

National Register of Historic Places Multiple Property Documentation Form

This form is used for documenting property groups relating to one or several historic contexts. See instructions in National Register Bulletin *How to Complete the Multiple Property Documentation Form* (formerly 16B). Complete each item by entering the requested information. For additional space, use continuation sheets (Form 10-900-a). Use a typewriter, word processor, or computer to complete all items

New Submission Amended Submission

A. Name of Multiple Property Listing

Historic Resources of the Monongahela River Navigation System in Pennsylvania and West Virginia, 1838 - 1960

B. Associated Historic Contexts

Systematic Navigation Improvements to the Monongahela River, 1840 – 1960;
Boat-Building Industry in the Monongahela River Valley, 1758 – 1960;
Influence of the Monongahela River Navigation System on the Development of the Coal,
Coke, Iron and Steel Industries in the Monongahela River Valley, 1878 – 1960;
Monongahela Riverside Community Development, 1878 – 1960.

C. Form Prepared by

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Updated September 2010 - See Continuation Sheet

D. Certification

As the designated authority under the National Historic Preservation Act of 1966, as amended, I hereby certify that this documentation form meets the National Register documentation standards and sets forth requirements for the listing of related properties consistent with the National Register criteria. This submission meets the procedural and professional requirements set forth in 36 CFR 60 and the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation.
(See continuation sheet for additional comments.)

Andrea MacDonald | 12/2/2010
Signature and title of certifying official | Date
Pennsylvania Historical & Museum Commission
State or Federal Agency or Tribal government

I hereby certify that this multiple property documentation form has been approved by the National Register as a basis for evaluating related properties for listing in the National Register.

Signature of the Keeper | _____
Date of Action

Continuation Sheet.

D. Certification

As the designated authority under the National Historic Preservation Act, as amended, I hereby certify that this documentation form meets the National Register documentation standards and sets forth requirements consistent with the National Register criteria. This submission meets the procedural and professional requirements set forth in 36 CFR Part 60 and the Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation.

Susan M. Pierce

Signature and title of certifying official

3/18/05

Date

WV Deputy State Historic Preservation Officer
West Virginia Division of Culture & History

Historic Resources of the Monongahela River Navigation System
In Pennsylvania and West Virginia, 1838 - 1960

Pennsylvania and
West Virginia
State

Name of Multiple Property Listing

Table of Contents for Written Narrative

Provide the following information on continuation sheets. Cite the letter and title before each section of the narrative. Assign page numbers according to the instructions for continuation sheets in National Register Bulletin *How to Complete the Multiple Property Documentation Form* (formerly 16B). Fill in page numbers for each section in the space below.

| | Page Numbers |
|---|--------------|
| E. Statement of Historic Contexts | |
| (if more than one historic context is documented, present them in sequential order.) | |
| Summary and Background | E - 1 |
| Systematic Navigation Improvements to the Monongahela River, 1840 – 1960 | E - 21 |
| Boat-Building Industry in the Monongahela River Valley, 1758 – 1960: | E - 28 |
| Influence of the Monongahela River Navigation System on the Development of the Coal, Coke, Iron and Steel Industries in the Monongahela River Valley, 1878 – 1960; | E - 37 |
| Monongahela Riverside Community Development, 1878 – 1960. | E - 60 |
| F. Associated Property Types | |
| (Provide description, significance, and registration requirements.) | |
| Continuation Sheets | F 1 |
| G. Geographical Data | |
| Continuation Sheets | G 1 |
| H. Summary of Identification and Evaluation Methods | |
| (Discuss the methods used in developing the multiple property listing.) | |
| Continuation Sheets | H 1 |
| I. Major Bibliographical References | |
| (List major written works and primary location of additional documentation: State Historic Preservation Office, other State agency, Federal agency, local government, university, or other, specifying repository.) | |
| Continuation Sheets | I 1 |

Paperwork Reduction Act Statement: This information is being collected for applications to the National Register of Historic Places to nominate properties for listing or determine eligibility for listing, to list properties, and to amend existing listings. Response to this request is required to obtain a benefit in accordance with the National Historic Preservation Act, as amended (16 U.S.C.460 et seq.).

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United States Department of the Interior
National Park Service

Historic Resources of the Monongahela River
Navigation System in Pennsylvania and West
Virginia, 1838 - 1960

National Register of Historic Places Continuation Sheet

Section number C Page 1

C. FORM PREPARED BY

The basic research and documentation for the Multiple Property documentation were performed by Heberling Associates, Inc. for the Pittsburgh District, U. S. Army Corps of Engineers in 2000. An extended review period for the original submittals with the Pennsylvania and West Virginia state historic preservations offices coincided with multiple changes in the National Register electronic forms and changes in the individual properties proposed for nomination. These necessitated an updated version of the Multiple Property forms and individual nomination forms to reflect changes between 2000 and 2010, including extension of the original period of significance from 1950 to 1960.

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United States Department of the Interior

National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 1**SUMMARY**

Americans have always had a passion for movement and mobility. As settlers moved inexorably west, they searched for good, cheap transportation, and, after the Revolutionary War, the leaders of the fledgling nation recognized the importance of connecting its various geographic sections. These two needs converged during the first half of the nineteenth century in what historians have called the Transportation Revolution, the development of a vast system of internal improvements. Despite the fact that individual improvement projects were sometimes haphazardly conceived and constructed, technological change proceeded at a dizzying pace, producing engineering feats that astounded the world. Roads, canals, rivers, and railroads were all subjects of innovative transportation solutions.

Economic incentives also played a significant role in the development of America's nineteenth-century internal improvements network. Emigrants moving west needed the manufactured products of the industrializing East; the settled regions wanted the agricultural commodities of the fertile new territories. To satisfy both migrants and merchants, the United States was forced to address its geographical problems and find negotiable, economically viable routes across the Appalachian Mountains. The Monongahela River, as one part of that solution, served as an important link in the settlement and commercial development of the new nation.

The State of Pennsylvania took an early interest in the Monongahela River, declaring it a public highway in 1782 and beginning navigation improvements ten years later. In its natural state, the Monongahela could be extremely difficult to navigate, as rapids, narrow channels, sand bars, snags, and boulders were common hazards; the current was slow, and much of the year the water level was very low. The first state-funded improvements on the Monongahela River consisted simply of channel clearing and snag removal, but they coincided with the first great wave of emigration into the Ohio country and the old Northwest Territory.

In 1814 and 1815, the Pennsylvania legislature recommended surveys of the Monongahela with an eye to further river improvement and in 1822 appropriated funds for channel-dredging and snag-removal projects. These continuing improvements facilitated navigation from the mouth of the Monongahela at Pittsburgh upriver as far as Morgantown by 1826. Although improvements in Pennsylvania continued to be funded privately or at the state level for many years, Congress authorized and provided funding for surveys and improvement projects on rivers, harbors, and canals generally, beginning in 1824. It was largely the rapid development and subsequent impact of the steamboat on western rivers that led Congress to pass the waterways and improvement legislation.

The chief advantage of steamboats was that they could move back upstream under their own power, carrying a full load of both passengers and cargo. Steamboats were the driving force behind the industrial development of the Monongahela-Allegheny-Ohio-Mississippi Valleys during the forty-five years preceding the Civil War, "the golden age of the river steamboat." Steamboats proved their value early in hauling passengers and freight, and in a development that came to be particularly important on western Pennsylvania rivers, began serving as towboats on the Ohio, Monongahela, and Allegheny, carrying coal and other resources to markets north, south, and west of Pittsburgh.

The Monongahela River Valley entered the boat-building business as early as the eighteenth century when garrisons stationed at Fort Pitt constructed bateaux for use in their military maneuvers on western Pennsylvania rivers. Settlers traveling west along the trails and rough roads of Pennsylvania and Maryland built flatboats and later keelboats when they reached the Monongahela or Youghiogheny in order to carry their families and

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 2

agricultural products downstream to Pittsburgh and into the Ohio country beyond. Boatyards capable of turning out hundreds of boats each year soon sprang up in communities such as Brownsville. Several other towns in the Monongahela Valley—Elizabeth, Monongahela, Belle Vernon, McKeesport, and California—also developed impressive construction operations. By 1830, the Pittsburgh area had no rival as the center of the western steamboat-building industry, a position it held for the next two decades.

In 1836 the state chartered a private corporation, the (second) Monongahela Navigation Company, to construct a slackwater navigation system of locks and dams extending ninety-two miles from Pittsburgh to the [West] Virginia state line. Construction on the first two locks and dams finally got under way in the summer of 1839. The Monongahela system was one of the first in the United States to be designed specifically for steamboats.

The first four locks and dams were in place and opened to river traffic in November of 1844, making it possible to navigate on five feet of slackwater for nearly sixty miles upriver, as far as Brownsville. By 1856 Locks Nos. 5 and 6 had extended slackwater another twenty-five miles. Following the Civil War, mining and business interests in Morgantown and Fairmont, West Virginia, called for extending slackwater navigation on the upper Monongahela River, and in 1871 federal legislation provided funds for surveys of the upper river. Locks and Dams Nos. 8 and 9 were constructed by the Corps of Engineers and No. 7 by the MNC between 1879 and 1889 to provide slackwater as far as Morgantown. In 1897 the Corps of Engineers assumed complete control over MNC property, thus creating a single free (no tolls) navigation system between Pittsburgh and Morgantown, West Virginia.

Five general kinds of goods were shipped on the Monongahela River system: agricultural products, extractive resources, manufactured goods, livestock, and eastern merchandise, but the most important of the products, without doubt, was coal. The coal trade provided the fuel for Pittsburgh's furnaces, foundries, and mills that produced munitions and armament during the Civil War. In addition, Monongahela Valley coal powered the boats that the Union used to keep the Mississippi River open for travel and shipping during the war and the railroads that increasingly tied the nation together.

The system transformed the coal industry overnight by providing navigable water at the loading areas near the mines. Shipping costs were slashed, and consumers were ensured a reliable supply of coal that was no longer dependent on river conditions. Furthermore, convenient access to large quantities of extremely cheap coal gave Pittsburgh manufacturers a huge competitive advantage over down-river rivals, who also relied on Monongahela Valley coal, but at inflated prices. It was these great quantities of coal, cheaply and regularly transported, that was at the core of Pittsburgh's early manufacturing development. Every coal barge that passed through a lock represented a toll paid to the MNC, whose revenues increased steadily over this period.

The slackwater system also had a tremendous impact on the boatbuilding industry in the lower Monongahela Valley. The huge increase in river commerce that occurred after construction of the locks and dams on the lower river led to an intensification of boatbuilding activity at a host of towns. Hundreds of hulls and completed vessels were constructed at local boatyards for both local and downriver customers, including large vessels destined for the Ohio and Mississippi rivers. By the late 1880s, however, most of the passenger boats being built for the inland river trade had become too large to be sent through Monongahela River locks, and the boatbuilding industry in the valley declined.

Most of the towns along the Monongahela predated the development of the slackwater navigation system, but, by 1850, the Monongahela Navigation Company's locks and dams both directly and indirectly had increased the

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 3

population, capital, and land values of the lower part of the valley from Brownsville to Pittsburgh. Town and population growth in the Monongahela Valley was further stimulated by the development of the coal and coke industries. Industrial coal mining in the later nineteenth and early twentieth centuries required the establishment of coal patches and towns near the mines to accommodate workers and their families, and this is the origin of many of the coal towns that dot the banks of the Monongahela River.

By the time that the federal government acquired the Monongahela Navigation System, several of the MNC's older facilities had deteriorated seriously. The small locks were also inadequate to handle the large tows that had become common on the river. Over the twenty years between 1897 and 1917, the Corps of Engineers repaired or replaced most of the facilities on the lower and middle sections of the river. By World War I, all of the locks on the lower river had been rebuilt to new standard dimensions, and after the war, the Corps planned additional changes to the system that they hoped would speed transit time on the river and reduce labor and maintenance costs in lock operations. They began to consolidate and reengineer some of the facilities in order to create a higher lift and reduce the need for a number of the existing locks and dams.

In 1938 the Emsworth Dam on the Ohio River was replaced, raising the upper Ohio pool which extended into both the Monongahela and Allegheny Rivers, eliminating the need for Locks and Dams No. 1 on each. Also in 1938, the Pittsburgh District, as part of a series of flood-control projects, constructed a reservoir on the Tygart River in West Virginia to augment the flow on the upper Monongahela during periods of drought.

Beginning in the 1920s, the major steel companies in the Monongahela Valley began to use the river much more heavily to ship both raw materials and finished steel products, where they had previously relied upon the railroads. Coal and coke also continued to account for a huge percentage of the barge traffic on the river. The Monongahela River throughout the twentieth century has consistently carried more daily commercial traffic than any other river system in the United States and much of the world (U.S. Army Corps of Engineers 1994: 51, 52).

After World War II, the Corps of Engineers initiated its second major improvement program, this time focusing on obsolete navigation facilities on the middle and upper river. Between 1946 and 1996, the Corps closed its repair shops and boatyard at North Charleroi, replaced Locks and Dams Nos. 10-15 in West Virginia, and completed three new locks and dams on the middle river, thus eliminating or replacing four older facilities. In 1992, Congress authorized the Corps' plan to modernize the locks and dams on the lower river (the "Lower Mon Project"), representing the final stage of its post-war modernization and consolidation program. In 2004, Locks and Dam 2 was renamed Braddock Locks and Dam upon the completion of the replacement gated dam. Work is in progress on the first of two new locks at Locks and Dam 4 as of 2010. Once the first lock is operational, the pools maintained by Braddock Dam and Dam 3 will be equalized and Locks and Dam 3 will be removed. The removal of Locks and Dam 3 will result in a system of eight lock and dam facilities in the place of fifteen that once provided slackwater the length of the Monongahela.

GENERAL BACKGROUND**Geography**

The Monongahela River has its source in the mountains of West Virginia, at the junction of the Tygart Valley and West Fork Rivers south of Fairmont, and flows north into Pennsylvania for 128.7 miles to Pittsburgh, where it joins the Allegheny River to form the Ohio. From its headwaters, the Monongahela winds its way downhill through rugged terrain and a well-defined valley, draining part of what is known as the Allegheny Plateau, "a wide and choppy sea of considerable local relief" (Wood 1996: 99), until it reaches its mouth at Pittsburgh. The

United States Department of the Interior

National Park Service

| |
|--|
| Historic Resources of the Monongahela River Navigation System in Pennsylvania and West Virginia, 1838 - 1960 |
|--|

**National Register of Historic Places
Continuation Sheet**Section number E Page 4

river flows through or touches two West Virginia counties, Monongalia and Marion, and five Pennsylvania counties—Greene, Washington, Fayette, Westmoreland, and Allegheny—during its journey to become part of the Ohio.

The Monongahela is about one-third the length of the Allegheny and was long considered by some to be merely a tributary of a combined Ohio-Allegheny River (Kussart 1938: 1). The Monongahela, however, has ultimately carried much more traffic through the region as it has tapped the resources of Virginia/West Virginia and southwestern Pennsylvania. It was, in its natural state, a more difficult and dangerous river to navigate and was the subject of improvement efforts early in the area's settlement period.

The Youghiogheny River, the main tributary of the Monongahela, flows into the latter near the present town of McKeesport, and together the two rivers drain the southwestern portion of the state. The headwaters of the Youghiogheny are in the Laurel Highlands of western Pennsylvania. Although the gradient is steep at the upper end, the Youghiogheny River has been navigable generally from about three miles above Connellsville to its end at the Monongahela. The Youghiogheny Valley contained vast deposits of coal and stands of timber and lesser amounts of iron ore and limestone (Gilpin 1975: 37-42).

Early History of the Monongahela Valley to 1800

The rivers that converged to create the "forks of the Ohio"—the site of present-day Pittsburgh—played a critical role in the movement of the region's prehistoric people and of the Indian groups that vied with each other for domination during the contact period. It was, of course, the on-going political struggle between France and Britain (and their Indian allies) for control of the new world empire west of the Allegheny Front during the seventeenth and eighteenth centuries that opened the area to exploration, trade, and settlement.

Early transportation routes in frontier Pennsylvania during the historic period followed the Indian paths across the mountains and along the rivers. The Indian people of the region, of course, also took their canoes up and down the various rivers and navigable creeks, moving people and trade goods over a wide area. Traders and soldiers were the first white men to penetrate the frontier regions of the state, and the Indian paths and natural water courses were generally sufficient for moving them and their supplies. The primary concern for seventeenth and early eighteenth-century travelers on the frontier was assuring access to trading posts and military forts. As the Pennsylvania proprietors claimed more and more land in the central and western parts of the colony, and as tensions between the English and French increased in the Ohio Valley during the 1740s, concern grew among settlers and the military over the ability to move men and supplies west to engage the French and their Indian allies and to protect British claims to the western lands.

The first new road was an eighty-mile path—often called Nemacolin's Path for the Delaware Indian who helped blaze it—opened by the Ohio Company in 1752 as the shortest trade route between the Potomac and the Monongahela (National Park Service 1994: 18-19). England and France were not the only competitors for western lands; several British colonies, most notably Pennsylvania and Virginia, were also heavily involved in promoting land speculation and the fur trade in the Ohio country. Establishing forts and trading posts on major western rivers, such as the Ohio, Monongahela, Youghiogheny, and Allegheny, was a primary strategy for enforcing claims as the race to the West began.

George Washington followed the old Indian paths, as well as the Ohio Company's route, on his missions from Virginia to the Ohio. Major General Edward Braddock, on his ill-fated expedition to engage the French at Fort

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 5

Duquesne in 1755, then expanded the Ohio Company's road to move his men, equipment, and supplies from Cumberland, Maryland, northwest along the Monongahela, creating what became known as Braddock's Road.

The Forbes Road, constructed in 1758 to transport British soldiers and military equipment west when General John Forbes finally succeeded in driving the French out of Fort Duquesne, essentially followed the old Indian trail, the Raystown Path, across the Alleghenies from Philadelphia to Bedford and on to the forks of the Ohio. This road was easily one hundred miles shorter than Braddock's and did not require a difficult river ford. The fact that Forbes's route was built entirely through Pennsylvania was perceived as a victory for Philadelphia's merchants and as a setback for the Virginians (including George Washington) who had land and trade interests in the Ohio Valley.

The French abandonment of Fort Duquesne following Forbes's successful campaign in 1758 effectively signaled the fact that the frontier was now located at the Ohio River. The outcome of the French and Indian War assured prospective settlers that the "Ohio Territory"—the region beyond the Alleghenies—would be British (National Park Service 1994: 25-26).

When trouble between the thirteen colonies and England erupted in 1775 creating unrest among the Indian allies of the English up and down the frontier, the Americans occupied the area at the forks of the Ohio and continued to hold this critical strategic position. From there American forces were able to launch offensives and prevent incursions by the Indians, thus ensuring firm American control of the Trans-Allegheny area at the conclusion of hostilities in 1783.

The southwestern Pennsylvania area around Pittsburgh, including the Monongahela River Valley, was first settled between 1769 and 1774, and Indian paths and natural rivers served as adequate transportation for those who had a need to travel. Those who had established homes on the frontier during that period generally fled back east at the outbreak of hostilities with England in 1775. Following the American Revolution, however, settlers began first to trickle and then flood back into the frontier areas of central and western Pennsylvania.

Westmoreland County, which was created from Bedford County in 1773, had a population of 22,700 by 1800; Washington and Greene Counties were actually a part of Virginia until 1781, when they were transferred to Pennsylvania. Westmoreland was later reduced in size, first to create Fayette County in 1783. In 1788 Allegheny was formed from portions of Westmoreland and Washington Counties; at the time of the first United States Census two years later, there were 10,322 people in Allegheny County, only 206 of whom were located north of the Allegheny and Ohio Rivers (Allegheny County Survey 1982:7).

