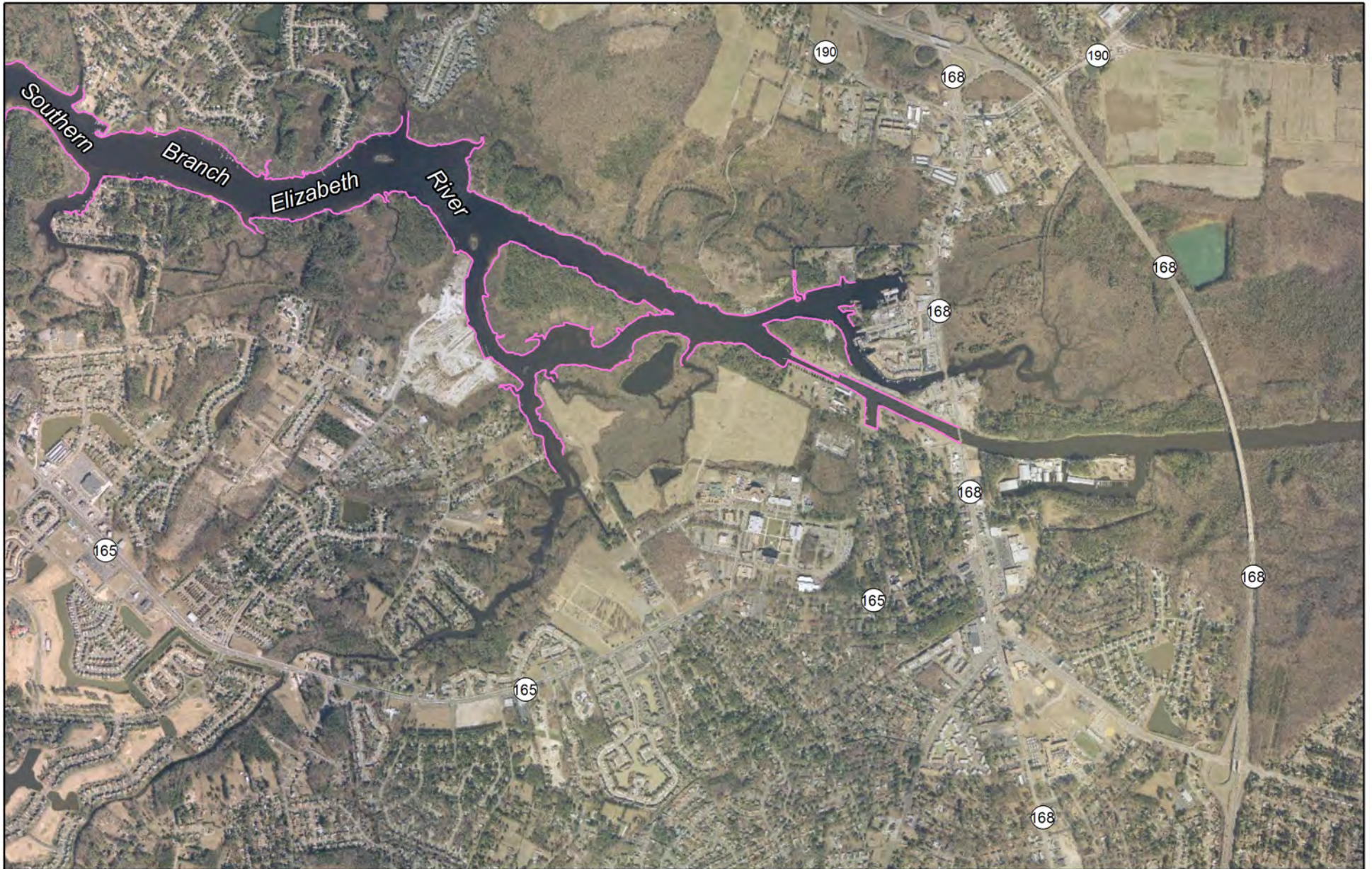
Legend
 Shoreline 1994



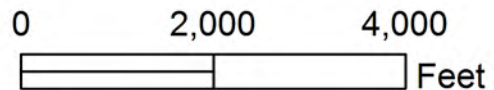
City of Chesapeake, Virginia Plate 7

Photo Date: 1994





Legend
 — Shoreline 2002



**City of Chesapeake, Virginia
 Plate 7**

Photo Date: 2002





Legend
 — Shoreline 2009

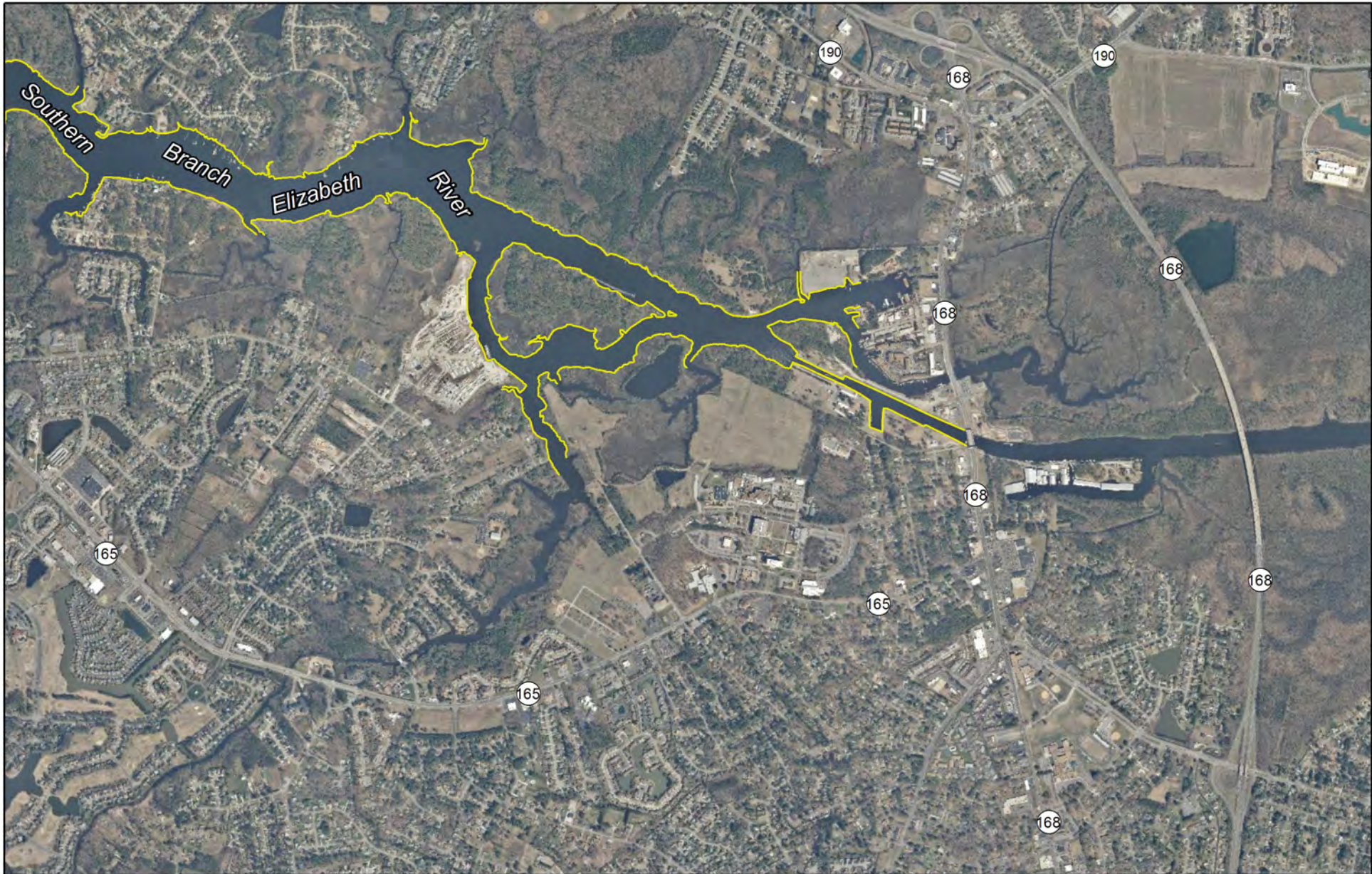


0 2,000 4,000
 Feet

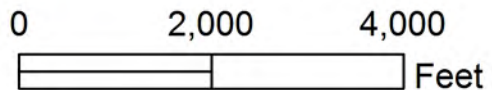
