ABSTRACT

J. Lee D. Cox, Jr. THE DELAWARE AND SUSQUEHANNA RIVERS: A HISTORICAL AND ARCHAEOLOGICAL INVESTIGATION TO ANALYZE THE POTENTIAL PRESENCE OF SUBMERGED CULTURAL RESOURCES.

The purpose of this study was to provide the Pennsylvania Historical and Museum Commission with an historical overview that traces the development of all maritime activity in the Delaware and Susquehanna River Basins. Activities such as settlers, shipbuilding, shipping, naval activity, ferry crossings, shipwrecks and dredging/shoreline filling were documented. This information, along with data compiled for an environmental assessment of the rivers, was used to create a preliminary sensitivity model which provided a ranking system. The ranking model judged portions of the rivers according to their perceived potential to yield submerged cultural resources in conjunction with the threat posed by disruptive activity. A generalized designation of High, Medium, Low-Medium and Low was accordingly assigned to each portion of the rivers.

An integral aspect of the project was the completion of an "on-site" investigation in portions of the Delaware River that were deemed highly sensitive. Nine specific areas were targeted for investigation. Within a total of eight field days, a remote sensing reconnaissance, utilizing a proton procession magnetometer, and limited dives were carried out during two separate work periods during the summer of 1984. The magnetometer reconnaissance produced a total of thirty-nine substantial magnetic targets or target clusters. Derelict vessels, visible shipwrecks

and submerged shipwrecks in the work areas were inventoried. The position and coordinates of all targets and sites were plotted on work area maps, which were included in the On-Site Investigation Summary. Also included in the summary were the designated target numbers, description of magnetic signatures or resource types, remarks, and sketches of the submerged shipwreck site and diagnostic artifacts which were recovered from it.

The Delaware and Susquehanna Rivers: A Historical and Archaeological Investigation to Analyze the Potential Presence of Submerged Cultural Resources

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by

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Introduction

Although Pennsylvania is geographically isolated from the Atlantic seaboard, its major river arteries have provided transportation routes that fostered development of naval and maritime activities. As a result of these activities, Pennsylvania waterways preserve valuable submerged cultural resources that are associated with every phase of the state's historical development. These submerged cultural resources and the historical data they preserve are threatened by a variety of destructive activities, including dredging operations, construction projects and sport divers. In order to assist in the development of plans for protection and preservation of these resources, this project was undertaken.

This project was designed to assess the potential for Pennsylvania's two major eastern rivers, the Delaware and Susquehanna, to possess submerged cultural resources. It was the first phase of a planned two-year study that will research each of the major waterways in the state. Partial funding was provided by the Pennsylvania Historical and Museum Commission, Bureau for Historic Preservation utilizing grant-in-aid funds from the National Park Service, U.S. Department of the Interior. Funding was also provided by the Philadelphia Maritime Museum and East Carolina University's Maritime History and Underwater Research Program.

A primary objective of the project was to establish a preliminary sensitivity analysis of portions of each of the two river systems. To accomplish this, information was compiled for an environmental assessment, which took into account water and shoreline characteristics and an historic overview. The overview documented such developments as shipbuilding, shipping, settlers,

dredging and naval activity. Information from both sections was utilized to establish the preliminary sensitivity analysis that ranked areas according to their perceived potential to yield cultural resources in conjunction with the potential threat posed by disruptive activity.

A six-day on-site investigation was conducted on various portions of the Delaware River that had been designated as High potential areas. The five member team from East Carolina that participated in the remote sensing reconnaissance provided a proton procession magnetometer, 25' survey vessel and a recording fathometer. Some limited diving on magnetic anomalies was completed. A followup, two-day project was completed in August in an attempt to relocate several of the targets and visually inspect them to determine what material generated the reading. A small, mid-late 19th century sailing vessel was discovered.

Delaware River Research

Environmental Assessment

Shoreline Features

Today well over seven million people live in the Delaware River Basin. Along the tidal portion of the river, Trenton, Philadelphia, Camden, Chester and Wilmington form a vast and expanding urban area where the suburbs of adjacent cities merge into one sprawling metropolitan region. A characteristic of these port cities is the almost complete "filling" of the original shoreline to construct facilities designed to handle modern sea-going vessels. Furthermore, riverfront property is historically very advantageous for the development of industries. Thus oil refineries, chemical plants, steel mills, warehouses, light industry, power plants, piers, railroad yards and highways dominate the present waterfronts. The lower Delaware River Basin (Trenton and below) is little used for recreation despite its ready access to millions. It has been determined that only 400 acres of park borders on the 86 miles of the river above the bay.[1] However, above the fall line of the river, the countryside features rolling farmland and forests. Small towns (the exception being Easton) are interspersed with the natural environmental features and the major portion of the river bank is tree-lined, creating an impression of how the river environment originally appeared. Riegelsville, Durham Furnace, New Hope and Yardley each developed because of their involvement with river transportation.

River Features and Water Quality

The Delaware River, with its headwaters in the New York Catskill Mountains, is approximately 300 miles long. It reaches the Atlantic Ocean through the Delaware Bay. The river is tidal, influenced by the tidal changes

in the ocean below Trenton, New Jersey. A rock outcrop, stretching roughly from New York City to Washington, D.C., separates the hard rocks of the rolling Piedmont from the sands of the coastal zone and forms the fall line at the river at Trenton. Below this point the waterway is an estuary of the Atlantic Ocean. Above Trenton, the river descends through a series of rapids and falls.

A considerable portion of the topography of the Delaware Valley was formed during the ice age. A series of four continental ice sheets advanced south into North America over one million years ago. Each successive ice sheet retreated further as the climate warmed. This left behind a rocky mantle which makes up the Pocono Mountains in Pennsylvania. As recently as 15,000 years ago, the peak of the latest advance, the glaciers still covered the northern portion of the Delaware River Basin. Throughout the warming periods large amounts of debris were washed into streams and were ultimately deposited as sand and clay over the coastal lowlands by the Delaware River. The Schuylkill and Brandywine Rivers also transported this material. During that era these three rivers ran parallel to each other and separately emptied into the ocean; eventually the Schuylkill and the Brandywine eroded to the east and combined with the Delaware River. As the glaciers continued to retreat and melt the sealevel rose and flooded the lower estuary, giving the Delaware Bay its present form.[2]

Each of the following river qualities affects either the preservation of submerged cultural resources or the type of underwater work which may be conducted in the river:

Salinity: The tidal region of the river estuary, from the mouth of the bay to the fall line, is approximately 115 nautical miles in length. The saline reach (salt water influence) of the estuary extends nearly 65 nmi from the

mouth of the bay to a point south of the Pennsylvania/Delaware border. It has been estimated that the salinity of the Delaware estuary is slowly increasing. This is likely due to a combination of the gradual rise in sea level and the increasing consumptive losses caused by upstream water withdrawals. In 1951 this increase in salinity caused Chester to abandon its local water supply.[3] The mean freshwater inflow of the river checks the advance of salinity; fluctuations in the inflow cause the saline portion of the river to vary constantly. The total mean freshwater inflow into the estuary is approximately 550 meters per second (ms/s). At the tide line in Trenton the freshwater inflow measures 320 ms/s. The Schuylkill River contributes approximately 80 ms/s.[4]

Tidal Range: The tidal range of the Delaware River estuary is measured by calculating the difference in height between a high tide and the proceeding or subsequent low tide. At Philadelphia, a range of 1.8 meters is normal, while at Trenton a 2.1 difference is found. The high water, or flood, phase of the tidal action requires about seven hours to progress from the breakwater at Lewes, Delaware, to Trenton. Eight and a half hours are required for the low water, or ebb, phase of the tide to traverse the length of the estuary.

Sedimentation: When assessing the environmental qualities of a riverine environment it is important to discuss the types and amount of sediment found in the river. The Delaware Estuary considered and evaluated eight sources of bottom sediment present in the Delaware River and Bay:

Source	Percentage
Erosion from non-tidal watercourses	68
Erosion of shores	9
Dredging leakage	6
Storm and sanitary sewer outfalls	4
Industrial effluents	2
Accumulation from phytoplankton	8
The Atlantic Ocean	NA
Airborne particles	3

The study also evaluated "sediment sinks" or factors which operate to remove bottom sediment from the estuary. Only two sources were considered:

Source	Percentage
Removal by dredging and deposition on upland areas	78
Sediment lost to marshes	22

Makeup of the bottom sediment was described in the following manner, "the characteristic sediment types found in the upper estuary are over 90% muds and sandy muds... exceptions do occur in certain channel pockets where silts dominate."[5] The null point in the river - location in the estuary where bottom currents are exactly balanced during the ebb and flood tidal phases - is near Artificial Island, below Wilmington, Del. The report adds that "the upper estuary consists of quartz-rich, muddy sediments with more abundant clays and a higher content of organic matter."[6]

Turbidity: Turbidity in the Delaware River is predominately caused by suspended inorganic sediment. Seston valves (which measure amounts of turbidity) in the river range from less than 1/mg/liter to over 200/mg/liter in various portions of the upper estuary. High levels of suspended sediments are the primary cause of attenuation of light and are related in a predictable fashion to attenuation. Tiny colloidal particles, phytoplankton algae, organic detrites, clays, silts and sands comprise the majority of the suspended sediments in the Delaware River. These elements are introduced to the estuarine waters primarily from erosion of land in the drainage basin. Severe rains also often cause a sewage overflow in urban areas, which allows untreated water to bypass treatment plants and directly enter the river. The problem of water turbidity was discussed in the Delaware River Basin:

> "The river is... a repository of a large quantity of toxic wastes - heavy metals and organic chemicals from industry, from inadequate sewage treatment plants, from urban stream runoff and even from air pollution fallout. They accumulate on the bottom except when stirred up

from time to time by dredging or by floods... Food processing plants, urban sewage and farmland runoff have overloaded the river with phosphates, nitrates and other nutrients. Eutrophication might be expected to stimulate extensive growth of unwanted aquatic plants. However, suspended silt and other solid matter prevent most sunlight from penetrating more than a few inches below the surface, thus inhibiting photosynthesis on which algae and other plants depend. Much of the silt comes from farmland erosion, from runoff and from sedimentation of new suburban development."7

River Channel, Anchorages and Dikes (See Fig. 14.)

For approximately the last century, a defined channel has been maintained in the Delaware River by the Army Corps of Engineers. In addition to the main shipping channel, anchorages and dikes have been established to upgrade accessibility to the river ports and facilitate navigation in the river. While these activities are designed to benefit the navigational needs of the river, they often inadvertently destroy and displace submerged cultural resources in the process.

The channel, from the mouth of Delaware Bay to Allegheny Avenue, is presently maintained at a 40' level by the Army Corps. In addition to regulating the depth of this main channel, the continuing Corps project for this portion of the river provides for six anchorages. Anchorages are dredged areas adjacent to the shipping channel where ships may anchor while awaiting entrance to the harbor facilities. Four of these six anchorages exist between the Pa.-NJ portion of the river.

1. Marcus Hook Anchorage opposite Marcus Hook, situated between the mouths of Oldmans Creek and Raccoon Creek, N.J.

2. Mantua Creek Anchorage above Paulsboro, N.J. between Mantua Creek and Woodbury Creek, N.J. Completed and in service by 1933.

3. Gloucester Anchorage opposite the Philadelphia Navy Yard at the confluence of Big Timber Creek and the Delaware River. Completed and in service 1933.

4. Port Richmond Anchorage between Petty Island and the foot of Allegheny Ave., Philadelphia. Completed and in service by 1933.

The authorization for the anchorages was adopted in 1910 and modified in 1930.

North of Allegheny Avenue the Corps maintains the 40' channel to the United States Steel Corporation's Fairless Works in Bucks County, Pa. A 35' channel exists from that point north to the Trenton Marine Terminal and a 12' channel is maintained to the Penn-Central Railroad Bridge in Trenton. Furthermore, the current project provides for an auxiliary 20' channel east of Burlington Island and two turning basins; one at the upper end of Burlington Island and the second at the Trenton Marine Terminal. Recent modification of the project has allowed for widening the Philadelphia side of the existing channel opposite the Tioga Marine Terminal.

A total of seven dikes has been constructed by the Corps along the Pennsylvania-New Jersey portion of the river. The construction and effect of these dikes are important to evaluate because they alter the natural sedimentation process on the river bottom. While dikes are built to enhance the river's flow through the main channel and thus limit shoaling in the channel - they eventually cause a buildup of sediment "behind" the dike. Potential submerged historical sites thus could be affected by the altered sediment deposition pattern. Dikes built in the Delaware River and Bay were classified as either "spur" or "longitudinal" dikes. The former are built in a roughly perpendicular angle to the shoreline while the latter are essentially parallel to the shoreline.

1. Chester Island Dike (spur, 7,200' long, 4' wide, 8' elevation) completed in 1916, north of Chester Island, it was constructed with a timber crib, rock filled. It closed the east channel of the river, diverting the flow around the west side of the island. The shore of Chester Island had cut back about 200'. Furthermore, the channel east of the island was filled to a depth of about 4-6',

primarily by dumping. The shoals behind the island have built up in prolongation with the island. A deep hole, 36' deep and 300' wide was scoured at the island end of the dike and a smaller hole at the shore end.

2. Mifflin or Tinicum Dike (spur, 7,200' long, 4' wide, 8' elevation) completed in 1916. It has a timber crib, rock filled and extending diagonally west from Hog Island, Pa. toward the eastern end of Little Tinicum Island. While it reduced the need for dredging on Mifflin Bar, it caused the back channel behind Tinicum Island to silt over.

3. Howell Cove Dike (longitudinal, 7,600' long, 8' wide, 12' elevation) stone construction, completed in 1932. Situated west of the mouth of Big Timber Creek (N.J.). It provided a disposal area (the land behind the dike was filled with spoil, extending the shoreline) and reduced shoaling in Horseshoe Range - adjacent to the Philadelphia Navy Yard.

4. Fisher's Point Dike (longitudinal, 4,300' long, 4' wide, 8' elevation) completed in 1890, it extends in a curving fashion from Fisher's Point, N.J. to the northeastern end of Petty Island. It was designed to eliminate the Five Mile Bar, which was located diagonally across the river from 5-mile point to Petty Island, by diverting the flow around Petty Island and sending the tidal flow along the Pa. side of the island. The back channel (N.J. side of the island) decreased in depth approximately 10' after the dike was completed.

5. Kinkora Dike (longitudinal, 600' long, 6' wide, 8' elevation) completed in 1890, situated off the western tip of Newbold Island. A timber crib, rock filled, it was designed to limit flow behind the island through the N.J. channel. It produced only negligible results.

6. Bordentown Dike (longitudinal, 5,221' long, 6' wide, 8' elevation) Completed in 1912, with a timber crib, rock filled. It is located just off the mouth of Crosswicks Creek, N.J. It provided a disposal area (for spoil fill) and reduced river cross section.

7. Biles Island (longitudinal, 1,762' long, 6' wide, 8' elevation) completed in 1913, it has a timber crib, rock filled. It is located off the northern portion of the island, facing the main channel side of the river. It was constructed to divert the tidal flow around the island and alleviate the shoaling on Perriwig Bar. Its effectiveness was negligible.

[1] The Delaware River Basin, An Assessment of Three Centuries of Change (Council on Environmental Quality, Philadelphia, 1973), 1, hereinafter cited as Delaware River Basin.

[2] Delaware River Basin, 1.

[3] The Delaware Estuary: Research as Background for Estuarine Management and Development (Delaware River and Bay Authority, Lewes, De., 1983), 10, hereinafter cited as Delaware Estuary.

[4] Delaware Estuary, 9.

[5] Delaware Estuary, 98.

[6] Delaware Estuary, 105.

[7] Delaware River Basin, 11.

Historic Overview

Explorers and Settlers

Henry Hudson, an English captain, was engaged by the Dutch East India Company in 1609 to command the Half Moon, 80 tons, to try to locate a safe North-west passage to the Orient. After traveling down the New England coast for some time, Hudson reached the mouth of the Delaware Bay on August 28, 1609. Having determined it was not a North-west passage, he chose not to ascend the bay, being content to record soundings, currents and its appearance.[1] Both English and Dutch thus had legitimate claims to the discovery of the bay, since Hudson was an Englishman sailing under the Dutch flag.

Activity on the bay and river for the next 20 to 30 years was exploratory in nature, with the Dutch responsible for most of these efforts. They were primarily interested in setting up outposts from which they could establish a fur trade network with the indigenous population. It was not until the 1640s that the first legitimate colony for settlers was established.

The first wave of explorers came from New Amsterdam (NYC) in 1614. The owners of five Dutch ships there were authorized by a decree of October 11, 1614, from the Hague to establish a company - the United Company of Merchants, which was allowed the exclusive right to navigate to the said newly discovered lands lying in America between New France and Virginia, now called "New Netherland," for four voyages in the period of three years, commencing in January of 1615.[2] The five Dutch skippers were able to create a diagram which illustrated the relative position of the bay and river. Subsequently, another Dutch captain from New Amsterdam, Cornelius Hendrickson, used their diagram to relocate the river and ascend it. He was successful

in producing a fairly accurate map of the river without charting the shoals, reefs or bars.[3]

Among the Dutch sailors who plied the Delaware during this period were Hendrick Christiaenson, Adriaen, Cornelius Jacobsen May and Cornelis Hendrickson. Their discoveries were the basis for the subsequent charter of the New Netherland Corporation. Hendrickson in 1616 ascended the river as high as the Schuylkill River in the yacht Restless, 16 tons. He submitted a brief report to the Dutch merchants, claiming to have found "certain lands, a bay and three rivers situated between 38 and 40 degrees."[4] It is generally believed that Cornelis May visited the Delaware River after Hendrickson "discovered" it, but how far he progressed up river was not recorded.

Captain May returned to Holland in the fall of 1620. The Dutch West Indies Company contracted with him to transport a party of colonists to "New Netherland." The group did not sail until 1623 or 1624 in the Nieu Nederlandt. They succeeded in proceeding up the Delaware River, but the actual location of this first settlement is not definitely known. It has been assumed that this expedition was responsible for creating Fort Nassau along the eastern shore of the river, near present Gloucester City, N.J. Weslager argues that this first settlement, headed by May, landed further upstream on Burlington Island. He draws his conclusion from a later statement sent from New Amsterdam to a Dutch captain:

> "Whereas we have received and examined a report about the condition of a certain island to be called "High Island," situated about 25 miles up the South (Delaware), below the first falls (at Trenton), we deem it expedient, unless a still more suitable place be found to settle there all the families and... sent thither in the ship Den Orangeboom and the following ship(s) is in itself a level field with a fertile soil and on both sides has much suitable, arable

> and pasture land as well as all kinds of timber...for this purpose, at the most suitable at the lower end of said island, such a provisional fortification is to be built as will best protect the people and their cattle."[5]

Burlington Island is later mentioned by name in the journal of two Dutch travelers in 1679. However they only refer to a settlement there subsequent to the original one. "...the island formally belonged to the Dutch Governor (d'Hinoyossa, 1659-64), who made it a pleasure ground or garden, built good houses upon it and sewed and planted it... It is the best and largest island in the South River and it is about four English miles long and two in breadth. It lies nearest the east side of the river. At the end of this island lies the Quaker village, Burlington..."[6]

Unfortunately it is impossible to attempt to relocate any settlement on Burlington Island because of the great degree of disturbance that has affected the southern end of the island. Modern dredging operations to obtain sand and gravel at the lower end of the island have obliterated the land. That portion of the island formerly rose to a 20' elevation - thus earning the name "High."[7]

If Burlington Island was indeed the first settlement, then Fort Nassau was the second. Most historians agree that the location of Fort Nassau was in the vicinity of present Gloucester Point and the mouth of Big Timber Creek. Various documents have referred to the fort as being "15 leagues up the river," "about 5 or 6 miles above Fort Christina," "about 16 miles up the river, on the eastern shore," and "it is about a mile south of (Phila.) "[8] The sole purpose of the fort was to protect the fur trade. It was not meant as a settlement. The actual date of its construction is tentative. Weslager feels 1626 is the year the Dutch built the structure. Finding the exact location of the fort was the goal of a joint effort by

committees from the New Jersey Historical Society and the Pennsylvania Historical Society in 1852. According to a map of 1643 entitled Kaert Vande Suyd Rivier in Nieu Sweden, the location of the fort is on the east bank of the Delaware south of a stream called Timmer Kill (now called Newton Creek). The outpost there remained in operation until 1651, when it was disassembled in favor of a larger and more strategically placed fortification on the river. The Dutch also established a whaling colony called Swanendael, at the site of present Lewes, Delaware. This colony was quickly destroyed by an Indian massacre in 1632.

The Swedes were the other peoples responsible for the first settlements in the Delaware Valley. In 1629 the Swedish West India Company, established in 1626, purchased from the Indians the tract of land on the west side of the Delaware River, extending from Cape Henlopen inland 32 miles and two miles wide. The purchase was ratified in July 1630.[9] It was not until Peter Minuit arrived in 1638 with an expedition, that the Swedish attempted to initiate a settlement. The Swedes found a suitable landing on the western shore (near Wilmington, Delaware) and quickly built a fort, called Christina. The Dutch, who opposed this settlement effort, quickly felt the impact the Swedes created in the fur trade with the Indians. The fort was described in 1645 as being "about 1/2 mile (Dutch) or 2-1/4 miles (English) within the Creek and nearly encircled by marsh, except on the northwest side where it can be approached by land; at its southwest (corner) it touches the kill (creek).[10] In 1640 the Swedes extended the limits of "New Sweden" from the Schuylkill River to the falls at Trenton.

After "obtaining" the rights to this land, the Swedes proceeded to set up three outposts along the banks of the Schuylkill River to enhance their beaver trade with the Indians - and in doing so reached the Indians

before they got to Fort Nassau and the Dutch traders. The first post, Fort Nya Korsholm was described as being "on a very convenient spot on an island near the edge of the kill, which is from the west side secured by another kill and from the south-southeast and east sides with underwood and valley lands."[11]

The second Swedish post, Fort Vasa, was "at a little distance from this fort (Nya Korsholm), runs a kill extending to the forest which place is named Kinsessing by the savages." The third post, Molndall, was "built on same Minquas Road."[12] John Printz was appointed the governor of "New Sweden" at the end of 1642. He came over in an expedition which landed at Tinicum Island (Pa.). A fortification was constructed there and was known as Fort New Gottenburg. The fort was constructed "by laying very heavy hemlock logs, the one on the other."[13] In addition, a mansion was built with an orchard and a pleasure house - the compound was called Printzhall, or Printzoff.

The Dutch, meanwhile, appointed Peter Stuyvesant as their director-general at New Netherland. His relationship with Printz grew tense. A series of "incidents" began to occur between the Dutch and Swedes in the years 1647-1651. In an attempt to reestablish their trade with the Indians, the Dutch built Fort Beversreede on the east bank of the Schuylkill River (Passyunk between the Penrose Bridge and Passyunk Bank[14]). This fort was built in 1648 and was temporarily successful in diminishing the effectiveness of the three Swedish outposts. Not to be outdone, the Swedes quickly constructed a trading house "right before the gate at the company's Fort Beversreede, not being a rod from the gate."[15] This trading house, sometimes referred to as Fort Elfsburgh, was reported to be 30' to 35' long, 25' wide with the river gable within 12' of the gate of the fort.[16] Stuyvesant,

who had built Fort Beversreede because the Swedes had outflanked him with the three outposts and Fort Christina, now saw his new fort effectively shut off from direct access to the river.

Therefore, Stuyvesant planned to organize a show of force to offset the encroachment of the Swedes. In 1651 he led 120 men on a march from New Amsterdam to Fort Nassau. There they rendezvoused with eleven Danish ships which had sailed around New Jersey and come up the river. It was the strongest exhibition of either military or naval force in the Delaware Valley up to that date. The Swedes offered no resistance and simply allowed the Dutch to move uninhibited along the river. Stuyvesant and his men proceeded to dismantle Fort Nassau and abandon Fort Beversreede, neither of which had any strategic value. They then relocated further down river on the west bank of the river.

The area where the Dutch set up their new settlement was on a sandy spit extending into the river, about one Dutch mile below the Swede's Fort Christina. A larger fort, called Fort Casimir, was built from which the Dutch were able to exert control over the Delaware Valley. Records indicate that the structure was 200' by 100' in size with the entrance on the eastern side facing the river. Between the palisades and the river bank stood an outer palisaded barricade mounted with cannon. The fort proper had four bastions mounted with cannon - most brought from Fort Nassau.[17]

The Dutch and the Swedes, although in direct competition with each other for the fur trade, maintained a cooperative existence most of the time in the face of their common adversary - the British - who had strong settlements in New England and Virginia. However, when Printz returned to Sweden in November 1653 and was replaced by John Rysingh in May of 1654, that cooperative existence was shattered. Immediately after assuming control

of the Swedish settlers, Rysingh in his ship Eagle captured Fort Casimir, on May 21, 1654, and renamed it Fort Trinity.[18] The Swedes controlled Fort Trinity for slightly more than a year, until the Dutch regained control. Stuyvesant once again led a large Dutch contingent from New Amsterdam, "with seven ships and having on board 600 or 700 men."[19] They succeeded in recapturing Fort Casimir on September 1, 1655, without a shot being fired. After reestablishing themselves in Fort Casimir, the Dutch set out to wipe out the rest of the Swedish strongholds on the river. They succeeded in capturing Fort Christina later that month and eventually destroyed Fort New Gottenburg in revenge. "Thus terminates the short career of Governor Rysingh and with him the Swedish power and influence on the Delaware River, the consequence of his rash and injudicious attack on the fort and disobedience to the instructions of his government."[20]

For the first time since the Swedes had first arrived, the Dutch controlled the entire river. "During their joint occupation of the river for about 17 years, such was the state of things arising from jealousy, and a mutual thirst for power, that the growth and settlement of the country made but little progress, though probably the Swedes had the advantage; yet their increase was small compared with what, under other circumstances, might reasonably have been expected. It is true, they (the Swedes) were not well sustained by the mother country, and to this may probably be attributed, in a great measure, their want of success."[21]

In the years between 1651-1664, the community that evolved around Fort Casimir was predominately Dutch in social and political character. There was a considerable faction of Swedes and Finns still in the community. The colonists were initially under the jurisdiction of the Dutch West Indies Company but in 1656 the colony formally became part of the city of Amsterdam

and was renamed New Amstel. The community thrived in the limited period before British intervention in 1664. In 1656 it was ordered that a bridge be constructed over the creek, "near the fortress Casimir, because the passage is now impracticable..." As well, the community was requested "to cut palisades to strengthen the fort, which public safety much requires, as the fort ought to be inclosed with palisades on every side."[22]

In October of 1664, Sir Robert Carr, under the authority from the Duke of York, captured New Amstel from the Dutch and renamed the settlement New Castle. This marked the end of the Dutch/Swedish settlement period and ~~ushered~~ in the English era in the Delaware Valley. The structures from the original New Amstel were neglected by the British and soon all remnants of that settlement were lost. "In time that sandy spit where Fort Casimir stood began to wash away: the fort itself started... to fall apart... What remained of the old foundations was eventually buried in the bottom sands of the Delaware. Today there is nothing to the fort site, the river having encroached even further on the shore side."[23]

Some 18 years later William Penn arrived and formed his colony.

[1] C.A. Weslager, Dutch Explorers, Traders and Settlers in the Delaware Valley, 1609-1664 (Philadelphia: Univ. of Pa. Press, 1961), 25, hereinafter cited as Weslager, Dutch Explorers.

[2] Samuel Hazard, Hazard's Annals of Pennsylvania, 1609-1682 (Philadelphia: Hazard and Mitchell, 1850), 6, hereinafter cited as Hazard, Annals of Pennsylvania.

[3] Marion Brewington, "Maritime Philadelphia, 1609-1837", Pennsylvania Magazine of Biography and History (April 1939), vol. 63, hereinafter cited as Brewington, Maritime Philadelphia.

[4] Weslager, Dutch Explorers, 45.

[5] Weslager, Dutch Explorers, 63.

[6] "Journal of a Voyage to New York in 1679/1680", Memoirs Long Island Historical Society (1867), 174.

[7] Weslager, Dutch Explorers, 75.

[8] Hazard, Annals of Pennsylvania, 13.

[9] Hazard, Annals of Pennsylvania, 16.

[10] Hazard, Annals of Pennsylvania, 183.

[11] Weslager, Dutch Explorers, 141.

[12] Weslager, Dutch Explorers, 141.

[13] Hazard, Annals of Pennsylvania, 70.

[14] Weslager, Dutch Explorers, 152.

[15] Hazard, Annals of Pennsylvania, 77.

[16] Weslager, Dutch Explorers, 152.

[17] Weslager, Dutch Explorers, 191.

[18] Hazard, Annals of Pennsylvania, 150.

[19] Hazard, Annals of Pennsylvania, (Rysingh's official report reprinted) 153 and Francis Brandt, The Majestic Delaware (Philadelphia: Brandt and Guinmere Co., 1929), 73, hereinafter cited as Brandt, Majestic Delaware.

[20] Hazard, Annals of Pennsylvania, 203.

[21] Hazard, Annals of Pennsylvania, 204.

[22] Hazard, Annals of Pennsylvania, 224.

[23] Weslager, Dutch Explorers, 211.

Shipbuilding

The practice of shipbuilding on the Delaware is recorded from the time of the Dutch and Swedish colonists in the middle of the 17th century. Within a couple of months of establishing their New Gottenburg settlement in 1644, the Swedes endeavored to build "two large, beautiful boats, one for use at Elfsborg, the other at Fort Christina."[1] These were apparently the first water vessels built by any "white man" on the Delaware. The Swedish colony had planned to construct further ships, but all three of the colony's ship carpenters fell ill and the Indians burned the seasoning timber. Ship construction activities were resumed three years later in 1647 when the Swedes built a barge and sloop. Governor Printz ordered the construction of a 200 ton vessel in 1651. One Claes Timmerman built and launched the vessel in 1652, but she was never fully finished. All Swedish shipbuilding activities were halted in 1655 when the Dutch took control of the region. No records have been found which indicate the Dutch built any vessels in the ensuing ten years before the English occupied the Delaware Valley.[2]

The first evidence of British ship construction appears in 1676 when the Glob was built for settlers in Philadelphia. Two other vessels were built in that year - for Gregory Maslow and Samuel Groome.[3] In his plans for his colony, William Penn had intended to establish a strong tradition of shipbuilding. He recognized the potential of the hardwood forests that stretched along the upper reaches of the Delaware River. This vast source of lumber for shipbuilding was vital, particularly since England's forests had been mostly exhausted by the end of the 16th century.[4] Logs were

soon being transported down the Delaware (to be discussed further in another section) in rafts. With these resources available, Penn advertised abroad for quality tradesmen to emigrate to Pennsylvania. He mentioned in "Some Account of the Province of Pennsylvania - 1681" that shipwrights were among nine craftsmen in Pennsylvania. By 1685, "there were shipwrights, boatwrights, ropemakers... sailmakers and blockmakers" all listed as residents of Philadelphia.[5]

William West, one of the first Philadelphia settlers and also a silent partner of Penn, built a vessel for Penn at "Penny-Pot Landing," at the foot of Vine Street. This vessel, likely the first to be built at Philadelphia, was called the Amity. Little is known of her, except that her rigging, iron and stores were acquisitioned from a condemned English vessel in Chester. West was then compensated for his efforts by Penn, who offered him the land at the foot of Vine Street where he established a shipyard.[6] Herman Wittbank was one of the first shipwrights in Philadelphia. James West, William's brother, received a grant to build a shipyard in this same period. As well, the Society of Free Traders built a number of whale boats in Philadelphia.[7]

Shipbuilding activity increased dramatically from the first years of settlement at Philadelphia in 1682. By 1700 there were four established shipyards in the city. One Philadelphian, Richard Castleman, mentioned in 1710 that "by a moderate computation there had been launched from the stocks in this city in 40 years, near 300 sail of ships besides small craft..."[8] Between 1682 and the beginning of maritime records in 1722 (ship registers, started by port authorities to collect customs) the average output can be estimated to be slightly less than ten vessels per annum - most less than 50 tons in size.[9] Several family "yards" were responsible for the majority

of vessels built by the early 18th century. The West family continued to be active until 1800. The Penrose Shipyard, founded by Bartholomew Penrose in 1707, lasted almost 150 years in the family. Other families which had shipyards in a slightly later period include Humphreys, Bowers, Eyre, Cramp, Lynn and Vaughan, to name a few.

After 1722, an idea of the output of the shipyards in the Delaware Valley can be gained from the "Ship Registers of Pennsylvania 1722-1776." A total of 3,241 vessels were registered in Philadelphia, a large percentage having been built in the Delaware Valley. Between 1722 and 1776, the region's shipbuilding yards produced around 95,000 tons of shipping if one estimates the output of missing years in the registers and adds it to the total recorded output of 87,346 tons. The peak years in terms of numbers of vessels built were 1748, 1750 and 1752, when Pennsylvania yards produced 51, 50 and 47 vessels respectively - amounting to 3,225, 2,957 and 2,454 tons. The largest ships built in Pennsylvania during this 54 year period were constructed just before the Revolutionary War in 1773 and 1774. In those years 40 and 33 vessels were built, accumulating some 3,654 and 3,637 tons.[10] The average mean tonnage of the vessels built in Philadelphia increased steadily. In 1727 the mean tonnage was 45.52, in 1740 it was 64.25, in 1750 it was 66.15, in 1760 it was 73.03, in 1770 it was 104.44 and in 1775 it was 153.15.[11]

In addition to the trend of building larger vessels, certain types of vessels became more prevalent throughout this well-documented period. Six types of vessels were listed in the registers: ships, snows, brigantines, sloops, schooners and shallops. Their basic distinguishing characteristics were the type of sails and rigging used, but they also varied in size as well. Crowther points out that although a full-rigged ship may be larger than a brig or snow in terms of burden, it may have been of equal size or

smaller. The number of full-rigged ships, as a percentage of the total number of registrations, increased between 1727 and 1775. The average size of these ships grew so that their contribution to total tonnage rose from 46% in 1727-1753 to 59% in 1754-1775. In tracing the development of the other vessel types, Crowther points out that the brigantine remained a consistently popular vessel - it grew in numbers and size. The snow, although it increased in average size during the century, declined in importance as a vessel type and its numbers decreased as a percentage.[12]

The three smaller vessel types did not increase in size but their relative contribution to the total number and the tonnage of vessels listed changed somewhat. Shallops, the smallest vessels used in ocean transport, practically disappear from the registers in the 1770s: Crowther feels that is likely because they became involved in intra-colonial trade, not overseas routes, and thus were not required to register in the same manner.[13] The schooners increased in numbers, as a percentage, while the sloop decreased numerically. The relative contribution of Pennsylvania shipyards in the years 1769 and 1771, in terms of tonnage, was fourth overall in the colonies, behind Massachusetts, New Hampshire and Rhode Island.[14]

Naval shipbuilding - building war vessels - did not occur in Pennsylvania before 1775. In that year the Continental Congress authorized the construction of 13 frigates. Four of these, a disproportionately high number, were to be built by Pennsylvania shipyards. The four frigates, Randolph (32 guns), Washington (32), Effingham (24) and Delaware (24) were built in rather small yards in the Philadelphia districts of Kensington and Southwark. The yards which received these contracts were Wharton and Humphreys, Eyre, Grice and Coats. The continental sloop Saratoga (18) was also built at Wharton and Humphreys in 1779. In addition to these Continental "war" vessels,

the State of Pennsylvania built its own navy of row galleys and gun boats.