Successful campaigns by the new United States Army against the Indians in the Old Northwest Territory (notably, under Generals Harmar, St. Clair, and Wayne) which culminated with the Battle of Fallen Timbers in 1794, opened the flood gates to western settlement in the Ohio country and beyond, including the Lake Erie region of northern Pennsylvania. By 1800 southwestern Pennsylvania boasted a population of nearly 100,000, and the thriving little town of Pittsburgh, which grew from 376 people in 1790 to 7248 in 1820, promoted itself as the natural center of trade with and embarkation for the West (National Park Service 1994: 28-30).

Politics, Economics, and Internal Improvements, 1790-1860

As the population increased, so did the need for better and faster means and routes of transportation. The extraordinary costs of moving people and products across the mountains had served as an effective barrier to development in the trans-Allegheny west. Efforts turned first to improving land travel by building and

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 6

maintaining better roads. By the 1780s, Pennsylvania had begun to address the problem and, although it was obvious that the state did not have the funds to build all of the necessary roads at public expense, there was a common belief that government did indeed have an important role to play in the process. As a result, therefore, the state, prompted by the Pennsylvania Society for Promoting the Improvement of Roads, devised a system of public/private cooperation.

Under this arrangement, the state chartered and subsidized the formation and activities of private stock companies for the purpose of constructing toll bridges and turnpikes around the state. This mixed corporation policy, which first developed within the banking industry, was applied to transportation in Pennsylvania in 1806 (Hartz 1968: 82-83). Despite the potential for conflict between the public and private sectors, there was surprisingly little of it during the period when "public improvements" largely signified improved land transportation. This model served Pennsylvania extremely well in providing access to remote as well as heavily-populated areas throughout the state, and stock companies sprang up everywhere. It was only when the focus shifted to water-based transportation in the 1820s that conflict arose, largely as a result of sectional rivalries within Pennsylvania and in the nation as a whole (Hartz 1968: 51-53).

Gallatin's Plan

In the national arena, the first decade of the nineteenth century was also a period of intense interest in internal improvements, with both the Federalists and Democrats of the Early Republic strongly supporting the concept. In 1807 then, Congress authorized Albert Gallatin, the Secretary of the Treasury, to study the subject and produce a report. Gallatin, a Swiss immigrant, financier, western Pennsylvania resident and land developer, and dedicated Jeffersonian, suggested the need for an extensive program of transportation projects planned and funded by the federal government.

Gallatin's 1808 *Report of the Secretary of the Treasury on the Subject of Roads and Canals*, which one economic historian has called "one of the great planning documents in American history" (Goodrich 1960, cited in Shaw 1990: 23), divided the projects into four distinct segments: 1) canals across four coastal necks of land; 2) canals running from the coasts into the interior; 3) interior canals in New York State and around the Great Lakes; and 4) interior roads and canals that would act as links and fill in gaps among the other systems (Richter 1995: 207). Gallatin himself believed that the projects would benefit the country as a whole and thus should be financed nationally. Many of his fellow Republicans disagreed, however, based upon their reading of the Constitution, and the debate over the proper role of the federal government in internal improvement—complicated by economic fluctuations, sectional tensions, personality conflicts, and a power struggle between the executive and legislative branches - raged until the 1850s.

Although the overall plan of interlocking improvements that Gallatin had envisioned was never realized, the individual components—in most cases built by private or mixed state-private enterprises—were finally completed over the following century. The technology of these subsequent projects was often different—railroads, for example, rather than canals and roads—but all of the transportation improvements were, one way or another, based upon the original 1808 blueprint.

Philosophy

By 1815, roads of all kinds, from narrow, muddy rural roads to sophisticated turnpikes, connected virtually all parts of the state (and the country from Maine to Georgia). The War of 1812 intensified the desire and enthusiasm for a transportation system that could move people, goods, and military supplies effectively from one area to another and convinced many leaders that reliable transportation was critical for national defense (Robinson

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 7

1983: 11). Politics at the local, state, and national level, of course, complicated the process of securing the internal improvements the citizens demanded. Much has been written over the years about the national political battles that raged during the early nineteenth century between the proponents of "strict" and "loose" construction of the Constitution, particularly with regard to the merits of Henry Clay's and John C. Calhoun's American System of public improvements, with a concern for military security and transportation and for a method of connecting the far-flung parts of the nation.

As George Rogers Taylor, the foremost historian of the Transportation Revolution, has indicated, Americans, who have always prided themselves on their interest in practical solutions rather than philosophical theories, were not concerned with the fine points of the role of the government in the nation's economic affairs. They believed that their economic condition would improve and that it was part of the government's job to take practical, expedient measures to insure that it did. They felt that constitutional issues were basically questions of federal vs. state jurisdiction, rather than whether or not government should be involved at all (Taylor 1968: 352-353).

Economic regulation had been widespread and accepted throughout the American colonies. After the Revolution this practice continued and, in fact, expanded with the tremendous changes in the economies of the new states following the War of 1812. Because the federal government seemed to be precluded by the Constitution from much direct involvement in economic development, responsibilities for transportation and banking activities, among others, fell to the states. Enterprise at this level was deemed wholly appropriate by most segments of the population, who actually took for granted the fact that the states would build and pay for—one way or another—most of the transportation improvements that were needed (Taylor 1968: 378-382). On the other hand, the new Republican Party in its first national platform in 1856 declared that congress had a constitutional right and obligation to fund river and harbor improvements to protect the lives and property of its citizens (Parkman 1983: 105).

Funding

The level of state debt during that period provides an indication of how deeply involved individual states were in promoting internal improvements. The states did not hesitate to underwrite many improvements because between 1815 and 1829 they were practically debt-free, and, until about 1830, they appropriated public money only gradually (Taylor 1968:374).

During the 1830s (the canal-building era), however, the Middle Atlantic states accumulated huge public debts by selling state bonds to finance the public improvements. When the boom ended abruptly in 1839 along with state credit/borrowing opportunities, the states found themselves deeply in debt. They also discovered that most of the improvements they owned or in which they held stock would never be profitable enough to pay off the bonds. As a result, they faced the unpleasant reality of levying taxes or defaulting on the debts. Pennsylvania is a prime example of a state that faced this dilemma, and by 1842 it had defaulted on many of its obligations. The executive and legislative branches of the government struggled with the issue of the state debt until prosperity returned and credit and expenditures again expanded in the 1850s (Taylor 1968: 374-376).

Many turnpikes, river improvements, and railroads were organized by vested business and/or political interests to make money, often largely at public expense. The corporation was the organizational form used by every state in building turnpike roads, but Pennsylvania was unique among the New England and Middle Atlantic states in the amount of public money—about one-third of the total—that subsidized the process. Under this model, the state financed transportation improvements by buying stock in the privately-owned companies and supporting them in many other ways.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number E Page 8

This mixture of public and private enterprise was widely accepted as the norm for the first several decades of the nineteenth century but was challenged legally and philosophically in the 1840s and 1850s as both practical and philosophical thinking about the economy changed. Public opinion and economic theory increasingly emphasized the virtues of private enterprise in banking, transportation, and industry. The economic problems of 1839 and the state debt, the improvement-company stock liquidations in 1843, and the rise of the railroads in the 1840s and 1850s propelled the state out of the public improvements business and made transportation primarily the responsibility of private corporations. One of the developments that made this possible was an abundance of private capital newly earned and available for investment.

Railroads changed the way that transportation companies did business. They were generally chartered by state governments, which granted them many special privileges, such as the right of eminent domain, lottery and banking rights, monopolies, and freedom from state taxation for a certain number of years or up to a particular threshold of earnings. Some states even required other businesses—banks, for example—to purchase railroad stocks before receiving their own charters (Taylor 1968: 88-90).

Economic Change and the Transportation Network

The United States suffered a series of economic displacements between the end of the War of 1812 and the Civil War resulting from internal as well as international factors, such as world pressures on banking practices and the money supply, stock and land speculation, fluctuating prices, and agricultural and manufactured products. The young country developed during this period from a colonial economy based upon the production of agricultural and natural resources into an industrial nation. The Panic of 1819 indicated how sensitive the United States economy could be to European markets, but prosperity returned rapidly, and the decades of the 1820s and 1830s produced steady economic growth, which, in turn stimulated expansion, innovation, and technological development, including intensive canal and railroad construction (Taylor 1968: 337-338).

For many reasons, including feverish speculation, increasingly unwise banking practices, and an unfavorable balance of foreign trade, the United States suffered through a series of economic downturns, beginning with the Panic of 1837, followed by a much more serious crisis in 1839. The period 1839-1843 was one of the severest depressions ever to hit the United States, and it had a disastrous impact on the ability of Pennsylvania to meet its obligations on the State Works. The return of prosperity in 1844 coincided with a tremendous boom in railroad construction around the country, including in Pennsylvania.

By the early 1850s, the new Pennsylvania Railroad had purchased the right-of-way of the Main Line Canal and had consolidated the State Works into a through-system running from Philadelphia to Pittsburgh. Lines also were built into remote regions of the state to haul natural resources, such as timber, coal, and oil to markets that had previously been inaccessible by water. In the 1850s also, technological experimentation in the American—and especially Pennsylvania—iron and steel industry began the process by which, after the Civil War, domestic manufacturers could compete with and ultimately out-produce British suppliers of railroad rails and machinery (National Park Service 1994: 86-90). As one study has concluded, “Western Pennsylvania’s combination of raw materials, strategic geography, well-developed industrial infrastructure and transportation corridors established the region as one of the most important components in the dramatic transformation of the trans-Appalachian West before the Civil War” (National Park Service 1994: 76).

United States Department of the Interior

National Park Service

| |
|--|
| Historic Resources of the Monongahela River Navigation System in Pennsylvania and West Virginia, 1838 - 1960 |
|--|

**National Register of Historic Places
Continuation Sheet**Section number E Page 9**Internal Improvements in the Middle Atlantic Interior Corridor, 1785-1856****Background**

Because of its size and topography, the United States was tied to its rivers from the very beginning. Development proceeded from the coasts up the major rivers to the fall lines and, subsequently, along all navigable rivers and streams. Land transportation was difficult, expensive, and slow, and a nation that depended upon the sale of agricultural crops that were ultimately perishable had to get its products to market as expeditiously as possible. As a result, inland areas all depended upon river commerce.

Roads served for a long time primarily as the connectors between farms and villages and the rivers, but they continued to have definite advantages over rivers and canals. They could, for example, provide the convenience of door-to-door pickup and delivery; they could, within some limits, be built just where they were needed, and they could be used throughout much of the winter when water routes were closed by ice (Stover 1980: 77).

Pennsylvania's rivers, such as the Ohio, Juniata, Susquehanna, and Kiskiminetas flowed east and west through the state, while the Allegheny, Monongahela, and Youghiogeny took north-south routes. Shipping and travel began on these rivers before the end of the eighteenth century and increased as settlers moved west in larger numbers between 1790 and 1800. The Monongahela was declared a public highway in 1782 as was the Allegheny in 1788 (Armstrong County Historic Sites Survey 1980: 3). These rivers and streams in their natural state, however, were unpredictable and dangerous, with flooding, drought, rapids, ice, snags, and boulders proving a hazard to all navigation. Small, light, shallow-draft boats could float down the rivers under normal conditions, but it was difficult to develop regular, dependable commerce under these circumstances.

As settlement in western Pennsylvania increased, the desire for trade with Baltimore and with the towns and cities along the Mississippi River grew. New Orleans was Pittsburgh's outlet to the sea, and there was a developing market for the natural resources and products of the West. Rafts, keelboats, and flatboats could float down the rivers to New Orleans and points along the way, getting products to market fairly easily, but it was extremely difficult and expensive to get products back upriver. As a result, until the 1820s and 1830s, manufactured goods still moved overland from east to west, transported by teams of freight wagons, an expensive shipping method.

Until the second decade of the nineteenth century in western Pennsylvania, then, the direction of trade was normally east to west by road from the coast across the mountains. Western products were sent downstream by river to the mouth of the Mississippi at the seaport of New Orleans, where they would be loaded on ocean-going vessels bound for the Atlantic coast. These western products would finally be unloaded at eastern ports, such as Baltimore and Philadelphia, where the cycle would start once again. This circular route was far cheaper than moving commerce both east and west by road across Pennsylvania (Reiser 1951: 4-5; Taylor 1968).

Commercial Rivalries

As the population of the United States flowed westward, competition grew among regions, states, and, particularly, cities like Baltimore, Philadelphia, New York, Pittsburgh, Wheeling, and Cincinnati, for control of trade with the interior. The Baltimore-Philadelphia rivalry was especially fierce, and it had a significant impact upon the development of the internal improvement systems of the new nation (Livingood 1947).

The construction of the various turnpikes, the National Road, the Chesapeake and Ohio Canal, Erie Canal, Pennsylvania State Works, and the Baltimore and Ohio and Pennsylvania Railroads, were strategic elements in

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 10

efforts to secure commerce for particular areas, while preventing others from doing the same. Envy, competition, and practicality went hand-in-hand on the internal-improvements front.

There was an intense rivalry between Pittsburgh and Wheeling—and, for a time, Brownsville and, later, Cincinnati—for preeminence on the Ohio River system. The newspapers in each area waged relentless public relations and propaganda campaigns, and the legislature was the place of intrigue and constant attempts to fund or promote one region over another (Reiser 1951; Livingood 1947; Ambler 1932: 150-151). Pennsylvania's financially disastrous State Works was an attempt to compete with New York State and its Erie Canal for the agricultural products moving east out of the new plains and lakes states.

Complicating the inter-city and state competition for internal improvements was an increasing sectionalism in the United States. The National Road, for example, was conceived, at least in part, as a way to link and integrate far-flung sections of the new country and extend the reach of central authority (Wood 1996: 109). This was precisely the problem. The National Road, in effect, had manifested a new set of spatial relationships in the antebellum period. The road divided North from South literally and figuratively, even as it connected East and West literally and figuratively (Wood 1996: 119).

After 1820 sectional politics prevented consensus on virtually every issue of any importance, including internal improvements and commercial policies. People in the Northeast and the West were interested in increasing trade, often at national expense. Southerners, however, despite the views of their native sons Henry Clay and John C. Calhoun, feared any federal funding for internal improvements. They were afraid that once the national camel had succeeded in getting his nose under the tent, further federal interference in states' rights issues would follow (Wood 1996: 120). Presidential vetoes of federal funding of internal improvements projects—by Monroe in 1822 (toll collection on the National Road) and Jackson in 1830 (Maysville Road)—made future congressional action on similar issues hopelessly complicated and nearly impossible.

Roads*Pennsylvania Road*

Within a few years of independence, the Pennsylvania legislature, concerned about the lack of a good east-west transportation route through the state, set up a lottery to raise money for road construction. It passed its first road-improvement bill in 1785, directing that a highway be constructed from the Carlisle area to Pittsburgh via Bedford, essentially upgrading the old Forbes Road. The General Assembly then appropriated the money for building the road, and it was constructed over six years, between 1787 and 1793 (Shank 1976: 46-47).

The first turnpike company in the United States was organized in 1792 to build a sixty-two mile road between Philadelphia and Lancaster in eastern Pennsylvania. This road—the Philadelphia-Lancaster Turnpike, or Lancaster Pike—followed the route of an old Indian path that had been widened slightly in the 1750s. The Lancaster Pike was a private stock venture chartered by the state. The surface proved so smooth, well-drained, and durable that it became an immediate success, generating enough money in tolls to more than offset the extra expense required for its construction. By 1795 the Philadelphia-Lancaster Turnpike was considered the best road in the country.

After 1803 many other turnpike companies were organized, with subscribers hoping to emulate the success of the Lancaster Pike. By 1804 there was a virtual “turnpike mania” spreading over the state, and by 1820 a link of ten stone-surfaced roads—including the Philadelphia-Lancaster Turnpike—between Philadelphia and Pittsburgh

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 11

collectively made up what became known as the Pennsylvania Road (Durrenberger 1968: 54; Butko 1996: xxiv-xxv). This route led from Philadelphia through Lancaster, Harrisburg, Shippensburg, and Bedford, where it picked up the Forbes Road/Carlisle-to-Bedford state road, and continued west through Ligonier and Greensburg to Pittsburgh. By 1832 Pennsylvania had 2,400 miles of turnpike roads, more than any other state, with the possible exception of New York (Durrenberger 1968: 56; National Park Service 1994: 36).

National Road

In 1802 Congress passed "an Act to enable the people of Ohio to form a State government and obtain admission to the Union." Secretary of the Treasury Albert Gallatin, realizing the need for an efficient system of roads to integrate the various sections of the new nation, insisted upon including in this legislation a mandate for a road from the east coast across Ohio. The Senate Committee on Internal Improvements then debated the actual route that a road over the Appalachians should take, trying to balance sectional interests and analyze patterns of commerce and travel, as well as the current road-building efforts of the states across which such a route was likely to run. Since the law mandated that the road must meet the Ohio River at some point in the state of Ohio, and because Ohioans conducted most of their trade with Philadelphia and Baltimore, the Senate committee was able to narrow the choices fairly rapidly. Unfortunately, they were relatively ignorant of topography (Raitz 1996: 47).

Despite construction difficulties, the final section—to the Ohio River at Wheeling—was completed in 1818 or 1821, depending upon one's definition of "completed." The actual cost of construction over the entire length of the road from Cumberland to Wheeling was more than double the original per-mile estimate (Peyton 1996: 130-142). The western section of the National Road, beginning at the Ohio River, was first surveyed in 1820. In that year Congress agreed to extend it as far as the Mississippi River but appropriated no money until 1825, when it again modified the route; the Road actually terminated at Vandalia, Illinois, in 1850, 591 miles from Cumberland, Maryland, and seventy-some miles short of its destination.

Despite the fact that turnpike-building was very popular for several decades, this type of road did not meet the state need for cheap transportation, and, for various reasons, turnpikes rarely were profitable. It was the inherent problems of the turnpikes themselves, such as the high costs of keeping the roads in good repair and travelers' aversions to paying tolls, rather than competition from other forms of transportation that really ended the building mania. Roads, in all of their forms, however, continued to be the primary means of transporting goods and people across the United States even after the development of alternative forms of transportation.

Canals*Erie Canal*

In 1817 the New York state legislature passed a bill authorizing the construction of the longest canal in the world, which was to stretch from Albany to Buffalo on Lake Erie, a distance of 364 miles from east to west. The federal government declined to participate financially in this enterprise, and the state thus accepted the challenge of raising the money and supervising the construction of the entire canal system. The purpose behind the construction of the Erie Canal was to carry freight—rather than people—back and forth across the state, but it played a major role in the great westward migration across the United States.

From its opening in 1825, the Erie Canal was an unqualified success, as traffic increased and revenues rose so fast that tolls financed its rapid completion. Despite the fact that the canal commissioners seriously considered banning packet boats on the Erie, it was an important people-mover from its very beginning. Emigrants bound for the Great Lakes and other parts of the Midwest traveled west to Buffalo on the canal along with vast quantities of

United States Department of the Interior

National Park Service

| |
|--|
| Historic Resources of the Monongahela River Navigation System in Pennsylvania and West Virginia, 1838 - 1960 |
|--|

**National Register of Historic Places
Continuation Sheet**Section number E Page 12

freight between 1825 and the early 1850s. Until the railroads reached the West in the period just before the Civil War, no other transportation system could carry passengers or freight at a more reasonable price than the Erie Canal.