City of Chesapeake, Virginia Plate 7

Photo Date: 2009





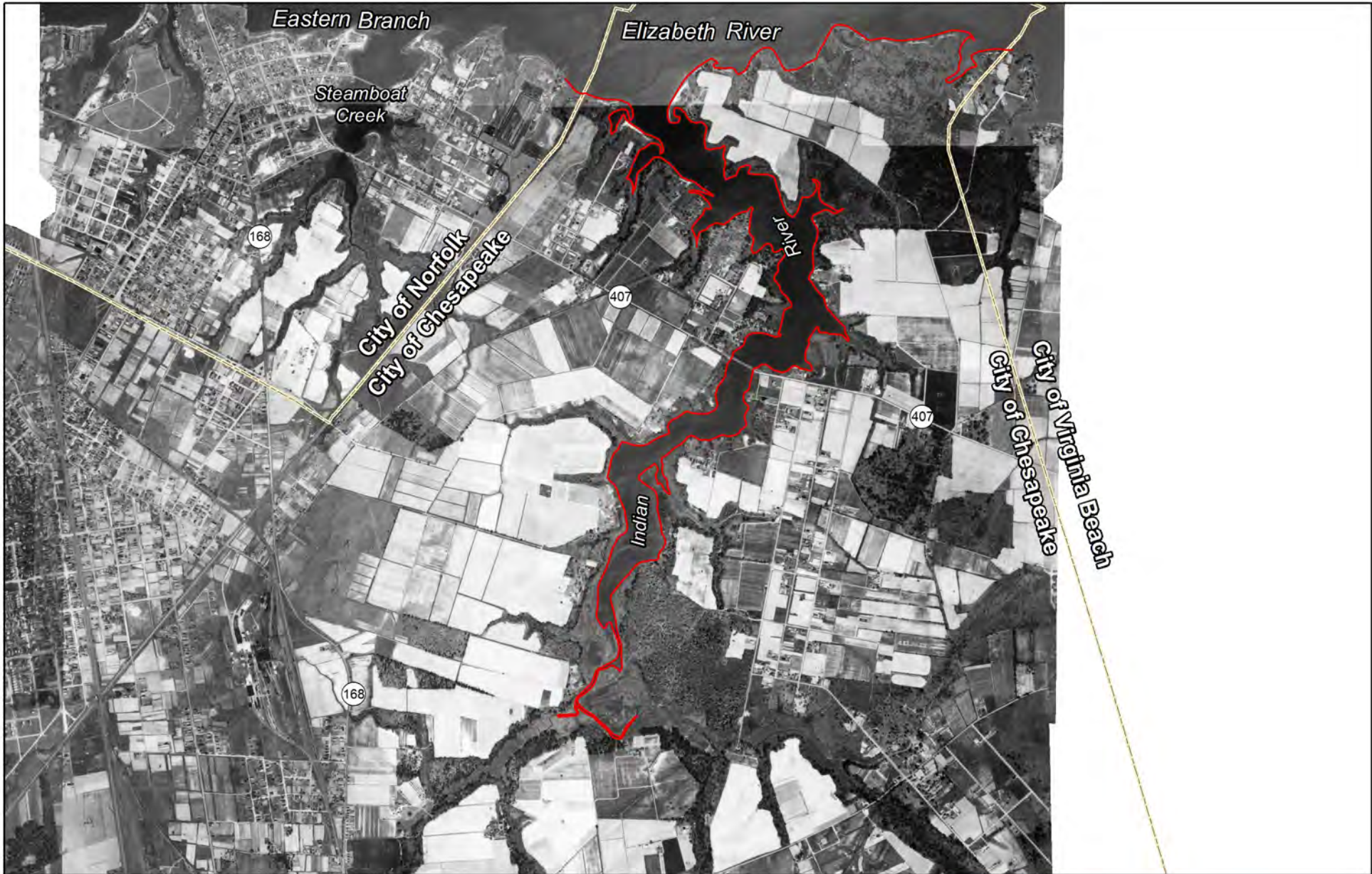
Legend
 — Shoreline 2013



**City of Chesapeake, Virginia
 Plate 7**

Photo Date: 2013





Legend
 — Shoreline 1937



**City of Chesapeake, Virginia
 Plate 8**

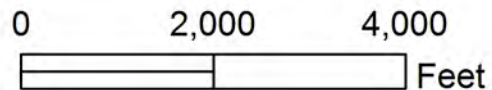
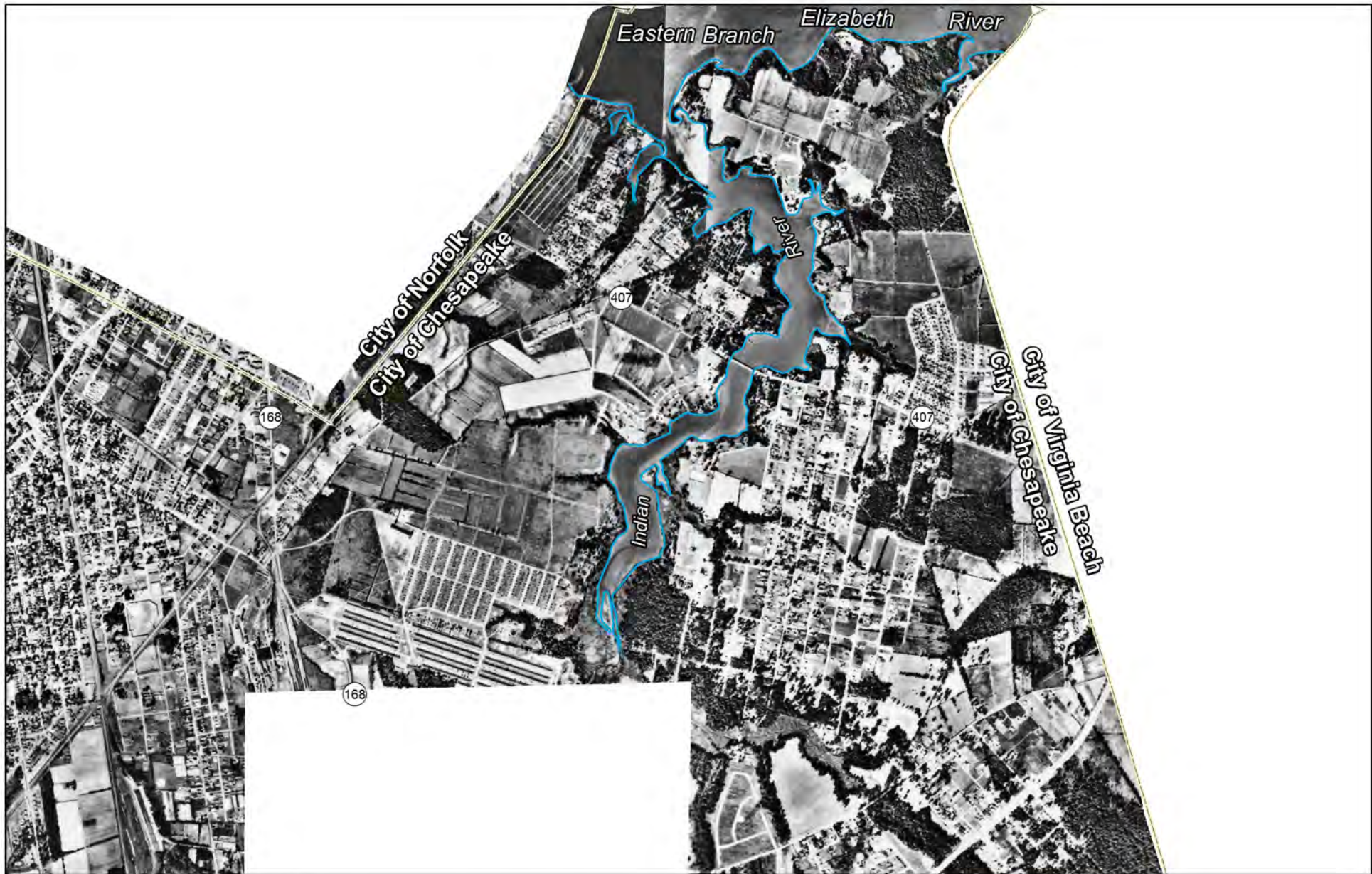
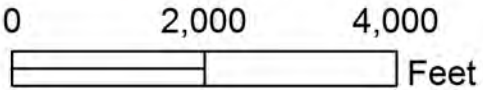


Photo Date: 1937