The peace of 1783 changed the focus of shipbuilding dramatically in Philadelphia - emphasis was diverted from the small, fast privateer types which required large crews to operate - to the burdensome cargo vessels that could be manned by a few men. Vessels were constructed for the new and expanded trade routes that the country was now able to develop. After the revolution, shipbuilders in Philadelphia organized a craft guild, the Ship Wrights Company, for the study and improvement of naval architecture. In 1795 this company established a school for the instruction of ship carpenters - the first institution of its kind in the United States.[15] Philadelphia built ships such as the Montesquier, North America, Canton and William Penn that were used in the far-reaching China trade network.

An important development in advancement of shipbuilding was the construction of the first steamboats by John Fitch in the late 1780s. Fitch's revolutionary designs, developed on the banks of the Delaware and successfully tried on the river, were described by himself in an article in Columbian Magazine (rewritten and corrected by Magazine editors):

> "The steam engine is to be similar to the late improved steam engines in Europe. The cylinder is to be horizontal and the steam to work with equal force of each end thereof. The mode of forming a vacuum is believed to be entirely new; also of letting into it and of letting it off against the atmosphere without any friction... it being a 12" cylinder. They expect it will move with a clear force; after deducting friction, of between 1,100 and 1,200 pounds weight; which force is to be applied to the turning of the axletree on a wheel of 18" diameter. The piston is to move about 3' and each vibration of the piston turns the axle tree about 2/3 round. They propose to make the piston to strike the 30 strokes in a minute; which will give the axle tree about 40 revolutions. Each revolution of the axle tree moves 12 oars 5-1/2'. As six oars come out of the water, six more enter the water; which makes a stroke of about 11' each revolution. The oars work perpendicularly and make a stroke similar to the paddle of a canoe..."[16]

The first of Fitch's two steamboats was 45' stem to stern, with a 40' keel, an 12' beam and a 3' draught. The boat was finished in 1787, and evoked this response, "It lay like a small, flat decked barge..."[17] To place the engine machinery on board, a furnace was built on deck, two-thirds of the way back on the boat. The pile of 1,300 bricks weighed some 7,000 pounds when mortared together. Although the vessel proved ineffective in several regards, Fitch continued and built a second vessel, Perseverance. This vessel had several modifications, an 8' beam, stern paddles and the furnace, placed directly under the boiler, was 7,000 pounds lighter.[18] This vessel proved to be slightly more successful, operating for an entire season between Philadelphia and Trenton. Thus, steam vessels got their start on the Delaware.

Naval shipbuilding began again in 1793 when armed vessels were needed to protect American commercial ships - which were being attacked by outside forces - particularly North African pirates. The new frigates were larger and more powerful than their Revolutionary War counterparts. The United States (44) was built by Joshua Humphreys in 1796-7 in his Southwark yard. The frigate Philadelphia (36) was finished by 1800. The Federal government purchased the property at 2nd and Federal Streets - the site of Humphries yard - and converted it into the Philadelphia Navy Yard. The brig Syren was the first ship built there in 1803. The Jeffersonian naval strategy of using no large ships, but rather employing very small gunboats in naval service, was reflected in the ship production at the Naval Ship Yard. Thirteen of these small boats were built at the Navy Yard and seven similar boats in other unidentified Philadelphia yards. The War of 1812 quickly changed the emphasis. Two large warships were built in 1812 at the Philadelphia Navy Yard, Guerriere (44) and Franklin (74). In all, in the

period between 1793 and 1815, there were five naval vessels built in Philadelphia (excluding the 20 gunboats). These vessels totalled nearly 7,000 tons.[19]

The War of 1812 disrupted all the commercial shipyards along the Delaware. Shipbuilding in these yards was virtually non-existent for several years. It was not until the introduction of the packet lines, that the industry regained normal productivity. After initiation of Cope's Liverpool Packet Line out of Philadelphia in 1824, several other lines began operating out of Philadelphia. This new trading network kept shipbuilders in Kensington and Southwark busy through the middle of the 19th century. The Eyres, the Grices, Robert Burton, the Bowers, Nicholas Van Dusen, Joseph Ogilby, Tees and Van Hook, Haines and Vaugh and several other yards were all building vessels for the packet lines.[20] By 1830 there were thirteen shipyards along Philadelphia's waterfront between Kensington and Southwark.[21] Other major Philadelphia shipyards which came into prominence in the 19th century included Cramp's, Neafie and Levy and Roach's.[22]

The naval vessels that were built between 1816 and 1846 included the 120 gun ship-of-the-line Pennsylvania, the most powerful ship in the American navy. A total of seven other vessels were built at the Philadelphia Navy Yard during this period. These included the ship-of-the-line North Carolina (74), the frigate Raritan (44), three sloops (16, 22 and 24) and a small schooner.[23] In the years leading up to the Civil War, the Navy Yard initiated the practice of building transitional warships - possessing both mechanical and sailing capabilities. Eight vessels of this type were built in the years 1839-1860. The most notable of these vessels was the Princeton (1843), the world's first successful screw propelled warship. Her engines were designed by John Ericcson. The Pawnie was the first navy

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vessel with twin screws. The rest of these transitional vessels were all wooden hulled with diagonal iron strapping.[24]

It is also important to recognize the contribution of Philadelphia shipyards to the proliferation of iron-hulled vessels. Throughout the middle of the 19th century the Delaware River has often been referred to as the "Clyde" of America - a reference to the great shipbuilding center in Scotland. One of the reasons for the expanded production in iron vessels was the abundant supply of iron in the Delaware River basin.

The Civil War pressed the Navy Yard and many of the commercial yards into service of producing warships once again. Some 36 naval vessels were listed by Baker as having been built during the war - the largest being the New Ironsides. She was built at Cramp's in 1862, with a 3,486 tonnage. The navy instituted several wartime measures at the outbreak of the insurrection; they ordered a class of 23 gunboats to be delivered in 90 days, they wanted ironclad vessels, an experimental submarine was to be built and a plan to construct high-speed cruisers was initiated. The 90-day gunboats, basically 2-masted schooners, were all built at four smaller yards. The Kensington shipyard of Neafie and Levy built the Alligator, a submersible spar torpedo.

> "Its crew of 17 operated hand cranks activating paddles which could move it at 2.5 knots. Forty-seven feet long, it was armed with two spar torpedoes."[25]

The high speed cruisers were intended to offset the effectiveness of Confederate commerce destroyers. The program was never completed because by 1864 the Union forces were clearly winning the war. Three classes of iron-clad moniters were also built at Philadelphia.

Ship construction on the upper Delaware, above the tide, was geared to building vessels which could effectively navigate the swift and treacherous

waters above Easton. Vessels were built to serve primarily in the ferry service, coal trade, lumber industry and bulk cargo transportation.

Although ferries varied in construction according to the environment in which they were to be used, a generalized account of the types which operated on the upper Delaware can be offered. They were typically a long, narrow boat with flat bottom and vertical sides. The flat bottom was sloped up at each end, to the height of the sides, which were parallel and about a foot high. At each end there was an "apron" which was hinged so that it could be brought in-board during a crossing and put outward at a landing. This was constructed to facilitate movement between the vessel and the shore. Teams of horses could thus board the ferries.[26] A specific reference to ferry construction can be found in Fackenthal:

> "Length 31½', breadth at the head 7½', extreme breadth 9', abaft the head 7'8". At the stern by a regular sweep from the extreme breadth, 7'2". Depth at the highest part of the sides, 24". The shear 2" to flare 3". The sides to be sawed 5" thick at the bottom edge and 3½" at the top edge. The head and stern posts, 18" wide and 8" thick on the front edge. The bottom planks to rabbit on 5". The bottom plank the whole length, and the cross plank the breadth of the flat, the whole 2" thick."[27]

Ferries were for the most part built locally, by craftsmen who were taught boat-building skills by the previous generation.

A commercial use for coal was developed early in the 19th century, and the vast coal supply available in the Lehigh Valley was thus to be shipped down the Lehigh and Delaware Rivers. The primary means of transporting this bulk cargo was by means of an ark - which was quickly constructed to make one down-river trip. Upon arriving at Trenton, the arks were usually broken up and used as lumber. Davis, in the History of Bucks County, says that William Trumbull built the first ark at Mauch Chunk in 1806, which made the trip to Philadelphia that year. Henry in the History of the Lehigh

Valley mentions the dispatch of several arks in 1813 and one in 1814, which was 65' long, with a breadth of 14' and could carry 24 tons of coal. Watson's Annals of Philadelphia mentions ark building: "The boat building is a curiosity. Here four men make a coal ark for 25 tons in 30 minutes. They plane the points of the pine boards with a plane of 9 irons, turned, to give it power, by a crank. Twenty spikes, of 6 inches length, are driven home, at a single stroke, one at a time."

Soon the consumption of lumber in the arks became so enormous that efforts were made to transport the coal to Philadelphia in vessels which could make a return voyage. They appear to have been tried during the three year interval between the completion of slack water navigation on the Lehigh in 1829 and the opening of the Delaware Division of the Pennsylvania Canal - from Bristol to Easton in 1832. Hazard's Register mentions an ironboat that was built in 1829 by the Lehigh Coal and Navigation Company. This vessel is said to have made her first voyage from Mauch Chunk to Easton and then back to Easton up the channel in the Delaware without any complications. Other experiments were made with wooden boats. However, once the canal opened coal was primarily transported on barges suited for navigation in the canals.[28]

Until the canals came into use, Durham boats were the sole means of moving commodities on the river in both directions. The Durham boat was well known on the Delaware for over a century - some 2,000 rivermen ran approximately 300 Durham boats between Easton and Philadelphia. The construction of the Durham boat was standardized - designed to carry a substantial cargo with a shallow draft. The sides were vertical with a slight curvature to correspond with a similar curvature on the bottom of the boat. The bottom of the boat was for the most part flat. Lengthwise, the sides were straight and parallel until they began to curve toward the stern and stern posts -

approximately 12' to 14' from the ends, where the decks, fore and aft, started. The rest of the boat was undecked. The partly rounded form of the hull was preserved at the ends. The typical length was 60', with a beam of 8'. The depth from the top of the gunwale to the 12" keel plank was normally 42' with an additional height of some 10" at the ends. The draft of the boat ranged from 3½" to 5" when light to approximately 25" when fully loaded. The boat could carry up to 20 tons downstream and a modest cargo of some two tons back upstream. (See Appendix for shipyard listing and Fig. 14.)

[1] Brewington, Maritime Philadelphia, 50.

[2] Brewington, Maritime Philadelphia, 51.

[3] Brewington, Maritime Philadelphia, 51.

[4] Untitled note, (Philadelphia Maritime Museum Shipbuilding Vertical File), 19.96.

[5] Untitled note, (Philadelphia Maritime Museum Shipbuilding Vertical File), 12.15-16.

[6] Brewington, Maritime Philadelphia, 51.

[7] Brewington, Maritime Philadelphia, 51.

[8] Brewington, Maritime Philadelphia, 52.

[9] Simeon Crowther, "The Shipbuilding Output of the Delaware Valley, 1722-1776," Proceedings, American Philosophical Society, Vol. 117, (1973), 43, hereinafter cited as Crowther, "Shipbuilding Output of the Delaware Valley."

[10] Crowther, "Shipbuilding Output of the Delaware Valley," 93.

[11] Crowther, "Shipbuilding Output of the Delaware Valley," 95.

[12] Crowther, "Shipbuilding Output of the Delaware Valley," 97.

[13] Crowther, "Shipbuilding Output of the Delaware Valley," 97.

[14] Crowther, "Shipbuilding Output of the Delaware Valley," 98.

[15] William Baker, "Commercial Shipping and Shipbuilding in the Delaware Valley," Society of Naval Architects and Marine Engineers, Spring Meeting Papers (New York, 1976), 4, hereinafter cited as Baker, "Commercial Shipping of the Delaware Valley."

16 Thomas Boyd, Poor John Fitch (New York, 1935), 162, hereinafter cited as Boyd, Poor John Fitch.

17 Boyd, Poor John Fitch, 172.

18 Boyd, Poor John Fitch, 183

19 Robert Egan, "Two Hundred Years of Naval Shipbuilding in the Delaware Valley," Society of Naval Architects and Marine Engineers; Spring Meeting Papers (New York, 1976), 3.4, hereinafter cited as Egan, "Naval Shipbuilding in the Delaware Valley."

20 David Gauer, Vaghan Shipwrights of Kensington, Philadelphia, The Van Hook and Norris Lineages and Combined Progeny, (Decorah, Iowa; Anundsen Publishing Co., 1982), 73.

21 Baker, "Commercial Shipping of the Delaware Valley," 11.

22 William McHugh and GAI Consultants Inc., "Delaware River Navigation Study (Interim): Cultural Resources Sensitivity Reconnaissance" (Army Corps of Engineers, Philadelphia District, 1983), 21, hereinafter cited as McHugh, "Delaware River Navigation Study."

23 Egan, "Naval Shipbuilding in the Delaware Valley," 3.5.

24 Egan, "Naval Shipbuilding in the Delaware Valley," 3.6.

25 Egan, "Naval Shipbuilding in the Delaware Valley," 3.8.

26 John Anderson, "Navigation on the Delaware and Lehigh Rivers," A Collection of Papers Read Before the Bucks County Historical Society, Vol. 4 (1917), 289, hereinafter cited as Anderson, "Navigation on the Delaware and Lehigh Rivers."

27 B.F. Fackenthal, Improving Navigation on the Delaware River with Some Account of its Ferries, Bridges, Canals and Floods (Bucks County, PA. Historical Society, 1932), 25, hereinafter cited as Fackenthal, Improving Navigation on the Delaware.

28 Anderson, "Navigation on the Delaware and Lehigh Rivers," 289.

Shipping, Commerce and Ferries

The Delaware River has historically been the vital transportation route which fostered the development of settlements and colonies. Dating back to the fur trade of the Dutch and Swedes, ships have plied the Delaware contributing to the economic progress of the region. William Penn helped establish defined trade routes for the Philadelphia merchants once the British had set up their colony. The initial trade routes to and from Philadelphia have been categorized as intracolonial trade, English trade, or southern European trade. Philadelphia was one of the several American ports that comprised the network of trade routes within the colonies. Each colony contributed its local products for export: Pennsylvania primarily shipped lumber, staves, wheat and flour. Later this trading system was extended to include several of the Caribbean ports.[1]

The trade between Philadelphia and the English ports was constantly a one-sided venture, with the upstart colony in need of most of the products which England had to offer, including manufactured goods, textiles, metals, tea, shoes and tools. Philadelphia only exported lumber, foodstuffs and furs to England. The inbalance created by this unequal trade was alleviated by the subsequent development of a triangular trade route that moved items from Philadelphia to the West Indies before the ships crossed over to England. The third trade system involved the southern European nations of Spain and Portugal. This trade brought wine, as the primary import, into Pennsylvania.[2]

An account of the developing trade routes of Philadelphia, around the start of the 18th century is provided by one Gabriel Thomas:

"Now the true reason why this flourishing city advance so considerably... is their great and extended traffique and commerce both by sea and land, viz, to New York, New England, Maryland, Carolina, Jamaica, Barbadoes, Nevis, Monsurat, Antego, St. Christophers, Barmudees, New Foundland, Maderas, Saltetudeus, and old England... Their merchandise chiefly consists horses, pipe-stoves, pork and beef... bread and flour, all sorts of grain, peas, beans, skins, furs, tobacco and potashes; wax which we bartered for rumm, sugar, molasses, silver, negroes, salt, wine, linen, household goods..."[3]

A more comprehensive account of trade in and out of Philadelphia at a slightly later period, circa 1754, is provided by Acrelius. He took the time to list articles which were shipped to and from the port of Philadelphia. He mentioned that wheat, flour, bread and beef were the major exports to the West Indies - which sent in return rum and sugar. Similar items were sent to Carolina, which in turn exported tar, pitch and turpentine. Philadelphia merchants sent rawhides, deerskins and several items previously acquired from the West Indies to London, Bristol and Liverpool. In return, "there are brought all kinds of English manufactures and even bottled liquors. But as this commerce is carried on with a very heavy balance against it, this must be made up by bills of exchange and by money..."[4] Acrelius continues to state that wheat, bread and wax were sent to Lisbon, whose merchants shipped wine, salt, olive oil, silk, satin and tea.[5]

The shipping routes coming from the Delaware River grew steadily throughout the 18th century. Port entrances and clearances in 1730 ranked Philadelphia third behind Boston and New York, but by 1772 Philadelphia had become the busiest port in North America. Boston was a close second in tonnage of ships entered and cleared, while New York was a distant third. The Revolutionary War completely disrupted the commercial development of the Delaware River ports. The superior British navy all but stopped shipping in most of the American ports. After the conclusion of the war, there was

a need to establish "new" routes to revitalize the shipping industry of the Delaware Valley. Local merchants helped sponsor a trade relationship with the Far East. The Canton left Philadelphia for China in 1785. She returned with silk, teas and Indian goods. This new route soon became a very profitable venture for many shipping firms. Other new routes were set up with Russian and Baltic ports in the 1790s. Often times these new routes were necessitated by the tendency of each state to regulate their trade by levying stiff tariffs on shipped goods. In 1800 some 40 vessels from Philadelphia were involved in the China trade.[6]

The development of shipping in the early 19th century was again disrupted by several events. The Napoleonic Wars tied up the majority of the European fleets in an embargo. In 1812 the British blockaded the Delaware once again in conjunction with the War of 1812. Several developments stimulated the revival of shipping following these restrictive actions. The introduction of an antracite coal trade, the growth of packet lines and the slow but steady conversion to steam navigation.

As mentioned previously, John Fitch successfully operated the world's first steamboat on the Delaware River. He was able to operate a passenger service between Philadelphia and Burlington, some 20 miles apart, in 1788. Unfortunately, the trip took on the average well over three hours and he was unable to offer a swifter service than that of the stages.[7] Fitch's ideas opened the door for an influx of better conceived steamboat plans.

The first regular steamboat service on the Delaware was in operation by 1809. The steamers Phoenix and Philadelphia carried passengers between Philadelphia and Bordentown, N.J. until 1813. The Phoenix was then replaced by the Eagle, which ran to Burlington three times a week. Seven steamboats

were said to have been operating on the Delaware in 1813. In 1819 the Vesta was the first steamboat to venture down the Delaware Bay to Cape May, N.J. twice a week.[8] Since it took some time for the steam engines to be considered totally reliable and safe, the steamers were only used at first in protected environments - such as rivers like the Delaware. Other early steamboat lines out of Philadelphia went to Wilmington, Del., Salem, N.J. and Smyrna, Delaware.

Coastal steam lines lagged behind the steam service available in the rivers and harbors. Steamboats were designed only to withstand calmer waters. The first steamboats modified for open-water transportation did not prove to be particularly seaworthy in more turbulent waters. In 1836 the 596 ton steamboat Charlestown, built at Philadelphia, ran to South Carolina. This service experienced many difficulties and was discontinued in 1839. It was not until 1849 that a steamship (a vessel designed specifically for the rigors of the open sea), the Philadelphia, was built for coastal service. She was equipped with side paddle wheels, driven by two side-lever engines. Other coastal steamers were rapidly built as the early steam ship lines began to thrive. The 227' paddle wheel steamer Quaker City ran between Philadelphia and Havanna in 1854. The Clyde Line to New York and Boston was started in 1842.[9]

Overseas shipping, during the first half of the 19th century was primarily centered around the development of the packet lines. Thomas Cope, in 1822, initiated Philadelphia's first transatlantic packet line to Liverpool with two ships, the 290 ton Lancaster and the 278 ton Tobacco Plant. Packet lines, regularly scheduled shipping lines, continued to thrive in Philadelphia until after the Civil War. Other lines which operated out of the Delaware River ports included the Welsh Line (1823-4), the New Line of Liverpool and

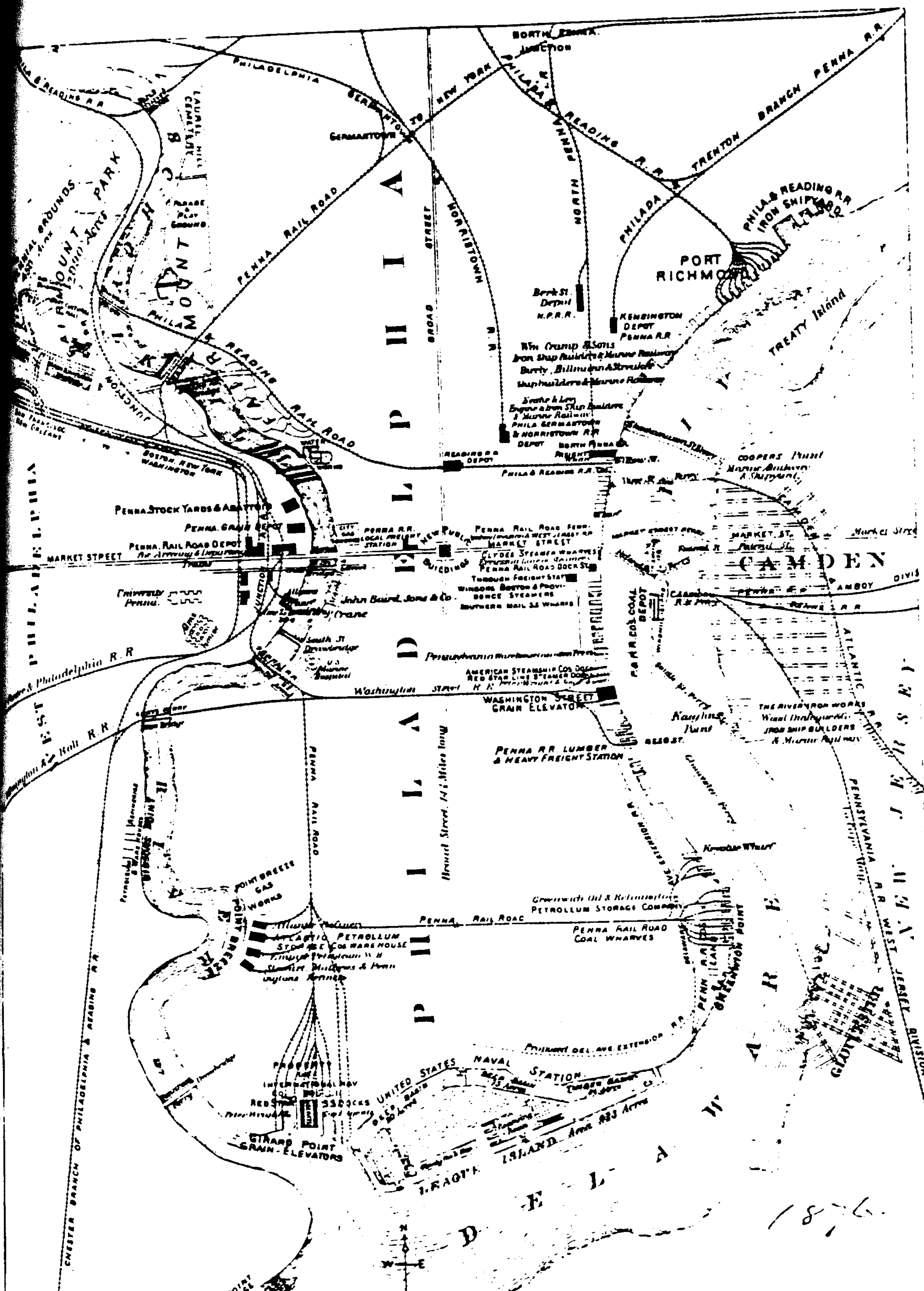
PHILADELPHIA
CAMDEN
PORT RICHMOND
TREATY Island
FAIRMOUNT PARK
LEAGUE ISLAND
DELAWARE
NEW JERSEY
WEST PHILADELPHIA
MARKET STREET
PENNA RAIL ROAD
PHILADELPHIA & READING R.R.
NAVAL STATION
GIRARD POINT GRAIN-ELEVATORS
WASHINGTON STREET GRAIN ELEVATOR
PENNA STOCK YARDS & ABATTOIR
Broad Street, 14½ Miles long
1876.

FIG. 1

Philadelphia Packets (1824-37), Black Diamond Line (1823-4), New Line (1847-55), Line of Liverpool Packets (1850-Civil War) and the Philadelphia-Liverpool Line (1852-4).[10] Coastal packet lines were also established to most of the American ports on the eastern seaboard - Boston (10 lines), New York (9), Charlestown (10), Savannah (7), Mobile (7), and New Orleans (12).[11] The emergence of clipper ships in the mid-19th century had little impact on the commerce of Philadelphia.

There were several attempts to introduce steam navigation above the tide. The Belvidere-Delaware Railroad in 1851 was opened from Trenton to Lambertville. In 1852 the stern wheel steamer, Major C. Barnett made regular trips between Lambertville and Easton - in conjunction with the train service. The hazardous river conditions necessitated the switch to a smaller, more maneuverable boat - the Raindeer. However, she was able to run effectively only for a short while. A steamboat, Alfred Thomas was built at Easton in 1860. The boat was to run between Belvidere and Port Jarvis, N.Y. but her boiler exploded on the first trip.[12]

Notwithstanding the relative failure of steam navigation on the upper Delaware, shipping was conducted on this portion of the river from at least the middle of the 18th century. Vessels were designed with shallow drafts to negotiate the tricky waters. An account of shipping on these reaches of the Delaware, from Smith's History of New Jersey, dated 1765:

> "...from Cushietunk to Trenton Falls are 14 considerable rifts, yet all passable in the passage in the long flat boats used in the navigation in these parts, some carrying 500 or 600 bushels of wheat... These boats are made like troughs, square above the heads and sterns, sloping a little fore and aft generally 40 or 50 feet long..."[13]

From this general description - similarities can be drawn with the Durham boat, if these were not themselves Durham boats, which were used extensively on the upper Delaware from the 1750s to the 1850s. The boat

draws its name from the model first developed by the Durham Iron Company in 1727 to carry products of the Durham furnace and forges to Philadelphia. The boats were then loaded with a much lighter cargo for the return journey upriver. Durham boats were made famous by Washington's crossing in the winter of 1777.

The movement of the Durham boat with the current was controlled by two 18' oars. To propel the boat upstream "setting poles" were used. These were 12' to 18' long. A 12' wide plank was laid on the thwarts on each side of the boat - these constituted "walking boards." Two members of a typical crew of three would plant the poles in the river bottom while at the forward end of the boat and "walk" the poles back to the stern pushing the boat forward. The captain used a long sweep (over 30') to steer the boat. The vessels could carry 15-20 tons of cargo downstream. The cargo was limited to 2 or 3 tons of manufactured items for the return trip. When the wind was agreeable, a small triangular fore and aft sail could be set. These boats became obsolete soon after the opening of the Delaware Division Canal in 1834. They altogether disappeared after the opening of the Belvidere-Delaware Railroad in 1854.[14] There is apparently no remaining evidence of this once vast fleet of boats. At the apex of their popularity several hundred Durham boats operated on the Delaware. The single largest fleet was located at Easton, carrying grain, whiskey and other local products from there. Lambertville and New Hope also had a sizable fleets of these boats.

Anthracite coal was first brought down the Delaware in a flatboat in 1806. It was not until 1814 when Joshua Malin had developed a means for making the coal commercially useful that coal was regularly transported down the river. In 1820 365 tons of coal passed down the river.[15] The primary means of transporting the coal was in specially designed "arks."

At first these arks were rectangular, made of heavy planks spiked together. The tightening of the joints, by the swelling of saturated wood, was apparently relied on for adequate buoyancy. Anderson does mention that floatation was often enhanced by placing lumber in the bottom of the ark and also by constructing a double-bottom with sufficient space from which leakage could be pumped. Originally these arks were moved individually. Eventually it was found that several arks could be lashed together, forming a long flexible craft, thus making each trip more profitable. These long combined arks were navigated by end oars, similar in many ways to rafts.[16] The coal boom reached its peak in 1833.[17] Railroads eventually took over the coal transportation service - thus making coal "arks" obsolete.

Log rafts were another type of vessel that was navigated along the upper Delaware River. Davis, in the History of Bucks County, mentions that the first raft to ply the river started from Cochecton, N.Y. some 40 miles above Port Jarvis, in 1746. However it is very likely that log rafts were in use well before this time. Since shipbuilding was practiced in Philadelphia from its early days, the necessary lumber was probably brought down the river in rafts. The raft which Davis referred to had six pine trees, seventy feet in length, which were to be masts for ships building at Philadelphia. Holes were drilled through the ends of each log and all were strung on poles, called spindles, with a pin at each end to keep the logs from spreading apart.[18] Extremely large amounts of timber were transported this way. This method of transportation steadily increased throughout the 18th century, peaked in 1840-5 and began to decrease after 1855. The season for moving these rafts was only about four weeks long, during the spring freshets. For the first two weeks, typically, the rafts contained sawed lumber. During the final two weeks logs were brought down in the rafts. The raft had no shelter

for its crew - thus traffic stopped at night. Single rafts had one oar at each end and double rafts had four oars - two at each end.[19] Hazard's Register of Pennsylvania estimates that in the spring of 1828 as many as a thousand rafts, containing 50 million feet of lumber descended the river during the rafting season. The lumber was normally brought down to Trenton by a steersman who was familiar with the channel. From Trenton the lumber was transferred to tow barges for the remainder of the trip to Philadelphia.[20]

Ferries

Ferries have been operated along all reaches of the Delaware from the 17th century, since the Delaware River separated two thriving colonies, and transportation across the river was vital. Above Philadelphia there was typically a ferry crossing every three or four miles. Permits which were required of the proprietors of the ferry crossings, often gave them the exclusive rights to operate a ferry for a couple of miles in either direction on the river. Ferries were usually established at the terminus of an existing road, path or railroad. They were used to carry not only passengers but also industrial cargo across the river. The nature of ferries, being numerous and usually known by two separate names (the ferry rights were owned by different individuals on either side), makes it difficult to chronicle their development. As well, the ownership changed frequently. It was not until relatively recently that ferries began to give way to bridges that spanned the river.

The vessel first used to "ferry" individuals was probably a canoe. Eventually a specific ferry type was developed according to the needs of the service. The first type of ferries built on the Delaware had straight or square bows, alike at both ends. The bottoms were flat, with a false

bottom on which the cargo rested. The angle of the ends varied according to the slope of the landing embankment. The differing river conditions necessitated the development of different vessel types and propulsion methods. Ferries below the tide were all originally propelled with oars and set poles and by sails when the wind was agreeable. Above the tide, where the river was narrower and the water had a stronger current, ferries were normally equipped with two ropes, one attached to each end of the boat. A pulley or pulleys at the other end of the hawsers were operated along a hemp rope cable which was suspended over the river above the high tide mark.

A history of ferries that crossed the Delaware at various stages above Philadelphia has been compiled by Fackenthal and Ewan. Information on ferries is vague and often misleading, which makes it difficult to document each historic crossing. Different researchers often tend to refer to the same crossing by two different names. Following is a list of the major ferry crossings on the river north of Philadelphia to Easton derived from the accounts of Fackenthal and Ewan:

Palmyra-Philadelphia Ferry - a modern steam ferry, which was located just below the Tacony-Palmyra Bridge on the Pennsylvania side. Service was discontinued with the opening of the bridge.

Hopkins Ferry - located at or near the terminus of Taylor's Lane, Cinnaminson, N.J. The service dated back to 1720.

Dunks Ferry - was three miles south of Bristol, near the mouth of Neshaminy Creek, opposite Burlington, N.J. Service was initiated in 1699 under Duncan Williamson. A redoubt was built at the Pennsylvania landing by General Washington's orders. The service was discontinued about 1852.

Bristol-Burlington Ferry - south of Burlington Island. Service was authorized in 1700, with a reference to an earlier ferry. Discontinued after 1862.

Minnick's Ferry - located approximately equidistant from the Bristol-Burlington Ferry and Schuyler's Ferry. Was operated by Christian Minnick around 1780. Later known as Bloomsdale Ferry. Service was discontinued after 1840.

FIG. 2

Schuyler's Ferry - likely the oldest ferry on the Delaware above Philadelphia. In regular use about 1677 - operated by Casparus Schuyler. Located between Tulleytown, Pa. and Florence, N.J.

Winners Ferry - an unimportant ferry which was slightly above Schuyler's Ferry and possibly succeeded it in 1785.

White Hill Ferry - a road is described as leading to this ferry in 1802. Above Newbold Island.

Bordentown Ferry - Falls Township, Pa. to Bordentown. A map of 1770 indicates this crossing as Kirkbridge (likely a Pa. name). The ferry which operated from just below the mouth of Crosswicks Creek, N.J. was authorized in 1718, but references are made to its being in use as early as 1695.

Biles Island Ferry - Falls Township, Pa. to Hamilton Township, Mercer County, N.J. Scott's Atlas of Bucks County indicates a ferry landing at the head of the island about equidistant between the Bordentown and Trenton ferries, about three miles from each.

Lamberton Ferry - below Trenton Falls - one mile south of the Trenton Ferry. A revival of the earlier Bond Ferry.

Trenton Ferry - the first of three ferries established at Morrisville, Pa. and Trenton. It was located at Ferry Street (in Trenton) immediately south of the Lincoln Highway Bridge. It had several other names. It was officially established by an act of the Pennsylvania Assembly in 1718.

Calhoun Street Ferry - located above the falls, about one mile above Trenton Ferry, just above the present Calhoun Street Bridge. It was the first ferry on the river above the tide, begun during the early days of the Revolution.

Yardley's Ferry - from Yardley, Pa. to Greensburg, now Wilburtha, Mercer Co., N.J. The ferry was established by an act from the Pennsylvania Assembly in 1722. Service was discontinued in 1835 when a bridge opened.

McKonkey's Ferry - located immediately above the present river bridge in Upper Makesfield Township, Bucks County to Hopewell, N.J. on a tract of land taken up in 1684 by Henry Baker, who established the first ferry there. The place where Washington crossed the Delaware.

Beaumonts Ferry - located in Brownsburg, formerly Pebbletown, slightly less than a mile north of Knowles Creek in Upper Makesfield Township. It is midway between New Hope and Washington's Crossing, 3-3/4 miles from each.

Corvell's Ferry - located between New Hope and Lambertville, N.J. First established in 1717 slightly below the site of the river bridge where the Logan House stands and a half mile above the head of Wells Falls. The first stage of the Old York Road crossed this ferry in 1769.

Centre Bridge Ferry - midway between New Hope and Lambertville, 3½ miles from each. Crossed from Centre Bridge, Bucks County to Stockton, Henderdon County, N.J. Established as Reading Ferry soon after 1700. Abandoned in 1814 when a river bridge opened.

Lumberton Ferry - from Lumberton, Solebury Township, Bucks County to Delaware Township, Hunterdon County, N.J. Located at a landing 3/4 mile south of Bull's Island, now Raven Rock Railroad Station. Discontinued when toll bridge was built in 1835.

Point Pleasant Ferry - Point Pleasant, Bucks County to Byram Station on the Penna. Railroad line in Kingswood Township, N.J. Ferry was started in 1739 and continued until bridge opened in 1835.

Frenchtown Ferry - ancient ferry, may have been established as early as 1699 when London Land Company purchased five miles of riverfront land. The first recorded ferry is in 1741 as London's Ferry below the present bridge in Tinicum Township, Bucks County between the towns of Uhlerstown, Pa. and Erwinna, Pa. to Frenchtown, N.J. Abandoned in 1844 when bridge was built.

Milford Ferry - from Upper Black Eddy, Bridgeton Township, Bucks County to Milford, Hunterdon County, N.J. A ford was used before the ferry was built. Ceased in 1842 with the bridge opening.

Monroe Ferry - from Monroe, later Lehnenburg, Durham Township, Bucks County to Holland Township, Hunterdon County, N.J. The ferry was started in 1786. Operated through the 1860s.