Pennsylvania Main Line Canal

Whereas in 1816 there were a mere one hundred miles of canals throughout the United States, by the 1820s states and private companies were rushing to cash in on this new transportation craze (Taylor 1968: 34-36). Pennsylvania was no exception, and, despite opposition from turnpike, freighting, and sectional interests and from those who wisely recognized the differences between New York and Pennsylvania topography, the state launched itself into what George Rogers Taylor has called her regular "canal-building orgy" (Taylor 1968: 43).

Philadelphia merchants had an understandable fear of the economic superiority of New York City, and they anticipated that the Erie would divert the potentially lucrative western Pennsylvania trade north and away from them. Philadelphia's business interests dominated state economic policies in the early nineteenth century, and her merchants and bankers, along with a rising chorus of voices from the interior of the state, clamored for the construction of their own canal system.

In 1826, therefore, the state of Pennsylvania bowed to those influences and began work on what was called the "State Works" or the Pennsylvania Main Line Canal. By that date the general consensus within Pennsylvania had swung around to the idea that public ownership of improvements was actually advantageous to state citizens (Hartz 1968: 131). The canal was, like the Erie, built entirely with public funds, but, unlike the Erie, it was incredibly expensive and never returned the considerable investment that the people of the state made in it. The Pennsylvania Main Line Canal never became a serious competitor of the Erie, but it did serve as an important transportation artery for at least twenty years (Swetnam 1968: 48).

Despite problems of terrain, railroad competition, corruption, and inefficiency, the Pennsylvania Main Line Canal provided a faster, more direct, and less expensive way to move commerce back and forth across Pennsylvania. It also connected the port of Philadelphia with the Allegheny, Monongahela, and Ohio Rivers, thus making Pennsylvania part of a broad transportation network and giving its citizens a wider world view (Swetnam 1968: 47-48). Once steamboat technology made it possible to navigate upstream on the western rivers, it was realistic to think of the Monongahela-Allegheny River corridor as extending from Virginia north into New York with an outlet at the Great Lakes through Lake Erie.

Railroads

The railroad, as well as canal, system in the United States also grew dramatically during the 1830s, providing yet another method of moving people and commerce across its vast expanses. The world's first railroad, the Stockton and Darlington, was constructed in England in 1825, the year in which the Erie Canal opened in the United States; in 1829 the Liverpool and Manchester Railroad proved the commercial viability of the new technology.

From the beginning, then, canals and railroads competed and sometimes complemented each other as Americans eagerly searched for efficient and inexpensive forms of transportation. In some states railroads, like roads and canals, were built with public funds, but it became increasingly common for private corporations to undertake the task, aided by liberal charter guarantees from the states. Pennsylvania became an early leader in railroad development; railroads were much better suited to the state's uneven terrain than were canals, were far more direct in terms of routes, and could operate all year around (Taylor 1968: 102-103).

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number E Page 13

Baltimore and Ohio Railroad

The contest for regional economic domination continued to influence the development of transportation networks in the United States in the 19th century. Baltimore in 1820 was the third largest city in the country, and it had an on-going rivalry with Philadelphia and Pittsburgh for control of the Ohio country trade. Baltimore's primary advantage over both New York City and Philadelphia was its shorter distance from the Ohio River. Many Baltimore merchants were convinced that in order to secure the interior trade advantage they would have to build a canal across the Alleghenies, and, in 1826, a group of stockholders organized the Chesapeake and Ohio Canal Company. At the same time, however, several members of the company realized that a railroad would probably be a better bet, given the technological challenges and costs involved in a trans-mountain canal.

In early 1827, then, the state of Maryland chartered the Baltimore and Ohio Railroad. In 1828, the same year in which construction was begun on the Chesapeake and Ohio Canal, work commenced on the railroad line (Daniels 1997: 9-10; Swetnam 1968: 63). Within a year and a half, the company had laid enough track to begin paid service runs and had constructed the world's first railroad station (Daniels 1997: 10). The federal government also played a role in the development of the B & O by lending a number of army engineers to help survey and design the route (National Park Service 1994: 86). The line reached Washington, D.C. in 1835 and Cumberland, Maryland, in 1843. When the Pennsylvania Railroad was organized in 1847, the Pennsylvania legislature effectively shut the B & O out of the Pennsylvania market—and its lucrative coal and manufacturing trade—for nearly twenty-five years and forced it to take the alternate Wheeling route. The B & O reached the Ohio River at Wheeling in 1852 and continued laying its tracks westward toward St. Louis and Chicago, gaining access to the latter city in the 1880s (National Park Service 1994: 92).

Pennsylvania Railroad

The Pennsylvania Railroad was chartered by the state of Pennsylvania on April 13, 1846. From the beginning, the Pennsylvania Railroad was involved in a frantic race with the Baltimore and Ohio Railroad to reach the Ohio, the former at Pittsburgh, the latter at Wheeling. The five-year race resulted in a virtual dead heat. The Pennsylvania Railroad, by incorporating the Allegheny Portage and the Philadelphia and Columbia Railroads, was able to offer continuous service between Philadelphia and Pittsburgh in December of 1852. Six weeks later, the B & O ran its first train west into Wheeling (Swetnam 1968: 64-65).

Within two years, the Pennsylvania Railroad had replaced its Portage route with two dazzling engineering feats, the Horseshoe Curve west of Altoona, that climbed a thousand feet in twelve miles, and the 3,750 foot long Gallitzin Tunnel, a few miles farther west on the Blair-Cambria County line (Daniels 1997: 23; Swetnam 1968: 65). By 1857, with the sale of the State Works to the Pennsylvania Railroad, the entire route across the state was owned and controlled by one company. It followed up that success by organizing a single system to transport both passengers and freight between Philadelphia and Chicago, thus giving it a decided commercial advantage in the increasingly prosperous American Midwest (Daniels 1997: 23).

Railroads vs. Waterways

All of the railroads became voracious consumers of coal, a resource mined in many parts of western Pennsylvania. The increased demand for coal, in turn, produced a demand for improvements in river and rail shipping to get that coal to market. In the antebellum period, the railroads completed the changes begun by the canals in the flow of trade across the mountains. Agricultural products and natural resources could move easily and inexpensively from west to east, directly to Philadelphia and Baltimore, without having to make the circuitous route down the rivers and out to sea to get back to the East Coast.

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 14

Railroads offered a number of advantages to passengers and shippers over river and canal systems. First of all, they were normally faster and more dependable and could promise more regular service. It was, in most cases, also more direct in terms of actual route and in being able to offer door-to-door pickup and delivery. Railroads could operate year round, and they ultimately triumphed a fair return (Taylor 1968: 103).

Taylor also notes that, with the exception of the Erie Canal, which for a long time provided cheap fares for poor immigrants, new railroad routes almost immediately "took away from competing waterways most of the passengers and light freight business . . . and most of the western canals rapidly lost the cream of their traffic [heavier and bulkier commodities] to the railroads during the fifties" (Taylor 1968: 165). River traffic also suffered. As the railroads reached the Ohio River between 1852 and 1854, the steamboat lines suffered a serious reduction in the number of passengers they carried. They were also forced to cut their freight rates dramatically to be commercially viable (Taylor 1968: 72-73).

Despite the profound impact the railroads had upon the economy and commerce of the United States, however, they did not put river shipping interests out of business. In many cases they stimulated each other and worked in partnership to create an efficient system to move people and goods; the rivers could still move some kinds of products more easily and more cheaply than the railroads. Even in 1860 most domestic commerce—measured by total tonnage—moved by water. Trade from west to east expanded so rapidly that all of the available transportation resources were necessary to move products to the northern seaboard markets (Taylor 1968: 166-167).

After 1852 the volume of goods shipped down the Ohio River to New Orleans declined because of railroad competition, but, so far as Ohio River traffic was concerned, this loss was more than compensated for by increased upriver shipments to the railheads at Pittsburgh and Wheeling, a growing traffic with St. Louis and the upper Mississippi River area, and greatly increased coal shipments (Taylor 1968: 165). Although both rivers and railroads increased the absolute amount of tonnage they carried, the rivers could not compete in terms of actual traffic. The nineteenth century, then, saw the rise of the steamboat on western rivers, its dominance over all other forms of transportation for about thirty years, and its decline following the Civil War as railroads on land and barges on the rivers took over its role in the cargo trade. Both could haul more freight and at cheaper rates than ever before. Passengers left the river for the railroads in the 1850s, leaving water transportation largely to commercial shippers.

The river trade also became more regional in nature as a whole transportation network developed in the United States. No longer was commerce oriented toward the south downstream on the rivers; it increasingly moved east and west across the state and the nation, and it could now also flow north without difficulty (Corps of Engineers 1979: 8). By 1860 direct east-west and regional trade had almost completely displaced the old circular route down the rivers to New Orleans, out to sea, and back to the East Coast. The country's commercial life then began to focus on the West, rather than east across the Atlantic (Taylor 1968: 396-398).

The potential profitability of American industry, agriculture, and western settlement produced a new interest on the part of both political leaders and the population as a whole in funding the internal improvements that were necessary to make it all work. Railroads had to be built across the West, and rivers needed improving to make extensive shipping on them possible and profitable. American business interests had a strong voice in determining government policies through money and access to the men in power, including those at city hall, in state legislatures, in Congress, and even in the White House.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number E Page 15

Businessmen had vested interests in moving materials and products, and to do that successfully they needed a modern, efficient transportation system. The philosophical arguments for a more vigorous federal role in funding and building transportation improvements had been increasing, as witnessed in the 1856 national Republican Party platform and in the 1863 waterways convention in Chicago that brought two thousand delegates together to lobby for improvements (Parkman 1983: 105).

Development of the Monongahela Valley, 1790-1860

Settlement Period

With the assurance of American independence and control of the Ohio country, settlement began in earnest in the trans-Allegheny region. Several scholars have noted that the Ohio Valley prior to 1830 was the single most important routeway for Americans moving West because of persistent Spanish control over the South and continued British dominance of the Great Lakes Region (Wilhelm 1996: 264).

The earliest settlers often claimed land along rivers and streams that could provide water power for small industrial operations, such as grist, clover, fulling, and saw mills, and for transportation when water conditions were just right. Most times of the year, they continued to use the centuries-old Indian paths that ran along the ridges and valleys, sometimes enlarging them enough for use by teams and wagons. Settlers were relatively few, and trading was normally done within a small local area since transportation was arduous. Only non-perishable resources could be shipped successfully over any distance, and hard currency was generally scarce on the frontier.

River and streamside mills of all kinds required minor modifications to the water sources to produce enough power to turn the wooden wheels that operated the shafts, belts, and pulleys. Mill dams and races were constructed to channel the water to the mill and store it at the proper height to produce the needed force. In an attempt to make the rivers and creeks at least somewhat passable, wing dams were built out from the shore, and logs, snags, and boulders were cleared where possible, all with local labor and private resources. Since little capital was available for river improvement, there were no extensive efforts at navigation improvements made on western Pennsylvania rivers before about 1824.

The growth rate in the United States as a whole and of the western territories in particular was explosive during the first half of the nineteenth century. In the West, the numbers doubled every ten years between 1810 and 1830, and, by 1840, one-third of the entire population lived beyond the mountains (National Park Service 1994, p. 74). The western cities grew along with the population, and the river ports of Pittsburgh, Cincinnati, Louisville, St. Louis, and New Orleans were important centers of commerce and industry by the time war broke out in 1860.

Economic Growth and Development of Western Pennsylvania

Pittsburgh was always the focus of economic life in western Pennsylvania, and it, in turn, looked south down the Mississippi River for its markets until about 1832 when the system of internal improvements was completed to the point at which it was economically feasible to make routine shipments eastward over the mountains. Because Pennsylvania got a late start in its improvements system, Pittsburgh had the opportunity and the time to develop and consolidate its position as the logical place to buy, sell, ship, and exchange the raw and manufactured goods that were produced in the West.

Pittsburgh's location in reference to the Ohio, Allegheny, and Monongahela Valleys, the limitations placed on the city by the vagaries of the developing economic system, the mountain barrier, the lack of effective transportation,

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 16

and the need for goods and supplies by the increasing numbers of emigrants who passed through on their way west all combined to encourage the establishment of small industrial manufacturing operations there at the forks of the Ohio. The increasing population provided Pittsburgh with a necessary labor supply of both craftsmen and unskilled workers; it had natural resources, such as coal, iron ore, timber, grain, glass sand, and wool, in abundance, and it had ready markets for the city's products.

Pittsburgh's industries expanded quickly after 1800 and suffered in the market collapse and retrenchment that followed the end of the War of 1812. The crisis of 1817 and Panic of 1819, although severe in many respects, by no means devastated the manufacturing community in western Pennsylvania. Pittsburghers apparently learned from the experience, weathered the storm, and continued to manufacture the products that were in demand in the West. The economic setbacks of the late 1830s and early 1840s had the same kinds of effects; there were dislocations in the economy as the depression hit certain industries and companies hard. Pittsburgh suffered temporarily, but the business community bounced back, this time on a more solid basis since the financial crisis had rid the economy of its speculative, unstable elements (Reiser 1951: 16-28).

The iron—and, beginning in the 1850s, steel—industries in Pittsburgh continued to grow unchallenged. In 1800 bar iron was generally hauled in from the Juniata region of central Pennsylvania and from the Allegheny River Valley to the north. As the century progressed, however, iron furnaces, forges, and rolling mills were established in Pittsburgh itself. The demand for nails and other iron building supplies, agricultural equipment, tools, and machinery produced an ever-growing market for the city's products.

The rise of the railroads created another market for Pittsburgh's mills. Although prior to the Civil War, most railroad rails came from Britain, these rails were made of iron and wore down quickly. As a result, Pittsburgh's rolling mills were kept busy rerolling British rails for use on American railroads. The city's dominance of the late nineteenth to mid-twentieth century steel industry in the United States was based upon the conjunction of steel mills and railroad lines—access to natural resources and the ability to transport both them and the finished products to market (National Park Service 1994: 100).

The rise of Pittsburgh as a manufacturing and commercial center also encouraged settlement as well as the development of markets south along the Monongahela. Pittsburgh thus had another outlet for her products, and the upriver areas had a market for their raw materials and agricultural produce. Once technology in the form of steamboats and railroads made upriver navigation and northern travel less difficult, Pittsburgh merchants and manufacturers were able to extend their economic influence throughout all of western Pennsylvania into parts of Ohio, Virginia, and New York State.

River Navigation

In its natural state the Monongahela River was difficult to navigate, as rapids, narrow channels, sand bars, snags, and boulders were common. The velocity of the current was only two to four miles per hour at best. In the summer low water could make it nearly impossible for boats to travel any distance. Many boatmen considered three feet to be navigable, but the river was rarely that high over its full length. Only shallow-draft vessels, such as canoes, rafts, flatboats, and keelboats could normally be used on it in its unimproved state, and many people had to wait for the spring freshets to carry them successfully down the Monongahela.

Rafts, Flatboats, and Keelboats

Rafts and flatboats carried the bulk of the commerce on western rivers such as the Monongahela from settlement until nearly the middle of the nineteenth century. They were commercially useful only on down-river journeys

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number E Page 17

and were normally broken up and sold as lumber at their destination. Flatboat and raft navigation was very imprecise and depended primarily upon the vagaries of the current; rudimentary steering was done with long oars. River hazards were constant threats. Flatboats were the vessels of choice for carrying both freight and people downstream until steamboats proved reliable on western rivers. Some boats did travel back upriver, of course, but the process of moving them against the current was an arduous one, and the boats could carry little or no cargo (Taylor 1968: 57).

The keelboat was the first vessel developed that was intended to carry a significant amount of cargo upstream. It was built somewhat like a sailing ship with a keel and hull, measuring between thirty and seventy-five feet long and five to ten feet wide, and it carried masts and sails. A board ran the length of each side, upon which the crew walked while poling the boat upriver (Johnson 1978: 27). Keelboats, however, were narrow and their cargo capacity very limited. Because they required intensive labor to get them back upstream, shipping was still very expensive (Taylor 1968: 57).

Steamboats

Americans experimented for years trying to adapt steam technology to the problems of river navigation. Although many people developed steam engines that could power boats, it was not until 1807 and 1809 that two inventors, Robert Fulton and John Stevens respectively, proved that steamboats had a commercial future. The advantage of steamboats, of course, was the fact that they could move back upstream under their own power and could carry a full load of both passengers and cargo.

These new vessels were adopted enthusiastically, and the period between 1815 and 1860 was "the golden age of the river steamboat." George Rogers Taylor says that "by 1830 it dominated American river transportation and for two decades thereafter was the most important agency of internal transportation in the country. For the most part turnpikes and canals proved feeders rather than effective competitors and not until the fifties did railroads become a serious threat" (Taylor 1968: 58). Steamboats were the driving force behind the industrial development of the Monongahela-Allegheny-Ohio-Mississippi Valleys during the forty-five years preceding the Civil War (Taylor 1968: 63). "Steam navigation, by quickening transportation and cutting distances, telescoped a half-century's development into a single generation" (Robinson 1983: 7).

The passenger steamboats developed on the rivers along the East Coast were not suitable for use on shallow western rivers like the Monongahela. The hulls for the western boats, upon which sat large wooden superstructures, had to be broad and draw as little water as possible; light, compact high-pressure engines were placed on deck, and the propeller wheel was mounted on the stern to save weight and permit the vessel to operate in low water, sometimes no deeper than thirty inches. The main decks on these steamboats were open, unlike those on eastern steamers, and the space not reserved for machinery could be used for stacking cargo. These steamboats were relatively inexpensive to build and operate and could carry large cargoes, as well as a significant number of passengers (Taylor 1968: 66-67; Corps of Engineers 1979: 9).

Major Stephen H. Long, often better known for his exploration of the Rocky Mountain West, played a role in the development and design of steamboats that were used on western waters. The *Western Engineer*, built in 1819 for military reconnaissance and scientific exploration, drew only nineteen inches of water and successfully made the trip from Pittsburgh down the Ohio and up the Missouri River. Long continued to be an innovator in the field of steamboat design and engineering; he was one of the developers of boats used to remove snags from western rivers, and he worked on methods to increase steam power and efficiency (Robinson 1983: 7; Taylor 1968: 66; Hunter 1985: 1-30).

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 18

Despite the fact that steamboats quickly became familiar sights on western rivers, they did not threaten the flatboat industry and, in fact, actually encouraged it. Boatmen could now get back upriver by steamboat without the time-consuming and exhausting trip they had previously faced. Many people who lived on streams and smaller rivers still had to use a flatboat for at least part of the trip and often found it easier to keep going downstream to port rather than break the trip to transfer their cargo to other types of vessels. Despite technological and navigational improvements, moreover, more commerce still moved downstream than up.

The peak of flatboat traffic on western rivers did not come until 1846-1847, but it then declined rapidly over the following decade as barges took over as the primary haulers of bulk freight. Steamboats were the dominant type of river vessel very early on the Ohio and Mississippi, and, as a result, shifted more flatboats and keelboats onto the Allegheny and Monongahela Rivers where they were thought to be safer. These boats were generally smaller and lighter than those that had been used on the larger rivers (Reiser 1951: 54).

The method of financing steamboats followed a different path from earlier transportation improvements in the developmental phase. Each boat was generally owned by individuals or small partnerships and financed by local capital. Steamboats proved their value early in hauling passengers and freight and, in a development that came to be particularly important on western Pennsylvania rivers, began serving as towboats on the Ohio, Monongahela, and Allegheny, carrying coal and other resources to markets north, south, and west of Pittsburgh. By the 1840s, it was common to see them pushing barges up and down the western rivers. Originally, barges, like flatboats, had floated with the current and were used only in downriver commerce (Corps of Engineers 1979: 19).