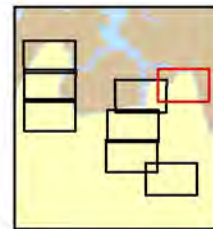


Legend
 — Shoreline 1954



**City of Chesapeake, Virginia
 Plate 8**

Photo Date: 1954





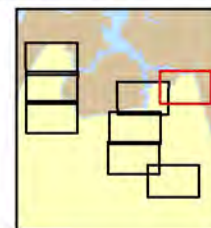
Legend
 — Shoreline 1963



0 2,000 4,000
 Feet

**City of Chesapeake, Virginia
 Plate 8**

Photo Date: 1963





Legend
 — Shoreline 1994



0 2,000 4,000
 Feet

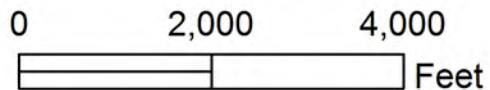
City of Chesapeake, Virginia Plate 8

Photo Date: 1994





Legend
 — Shoreline 2002



City of Chesapeake, Virginia Plate 8

Photo Date: 2002





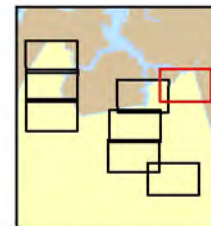
Legend
 — Shoreline 2009




0 2,000 4,000
 Feet

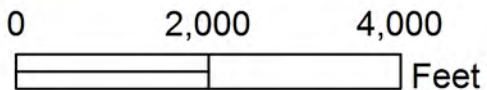
City of Chesapeake, Virginia Plate 8

Photo Date: 2009





Legend
 Shoreline 2013



City of Chesapeake, Virginia Plate 8

Photo Date: 2013