Durham Cave Ferry - immediately in front of Durham Cave in Burham Township, Bucks County to Holland Township, Hunterdon County, N.J. The ferry dates to about 1742, when the first forges were built on the Musconetcong Creek in New Jersey.

Durham Furnace Ferry - a successor to the Cave Ferry - actually crossed at about the same place, but about a century later. When the new blast furnace at Durham was installed, a more sophisticated ferry system was developed. It had wire rope cables and a large top-deck boat for carrying iron ore across the river to the works and to return with pig iron and castings. Service was started in 1877 on a 50' vessel which could hold five small, narrow gauge cars or 12½ tons. In 1879 a larger boat was employed which had the capacity to carry four large standard railroad cars. The ferry was discontinued in 1896 when the Quakertown and Eastern Railroad was completed.

Henry Quinn Ferry - operated from Durham Township, Bucks County, to Hollard Township, Hunterdon County, N.J. It was a private ferry with the Pennsylvania end close to the southern boundary of the borough of Riegelsville. Quinn installed, on the Pa. side, an incline plane with oar and windlass to haul the cargo from his ferry boat to the towing path of the Delaware Division Canal. The N.J. side was just below the Durham Rapids. It was pulled back and forth by means of a rope cable attached to an eye bolt in rocks on both sides. Pulleys were typically attached to both ends of the scow. It was used until 1849 when the mill was destroyed by fire (eye bolts can still be seen.)

Riegelsville Ferry - from Riegelsville, Bucks County to Riegelsville, Warren County, N.J. Originally called Shenk's Ferry in 1774. The N.J. landing is immediately north of Musconetcong Creek. Operated until 1837 when a bridge was opened.

Raubsville Ferry - operated from Raubsville, Northampton County to Carpentersville, Warren County, N.J. There were apparently two different ferries here at different times with separate landings. The first crossing was just below "Old Sow" Island to just below Carpentersville Station of the Pa. Railroad. There is no definite information on when it was first started - sometime early in the 19th century, around 1815. The survey of the Delaware Division Canal on file at Harrisburg from 1827 depicts a ferry at the southern end of Ground Hog Island, opposite a hotel. When this first ferry was abandoned, it was succeeded by an operation initiated about a half mile further up the river, opposite Ground Hog locks where a distillery was built. Later this site became a paper mill. The ferry operated until 1916, when a tramway over the river was built. In 1903 it is reported that the ferry boat capsized carrying coal in midstream - apparently breaking loose from the cable and floating downstream.

Easton Ferry - a patent for ferries was granted by King George to David Martin in 1739. The ferry likely carried passengers over either or both the Delaware and Lehigh Rivers. Martin constructed the first house at the "point" of land created by the confluence of the two rivers.[20] With one landing likely there, the other landings were probably located at a place called Snufftown, Pa. south of the Lehigh and just north of the Lopatcong Creek, a half mile below what is known as Centre Square, Phillipsburg, N.J.

Philadelphia-Camden Ferries

The first ferry between Philadelphia and Camden is mentioned as having been operated from Cooper's Point, N.J. in 1681. The year has also been stated as 1688, when the Gloucester County Court sanctioned a ferry from Gloucester Point, N.J. to Philadelphia. This was run by William Roydan. The types of vessels used in ferry services between Philadelphia and Camden were more diversified than those used in similar operations up-river because of the varying nature of the large volume of traffic. Originally long "wherry" boats were used to carry 10 to 12 people and were propelled by sails and oars. Wherries had sharp bows, decked over for a few feet back from the stern and

were equipped with iron shot "skids" or runners, on either side of the keel. Also "horse boats" were employed. They were much larger than wherries, resembling basic scows. These vessels were used for the transportation of horses, carriages and cattle. They were equipped with sails but it is likely they were used only under very favorable conditions. A third type of vessel would come under the broad classification of "team boats." They were again a much larger craft, in which horses or mules provided the motive power. There were two types of "team boats." In one, five horses were placed on one side of the boat on a circular tread wheel. The paddle wheels, similar to those of a side wheel steamer of a later age, were turned by means of cogs and gearing connected with other cogs on the shaft of the paddle wheels. Horses were hitched to strong timbers and by "walking" they caused the tread wheel to revolve and operate the gear wheels. The second type of team boat had a revolving wheel in the middle of the vessel. Horses were attached to it and as they "walked" in a circle the wheel revolved, operating the paddle wheel through a series of gears. Team boats of this type were comprised of two complete hulls joined by a bridge or deck, but separated far enough to allow the paddle to be placed between them. They were sharp at both ends and could be propelled in either direction.[21]

The first steam ferryboat on the Delaware seems to have been the Camden in 1812, which operated from Market Street, Philadelphia to Springers Ferry, Camden. She was built in 1810 with a horizontal engine.[22] She was without any decks and had a sidewheel. Camden was designed only for passengers. The first cabins appeared on ferries in 1835.[23] By the 1830s the double ended construction was common and by 1850 there appeared the long cabins for passengers along each side of the vessel with a covered way between the cabins for vehicles. On the smaller ferries the engine was on one side and

the boiler on the other. The larger vessels had centerline machinery casing.[24]

There were five ferries in operation between Camden and Philadelphia in 1836 when the Camden and Philadelphia Steamboat Ferry Company was organized. There was another in service between Port Richmond and the N.J. shore north of Petty Island. The Camden and Philadelphia Steamboat Company obtained permission in 1838 to cut a channel through Windmill Island which lay in the direct path of the crossing.[25]

The following ferries were the primary operations in the mid-19th century connecting Philadelphia with Camden:[26]

Cooper's Ferry - established in 1708 by William Cooper at what is known as Cooper's Point, N.J. Operated in the family until it was bought by the Camden-Atlantic Railroad Company in 1854. Ferry between Cooper's Point and Vine Street, Philadelphia. However the original landing on the Pa. side changed between Kensington, Arch Street and Poplar Street. From 1855 on it was located at Vine Street.

Kaighn's Ferry - Joseph Kaighn opened the first continuous ferry service from Philadelphia to Kaighnton in 1809, when he placed a passenger boat in service. It landed at the foot of Queen Street (Southwark) in Philadelphia.

Camden and Philadelphia Steamboat Company - was incorporated in 1836. The Pa. landings were just below Chestnut Street and upper side of Market Street to Federal Street in Camden.

West Jersey Ferry Company - was established in 1849. It had two lines into Philadelphia; the lower side of Market Street and Callowhill Street. The Camden landing was at Market Street.

The South Camden Ferry Company - was initiated in 1851. It used the foot of Kaighn's Avenue in Camden for a landing. The Philadelphia landing is unclear. It became the Kaighn's Point and Philadelphia Ferry Company in 1859 and in 1888 it was bought by the Delaware River Ferry Company.

Kensington and New Jersey Ferry Company - was started in 1866. It operated at North Point Street, Camden and Shackamaxon Street, Philadelphia. In 1880 it was purchased by the Camden and Atlantic Railroad Company.

There were several other ferry services that used South Street, Philadelphia as a landing site. The primary interest of this survey is to record the relative scope of ferry service, the types of vessels employed and the location of the landing sites.

[1] Brewington, Maritime Philadelphia, 62.

[2] Brewington, Maritime Philadelphia, 63.

[3] Francis Brandt, The Majestic Delaware (Philadelphia: The Brandt and Guinmere Comp. 1929), 87, hereinafter cited as Brandt, The Majestic Delaware.

[4] Brandt, The Majestic Delaware, 97.

[5] Brandt, The Majestic Delaware, 99.

[6] Brewington, Maritime Philadelphia, 66.

[7] Boyd, Poor John Fitch, 210; Brandt, The Majestic Delaware, 130.

[8] Baker, "Commercial Shipping & Shipbuilding in the Delaware Valley," 9.

[9] Baker, "Commercial Shipping & Shipbuilding in the Delaware Valley," 19.

[10] Baker, "Commercial Shipping & Shipbuilding in the Delaware Valley," 7.

[11] Baker, "Commercial Shipping & Shipbuilding in the Delaware Valley," 7.

[12] Anderson, "Navigation on the Delaware & Lehigh Rivers," 293.

[13] Anderson, "Navigation on the Delaware & Lehigh Rivers," 302.

[14] Fackenthal, Improving Navigation on the Delaware River, 8.

[15] Anderson, "Navigation on the Delaware and Lehigh Rivers," 287.

[16] Anderson, "Navigation on the Delaware and Lehigh Rivers," 288.

17 Baker, "Commercial Shipping & Shipbuilding in the Delaware Valley," 10.

18 Anderson, "Navigation on the Delaware and Lehigh Rivers," 284.

19 Anderson, "Navigation on the Delaware and Lehigh Rivers," 285.

20 Fackenthal, Improving Navigation on the Delaware River, 13.

21 Charles Boyer, "Old Ferries of Camden," Annals of Camden (Camden, No. 3, 1921), 5-7, hereinafter cited as Boyer, "Old Ferries of Camden."

22 Thomas Scharf and Thompson Wescott, History of Philadelphia, 1609-1884, (Philadelphia, Vol. 3, 1884), 2137.

23 Boyer, "Old Ferries of Camden," 8.

24 Baker, "Commercial Shipping and Shipbuilding in the Delaware Valley," 17.

25 Baker, "Commercial Shipping and Shipbuilding in the Delaware Valley," 17.

26 Boyer, "Old Ferries of Camden," 13.

Naval Activity

The Delaware River was the scene of several significant naval engagements in the Revolutionary War. The various developments and actions are described in John Jackson's The Pennsylvania Navy and the Defense of the Delaware, 1775-1781 and in Samuel Smith's Fight for the Delaware. These works provide a thorough accounting of the naval encounters between Howe's invading British fleet and the determined defense offered by the citizens of the Delaware Valley. The engagements of the English and Americans in 1777-78 were the only notable naval battles that occurred on the river. Since these activities resulted in the loss of numerous vessels, both British and American, they will be recounted in some detail. Developments of interest to this survey include the construction of a fleet of vessels, the construction and placement of chevaux-de-frise river obstructions, the activity of three forts, and the sunken and scuttled vessels.

The building of a small fleet of vessels was the primary concern facing the rebel American forces when they were formulating plans to defend the Delaware River. Although the Continental Congress had approved the construction of thirteen Continental frigates, of the four built at Philadelphia, Effingham, Washington, Delaware and Randolph, only the latter two were ever outfitted and able to serve in active duty. Of these, only the Delaware was involved with the defense of the city. The colony of Pennsylvania had to rely on its own state navy to provide the largest part of the defense forces. It was decided that a fleet of small vessels be built, that would be highly maneuverable in the shoaled waters below Philadelphia. Although tiny in comparison to the powerful British warships, this fleet of vessels was believed to be the most effective means for protecting the river obstructions and the forts.

The fleet had two sections, rowing vessels and sailing vessels. The rowing section included galleys, guard boats, floating batteries and fire rafts. The sailing section was made up of schooners, sloops, shallops and fire-ships. In addition the state did build some larger vessels: the flagship Montgomery, originally with 14 18-pound guns, the armed schooner Delaware and brig Convention. The rest of the small navy was purchased, not built by the colony.[1]

Thirteen row galleys were built. These galleys were smaller than those built in other states. Based on models submitted by shipwrights John Wharton and Emanuel Eyre, the dimensions were 47'-50' keel, 13' beam and 4½' depth amidships. Their construction was double-ended, pointed at the bow and stern, with flat bottoms which were specifically suited for navigation over the shoals and obstructions in the river. The galleys were decked over, with a hold that was partitioned to serve as cabins. Each galley had one gun that was positioned over the bow of the boat. The gun on each vessel ranged from 18-32 pounds. Propulsion was provided by both oar and sail: the galleys had 20 double-banked oars in addition to two short masts, each with a long yard for a lateen sail. Additional items on board included a small iron hearth, howitzers, pikes, cutlasses and muskets.[2]

Fire rafts were a second type of "rowed" vessel involved in defending the river. These unique boats were described, in an undated manuscript in the Pennsylvania Archives, as being "... 35' long and 13' wide ... to be loaded with hogsheads and other casks, the staves of tarbarrels, oilbarrels, turpentine and rosin casks with hay or straw, turpentine, brimstone and other combustible substances thrown into the hogsheads and between them a quantity of pine wood intermixed and powdered rosin strew'd over the whole to convey the fire with greater rapidity to every part..."[3] These fire rafts

were comprised of a series of lighters which were chained together and secured with cable to the river bank until they were properly prepared. The rafts or lighters were then set afire as the cables to the shore were severed. There were six rafts to a chain. Each was outfitted with protruding prongs of barbed iron which were designed to attach the raft to enemy vessels.[4] There is no report of a fire raft actually causing any damage to the enemy.

Jackson was able to find records indicating that 21 guard boats were constructed. They had similar but smaller dimensions than the row galleys. Guard boats were limited by their size to patroling the mouths of creeks, working in conjunction with the fire rafts and protecting the alarm posts established along the bay and river. They carried either a 2, 3, or 4-pounder and several smaller arms and were operated by between 10 and 15 men.[5] There is no detailed information concerning the construction of floating batteries. Altogether a fleet of 57 vessels, many non-descript auxiliary boats, were either built or purchased for the defense of Philadelphia.[6]

Obstructions, chevaux-de-frise, were placed across the river in two places. The lower tier of frames stretched across the river opposite Fort Billingsport (N.J.) The upper branch of chevaux-de-frise was placed roughly between Forts Mifflin and Mercer. Furthermore two hulks were purchased by the colony and sunk to fill gaps between the frames. There was a narrow channel left open between the chevaux-de-frise and Fort Mifflin. This channel was regulated by extending a boom attached to piers built on Fort Island.[7]

In the spring of 1776 Capt. Hamond, of the HMS Roebuck, was ordered to lead a reconnaissance expedition up the river to assess the strength of the enemy's river defenses. Participating in this venture were also the

frigate Liverpool and the brig Betsey. The Americans ordered the thirteen row galleys and the firesloop Aetna downriver below the lower tier of chevaux-de-frise to meet the British ships. Stationed just north of the obstructions were the ships Montgomery and Reprisal and floating battery Arnold.[8]

The two forces first met near Wilmington, just above the mouth of the Christina River on May 8, 1776. The first naval engagement on the river was inconclusive but indicative of future skirmishes between the two navies. The tiny galleys spread out in shallow waters, never venturing very close to the powerful British frigates. The British warships, on the other hand, had considerable difficulty hitting such small targets. Keeping distance between the galleys was essential because if they were in a closed formation one well placed shot could conceivable destroy half the fleet. One of the British frigates, the Roebuck, ran aground while trying to close on the galleys. Although she was refloated that night the British realized the difficulties they were going to encounter in their attempt to control the river.

The next morning the British sighted the galleys anchored two miles up river. While attempting to pursue the American galleys, both the Roebuck and the Liverpool briefly ran aground. Discouraged, the British were forced to retreat downstream where the channel was wider. To the surprise of the British, the American fleet persisted and followed the warships downriver. A four hour engagement was carried out, again without any major damage being inflicted on either side. Finally, on May 12, Hamond led the British fleet back down the river to Cape Henlopen.[9]

Further naval encounters did not occur until the fall of 1777 when the British army occupied Philadelphia. The Americans still controlled the river - thus effectively regulating all transportation on it. Since the British had to supply their troops in Philadelphia via the Delaware River,

control of that waterway became their major objective. The British marched into Philadelphia on September 26, 1777. On September 25th the Continental frigates Effingham and Washington (neither fully outfitted) and the packet Mercury fled the city to avoid capture. They were taken upriver - the frigates to White Hill, N.J. and the Mercury to Bordentown.[10]

On September 25 the captains from all the state and Continental vessels met and decided to send a flotilla up river to Philadelphia to harass the invading British troops and to prevent them from erecting any river fortifications along the city's waterfront. Captain Alexander of the Continental frigate Delaware, the largest American vessel on the Delaware, led this small fleet up to Philadelphia. Also involved were the Continental sloop Fly, the state flagship Montgomery and four galleys. The Delaware anchored 500 yards from the first battery and apparently ran aground in the ebb tide. Stranded, she was exposed to heavy, hot fire from the British field artillery. The other vessels were engaged with a second installation and thus unable to aid the Delaware. Alexander was forced to strike his colors. "In maneuvering, either to avoid the fire of the batteries or to gain position to more effectively use his cannon, Alexander ran the Delaware aground... the Delaware was damaged and on fire when Alexander struck his colors..."[11]

A further description of the capture of the Delaware is offered by the journal of a British officer:

> "At half past eight, wind at west, two of the rebel frigates a 5 row galleys came up with the tide with orders to lay as close to the city as possible and cannonade it in order to drive the king's troops out. Fortunately, the lower two batteries were just completed as they approached us within cannon shot, when we opened fire upon them and the artillery being extremely well directed their best frigate, the Delaware which somehow got aground, struck to us..."[12]

The British then moved the Delaware to the north battery of the city. The Montgomery had her mast shot away but did manage to escape safely with the

Fly. Though the engagement was strategically minor, the British had succeeded in capturing the American ship that carried the most armament in the squadron. Later that fall, the Delaware, which the British kept tied up at Philadelphia throughout their occupation, harassed and sank several American vessels retreating up the river.

The British essentially had the small American navy trapped. The British army was to the north and their naval fleet to the south. The Americans were stationed in and around Forts Mifflin and Mercer. Fort Billingsport, which guarded the lower tier of obstructions, quickly fell to the British. This was due in part to poor planning and construction by the Americans. One engineer noted, before the battle, that "the Fort is badly situated, the battery which forms its principal object is improperly directed, which renders half the guns useless." He goes on to state, "the fort cannot prevent the passage of the enemy and when they have passed, it can be of no use, consequently it can answer no valuable purpose."[13] Having overtaken this fort, the British next cleared a channel through the lower tier of chevaux-de-frise on October 20. The British squadron involved in this action was comprised of nine war vessels and several transports. They carried 285 guns on the vessels alone.[14]

A subsequent survey of the river, conducted by the Port Wardens of Philadelphia in 1784, actually documented that the British succeeded in removing three frames of chevaux-de-frise off of Fort Billingsport.[15] With a channel broached through the obstructions, six vessels proceeded up the river on October 22nd. The frigates Augusta (64), Roebuck (44), Liverpool (28) and Pearl (32), sloop of war Merlin (18) and galley Cornwalis proceeded to anchor near Hog Island.[16] Again, these large vessels had a problem navigating in the narrow confines of the channel in this portion of

the river. Liverpool ran aground that day, as did the Roebuck. Lighters were kept busy in helping these ships to be refloated.[17] The difficulty in maneuvering these warships forced the British to limit the size of the fleet which could engage the American forts. However the British did organize a well-conceived plan of attack. The main flotilla operated in the main channel above the lower chevaux-de-frise. The Vigilant and Fury were slowly brought up the shallow west channel behind the series of islands that lined the Pennsylvania shore. They were used in flanking action against the weak west wall of Fort Mifflin. The Americans had never fortified the west side of Fort Mifflin, obviously not believing a war ship could advance up that shallow channel. Several American row galleys dropped down the west side of Fort Island to contest the position of the Fury and Vigilant, but quickly had to retreat due to the fire from the British shore batteries located west of Fort Mifflin.[18]

The battles of October 22nd were fought at long range. The row galleys remained at a relatively safe distance, while still protecting the chevaux-de-frise from the British attempts to remove them. That night, the British fleet returned downstream to a safe anchorage. However, the Augusta and Merlin ran aground. A report from Howe mentioned that,

> "the change in the natural course of the river caused by the obstructions, appearing to have altered the channel, the Augusta and Merlin unfortunately grounded some distance below the second line of chevaux-de-frise and the fresh northwardly wind which then prevailed, greatly checking the rising of the tide, they could not be got afloat on the subsequent flood."[19]

The Americans apparently did not become aware of the situation until the next morning. Meanwhile the British struggled throughout the night to lighten the vessels by taking off their guns. The Augusta had grounded below Fort Mercer, near the mouth of Woodbury Creek, while the Merlin was stuck

about two-thirds of a mile below the Augusta, near the mouth of Mantua Creek. The next morning when they became aware of the predicament of the British ships, the Americans attacked the stranded vessels. Besides standard shelling of the Augusta, the Americans sent a series of fire rafts down river in an attempt to destroy the vessel. Then suddenly, sometime between 10:30 and 11:00 A.M., an accidental fire ignited aboard the Augusta. The fire spread rapidly and the ship was hastily abandoned before it blew up. After the Augusta exploded, the British decided to scuttle the Merlin which was still aground. The two vessels burned throughout the rest of the day. The remainder of the British fleet dropped down river to Billingsport, vacating that portion of the river to avoid other possible explosions.[20]

Apparently the fire on the Augusta continued for several days. Both sides were extremely interested in salvaging her guns and other military supplies. The State Navy Board wrote to President Wharton that "...the enemy have landed a number of men at Billingsport and are erecting a battery above that place to defend their wrecks that we may get nothing out of them."[21] American Commodore Hazelwood ordered several galleys down the river to salvage any artifacts remaining on the wrecks. However the Americans were caught up in defending Fort Mifflin, the weather was adverse and the British strongly challenged all American attempts at salvage. These factors combined to limit the effectiveness of the American salvage efforts. An officer, Mr. Bradford, wrote on October 26th, that "I had the pleasure of being on board a part of a 64 gun ship - most of her guns are in the wreck and we brought off two of her 24 pounders and are this day preparing to get the rest if the ships do not come near us..."[22] There is no record of the Americans taking any further guns from the site, although they did manage to salvage various other artifacts[23] In a letter written to Emanuel Eyre(s), one officer mentions that "it is probable

that the British removed the guns from the upper deck, quarterdeck and forecastle, which were considerably lighter than those of the lower deck because all of the guns which were on her when she was raised were 24 pounders and those she carried on her lower deck.[24]

Despite these two losses, the British regrouped and prepared another assault on the forts in November. The British were extremely anxious to open the river before the onset of winter. The colder temperatures periodically froze the river, closing it to navigation. Again Fury and Vigilant worked their way up the western channel.

> "The Vigilant is to come up as soon as the tide will admit her. She is not to come over or through any part of the chevaux-de-frise, but up a creek between Province Island and another small isle. Her station is to be on the angle of the rebel grand battery and on the right of our batteries. A sloop (Fury) likewise, with 3 18-pounders, is to follow the Vigilant and after she is moored the sloop is to anchor just ahead of her."[25]

The main fleet assembled in the center channel adjacent to Fort Mifflin. The strategy was essentially the same as the plan of the October 22-23 assault. The Vigilant, along with the land batteries were to provide a massive bombardment to the west side of the Fort. The engineer John Montressor, who helped to build the fort originally in 1773, knew its inherent weakness. On November 10th the siege of Fort Mifflin commenced. The battle raged for five days with the fort being steadily bombed into submission.[26]

By 11:00 A.M. November 15th, the Vigilant and Fury commenced a final bombardment on the fort. The larger warships were occupying the attention of the galleys and floating batteries in the main channel. Fort Mifflin only had two guns on its western flank with which it could reply to the assault from Vigilant and Fury. By 1:00 P.M. the fort was badly damaged

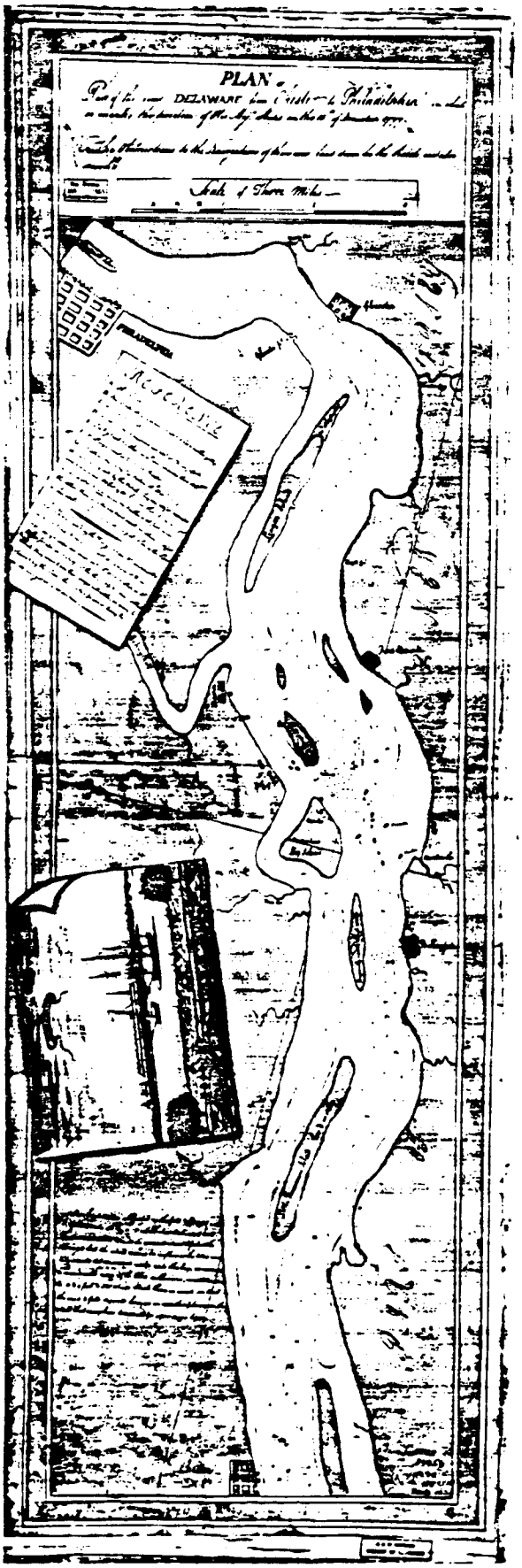

FIG. 3

and ammunition was running out. Furthermore, an American sloop carrying ten 8-pound guns was sunk near the fort.[27] At 5:00 P.M. the British, satisfied that the fort would be evacuated that night, fell back to Billingsport. They prepared to take over the fort the next morning. The Americans did evacuate the fort that night, but not until they destroyed all remaining guns and carriages. Thus the eight week long defense of Fort Mifflin was finished - the British landed a small battalion on it the next morning.[28]

With the evacuation of Fort Mifflin and the decision to remove the garrison from Fort Mercer, the fleet of American vessels became vulnerable to attack. It was temporarily stationed at "Ladd's Cove" at the mouth of Big Timber Creek, N.J., a short distance above Fort Mercer. On November 19th it was decided to send the fleet upstream past the enemy positions at Philadelphia, to seek winter refuge in any of the creeks and tributaries above the city. The fleet was divided into two squadrons; the first group was comprised of the larger vessels of the State Navy and all the remaining Continental vessels and the second group included the galleys and smaller vessels. The latter group successfully slipped past the city undetected on the night of November 19th. By rowing the vessels upstream along the eastern shoreline, the Americans succeeded in getting half their fleet to Bristol by 10:00 A.M. November 20th. Encouraged by their success, American leaders ordered the larger vessels to attempt a passage the next night. However these vessels had to use sails to get underway and were quickly spotted by the British in Philadelphia. The land batteries and the guns from the Delaware opened fire on the American fleet.

Two small sloops were driven ashore on the Jersey side as they passed the northern batteries. One was captured and the other was set afire. Jackson mentions that one schooner, five sloops and the brig Convention safely

passed the city. Two shallops and a few guard boats remained under cover to transfer stores to wagons on land. At least three guard boats apparently made it safely to Bristol. However the remainder of the fleet, which included the flagship Montgomery, all Continental vessels and the two floating batteries, was destroyed in accordance with the preconceived plan to laden all vessels with combustibles and ignite them in the event of imminent capture.[29] Joshua Barney, aboard the Convention, later wrote,

> "On our evacuation of the forts and the destroying of our fleets, (ours) was the only boat that arrived at Bordentown (N.J.) loaded with powder, the remainder were drove on shore in passing the city by the very severe fire from the enemy. Our ships on fire making it as bright as day, the gallies luckily escaped the night before."[30]

Commodore Hazelwood recounted the actions in a letter to President Wharton,

> "...we on that day (Nov. 17) brought the galleys up into Lads Cove where we held council... we lay two nights for a wind to pass the fleet but having none it was agreed by the whole Gentleman that galleys ought to pass that night, accordingly I got them under way at 3:00 A.M. and about 4:00 A.M. they past the city without having one shott fired at them, they had with them nine armed boats whom all got safe up about 10:00 A.M. same day..."

He went on to mention that later that day, he attempted to get support from General Vernon's troops to protect the larger ships but that since they were already in Haddonfield they could not help. He then,

> "dispatched the galleys down to assist in getting the remainder of the fleet past the city but it being late when I got up and the tide not answering until morning and before day I heard a firing at town and soon after saw one of our boats whom told me that what part of the fleet they thought could be got bye was passed and the rest was sett on fire agreeable to a council held in the evening."[31]

Overall, the vessels that did pass the city included: 13 galleys, 12 armed boats, sloops Province and Amunition, brig Convention, one ammunition sloop, one provision sloop, one provision schooner, and two

flats with stores and eleven 18-pound cannon. Sundry stores and ammunition was saved.[32] Among the Continental vessels destroyed were xebecks, and the brigs Andria Doria, Repulse and Champion. The fleet was set afire "near League Island." As the ships were burning, Robert Morton mentioned that "The American Navy on fire coming up with the flood tide and burning with the greatest fury. Some of them drifted within two miles of the town and were carried back by the ebb tide. They burned nearly five hours: four of them blew up."[33]

To avoid possible capture, the American captains had to decide where to send the vessels for the winter. Bristol was not safe, the British could easily send a large landing party and the Continental troops at Valley Forge would be unable to help. Exactly where all the vessels took refuge has never been clearly documented. The major portion of the fleet was sent up Crosswicks Creek at Bordentown, N.J. All sails, stores, rigging and guns were taken off vessels and the boats were ordered scuttled in "some convenient creek where they could be raised in the spring."[34]

Almost all naval activity ceased in the winter months, the ice making navigation nearly impossible. British officer Downman relates the navigational hazzards of the frozen Delaware:

> "...several of our small vessels, incoming up the Delaware or going down, have been driven ashore by the ice and some have been taken with clothing and officers baggage aboard... we have dilly dallied and shilly shallied 'till the river is frozen up, by which several of our ships have been caught, stripped of their cargo and then set on fire."[35]

Americans did make a further attempt to harass the British later in the winter; Joshua Barney mentions some activity on the river which he participated in:

> "On my arrival at Bordentown, I was made commisary for the seamen of the late fleet and with Captain Robinson, had the (opportunity of) conducting the famous battle of the kegs - after which Captain (John) Barry and myself in two barges,

> passed Philadelphia through the ice, where we captured a British schooner of 8 guns and 2 ships, one of 6 guns, after an running fight of 3 hours. Those vessels we were obliged to destroy, being shortly after pursued by 2 frigates. In those barges we cruised until the middle of April, preventing any communication from the country with the enemy by water."[36]

In May the British decided to destroy the "Pennsylvania Navy" which, as mentioned, had wintered in creeks above Philadelphia. A large British squadron was organized under the direction of Captain John Henry. The force included the galleys Cornwalis, Ferret, Hussar and Philadelphia, armed schooners Pembroke and Viper, 4 gunboats and several flatboats which carried the majority of the 700 soldiers. They left Philadelphia on May 7, 1778, and spent that night on Rancocas Creek, N.J. Captain Henry reports on the next day (8th), "At noon we were abreast of White Hill (Fieldsboro, N.J.) where the galleys, armed vessels and gunboats were placed to cover the landing of troops, which was performed without opposition. At this place, the Washington and Effingham, rebel frigates... were set on fire and consumed, together with a barge and a sloop."[37]

From White Hill, the force proceeded to Bordentown and Crosswicks Creek. Henry reported that

> "the troops then marched, took possession of Bordentown and destroyed a battery of three 6-pounders, whereupon the galleys, armed vessels and co. proceeded to that place, where they burnt two new ships, one of which was pierced for 18 guns, one privateer sloop for 10 guns, with 10 sail of brigs, schooners and sloops... This service being executed, the boats proceeded up Crosswell (Crosswicks) Creek and set fire to the Sturdy Beggar, privateer, pierced for 18 guns and 8 sail of brigs, sloops and schooners..."[38]

The report of Major-Commander John Maitland mentions that, "the rebels still kept in front and at a creek where I was obliged to pass a dam, part of which was wood, they made a stand, having a field piece with them and attempted to break down the dam to prevent any passage... they abandoned their field pieces..."[39]

On the next morning the British destruction continued. Henry states that,

> "the Hussar and Ferret galleys, gunboats and co. row up to Biles Island (Pa.) Creek and burnt one new schooner pierced for 14 guns, one new sloop pierced for 16 guns, one old schooner for 10 guns, one old large sloop for 16 guns and 2 large new sloops..."

Maitland wrote that "we proceeded to Biles Island Creek and burnt some valuable vessels belonging to the rebels, particularly 2 ships loaded with tobacco, rum and military stores..."[40] The force quickly crossed to the New Jersey shore at a place known as "Watson's Creek" and found rebel galleys scuttled there which were sunk too deep to destroy. From "Watson's Creek" the force dropped down to Bristol that afternoon. Maitland mentions that at "about 2:00 P.M. the battalion marched for Bristol where they arrived at 5:00 P.M., burnt what vessels were there belonging to the enemy and embarked by sunset."[41] Henry reported that they traveled to Bristol, but "first burning 2 sloops at the ferry... burnt the remaining vessels, consisting of 4 new ships, one new brig and an old schooner. The whole number of vessels destroyed was 44 sail."[42]

In his report Maitland summed up the total of ships destroyed during the two-day expedition. He listed as having been destroyed: 2 frigates, 9 large ships, 3 privateer sloops, for 16 guns each, 3 privateers for 10 guns each, 23 brigs, along with a number of sloops and schooners.

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2 Jackson, The Pennsylvania Navy. 15-16.

3 Jackson, The Pennsylvania Navy, 19.

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5 Jackson, The Pennsylvania Navy, 20.

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7 Jackson, The Pennsylvania Navy, 38-40.

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12 John Montresor, The Montresor Journals (September 27, 1777).

13 Philippe DuCoudray, "Observations on the Forts Intended for the Defense of the Two Passages of the Delaware River, July 1777", Pennsylvania Magazine of History and Biography (Vol. 24, 1900), 345.

14 Wallace McGeorge, "The Frigate Augusta; Its Action in the Attack on the American Fleet at the Battle of Red Bank", Gloucester County Democrat, July, 20 1905, 1, hereinafter cited as McGeorge, "The Frigate Augusta ".

15 Jackson, The Pennsylvania Navy, 141

16 McGeorge, "The Frigate Augusta," 1.

17 Jackson, The Pennsylvania Navy, 170.

18 Jackson, The Pennsylvania Navy, 171.

19 McGeorge, "The Frigate Augusta," 1.

20 Jackson, The Pennsylvania Navy, 95.

21 Pennsylvania Archives, First Series, Vol. 5, 722.

22 Pennsylvania Magazine of Biography and History, Philadelphia: 1882, Vol. 6, 50.

23 McGeorge, "The Frigate Augusta," 1.

24 McGeorge, "The Frigate Augusta," 1.

25 Francis Downman, "The Services of Lieut-Colonel Francis Downman, R.A. in France, North America and the West Indies, Between the Years 1758 and 1784," Proceedings of the Royal Artillery Institution, (Vol. 25, 1898), 271, hereinafter cited as Downman, "The Services of Lt. Col. Downman."

26 Jackson, The Pennsylvania Navy, 250.

27 Jackson, The Pennsylvania Navy, 254.

28 Jackson, The Pennsylvania Navy, 256.

29 Pennsylvania Archives (First Series, Vol. 6, Harrisburg) 27-28; 47-50, hereinafter cited as Pennsylvania Archives, First Series, Vol. 6.