Not only were steamboats quickly pressed into service on the western Pennsylvania rivers, but the Pittsburgh area also jumped into the boat-building business early in the nineteenth century. In 1815 the *Enterprise*, a steamboat built on the Monongahela in Brownsville, completed a round trip between Pittsburgh and New Orleans, demonstrating the vessel's usefulness in western trade. Fifteen years later Pittsburgh had no rival as the center of the western steamboat-building industry, a position it held for the next two decades. Several other towns in the Monongahela Valley besides Brownsville—Elizabeth, Monongahela, Belle Vernon, McKeesport, and California—developed impressive construction operations (National Park Service 1994: 75).

Between 1840 and the outbreak of the Civil War, Pittsburgh expanded her shipyard businesses and produced innovative iron steam warships, other Navy vessels, and government revenue cutters, as well as freighters for east coast shipping companies and other types of iron boats and ships. Other area companies specialized in steamboat engines, ship fittings, and machinery. The shipping industry was an important part of Pittsburgh's economy, and the Monongahela River Valley provided raw materials used in constructing oceangoing sail and steam ships (National Park Service 1994: 75-77).

Passenger Travel on the Monongahela River

As has been noted, between the end of the Revolutionary War and the end of the eighteenth century, Americans headed west from the Atlantic coastal areas in increasingly large numbers. By 1800 there were at least 400,000 people west of the Appalachian Mountains, and southwestern Pennsylvania already had 100,000 of them (National Park Service 1994: 29, 36). The primary factor in the rapid development of this part of the state was its "large-scale dependence upon water transportation" (Kehl 1956: 24). Kehl also says that until 1825 "more people embarked on western waters in the southern counties than in the north because of the direct flow of migration across the mountains from Philadelphia and Baltimore."

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 19

The Monongahela was one of the primary river routes for emigrants heading west to the Ohio River and the Ohio country beyond the Alleghenies. One commentator has remarked, "It has been said that in their unimproved condition the Monongahela and Ohio rivers floated the founders of half of the western and southwestern states to their wilderness homes" (Corps of Engineers 1996: 2-3). Because of the seemingly natural route down the Monongahela to its junction with the Allegheny, many people considered the Monongahela effectively a part of the Ohio River for years (Corps of Engineers 1979: 47).

It was Brownsville, on the east side of the Monongahela River in Fayette County—West Brownsville is across the river in Washington County—that served as the primary point of embarkation and the focus of much of the Monongahela River commerce. This town, the fourth-largest urban area in the region, became the center of the important western Pennsylvania boat-building industry early in the nineteenth century. Once travelers had reached Brownsville, they could choose among three different routes to the Ohio.

Between the completion of the National Road through the area in 1819 and the coming of the Baltimore and Ohio Railroad to Wheeling in early 1853, stagecoach passengers going to Pittsburgh routinely transferred to steamboats at Brownsville for the trip downriver (Corps of Engineers 1979, 48). According to a nineteenth century source, National Road stage lines carried 18,000 passengers between the river at Brownsville and Cumberland, Maryland in 1850, fewer than in the three previous years (Waterman, Watkins Co. 1884: 177). Charles H. Ambler (1932) says that in the 1820s only one out of ten wagons traveling the National Road bound for the Ohio continued by road to Wheeling; the rest sent their cargoes down the Monongahela to Pittsburgh.

Regular steamboat packet (passenger) service was also developed on the river between Brownsville and Pittsburgh during that period, with many companies and boats competing for the business of moving thousands of travelers annually until the coming of the railroads in the 1850s (Ambler 1932: 137-138). According to Leland Johnson, however, "steamboating on the Monongahela did not thrive until after slackwater opened to Brownsville in 1844" (Johnson 1979: 91).

Monongahela River Improvements, 1790-1840**Improvement Legislation**

The traffic and commercial tonnage carried on western Pennsylvania rivers was, from the beginning, heaviest on the Ohio and Monongahela, and the pressure for organized river improvements was felt much earlier along those more-heavily used rivers, particularly the Monongahela. River improvement, like other forms of transportation-related projects, was largely seen as the province of state governments and private enterprise until after the Civil War.

Internal improvements were caught up in the continuing political controversy of the Early Republic, and occasionally the federal government took a hand in constructing roads, canals, and river and harbor improvements if it could be demonstrated that the works benefited a national rather than a local constituency. The line between the two was frequently rather blurred. Before 1824 the federal role in navigation had been restricted almost entirely to such activities as building lighthouses and improving harbors (Robinson 1983: 11).

The State of Pennsylvania took an early interest in the Monongahela River, declaring it a public highway in 1782 and beginning navigation improvements ten years later. These first state-funded improvements consisted simply of channel clearing and snag removal, but they coincided with the first great wave of emigration into the Ohio country and the old Northwest Territory. Thousands of people setting out for new homes in what are now the

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 20

states of Ohio, Indiana, Illinois, Tennessee, and Kentucky floated down the Monongahela River on their way to Pittsburgh and the Ohio River. When the river was high in the spring, transportation was easy. In the summer when the water level dropped, people had to wait for weeks or sometimes months to launch their flatboats, keelboats, and rafts to start on their way west. They also had to navigate around the private dams and weirs that individuals had erected along the course of the river (Corps of Engineers 1996: 3).

In 1814 and 1815 the Pennsylvania legislature recommended surveys of the Monongahela with an eye to further river improvement, and legislators in southwestern Pennsylvania counties, particularly Fayette, "became preoccupied with bills to improve navigation on the river" (Kehl 1956: 67). The report recommended a series of sixteen locks and dams that would enable boats to use the river year around, and in 1817 the state chartered the first Monongahela Navigation Company to implement the plan. The legislature appropriated money for stock in the new company, but when the charter expired in 1822 before construction had begun, the General Assembly transferred the funds to channel-dredging and snag-removal projects instead. These continuing improvements facilitated navigation from the mouth at Pittsburgh upriver as far as Morgantown by 1826 (Corps of Engineers 1996: 3).

Year 1824 was a landmark in the area of river improvement. On April 30 Congress passed the General Survey Act, which authorized the use of both military (Army) and civil engineers in surveying and planning land and water improvement projects. On May 24, 1824, in a move that would, in the years to come, have a significant impact on western Pennsylvania, a bill providing \$75,000 to remove snags and sandbars from the Ohio and Mississippi Rivers using "engineers in the public service" made its way through Congress. The President then assigned the Army engineers this task, thus beginning their involvement in domestic water projects. On May 20, 1826, Congress passed the first omnibus rivers and harbors bill, an act that became an annual occurrence through 1838. Under these bills, Congress authorized and provided funding for further surveys and improvement projects on rivers, harbors, and canals (Parkman 1983: 43-44, 101). It was largely the rapid development and subsequent impact of the steamboat on western rivers that led Congress to pass the waterways improvement legislation as early as 1824 (Corps of Engineers 1979: 7).

Survey and General Improvements

The success of river clearance on the Ohio and Mississippi led Congress to extend the authorization of the 1824 legislation to work on the Monongahela River. An 1828 survey performed by Edward F. Gay, a Pennsylvania Canal engineer, and funded by the state of Pennsylvania had recommended a series of locks and dams be constructed on the Monongahela to canalize the river from Pittsburgh to [West] Virginia. A second survey was conducted in 1833 under the direction of Dr. William Howard, a civil engineer, to investigate the possibility of improving steamboat navigation on that river from Pittsburgh to the intersection of the Cumberland, or National, Road at Brownsville. Again, Howard's recommendation was to construct locks with dams that flatboats could pass over in high water, but neither the federal nor state government followed through (Johnson 1978: 91-93).

The State of Pennsylvania curtailed its funding of unrelated river improvements while it concentrated on the construction of the Pennsylvania Main Line Canal. Public interest in river navigation did not diminish, however, and on March 31, 1836, the state chartered a private corporation, the second Monongahela Navigation Company, whose purpose was to construct a slackwater navigation system incorporating a series of locks and dams and extending ninety-two miles from Pittsburgh to the [West] Virginia state line.

The Monongahela was, at that time, already carrying a heavier load of commercial traffic than nearly any other river because it crossed a formation containing an exceptionally rich bed of bituminous coal. Coal and coke were

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 21

shipped by river to Pittsburgh and beyond, and these boats too were affected by the seasonal height of the water in the river. Monongahela River sand was also in demand by Pittsburgh-area glass manufacturers who wanted a guaranteed source of this vital reserve.

Monongahela River navigation was caught up in the continuing competition for economic supremacy among the cities vying for control of commerce between the Atlantic coast and the Ohio Valley. Merchants in Pittsburgh were afraid that without improvements on the Monongahela, vital commercial traffic would be sent west on the National Road, the Chesapeake and Ohio Canal, the Baltimore and Ohio Railroad—or possibly even farther north on the Erie Canal. People in Washington, Greene, Fayette, and southern Westmoreland Counties also promoted Monongahela River commerce as opposed to improvements on the Ohio, construction of the Pennsylvania State Works, or any other direct, toll-free route that crossed the central or northern part of the state and was thus of no immediate benefit to their area. Their idea of internal improvements involved protecting and enhancing their own interests, and, as a result, they supported the National Road and navigation on the Monongahela and Youghiogheny rivers (Kehl 1956: 70).

The legislative act that chartered the Monongahela Navigation Company also provided start-up funding for construction, as well as directions for the acquisition and use of building materials. The legislature's intention was to prevent self-interest and self-dealing on the part of company managers by prohibiting their involvement in direct commercial transactions on or along the river. Tolls were set at the same level as those already being collected by the eastern Schuylkill Navigation Company.

W. Milnor Roberts was named chief engineer for the new project in 1837, and the following year he completed another—detailed—survey of the Monongahela that recommended fewer but higher dams and very large locks that would facilitate steamboat navigation on the river. The state legislature approved the plan over the complaints of existing commercial interests, such as mill owners and flatboat/keelboat operators, who feared that the improvements would eliminate or interfere with their business activities (Johnson 1978: 93).

The Monongahela Navigation Company let their contract for the first lock and dam in mid-December of 1837, but construction did not really get under way until the summer of 1839. A few months later, Roberts, as a result of new studies on locks designed for steamboat traffic, recommended relocating and redesigning the first two locks and dams. The company determined, at that point then, to construct all of the locks and dams on the Monongahela to accommodate steamboats.

The nationwide Panic of 1837 affected the Monongahela Navigation Company and its construction project profoundly. Congress ceased funding inland navigation for more than four years—between 1838 and 1842—and, when the Bank of the United States failed, the money promised to internal improvements evaporated (Snyder 1958: 80). The financial crisis affected all transportation projects being constructed or subsidized by state and federal funding, from navigation on the Ohio River to the State Works to the National Road to the Monongahela River.

SYSTEMATIC NAVIGATION IMPROVEMENTS TO THE MONONGAHELA RIVER, 1840-1960**General History**

The financial exigencies of the late 1830s and early 1840s soured the people of Pennsylvania, as well as federal and state legislators, on public funding for internal improvements. The state of Pennsylvania, therefore, determined to sell off its stock in the various transportation companies and projects throughout the

United States Department of the Interior

National Park Service

| |
|--|
| Historic Resources of the Monongahela River Navigation System in Pennsylvania and West Virginia, 1838 - 1960 |
|--|

**National Register of Historic Places
Continuation Sheet**Section number E Page 22

Commonwealth. In 1843, a group of local businessmen, under the leadership of James K. Moorhead, purchased the state's shares in the Monongahela Navigation Company at the bargain price of \$3.00 a piece, creating a privately-held company organized to complete the construction of the river improvements. All of the new stockholders had previous experience in transportation and engineering, and most owned river-related businesses as well (Corps of Engineers 1994: 20-22).

The new owners reorganized the Monongahela Navigation Company, issued bonds to secure further funding, and repaired the damage that had occurred to the first two locks and dams since their opening in 1841 (extending slackwater for eighteen miles upriver). By November of 1844, all of the first four locks and dams were in place and were opened to river traffic of all types. Commercial shipments of coal, sand, and other natural materials increased dramatically (Johnson 1979: 93-97).

The completion of Lock and Dam No. 4 in 1844 made it possible to navigate on five feet of slackwater for nearly sixty miles, as far as Brownsville (Johnson 1979: 97). The locks were a uniform 190 feet long and 50 feet wide (Gannett Fleming et al 1980: 2-5, Johnson 1979: 91-101, COE 1994: 17-30, Gundy et al 1996: 54-55, DiCiccio 1996: 32-33). Financial stability remained a question for several years, but by 1853, the appreciated value of the stock coupled with increased freight revenue made it possible for the company to pay off its remaining debt.

The coal trade that encouraged the investors to undertake the lock and dam construction expanded, and the increasingly heavy coal traffic induced the Monongahela Navigation Company to add an additional, larger lock, 56 feet wide by 250 feet long, at both Lock Nos. 1 and 2. These were completed in 1848 and 1854, respectively. Coal mines continued to be opened farther upriver, and by 1856, Lock and Dam Nos. 5 and 6 were constructed. The amount of traffic and commercial tonnage on the Monongahela continued to increase, but the Monongahela Navigation Company, once again in debt, petitioned the Commonwealth to postpone the construction on Lock and Dam No. 7, a plea that was granted in 1857.

Five general types of goods were shipped on this slackwater navigation system: agricultural products, extractive resources, manufactured goods, livestock, and eastern merchandise, but the most important of the products, without doubt, continued to be coal (Reiser 1951: 62). The coal trade provided the fuel for Pittsburgh's furnaces, foundries, and mills that produced munitions and armament during the Civil War. In addition, Monongahela Valley coal powered the boats that the Union used to keep the Mississippi River open for travel and shipping during the war and also was consumed in vast quantities by the railroads (COE 1994: 26-29, Gannett Fleming et al 1980: 2-5, Gundy et al 1996: 58-59, Johnson 1979: 107).

Through the 1860s, no railroads were constructed in the Monongahela Valley above McKeesport, so virtually all coal and other freight was moved by boat or barge. Through the rest of the nineteenth century, railroad construction proceeded only very slowly along the Monongahela, to the benefit of the boat and barge operators (Kudlik 1999: 43, 47). The slow progress of railroads through the valley was a testament to the success of the slackwater system and the efficiency with which barges could transport metal and raw materials produced near the river (COE 1994: 28).

The system transformed the coal industry overnight by providing navigable water at the loading areas near the mines. Shipping costs were slashed, and consumers were ensured a reliable supply of coal that was no longer dependent on river conditions. There would be no more calamities like that which occurred in 1840, when all of the coal boats between Brownsville and Pittsburgh were trapped by low water in the autumn and destroyed by winter ice. Furthermore, convenient access to large quantities of extremely cheap coal gave Pittsburgh

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number E Page 23

manufacturers a huge competitive advantage over downriver rivals, who also relied on Monongahela Valley coal, but at inflated prices. It has been said that "it was these great quantities of coal, cheaply and regularly transported, that was at the core of Pittsburgh's early manufacturing development" (Kudlik 1999: 57). Between 1844 and 1872, nearly 31 million tons of coal passed through the locks of the Monongahela Navigation Company. This was 1,068,871 tons per year or, at 4,000 tons of coal to the acre," the equivalent of about 267 acres of the Monongahela River Valley floated down the river and through the MNC's locks annually for 29 consecutive years" (Carlisle 2000). Every coal barge that passed through a lock represented a toll paid to the MNC, whose revenues increased steadily over this period.

The success of the Monongahela system led to the construction of a private system of locks and dams on the Youghiogheny River in 1850, creating slackwater as far upriver as West Newton. Although the Youghiogheny slackwater system was heavily used, contributing to the economic development of both the Youghiogheny and lower Monongahela valleys, the system was often in disrepair. The dams were not rebuilt after they were severely damaged by an ice-flood in 1865, effectively ending the brief period of steamboat navigation on that river (COE 1994: 30-31; Kudlik 1999: 38-39, 46).

Following the Civil War, mining and business interests in Morgantown and Fairmont, West Virginia, called for extending slackwater navigation on the upper Monongahela River. Federal legislation approved in 1871 provided funds for surveys of the upper river. Congress authorized the Corps of Engineers to construct Lock and Dam Nos. 8 and 9. Lock and Dam No. 9 became operational first in 1879, followed by No. 8 ten years later. The Monongahela Navigation Company completed construction of their Lock and Dam No. 7 in 1884. Together, these three upper locks and dams extended slackwater as far as Morgantown (Gannett Fleming 1980: 5, DiCiccio 1996: 32-33, COE 1994: 27, Johnson 1979: 128-129).

The demand for coal increased dramatically as industrial enterprises of all kinds in Pittsburgh and the surrounding area, as well as in other cities along the Ohio, Mississippi, and Missouri Rivers, multiplied. The development of mild steel production by 1875, using Bessemer and open-hearth methods, required large amounts of coke made from Monongahela Valley coal, much of it from the Connellsville area. As a result of the vast increase in the coal and coke trade, the Monongahela Navigation Company added a second lock to Nos. 3 and 4 in 1884 and 1886, respectively (COE 1994: 28-29, DiCiccio 1996: 41, Gundy et al. 1996: 47-48, Johnson 1979: 128).

Federal legislation in 1884 authorized the Corps of Engineers to purchase all or part of the Monongahela Navigation Company locks and dams. When they declined to sell, the Corps then initiated condemnation proceedings and the Monongahela Navigation Company fought the condemnation all the way to the Supreme Court. The Court decided in favor of the federal government, and, in 1897, after a decade of litigation and payment of just under \$4 million to the Monongahela Navigation Company, the Corps was given control over MNC property, creating a single free navigation system between Pittsburgh and Morgantown.

The Corps began an ambitious plan of expansion and renovation of the Monongahela River locks and dams. Locks and Dams Nos. 10-15 provided slackwater from Morgantown to Fairmont, West Virginia, in the period between 1897 and 1903. The Corps constructed new Lock and Dam Nos. 2 (Braddock) and 3 (Elizabeth) in 1904-1907, replacing the original MNC structures. The coal trade continued to expand, justifying the additional expenditures.

Following the end of World War I, the Corps planned additional changes. Lock and Dam Nos. 7 and 8 were rebuilt at new locations, each with a higher lift. Lock and Dam No. 9 was eliminated. The closing of No. 9

United States Department of the Interior

National Park Service

| |
|--|
| Historic Resources of the Monongahela River Navigation System in Pennsylvania and West Virginia, 1838 - 1960 |
|--|

**National Register of Historic Places
Continuation Sheet**Section number E Page 24

became the first of a series of consolidations, by which a higher lift was used to reduce the number of locks and dams. By these changes, the Corps hoped to speed transit time on the river and reduce labor and maintenance costs in lock and dam operations.

The second consolidation occurred in 1938, with the reconstruction of the Emsworth Dams on the Ohio River. The pool maintained by the new Emsworth Dams was raised by seven feet, eliminating the need for Locks and Dam Nos. 1 on both the Monongahela and Allegheny rivers. With their removal, thirteen locks and dams remained on the Monongahela River.