30 Luke Matthewman, "Narrative of Lieutenant Luke Matthewman of the Revolutionary War," Magazine of American History (Vol. 2, Part 1, 1878), 178, hereinafter cited as Matthewman, "Narrative of Lt. Luke Matthewman."

31 Pennsylvania Archives, First Series, Vol. 6, 49.

32 Pennsylvania Archives, First Series, Vol. 6, 50.

33 Samuel Smith, Fight for the Delaware, (Monmouth Beach, 1970), 40.

34 Pennsylvania Archives (Second Series, Vol. 6, Harrisburg) 110; 132.

35 Downman, "The Services of Lt. Col. Downman," 216.

36 Matthewman, "Narrative of Lt. Luke Matthewman," 178.

37 John Almond, The Remembrancer (London, Vol. 6, 1776), 149.

38 Universal Magazine of Knowledge and Pleasure (London, Vol. 62, 1778), 320, hereinafter cited as Universal Magazine.

39 Universal Magazine, 315.

40 Universal Magazine, 319.

41 Universal Magazine, 319-320.

42 Universal Magazine, 319-320

Navigation and Dredging

Navigation of the Delaware River was a challenge to the initial explorers and settlers of the Delaware Valley. Although the bay was discovered in 1609, it did not appear on any charts until 1614. The Dutch captain Cornelius Hendrickson drew a "surprisingly good map of what he found" in 1614. He did fail, however, to illustrate shoals, reefs or bars.[1] The first attempt to make a comprehensive chart of the bay and river was not until 1756. In that year Joshua Fisher charted the waters of the bay and river, and attempted also to indicate bottom contours and soundings. Standardized charting of the river was not initiated until the first United States Coast Survey was completed in 1846. Dredging the river systematically was not started until the late 1870s - relatively recently. However, the river's bottom and shoreline have been drastically altered in the pursuit of better navigation along the river.

The shoal infested river hampered shipping from its inception with the Dutch and Swedish settlers. The inhabitants of New Amstel often complained of the river conditions. John Alricks, after hearing many of these complaints, conferred with the seafaring men and later reported that, "it was agreed that it would be best to lay five or six buoys there..."[2] Apparently this was the first effort to provide navigational aids on the river. As well, Alricks suggested the need for dredging, by mentioning that "appropriations ought to be made to render it safer and better for incoming ships."[3] The Dutch did succeed in establishing a system of pilotage by hiring persons "who have a perfect knowledge of the bottom, depths and shoals in and about the South (Delaware) River, to make use of them as pilots."[4] Two men, Sol Garrotson and Peter Lourison, were engaged for a

fee of ten shillings a day.

While the Dutch were conscientious in their committment to improving the navigation on the river, the English neglected it; after the British assumed control of the Delaware Valley in the 1660s, they failed to maintain the system of buoys which the Dutch had established. William Penn recognized this shortcoming and laid a tax on vessels entering the river. The money collected was to be used to continue the Dutch system of buoys.[5] In 1687 the Assembly agreed to "take a speedy account of the monies paid for the erecting of buoys and to place them as soon as possible..."[6] Despite these efforts, little work was recorded as having been done.

Neither was any serious work done to improve navigation throughout the first half of the 18th century, despite the continued pleas of merchants. They often saw their shipping disrupted because of the shoaled waters. Merchants constantly sought assistance from the government in installing permanent navigational aids. Through its early development there was no coordination among the various parties involved with the port. In addition to the stalled efforts to improve navigation, there existed no plan for the establishment of a system that would coordinate the port's development. There were no regulations to check the rapidly expanding wharf-line and no procedures to license qualified pilots.[7] In 1765 the merchants supported by maritime insurers petitioned the Commonwealth by complaining of "grievous losses because of the lack of proper regulation" of pilots.[8]

Finally in 1766 the port was placed under the control of the Wardens of Port of Philadelphia. The office of the wardens was created by the enactment of "An Act for Appointing Wardens for the Port of Philadelphia and for Regulating Pilots Plying the River and Bay to and from Said Port."[9] The Wardens took on the responsibility of licensing of pilots, the placement

of buoys, alleviating the problem of winter icing, the erection of lighthouses and the dredging of wharves and piers.

Every winter, almost without exception until the middle of the 19th century, the river froze over. This phenomenon not only placed a "natural embargo" on the port every winter, sometimes lasting over a month, it also posed a serious threat to any unfortunate vessel that became entrapped in the ice floes. The sharp ice masses severed anchor cables and could easily sheer a wooden hull. The first attempt to manage this problem was in 1762 when the first of a series of ice piers was constructed above the northern shore of Reedy Island. Two piers were built there. The first was 180' by 30', and the second was 205' by 30'. They served to break up the floes as they came down the river and to provide a safe anchorage for ships. The piers diverted the ice into the center of the channel. Similar piers were built off Marcus Hook.[10]

Navigation in the ice was not possible until the city purchased its first steam ice-breaker in 1837.[11] The Camden and Amboy Railroad constructed a steamer, Ice Breaker for winter crossings. Its first voyage was successfully completed, but three days later she became stuck and proved to be ineffective. The Philadelphia City Council borrowed $70,000 for the construction of a steamboat, the hull of which was built by Van Dusen and Bierly. Later, in 1866 Cramp Shipyard built City Ice Boat #1 and City Ice Boat #2, which operated with side paddle wheels.[12] These vessels were responsible for regulating the ice accumulation in the river. However, the problem of the river freezing was overcome primarily by the fact that in the 19th century the river did not freeze that frequently. Urbanization and subsequent pollution both contributed to warming the river.

Another navigational hazard of the river was the placement of chevaux-de-frise during the Revolution. These frames, designed to defend

the river, became serious threats to shipping after the conclusion of the war. In July of 1775 "Mr. Robert Smith (carpenter) appeared at this board with a model of a machine for obstructing the navigation of the Delaware River and explained the construction of it, which was approved of..."[13] As mentioned previously, two major tiers of chevaux-de-frise were laid on the river bottom. In 1783 the Port Wardens determined the location of buoys to mark the obstructions. The Supreme Executive Council instructed the Port Wardens to develop plans to facilitate the removal of the obstructions.[14] Arthur Donaldson and Levi Hollinsworth were contracted and provided with a vessel to survey in May of 1784. By October they succeeded in removing 54 frames.[15] It is difficult to determine how thorough their effort was because there is no way of knowing how many frames the British had removed while they were clearing a passage through the obstructions. It was reported by the Port Wardens that after a year of completing the removal project, only one incident concerning an obstruction frame was reported.[16] Army Corps dredges periodically struck a stray frame while dredging the main channel in the 1930s and 40s.

The principal navigational hazard in the Delaware River was shoaled waters. Shoals accumulated throughout the river and were constantly shifting. The average water depth, in the early part of the 19th century, was between 15' and 25' in the main channel. This provided adequate draft for most of the vessels then plying the river. Dredging was required in the harbors, where wharves tended to accumulate considerable amounts of silt. It was in the harbors of Philadelphia where Arthur Donaldson in 1774 used his invention, the forerunner of the clamshell dredge, to clear silt and mud. However, his pioneering efforts were diverted by the Revolutionary War. It was not until Oliver Evans equipped a "carriage" with a steam engine and stern paddle wheel

and operated it on the Delaware River in 1804 that any notable dredging was completed. This "Orukterg Amphibolos" was probably the first application of a mechanically powered dredge on the Delaware.[17] In 1805 the Chamber of Commerce requested the Port Wardens to administer a tonnage "to be laid on vessels employed in Foreign trade for the improvement and protection of the Delaware River and Bay."[18] The five cent duty was intended to pay to remove natural obstructions in the river and to erect winter piers.

The first substantial dredging was not undertaken until 1864, when an act was passed that provided the Port Wardens with jurisdiction over wharves and piers. Once vested with this right, they forced the owners of all wharf property and waterfront facilities to:

> "Maintain a minimum depth of water at the bulkhead of not less than three feet at low water and as much great depth as in the judgment of the wardens may be required for the accommodations of. . . vessels as usually require berths at the piers surrounding such docks.[19]

Earlier, in 1829, Congress addressed the problem of navigation in the river by approving an appropriation for the procurement of a "Dredging machine to be applied to the deepening of the Delaware River Harbors."[20] This device was likely some form of a ladder dredge. But major dredging operations out in the river were not possible until the technological advances of the 1870s. In 1878 a sea-going vessel with a normal draft of 20' to 24' could ground in the channel without the benefit of a full tide. The major "natural obstruction" in the river was a rock reef known as Schooner's Ledge. This hazard was located 18 miles below Philadelphia extending from the Pennsylvania shore. It "could be regarded as the most dangerous if not the most serious obstruction in the river."[21] Rock excavations there were started in 1879. The rock face was drilled with a rack and pinion device. Blasting charges were inserted in the 3" drilled holes and the

ledge was "blown up." The rock material was then removed with a dipper dredge and later most was deposited behind Chester Island. Other major obstructions that were attended to during this period were the bars at Petty Island and Fort Mifflin. Work was carried out between 1877 and 1882. The spoil from these bars was deposited on government land at Fort Mifflin and League Island.[22]

Finally, in 1885, legislation was enacted to authorize the permanent improvement of the Delaware River. The previous dredging operations had only been sporadic - in specific areas, according to necessity. Starting in 1885 the Army Corps of Engineers supervised all "improvements" on the river, including dredging, construction and maintenance of anchorages, dikes and harbors. Furthermore, the River and Harbor Act of 1896 authorized a 30' channel from Philadelphia (Christian Street) to Bombay Hook (56 miles).[23]

In August of 1888, Congress appropriated $500,000 to inaugurate work designed to improve the harbor of Philadelphia. The thrust of this work was geared toward the removal of Smith and Windmill Islands, and improving the channel opposite the port of Philadelphia. The channel was to be dredged for 1,900' between pierlines, one thousand feet along the Philadelphia waterfront at a minimum depth of 26', and the remaining nine-hundred feet along Camden's waterfront at a depth decreasing from 26' to 12'. Other specific objectives of the channel improvements included:

1. the further removal of a portion of Schooner Ledge Rock and the deepening of the channel along that range, south of Chester Island.

2. the removal of the bar, or middle ground, at Greenwich Point and the deepening of the western channel of the river along the front of Philadelphia from Pier 38 south to Morris Street, and

3. deepening of the channel through Fort Mifflin bar and the Lincoln Park Wharf, immediately in the line of the

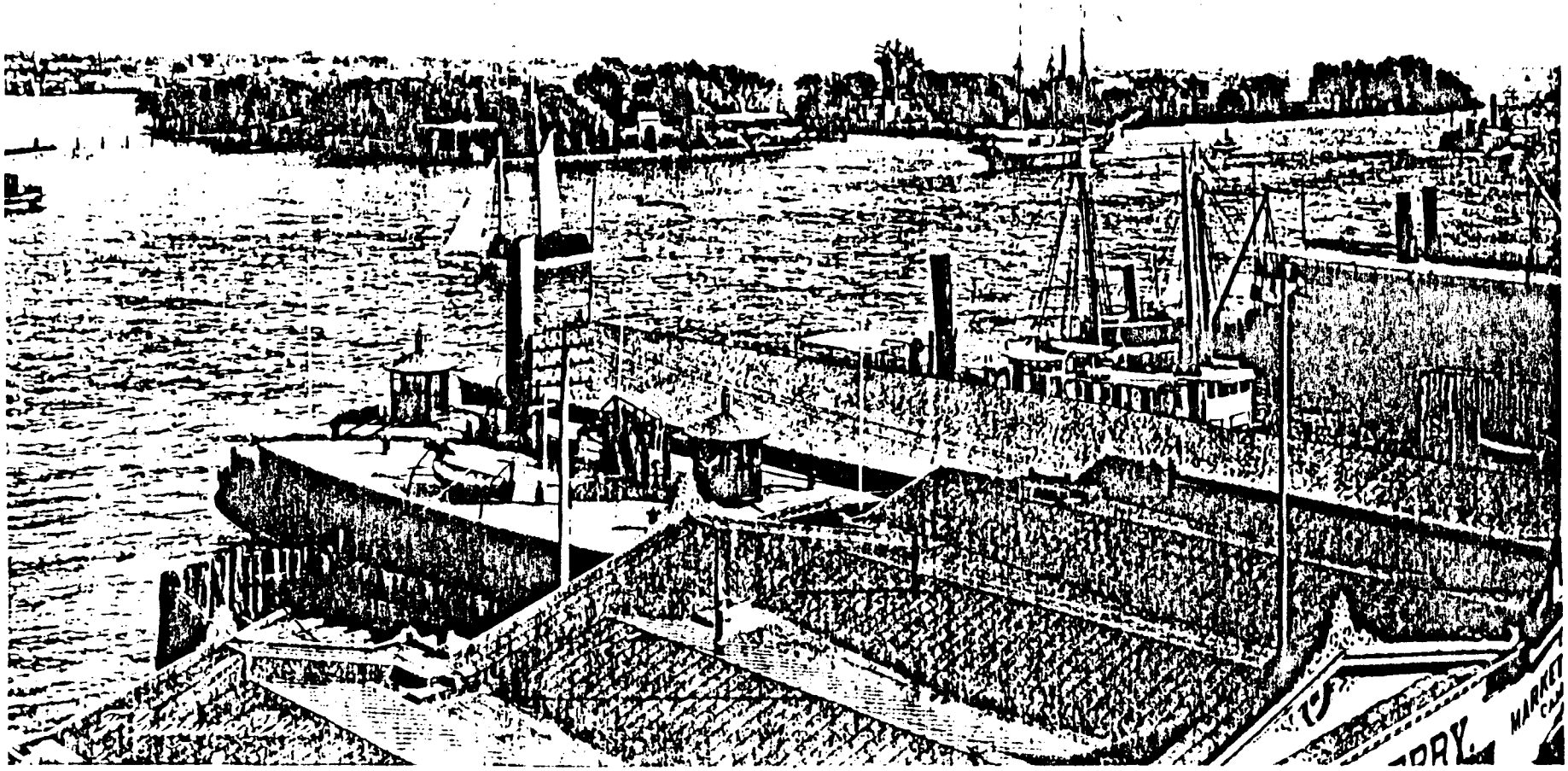


FIG. 4

> Fort Mifflin Bar Lighthouse Range. It also included the removal of the shoal at the south (west) end of Tinicum Island. The channel cleared was 600' wide and 26' deep.[24]

Smith and Windmill Islands likely formed from two shoals or mud banks that appear on Holmes' map of 1683-5 - one opposite Spruce and Pine Streets and the other lying below South Street. They slowly developed, united and formed one island. In 1838 a channel was created through the island to facilitate the crossing of ferries between Philadelphia and Camden. The island housed a bathing resort and park for most of the 19th century. The increasingly larger ships using the port facilities during the second half of the 19th century required greater pier space and a wider turning radius. The continued growth of the port thus made the islands expendable. In 1887 a report was written that recommended the removal of the two islands, the extension of the wharves in Philadelphia and the modification of the harbor lines.[25] The islands were removed in 1894.

Another major natural obstacle to navigation in the river was the Petty Island or Five Mile Bar. This bar was formed from a deposit of fine sand which built up a submerged ridge, extending from a point in the Pennsylvania channel below the head of Petty Island, in an easy curve to Harrison's Wharf. The total distance of the ridge was some 8,000'. It occupied the natural ground between the paths of the flood and ebb tide and being composed of light material, was easily affected by the opposing forces to which it was subjected.[26] The Board of Engineers, in 1885, assessed the situation:

> "...board concluded that an increased tidal flow through the west (north) channel near the head of the island, sufficient to secure the increased depth and width required, could be procured by a deflecting dike, starting from Fishers Point (N.J.) and running downstream in a slightly curved direction, sensibly parallel with the pierline of the

Pennsylvania shore opposite, extending toward the head of Petty's Island, as far as might be necessary for the purpose of directing into the west (north) channel a considerable part of the ebb tidal volume now passing down the east (south) channel."[27]

The dike was completed in 1886. The Report of Engineers for 1886 mentioned that the dike from Fisher Point was 3,000 feet long with a mattress sill about 3' thick projecting 500' further. This left an opening of about 3,000 feet between the end of sill and Petty Island. The top of the dike is level with mean low water - allowing tides to flow over it. This dike, which was designed to change the course of the tide, only succeeded in extending the other (western) end of the island. Depths in the channel behind Petty Island which reached 30' in many places before the construction of the dike were significantly decreased. Army Corps soundings indicate that the depth of the channel was reduced to 15'-18' on the average, after the dike was finished. The problem of the Five Mile Bar was eliminated when the 30' channel was extended from Philadelphia to Trenton in 1895.

In accordance with the provisions of the Ordinance of Councils, approved in April 1898, the material dredged by the city from the Delaware and Schuylkill Rivers, with the exception of the rock from Schooner Ledge, was deposited on low ground adjacent to the rivers, within city limits. A great portion of this material was placed on League Island Park, at the southern end of Broad Street. A portion of the rocky material from Schooner Ledge was placed in front of the city as a support for the piles of bulkheads and new piers constructed along Delaware Avenue. The rest of the rock was dumped in back of Chester Island.[28]

The common term for the material dredged from the Delaware is mud. "Mud" is too vague to describe the material accurately. The predominant ingredients, as identified in the disposal areas, "Are organic clay and silt,

sand, peat and gravel. For hydraulic dredging, mud is differentiated from sand as it contains appreciable quantities of carbon dioxide and methane and must be treated as a solid water-gas mixture."[29]

The current main shipping channel dredging project at the Army Corps of Engineers was adopted in 1910 and modified in 1930, 1933, 1935, 1938, 1945, 1954 and 1958. This provides for a channel from Allegheny Avenue (Philadelphia) to deep water in Delaware Bay. The depth was originally going to be 30', but it was revised twice during the 20th century, once to 35' and finally to the present 40' channel. The existing project of the Corps also provides for six anchorages and the further construction of dikes and training works for the regulation and control of tidal flow. The 40' channel, from the Philadelphia Navy Yard at League Island to the sea and also from the Navy Base to Allegheny Avenue was completed in 1942 and 1962, respectively.

According to a Cultural Resources Sensitivity Report commissioned by the Army Corps of Engineers in 1983, the proposed area for future dredging in the river are: Beckett Street Terminal, Tioga Marine Terminal and Mifflin Range and Schuylkill River Improvements. While dredging these areas does not seem to pose any threat to submerged cultural resources (these areas have been extensively dredged in the past), the problem is where the dredge spoil will be deposited. Among the proposed disposal sites for material from the Beckett Street Terminal are:

1. The inner curve of Horseshoe Bend between the main channel and League Island, in a shallow zone called Horseshoe Shoals.

2. Across the river at the mouth of Big Timber Creek, off the town of Westville, N.J.

3. An irregularly shaped area south of the deep navigation channel stretching downstream from Red Bank beyond Fort Mercer.[30]

The disposal sites for the spoil from the Schuylkill River improvements include an area immediately south of the mouth of the Schuylkill River, on the Fort Mifflin Reservation, on the eastern end of Mud Island. This area has been diked and previously filled.[31]

The area adjacent to the Tioga Marine Terminal is to be deepened from 36' to 40', over a distance of about 4,500 feet and an existing turning basin on the other side of the channel is to be deepened to 40'. The area of this proposed improvement is located between Petty Island and Five Mile Point, and is situated where Five Mile Bar was once located. Of the six potential disposal areas, only one could possibly affect submerged cultural resources. This area is located on the Philadelphia river front, a short distance below the place where Pennypack Creek empties into the Delaware River. This area covers 40 acres on or next to the House of Correction grounds. A bulkhead defines the riverside edge of this site and the report mentioned that it was likely that the tidal flats, on either side of the site, were filled to form this land.[32]

The Act of 1930, modified by further acts in 1935, 1937, 1946 and 1954, provides for a channel from Allegheny Avenue (Philadelphia) to the Trenton Marine Terminal. The depth of the channel is presently 40' and it is between 400' and 800' wide as far north as the U.S. Steel Fairless Works. From Fairless to Trenton, the channel reaches 35'. The project provides for an auxiliary 20' deep channel, on the east side of Burlington Island, with a turning basin at the upper end of the island that is 20' deep and 450' wide. It also includes a turning basin at Trenton Marine Terminal to be maintained at 35' deep, 800' wide and 1,700' long. An initial crosschannel is to be dredged opposite Delano (N.J.) which will be 8' deep and 200' wide. Recent modifications also include the widening of the Philadelphia side of

the existing channel near the Tioga Marine Terminal to an average width of 1,000 feet between Allegheny Avenue and the Delair Bridge - 1.2 miles long.

Navigation Above Trenton
(See Fig. 17.)

In September, 1789, an act was passed by the Pennsylvania Assembly and a subsequent appropriation was made by the Commonwealth to clear the channel between Trenton and the New York border. Richard Blackhouse and Col. George Wall Jr. were contracted to clear the river of its main obstacles. Their work was completed by 1793.[33] The major part of their work centered on the obstruction at Foul Rift, just above Easton. They reported removing rocks and boulders, as well as contructing various types of wing dams.

Numerous obstacles still hampered the transit of vessels along the Delaware between Easton and Trenton, so the Pennsylvania Legislature appropriated $10,000 in 1817 to improve the river from Trenton to Foul Rift, some 12 miles above Easton. Most of that money was utilized at Rocky Falls, seven miles below Easton, blasting rock and building wing dams. Similar work was also completed at Tumble Falls, above Point Pleasant and at Wells Falls, approximately halfway between Easton and Trenton a mile downstream from New Hope.

Hazard's Register of Pennsylvania (January 1828, Vol. 1, page 57) lists all of the Delaware River obstructions between Trenton and Easton. The twenty-five different hazards give an indication of how difficult navigation was on the river. The distance between those two cities is only 49 miles, yet the river drops 160' 5" in that stretch, according to Hazard.

Obstruction	Distance Below the Lehigh River (Easton	Feet Above Low Tide Level
Bixler Rift	1/2 mile	160' 5"
Cliffords Rift	3½	150' 10"
Old Sow Rift	5	145' 7"
Ground Hog's Rift	6	138' 1"
Rocky Falls	7	136' 1"
Gravelly Falls	8	133' 3"
Durham Falls	9½	130' 3"
Linn's Falls	12	127' 5"
Nockamixon Falls	14	117' 6"
Firman's Falls	17	110' 11"
Stuhl's Falls	18	107' 2"
Man of War Rift	20	102' 3"
Marshall Island	21-23½	100' 7"
Tumbling Dam Falls	24-25	89' 1"
Cutsow Rift	25½	85' 4"
Bull's Falls	27½	72' 2"
Howell's Rift	31-32	68' 3"
Galloper's Rift	31-32	68' 3"
Greenbank Rift	32	58' 9"
Well's Falls	35½	49' 9"
Buck Tail Rift	36½	36' 5"
Knowle's Point Rift	39½	33' 6"
Scudder's Rift	44	24' 8"
Gould's Rapid	46½	16' 8"
Trenton Falls	49	9' 8"

Accompanying the list of hazards was a brief description of each one:

Bixler's Rift is a uniform straight rapid with a bottom composed of stones and gravel.

Clifford's Rift is a uniform straight rapid with a bottom composed of stones and gravel.

Old Sow Rift is a uniform rapid with a bottom composed of smooth stones and gravel.

Ground Hog Rift forms a long curved channel over a bottom of stones and gravel.

Rocky Falls has a short rift at the head; the remainder is a semi-pool among large rocks.

Gravelly Falls has a current forming a long curve over a bed of small stone and gravel.

The Head of Durham Falls is a short rocky rift on the New Jersey side. The whole fall is smooth on the Pennsylvania side.

Linn's Falls has two rifts with a semi-pool between them sufficient for steamboats, bottom of stone and gravel.

Nockamixon Falls has a rocky bottom and a crooked channel among large rocks.

Firman's Falls is a uniform rapid, having a bottom of smooth stones and gravel.

Stuhl's Falls is a uniform rapid, with a bottom of stones and gravel.

Man of War Rift is a short shoal, with a bottom of stone and gravel, presenting little obstruction.

Marshall's Island Rapids are principally composed of three separate rifts with a semi-pool between, the water between the rifts being sufficient for a steamboat.

Tumbling Dam Falls are composed of separate reefs or steps of rocks extending across the river.

Cutsow Rift is composed of a flat reef of rocks extending across the river.

Bull's Falls is a straight uniform rapid with a bottom of stone and gravel.

Galloper's and Howell's Rifts although nearly a mile apart, they are connected together by a current not sufficiently quick to be called a rapid - it forms a semi-pool and is deep and slow enough for steamboats.

Greenbank Rift has a smooth gravelly bottom and presents very little obstruction.

Well's Falls has a bottom entirely of rock; loose rocks are scattered across the river, with a crooked channel.

Buck Tail Rift is composed of two rocky reefs, having deep water near the Jersey shore.

Knowle's Point Rift is a uniform deep rapid, with a bottom of stone, gravel and rock.

Scudder's Rift is a uniform rapid, quick at the head, having a bottom of stone and gravel.

Gould's Rapids are composed of two rifts half a mile apart, with slower and deeper water, or a semi-pool, between them.

Trenton Falls is a rapid of nearly uniform descent with a crooked channel and very rocky.

1 Eugene Slaski, Poorly Marked and Worse Lighted: Being a History of the Port Wardens of Philadelphia, 1766-1907 (Harrisburg, 1979), 3, hereinafter cited as Slaski, History of the Port Wardens.

2 Weslager, Dutch Explorers, 207.

3 Weslager, Dutch Explorers, 207.

4 Hazard, Annals of Pennsylvania, 181.

5 Pennsylvania Colonial Records, Votes and Proceedings of the House of Representatives of the Province of Pennsylvania, 1682-1776 (Harrisburg, Vol. 1), 82, hereinafter cited as Pennsylvania Colonial Records.

6 Slaski, History of the Port Wardens, 3.

7 Slaski, History of the Port Wardens, 6.

8 Slaski, History of the Port Wardens, 6.

9 McHugh, "Delaware River Navigation Study," 24.

10 Baker, "Commercial Shipping and Shipbuilding in the Delaware Valley," 16.

11 Warden's of the Port, Minute Books (Vol. 1, Folder 1766-1773) Record Group 41: Records of the Navigation Commission For the Delaware River and Its Navigable Tributories, (Pennsylvania Archives, Harrisburg), hereinafter cited as Minute Books.

12 Baker, "Commercial Shipping and Shipbuilding in the Delaware Valley," 16.

13 Pennsylvania Colonial Records (Vol. 10), 290.

14 Pennsylvania Colonial Records (Vol. 13) 595; 671.

15 Slaski, History of the Port Wardens, 24.

16
Pennsylvania Colonial Records (Vol. 14), 500-501.

17
Frank Snyder and Brian Guss, The District, A History of the Philadelphia District U.S. Army Corps of Engineers, 1866-1971 (Philadelphia, 1974), 64, hereinafter cited as Snyder, The District.

18
Slaski, History of the Port Wardens, 45.

19
Minute Books (Vol. 40) September 5, 1864.

20
Snyder, The District, 65.

21
Snyder, The District, 67.

22
Snyder, The District, 67.

23
Snyder, The District, 69.

24
George Webster, "The Improvement of the Delaware River and Harbor and the Landing Facilities of the Port of Philadelphia," Journal of the Franklin Institute, (Philadelphia, Vol. 160, 1905), 102, hereinafter cited as Webster, "The Improvement of the Delaware River."

25
The Port of Philadelphia, Its History, Facilities and Advantages, (The Dept. of Wharves, Docks and Ferries, Philadelphia, 1926), 23.

26
L. M. Haupt, "Improvements of the Port of Philadelphia," Journal of the Franklin Institute, Philadelphia; Vol. 124, 1887, 325.

27
"Preliminary Report of the Permanent Improvement of the Delaware River," Report to the Chief of Engineers, Washington, D.C.; 1885, 1185

28
Webster, "The Improvement of the Delaware River," 102.

29
Snyder, The District, 6.

30 McHugh, "Delaware River Navigation Study," 33.

31 McHugh, "Delaware River Navigation Study," 31.

32 McHugh, "Delaware River Navigation Study," 31.

33 Fackenthal, Improving Navigation on the Delaware River, 16.

Salvage, Shipwrecks and Potential Sites

Actual documented salvage operations on sites in the river have been very limited. Typically the only contact with submerged cultural resources has been via the cutter-head of a dredge. The wreck of HMS Augusta was significant enough to raise the interest of certain 19th century parties. As mentioned previously, attempts were made to salvage items immediately after she sank. Apparently the Americans succeeded in recovering two 24-pound guns from her. However, the Augusta, commanded by Captain Francis Reynolds, carried 64 guns, 26 24-pounders on her lower deck, 26 18-pounders on her upper deck, 10 9-pounders on her quarterdeck and 2 9-pounders on her forecastle. She was launched at Rotherhithe, London in 1763.[1] The Americans did succeed in retrieving various other items which are listed in a document by a Mr. Blewer in the Pa. Historical Society. Listed in the report were items such as: red coats, blue coats, waistcoats, jackets, bretchs, frocks, various types of shirts, stockings, shoes, shot, gun barrels and sundry doctor's instruments.[2]

The wreck remained on the Red Bank Shoal relatively undisturbed until 1867. However the wreck did not go unnoticed, primarily because it snared the nets of the Delaware shad fishermen. Normally during fishing seasons, the fishermen would stake markers around the hull, so they could avoid the obstruction. Frequently a lantern was attached to the site, to warn the fishermen at night. The wreck, lying lengthwise across the east edge of the channel was also a menace to navigation. This was particularly the case with the truck boats which came up the river from the creeks on the Jersey side loaded with produce for Philadelphia.[3]

In 1867 five men, motivated by the notion that the wreck possessed

a substantial quantity of gold, attempted to raise the Augusta. James Powell, Joseph Moore, George Murphy, Gabriel Shapley and Charles Myers worked for over two years and eventually succeeded in raising the wreck and moving her to Gloucester City, N.J. Sand and mud had to be dredged out of her before pontoons could be used to float the hulk after the water was pumped out. When the safe was opened, no treasure was found in it. Items recovered during this operation included "A lot of silver spoons, marked 'H.W. 1748' with a coat of arms consisting of an ancient-shaped cross, an old English Bull's Eye watch, 7 guinea pieces bearing the vignette of George III and with dates ranging from 1760 to 1770, some Spanish silver dollars, 3 guns of heavy calibre, which now lie on the beach at Red Bank, about 60 tons weight of balls, and about 100 tons of Kentlidge iron (ballast)." As well, three human skulls were found.[4] "The vessel had been constructed of Irish oak and joined with trunnels of the same material. The timber is today pronounced as good as when put together."

The wreck was transferred to Gloucester City and anchored at the foot of Market Street. The salvagers decided to open the wreck to the public and enclosed the remains of the Augusta with a stockade. Admission was charged for visitors. One of the three guns taken from the wreck was also placed on exhibit but later it was sold for scrap. However, public interest lagged after two years and the site fell into disrepair. A storm and an unusually high tide destroyed the stockade and washed the Augusta up on a beach. The remains were still visible in the latter half of the 19th century during low tides with an appropriate wind. Later in the 19th century a man who claimed to own the shoreline where the wreck lay made repeated efforts to set the wreck on fire in an attempt to "clear" his property. His persistent efforts succeeded in only marginally damaging the wreck. In the early 1900s

certain individuals contracted with the State of New Jersey to remove portions of her timbers. These timbers were then made into furniture for the New Jersey room in Washington, D.C. What remains of the wreck is said still to be visible on a very low tide off Market Street in Gloucester City.

The remains of four much less heralded vessels are located in the mud at the foot of Mifflin Street in South Philadelphia. Three of these vessels, formerly known as the "dead fleet" have laid next to Pier 78 since a fire destroyed them in 1947. The fourth vessel is an iron-hulled, center paddle wheeled steamboat. The schooner wrecks are the remains of three of the last four-masted schooners ever built in this country. Four-masted schooners were built in the United States from 1880-1921 in a fairly standardized fashion. All but seven of the 458 vessels of this type on the East and Gulf coasts were wooden. In order to provide a little background to these wrecks, a brief description of a schooner is provided. "It is a vessel with two or more masts with a fore mast being shorter or almost equal to, but not taller than the main mast. Upon these masts are set sails on gaffs, booms and stays which run the length of, or fore aft with the longitudinal direction of the vessel."[5] There were generally two types of hull construction: deep hulls and shallow hulls with a centerboard. The centerboard models were generally the earlier forms. The masts were commonly uniform in height and most had two decks.

The three vessels at Pier 76 were tied up there for many years with only skeleton crews. By 1933 the last guardian left the vessels. Vandals quickly stripped the ships. The Bureau of Navigation deemed the vessels a hazard to navigation and ordered them burnt in August, 1947. The vessels were named Francis J. McDonald, Albert D. Cummins and Marie F. Cummins. The Francis J. McDonald was built in 1917 at Noank, Conn. She measured: length

201.9', beam 37.1', draft 18.8', gross tonnage 1,059. She was registered in Philadelphia (1919-21) and Wilmington (1925) and owned by A.D. Cummins and McDonald Transportation Co. (1925). The Albert D. Cummins was built in 1920 at Beaumont, Texas. She measured: length 189.5', beam 41.1', draft 19.7', and gross tonnage 1,163. She was registered in Philadelphia and Wilmington (1921-25) and owned by A.D. Cummins (1921) and Haldt Transportation Co. (19 25). The Marie F. Cummins was also built in 1920 at Beaumont, Texas. She was almost identical in every aspect with her sister ship, length 189.5', beam 41.1', draft 19.7', with a gross tonnage of 1,167. Likewise she was registered in Philadelphia and Wilmington and owned by A.D. Cummins and Cummins Transportation Co. (1925).

The vessels have been untouched since they were burnt in 1947. All three are clearly visible in aerial photographs of Philadelphia's waterfront. The vessels are located in an area of waterfront that is protected as a shallow water habitat area. The South Delaware Waterfront District Plan mentions that there are some 30 acres of "submerged lands" shallower than 10' in this district and thus subject to federal environmental controls. The Federal Clean Water Act established a national goal of shallow water protection as a means of preserving aquatic ecosystems. This law established the Section 404 permit program, which is administered by the Army Corps of Engineers, to regulate fill activities and the discharge of dredged materials in navigable waters.[6]

Two significant submerged sites have reportedly been encountered in all the years of dredging activities in the Delaware River. Without a doubt the dredges have come across other "sites" which either went undocumented or otherwise unnoticed. The first instance occurred while a new 34-foot channel off Hog Island was being dug in January, 1941. The Atlantic Refining

Company was building a large wharf on the island and received permission to have the access channel cleared. The oil company built a dike on Hog Island that was eventually filled with more than 100,000 square yards of dirt and fill. The top of the dike was nearly a mile around. Three suction dredges were then floated out over the spots where the channel was to be cleared. The bottom material was brought up through the "cutterhead" and onto the deck of the dredge barge. From the barge, the material was sent through a large pipeline to the shore disposal site.[7]

Among the items that were retrived from the disposal areas were various artifacts apparently from different time periods. An iron anchor, hand-forged and weighing about 40 pounds, was found with one fluke missing and in a good state of preservation. Some 280 pounds of copper sheeting, hand-made nails, a hand-forged brass spike, an iron cannon ball, a brass collar marked "USNYN, 1871" and a copper spoon were among the items recovered. No mention was made of any timbers being encountered.

The second "site" was encountered only seven years later, just on the other side of the river. Actually the dredge located two sites while clearing the bottom to 40 feet for the Mantua Creek Anchorage. The vessels, one west of Woodbury Creek and the other near Mantua Creek, were said to be imbedded to a depth of six feet or more in the mud under about 30 feet of water. The sunken vessel off Woodbury Creek, close to the Pa. side, was estimated to be 200 feet long. A diver mentioned the cutter head of the dredge had clipped off part of the deck, revealing a vast number of "kegs containing nails." Some of the items that were drawn up from the bottom and survived the mile and a half journey through a 27 inch pipe to the disposal area on a farm near Thorofare, N.J. included a harpoon, table knives, hand scythes, brass locks and keys, pewter plates, hoes, hinges, silver shoe

buckles, copper tea kettles and bottles. At the time of the discovery the origin of the ship was debated. W. K. Boyer, curator of folk history of the Pennsylvania Historical and Museum Commission, suggested that the ship was Dutch. Pewter found in the refuse, he felt, was of Dutch manufacture. He concluded that the ship had taken on its cargo at a British port. (Location of the ship is just east of the main channel.)

Evidence indicated that the vessel was likely a merchant or supply vessel rather than a warship. Mr. Boyer commented, after he spoke at the Gloucester Historical Society, that much of the material, the ceramics, glass, brass and other metal objects, had been made in the early 1700s or earlier. Unfortunately, the material from the farm of Alfie Leone quickly disappeared. Many of the items were offered to museums and historical societies, but apparently no inventory was compiled and no record was kept of where the artifacts went.

The Burlington, originally named John A. Warner, was a passenger and excursion vessel built by Harlon and Hollingsworth in 1857. She was an iron-hulled, center paddle wheel steamboat, 592 tons, originally operated by the Upper Delaware River Transportation Company. Renamed Burlington in 1905, she ran between Philadelphia and Trenton until 1910 when she struck a submerged cable from a dredge barge and foundered near the mouth of Biles Island Creek. The wreck remains visible at low tide, just off the Pennsylvania shoreline, south of Biles Island Creek.

Three Areas of Historic Interest

Biles Island - Biles Island represents a large tract of undeveloped land in a rapidly developing area of Pennsylvania. It is owned entirely by the United States Steel Corporation. The island's relatively pristine environment

and the increasing development pressures upon the use of vacant land in Bucks County combined to have it designated as a "Geographic Area of Particular Concern in the Coastal Zone Management Plan." About 600 acres in area, the island resembles a teardrop in shape. Its width ranges from 800' at the northern end to over 4,000' at its widest point. Approximately half the island is densely forested while the remainder has been cleared by the Corps to serve as a disposal site for dredge spoil. Two portions of the island have been diked and filled with dredge spoil. The underbrush covering much of the island is so extensive that only limited entry is possible. Aside from occasional visits from hunters and canoeists, man's impact has had a nominal effect.

Biles Creek, which separates the island from the mainland on which USS has its Fairless Works, no longer provides complete separation for the island. A land bridge, on which a highway interchange was built, has obstructed the continuity of the creek which was 2.5 miles long. The creek is of historic interest because Revolutionary War documents indicate that six American sailing vessels were sunk here. It is not a large waterway. The natural width between high-water lines averages 400'. The width of the creek diminishes considerably due to the 6'-7' tidal range of the river here. Historically, the creek was a secondary channel of some importance when the main river channel was obstructed by the notoriously treacherous Perriwig Bar - located about midway along the Biles Island frontage. However, with the increase in hydraulic capacity of the main river channel which accompanied its improvement for navigation, the flow through the creek diminished substantially. The back channel subsequently shoaled until it was only useful for drainage of the tributary upland. At high tide an 8' channel still exists through the lower mouth of the creek and extends with an increasingly shallower depth, approximately

halfway around the island. At this point the creek's depth becomes negligible, due to the construction of the interchange. The water is not stagnant, however, being influenced by the tidal change.

Previous to the construction of the USS Fairless Works, the mainland across the creek from Biles Island was the site of the Pennsylvania Maritime Academy from 1891-1947. At one point in 1945, Academy representatives approached the Corps to discuss the possibility of dredging a deeper channel for the anchorage of their training ship in the creek. The ensuing survey completed by the Corps indicated the presence of wreckage along the waterfront adjacent to the Academy.

Little Tinicum Island and Essington - Located just below the Philadelphia International Airport, Little Tinicum Island is the only remaining island in what was once a series of islands in this portion of the river. The other islands, Hog, Fort, League..., were all either incorporated with the mainland or destroyed. Little Tinicum Island is a dynamic land mass, often influenced by the hydrological measures undertaken by the Corps. It is slightly over two miles in length and its width ranges from 140' to 840'. Approximately 3,000' appears to have eroded from the west end of the island since 1862. Until 1940 the eastern three-quarters of the island flooded at high tide and was visible as sand bars at low tide. During World War II the main channel was dredged to 40' and the island no longer flooded with daily tides. Shortly vegetation became established in the eastern portions of the island. Several diked enclosures have been built on the eastern third of the island to hold dredge spoil. The easternmost enclosure now contains a tidal pond connected to the back channel of the river by a deep cleft in the dike.[8]

The nearly extinct back channel was used by the British vessels Fury and Vigilant to gain a strategic position for their attack on Fort Mifflin in 1777.

Presently the back channel is used by boaters and fishermen who come from Essington or Darby Creek. The only dredging that has been completed in the back channel has been done by private interests maintaining their own facilities. This back channel represents the single largest "undisturbed" portion of river bottom on the Pennsylvania side of the river below Trenton. The major portion of Essington's waterfront is made up of rather dilapidated finger piers and docks. The shoreline features such notable places as Printz Park, the location of Governor Printz' first Swedish settlement in the area, the Lazaretto, the state's first quarantine station of 1800, and the Corinthian Yacht Club, the country's oldest.

Construction of "permanent" structures on Little Tinicum Island has never been accurately documented. It has been mentioned that "in the early days" Sydney Fisher and Dr. Glass, affiliated with the Corinthian Yacht Club, "discovered the foundations of a large house and in the mud the remains of a boat about 50' long, both of which they thought must be Swedish. They towed the boat timbers over to the club, where they lay for years in the mud among the spatterdocks and are now buried under the filled in lawn."[9] Further documentation of potentially historically significant submerged cultural sites is mentioned in the Handbook of the Lower Delaware. "The waters of the river have long ago swallowed up the exact site of the Swedish buildings of state (Printzhaft), but it is said that ancient bricks are occasionally found along the shores at low tide which once had a place in their walls."[10]

Petty Island - Also historically known as Treaty Island since it lies directly opposite the site of Penn's Treaty signing with the Indians in Kensington. The island is an alluvial bar in mid-river which was formed before the introduction of Europeans to the river. A marshy flood plain existed along all the shores into the present century.[11] The back channel, between the island

and the New Jersey shoreline, was once greater than 30'. A dike built at Fisher's Point in 1888 dramatically decreased the tidal flow through the back channel - thus allowing sediment to accumulate on the bottom. Today the average channel depth is approximately 18'. That depth has remained relatively constant without any systematic dredging ever being done in the back channel. Dredge spoil from the main shipping channel has been deposited on the western end of Petty Island "many times."

This back channel has a long history of being a graveyard for abandoned and derelict ships. Presently there are several visible abandoned vessels which line the western and southern shore of Petty Island. Heite, who completed an impact assessment of potential disposal sites for the Army Corps, mentioned that "map research indicates that the shore opposite Cooper's Point (south shore of Petty Island) has a high potential for yielding maritime remains... the (tidal) flats have remained relatively undisturbed since at least 1843 and their research potential is very high. Although the island has been covered by both industrial filling and dredge spoil, maps indicate that development on the south side has been relatively benign from an archaeological point of view, merely covering whatever was there before."[12]

The ship most often associated with Petty Island is the frigate Alliance, of Revolutionary War fame. After a successful war career, she was bought by Robert Morris in 1785 for use in the China trade. By the 1790s she was left "behind" Petty Island for scrap. There are second hand references that the remains lay intact in the mud until 1902 when dredging activities destroyed her. However, it has been impossible to corroborate this account.

1 McGeorge, "The Frigate Augusta," 2.

2 "Invoice of Sundrys from the Burnt Ships," Account Book of Commander Joseph Blewer (Manuscript in Pennsylvania Historical Society, 1777).

3 McGeorge, "The Frigate Augusta," 2.

4 McGeorge, "The Frigate Augusta," 2.

5 Paul Morris, Four Masted Schooners of the East Coast (Lower Cape Publishing, Orleans, Ma., 1975), 1.

6 South Delaware Waterfront District Plan, (Philadelphia City Planning Commission, 1982), 50.

7 Philadelphia Bulletin, January 6, 1941.

8 Four Environmentally Significant Areas (Delaware Valley Regional Planning Commission, Philadelphia, 1976), 15.

9 Robert Barrie, Early Days of the Corinthian Yacht Club of Philadelphia (Philadelphia, 1940), 37.

10 Frank Taylor, The hand-book of the lower Delaware River: ports, tides, pilots, quarantine stations, light-house service, life-saving and maritime reporting stations (Philadelphia, 1895), 8.

11 Edward Heite, "Cultural Resources Reconnaissance in connection with Petty Island Back Channel" (U.S. Army Corps of Engineers, Philadelphia, 1982), 5, hereinafter cited as Heite, "Cultural Resources Reconnaissance."

12 Heite, "Cultural Resources Reconnaissance," 48.

Susquehanna River Research

Environmental Assessment

River Features

A vast water system with a 27,500 square mile drainage area, the Susquehanna River stretches over portions of Pennsylvania, Maryland and New York. Next to the St. Lawrence River, it is the largest water basin in eastern North America and it is the largest river lying completely in the United States which empties into the Atlantic Ocean.[1] The layout of the river approximates the letter "Y" with the main branch as the stem and the north and west branches as the arms. Since the North Branch is more voluminous and has a greater number of tributaries, it is often considered the true extension of the main branch. The North Branch originates in central New York State and drains the south central portion of the state. The West Branch stems from the central part of Pennsylvania and winds a course through numerous mountain ranges in western, central and eastern Pennsylvania. From where the two branches meet at Sunbury, the main branch flows through the south central part of the state, evenutally emptying into the Chesapeake Bay.[2]

Water from the Susquehanna actually reaches the Atlantic Ocean after passing through the Chesapeake Bay. Originally, the bay was considered to be an extension of the Susquehanna River which became submerged during the last terrestrial shift. When the coastal plateau and adjacent land masses sank all along the eastern seaboard, the bay assumed its present characteristics.[3] Today, the Susquehanna provides eighty percent of the fresh water entering the upper Chesapeake Bay. The average flow at Harrisburg has been recorded at 22 bgd (billion gallons per day). Furthermore, it has been estimated that the flow of the river at Harrisburg exceeds 28 bgd twenty-five percent of the time.[4]

The headwaters of the North Branch originate in Lake Otsego, near Cooperstown, N.Y. Following a winding course, the North Branch takes 300 miles to reach Northumberland - or roughly twice the straight line distance. It initially flows in a southwest direction through Otsego and Broome County, where it enters Pennsylvania for the first time below Windsor. After resuming a westerly course back in New York, the river again passes into Pennsylvania near Waverly. Hence the river continues through Pennsylvania in a southeast, then southwest course. It passes through the cities of Scranton and Wilkes-Barre before joining the West Branch at Sunbury. The total distance of the North Branch from the state line to Sunbury is 160 miles. It possesses a total fall of 337' with an average fall of slightly more than two feet/mile. There are 78 streams which join the river on the east side and another 101 streams on the west side.[5]

The West Branch forms in the northeastern part of Clearfield County at the junction of Clearfield and Moshannon Creeks. From this point the river flows in a northeast direction to Keating where it receives the Sinnemahoning Creek. The river turns east to approximately the north edge of Northumberland County, and then flows south to join the North Branch. Total distance of the West Branch is 125 miles to Sunbury. Between the headwaters and Williamsport, the river drops almost 350'.[6]

At the junction of the two branches, the elevation of the river is approximately 430' above sea level at Havre de Grace, Md. That elevation, combined with its 125 mile length, creates a slope that averages a three and one-half foot drop per mile. This slope rate varies at different portions of the river. For example, the drop averages five feet per mile over the last forty miles and only two and a half feet per mile on the upper forty mile portion of the river.[7]

The width of the main branch ranges from one half mile to approximately a mile wide on the average. Water is not deep or still anywhere along this portion of the river, except at the four downstream power dams. Generally the river falls rapidly over and by boulders, riffles and rock ledges and is interspersed with numerous islands of all sizes.

Dams

Main Branch

Name	Height - Feet
Harrisburg Sanitation Dam	4
York Haven Dam	17
Safe Harbor Dam	57
Holtwood Dam	57
Conowingo Dam	100

North Branch

Cooperstown Water Supply Dam	-
Goodyear Lake Dam	28
First Oneonta Dam	3
Second Oneonta Dam	5
Unadilla Dam	
Center Village Dam	
- destroyed dam (3 miles above Quaquaga)	
Quaquaga Dam (largely destroyed	
Windsor Dam (only remnants remain)	
Susquehanna-Oakland Dam	5
Rockbottom Dam	5
Center Binghamton Dam	
Binghamton Low Dam	7

West Branch

Curwensville Reservoir Dam	10
Curwensville Lower Dam	2
Clearfield Dam	5-6
Shawville Dam	2
Lock Haven Dam	8
Williamsport Dam	3-4

Water Quality

The industry of anthracite coal removal along the shores of both branches of the Susquehanna River has adversely affected the quality of water in the basin. Historically, those who first became aware of its presence had no use for the coal. Indians and early settlers both encountered the resource, but it was not until the 19th century when a commercial use was discovered for anthracite coal that it was extracted from the mountains. Thereafter, coal was floated down the river, eventually reaching Philadelphia. However, in a rush to extract and ship the resource, careless methods have historically been used throughout the Susquehanna basin.

> "Now sunk beneath the valley run literally hundreds of miles of tunnels and shafts. While many have since been sealed and abandoned, each disruption of the rock strata allows water to percolate throughout the underground labyrinth, where it combines with residual hydrocarbons to form acid. Gathering potency, the seepage inevitably reaches the Susquehanna River and its tributaries, where it dyes itself mile after mile into tree trunks and floodwalls astride the high tide mark."[8]

Results of coal mining have in certain areas drastically altered the water quality of the river. Lackawanna Valley and Wyoming Valley each suffer from heavy amounts of industrial and coal mine pollutants. Also, upper portions of the West Branch and its tributaries have been biologically dead for generations as a result of coal drainage impregnated with sulfuric acid, iron manganese.[9]

Tangible evidence of poor mining techniques is exhibited by the presence of floating coal dredges on the river. These dredges recover particles that have been swept downstream. Recovery is high and this industry has thrived. Average annual retrieval since 1889 has been estimated at 350,000 tons.[10]

Shoreline Features

Main Branch (See Fig. 5.)

The following sites, towns and features are listed (primarily from Burmeister) to provide an indication of the extent of historic activity and present development along each portion of the Susquehanna.

Fishers Ferry - across from Isle of Que, has Penn House Tavern, ca. 1756.

Millersburg - ca. 1790. A small stern wheel boat of flat bottom design, located there is the only remaining Susquehanna ferry, linking Rts 147 and 17.

Halifax - named for Fort Halifax, ca. 1756, which served a part of a chain of outlying defenses.

Haldeman Island - Indians cherished most islands for their strategic importance and for cultural purposes.

Duncan Island - west of Haldeman Island, was once an important Indian burial ground. The construction of the Pa. canal in 1828-29 destroyed a burial site on the island.

Fort Hunter - on eastern shore across from Marysville, ca. 1756.

Harris Ferry - ca. 1785, Harrisburg developed on site established by John Harris.

Middletown - ca. 1775, above northern shore where Swatara Creek joins river.

Columbia - ca. 1726. Quaker John Wright built a ferry. Today an industrial rural trading center.

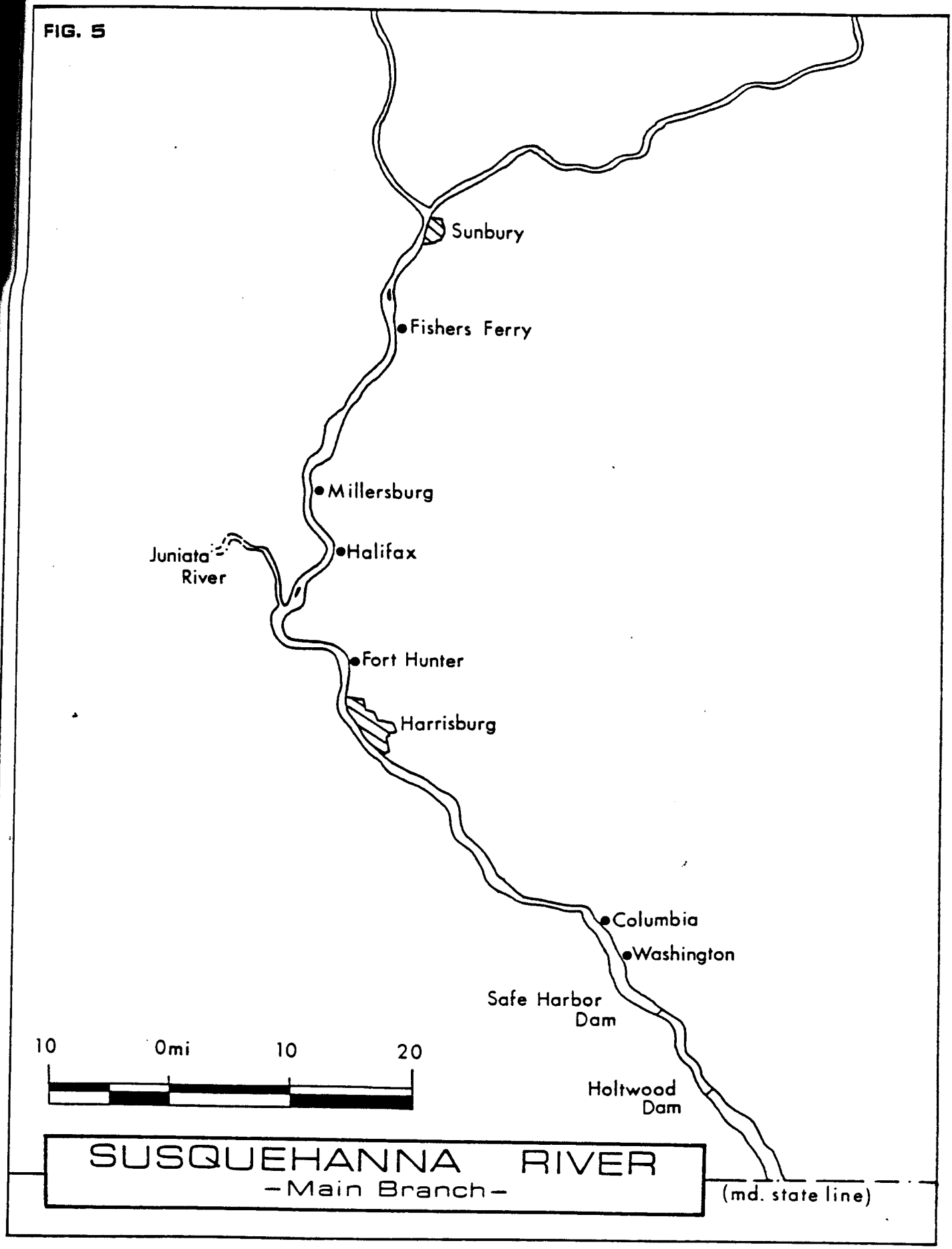
Washington - small community along northeastern shore, on the site of Indian village. Developed during rafting days. A 2½ mile stretch of eight major islands south of Washington has been the site of archaeological expeditions in the 1930s. Indian artifacts and ancient petroglyphs have been recovered from several of the islands.

Shenks Ferry - near Holtwood Dam. When ferry operated water level was 50' lower.

North Branch (See Fig. 6.)

Tioga - Indian for "meeting of the waters." Site of the largest Pa. Indian community north of Shamokin (Sunbury). Also a prime Iroquois hunting ground. It was destroyed in 1779 by Continental Army in response to Wyoming Valley Massacre.

FIG. 5


Sunbury
Fishers Ferry
Millersburg
Halifax
Juniata River
Fort Hunter
Harrisburg
Columbia
Washington
Safe Harbor Dam
Holtwood Dam
10 0mi 10 20
SUSQUEHANNA RIVER
-Main Branch-
(md. state line)

Towanda - ca. 1812. Industrial town. Downstream from Towanda the river flows in a series of large bends down to Laceyville.

Asylum - French Azilum was a colony founded in 1793 by Louis de Noailles, brother-in-law of the Marquis de Lafayette, as a place for refugees of the French Revolution. Colony soon perished, when in 1802 Napoleon offered amnesty to exiled nobles. Since 1940 a non-profit organization has attempted restoration of the French settlement.

Wyalusing - ca. 1750. Indian name for "good hunting grounds."

Laceyville-Skinners Eddy - occupy narrow terraces along left shore. ca. 1790. A river eddy here made this a prime stopping plaza for early boatsmen and rafts.

Meshoppen - Indian meaning "place of beads." On left bank, occupying bottomland at the foot of ridges and the narrow valley trench of Meshoppen Creek.

Tunkhannock - Indian word meaning "meeting of waters." On left shore, settled in 1775 after a Hollander Jeremiah Osterhout built a cabin and established a trade system along the Indian trail.

Wyoming Valley - two-mile wide valley, seventeen miles long from Lackawanna River to Nanticoke River. River passes Exeter, Wyoming, Forty Fort, Wilkes-Barre, Kingston, Larksville and Plymouth. Strip-mining conducted throughout this valley.

Berwick - ca. 1786, a prosperous industrial center.

Nescopeck Falls - 1826. Steamboat Susquehanna wrecked here.

Bloomsburg - ca. 1802.

Catawissa - ca. 1787, Indian meaning "growing fat" on the western outskirts of Bloomsburg.

Northumberland - ca. 1772. Coal dredging done here. Floating dredges pump coal particles from the river bed.

Sunbury - ca. 1772. First European visitors in 1742. Originally the central point of a string of three Indian villages along the Indian headquarters of central Pa. Site of Fort Augusta, 1755.

West Branch (See Fig. 7.)

While the North Branch was subjected to early (18th century) cultural influences from European settlers, the wilderness isolation of the west bank territories remained pristine for a longer period, and when settlers did come, they were primarily interested in developing lumber industry rather than

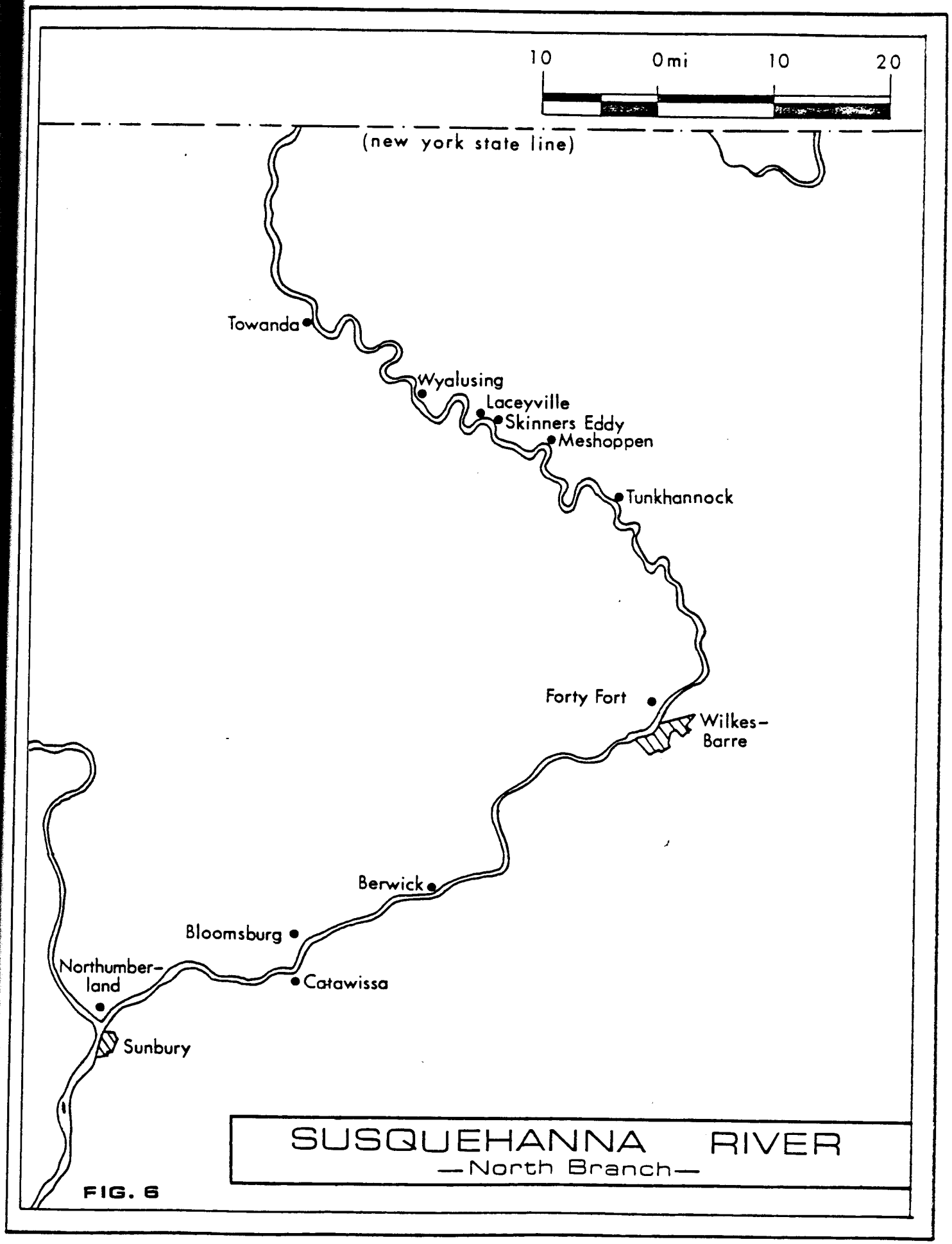

10
0 mi
10
20
(new york state line)
Towanda
Wyalusing
Laceyville
Skinners Eddy
Meshoppen
Tunkhannock
Forty Fort
Wilkes-
Barre
Berwick
Bloomsburg
Northumber-
land
Catawissa
Sunbury
SUSQUEHANNA RIVER
—North Branch—

FIG. 6

expanding civilized living standards.

Cherry Tree - ca. 1822, founded on site of what Indians called "Canoe Place." The Canoe Place Monument was approximately positioned where a cherry tree stood, which served as a boundary line in the Fort Stanwix Treaty of 1768.

McGees Mills - old covered bridge, ca. 1860. Town settled in 1826, involved in the lumber industry which continued until the 1930s. These forests provided lumber for the infamous "Last Raft" in 1938 which smashed into the Muncy RR bridge and disintegrated.

Curwensville - ca. 1812.

Clearfield - occupies the site of an Indian village named Chinklacamoose, roughly translated as "no one tarries here willingly."

Renovo - ca. 1863, constructed around RR shops.

Lock Haven - originally the site of an Indian village. A primitive frontier village, ca. 1834.

Old Bald Eagle Canal - now filled in. During its construction the channel disturbed a large Indian mound disclosing skeletal remains and stone artifacts.

Jersey Shore - ca. 1785, settled by a group from New Jersey.

Williamsport - largest West Branch community, ca. 1795. Developed on the site of a large Indian village. Logging industry made this one of the largest lumbering centers in the country in the late 1800s.

Muncy - ca. 1797, misspelled version of Munsee Indians. "Last Raft" smashed into RR bridge here. The site of Fort Brady which overlooks Muncy Creek. Captain John Brady built this early stockade.

Lewisburg - original settlement was named for Ludwig Doerr.

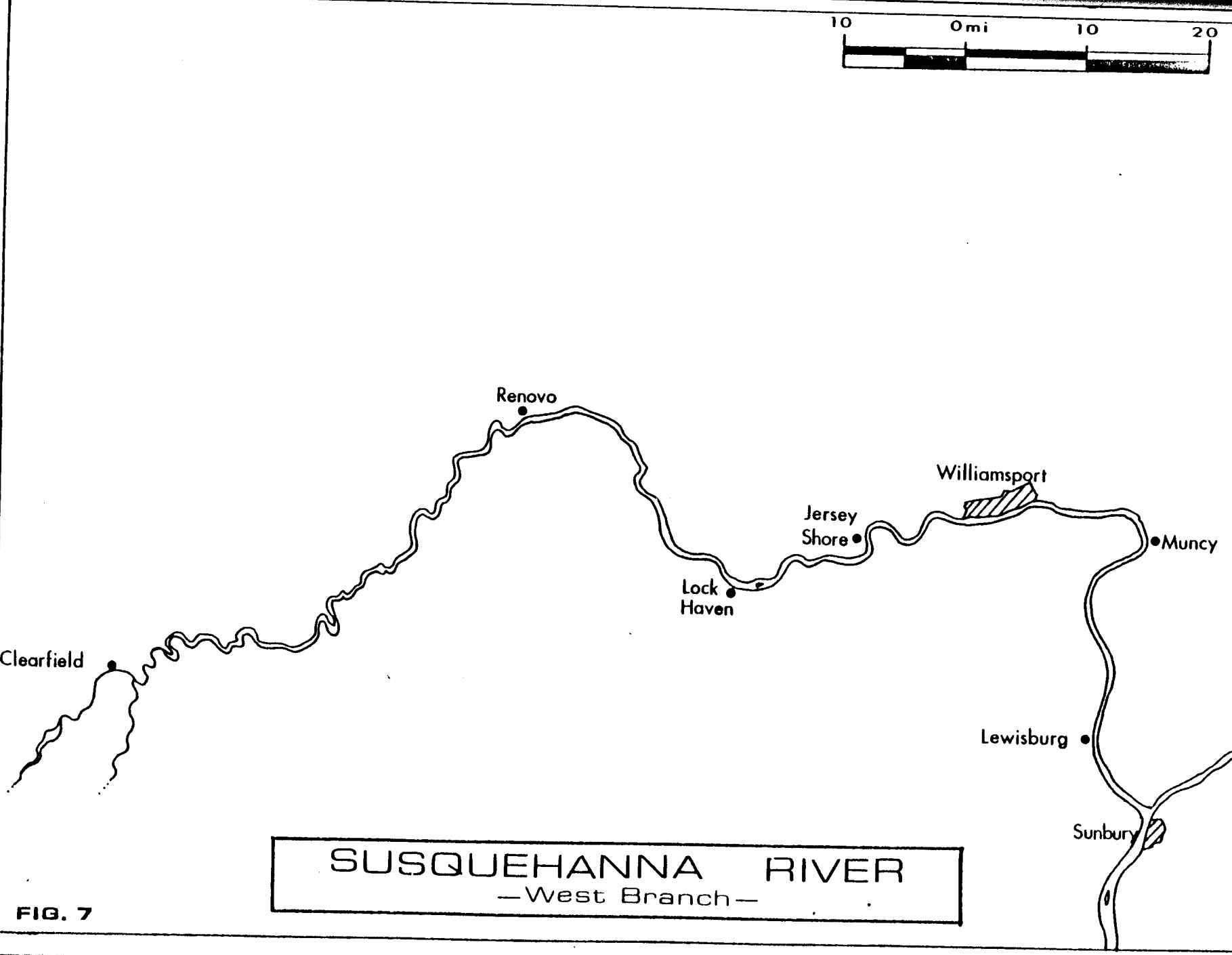

10 0 mi 10 20
Renovo
Williamsport
Jersey Shore
Muncy
Lock Haven
Clearfield
Lewisburg
Sunbury
SUSQUEHANNA RIVER
—West Branch—

FIG. 7

1 Edmond Seay, "The Susquehanna - A Sleeping Giant" in Susquehanna River Basin Commission: Annual Report (1982), 15, hereinafter cited as Seay, The Susquehanna.

2 Walter Burmeister, Appalachian Waters 3: The Susquehanna River and Its Tributaries (Oakton, VA, 1925), 8, hereinafter cited as Burmeister, Appalachian Waters.

3 Burmeister, Appalachian Waters, 1.

4 Seay, The Susquehanna, 15.

5 Col. G. Weitzel, "Survey of the North Branch of the Susquehanna River from Pittston to Athens, PA," Senate Executive Document No. 59, 48th Congress, 1st Session (1884), 21, hereinafter cited as Weitzel, Survey of the North Branch.

6 C.W. Raymond, "Preliminary Examination of the West Branch of the Susquehanna River," House Document No. 126, 51st Congress, 2nd Session (1890), 1102, hereinafter cited as Raymond, Examination of the West Branch.

7 Raymond, Examination of the West Branch, 1102.

8 Alfred Runte, "Shining River, the Susquehanna," Susquehanna River Basin Commission, Annual Report (1976), 16, hereinafter cited as Runte, Shining River.

9 William Voight, The Susquehanna Compact (Rutgers University Press, New Brunswick, 1972), 12.

10 Burmeister, Appalachian Waters, 32.

Historic Overview

Explorers and Settlers

Before the arrival of European settlers, indigenous Indian populations flourished throughout the Susquehanna Valley. Many of the creeks, towns and roads bear the names derived from Indian heritage. The Iroquois, although originally based in central New York, frequented the Susquehanna River basin as a favorite hunting ground. War parties also traveled into Pennsylvania to raid their southern enemies. Among others, the native Susquehannocks were victimized by the Iroquois efforts. The introduction of the European settlers, rather than ally the Indians, caused further division through a competitive rivalry over the fur trade.[1]

At Sunbury once stood the famous Indian village of the colonial era, called Shamokin. At its apex Shamokin was the cultural and political mecca of the Minsi, Iroquois, Shawnee, Conoy and Nanticoke tribes. This was the center of the six-nations of the Iroquois confederacy.[2]

Initially colonists ignored the upper Susquehanna basin. It was susceptible to Indian hostility and the abundance of fertile land closer to the coastal settlements led settlers to ignore this valley. Some of the first people to relocate to the upper Susquehanna basin chose Wyoming Valley on the North Branch. The first serious settlement attempts began during the 1760s in Wyoming Valley - a twenty-five by four mile area. Pioneers from Connecticut were instrumental in organizing the settlement, claiming the Wyoming Valley by virtue of grants to western lands in their original charter.[3] Pennsylvanians disputed their claim and on several occasions called up the militia. Eventually they drove off the New Englanders.

Settlements grew stronger and soon the Americans began to expand

their claims. Cognizant of the long-range effects of the settler's efforts, most Iroquois allied with the British at the onset of the Revolutionary War. The British gained their support by promising to protect Indian land.[4] Indian attention was focused on the Wyoming Valley settlement and the British valued the strategic importance of the valley as a base for inland operations. Accordingly a joint force of 1,100 loyalist rangers and Indian warriors massed at Tioga Point in June 1778. On the 30th they proceeded down the river into Wyoming Valley.[5]

Settlers, upon receiving news of the impending assault, sought refuge at Forty Fort - a two acre stockade near Wilkes-Barre. A force of three hundred men was sent out to provide resistance and discourage a siege. The men were easily defeated on July 3rd. The fort surrendered the next day. News of Forty Fort's capitulation triggered a panic among the other Susquehanna valley settlers whose flight became known as the "great runaway."[6]

The Continental Army was not able to mount a counter-attack until the following year, 1779. The primary objective of Generals Clinton and Sullivan was to destroy Iroquois resistance in the region. A contingent of 3,500 men converged on Tioga Point; Sullivan's men from Wyoming Valley to the south and Clinton's squadron from Lake Otsego to the north. Sullivan captured Forty Fort and marched his men to Tioga Point. Clinton was to bring his men south via boats on the river. However, he found the water too shallow to permit passage for his 208 boats. He ordered the river dammed. It was mid-August before the lake filled and the barrier could be removed. Reloading the flotilla, Clinton's boats rode easily downstream on the produced freshet.[7]

The two forces united on August 24th at Tioga Point. On August 29th a small engagement was conducted with the British/Indian force. The American forces easily swept aside this resistance at the "Battle of Newtown." To

fulfill their original objectives the Continental army marched north in search of all Iroquois strongholds. They marched through the Finger Lakes and westward to the Genesee River, destroying all Iroquois settlements along the way. Thus 1779 is viewed as the end of the Iroquois confederacy. In all, forty Iroquois villages were burnt by the Continental army expedition. With the Indian population virtually destroyed, settlers again resumed their activities in the Susquehanna Valley. Subsequent treaties with the Iroquois between 1784 and 1790 further encouraged settlement.[8]

1
Runte, Shining River, 111.

2
Burmeister, Appalachian Waters, 73.

3
Runte, Shining River, 14.

4
Runte, Shining River, 14.

5
Runte, Shining River, 14.

6
Runte, Shining River, 15.

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Runte, Shining River, 15.