In 1938 the Corps also completed construction of Tygart Dam on the Tygart River, a tributary of the Monongahela, in West Virginia. This reservoir was designed primarily to store water for flow augmentation of the upper Monongahela, necessary to maintain navigation during low flow periods. It also provided flood control storage, envisioned by the members of the Flood Commission of Pittsburgh as part of a series of flood control measures on the headwaters and tributaries of the Monongahela and Allegheny rivers. This commission, made up of Pittsburgh's most influential businessmen, was organized after the disastrous 1907 Pittsburgh flood to ensure that such an event would never happen again. The Flood Commission lobbied for and/or sponsored several engineering studies and surveys and pressed the government to act. In 1936, during the Great Depression, the federal government passed the landmark Flood Control Act and initiated construction on some of the Commission's system of dams (Flood Commission of Pittsburgh, April 30, 1930, letter and report; U.S. Army Corps of Engineers 1938, report).

Following the end of World War II, the Corps planned additional consolidation of Monongahela navigation facilities. In 1948, work began on a new lock and dam at Morgantown. Completed in 1950, the new facility replaced old Nos. 10 and 11. Hildebrand Lock and Dams was constructed in 1956-1958 and permitted the removal of Locks and Dams Nos. 12 and 13. Opekiska Lock and Dam opened in 1967, replacing Locks and Dams Nos. 14 and 15.

Consolidation on the middle Monongahela River also occurred in the same period. A new gated dam was constructed at Lock and Dam No. 8, raising the pool to provide a minimum 9-foot navigable depth. Maxwell Locks and Dam, completed in 1965, permitted the removal of Lock and Dam Nos. 5 and 6. In 1994, a new lock chamber, 84 feet wide and 600 feet long, replaced old Lock 8, and the new complex was renamed Point Marion. Grays Landing Lock and Dam was completed in 1996, eliminating Locks and Dam No. 7.

Congress approved the Corps' plan for modernizing the lower Monongahela projects in 1992, which when completed will conclude the post-1945 modernization program of the system. The plan included the replacement of Dam 2 with a gated dam, and renaming the facility to Braddock Locks and Dam, which occurred in 2004. The next phase of construction is the replacement of the Locks 4 river chamber with a new lock having the modern standard lock dimensions of 84 feet wide and 600 feet long. Once completed, Pool 3 will be lowered and Braddock Pool raised to equalize their elevations and allow the removal of Locks and Dam No. 3 at Elizabeth. The final phase of construction will be to replace the land chamber at Locks 4, and rename the facility to Charleroi Locks and Dam. Eight lock and dam facilities will provide nine feet of slackwater the length of the Monongahela, where fifteen once were needed to provide five to seven feet of depth.

In Pennsylvania, the coal trade continues to drive the renovation and construction of the Monongahela River locks and dams. The 30 million tons of coal hauled annually on the river constitute the largest and most important

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 25

commodity on the lower section. The shipping of West Virginia coal with its higher sulfur content has declined dramatically, however, leaving the upper Monongahela locks and dams with comparatively little industrial traffic.

Technological History

The general principles governing the operation of the Monongahela River locks and dams have changed little since the time of initial lock construction. What has changed over time are the lock and dam materials, construction techniques, size, and technology. These changes generally occurred in discreet periods, allowing the evolution of the navigation structures to be divided into three phases: the Monongahela Navigation Company operation (1840-1890), the early Corps of Engineers operation (1879-1945), and the post-war Corps of Engineers operation (1945-present). Technological and engineering characteristics of each phase are summarized below¹.

Monongahela Navigation Company Locks and Dams (1840-1890)

The earliest navigational structures on the Monongahela River were constructed using hand-operated derricks and simple earthen dike cofferdams (Jansen 1948: 26). These cofferdams, though susceptible to damage from heavy rains, provided the dry conditions needed for lock and dam construction. Later, the dams were made more watertight by installing a central cutoff wall of wood sheeting and covering the dike with riprap to prevent scour.

The early Monongahela Navigation Company dams (Nos. 1-6, all built in the 1840s and 1850s) varied in length from 600 feet to 1,100 feet, with the length decreasing as one moved upstream. All were timber cribs filled with stone and gravel, faced with thick timber planks to prevent damage from water-borne debris. The cribs were constructed of large logs laid in alternate courses crossing each other at right angles, forming open cribs of seven to nine feet each. The walls were built up perpendicularly from the bed of the river to near the water level, at which point they sloped up to the crest. The mass of the stone-filled cribs helped them to secure the dams in place, but a double course of vertical sheet piling also was used to anchor them to the river bottom (MNC 1840: 31).

The first locks were constructed of smooth-dressed cut stone set in hydraulic cement founded either on wood or on gravel and sand, with floors of heavy longitudinal timbers covered with heavy planking. They had chambers 190 feet long and 50 feet wide, large enough to pass the relatively small boats currently being built along the river. Like the dams, the guidewalls and guardwalls above and below the locks were constructed of stone-filled timber cribs. The miter gates were constructed of white oak, with 12 inch white oak sills. Originally, the gates were opened on rollers that moved along a semi-circular track in the floor of the lock. Submarine chains were used to move the gates. The system proved not to work well because the rollers were often entangled with drift, logs, snags, and other debris, thus hindering the free movement of the gates. Because of these problems, the MNC soon reconstructed the gates so that they were suspended from posts on the lock walls, using a design patented by Henry McCarty, assistant to John Sanders of the Pittsburgh Engineer Office. This new method allowed the gates to swing open and closed like common house doors (Johnson 1979: 97).

Initially, the gates were opened and closed by hand by means of chains wound on hand-powered capstans located on top of the lock walls. In 1876 Superintendent George W. Lutes installed a waterwheel to take advantage of the current passing over the dam at Lock No. 3. The power generated operated a system of drums, shafting, clutches,

¹ This section is an edited and abridged version of the Monongahela River Navigation System Historical Engineering Evaluation prepared by John Milner Associates for the Pittsburgh District (McVarish 1999: 89-101). Portions of the Milner document have been used verbatim.

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 26

and gearing and allowed the automated opening of a lock gate in thirty seconds, an eighth of the time it took by hand (Johnson 1979: 158). This system was installed at Lock and Dam Nos. 1 through 4.

In later years, the filling valves located in the head bay discharged water into the lock under the miter sill, and the wickets located at the bottom of the lower gates drained the chamber (HAER 1994). The wickets originally were made of cast iron and later, of steel. They were operated with a rack and gear mechanism connected to the wickets by chains.

MNC Lock and Dam No. 7, the last to be built privately (1882-1883), incorporated essentially the same technology as Nos. 1-6, with a stone-filled timber crib dam and a 50-foot by 195-foot lock. The lock chamber was constructed of dressed cut stone and had wooden miter gates that were opened and closed with six hand-powered winches. Hand-operated butterfly valves and wickets in the gates filled and emptied the chamber.

Early U.S. Army Corps of Engineers Locks and Dams (1879-1945)

During the first years of Corps of Engineers' control of the Monongahela navigation system, significant improvements were made in lock and dam technology. Notable features of the first Corps-built lock and dam on the river, No. 9 (completed in 1879), included the only stone masonry dam on the river, the first use of culverts through the lock walls rather than valves or wickets in lock gates for filling and emptying the lock chamber, and the first use in the United States of British-designed Stoney valves to open and close the culverts (COE 1996: 7).

Further steps toward automating lock operation soon occurred. By the end of the nineteenth century, miter gates were operated by steam power, except in the river wall of the river chamber, where power was derived from a waterwheel placed in the dam. The waterwheel provided power for a system of drums, shafting, clutches, and gearing that operated the gates. After the turn of the century, electricity generated by a water-powered turbine and generator became the power to open ever-larger gates and valves. During the 1910s and 1920s, water turbines were installed at all of the lower locks and dams, replacing the steam plants.

The Corps embarked on a major expansion of the system at the turn-of-the-century, extending navigation upriver to Fairmont, West Virginia, and reconstructing or replacing many of the older locks and dams on the lower river. Lock and Dam Nos. 10-15 in West Virginia, constructed between 1897 and 1903, were all very similar. All featured fixed-crest concrete dams and had a single lock measuring 56 feet wide and 182 feet long, with six filling valves below the upper miter sill and emptying valves in the lock walls beyond the lower miter sill. The original timber miter gates were later replaced by steel gates. In contrast to the locks on the lower Monongahela, the valves and gates at locks on the upper river were manually operated until World War II.

At about the same time, the Corps began to rebuild the original Monongahela Navigation Company locks and dams on the lower river. The new and reconstructed locks on the lower Monongahela featured much larger chambers (56 feet wide by 360 feet long) to accommodate the larger boats and tows then in use on the river. The older dams were capped with concrete, and the new ones were constructed entirely of concrete. Timber or concrete aprons were added on the downstream side. The new locks (Nos. 2, 3, and 5) all had steel miter gates, with culverts and cylindrical or butterfly valves to fill and empty the chambers. The valves could be operated by compressed air or by hand.

Compressed air was the motive power of all of the older locks during their last period of operation. The plant consisted of a water turbine, connected by bevel-gears to an air compressor. Air was piped from the reservoirs to the engines operating the valves and gates. It was said that one stroke of the cylinder could open or close a miter

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 27

gate in forty seconds. The hydraulic cylinder was connected to the rack spar machinery consisting of gears, racks, and pinions that operated the lock gates (Stickle 1919: 699). Except for No. 8, which was powered by turbines, all of the upper lock gates continued to be operated by hand.

The new locks and dams built in the 1920s and 1930s were constructed entirely of concrete. Butterfly valves and lock gates were constructed of steel rather than iron and wood. Gravity-fed hydraulic systems operated the gates and valves, replacing the old manual and compressed air systems. The hydraulic system of COE Lock No. 7 was typical. Water that entered through penstocks turned the spinning vertical wicket turbines that powered the Aldrich hydraulic pump. Oil ran into the hydraulic pumping system, which controlled the gears that opened or closed the butterfly valve to fill or empty the chamber. When the proper level was attained, the hydraulic gears operated the lock gate mechanisms to open or close the lock gates (HAER 1994).

Although the hydraulic systems of the early twentieth century operated gates and valves well, they could not move unpowered tows, or groups of barges, in the locks. Electric motors continued to provide power to capstans to move tows. The use of electricity meant that a separate turbine was required to generate electricity, which was also used to illuminate the operations. Turbines already existed at some of the locks. In the 1920s, water turbines were added to Lock Nos. 5, 7, and 8 (COE 1996: 7).

Due to the naturally low flows on the Monongahela River, sufficient flow to maintain navigable depths, particularly on the upper river, was sometimes not available. The earliest method used to counteract this was the installation of flashboards on the dams on the lower river to increase the depth and volume of ponded water. These flashboards were vertical boards secured by iron pins in holes in the tops of the dams. In June of 1898, the U.S. Engineer Office in Pittsburgh specified that flashboards of sufficient height to raise the pools from twelve inches to thirty inches were to be installed at Dam Nos. 1-5. Unfortunately, flashboards had significant disadvantages; not only did the boards have to be installed and removed by hand, but, in addition, the boring of numerous holes into the tops of dams for flashboards tended to weaken the dams. It soon became obvious that the dams either had to be raised or the locks lowered. Soon thereafter, dams on the Monongahela were the sites of experiments in movable crest dams, although flashboards remained in use at Dam No. 7. Dam Nos. 1 and 5 were equipped with Betwa wickets, and Dam Nos. 2 and 3, with Chittenden drums. The performance of these movable crest dams was not satisfactory, and in 1921 they were replaced by fixed concrete dam tops.

Post-World War II Locks and Dams (1945-present)

All three operational lock and dam facilities on the lower Monongahela River date in part to the first third of the twentieth century. The six lock and dam facilities on the middle and upper river all date to the post-World War II period. Of the latter, the oldest of these, Morgantown, was opened in 1950, while the most recent, Grays Landing and Point Marion, opened in 1993 and 1994, respectively. Most of these locks and dams evidence similarities in construction and technology. With the exception of Morgantown, all use two Tainter valves to empty the lock chamber(s). Morgantown uses butterfly valves. All of these locks are operated using a hydraulic cylinder and machinery consisting of a rack and sector gear. Two of the older facilities, Lock and Dam Nos. 3 and 4, employ hydraulically-operated wickets in the upper lock gates to supplement the butterfly valves in the lock walls.

With the exception of the concrete weir of Grays Landing Dam, all of the Monongahela River dams constructed after World War II are of the gated, non-navigable type. By the mid-twentieth century, several different types of movable dam gates were in use in the United States to control the depth of navigational pools. These included the roller gate, the vertical lift gate, the Tainter gate, and a variation of the Tainter gate with a movable trunnion named the Sidney gate. Dam 4 uses two variations of the Sidney gate, while the other movable crest

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 28

Monongahela River dams use Tainter gates. A major advantage of the Tainter gate over other types of movable gates is the lower cost of installation. Two types of Tainter gates are used on the Monongahela and other river installations: the non-submersible and the submersible.

The Morgantown and Hildebrand dams each have six 60-foot wide crest gates, while Opekiska has four 84-foot crest gates. The Maxwell Dam consists of five gated sections, each 84 feet in length. The Point Marion Dam consists of two fixed weir sections (one 65 feet long, located adjacent to the abutment, and the other 110 feet long, located next to the lock), and six gated, controlled spillway sections, each 70 feet long. These gates provide for deeper and longer navigation pools. The crest gates rest on the concrete sills of the dams holding pools of the required depth during normal and lower river flows and are raised between the piers of the water surface to allow unobstructed passage of flood water and ice through the dam (Johnson 1979: 239).

The three post-1945 upper river locks marked the first use of several technological innovations on the river. Among these was the installation of an emergency bulkhead system. At Hildebrand, an independent emergency bulkhead and hoist structure was permanently installed upstream of the upper lock gate. At Opekiska the closure structure is an extension of the emergency bulkhead and traveling hoist system serving the dam crest gate openings and is also located upstream of the upper gates (Johnson 1979: 239). The width of the Opekiska crest gates permits the use of the same size emergency bulkheads for both the gates and the lock chamber (Johnson 1979: 240).

The major recent engineering innovation is the use of package hydraulic plants for operation of the miter gate and valve machinery. This technology has been used in the reconstruction of the Point Marion Lock, as well as in the Grays Landing Lock. These individual hydraulic systems, one of which is provided for each gate leaf and each valve, eliminated the necessity of providing hydraulic pumps in the operations building and running thousands of feet of steel pipes from these pumps through culverts to the machinery. Not only have construction costs been reduced, but a hydraulic system failure or leak will not make the entire lock inoperable.

BOAT-BUILDING INDUSTRY IN THE MONONGAHELA RIVER VALLEY, 1758-1960

Steamboats revolutionized nineteenth-century transportation on the inland rivers of the United States. In the era before the coming of the railroads, they were instrumental in facilitating the growth of industries, encouraging the migration westward, and promoting the evolution of market commerce in both eastern and frontier society (Puth 1988: 141-142). Along the Monongahela River in Western Pennsylvania a bustling boat industry emerged at a very early stage in the steam revolution².

Builders and operators between Pittsburgh and Brownsville invented many of the basic concepts that permitted navigation in an often-shallow and unpredictable river. As the nineteenth century progressed, steamboats continued to have a profound effect on many aspects of the social and economic existence of the Monongahela Valley. The evolution of lock and dam improvement is intimately connected with this story of boat building, river navigation, and the settlement and character of the people living along its banks (Wiley 1937: 69-82).

² This historic context section is an edited and abridged version of "Locks, Dams, Steamboats and Monongahela River Navigation" prepared by John J. Kudlik, Ph.D. for the Pittsburgh District as part of a collection of essays to examine historical themes of particular importance to the Monongahela River navigation system in preparation for the National Register nomination. Portions of the Kudlik manuscript have been used verbatim.

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 29

For over a century, boat building was one of the leading beneficiaries of the slackwater system, and the arrival of steamboats brought prosperity to almost all of the towns along the river. As a leading Pittsburgh area industry, boat building aided the evolution of transportation not just on the Monongahela River but also on the entire Mississippi-Ohio inland river system. Many of the concepts first applied along the Monongahela for the construction and incorporation of steamboats into trade and commerce applied equally well to conditions on many other inland waterways.

Significantly, the Monongahela Navigation Company's locks and dams (1840) were the first in the United States to be designed specifically for steamboats. The design changes in the vessels produced by the boat-building industry on the Monongahela, as well as the demands of the commercial enterprises that used the boats, directly influenced the design of the engineering features of the Monongahela River navigation system in such areas as lock dimensions, dam heights, and the introduction of power to the lock operations to speed up transit time. The evolution of a lucrative transportation industry and slackwater system here was a starting point for the successful introduction of steamboats and river improvements into other sections of the United States (Hunter 1949: 206-207).

Flatboats and Keelboats

The English garrisons at Fort Pitt started the boat-building tradition on the Monongahela when they constructed boats for military operations on shallow Western Pennsylvania rivers beginning in 1758. During the last third of the eighteenth century, the lower Monongahela between Pittsburgh and Brownsville became the busiest center of flatboat-building in the entire Ohio-Mississippi system. These boats were low-cost and fairly simple to construct; in terms of design, they were little more than rectangular boxes formed from square hardwood timbers. They were used for downstream transportation only and were broken up at the end of the journey and sold for lumber.

By the 1790s, the design had evolved into several basic types: the "family" or "Kentucky" boats for emigrant-livestock traffic, larger "New Orleans" boats for heavier commerce down the Mississippi, and Monongahela "arks" intended as regional conveyances. The beauty of these craft was the fact that they could be built on-site to the specifications of the intended cargo using a minimal amount of machinery and labor (Andrist 1962: 23-32). When passenger and freight traffic heading down the Monongahela at Brownsville increased substantially, boat building became a very profitable enterprise at selected locations along the river.

The need became more urgent for a boat that could transport cargo and passengers upstream more efficiently, and by the 1780s, keelboats were plying the waters of the Monongahela and other western rivers. There are references to their construction in Elizabeth (PA) as early as 1788. Pointed at bow and stern, they were forty to eighty feet in length, with a shallow keel that drew only two to three feet of water when the boat was fully loaded. Keelboats were powered by a crew of eight to twelve men laboring on deck with long poles to push the craft over obstacles or upstream against the current.

These boats were reasonably reliable and stable and, in the long run, brought a higher degree of professionalism to river transportation than did flatboating. An increasing number of entrepreneurs established store-warehouse-ferry landing operations along the river banks, and some also operated keelboat lines in order to control the whole supply process.

There were boatyards in nearly all the larger settlements well before 1800. The keelboats and flatboats produced in these yards were responsible for a tremendous increase in the volume of commerce centered at Pittsburgh (Reiser 1951: 44-45). The commercial traffic of the Allegheny, Monongahela, and Youghiogheny valleys made

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number E Page 30

the town a natural depot for all types of products. As the headwater port for the Ohio-Mississippi rivers, Pittsburgh was well on its way to becoming the best-known of all inland river towns as early as the eighteenth century. Pittsburgh and the Monongahela Valley became part of a complex economy that encouraged manufacturing and attracted river trade in products local residents were able to provide (Reiser 1951: 53).

Steamboats

Monongahela Valley keelboat-builders like Henry Shreve and Daniel French were the men primarily responsible for improving upon the work of Robert Fulton and other early developers of the steamboat in making the new craft practical for travel on shallow western rivers. They realized that what was needed was a flat-bottomed hull design that would support weight with minimum draft, and the best ideas for western riverboats came out of long-established boatyards on the Monongahela. These yards employed men with years of practical experience and an understanding of what was needed to make it possible to operate in shallow, obstructed rivers.

River steamers, then, were essentially reinvented in the Monongahela Valley. The design continued to evolve, but most of the developments were variations or refinements of the original ideas. Builders in Brownsville and Pittsburgh worked out many of the features by a system of trial and error. It was not long before Pennsylvania boats set the standard for the western rivers and were in high demand for the Ohio and Mississippi freight and passenger trade.