8
Runte, Shining River, 15.

Shipbuilding, Shipping and Commerce

The hazardous navigational conditions along vast stretches of the Susquehanna River curtailed the development of river transportation along this waterway. Navigation was limited to one way downstream voyages and these were only completed when the river level was sufficiently high. For a brief period steam navigation was attempted on the river. All attempts ended in failure. Canals were constructed along the shores of the Susquehanna during the first half of the 19th century. While activity related to canals is not covered in this report, it must be noted that most shipping in the Susquehanna River basin used the vast network of canal passages. The lumber industry, for one, continued to use the river to transport "log rafts" to saw mills.

Indians traversed the Susquehanna in canoes centuries before the arrival of European explorers and settlers. Similarly, the first white pioneers in the Susquehanna Valley used canoes and followed Indian trails along either side of the river. Canoes were convenient because they could be paddled in either direction, then lifted out of the water and carried around major obstructions in the river. The amount of cargo which could be carried on board was very limited. The first fur traders used canoes extensively. However, much of central Pennsylvania early travel was by land, not water. The canoe birch, used on most eastern rivers, did not grow in Pennsylvania and the dugout canoe, usually tulip, sycamore, walnut or poplar was heavy and hard to maneuver in the swift Susquehanna. Even the elmbark canoe, which was used extensively on the Susquehanna, was awkward in the water and deadweight on the portage.[1]

Experimentation with various types of flat-bottomed boats was attempted during the colonial period. Versions of bateauxs, Durham boats and arks were used to carry sizable cargoes. They were limited to high-water seasons and could only return upstream if they were pulled from the shore. Typically, they were sold at the completion of the journey to be broken up for the lumber they contained. Of these types, the most prominent vessel on the Susquehanna was the ark. Arks were often similar in size to the "log raft," occasionally reaching 225' long by 24' wide. They were used to carry a wide assortment of items; grain, livestock, coal, iron, brick and shingles.[2] Their construction normally featured a broad, flat bottom which was caulked. This allowed them to carry heavy loads with a very shallow draft and also provide space for the crew's living quarters. Arks, much more so than log rafts, resembled a true "boat" form.[3]

Generally, three types of log rafts were built to transport timber downstream. 1.) Spar rafts were made up of the largest, straightest logs, which were often used for masts and spars. They had the finest lumber; logs were typically over 100' long. 2.) Timber rafts were comprised of squared lumber - pre-cut for use in the building trades. 3.) Lumber rafts consisted of logs which had already passed through saw mills and were cut into boards. They were stacked in a long hull and transported directly to downriver towns.[4]

All of these craft made only one trip downstream. They were propelled by the river's current. An account of raft construction is provided by Olive Glaze:

> "...ten or twelve timber sticks were placed side by side and fastened together with a 'lash pole' to which the sticks were attached with bows of split wood that were held firmly by wooden pins in the hole bored into the logs, six inches apart at either end. The larger logs were spliced with short logs to break joints, as is done in laying flooring. This made a platform. Three of these

> platforms were then coupled together to make a 'pip.' After the pips reached the river, they were coupled together into large rafts... a headlock was placed at each end of the raft and a wooden pin was driven into it to form an axis which would swing the heavy oars or sweeps - some sixty feet... a collapsible shanty in the center, which served as a bunk house and a cookshack for the crew completed the equipment."[5]

The larger rafts required crews of up to thirty men to navigate them through the passageways called "chutes" which were openings in dams.

As mentioned previously, there were only certain periods when shipping was possible. Shipping was carried out during one of the three major seasons; 1.) the spring freshet (most important,) 2.) June freshet (least important) and 3.) autumn run, which took place just before freezing set in. Assorted rafts may have passed down the river at other times, but they were few because it was considered too dangerous.[6]

The lumber industry enjoyed rapid growth in the Susquehanna Valley throughout the 19th century. Upper portions of both branches of the Susquehanna passed through virgin forest lands of the Appalachian plateaus. Eventually the logging industry became concentrated and several centers rapidly grew into boom towns. Williamsport, Lock Haven,Clearfield and Renovo on the West Branch and Towando on the North Branch all became strategic lumber towns by the middle of the 19th century. Most of the lumber from these forests was taken to one of the two chief markets, Marietta in Lancaster County below Conewago Falls or further south at Port Deposit, Md. at the head of the tidewater.[7]

Boom companies, or storage facilities for logs awaiting processing at the mills, emerged in many areas along the river. The booms were large, dam-like structures, built of logs that were securely anchored in the river. Within these barriers the logs were stored. The boom companies then charged the mills a storage fee. On occasion these booms reached incredible proportions,

often hindering navigation on the river. The Susquehanna Boom Company built a boom that stretched for six miles diagonally across the river at Williamsport.[8]

A Harrisburg resident provided an account of the extent of river traffic in 1827. He listed 1,631 rafts and 1,370 arks as having passed Harrisburg. The rafts contained an average of 25,000 feet of lumber - in all 40,775,600 feet of lumber were estimated to have been transported past Harrisburg. His account further pointed out that 200 arks carried 55 tons each and 1,170 arks contained 400 barrels of flour and whiskey each. Three hundred vessels were keel bottomed boats carrying from 800-900 bushels of wheat.[9] By the middle of the 19th century, it has been estimated that between 2,000 and 2,500 rafts came down the river each year and that about half of these reached tidewater.

The primary lumber shipped was white pine and oak. This industry continued to flourish until well past mid-century when the introduction of railroads and on-site milling brought an end to the "era of rafting." However, as forests eventually gave way to fields, the demand for produce offered a similar inducement to inhabitants to export downriver in arks.

Attempts to introduce steam navigation on the Susquehanna were made in the first half of the 19th century. Baltimore merchants were particularly interested in developing a steam line on the river. Isaac Chapman was commissioned in 1824 to build a vessel suitable for navigation on the river. His experimental "teamboat" was operated by mechanical means but was never seriously considered as a functional craft. In 1825 the steamboat Susquehanna, drawing only twenty-two inches was launched in Baltimore. It was towed to Port Deposit from where it was to steam to Columbia, Lancaster County. Unfortunately, the vessel could make no headway against the current.

Baltimore merchants financed a second steamboat in 1826, the Cordorus, which measured 60' by 9', was an iron-hulled (one of the world's first) steamer built at York Haven. It successfully steamed up to Binghamton, N.Y. and back. The voyage, however, took four months to be completed as low water, natural hazards and mechanical failures hampered progress. Upon completion of the trip, the captain reported that any further attempts at steam navigation would be impractical. He mentioned that the numerous natural obstacles and seasonal dependence on high water would prevent effective operation for most of the year.[10]

Two years later, another steamboat, the Susquehanna and Baltimore was built by a Baltimore interest. This vessel operated above Conewago Falls and made several trips in 1826. After experiencing only limited difficulty in her initial voyages, the boilers exploded on May 3, 1826 after the ship struck rocks at Nescopeck Falls.[11] Another attempt at steam navigation was made in 1834 by a company from Wilkes-Barre. By 1835 a steamboat was launched in Owego, N.Y. The vessel completed the journey to Wilkes-Barre in eleven hours. Despite this success, it was unable to make the return trip after encountering numerous problems and was thereafter used only for excursion rides in and around Wilkes-Barre. A few years later it became disabled on a sandbar near Wilkes-Barre.[12]

The final effort to introduce steamboats on the Susquehanna occurred in 1851. The Enterprise was launched in Bainbridge, N.Y. but it quickly succumbed to the turbulent conditions of the river.[13] The task of transporting cargo along the Susquehanna River was carried out almost exclusively on either the railroads or via the canal paths.

1 Paul Wallace, Indian Paths of Pennsylvania (Harrisburg, 1965), 2.

2 Gerald Smeltzer, Canals Along the Lower Susquehanna (York Historical Society, 1963), 5, hereinafter cited as Smeltzer, Canals Along the Lower Susquehanna.

3 Richmond Myers, The Long Crooked River (Boston, 1949), 182, hereinafter cited as Myers, The Long Crooked River.

4 Myers, The Long Crooked River, 182.

5 Olive Glaze, "Rafting in the Susquehanna," (Publications of the Snyder Co. Historical Society, Vol. 2, No. 6, 1943), 5.

6 Myers, The Long Crooked River, 187.

7 Myers, The Long Crooked River, 181.

8 Myers, The Long Crooked River, 190.

9 Samuel Hazard, The Register of Pennsylvania (Philadelphia, Vol. 3), 67.

10 Myers, The Long Crooked River, 158.

11 Myers, The Long Crooked River, 159.

12 Myers, The Long Crooked River, 159.

13 Myers, The Long Crooked River, 160.

Navigation

The concept of converting the Susquehanna River into a navigable waterway had been discussed as early at 1762 when the first surveys were completed to estimate the feasibility of connecting the Ohio and Delaware Rivers and Lake Erie. A navigable Susquehanna and a series of canals would have created a 582 mile long continuous waterway.[1] It was not until 1771 that the first legislative action was taken on the Susquehanna River. The Pennsylvania Assembly, in an effort to detour trade away from Baltimore, declared the river a public highway and initiated efforts to improve it. The act opened the river as a public thorofare as far south as Wright's Ferry and appointed commissioners. They were authorized to receive subscriptions and collect money for clearing this section of the river.[2] Despite this legislation little or no work was completed on the river at this time. In 1785 the entire portion of the river throughout Pennsylvania was declared a public highway. Money was allocated to the improvement of the river for the first time in 1791 - (£6,290).[3]

Between 1790 and 1825 several efforts were made to improve the conditions of the river. Money generated from the state legislature, public and private subscription and by lotteries financed the operations. Over $50,000 is estimated to have been raised to sponsor the improvements during these years. Improvement primarily consisted of removing rocks that hampered arks and rafts. The first canal built in Pennsylvania (and one of the first in the country) was constructed along the west bank of Conewago Falls in 1797 fourteen miles north of Wrightsville, Pa. It was a mile and a quarter long. It was built to convey log rafts around the treacherous nineteen foot drop

in the river at this point. The state of Maryland was instrumental in having this canal completed because Baltimore lost traffic from the river once a canal was built to the Schuylkill River. Maryland merchants felt they occupied the natural receiving end of the potential wealth of the Susquehanna valley and thus made the effort to remove all obstacles which impeded the transportation on the river. They removed rocks below Columbia and financed a canal from Port Deposit northward.[4] A one mile long canal was also completed around the falls at York Haven. This improvement had two locks at its southern end, each twelve feet wide and eighty feet long and with the capability of lowering a raft or flat boat a total of twenty feet.[5]

In the second half of the 19th century the Baltimore District of the Army Corps of Engineers sponsored a series of feasibility surveys for opening both branches of the river for navigation. It was mentioned that any improvement of the Susquehanna River must deal with three characteristics: 1.) a limited supply of water during several months, 2.) a decidedly steep slope, and 3.) occasional high and damaging floods, sometimes accompanied by heavy ice.[6]

An act of Congress in June of 1880 appropriated $15,000 for the improvement of the north branch of the river above Richard's Island. Money was allocated for preparation of an assessment of the river between Richard's Island and Pittston, dredging the natural channel at shoal places between Richard's Island and Wilkes-Barre and construction of a dike connecting the head of Wilkes-Barre Island with the north shore.[7] It was felt that the work would accommodate the inhabitants living along the 117 mile stretch of the north branch between Richard's Island and the New York state line in their effort to transport coal, iron, oil and cereal products. One hundred miles of this portion of the river already possessed the required two foot natural

channel. Despite these efforts, navigation was never satisfactorily completed in the river. Myers describes the general difficulties in accomplishing this goal,

> "North of Sunbury, the great bends of the two branches, but chiefly those of the north branch, caused a great deal of inconvenience. They lengthened the river's mileage between points by many leagues, rendering the frequent portage of goods almost essential in upstream travel. Such difficulties were not as prohibitive as the rock barriers in the lower river, but they did discourage any larger scale use of the river in its natural state as a water way."[8]

A reconnaissance survey by the Corps was also completed on the west branch of the river. Exceedingly difficult conditions made any navigational improvement all but impossible. Raymond, in his report to the Chief of Engineers, mentioned that, "...(it is) not used for navigation and is not navigable at its ordinary stages. At these stages its slope and volume preclude the possibility of obtaining a channel of navigable depth by the construction of embankments."[9]

Navigation of the Susquehanna was conducted primarily on the canals. Initially they were built only to circumvent falls and rapids. However, by the middle of the 19th century a complex network of canals was completed. The Susquehanna alone had some 400 miles of canals along its shores, while another 400 miles of canals followed the shores of its tributaries.[10] The canals were long ditches which paralleled the course of the river, and whenever possible, the actual river was used in the system. To offset the fall of the river, locks were constructed to allow the boats to pass. Often small dams were built to maintain a steady supply of water for the canals.[11] While canal traffic reached its peak in the 1830s and 1840s, the major part of their cargos were soon carried by the railroads. Most of the Susquehanna commerce was transported by train by 1860.

[1] Jarad Smith, "Preliminary Examination of the Susquehanna River, Near Wilkes-Barre, PA," House Document No. 197, 58th Congress, 2nd Session (1902), 1299, hereinafter cited as Smith, Examination Near Wilkes-Barre.

[2] Weitzel, Survey of the North Branch, 18.

[3] Weitzel, Survey of the North Branch, 18.

[4] Smith, Examination Near Wilkes-Barre, 1299.

[5] Smeltzer, Canals Along the Lower Susquehanna, 8.

[6] Weitzel, Survey of the North Branch, 14.

[7] Weitzel, Survey of the North Branch, 23.

[8] Myers, The Long Crooked River, 156.

[9] Raymond, Examination of the West Branch, 1104-1105.

[10] Smeltzer, Canals Along the Lower Susquehanna, 2.

[11] Myers, The Long Crooked River, 166.

Sensitivity Analysis

Sensitivity Analysis/Predictive Model

Introduction

"Submerged cultural resources" is the term which archaeologists use when referring to historically significant material which is located in a marine environment. This type of resource is extremely diverse. Sites, artifacts and assorted material - encompassing a complete range of prehistoric/historic items which have only their submerged environment as the common, unifying bond - all are viewed as submerged cultural resources. This fact alone makes more difficult the task of assessing the potential for a specific marine environment to yield such resources. One must attempt to assess vastly differing archaeological resources in a marine system.

In a very general method the types of submerged archaeological sites may be defined as either: A. Shipwreck, and material associated with a shipwreck, B. Inundated terrestrial sites, and C. Structures built connecting the land/water border. Shipwrecks obviously comprise the majority of submerged sites. These sites may be viewed as time capsules, for the ships and the cargo they carried represent an untapped data source for information on cultural and shipboard practices. Inundated terrestrial sites often existed along the shores of waterways, only to be consumed by them through an environmental shift. In several documented cases, material from this type of site has survived better than it would have had the transition not occurred. Material from such sites normally is not maritime in nature - but because of its environment is studied by underwater archaeologists. Piers, wharves and bulkheads represent a third type of resource, one that was constructed to extend into the water. Information can be obtained on port

activities through examining the "remains" of historic structures of this category. Random items discarded or lost from vessels and the shore are not being considered as a site type in this study, although they represent a potential of archaeological information.

The prediction of a site type and site distribution is an essential criteria for creating an accurate assessment of a specific water system. A strong correlation between site distribution and historical development exists. No substantial early colonial settlement could have been established in an area that did not offer good water access. Thus, as a settlement grew stronger and expanded, the extent of water-borne transportation proportionally increased. As marine transportation proliferated, the potential for ship-wrecks increased. Both site distribution and historical development are affected by the impact of the environment and its changes. Environmental concerns dictated where the populations originally settled, what types of vessels they could use and, in part, how often they were wrecked as well as in what condition the wrecks have survived.

The type of shipwreck, or site, will be in direct correlation to the extent of that area's historical development. If an area was active in one particular historical period, and this must be documented through historical research, then vessel types common to that period make up a proportional amount of the sites which exist there. The characteristics of an area's maritime commerce must be examined. Type and frequency of trade would indicate the vessel type likely used. An area which thrived on coastal trade through the colonial era is likely represented in its submerged archaeological sites by a good percentage of small schooners, sloops and snows. Historic development in the form of naval encounters must be reviewed. The percentage of ship fatalities (wrecks) to total number of operating vessels likely

decreased throughout the last three centuries. Modern developments in navigation, navigational aids, maintenance of channels, to name but a few, have served to enhance the mariners' safety.

The preservation of submerged sites is related to the environment within which it has become a part. Certain conditions - deep water, fresh water, silt, loose muddy bottom - are conducive to protecting and preserving sites. Other, more dynamic conditions: surf, rock or hard bottom, salt water, strong bottom currents, would operate against a site's preservation.

Despite these correlations there is no "scientific" method of predicting accurately the location of submerged sites. While trends and tendencies can be assumed, the fact remains that submerged sites result from a calamity in almost all cases. Any misfortune, ranging from human error to defective vessels to natural disasters, could have contributed to the deposition of a submerged site. These misfortunes are practically impossible to predict. What can be predicted is: 1. the influence of the environment in contributing to such an accident, and 2. the volume of traffic in a specific area, which when increased, raises the potential for vessels in that traffic to be affected by adverse elements. Furthermore, it may be stated that historic activity is a prerequisite for site deposition. Activity must have existed for the potential sites to be there. The reverse, however, is not necessarily true; historic activity does not preclude that submerged sites exist in an area. The environmental impact must be assessed. By using these variables it is possible to roughly predict site distribution and site type. The predictive model is nonetheless vital to determining where to look and what to look for.

Criteria and Findings

While compiling data for use in the Sensitivity Analysis, emphasis was placed on various factors relating to the maritime development along each waterway. These nine characteristics have been used as criteria for establishing the preliminary "rating" of each portion of the river. The selected criteria address all aspects of both the positive and negative forces which affect the deposition and preservation of submerged archaeological sites. The importance of each will be considered. Criteria factors used in the sensitivity analysis are:

1. Population density - from time of settlers.
2. Transportation activity.
3. Vessel construction.
4. Documented shipwreck sites.
5. Archaeological shoreline sites/historic sites.
6. Dredging, disturbance.
7. Future development.
8. Physical characteristics of river.
9. Naval activity.

As mentioned previously, the impact, whether positive or negative, of each factor may vary. A brief description, detailing the type and degree of impact, is warranted: 1. Population density - potentially both a positive and negative force. Early settlements are a good indication of the existence of historic archaeological sites, while modern population density often destroys such sites. 2. Transportation activity - a positive factor. The higher the volume of historic transportation activity, the higher the possibility of existing submerged sites. 3. Vessel Construction - a positive factor, however of less importance than other positive factors. The amount of shipbuilding

gives an indication of the industry of any area, and the importance of shipping and shiptypes to an area more than it indicates the presence of a submerged archaeological site. 4. Documented shipwreck sites - a positive factor, since it concerns known sites, this criteria is very significant. 5. Archaeological shoreline sites/historic sites - positive factor. Indicates activity at various portions of rivers, also the possibility of an inundated terrestrial site. This criteria is considered to be of medium impact. 6. Dredging, disturbance - negative factor. This activity is overwhelmingly considered to be the most important. Dredging, construction and spoil deposition alter the original condition of water bottom, displacing or impacting historic material. Dredging activities on occasion reveal the location of sites which, if they are not totally destroyed, may be studied. 7. Future development - negative factor. Any activity which destroys the integrity of a waterway's environment is potentially damaging to unknown sites. However, future development often necessitates archaeological surveys - "salvage" surveys which are often the only means of locating submerged sites. 8. Physical characteristics of river - can be either positive or negative. Positive characteristics would be such things as a soft bottom, bend in the river (often the site for landings), high ground on adjacent shore or rapids (since many vessels foundered on them). Negative characteristics in a river - such as hard bottom - are a minus because the river is judged lacking in positive features. The impact of physical characteristics is considerable because often this is the sole clue an archaeologist may have to assess certain portions of a river. 9. Naval activity - positive factor. Any naval encounter of importance, by the nature of the activity, leaves behind cultural material. When applicable, this is the most important of the "positive" criteria.

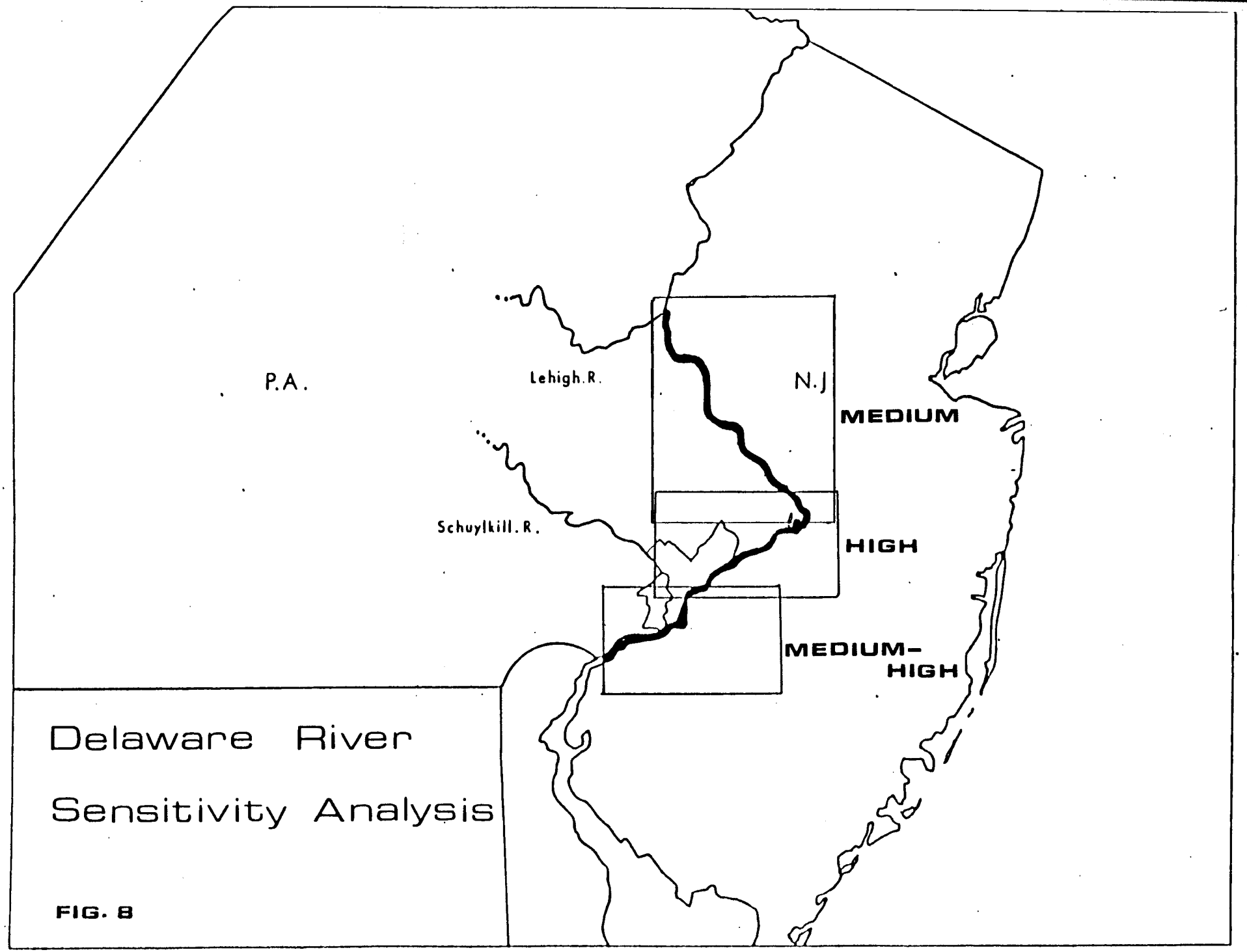

P.A.
Lehigh.R.
N.J
MEDIUM
Schuylkill.R.
HIGH
MEDIUM-
HIGH
Delaware River
Sensitivity Analysis

FIG. 8

Since the scope of the survey is extremely broad, the following designations are necessarily generalized and preliminary in nature. The Delaware River has been considered in three separate regions: Marcus Hook to Philadelphia (Allegheny Avenue), Philadelphia to Trenton, and Trenton to Easton. Each complete portion of the river will be evaluated as a whole and designated with a "High," "Medium-High," "Medium," "Low-Medium," or "Low" potential to possess submerged cultural resources.

HIGH POTENTIAL is assigned to an area where the positive criteria have an extremely significant impact. An area with an extensive maritime history, known archaeological sites, documented ship losses or known hazards to navigation, in conjunction with limited disturbance, would be designated with a High rating.

MEDIUM-HIGH POTENTIAL is assigned to an area that possesses both a high degree of positive and negative influences. The extent of positive factors is similar to those in the High rating, the difference results from the amount of disruptive activity in this area. For example, non-intact submerged cultural resources or disturbed yet significant sites, might be found in this area. The historic development of the area strongly indicates the presence of sites, but subsequent activity has disturbed these sites from their original condition.

MEDIUM POTENTIAL is assigned to an area that is not significantly affected by either positive or negative factors; areas where research indicates nominal maritime activity with slight, if any, distruptive activity.

LOW-MEDIUM POTENTIAL is assigned to a fringe area of maritime activity that had a high degree of negative influence. Any submerged cultural material that might have been deposited has probably been destroyed.

LOW POTENTIAL is assigned to an area that has either a complete lack of positive factors or where bottom lands have been previously disturbed to the extent that no cultural resources exist.

The criteria will be considered for each portion of the river as a whole. This general ranking method obviously evaluates vastly differing smaller portions of the river system into one category - but it is necessary

if the entire river is to be evaluated. An effort has been made to distinguish specific areas that clearly differ from the perceived "norm" of the entire region. As well, a predictive model for resource types will be discussed for each region.

Marcus Hook to Philadelphia

Population density: first settlers arrived in the first half of the 17th century and established various settlements along the river. Philadelphia has thrived since 1682. Population density has historically been very heavy along virtually the entire river length. Marcus Hook, Chester, Essington and Philadelphia dominate the shoreline of the river today. The positive factors of early settlement and negative factors of present development offset each other. (A Medium-High factor.)

Transportation activity has historically been very heavy. The ports of Philadelphia have always been among the busiest in the country. International and coastal trade emanated from the Delaware River. A significant positive factor. (High.)

Vessel Construction has been documented back to the first Swedish settlement in the 1640s. Philadelphia and vicinity was one of the country's shipbuilding leaders throughout the 18th, 19th and early 20th centuries. The yards were particularly active as forerunners in the construction of innovation iron hull ships and steamers. (Medium-high.)

Documented shipwreck sites: Citings of shipwrecks are numerous, dating back to the first reliable news accounts in the 18th century. A large number of vessels was lost during the battle for the Delaware River in 1777. The Augusta and Merlin were the most noteworthy wrecks of the Revolutionary battle. The remains of three 4-masted schooners and one iron-hull center paddlewheel steamer are located at Piers 76 and 78 in South Philadelphia. The remains of

one of the schooners is claimed to be the best preserved vessel of its type in the country. Remains of chevaux-de-frise have been periodically recovered from the river. (A High factor.)

Archaeological sites/historic sites: There is only one archaeological site in the Pennsylvania archaeological files: Governor Printz Park, Essington. There are several historical sites of note, the major ones include Fort Mifflin, the Lazaretto, William Penn's Landing, and Penn Treaty Park. (Low-Medium.)

Dredging/Disturbance has been very extensive throughout this entire region. A 40' channel has been maintained since WWII. In most areas up to 80% of the river bottom has been disturbed. Between Philadelphia and Camden nearly 100% of the bottom has been disturbed. Dredging is the primary mechanism of disturbance. Landfill has also destroyed most of the "original" shoreline. Hydrological dynamics, influenced by efforts of the Corps, has altered the makeup of the river geography and river bottom. A series of islands which existed in the 18th century along the Pennsylvania shoreline, most below the Schuylkill River, have all, except for Little Tinicum Island, been incorporated with the mainland or destroyed. There is slightly less disturbance along the New Jersey shoreline. (This activity is considered a highly negative factor.)

Future Development: The United States Coast Guard will be constructing a new station at Piers 46 and 48 in South Philadelphia. As well, the Army Corps is constantly in need of new locations to deposit dredge spoil. (Low Medium.)

River characteristics: Tidal, with approximately a 7' mean range. The largest tributary along the entire Delaware, the Schuylkill River, joins the river below League Island. The river follows a north and east course from Marcus Hook to Philadelphia, steadily narrowing from over 3/4 mile wide at the former to less than 1/2 mile wide at Allegheny Avenue. The river bottom along the Pennsylvania shore is primarily comprised of loose mud which is very thick. (Medium.)

Rank and Recommendation: The potential for this portion of the river to yield submerged cultural resources is Medium-High. While the river here has been the scene of a tremendously high volume of all types of historic activity, including several "firsts" in both shipping and shipbuilding, it has also been highly disturbed from its original condition. Therefore, the conclusion has been made that historic material does exist on the river bottom, but it is unlikely that the resources have remained intact.

Areas of Special Attention:

1. The site of the aforementioned 4-masted schooners at Pier 78 in Philadelphia should be considered for future research. They are evidence of an "extinct" shiptype which once thrived in American coastal trade. Presently they do not appear to be in any danger - but should the ownership of those piers change, the vessels might be destroyed. One of the vessels is in excellent condition.

2. The back channel behind Little Tinicum Island and the mouth of Darby Creek should be considered as an area of importance. It has a long record of historic activity and the area has never been systematically dredged. Timbers from old wrecks have been encountered in at least two separate incidents and mention is made of an American vessel being scuttled at the mouth of Darby Creek in 1777.

3. The channel behind Petty Island should be considered sensitive. While some dredging and fill deposit have occurred, the potential for surviving cultural resources is high. The remains of the Revolutionary War frigate Alliance and John Fitch's steamboat are reported to be behind Petty Island. Any material deposited on the river bottom prior to the completion of Fisher Point Dike is now covered by as much as 10' of loose mud, silt and possibly dredge spoil.

4. The main shipping channel will not possess any intact submerged cultural resources. Individual items, or even a series of items have in the past and will in the future be recovered from the channel bottom; but they have been torn away from the archaeological sites which once existed. Furthermore, any historic material which existed along the Philadelphia shoreline has either been destroyed by dredging or encompassed within a "fill" site.

Predictive Model For Resource Types: Since activity dates back to the first half of the 17th century, the possibility exists for material dating to that period. Evidence of activity on or near the river before the arrival of Europeans has, in all likelihood, been destroyed. Vessels involved in all phases of Philadelphia's trade network could be found in the Delaware. Wooden hulled vessels, ranging from small sloops and schooners to ship rigged war frigates, were lost in the river. Iron hulled steamers, primarily center paddlewheelers, might also be found. Along with historic material, the bottom will be littered with an abundance of modern debris ranging from bottles to engine blocks to car batteries.

Philadelphia to Trenton

Population density: there are reports that mention Burlington Island as the first settlement attempt in the 1620s. Regardless of the accuracy of that idea, this portion of the river shoreline has been settled since the middle of the 17th century. The population today is concentrated in three urban areas, Philadelphia, Bristol and Trenton. Bucks County has been primarily a rural region until the last two decades. Farmland has been converted into housing projects and developments. (Medium-High.)

Transportation activity: the channel from the Bay extends to Trenton, thus this portion of the river has hosted a similar type of maritime traffic (but on a smaller scale) to that which operated out of Philadelphia. A considerable

amount of industrial product was shipped down the Upper Delaware River to Trenton. There it was transferred into larger vessels for the continuation of its journey to Philadelphia, Baltimore or beyond. Ten to twelve ferries operated along this portion of the river. The amount of activity is considered high.

Vessel Construction: the Kensington yards at Philadelphia were very active during the late 18th and the entire 19th century. There was a yard at Bordentown, N.J. and other smaller yards upriver as well. (Medium.)

Documented Shipwreck Sites: Many of the cited shipwrecks in the river were not specifically located. It is assumed that since the volume of river traffic above Philadelphia was lower than that below the city, the number of wrecks would be fewer. One note to mention: the navigation above Philadelphia was more difficult, possibly increasing the percentage between traffic volume/shipwrecks. The City of Burlington, an ironhull, center paddlewheel steamer, wrecked in 1910 just below Biles Island is visible during low tide. The remains of six LCN canal boats and a scow are also visible during low tide in Biles Island Creek. Over forty American vessels were burned by the British in 1778 in various creeks along this portion of the river. (High.)

Archaeological Sites/Historic Sites: There are no shoreline archaeological sites on file in the state's archaeological records. There are two relevant sites along the shore that are of historic importance: the Nicholas Biddle Manor (Andalusia) near Cornwells Heights and Pennsbury Manor. (Low-Medium.)

Dredging/Disturbance: A 40' channel is maintained to the Fairless Hills Plant of USS and a 35' channel from there to the Trenton Marine Terminal. 50% to 70% of the river bottom is estimated to have been disturbed. Three dikes were built and fill has been deposited in three locations, off the mouth of Poquessing Creek, Money Island and on Biles Island. (High.)

River Characteristics: Tidal with a 7' range. Six major creeks join the river on the Pennsylvania side here. The river experiences several sharp bends, but generally follows a northeasterly direction. The river bottom is primarily made up of loosely packed mud. The bottom off of Andalusia is rocky and hard. (Medium.)

Rank and Recommendation: The potential for this portion of the river to yield submerged cultural resources is High. Again, potential sites have likely been disturbed in some fashion by the dredging activities. The mouths of the several creeks which empty into the Delaware are of particular interest. The Americans scuttled their entire Philadelphia naval forces in these creeks. Any submerged site would be covered by a substantial amount of mud - which serves to preserve the wood as well as to hide its location from relic hunters.

Areas of Special Attention:

1. Biles Island Creek was the location where the British burned six American sloops and schooners. The small back channel behind the island has never been dredged. However, construction of an interchange has completely obstructed the creek's flow and added to the accumulation of bottom mud in the creek. A number of late 19th/early 20th century canal boat remains are visible in the creek.

2. The mouth of Poquessing Creek and the channel behind Mud Island deserve further research. The area was noted as being an historic graveyard for vessels and the area has remained more or less undisturbed. Dredging or quarrying rock from the river bottom in the vicinity of Andalusia in the last couple of decades has reportedly turned up various historic materials.

3. The area with the greatest potential for possessing 18th century resources is in Crosswicks Creek, near Bordentown, N.J., beyond the scope of this project.

4. As they are in the preceding segment of the river, submerged cultural

resources are likely dispersed along the river bottom where dredging has been completed. A high volume of activity transpired in Kensington: shipbuilding, shipping and use as a ship graveyard, but extensive dredging and filling have transformed the shoreline into part of Port Richmond and other "modern" waterfront facilities.

Predictive Model For Resource Types: Wooden sailing vessels, dating back to the early 18th century, plied the length of this portion of the river. Small merchantmen, coastal sloops and schooners were what the British destroyed in 1778. Iron hulled steamers carried passengers between Trenton and Philadelphia on a regular basis for most of the 19th century. Double-ended ferry boats crossed the river at approximately 12 different locations. A number of tugs and barges have more recently used this portion of the river and have occasionally sunk or otherwise ended their careers on the river here. Modern debris will again comprise the major part of material on the surface of the river bottom.

Trenton to Easton

Population Density: With the exception of Easton, settlement along the river in Bucks County and the lower portion of Northampton County has been relatively sparse. Settlement in Easton dates to 1739 when the first ferry was established. Today, only small towns exist along the river: Riegelsville, Durham Furnace, Upper Black Eddy, Point Pleasant, Lumberville, New Hope, Washington Crossing and Yardley. The positive influence of this settlement is rated as Medium.

Transportation Activity: The river drops through a series of rapids in this portion of the state. These rapids made conventional navigation inappropriate. Nonetheless, industrial material from the upper portions of Pennsylvania (primarily coal and lumber) was transported down the river. Coal arks and lumber rafts were initially the primary means of transporting this material.

Later (mid-18th century), Durham boats were developed to haul bulk cargo both downstream and back upriver. These Durham boats dominated the river throughout the 19th century until canals were built. Fifteen ferries crossed the river in this portion of the Delaware. (Medium-High.)

Vessel Construction: Most craft built for the coal and lumber industry were simply dismantled when they reached their destination - normally Trenton. These vessels were crudely constructed at the point of origin, having only to survive one trip. Durham boats were built in a standardized fashion at numerous undocumented yards up and down this portion of the river. A substantial portion of the estimated fleet of 300 was based in Easton. (Low-Medium.)

Documented Shipwreck Sites: Despite an occasional mention of a "wreck" of a ferry, no documented shipwreck was discovered. There were doubtlessly wrecks, capsizes and casualties experienced by those who navigated vessels along this portion of the Delaware River. Archaeological work has been completed with a high level of success in a similar river environment (in Minnesota) by surveying the river bottom below the most treacherous of the navigational hazards (see Voices from the Rapids; An Underwater Search for Fur Trade Artifacts 1960-73) (Low-Medium.)

Archaeological/Historic Sites: There are 17 archaeological sites along the river shoreline in the State's files. Thirteen of these are in Bucks County and four are in Northampton County. Of these, eight have been designated as either early, middle or late woodland, three as middle or late archaic, one as historic and seven with no designation. Historic sites include Washington Crossing State Park and Stover's Mill in Erwinna. (Medium-high.)

Dredging/Disturbance: Has been relatively negligible. Some work was sponsored by the Pennsylvania government in 1793 and 1817. Rock was blasted (particularly at an area known as Rocky Falls) and wing dams were built. Work was also

finished above Point Pleasant (at "Tumble Falls") and at a location one mile below New Hope (at "Well's Falls"). Other than these efforts, the major disruptive action (besides filling at Easton and other river towns) would be the occasional flood that afflicts the area. (Low-Medium.)

Future Development: The planned Point Pleasant Pumping Station. (Low Impact.)

River Characteristics: Above the tidal influence. The river drops approximately 160' over the 49 mile length. There are between 25 and 30 rapids in the river. Where the river narrows the current is the swiftest. The current is relative to the water level which fluctuates according to the season and weather conditions. In many places the river averages approximately 4-5 knots. The river runs approximately north-northwest. The Lehigh River joins the Delaware at Easton. (Medium to high negative factor.)

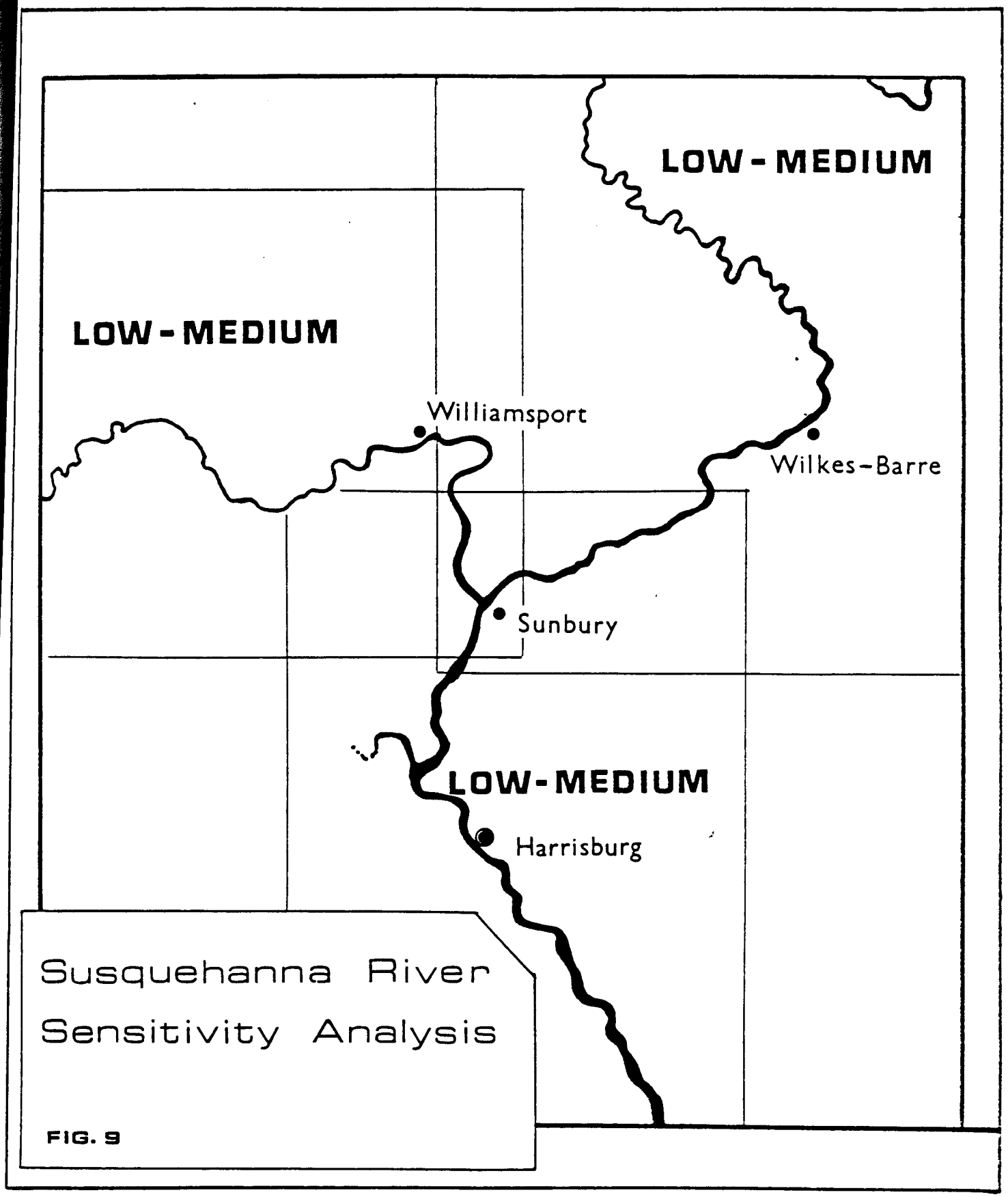
Rank/Recommendation: The potential is Medium. The swift current and periodic flooding operate against sites surviving in most portions of the river. All the numerous terrestrial sites located along the shore had some connection with maritime activity. Whether remnants have survived a possible inundation is questionable. There are numerous eddys and areas of slack water along portions of the river where the water/shoreline border is less dynamic. These areas were historically used as staging areas, landings for vessels. The potential for locating cultural remains in these areas is higher. However, these areas are not numerous enough to warrant a higher classification for the area as a whole.

Areas of Special Attention: Specific areas which do deserve individual High designation are the portions of river just below the location of rapids. (See Fig. 17.)

The more dangerous the rapid the more likely vessels carrying cargo were to wreck. The most dangerous obstacle is located just below New Hope - known

historically as Well's Falls. Other areas that are of particular interest are the ferry crossing locations.

Predictive Model for Resource Types: Durham boats would be the most likely shiptype to be discovered. None of the extensive original fleet is afloat today - however records indicate that they were uniformly constructed - 60' x 12' with a shallow 24" draft when loaded. Artifacts associated with any of the archaeological sites (woodland sites predominate) could be expected to be found strewn along the banks of the river, adjacent and downstream from identified sites on shore.


LOW-MEDIUM
LOW-MEDIUM
Williamsport
Wilkes-Barre
Sunbury
LOW-MEDIUM
Harrisburg
Susquehanna River
Sensitivity Analysis
FIG. 9

Due to the Delaware River's extensive maritime activity, and the relative lack of similar developments along the Susquehanna River, research was primarily geared toward studying the Delaware Basin. Nontheless, the Susquehanna has been considered in three regions: the Main Branch, West Branch and North Branch. As with the Delaware River designations, each portion of the Susquehanna will be evaluated as a whole. A predictive model will be included.

Main Branch

Population density: A fairly active Indian population flourished along the river before settlers arrived in the middle of the 18th century. Although a ferry at Columbia dates to 1726, most of the river basin was settled during the middle of the 18th century or later. Harrisburg and Sunbury are the only large urban centers along the river, and despite numerous small towns that are located every few miles on both sides, settlement has remained nominal. (Medium.)

Transportation activity: Log rafts and arks were sent down river to reach both Pennsylvania and Maryland destinations. Although limited to three main seasons, this activity developed significantly toward the middle of the 19th century. After that time most traffic utilized the elaborate canal system. (Medium.)

Vessel Construction: Little information was compiled on shipbuilding along the Main Branch. This was likely because most vessels were built at upstream portions of the river. (Low.)

Documented Shipwreck sites: There were no documented wreck sites discovered although it is very likely that vessels capsized or foundered while navigating

the many rapids and falls during the 19th century. The simple mention of "wreck buyers" on the river, found in several publications, provides evidence of wrecks happening on a fairly regular interval. (Low-medium.)

Archaeological sites/historic sites: There are a total of 136 archaeological sites on file in the state's office, that exist along the shores of the main branch. These range from archaic to historic. A large number of these were discovered in the vicinity of the Holtwood Dam and the Safe Harbor Dam. Other large concentrations of sites include Middletown, Millersburg and Sunbury. (High.)

Dredging/Disturbance: The major types of disturbances would be the periodic floods which afflict the river and the construction of four major dams below Harrisburg. Floods may possibly dislodge submerged cultural resources while the construction of dams significantly increased the water level behind the dams - submerging much of the historic shoreline. The positive and negative factors offset each other. Also, a certain amount of filling has been completed along portions of the urban shorelines, in many cases to protect from flood damage. (Medium.)

River Characteristics: generally the river is broad and shallow, with a number of natural obstacles in the water. The width fluctuates between a half-mile and a mile and drops approximately 430' over its 125 mile length. The drop is more dramatic at the southern, downstream end of the river. (Low-Medium.)

Rank and Recommendation: The potential for this portion of the river to yield submerged cultural resources is Low-Medium. The lack of traditional maritime activity on the river is responsible for the designation. While this activity did thrive for a period, it was only marginal in its impact on the river. A more promising potential for the river would be at landing sites, ferry crossings and in the vicinity of shoreline archaeological sites. Possible artifacts

associated with these features have doubtlessly ended up in the river. While they would be subject to the swift current and flood waters, they would be redeposited along downstream sections of the river. Intact sites are highly unlikely.

Predictive Model for Resource Types: The high level of prehistoric activity along the shores would indicate that artifacts from those periods exist, probably in a scattered fashion, along many parts of the river bottom. Otherwise, evidence from landing sites, ferry crossings and the remains of early bridges would be the most likely type of submerged cultural resource in the Main Branch.

West Branch

Population Density: Indians were active, if perhaps to a lesser degree than on the Main Branch, along the West Branch well before the arrival of European settlers. It was not until late in the 18th century that the first settlers arrived on the West Branch and the majority of towns were not established until the 19th century. With the exception of Williamsport, there are no large urban areas. Several towns prospered in the mid-late 19th century, in conjunction with the lumber industry, but these have since faded in size. (Low-Medium.)

Transportation Activity: similar to the other portions of the Susquehanna. Rafts and arks were the predominate form of water transportation. Traffic was heavy during the proper seasons in the 19th century, but it has since been drastically curtailed. (Medium.)

Vessel Construction: Log rafts and arks were built at the various disembarking locations for the cargo. All were intended to make only one trip and were thus hastily constructed. (Low-Medium.)

Documented Shipwreck Sites: The only documented wreck was the "Last Raft" accident at the Muncy Railroad bridge in 1938. As is the case with the other branches, navigation was treacherous around all rapids and thus numerous vessels probably wrecked in these areas. (Low-Medium.)

Archaeological Sites/Historic Sites: There are a total of 127 archaeological sites on file in Harrisburg that exist along the shores of the West Branch. They date back to archaic sites. Concentrations of sites are located near Linden, Jersey Shore and Lock Haven. (High.)

Dredging/Disturbance: Floods and dams are the major disturbing influences along the West Branch. There are six relatively small dams, typically associated with adjacent towns. Bridge construction and isolated filling also acted as a minor factor. (Low-Medium.)

River Characteristics: The river passes through several mountain ranges in the middle of the state. Water is typically very shallow with a swift current. Along its 125 miles it drops approximately 350'. (Low-Medium.)

Rank and Recommendation: The potential for the West Branch to yield submerged cultural resources is Low-Medium. Refer to Main Branch discussion.

Predictive Model for Resource Types: Refer to Main Branch discussion.

North Branch

Population Density: Indians were very active along the North Branch. Settlement by Europeans dates to the 1760s, primarily in the Wyoming Valley. The settlements grew into towns after the Revolutionary War and the extermination of the "Indian threat." Many smaller towns prospered during the lumber era in the 19th century. Several present communities were initially Indian villages. Wilkes-Barre is the largest urban center, while smaller towns such as Bloomsburg, Berwick and Towanda exist along the North Branch. (Medium.)

Transportation Activity: This branch is very similar to the West Branch transportation patterns, however several attempts were made at establishing a permanent steam boat service along certain portions of the North Branch. Activity has been minimal since the end of the 19th century. (Medium.)

Vessel Construction: See West Branch discussion. (Low-Medium.)

Documented Shipwreck Sites: A vessel built at Owego, N.Y. in 1834 became disabled on a sand bar near Wilkes-Barre around 1837. The steamboat, Susquehanna and Baltimore wrecked at Nescopeck Falls in 1826. Refer to West and North Branch discussions on the impact of rapids and falls. (Low-Medium.)

Archaeological Sites/Historic Sites: There are 74 archaeological sites on file in Harrisburg that exist along the North Branch. These sites were not clustered in specific areas as they are in the other branches. Only one area, Berwick, with 14, has more than a single digit total. The sites are located in 16 different quad map areas. (Medium-High.)

Dredging/Disturbance: Again, dams and floods are the major disturbance factors. There are 13 dams along the North Branch; Goodyear Lake Dam is the largest of these. Some limited channel improvements were made in the 1880s by the Army Corps of Engineers. Rocks were removed and minor dredging was completed around Wilkes-Barre. Refer to West Branch discussion. (Low-Medium.)

River Characteristics: The North Branch follows a winding course along its 160 mile length from the New York State line to Sunbury. It descends 337' for an average fall of slightly more than 2 feet per mile. (Low-Medium.)

Rank/Recommendation: The potential for the North Branch to yield submerged cultural resources is Low-Medium. Refer to Main Branch discussion.

Predictive Model for Resource Types: Refer to Main Branch discussion.

On-Site Investigation

Introduction

From May 7th to May 12th, 1984, a preliminary reconnaissance for submerged cultural resources was completed in the Delaware River. A five-member team from East Carolina University's Maritime History and Underwater Research Program assisted in the project. Work was conducted in various portions of the river that had been determined as "High" potential areas for possessing archaeological sites. A proton procession magnetometer and a recording fathometer were utilized in the reconnaissance. A follow-up, two-day project was completed August 4-5, in an attempt to identify the sources of several of the most promising remote sensing targets.

The primary objective of the on-site project was to compile as much remote sensing information as possible during the six days. A second objective was to locate a specific archaeological site, from which future archaeological work may be generated. The reconnaissance produced a total of thirty-nine substantial magnetic targets or target clusters. While diving on targets was limited, many of the magnetic anomalies may reliably be dismissed as modern debris or other non-historically significant objects. Thirteen derelict vessels and the visible remains of one shipwreck were observed. One target proved to be the remains of a small, mid- to late-nineteenth century sailing vessel.

Location of Work Areas

The first three days of the reconnaissance were devoted to the following areas above Philadelphia: (1.) Poquessing Creek to Andalusia (behind Mud Island), (2.) Biles Island Creek and Vicinity, (3.) Pennsbury Manor to the mouth of Martins Creek, (4.) Bristol and vicinity. In each area the survey was completed between the Pennsylvania side of the main channel and the Pennsylvania shore. The final three project days were devoted to the following areas around and below Philadelphia: (1.) Little Tinicum Island and the mouth of Darby Creek, (2.) Adjacent to Red Bank National Park (N.J.), (3.) off Woodbury Creek (N.J.), (4.) along the Mantua Creek Anchorage, (5.) off League Island, and (6.) behind Petty Island. (see Fig. 16.)

Methodology

Three types of surveys were used to achieve the objectives of the reconnaissance: (1.) a controlled survey of a specific "High" potential area, (2.) an attempt to relocate and establish the position of "known" shipwreck sites, and (3.) a random survey along specified portions of the river. A controlled survey was undertaken in two of the work areas, behind Little Tinicum Island and behind Petty Island. An attempt was made to relocate the remains of a reported 18th century vessel off Woodbury Creek, in the vicinity of Forts Mifflin and Mercer. Random surveying, ideal in river systems, was completed in the remaining six work areas. Emphasis was placed on Biles Island Creek and vicinity. To supplement the remote sensing information, divers inspected several of the targets to identify the material responsible for generating the magnetic anomalies. The accompanying tables classify the results of the reconnaissance under three headings: Remote Sensing Targets, Derelict Vessels and Visible Shipwrecks.

A preliminary map and site assessment of a small nineteenth century vessel, which was discovered during the follow-up survey, will also be included.

Summary of Findings

The submerged cultural resource reconnaissance of the Delaware River resulted in the identification of thirty-nine significant magnetic targets, thirteen derelict vessels, one visible shipwreck and one submerged shipwreck in the nine work areas. Dives were completed in four of the work areas on ten targets or target clusters. The findings have been compiled in the following tables for each of the nine work areas.

Biles Island Creek and Vicinity (See Fig. 10.)

Work was concentrated in the Creek, along the river side of the island as far north as buoy "105" and south along the Pennsylvania side of the channel as far south as buoy "83." Analysis of magnetic remote sensing data confirmed the presence of eleven targets in this area. Dives were completed on four of the targets. Six derelict hulks were discovered and the visible remains of one shipwreck were observed.

Remote Sensing Targets

Target Number	Coordinates* All Zone 18	Magnetic Intensity and Type	Remarks
R.S. 01	N 4447180 E 522285	160g dipolar	Four pulse signature, in the vicinity of "submerged pilings" notation on chart. One in a series of three (R.S. 02 and 03) consecutive targets. Water depth 10'. Dives on target indicate the extensive mud and silt top layer effectively cover the material responsible for the target.
R.S. 02	N 4447150 E 522305	110g negative, monopolar	Eight pulse signature, thirty feet south of R.S. 01. The same bottom conditions exist.
R.S. 03	N 4447100 E 522340	80g positive, monopolar	Eight pulse signature, twenty feet south of R.S. 02. Similar bottom conditions exist.
R.S. 04	N 4446955 E 522440	120g positive, monopolar	Eight pulse signature, adjacent to boat ramp on Biles Island. Located over Perriwig Bar, just west of channel. While no diver inspected this target, it is assumed that a substantial layer of mud is present on the bottom, effectively covering any material responsible for the anomaly.

*U.T.M. easting, northing.

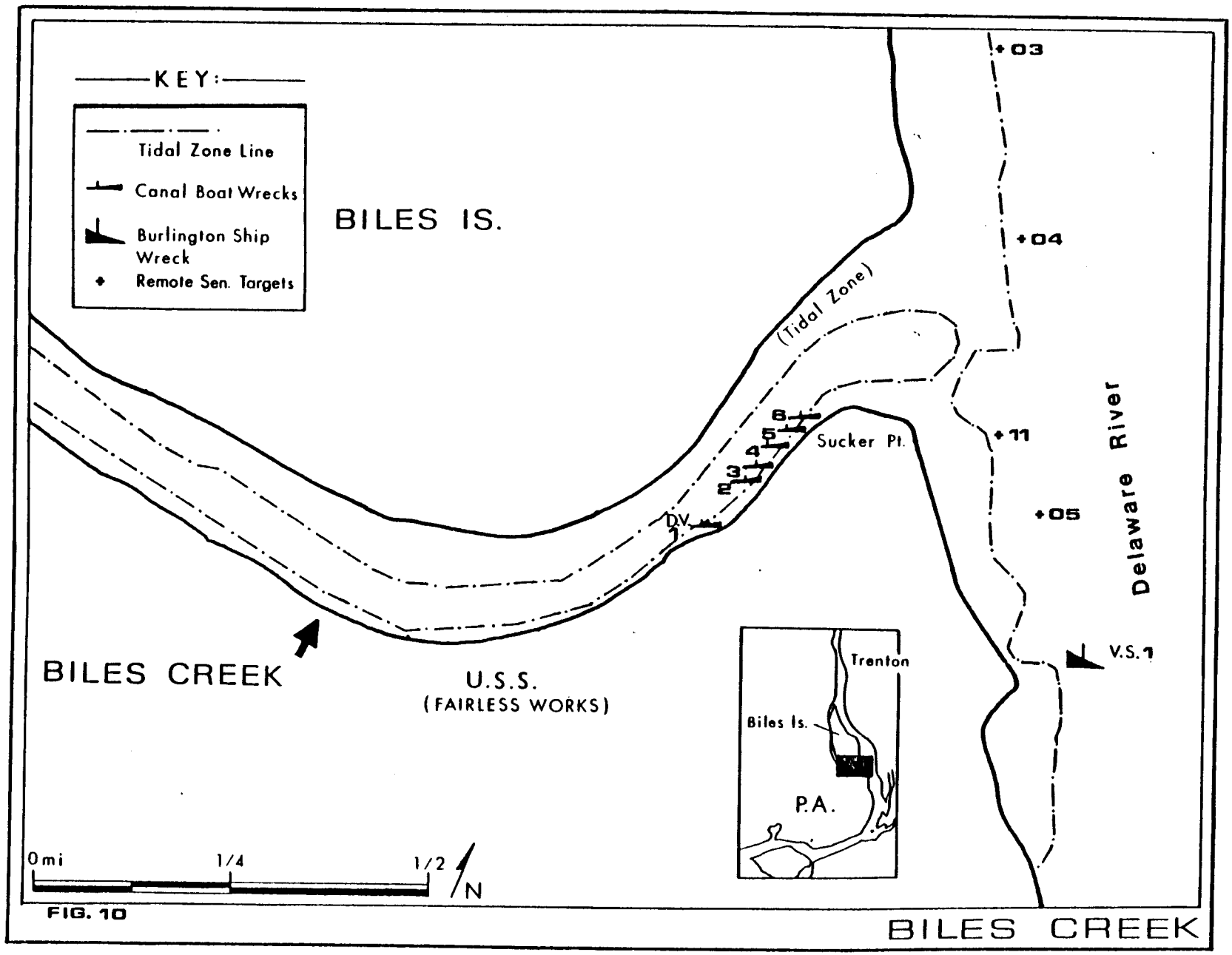
Target Number	Coordinates	Magnetic Intensity and Type	Remarks
R.S. 05	N 4446730 E 522620	60g dipolar	Eight pulse signature, located just south of the mouth of the Biles Island Creek. Similar in intensity and duration to surrounding targets; again assumed to be covered by a substantial layer of mud.
R.S. 06	N 4446505 E 522725	930g negative, monopolar	Twenty-two pulse signature, related to the visible remains of the Burlington. See Shipwreck Listing.
R.S. 07	N 4444490 E 523605	60g positive, monopolar	Five pulse signature, located just north of buoy "89." Near the mouth of Crosswicks Creek, N.J. It appears to be an isolated insignificant target.
R.S. 08	N 444405 E 523480	68g negative, monopolar	Eight pulse signature, just southwest of the mouth of Crosswicks Creek. Water depth 12'.
R.S. 09	N 4443665 E 523145	290g negative, monopolar	Eleven pulse signature, located across from Fieldsboro, N.J. Apparently associated with R.S. 10, which is located 30 yards to the south. This target generated a significant signature but the bottom is likely covered by a thick mud layer.
R.S. 10	N 4443630 E 523110	195g positive, monopolar	Nine pulse signature, likely associated with R.S. 09. Similar bottom conditions exist.
R.S. 11	N 4446705 E 522545	340g negative, monopolar	Thirteen pulse signature, located in the mouth of Biles Island Creek. Diver discovered modern debris; 1" diameter wire cable and a section of 5" diameter pipe. Water depth 8'.

Derelict Vessels

Vessel No.	Coordinates	Type	Remarks
D.V. 01	N 4446490 E 522295	Lehigh Canal Navigation (LCN) Canal Boat	Located in Biles Island Creek. Boat was measured and found to be 86' 6½" long with a beam of 10' 6", and 2" planks. This was the best preserved of the six vessels in the creek. It appeared to be resting on a platform which would have allowed the vessel to be loaded and unloaded at low tide. Wreckage of a derelict pier and platform is visible along the length of the Pennsylvania shoreline just inside the mouth of the creek. The vessels date to approximately the late 19th or early 20th century. (see fig.
D.V. 02	N 4446510 E 522310	LCN Canal Boat	
D.V. 03	N 4446590 E 522320	LCN Canal Boat	
D.V. 04	N 4446600 E 522325	LCN Canal Boat	
D.V. 05	N 4446630 E 522330	LCN Canal Boat	
D.V. 06	N 4446650 E 522335	Scow	Next to several of the Canal Boats, apparently utilized in a similar manner.

Visible Shipwrecks

V.S. 01	N 4446505 E 522725	Iron hull, center paddlewheel steamer	The site of the Burlington, which struck a submerged object and sunk off Fairless Hills in the summer of 1910. The lower portions of the hull are in good condition. Her bow and portions of her forward deck are visible at low tide. Portions of her machinery appear to be well preserved; the piston cylinder, bell crank and walking beam are each partially visible. She rests in a mud shoal approximately 100' from the Pennsylvania shore.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Canal Boat Wrecks
Burlington Ship Wreck
Remote Sen. Targets
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(Tidal Zone)
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BILES CREEK

FIG. 10

Pennsbury Manor to the mouth of Martin's Creek

Work was completed along the Pennsylvania side of the channel along a lane approximately 150' off-shore. The survey extended from buoy "75" to the north down to buoy "60" near Martin's Creek to the south. Analysis of magnetic remote sensing data confirmed the presence of six targets. A dive was completed on one of these targets. There were no derelict vessels observed.

Remote Sensing Targets

Target Number	Coordinates	Magnetic Intensity and Type	Remarks
R.S. 12	N 4441875 E 519390	80g positive, monopolar	Seven pulse signature, located just south of the manor. Water depth 12'. An isolated target.
R.S. 13	N 4441420 E 518805	285g negative, monopolar	Sixteen pulse signature, located equidistant between Money Island Dam and buoy "71." A large signature, with extended duration. Water depth 13'.
R.S. 14	N 4441005 E 517780	420g multicomponent	Twelve pulse signature, located on Kinkora Bar, midway between buoys "65" and "69". The extensive, radical reading gives an indication that this target was generated by modern debris. Water depth 12'.
R.S. 15	N 4441245 E 517205	720g multicomponent	Twenty-one pulse signature, located just below the mouth of Money Island Creek. A substantial anomaly which was not investigated by divers. Water depth 14'.
R.S. 16	N 4441425 E 516765	400g negative, monopolar	Seventeen pulse signature, located just north of buoy "63" and adjacent to a small inlet on the Pennsylvania shore. Water depth 15'. A diver identified two large iron and wood pads, the type used to load heavy equipment.
R.S. 17	N 4441450 E 516605	105g negative, monopolar	Nine pulse signature, adjacent to a "ruins" notation of the navigational chart, just north of buoy "60." An isolated target that was not inspected.

Bristol and Vicinity

Work was completed on the Pennsylvania side of the channel in a lane approximately 150' from shore. The lane extended from buoy "51" above Bristol to buoy "39 below Otter Creek. There was a considerable amount of background disturbance. However, no remote sensing targets were recorded. No derelict vessels were observed.

Poquessing Creek to Andalusia (See Fig. 11.)

Work was initiated on the main channel side of Mud Island, progressing southwest around the western end of the island and continued northeast along the Pennsylvania shore to Andalusia. Analysis of magnetic remote sensing information confirmed the presence of five targets. No derelict vessels were discovered. There were no dives completed on any of these targets.

Remote Sensing Targets

Target Number	Coordinates	Magnetic Intensity and Type	Remarks
R.S. 18	N 4433890 E 502660	160g positive, monopolar	Six pulse signature, located behind Mud Island, directly between the Torresdale Range markers. Water depth 9'. Target was situated near the shore and may be possibly associated with development onshore.
R.S. 19	N 4433905 E 502475	325g dipolar	Nine pulse signature, directly offshore from a privately owned pier on the Pennsylvania shore behind Mud Island. Water depth 7'. Target assumed to be associated with modern shoreline activity.
R.S. 20	N 4433935 E 502555	95g multicomponent	Fifteen pulse signature, located just east of a small inlet behind Mud Island. Water depth 6'. Likely a cluster of small targets.
R.S. 21	N 4434300 E 503860	390g Multicomponent	Fifteen pulse signature, located fifty yards east of the Biddle estate. An extremely noisy target, possibly caused by the natural rock bottom found in this portion of the river.

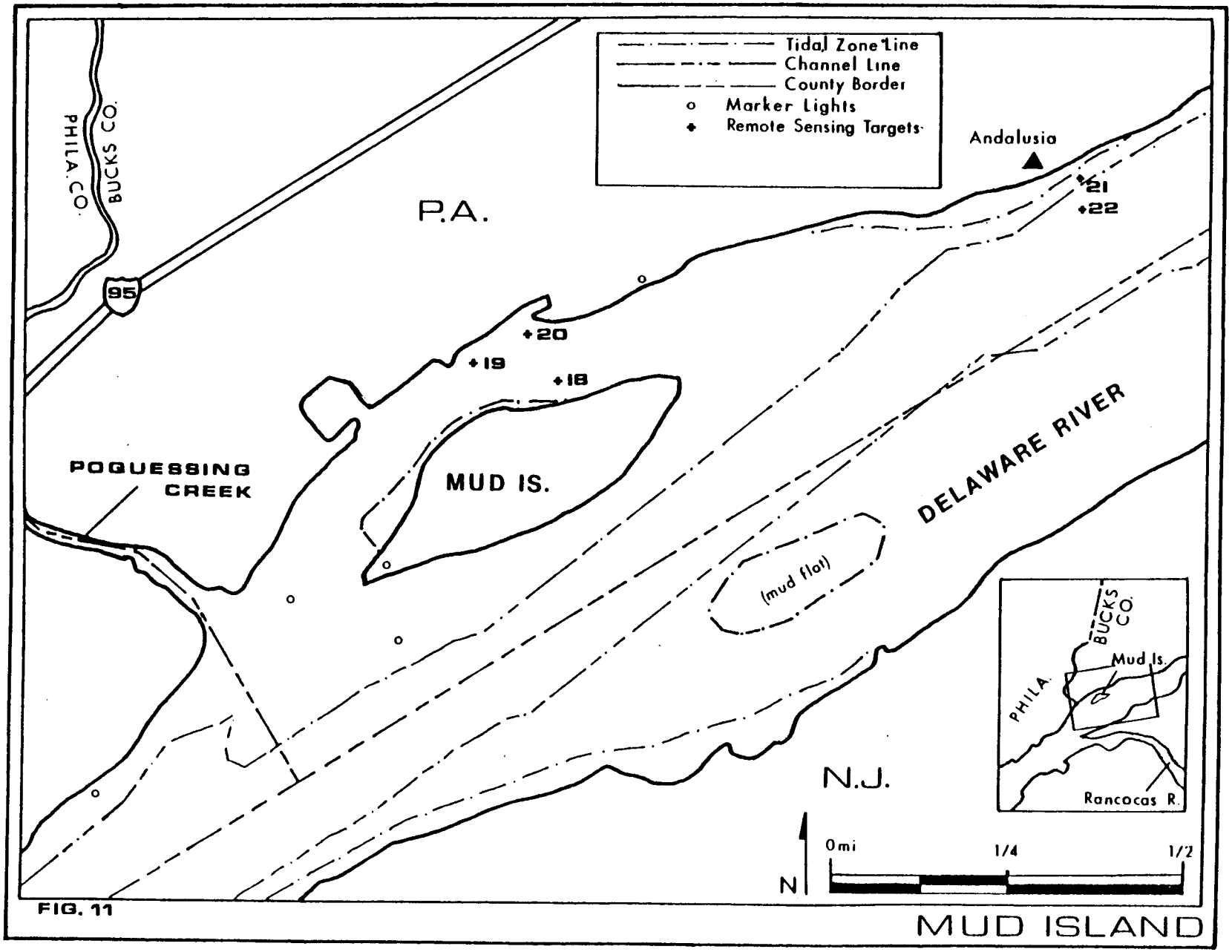


FIG. 11

MUD ISLAND

Target Number	Coordinates	Magnetic Intensity and Type	Remarks
R.S. 22	N 4434205 E 503880	880g multicomponent	Twenty-seven pulse signature, located further offshore (100 yards) from R.S. 21. Similar bottom conditions.

Petty Island (See Fig. 12.)

Six survey lanes were completed behind the southwestern portion of Petty Island. The initial lane was run between the "P" buoy which marks the entrance of the back channel, and the "C-1" buoy adjacent to the mouth of the Cooper River Each succeeding lane was completed 50' closer to Petty Island. The sixth lane was terminated when the vessel encountered submerged wreckage associated with a derelict vessel. Analysis of magnetic remote sensing data confirmed the presence of five targets. Two derelict vessels were observed. No dives were completed.

Target Number	Coordinates	Magnetic Intensity and Type	Remarks
R.S. 23	N 4423110 E 489905	90g positive, monopolar	Nine pulse signature, located in the first lane, approximately halfway between the buoys. Water depth 18'.
R.S. 24	N 4422960 E 490455	95g dipolar	Fourteen pulse signature, located in the second lane, approximately 100' from buoy "C-1". Water depth is 18'.
R.S. 25	N 4423245 E 489800	810g multicomponent	Twenty-five pulse signature, located in the fourth lane. Target is associated with a partially submerged derelict vessel. Water depth 12'.
R.S. 26	N 4423190 E 489960	85g positive, monopolar	Six pulse signature, located in the fifth lane, approximately 150' from the start of the lane toward the Cooper River. Water depth 10'.
R.S. 27	N 4422940 E 490805	205g dipolar	Fourteen pulse signature, located while running a separate lane further up the Petty Island Back Channel.