Pittsburgh and the Monongahela River Valley had everything necessary to encourage steamboat development, including a river location and a stimulating economic, social, and technological climate. Prompted by the material demands of the War of 1812 and the increasing numbers of westward emigrants, many manufacturers and tradesmen offered products and services that facilitated steamboat construction: ropewalks, sawmills, lumber yards, carpentry, blacksmithing, pattern and machine shops, rolling mills, engineering. The Monongahela Valley contained huge stands of virgin timber. For many years, then, the Pittsburgh area had the natural and industrial resources necessary to maintain the greatest number of boatyards actively producing river craft of all kinds (Reiser 1951: 29-51).

By the mid-nineteenth century, the Monongahela River region had become a major center of inland-river steamboat production, followed by Wheeling, Cincinnati, Louisville, and later St. Louis. Hundreds were employed in this industry, which grew until it produced more than half of the steamboats on the western rivers. Monongahela builders constructed vessels for local use, as well as for the Ohio and Mississippi trade. Steamboat traffic here was the greatest of any river of its size in the United States, and the lower Monongahela was one of the busiest streams to feed upper Ohio River commerce.

The rise of the West and the rise of steam power went hand-in-hand. Nowhere was this more obvious than in the Monongahela Valley, where steam power provided the impetus for more diversified manufacturing and whole new industries associated with steamboat operations. On the home waters, however, opportunities continued to be constrained by navigational difficulties that restrained local trade. For local use, builders continued their attempts to reduce boat weight while, at the same time, maximizing cargo capacity for available water depths. Boats had to be rather small, and travel was irregular, being concentrated during spring and fall high-water seasons. This smaller size solved some navigational problems, but smaller boats meant smaller cargoes, and that meant smaller profits.

Larger steamboats were constructed in the Monongahela area, like the 175-foot Mediterranean built in Elizabeth in 1833. The yards in these communities, particularly in Elizabeth and Brownsville, became increasingly skilled

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 31

in building longer and wider boat hulls while, at the same time decreasing their depth. This technique increased the water plane, distributing the weight over a larger surface area. Despite these innovations, however, low-water conditions in the river usually meant that only the hulls, rather than the heavier completed boats, could be built in Monongahela pools and floated down to Pittsburgh for completion (Kussart 1937: 62, 94).

The physical characteristics of the river and the natural resources of the Monongahela Valley played a large role in determining the location and operation of nineteenth-century boatyards. They also determined the structural design of steamboats and the conditions under which they operated. Monongahela River steamboats operated in shallow water in a basically rural area that had few or no formal landing facilities, such as wharves and docks. Western Pennsylvania builders continued to try to lighten their boats as much as possible, and, by the 1840s, they were constructing boats without external keels on the hulls, this function having been replaced by a keelson that ran the inside length of the hull (Watson 1985: 54-63).

With that change, steamboats became virtually flatbottomed and were able to land by running the bow into the mud of a sloping natural shoreline, close enough to reach freight and passengers by gangplanks. Given the frequent fluctuations in water levels, fixed shore structures like wharves were impractical, but this proved to be an advantage. Steamboats could make landings at nearly any village or rural point along the river, and it was possible to keep expenses lower since there was no need to construct or maintain landing facilities. This "way business" was commercially important, and boat operators could carry high volumes of cargo and demand higher rates for the flexible service they provided (Watson 1985: 89-112).

The more formal passenger and freight service was referred to as "through traffic" and involved landing at fixed points that contained facilities that ranged from simple to complex. The most elaborate arrangements included a graded shoreline down to the water's edge (paved in brick in larger cities like Pittsburgh), wharf boats (permanently-anchored barges with building-structures on them), and warehouses on shore for storage (Watson 1985: 89-112). Wharf boats were introduced in the 1840s but were not common until after the Civil War. They were usually constructed from the hulls of retired riverboats and had deck cabins added. Packet companies often had their offices on wharf boats in terminals such as Pittsburgh.

All of these developments in the construction and operation of steamboats led to increased demand from the Monongahela Valley business community and local newspaper editors for river improvements by the 1830s. They agitated for river clearance and for the construction of locks and dams that would create slackwater navigation pools to permit more reliable and longer periods of service and more favorable conditions for moving larger boats up and down the river.

Boat-building activity increased along the Monongahela, and major yards developed in McKeesport, Webster, Belle Vernon, Monongahela City, Fayette City, California, Brownsville, West Brownsville, and a host of lesser sites. Steamboating became increasingly woven into the fabric of both urban and rural businesses. The production of labor and supplies for boat construction at one end and the use of those boats to transport commercial cargoes at the other meant increased productivity. By the 1830s, local businessmen understood that river improvements were critical to regional prosperity. As commerce increased, so did the clamor for navigation improvements (Veech 1873: 1-10).

Both a state and a federal survey of the Monongahela, made in 1828 and 1832, respectively, proposed a system of locks and dams on the river. In 1836 a (second) private Monongahela Navigation Company was chartered for the

United States Department of the Interior

National Park Service

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| Historic Resources of the Monongahela River Navigation System in Pennsylvania and West Virginia, 1838 - 1960 |
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**National Register of Historic Places
Continuation Sheet**Section number E Page 32

express purpose of creating a slackwater system to the [West] Virginia state line. Efforts were first focused on improving the river to create a continuous navigation channel between Brownsville and Pittsburgh.

The MNC actually began lock and dam construction in 1839 on the lower Monongahela, and the two lower installations were finally completed in October of 1841. Business immediately increased so rapidly that more steamboats were added to deal with the growing level of river commerce. The new slackwater system boosted trade along the twenty-five miles of deeper pools. There was so much business in Pittsburgh that the Monongahela wharf was again extended and improved, and at times the volume of boats trying to dock was so large that many were delayed for hours.

By the time that Lock and Dam Nos. 3 and 4 were completed in 1844, the obvious benefits of the slackwater navigation system had silenced all of the critics. What was constructed on the Monongahela River was the first financially successful large-scale navigational improvement project in the United States (Wiley 1937: 166). The locks and dams were the engineering marvels of their day, huge compared to canal locks and mills dams and successful in raising and stabilizing water levels. They were also the first locks and dams to be designed specifically to handle steamboat traffic. Locally, slackwater navigation to Brownsville resulted in an immediate increase in profits for businesses using the river. The first stage of the MNC navigation improvements ushered in the era of fullest development of the steam packet carrying trade and steamboat construction.

During the 1840s and 1850s, the boatyards and engine works along the Monongahela reached their height in reputation and production. Between 1852 and 1856, 362 steamboats were built in the communities between Brownsville and Pittsburgh, along with an unknown quantity of barges and flatboats. Monongahela steamboats were the standard for boatyards everywhere, and with the advent of the slackwater system, larger boats could be constructed and floated down the river to the Ohio and Mississippi (Ellis 1882: 270). By the 1850s, boats on the lower Monongahela could reasonably have hulls with a five-foot draft; boats attempting to reach the upper stretches of the river, however, were still limited in size (to a three-foot draft) and cargo capacity (Way 1983: various entries).

1856 saw the opening of two more Monongahela Navigation Company locks and dams, Nos. 5 and 6, that extended slackwater navigation to New Geneva, eighty-five miles above Pittsburgh. The Brownsville and Pittsburgh Packet Company, ever alert for new business opportunities, immediately commissioned the building of a new steamboat, the Telegraph, in California, Pennsylvania. Like most of the packets of the period, this one generated a handsome profit. Its parent company had successfully negotiated agreements for carrying through-passengers and cargo in an arrangement that had made the packet boats an essential link in a transportation chain that joined river travel with stagecoaches on the National Road and with the new Baltimore and Ohio Railroad. This provided efficient transportation between the eastern seaboard and the Ohio River.

During the period before the Civil War, boat builders continued to perfect the design of their steamboats and reduce the weight of the machinery to produce ever-larger boats with very shallow drafts for operating under low-water conditions. Monongahela boatyards maintained their reputation for turning out strong oak hulls capable of taking a beating on sandbars and ripples anywhere in the inland river system. They were preferred above all others on the Missouri River, which presented extremely difficult navigation conditions that required strong, light craft. Monongahela boats were built with superstructures constructed largely of thin pine and poplar to reduce the weight further (Lass 1962: 107-111). The Argos, for example, was a local sternwheeler of the era that drew a mere 8 ½ inches of water, still too much to enable it to dock at the Pittsburgh wharf in especially dry summers (Way 1983: 28).

United States Department of the Interior

National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places Continuation Sheet

Section number E Page 33

On the Monongahela River, the most profitable years for boat construction occurred between the initiation of lock-and-dam slackwater in 1841 and the late 1850s. Combined passenger and freight packet traffic was at a high volume, and there was minimal competition from rail transportation. Rivalries among steamboat lines kept prices fairly low and service as close to scheduled times as possible. The lines regularly ordered new steamboats from the Monongahela River Valley boatyards.

Beginning in the 1850s, the railroads began their incursion into Western Pennsylvania, and the public began to appreciate the more predictable service and cheaper passenger fares that the railroad offered. Freight could still be moved more economically by river, however, and it was many years before railroads took over even the short-haul trade. The packets continued to serve the area for about a decade after the Civil War, and there was a push to complete the locks and dams on the upper section of the Monongahela. A rivalry between railroads and steamboats developed in the 1870s; packet freight tonnage fell by 75 percent during the years between 1870 and 1900.

Lock No. 9, nearly on the West Virginia line, was completed in 1879; Lock No. 7, below New Geneva, opened in 1884, and Lock No. 8, in 1889; improvements were made to older locks during the same period. The packet companies subsequently developed a lucrative excursion business on the scenic upper Monongahela. Although the excursion business continued well into the twentieth century, packet boats were no longer being built in the Monongahela Valley by that time.

The decline of passenger boat-building along the Monongahela began after the Civil War for a variety of reasons. Sources of virgin oak, so long the wood of choice in the construction of hulls, became increasingly scarce and declined in both quality and size. The slow push of the railroads along both banks of the Monongahela ultimately allowed the lines to cut through traditional boatyard sites or placed too many obstructions along the shore to permit boats to be launched (Wiley 1936: 82).

The locks and dams that had initially promoted steamboat-building ultimately hastened the demise of the industry in the valley. The inland-river operators began calling for larger hulls and boats, and, by the 1880s, the types of boats in demand were too large for easy passage through the Monongahela navigation system as it then existed. The last steamboats built in California had to wait for a freshet to float them over the dam because they were too large for the locks (Hornbake 1949: 27-28). In Elizabeth the old boatyards were converted to coal barge construction in the 1870s because the latter were in great demand and required less timber and smaller-scale construction operations.

Barges

As early as 1809, coal from the Monongahela River Valley was loaded on boats for shipment down the Ohio River to Cincinnati, where it was scarce and in high demand. In 1837, half of the coal mined in the lower Monongahela Valley was shipped down the Ohio on flatboats (Harris 1837: 174-175). The implication is that a large number of Pittsburgh-area rivermen, perhaps as many as 3,000 in 1838, were concerned primarily with the building and operation of coal boats (*Pittsburgh Advocate*, January 5, 1838).

Flat-bottomed current and steering-oar propelled boats hauled coal from mining villages farther up the Monongahela when the coal closest to Pittsburgh began to play out in the late 1820s. Wooden slide tipples were a common sight along the river, and coal was moved down chutes directly onto waiting flatboats or into piles at riverside storage areas. The river craft employed in this enterprise during the first half of the nineteenth century

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places Continuation Sheet

Section number E Page 34

were not much different from the flatboats used to transport emigrants and freight in the previous century. They were essentially large clumsy boxes that any carpenter could build. With only a minimal change in the arrangement of the timber beams and planks, a boatyard could produce both passenger and coal boats. The latter, of course, had to be able to carry heavier loads and required higher planking on the sides. Like other flatboats, the coal boats too were designed as one-way craft, to be broken up and sold for their lumber at the end of the downstream trip.

Newspaper articles indicate that coal was shipped down the Monongahela on nearly any kind of conveyance that could float, including keelboats, but it was flatboats that carried the greatest volume and handled the bulk of the business (Pittsburgh Gazette, Feb. 7, 1789; Kussart 1937: 862). In the 1820s, large numbers of coal boats arrived at the city wharf in Pittsburgh during periods of high water, but when the water level dropped, the traffic halted, and customers were in distress (Veech 1873: 4). When coal had to be transported overland, costs rose.

Although the coal trade was a significant commercial activity in the 1830s, it suffered from the same kinds of river-related problems as other enterprises that depended on water transportation (Reiser 1951: 60). The Monongahela, however, was definitely the preferred highway for cheap and reliable delivery, and tonnage figures increased, despite uncertain channel conditions. Once steamboats had become the dominant form of river craft, the packet lines attempted to haul as much coal as they could by transporting it on deck in baskets and sacks, after having accommodated other freight and passengers. Until the advent of slackwater navigation, however, the all-purpose steamboat played a relatively small role in the coal hauling business.

The transportation of coal ultimately played a very large role in the movement to improve the Monongahela River, and the Monongahela Navigation Company considered the emerging coal trade as potentially a source of great revenue for their lock-and-dam system. They were correct. Within the first two months of operation of Lock and Dam Nos. 1 and 2 in 1841, 1,200,000 bushels of coal were locked through and arrived in Pittsburgh before the onset of winter. The price of coal was subsequently reduced by about half with this increase in quantity and the lower insurance costs that resulted from decreased shipping risks (Kussart 1937: 871-872).

Monongahela navigation improvements had a truly significant impact on the economic development of Pittsburgh and the Monongahela Valley. The predictability of delivery of raw materials and finished products greatly accelerated manufacturing of all kinds in the area. Since major urban areas from Cincinnati to St. Louis and on to New Orleans looked to the Monongahela Valley as the principal supplier of their coal, river improvements on the Monongahela were the first step in providing reliable delivery on the rest of the inland waterways (Eavenson 1942: 387ff). By the time Lock and Dam Nos. 3 and 4 were opened in late 1844, coal shipments were moving regularly in ever-increasing quantities (except when the river was frozen).

Increased demand led to congestion at the locks. In 1848, a second chamber was added to Lock No. 1, and the same thing was done at No. 2 in 1854. Deeper pools encouraged the construction of larger coal flatboats with deeper drafts. Flatboats were built upside down on cradle structures in boatyards along the riverbank and flipped into the river. Skilled builders typically launched two a week and as many as 750 a year (Way 1990: xiii). By the late 1840s, these boats averaged one hundred feet in length and twenty-four feet in width and were still steered by sweep oars on the sides and stern. Lengths of up to 150 feet were not uncommon, but the lock dimensions limited the size of the boats the Monongahela yards could turn out (Kussart 1938: 273-279).

Coalboat pilots, as well as boat builders, were in high demand as increasing boat size led to a need for skilled professionals to handle the craft and their valuable cargoes. Companies developed the technique of lashing boats

United States Department of the Interior

National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places Continuation Sheet

Section number E Page 35

together side-by-side in pairs to provide greater stability and carrying capacity. The existence of the navigation system made it necessary to guide these unwieldy flatboats through lock gates, rather than merely into natural river channels, and traditional coalboat crews developed into a specialized class of workers. By the 1860s, coal had become one of the most commercially significant aspects of life in the Monongahela Valley economy (Gould 1889: 497-508; *Pittsburgh Commercial*, October 26, 1869).

The industrial needs of the Civil War led to an increase in the coal trade, and this, in turn, resulted in steamboats replacing flatboats as a safer and more reliable method of hauling coal (Wiley 1937: 181). By the end of the war, flatboats were virtually obsolete in the coal trade.

Steam towboating on the Monongahela was an innovation that led to an expansion in the bulk commodities trade. It represented a fundamental reorganization of river transportation and greatly expanded the coal and iron businesses. Until the 1850s, steam towing meant nothing more than lashing one or two flatboats (called "lighters") alongside a standard riverboat to take on additional cargo and lighten the primary hull draft by distributing weight over a greater surface area (Way 1990: xi-xii). The practice was controversial because navigation was difficult and dangerous; insurance companies doubled their rates to discourage the practice (Hunter 1949: 568-569). In the end, operators decided that passenger service and express freight delivery (their primary source of income) were incompatible with hauling bulk freight.

The bulk freight trade needed steamboats actually designed for towing with more engine and boiler power and heavier hull construction, rather than all-purpose packet service. They also needed to develop new techniques of river navigation so that barges at least the size of the flatboats could be handled safely and profitably (Hunter 1949: 569). It meant reinventing the concept of steam paddlewheelers, ones that would not be equipped for passengers and would not stop for miscellaneous way-freight. All of these developments made towboats much less expensive to construct and operate (Wayman n.d.: 312).

Until the 1880s, towboats continued to have the rounded bows of the packet steamers, but a significant design change during that period resulted in the appearance of square bows fitted with "towing knees" to facilitate pushing barges. This reflected a change in the towing style in which the steamer faced up to the barges, rather than being set back in the earlier clustering style (Way 1990: xiii).

Despite a few small-scale attempts to employ towing steamboats at scattered mines in the 1830s, the earliest true steam towing of Monongahela coal down the Ohio River took place in 1845 by the twenty-eight-ton *Walter Forward*, a Pittsburgh-built boat that had no passenger deck or cabin (Gould 1889: 502-503). Although it took a few more years for this type of boat to become common on the Monongahela, the Monongahela Valley boatyards were inventing a new class of steamboats.

These new boats became known as "pool boats," whose sole function was towing barges in the slackwater pools adjacent to the coal mines. On a true pool boat, the pilothouse was set forward on the second deck, rather than on the roof, a style typical of the packet boats. This design permitted the pool boats to operate easily under the low bridges on the Monongahela. Sturdier wooden barges designed to draw less water and not be dismantled after one trip were also added to the new concept of towing.

Most of the Monongahela River boatyards became known in the 1850s for constructing pool boats and barges. By the 1870s, barge and boat-building companies were economic mainstays of many of the communities. Towboats also hauled unfinished boat hulls from the Allegheny Valley to siding yards along the Monongahela. Riverton

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places Continuation Sheet

Section number E Page 36

(below McKeesport), Dravosburg, West Elizabeth, and Monongahela City were among the active sites where higher siding and gunwale planks were applied to complete the containers. These yards could finish as many as twenty complete transports a week (Way 1990: xiv).

The design of coal containers built and used on the Monongahela evolved throughout the nineteenth century into the following major styles:

- *coal boats* – not much different from traditional current-propelled flatboats, altered to accommodate the lock dimensions between Monongahela River mines and Pittsburgh; typically 170 feet by 25 feet, carried 25,000 bushels; remained one-way containers sold with the cargo until the 1870s when it became more common to return them upstream for new loads.
- *barges* – smaller than coal boats, 130 feet by 25 feet, but sturdy with a life span of up to a decade; always returned to home port; carried up to 1300 bushels; originally constructed along the Allegheny but later built in Monongahela Valley boatyards; in early twentieth century, replaced by steel barges.
- *flats* – commonly 90 feet by 16 feet; a smaller, cheaper form of barge.
- *model barges* – up to 200 or more feet by 39 feet; resembled a huge canal boat or ark covered with hatches; used primarily from Pittsburgh on down the Ohio River.

The 198-ton, 167-foot long *Lake Erie No. 3*, built in McKeesport in 1851, was the first really large towboat. Its appearance marked the advent of serious steam-propelled coal transportation in the Monongahela Valley (Way 1990: 141). In 1853, J.J. Vandergrift of Pittsburgh became the first captain to place coal flats in front of his steamers instead of lashing them to the sides in the traditional fashion, a method that had been considered impossibly dangerous (Kussart 1937: 918). By the 1860s, this technique of pushing barges in front of the towboats had become the accepted method because it allowed pilots to stop, reverse, and change course with greater control.