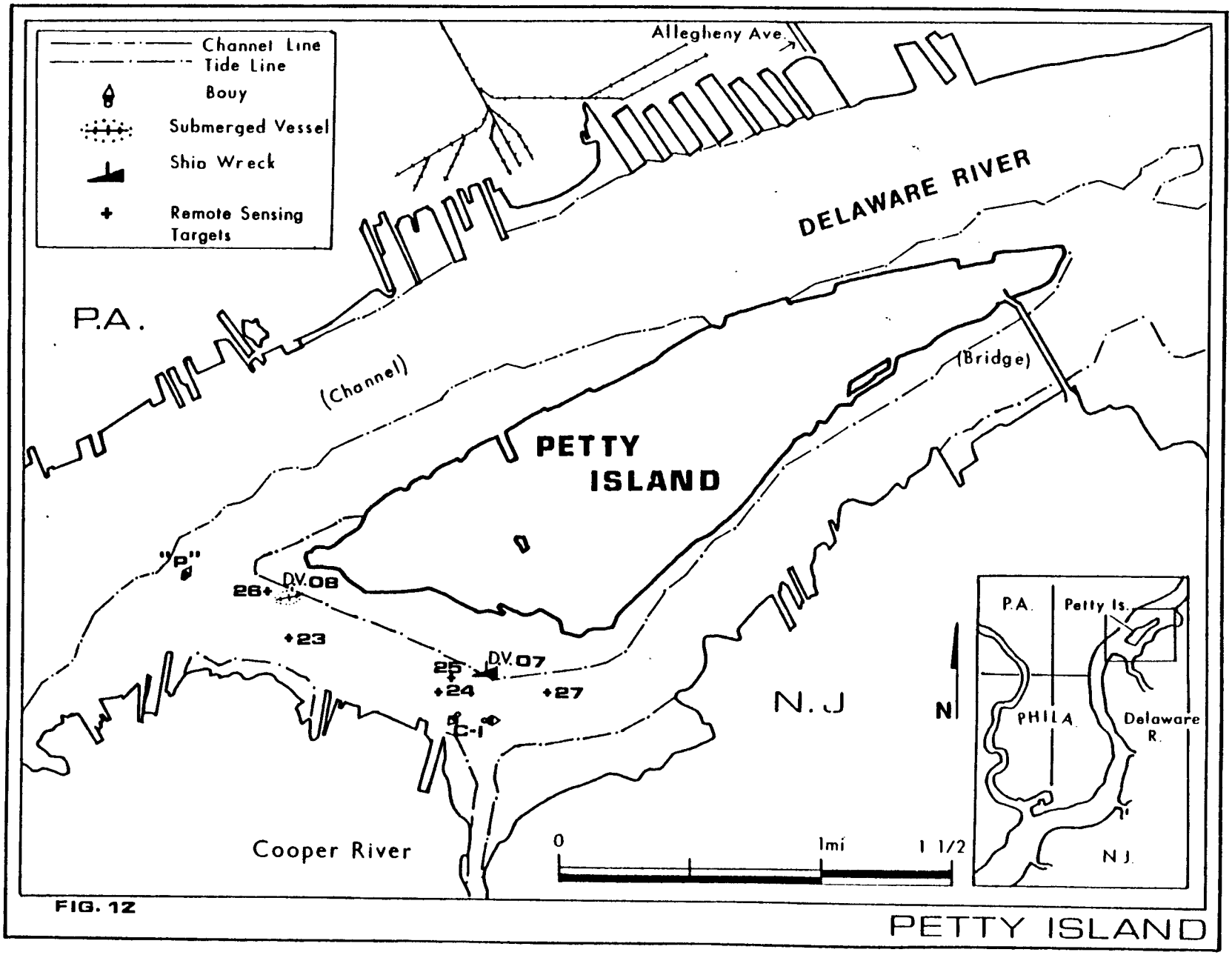


FIG. 12

PETTY ISLAND

Derelict Vessels

Vessel No.	Coordinates	Type	Remarks
D.V. 07	N 4423020 E 490565	A large wooden barge	The remains of this relatively modern (20th century) barge are located on the edge of the tidal flats behind Petty Island.
D.V. 08	N 4423275 E 489860	Undistinguishable	Approximately ninety percent of this stranded vessel is submerged. Also located on the shoal behind Petty Island.

Red Bank National Park

Work was completed from the mouth of Woodbury Creek north to just beyond the Childred's Sanitarium in Gloucester, N.J. The survey lane, approximately 200' from shore, passed behind a small island directly in front of where Fort Mercer once stood. Analysis of magnetic remote sensing date confirmed the presence of one target. The target was inspected by a diver.

Target Number	Coordinates	Magnetic Intensity and Type	Remarks
R.S. 28	N 4413655 E 483710	180g multicomponent	Twenty-two pulse signature, located directly between the small island and the Red Bank Monument. Water depth 20'. Diver located scattered 20th century material; angle iron, copper wire, bottles and plywood.

League Island

Work was completed from Pier 7, on the west to Greenwich Point on the east. The survey lane was 100 yards from the shore and crossed over Horseshoe Shoals. A large amount of background noise was encountered and no remote sensing targets were discovered.

Woodbury Creek

Work was completed between the white run buoys "C" and "D", which marked the northern end of the Mantua Creek Anchorage. Dredging operations in the 1940s brought a series of 18th century artifacts to the surface. Furthermore, a reported 18th century site had been encountered by a diving expedition in the 1970s. The search was concentrated along the drop-off shelf, where the natural 15'-18' bottom has been dredged to 40'. Analysis of magnetic remote sensing data confirmed the presence of three targets. Each was investigated by divers and the remains of a small, mid to late 19th century vessel were discovered in the general vicinity of one target. No derelicts were observed.

Target Number	Coordinates	Magnetic Intensity and Type	Remarks
R.S. 29	N 4413220 E 482795	1,180g multicomponent	Twenty-two pulse signature, located one-third of the way between buoy "C" and buoy "D". Water depth 35'. Diver found large wire cable (two inch diameter) strewn over a hard mud bottom. The cable which stretches over a vast area could possibly "mask" a historic site located beneath it.
R.S. 30	N 4413185 E 482655	690g multicomponent	Twenty-one pulse signature, located approximately 100' northeast of buoy "C". Water depth 40'. The magnetic target corresponded with an anomaly on the fathometer. A diver located a large metal sled type of structure, similar to a skid frame with box beams (approximately 20'x 15').
R.S. 31	N 4413245 E 482940	640g multicomponent	Seventeen pulse signature, located approximately 150' southeast from R.S. 29. Water depth 25'. Diver found cable wire again. While searching the perimeter of the target location, he discovered the remains of an estimated 40' long, mid-late 19th century sailing vessel. See accompanying preliminary site assessment.

Mantua Creek Anchorage

Work completed along the east side of the Mantua Creek Anchorage, marked by buoys "B" and "C". The Anchorage is located between the mouths of Mantua and Woodbury Creeks, on the New Jersey side of the channel. There was a considerable amount of background disturbance, pipelines between oil refineries on each shore distorted some readings. However, analysis of the magnetic remote sensing information confirmed the presence of two targets. A dive was completed on one target.

Target Number	Coordinates	Magnetic Intensity and Type	Remarks
R.S. 32	N 4412360 E 481610	165g dipolar	Eight pulse signature, located directly across the river from Philadelphia Airport central tower. The target correlated with a 10' contour on the bottom.
R.S. 33	N 4412810 E 482295	480g multicomponent	Eighteen pulse signature, which became partially masked by disturbance eminating from a barge positioned next to the anchorage. A diver found only scattered modern debris. He searched along the contour deliniating the perimeter of the anchorage.

Little Tinicum Island and Essington (See Fig. 13.)

Seven controlled survey lanes were completed behind Little Tinicum Island and in the vicinity of the mouth of Darby Creek. Four lanes southwest of Little Tinicum Island, in toward the Pennsylvania shore between Darby Creek and the Lazaretto Sea Plane Base (in Essington). Three lanes were completed along the Essington waterfront. To control these three lanes, six range points were established on shore to accurately mark the lanes. Analysis of remote sensing data confirmed the presence of six targets. Dives were completed on two targets and in front of the sea plane base. One derelict vessel was observed.

Remote Sensing Targets

Target Number	Coordinates	Magnetic Intensity	Remarks
R.S. 34	N 4412050 E 473025	245g positive, monopolar	Eleven pulse signature, located in Lane 1, just before the mouth of Darby Creek. The target was on the shoulder of the channel into the creek. The water depth varied from 5' to 12'. Bottom was composed of consolidated mud, interspersed with sand. No evidence of the target was located on the bottom surface. Pieces of iron stalagtide were found approximately one foot below the mud layer.
R.S. 35	N 4411595 E 475500	260g negative, monopolar	Twenty-six pulse signature, located in Lane 6, adjacent to wreckage on Little Tinicum Island. Target was not inspected.
R.S. 36	N 4411700 E 473940	198g positive, monopolar	Twenty-four pulse signature, located in Lane 6 across from Corinthian Yacht Club. The gravel and mud bottom was 15' deep. No material was located on the surface of the bottom besides scattered modern debris.
R.S. 37	N 4411870 E 473645	140g positive, monopolar	Eighteen pulse signature located in Lane 7. Water depth 10'.
R.S. 38	N 4411850 E 473875	120g dipolar	Eleven pulse signature, located in Lane 7 opposite the Corinthian Yacht Club. Many engine blocks reportedly litter the bottom here. They were once used as mooring anchors.
R.S. 39	N 4411790 E 474415	160g dipolar	Thirteen pulse signature, located in Lane 7, opposite the Mobile Dock in Essington. Engine blocks were placed in this area as well. Diver found that the bottom was hard mud out away from the docks and extremely silted over under the piers where the influence of the current was negligible.

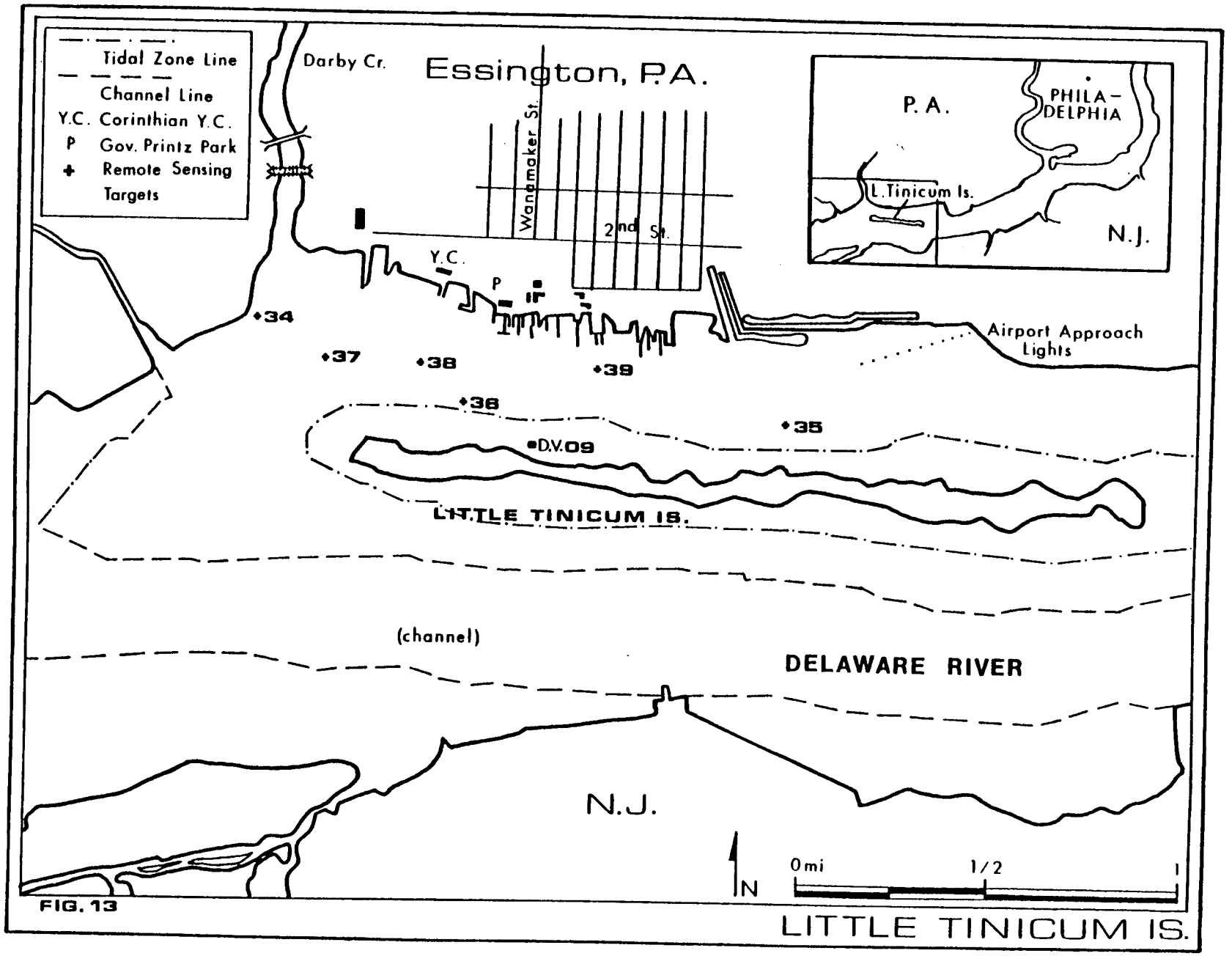


FIG. 13

LITTLE TINICUM IS.

Derelict Vessels

Vessel No.	Coordinates	Type	Remarks
D.V. 09	N 4411395 E 474550	Wooden, center-board vessel	Vessel lies on the tidal flat on the back channel side of Little Tinicum Island. It is fully visible at low tide, approximately 50' long. Appears to date from mid-20th century.

Historic research revealed the location of three 4-masted schooners, and a brief visual survey was conducted on these vessels. In the midst of the inspection, a fourth vessel was discovered. All vessels lie at Piers 76-78 in South Philadelphia's waterfront.

Vessel No.	Coordinates	Type	Remarks
D.V. 10	N 4418870 E 488160	4-masted schooner, wooden	Marie Cummins, lying on its port side, apparently caused by dredge removal after it was burned. The furthest south of the vessels.
D.V. 11	N 4418890 E 488160	4-masted schooner, wooden	Francis McDonald, a round-sterned converted coal barge. Most of it is submerged, little is exposed above the low tide mark.
D.V. 12	N 4418910 E 488165	4-masted schooner, wooden	Albert Cummins, best preserved of the vessels. The main deck and bulwarks are mostly in fair-good condition. Most of the poop deck gone, and the forward bulkhead is in place. 10-12' of the foremast is intact. The hatchs are also intact. This is possibly the best preserved 4-masted schooner in the country.
D.V. 13	N 4418930 E 488165	Iron-hulled, center paddle-wheel steamer	North of the schooners. This pier was formerly a ship repair yard and this vessel's name might be found through research of that yard. Remnants of the "A-frame" of a walking beam engine are visible. Otherwise, the only visible part of the vessel is the top of the iron hull which is intact from approximately amidships on the starboard side up to the bow. Portions of the port side are also visible near the bow. Appears similar to vessels built at Harlan and Hollingsworth throughout the second half of the 19th century.

Appendices

PENNSYLVANIA UNDERWATER ARCHAEOLOGICAL SITE FORM

Site Number D.R. 01 Site Name Mantua Anchorage Wreck

Location Offshore from the mouth of Woodbury Creek, adjacent to the northeast boundary of the Mantua Creek Anchorage in the Delaware River. Just below the Philadelphia Navy Yard, between Forts Mifflin and Mercer.

Map Reference NOAA, Phila.-Camden Waterfront Chart and Woodbury Quad Sheet

Coordinates (U.T.M.) Zone 18 Northing 4413254 Easting 482940

Site Conditions: Depth of Site 25'

Bottom Type Hard mud

Visibility 2' (with light) on outgoing tide; 0'-6" on flood tide.

Currents Approximately 2-3 knots on flood tide

Other Conditions bottom appears to have been dredged.

Site Size: Core area 20' x 40' Maximum Dispersion 30' x 50'

Items Recovered: Anchor (sketched, photographed and returned to site), one cast iron tea kettle, one pair of coal tongs, one iron spike, one brick with one side rounded off.

Collection in Possession of Philadelphia Maritime Museum

Type of Site (with a projected date) A mid-late 19th century wooden sailing vessel. A small vessel, likely 30' to 50' long. It is estimated that it is a 2-masted boat, possibly a schooner. The wreck, or what is left of it is lying in two sections, appearing to have been disturbed by dredging.

State of Preservation Wood that is left is in good condition. Iron artifacts, good.

Possibility of Destruction Has already been disturbed, possibility of future disturbance - likely.

Sketch Map (on back or attach)

Submitted by Lee Cox Date August 21, 1984

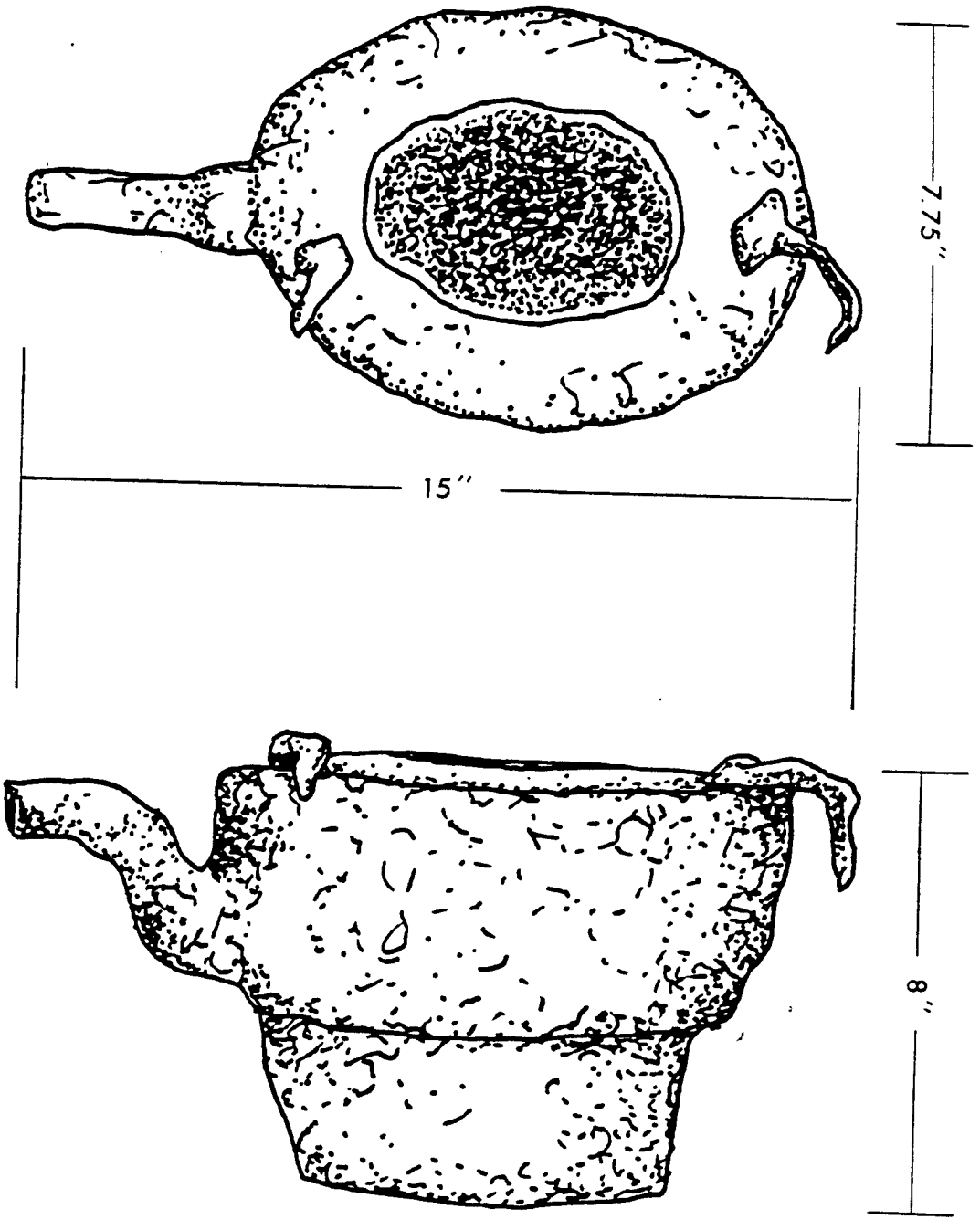
Approx. 1/2 scale

15.25"

10.75"

TONGS + ROD FROM D.R. 01

Approx. 1/3 scale



TEA KETTLE D.R.01

MAJOR SHIPYARDS (See Fig. 14.)

Chester and Vicinity

Name	Date	Map Number
Barton (Marcus Hook)	ca. 1910	NS
Chester Shipbuilding	-	1
N. F. Palmer Jr. & Co.	-	2
Pioneer Iron Works (Marcus Hook)	ca. 1800-1881	NS
Thomas Reaney, Son & Archbold	1859-1871	3
*John Roach and Sons	1872-1885	4
*Delaware River Iron Shipbuilding and Engine Works	1885-1907	4
**Sun Shipbuilding and Dry Dock Co.	1916-1981	5
**Penn Ship	1981 -	5

Philadelphia

American Shipbuilding Co. of Philadelphia (Port Richmond)	-	NS
American International Shipbuilding Corp. (Hog Island)	1918-1921	6
T. Birely	ca. 1850s	NS
John Birely & Son	ca. 1850s	NS
Birely & Lynn	ca. 1850s	NS
Samuel Bowers & Thomas Vaughan, Jr.	early 1800s	NS
Parrock Brown	ca. late 17th, early 18th cent.	7
William Brown	ca. 1810	NS
Thomas Brown & Sons	ca. 1870s	NS
Warwick Coats (Southwark)	-	NS

* Names of the same yard
** Names of the same yard

Philadelphia (Continued)

Name	Date	Map Number
*Cramp's Shipyard	1830-1872	8
*Wm. Cramp & Sons Ship and Engine Building Co.	1872-1900	8
*The Kensington Shipyard Co.	1900-1927	8
*Cramp Shipbuilding Co.	1940-1945	8
Manuel, Jehu & Benjamin Eyre (Kensington)	ca. mid-18th cent.	NS
Grice & Coats	-	NS
Samuel Grice	ca. early 19th cent.	NS
Joseph & Francie Grice (Southwark)	ca. 1780s	NS
John Hammitt	ca. 1850s	NS
Charles Hillman & Sons Ship and Engine Building Co.	ca. mid-19th cent.-1900	9
Hillman & Streaker (Kensington)	ca. 1850s	NS
Humphreys, Hutton & Delavane	-	NS
Joshua Humphreys	ca. 1790-1803	10
Samuel Humphreys	ca. 1800-1820	NS
Benjamin Hutton	ca. 1812	NS
Nathaniel Hutton	-	NS
Levy (Federal Street)	-	NS
**Lynn Family	ca. 1717-1860s	12
**John W. Lynn	ca. 1850s-1860s	12
Merchant Shipbuilding Corp. (1 yard at old Roach Yard) (1 yard at Bristol)	ca. 1917-1921	NS

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* Names of the same yard
** Names of the same yard

Philadelphia (Continued)

Name	Date	Map Number
*Neafie, Reaney & Smith	1838-1845	13
*Neafie, Reaney & Co.	1845-1859	13
*Neafie & Levy	1859-1891	13
*Neafie & Levy Ship and Engine Building Co.	1891-1907	13
Joseph Ogilby (Southwark)		14
Penrose Family	1707-1845	15
Philadelphia Navy Yard (Original)	1802-1880s	16
Philadelphia Navy Yard (League Is.)	1880s -	17
Benjamin Phillips	ca. 1810	NS
A.S. Simpson & Bro.	ca. 1828	NS
J. Simpson & Neill	ca. 1855	18
Moses Starr & Sons	-	NS
Jesse W. Starr (Kensington)	ca. 1829	NS
Steward & Walters	ca. 1850s	NS
James T. Sutton & Co.	ca. 1840s	NS
Tees & Van Hook (Kensington)	-	NS
Traylor Shipbuilding Corp. (Cornwells Heights, Pa.)	ca. 1919	NS
Robert Turner	-	19
Nicholas Van Dusen	ca. early 19th cent.	NS
Van Dusen & Birely	-	NS
Thomas Vaughan, Jr. & Samuel Bowers (Kensington)	ca. early 1800s	-
John Vaughan	1810-1833	-

*Names of the same yard ("Penn Works").

Philadelphia (Continued)

Name	Date	Map Number
Thomas Vaughan, Jr. & John Haines (Hanover St., Kensington)	ca. 1827	-
Thomas & John Vaughan (Marlborough St., Kensington)	ca. 1828	-
*John Vaughan & Son (Kensington)	1833-1846	-
*Vaughan & Lynn (Shackamaxon St.)	1847-1857	-
Vaughan & Griffith (Allen St., Kensington)	1837-1839	-
Vaughan & Fisher (near Shackamaxon St.)	1851-1863	-
William West & Family	ca. 1683-1800	20
Wharton & Humphreys	1774-1790	21
White Shipyard (Kensington)	ca. late 18th, early 19th cent.	NS

Camden and New Jersey

John Dialogue & Sons	1862-1914	22
Holmes, Shaw, Brown & Co. (Bordentown)	ca. 1876	NS
J. H. Mathis Co.	ca. 1907-1940s	23
D. S. Mershon (Bordentown)		24
National Iron, Armor & Shipbuilding Co.	ca. 1862-1864	NS
New York Shipbuilding Co.	1899-1968	25
Penn-Jersey Corp.		26
Pennsylvania Shipbuilding Co. (Gloucester)		27
John Trumpy		28
Wilcox & Witting		29
Wood & Dialogue (River Iron Works Kaighn's Point)	ca. 1872	NS

* Names of the same yard.

DELAWARE RIVER SHIPWRECKS

Date	Name	Where	Type	How
1757	Sally	Brandywine	NA	Foundered
1757	Pusey	Reedy Island	NA	Foundered
1760	Molly	Delaware River	NA	Sank
1766	Charlestown	Brandywine	NA	Wrecked
1768	Kildare	Mouth of river		"
1775	Endeavor	Reedy Island		Fire & Sank
10/1777	Washington	White Hill, N.J.	Frigate (32)	Scuttled, la burned
10/1777	Effingham	White Hill, N.J.	Frigate (28)	"
11/1777	Sachem	off League Island		
11/1777	Independence (10)	"	NA (10)	Burned
11/1777	Dolphin	"	NA (10)	"
11/1777	Andria Doria	near League Island	Brig (14)	"
11/1777	Xebecks	"	Brig	"
11/1777	Repulse	"	Brig	"
11/1777	Champion	"	Brig	"
11/1777	Wasp	"	NA (8)	"
11/1777	Mosquito	"	NA (4)	"
10/1777	Augusta	mouth of Mantua Creek	Frigate (64)	Explosion
10/1777	Merlin	off of Mantua Creek	Sloop of War (20)	Scuttled
11/1777	unknown (20)	Camden	Small sloop	Burned
11/1777	Montgomery	near League Island	Brig (20)	"
11/1777	unknown	"	floating battery	"
11/1777	unknown	"	" "	"
5/1778	unknown	Bordentown	Ship (18)	"

Date	Name	Where	Type	How
5/1778	unknown	Bordentown	ship	Burned
5/1778	unknown	"	privateer sloop	"
5/1778	10 unknown	"	brigs, schooners & sloops	"
5/1778	Sturdy Beggar	Crosswicks Creek	privateer (18)	"
5/1778	8 unknown	"	brigs, schooners & sloops	"
5/1778	unknown	Biles Is. Creek	schooner (14)	"
5/1778	unknown	"	sloop (16)	"
5/1778	"	"	schooner (10)	"
5/1778	"	"	sloop (16)	"
5/1778	" (50)	"	sloop	"
5/1778	"	"	"	"
5/1778	6 unknown ships	Bristol	brigs & schooners	"
5/1778	2 unknown	"ferry above Bristol"	sloops	"
1784	Peace (60)	Hog Island	NA	Wrecked
12/5/1790	John	near Philadelphia	merchantman	"
1790	Alliance	Petty's Island	frigate	Abandoned, broken up
1790?	Perseverance	"	steamer	Abandoned
1796	Minerva	mouth of river	merchantman	Wrecked
1800	George	at Philadelphia	"	Sank
1800	unidentified	near mouth of river	NA	Sank
1816	Phoenix	mud flats of Kensington	steamer	scrapped
3/15/1856	New Jersey	opp Pearl St., Camden	ferry	fire, explosi
winter 1809-10	17 unidentified vessels crushed by ice and lost			

Date	Name	Where	Type	How
1863	John Teux	"foot of Race St."	NA	Ice
9/28/1875	Marian Gage	"near 'Miah Maul Shoal' Del. River"	schooner, wood	wrecked Achilles
1/1/1876	Francis Jane	Phila. Harbor	oyster schooner, wood	sunk
11/29/76	St. Fields	Chester	steamer, wood	Fire
2/23/77	George A. Twibill (90)	Tinicum Island	canal schooner, wood	Rammed by S.S. Ohio
5/19/77	Armenia Bartlett	12 Miles no. of Hog Island	schooner	Aground
4/6/78	Sophia Wilson	near Hog Island	schooner, wood	sunk, rammed schooner Townsend Adeline
1/26/79	Gavin Woodward	opposite Hog Island	schooner, wood	Ice
2/8/80	Emma	off Chester Creek	sloop, wood	Ice
10/19 1880	Mary Taulane	1 mile west of Chester Creek	schooner, wood	Rammed by tug John Marker
3/12/82	Ella	Pier 8, So., Phila.	steam tug, wood	Fire, explosi
3/12/82	Henry C. Pratt	"	steam tug	" "
11/30/83	M. Massey	Chester	steam propeller, wood	Fire
7/27/84	Sallie Mair	near Hog Island	schooner	foundered on submerged wrec
9/19/84	J.B. Woodward	Chester	tug	Fire
10/22/84	B. Bradley	Between League Is. & Schuylkill River	schooner	Capsized
12/5/85	Taylor M. Uhler	Pier 40 N., Phila.	steam tug	sunk
12/12/85	John B. Hegeman	below Billingsport, N.J.	schooner, wood	Collision with SS Centipede
1/10/86	Jas. Kelley	mouth of Pennypack Creek	tug, wood	Fire
12/24/86	Marcella	Almond St. Wharf, Philadelphia	tug	fire, explosion

Date	Name	Where	Type	How
3/21 1887	Emma	Jeffrey St. Wharf, Chester	tug, wood	Fire
5/2/87	Grace K. Green	mouth of Schuylkill River	schooner, wood	Sunk after l ting obstruc ion, later refloated
12/22/87	Sagua	opposite Billingsport, N.J.	brig	collision wi schooner Ann C. Grace
10/26/88	W.N.Graham	1 mile above Christiana Creek	steam tug	capsized and sunk
6/22/89	Taylor M. Uhler	Christian St. Wharf	steam tug, wood	sunk
7/13/90	Benjamin Hooley	Bainbridge St. Wharf	steam tug, wood	capsized fro ferry boat swells & sun
6/26/91	Col.S.L. Brown	Pier 40 S., Phila.	steam tug, wood	Fire
10/29/91	George E. Weed	Del. River	steam tug, wood	collided wit tug James Brown
1/22/92	Josie	Plum St. Wharf, Port Richmond, Phila.	steam tug, wood	Fire
9/3/92	Yankee Doodle	inside Tinicum Island, near the Pa. shore	steam yacht	Fire
10/12/92	Excelsior	Roaches Wharf, Chester	steamer, wood	Fire
11/1/92	Maryland	Point Breeze, Phila.	tug, wood	fire, oil in river ignited & burnt tug
12/12/92	David Smyth	5 miles below Bridesburg	tug, wood	Fire
12/31/92	Ellen McAvey	Port Richmond, Phila	tug, wood	ice
1/17/93	Sallie	"below Cramps shipyard"	tug, iron	ice
5/11/93	C.N.Armstrong	"off Petty's Island"	steam tug	Fire
8/29/93	Nellie S. Tygert	Del. River	steam tug	struck log & sunk
1/24/94	Sarah Louisa	"five-mile pt.", Phila.	NA	Fire
9/23/94	Belmont	off Cooper Pt., Camden	steamer, steel	Fire

Date	Name	Where	Type	How
9/28/94	S. Shaw	William St. Wharf, Phila.	Steamer	Fire
10/4/94	Mary R. Con	"between Bridesburgh & 5-mile point"	Tug, wood	Fire
8/2/95	Owego	"Pa. shore opposite Gloucester, N.J."	Steam yacht, wood	struck sunke canal boat (Augusta?)
8/14/95	S. Shaw	Gillingham Wharf, Phila.	tug	Fire
6/14/97	Lulu B. Grammer	Point of Tinicum Is.	tug, wood	Fire
7/16/97	A.R. Gray	off Andalusa, Pa.	tug, wood	Fire
12/31/98	Lottie	Tulleytown Wharfs, Bucks Co.	tug, wood	Fire
11/30/98	Clara	opposite Tinicum Is., west of Thompson's Pt.	2-masted schooner, wood	run down by steamer Errickson wh at anchor
8/15 1900	S.S. Bermuda	Pier 19 S., Phila	steamer	sunk, mast removed in 1904
11/28 1900	John B. Patton	off Laurel St. Wharf, Phila.	tug, wood	collision wi a barge towe by tug Winfi Cahill
3/20/01	Mary Baxter	"½ mile from Lincoln Park"	NA	run down by steamer Manhattan
8/28/01	City of Trenton	below Torresdale, Pa.	steamer, steel	boiler explosion
3/29/02	Edna Earl	vicinity of Reedy Pt., Del. River	schooner, wood	collision wit steamer Ramsdale
2/25/05	Southwark	off mouth of Mantua Creek	tug, wood	ice
1/9/1907	Nellie	"college wharf", Del. River	tug, wood	fire
4/22/07	Eden	near Tinicum Island	oysterboat, schooner rigged	"capsized in 39' of water"

Date	Name	Where	Type	How
6/28/07	Clara	opposite Market St.	towboat, iron	collision ferryboat Beverly, t beached
7/23/07	Jimmy	Tasher St. Wharf	steamer, wood	sunk
1910	City of Burlington	above Bordentown, off the Pa. shore	steamer, iron	struck sub merged dre cable & su
9/9/12	Imporator	channel off Salt Works' wharf	tug, wood	collision steampacke Riverside above Greenwich
1/3/1915	Mohawk	Kaighn's Pt., Camden	steamer, wood	burned fro fire at Pa. station and lumberyard
4/30/16	Zenith	west side of Tinicum Is.	Gas screw, wood	explosion & fire
6/14/17	Sarah A. Beckett	foot of 32nd St., Camden	Gas screw, wood	went adrift hit old wre
10/30/16	Governor Pennypacker	off Chester Island	steamship, iron	propeller h what seemed be obstruct of wood, br ing wheel completely
2/5/17	Cape May	opposite Camden Coke Co. wharf	ferry	"while enrou between Cam & Phila, au machine move backward entire lengt of boat broke throug gate & dropp from stern"
3/18/17	Fram	Pier 18, Port Richmond	barge, wood	foundered
11/1/17	Chester	off Lincoln Park, N.J.	steamer, iron	collision wi steamer Delaware
1/31/27	Juvigny	Del. River	screw, steel	collision wi S.S. Valemor

Date	Name	Where	Type	How
5/27/30	Wakefield	Horseshoe Shoal	Barge	Foundered
1932	Franklin	in Philadelphia	steamer, iron	burned
1946	Francis McDonald	Pier 78 S., Phila.	4-masted schooner, wood	burned
1946	Albert Cummins	"	"	"
1946	Marie Cummins	"	"	"

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