Locally-built pool boats were a common sight on the lower Monongahela, and many of them were operated by local mine owners. Until after the Civil War, it was the more easily controlled and faster sidewheeler steamboats that dominated the Monongahela River, and they did remain the standard in the packet trade until the end. With the improvements in boilers, high-pressure engines, and hull designs, however, sternwheelers became the most common style of steamboat for nearly all inland-river towing operations.

In 1899, the Monongahela Consolidated Coal and Coke Company was formed, and this organization ended competition among the myriad numbers of rival mine operators in the valley. Most of the coal lands between Pittsburgh and the West Virginia border were taken over by the new organization. They also consolidated their respective river operations consisting of over eighty towboats, 6,000 coal boats and barges, as well as wharves, boatyards, marine ways, and similar kinds of properties. This move revolutionized transportation in the areas of efficiency and costs and led to increased demands to the government to increase the size of the Monongahela locks so that they could avoid breaking up their barge tows.

The coal company established or bought its own saw mills and lumber yards for boat and barge construction, and it built and repaired towboats on its own marine ways. Boats were built in every size necessary to accommodate the wide variety of river operations that the company performed. At the end of 1899, the "Combine" shipped 876 barges and 512 coal boats south from Pittsburgh (Way 1990: xvii-xviii). The steamer *Sprague*, at 1,479 tons and 318 feet, was the largest towboat in the world when it was built in 1902. These huge towboats were constructed

United States Department of the Interior

National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 37

for use on the Ohio and Mississippi rivers, rather than on the Monongahela, where the smaller pool boats and smaller locks remained the standard (Wiley 1936: 145).

A few of the major steel companies also maintained their own boatbuilding and repair yards on the Monongahela well into the twentieth century. Carnegie/U.S. Steel, for example, obtained barge hulls from the American Bridge Company's barge yard on the Ohio River and towed them to the marine ways at Coal Valley on the Monongahela where they were equipped with superstructures, engines, and other fittings. The ways here, 195 feet long by 210 feet wide, were the largest on the Monongahela River. The steel company stated that the slackwater navigation system as it existed in the early twentieth century was the primary reason for their ability to move large quantities of coal and coke to their steel mills and finished products on to customers regularly and economically (Carnegie-Illinois Steel Corp. 1938: n.p.).

INFLUENCE OF THE MONONGAHELA RIVER NAVIGATION SYSTEM ON THE DEVELOPMENT OF THE COAL, COKE, IRON, AND STEEL INDUSTRIES IN THE MONONGAHELA RIVER VALLEY, 1787-1960

The Monongahela River originates at the junction of the West Fork and Tygart rivers about one mile south of Fairmont, West Virginia. About 80 miles of the Monongahela River's length pass through lands rich in coal. Coal lies at the heart of understanding the history of the Monongahela River Valley's industrial development, but for it to be useful, coal must be mined and transported to mills, power plants, and homes. From the late eighteenth century through the present, the Monongahela River has been the chief corridor for the transportation of both coal and coke. Like the string of a necklace, the river strung together the individual "pearls"—chiefly coal, coke, iron, and steel—that made the Monongahela River Valley world famous³.

This industrial growth—first in coal, then in coke, then iron, then steel—was made possible at its most basic level by the presence of the extensive bituminous coal deposits in the Monongahela River Valley and especially by the Connellsville Coke District to the east that is bisected by the Youghiogheny River. The abundant coal reserves of the Monongahela River Valley could never have been commercially exploited on a sufficiently massive scale nor the profits used to finance the industrial expansion of southwestern Pennsylvania had it not been for the transportation possibilities afforded by the Youghiogheny and Monongahela Rivers and for the private and governmental efforts expended to make them navigable year-round. In 1928, the Monongahela River carried 27,412,143 tons of freight—more than any other single inland river of the United States—of which 85.1 percent consisted of coal and coke (Bureau of Railway Economics 1930: 101; 102, Table 17).

Coal, and its highly productive "twin," coke, therefore lie at the heart of understanding the "industrial synergy" that transformed the nineteenth and twentieth-century Monongahela River Valley into an interconnected and industrial juggernaut without parallel in the world. Henry Clay Frick, one of the paramount industrialists of the period, was fond of reminding people that "coke's the thing they can't make steel without." But coal is the thing you can't make coke without, and neither of them could have been exploited so successfully and on such a massive scale without a navigable river to transport them. Moreover, most of the coal and coke freight on the

³ This historic context section is an edited and abridged version of "The Influence of the Monongahela River Navigation System on the Development of Coal, Coke, Iron, and Steel Industries of the Monongahela River Valley" prepared by Ronald C. Carlisle, Ph.D. for the Pittsburgh District as part of a collection of essays to examine historical themes of particular importance to the Monongahela River navigation system in preparation for the National Register nomination. Portions of the Carlisle manuscript have been used verbatim.

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 38

Monongahela was carried but a short distance (an average of 41.4 miles in 1928). This reflects the fact that the river valley was not only the leading national producer of coal and coke but that its industrial mills were also the chief consumers of those products.

The Economic Geology of Monongahela River Valley Coal

Pittsburgh and the Monongahela River Valley are blessed with vast deposits of bituminous coal. South and southeast of Pittsburgh the bituminous coal fields found in the Monongahela River counties of Westmoreland, Washington, Greene, and Fayette and adjoining counties of West Virginia are part of the northernmost extension of the northeast-to-southwest trending Appalachian or Eastern Coal Region, one of seven major coal regions of the United States. This coal region extends over nine states from Pennsylvania to Alabama and Georgia and is some 900 miles long and 30-180 miles wide. The Main Bituminous Field in the western and southwestern part of Pennsylvania represents one of four major deposit of bituminous coal in the Commonwealth.

Historically, the Pittsburgh seam, which lies closest to ground surface, has produced about 80 percent of the bituminous coal mined in southwestern Pennsylvania. It has been called "the world's most valuable single mineral deposit," and the economic value of the 54 billion tons of coal it was estimated to contain following the Civil War was said to exceed the total worth of the California gold fields over 1,000 years (DiCiccio 1996b: 12, 13).

In addition to being useful in homes, it fired the furnaces of early Pittsburgh glass makers and the retorts of early salt makers. Its combination of high carbon content, relatively low percentage of volatile materials, and low ash and sulfur, however, also made the Pittsburgh coal ideal for making coke, essentially "baked coal" (Enman 1962: 63). Coke became vital first to iron production and later to steel making.

Early American iron making used wood charcoal as the predominant source of carbon and as a fuel that was combined in an iron furnace with iron ore and limestone. The great expanses of early America's virgin forests supplied this charcoal, but the process used up enormous numbers of trees. Eventually, experimentation with coke produced from the enormous quantities of bituminous coal available in the Monongahela River Valley led to coke's use as an alternative iron-making fuel and carbon source. The adoption of the technology of coke-smelted iron sparked the beginnings of that industry in the Monongahela River Valley. Further, since steel requires coke as one of its essential ingredients, coke also contributed to the Monongahela River Valley's subsequent growth into the steel producing capital of the world between 1875 and the end of the Second World War.

Another fortuitous part of the economic geology of the Monongahela River Valley was the location of the Connellsville Coke District just to the east of the Monongahela River and within the valley of the tributary Youghiogheny River. The Connellsville Coke District in Fayette and Westmoreland counties, Pennsylvania, consists entirely of coal from the Pittsburgh seam. It is widely regarded as the finest coking coal in the world.

Extensive mining of the Pittsburgh seam for coal and coke production during the nineteenth and twentieth centuries excavated perhaps half of the area's original reserves. Pennsylvania was the leading bituminous coal producing state in the country and was responsible for upwards of 30 percent of all coal mined in the country between 1840 and 1930. By 1970, Pennsylvania mines had produced over 18 billion tons of bituminous coal as well as 10.75 billion tons of anthracite coal, the latter from mines in the northeastern part of the Commonwealth.

Due to the extensive earlier mining in Fayette and Westmoreland counties, the focus of present-day bituminous coal mining in the Monongahela River Valley has shifted to Washington and Greene counties, Pennsylvania, and

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 39

to the adjoining coal fields of West Virginia in the valley's upper reaches. This is the current origin of most of the bituminous coal that continues to be transported down the river in large tows of barges. Although Pennsylvania's coal production has dropped about 30 percent from the levels attained during World War II, it still ranks fifth among states in overall coal production. Washington and Greene counties contribute about 28 percent of all the coal mined in Pennsylvania (Jones and Jones 1994: 17).

Mining, Transportation, and Use of Monongahela River Valley Coal Before the First River Navigation Improvements

A coal mine, opened about 1758 on Coal Hill for the use of the garrison at Fort Pitt, was located on the south side of the Monongahela River between the current Fort Pitt Bridge and the Smithfield Street Bridge, possibly just west of the Duquesne Incline. It tapped the Pittsburgh Seam of coal near the crest of Mt. Washington. An observer recorded that mined coal was put into bags and tumbled down the side of the hill to the river, where it was transported across the Monongahela River to the fort in a flatboat. This account provides the earliest known evidence of coal transportation on the Monongahela River, even though it was being transported across, not along the river. The troops at the fort used it for both heating and cooking. Coal also was reduced by the soldiers to make tar for caulking boats and for waterproofing. The French might also have mined some coal for use at Fort Duquesne during their occupation of the post between 1754 and 1758.

The early settlers of Pittsburgh found they could obtain small quantities of coal for heating (often called "home coal") with relatively little labor or expense as the Pittsburgh seam has frequent exposures in the hillsides above the Monongahela River. Small drift mines, dug horizontally into these exposures, could be mined by one or two individuals. In some cases, coal mined from the Pittsburgh Seam was loaded directly from the mouth of the mine into waiting boats by dumping the coal through a simple wooden chute or tipple.

As the population in the largely agricultural Monongahela River Valley counties of Fayette, Washington, and Westmoreland south of Pittsburgh grew during the late eighteenth and early nineteenth centuries, other exposures of bituminous coal were identified and mined. At first, most of the coal production for the population of this area was for local use, and coal was transported only short distances in wagons, but other coal was mined commercially and offered for sale at Pittsburgh. Given the rudimentary development of roads at the time, the Monongahela River became the principal route of longer distance coal transportation from early mines in the Youghiogheny and Monongahela River Valleys to Pittsburgh.

Rapidly growing river towns located outside the rich Appalachian Coal Region, such as Cincinnati and St. Louis, developed as new urban markets for the exceptional bituminous coal reserves of the Youghiogheny and Monongahela River Valleys. The exploitation of these early coal reserves, together with diversification of manufacturing, the establishment of small towns, better and more roads, and agricultural specialization played important roles in the commercialization of an otherwise overwhelmingly agricultural early American economy.

Early newspaper accounts document some transportation of coal on the Monongahela River near Pittsburgh before 1800, long before any concerted efforts were made to improve navigation on the natural river. The first documented coal shipment from Pittsburgh for other than local use occurred in 1803, when a company of French merchants shipped 350 tons of coal as ballast on a ship called the Louisiana. The coal was taken down the Ohio and Mississippi rivers to New Orleans and was shipped from there along the coast to Philadelphia, where it sold at a price of \$9-10 per ton.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number E Page 40

Before 1800 commercial ventures in the Pittsburgh area were largely speculative undertakings often financed by established Philadelphia trading companies eager to exploit the lucrative fur trade with interior Indian populations (Reiser 1951: 3). After 1800, however, population growth and increased settlement in southwestern Pennsylvania combined with the area's abundant deposits of natural resources stimulated the development of locally financed commercial and early industrial enterprises. As stands of native trees disappeared and the cost of wood increased, bituminous coal soon proved to be an economical alternative to wood for many Pittsburgh industries, particularly the early glass factories.

The location of glasshouses on or near the Monongahela River exemplifies the significant role that the river played in the transportation and merchandising of the finished fragile product that could not withstand the rough handling of long distance overland transportation. The rapid spread of settlement down the Ohio River and up the Allegheny River into the Northwest Territory created new and growing markets, and most of Pittsburgh's early glass was shipped west and south by river. The most frequent problem that delayed the delivery of orders was the condition of the river. It is not surprising then that navigation improvement was a matter of direct and immediate economic concern to Pittsburgh glassmakers. For that reason, many of them, became stockholders and/or managers of the Monongahela Navigation Company, which before the Civil War began to address the problem of navigation on the Monongahela River (Innes 1976: 17; Veech 1873: 27, 28).

Southwestern Pennsylvania bituminous coal had the twin virtues of being both cheap and plentiful. The high cost of transporting it overland was significantly reduced by river shipping even though the natural river could be treacherous and unpredictable. High labor costs also drove up the market price. The fact that the river often froze over for long periods during the winter months, just when demand for coal for heating was at its highest, could temporarily force up the price of coal at Pittsburgh or other river markets. Alternatively, if a number of loaded coal boats became marooned by the ice at one of these towns, a local coal glut could force the owners to sell their coal at or below cost. They could also face potential economic ruin through the loss of their boats and cargo in a sudden thaw.

River water levels in the summer and early autumn months were usually quite low, and river traffic often came to a halt for weeks or longer at a time. Coal was therefore usually mined in the winter. It might be stored in piles along the riverbank, then loaded into boats just before the few weeks each spring when river freshets provided enough water to float the heavily laden coal barges down river. The water level usually rose later in the fall, and this time of year was a busy one for getting coal to city markets before the onset of winter.

A variety of boats were used in the early coal trade in western Pennsylvania, but most of the larger mines that developed in the Monongahela Valley adapted "French Creek boats" to ship their coal. This boat type had been developed in the valley of French Creek (a tributary of the Allegheny River north of Pittsburgh) and was used to transport iron, lumber, salt, and agricultural products to Pittsburgh. Early coal merchants purchased the boats and raised their sides to six or seven feet so that they would hold more coal. Pairs of them were sometimes lashed together creating the forerunner of the Monongahela coal barge tows. At the end of the trip, the boats were sold for scrap lumber.

In addition to the French Creek boats, barges and keelboats were also being used for coal transportation by 1810, and a small but growing river business in the delivery of western Pennsylvania bituminous coal to Ohio River towns had been established by the time of the War of 1812. In 1814 there were perhaps forty to fifty coal pits in operation on both sides of the Monongahela River at Pittsburgh. By this time coal also had already had an impact on early Pittsburgh's industrial growth.

United States Department of the Interior

National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places Continuation Sheet

Section number E Page 41

Despite the national economic downturn that followed the end of the War of 1812, the first shipments of coal on a regular basis down the Ohio River from Pittsburgh began in 1817. In that year, a boat piloted by Tom Jones carried coal to Maysville, Kentucky. There were also regular shipments of Monongahela River Valley coal to Cincinnati, St. Louis, and New Orleans by this time. The 457-mile river trip from Pittsburgh to Cincinnati took about five days to complete (DiCiccio 1996b: 18).

By 1825, Pittsburgh was being supplied by coal from the Walton Pool No. 1 and the Castle Shannon mines in addition to the mines in Pittsburgh itself. In 1837, there were at least ten such mines on Coal Hill alone that produced over 200,000 tons of coal per year. However, this was insufficient to meet the needs of even the city, and this local demand stimulated the opening of other mines up the Monongahela River and elsewhere in the Pittsburgh area. Although a great deal of coal was shipped down the Ohio River to other towns, the rapidly growing city of Pittsburgh itself became the most immediate market for Monongahela and Youghiogheny River Valley coal.

Towns farther down the Ohio River received progressively smaller—though still significant—amounts of southwestern Pennsylvania coal. The records for Pittsburgh coal shipped to the port of New Orleans are especially well preserved and reflect dramatic growth over a forty-five year period. This would have been impossible had it not been for the ability to transport coal on a Monongahela-Ohio-Mississippi river system that was navigable at least seasonally each year.

By the 1840s, western Pennsylvania bituminous coal was a critical and essential economic factor in the continued growth and industrial development of towns and cities from Pittsburgh to New Orleans. The demand for ever-larger amounts of this cheap and readily available fuel continued to increase with the meteoric rise in the nation's western population. There were perhaps thirty-five to forty mines operating in the Monongahela River Valley by 1837. Washington County alone had twenty-seven coal mines in operation in 1840, and Allegheny County was the leading single producer of bituminous coal in the country.

Coal transportation by river was the only effective means of meeting the nation's growing demand. River navigation, however, was unpredictable, and the volume of river commerce had developed about as far as it could given the status of navigation on the natural Monongahela River. Continued economic growth required navigation improvements.

The Monongahela Navigation Company and the Coal Trade, ca. 1840-1870

Owners of gristmills and sawmills built the first dams on the Monongahela River. These privately constructed and maintained improvements harnessed waterpower but also hindered navigation, particularly for the efficient transportation of heavy loads, such as sand and coal. Pennsylvania eventually regulated these improvements by requiring the mill dams to be no more than 4.5 feet high. This allowed smaller keelboats and flatboats to go over the dam during periods of high water. Owners also had to provide a chute at the side of their dam so that boats could by-pass it during periods of low water. The wool and cotton carding firm of Gillespie and Clarke constructed the first lock on the Monongahela River at Brownsville about 1807.

Legislative efforts to remedy the navigation problem began as early as 1814 with the passage of an act to survey the river and to assess the number of mill dams constructed on it. The Monongahela Navigation Company (hereafter, MNC) was incorporated in 1817 for the purpose of building a slackwater navigation system on the

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places Continuation Sheet

Section number E Page 42

river, but the company's charter was revoked in 1822. Official surveys made in 1828 and 1832 both recommended navigation improvements.

Support for federal involvement in surveying the river came from businessmen in the Brownsville area. The 1832-1833 Howard study specifically considered how to improve steamboat navigation on the Monongahela. Howard's report also addressed the economic potential of the coal resources that outcropped all along the river if this valuable mineral could be efficiently extracted and transported to market. The surveys increased the engineering knowledge and mapping of the Monongahela River, and in 1836 Pennsylvania re-incorporated the MNC, charging it with carrying out the construction of navigation locks and dams on the river from Pittsburgh to the (West) Virginia state line.

A number of technological and economic developments propelled the MNC's agenda. First, the rapid evolution of steam power and its adaptation to river craft allowed larger steam-powered boats to be constructed on the Monongahela and gave new impetus to this widespread valley business. The MNC's lock and dam system was among the first in the United States to take steamboat size into consideration in determining the dimensions of their locks.

Second, the adoption of steam power also stimulated the use of coal for fuel, and this increased the demand for the efficient extraction and transport of Monongahela River Valley coal as well as the sand that was used in the valley's prominent glass making industry. A third MNC consideration was the opening of the Pennsylvania Canal at Pittsburgh in 1831 and the completion of an outlet lock on the Monongahela that held the added promise of transporting Monongahela Valley coal by canal boat to eastern Pennsylvania. High freight rates, small canal boats, narrow locks, and competition from anthracite coal producers in eastern Pennsylvania and other coal producers in Virginia, Maryland, and Great Britain, however, worked against the economics of shipping western Pennsylvania bituminous coal eastward on the canal (DiCiccio 1996b: 34).

The national economic depression that began in 1837 brought work on the MNC's new lock and dam system to a halt, but in 1843 a group of businessmen led by James K. Moorhead purchased a majority interest in the depressed shares of MNC stock and revived the company's fortunes. Between 1841 and 1856, the MNC constructed and opened Lock and Dam Nos. 1 through 6 on the Monongahela River providing a navigation pool as far upriver as New Geneva/Greensboro (Gannett Fleming, Corddry, and Carpenter, Inc. 1980: 4).

Although brick and glass were important components of the river freight that passed through these locks, coal was the river's most important commodity from the navigation system's earliest days. The opening of just these first four locks of the navigation system significantly spurred the exploitation of coal from mines in the lower and middle stretches of the river. Some 30,686 tons of coal passed through Lock No. 1 to Pittsburgh in 1844, all of it extracted from Allegheny County mines that could take advantage of the navigation available in the pool maintained by Dam No. 1. In general, the largest amounts of coal at this time came from the mines closer to Pittsburgh.

In the years between 1845 and 1860, the amount of coal shipped down the Monongahela (and after 1852, the Youghiogheny) river, according to Monongahela Navigation Company records, increased about seven times. Access to slackwater navigation throughout most of what in 1856 was the main coal-producing section of the Monongahela River Valley played a major role in achieving this significant increase in coal transportation. The opening of the two locks and dams above Brownsville that year brought slackwater navigation to within 7 miles of the (West) Virginia border (Albig 1914: 72). The only shortfall during this period was recorded in 1856, due to

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 43

severe winter weather. By 1860, nearly half of the bituminous coal mined in the United States came from Pennsylvania mines (Binder 1974: 3). It was widely recognized that such steady and dramatic increases would have been impossible were it not for the construction of the Monongahela Navigation Company's locks and dams and for the resulting extension of navigation pools up the river.

Since much of the bituminous coal that was transported on the river was actually consumed in Pittsburgh, operation of the MNC's navigation system had the immediate effect of keeping the coal supply high and its price correspondingly low for Pittsburgh residents, businesses, and industries. Since coal was used for everything from home heating to the production of power for large industrial concerns, even a small increase in its price could have a direct effect on the city's economy.

During the first two years of the navigation system's operation, tolls nearly doubled, but accumulated debt and interest from the company's earlier years and maintenance costs on the locks and dams continued to create economic problems for the MNC. Despite the reasonable tolls on the Monongahela, coal operators still complained about what they saw as the high cost of using the MNC's facilities. They also wanted the dams on the river lowered to 4.5 feet from 8 feet so that they could float their barges directly over the dams at times of high water and avoid paying the MNC toll altogether.

The dams were not lowered, but the MNC did further reduce its tolls, and that action stimulated the exploitation of coal and increased river traffic. However, at the same time, it also reduced the funds available for lock and dam maintenance and upriver expansion of the navigation system. Despite such difficulties, by 1847 the company had begun to pay off its bond issues, and revenues were good. Coal and coke hauling were responsible for most of the navigation system's revenue and for its brighter economic prospects.

Experiments with coal towing on the Monongahela River began in 1845, the year after the MNC had extended the navigable pool of the Monongahela River upriver as far as Brownsville. Access to the improved navigation facilities adjacent to the coal-rich middle and lower river valley immediately allowed the use of larger, more heavily laden coal boats and barges, and it also stimulated the rapid evolution of a new form of transportation—coal boat towing. By the 1880s, a coal "tow" often consisted of a steam towboat and as many as ten to fourteen coal boats, barges, or flatboats and from one to four fuel boats that supplied the steamer during the voyage. The boats were all lashed together and made up a unit perhaps 350 feet long and 150 feet wide. Such a flotilla could carry some 24,000 tons of coal, representing the production from as many as seven acres of coal lands.

In 1859, Pittsburgher George Thurston published a directory of the Monongahela River Valley (Thurston 1859). As part of his directory, Thurston included an inventory of coal businesses throughout the Monongahela and Youghiogheny Valleys. This work provides a valuable snapshot of the state of coal mining here just prior to the Civil War. Thurston listed approximately fifty coal mining operations for the Monongahela River Valley; the great majority of these coal works were found in the first three navigation pools of the river. Only one was located above Brownsville in the fifth navigation pool.

Annual coal production from the Monongahela River Valley mines in 1859 varied widely, from several thousand tons to 60,000 tons. Six coal firms on the Monongahela owned their own steam towboats in 1859. Most firms seem to have made their own runs to markets down the Ohio River, but other mines sold their coal to merchants who then transported it. To judge from Thurston's information, Pittsburgh's down-river coal markets were well-developed by 1859.

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 44

The construction of navigation improvements on the Youghiogheny River in the early 1850s also stimulated the opening of coal works in that area. Thurston's directory listed some fourteen coal works on this river in 1859. Collective production was considerably below that of mines on the Monongahela River but still accounted for some 224,496 tons of coal per year.

Between 1844 and 1872, almost 30 million tons of coal and coke passed through the MNC's lock system, the equivalent of about 267 acres of the Monongahela River Valley floating down the river and through the locks annually for twenty-nine consecutive years. The coal and coke traffic was the economic mainstay of the system. Of the nearly \$3 million the company collected in tolls between 1845 and 1872, fully 45 percent came from coal and coke (Veech 1873: 23-25; Bissell 1952: 148).

The coal trade volume generated by mines in the vicinity of the lower four locks of the navigation system grew so rapidly that the MNC constructed second locks at each of them, moving progressively upriver to service the major coal producing areas of the river. A second lock was added at Lock No. 1 in 1848, at Lock No. 2 in 1854, at Lock No. 3 in 1884, and at Lock No. 4 in 1886. The second locks were also larger than the 50-foot wide by 158-foot long original locks. When the second lock was built at Lock No. 1 in 1848, it was reputed to be the largest in the country (Wiley 1937: 151). The use of doubled locks and an increase in the width and length of the new locks in the middle and lower sections of the river resulted overwhelmingly from the need to handle a greater volume of larger coal barges and wider coal barge tows. Before the construction of the larger locks, it was necessary to disassemble a tow to lock through, a time-consuming process that slowed down the pace of the river coal traffic.

Another measure of the importance of the coal trade between Lock and Dam Nos. 1 and 4 is that the MNC constructed second locks at Lock Nos. 1 and 2 two years before the state legislature required the company to take the next step of extending the navigation system above Brownsville by constructing Lock and Dam No. 5 at Denbo and Lock and Dam No. 6 at Rice's Landing (1856). Both of these new locks were of the old dimensions, however. The decision to use the smaller lock dimensions increased the volume of steamboat passenger traffic on the upper reaches of the river, but also reflected the more rudimentary development of coal lands here before the Civil War. The statistics of coal and coke transportation through the MNC locks help to explain why the company was slow to extend the navigation system toward the West Virginia state line. As long as mines in the middle and lower stretches of the river remained so productive and profitable for the company, there was little incentive for the MNC to take on additional construction and maintenance debt for a diminishing return on tolls.

Development and Decline of a National Coal Industry, ca. 1870-1950

Coal shipments down the Monongahela River slowed during the first two years of the Civil War but then increased steadily from 1863 through 1865 as the war effort exerted new demands on southwestern Pennsylvania coal producers for increased production. After the war, coal shipments on the Monongahela increased steadily (except during 1867). The MNC also spent a large amount of the money it collected on improvements and repairs, especially on the locks and dams between Brownsville and Pittsburgh, where the most lucrative and productive coal mines were located. The company's upkeep of the navigation system played an important role in the success of the southwestern Pennsylvania coal trade.

The increased demand for southwestern Pennsylvania bituminous coal in the decades following the Civil War resulted from its diverse uses and the relative ease with which large amounts of it could be transported by river. The rapidly growing populations of Ohio and Mississippi River towns required more coal for domestic use, as well as for the illumination of homes, offices, and industrial plants. As the southern economy was rebuilt after the Civil War, western Pennsylvania coal fueled the steam engines that ran southern cotton gins and fired the boilers

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 45

of sugar refiners. Western migration also opened up new markets for coal. The construction of greater numbers of ever-larger steamboats greatly increased the demand for coal to fuel the boilers.

Coke also came into wider use in the manufacture of iron after the war and would be indispensable for the growth of the steel industry yet to come. The expansion of existing railroad lines, the establishment of new ones, and the development of improved firebox technology increased the number of coal-fired steam locomotives in service and generated further demand for coal.

Although rail lines posed a potential threat to the river trade in coal and coke, river navigation offered such a significant economy of scale, especially in the transportation of coal, that early railroads could not match it. This was especially true given the high rail freight rates of the time, the correspondingly low tolls for river transportation, the comparatively small capacity of railroad freight cars, and the eventual development of steel river barges capable of carrying even larger loads than their wooden predecessors.

The railroad did enjoy some significant advantages over water transportation, primarily speed and the ability to move in nearly all kinds of weather. Railroads could also be constructed in places where there were no streams or rivers, and they could transport goods and passengers to hard-to-reach places. American railroads built before 1850, however, usually established termini at navigable rivers, since they were the major corridors of trade and travel at the time.

From the beginning, railroads proved to be effective competitors against most canals for both passengers and freight traffic. Navigable rivers, however, held their own against the railroads, especially in the transportation of heavy bulk goods, such as coal, sand and gravel, coke, iron, and steel. The expanding railroad lines of the country also became one of the best markets for southwestern Pennsylvania bituminous coal and remained so from the Civil War to the appearance of the diesel locomotive in the 1930s (DiCiccio 1996b: 34). By the middle of the nineteenth century, rail construction had made it possible to transport western Pennsylvania gas coals to eastern Pennsylvania's and New York's urban markets. This was a new market for this coal that had not been served by river transportation (Baer 1981: 8; DiCiccio 1996b: 35).

Some railroad construction also increased the amount of coal freight traffic on rivers by making the exploitation of inland deposits feasible for the first time. Exploitation of the Connellsville Coke District in Fayette and Westmoreland counties, Pennsylvania, during the last quarter of the nineteenth century, for example, would not have been possible without the construction of rail lines into the fields. Connellsville coal was not suitable for long-distance rail shipment as it tended to break into small pieces (Jardini 1992: 5). However, the coal could be hauled a relatively short distance by rail to the river and then loaded into barges for the longer trip. The transfer of coal, sand, and gravel between land and river transportation stimulated the development of riverside docks, tipples, derricks, and terminal warehouses (U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers 1893*: 2492).

As coke became more integrated into the production of iron and steel, rail lines were built directly to the batteries of beehive coke ovens located throughout the fields. Unlike coal, coke did not crush under its own weight in the rail cars, and railroads became indispensable in the development of integrated mining and coking operations. As major coal customers, many railroad companies were instrumental in opening new mines in order to assure themselves of a steady supply of steam coal. By 1909 railroad companies' "captive mines" controlled about a quarter of the nation's coal production (DiCiccio 1996b: 63, 102).

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 46

As coal production increased in the stretch of the Monongahela between Brownsville and Pittsburgh during the 1870s, the mines there began to play out, and the attention of the coal operators turned to the upper stretches of the river. Between 1856 and the MNC's construction of Lock and Dam No. 7 at Jacob's Creek in 1883, Greensboro and New Geneva in Greene and Fayette counties, respectively, marked the head of navigation on the Monongahela. The coal lands between Brownsville and these towns had thus far contributed relatively little to the overall river trade in coal. Coal operators, however, continued to buy up coal rights in the upper stretches of the river into West Virginia. They also began to organize themselves politically to demand an end to river tolls. They formed the Pittsburgh Coal Exchange in the 1860s, incorporating in 1891 for the purpose of securing free use of the rivers and improved navigation, measures that would contribute significantly to the country's further industrialization and, of course, their own profits.

The coal operators of Pittsburgh and Brownsville felt justified in these demands because of the development of toll-free transportation on the Upper Monongahela River in West Virginia and on the federally constructed Kanawha River navigation system. Coal in the Kanawha River Valley could be shipped without charge to the Ohio below Pittsburgh and from there to towns on the Mississippi. These were Pittsburgh's traditional markets, and her businessmen feared that the river transportation tolls they had to pay on the Monongahela would now make them noncompetitive with these new suppliers. The arguments of the Pittsburgh coal interests received the backing of other Pittsburgh businessmen who also saw a potential loss of revenue for their city in the opening of the new coal fields in West Virginia, Kentucky, and Tennessee. They, too, now supported a greater role for the federal government in the construction and maintenance of locks and dams on the Upper Monongahela and for the removal of river tolls.

The passage of the Rivers and Harbors Act of 1871 was the federal government's first real role in improving the nation's inland navigation system. This legislation resulted in a survey of the Upper Monongahela by Charles Reichspfonn, E. A. Chase, and J.F. Wilson whose 1872 report recommended the construction of three additional locks and dams. It was not until the completion of Lock and Dam No. 8 in 1889, however, that the Monongahela River was fully navigable between Pittsburgh and Morgantown, West Virginia. After 1879 the navigation system was administered by both the federal government and the MNC, but the MNC continued to levy tolls for use of its locks.

Political pressure continued to be applied by the coal owners and other business interests for the federal government to operate the Monongahela River navigation system as a "free river." To be sure, the industrial development of the United States was demanding ever-larger quantities of both anthracite and bituminous coal. Coal economics and the national market therefore supported the political demands of the western Pennsylvania coal producers for improved transportation at lower cost. The coal and other industrial interests eventually got what they wanted. At the conclusion of protracted litigation, the federal government took over total ownership and control of the MNC's facilities in July of 1897, eliminating all tolls for navigation on the river.

Between 1897 and 1903, the federal government extended the reach of the Monongahela navigation system by constructing Lock and Dam Nos. 10 through 15 and by improving existing river facilities. The new locks and dams lengthened the navigation system twenty-eight river miles up the Monongahela from Morgantown to four miles above Fairmont, West Virginia. By 1903, the date of the completion of these new facilities, the Monongahela was navigable over a total distance of 131 river miles from Fairmont to Pittsburgh (Gannett, Fleming, Corddry & Carpenter, Inc. 1980: 15). These improvements were justified by the fact that Pennsylvania produced 66 percent of the country's coal in 1880, and in 1897 bituminous coal surpassed anthracite coal as the Commonwealth's principal mineral product.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number E Page 47

The MNC's older navigation facilities also were upgraded between 1902 and 1916. These improvements were designed to accommodate the increased coal production from mines in the upper part of the river, the larger sizes of the coal barges and tows then in use, and the country's seemingly insatiable demand for coal. Iron and steel haulers in the lower part of the river also benefited greatly from these lock improvements. With the elimination of tolls, the construction of new locks and dams, and improvement to existing facilities, river freight traffic grew significantly (U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers* 1897: 2406 and 1903: 1665; 1919: 3071).

The opening of the by-product coke ovens at the Monongahela River town of Clairton, Pennsylvania, in 1919 provided another major boost to coal traffic on the river. The plant was the largest producer of by-product coke in the nation at a time when Pittsburgh was the largest coke-producing district in the country. The plant was supplied daily by 1,000-ton barges of coal shipped from the Connellsville Coke District. By-product coke technology, unlike the older beehive coking process, could use coal of inferior quality to make adequate coke. Thus, coal mined in the upper reaches of the Monongahela River Valley outside the Connellsville Coke District could now be used successfully in steel manufacture. By-product coke technology therefore further stimulated the opening of new coal mines in the upper river valley (DiCiccio 1996b: 79, 80, 84).

Coal production in the Monongahela River Valley during the latter nineteenth century was increased not only by the improvement of the river navigation facilities but also by internal reorganization in the coal industry, where national growth had yielded economic opportunity while increasing competition. The resulting over-production and price reductions pushed the market price of coal below the cost of mining it.

One response to this problem was consolidation within the coal industry. In June 1899, the Monongahela River Consolidated Coal and Coke Company, usually called "the Combine," was formed out of an amalgamation of smaller coal companies. The Combine soon owned most of the productive coal lands on both sides of the Monongahela River. Some of its mines were located on the Pittsburgh, McKeesport, and Youghiogheny Railroad, and about twenty-five of the Combine's fifty mines were equipped with river tipples where coal was directly loaded into the company's river barges. These river tipples also served as important transfer points where coal shipped by rail from inland mines was loaded into barges. The Combine also maintained boat yards at Elizabeth and Monongahela City for repairs to its barges and river tugs. Although some independent coal companies held out and did not join the Combine, the economics and scale of the company's operation soon proved successful.

The Pittsburgh Coal Company also was formed in 1899 out of an amalgamation of smaller Monongahela River Valley companies. Formed in Pittsburgh, Pittsburgh Coal, like "the Combine" also owned mines, boats, barges, docks, and railroad lines, the great majority of which were located in Allegheny, Westmoreland, and Fayette counties. Its early board of directors included some of Pittsburgh's most important industrialists and financiers, among whom were Andrew W. Mellon, Henry R. Rea, Henry W. Oliver, and Henry Clay Frick. By 1900, it was the largest coal company in the nation, and three years later acquired majority stock ownership of "the Combine." The two companies formally merged in 1916. Sixty of the company's mines and 152,745 acres of untapped coal lands were in southwestern Pennsylvania (DiCiccio 1996b: 104).

Between 1905 and the outbreak of the First World War in 1914, the Monongahela River never carried less than the 24,677,800 tons of coal recorded in 1908. The demands of wartime production created an even greater market for coal (U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers* 1909: 1764; 1916: 2843; 1918:

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 48

2987; 1919: 3071). The iron and steel mills of the Monongahela River Valley produced vast quantities of arms and munitions during World War I. Together with the iron and steel industries, the coal industry of the valley helped boost the total amount of freight carried on the Monongahela during the war to world-class levels.

During the war, bituminous coal produced 69.5 percent of the country's total energy supply, a percentage that has never been equaled since (DiCiccio 1996b: 137). More freight per mile was carried on this one river than on the Great Lakes or Suez Canal or in the major ports of New York, Hamburg, London, and Marseilles combined. It carried more freight per day than the rest of the Ohio River system or the Mississippi River system. Only the tremendous trade in iron ore that passed through the St. Mary's Falls Canal at Sault Ste. Marie ever surpassed the freight tonnage carried on the Monongahela. Due to the demands of the war effort, the length of one lock chamber at Lock No. 3 was doubled in size to 720 feet (U.S. Army Corps of Engineers 1994: 51, 52).

By the time that Pittsburgh Coal bought a controlling interest in the Combine to form Pittsburgh Coal Company, Inc., a number of mines in the Connellsville Coke District of southwestern Pennsylvania already had played out and were closing. A period of mine closures in the district began about 1910 and continued until about 1931. Many new mines continued to open, however, in order to meet the needs of the war effort. Pennsylvania remained the country's leading bituminous coal producer during this time despite the opening of many new mines in other states. Pennsylvania mines produced 42 percent of the country's bituminous coal between 1912 and 1916 and 36 percent from 1917 to 1921. 1918 was Pennsylvania's peak production year for both bituminous and anthracite coal (DiCiccio 1996b: 137).

There were certain weaknesses inherent in the mining business. These included the vast over-expansion of mining between 1890 and 1920, a decrease in the need for coal (especially after the development of more efficient steam locomotives, followed by the introduction of diesel-powered locomotives), and the further development of oil, natural gas, and hydro-electricity as new fuel sources. Iron and steel producers also became more efficient in their use of coal and coke. The substitution of by-product coke production for the older and less efficient beehive method also decreased the demand for coal.

On the national scene, the decade from 1920 to 1930 was the most turbulent and troubling one for coal since the beginnings of the industry. The problems were especially hard on Pennsylvania since the Commonwealth employed more miners than any other state at the time. Severe competition and the opening of new mines drew far more men into the industry than it could support and pushed production far beyond demand. Price wars and competition from newly opened non-union mines in the South drove coal prices down and put many mines out of business. Labor unrest and strikes often shut mines down, at least temporarily. Increasing demand for cleaner coal required owners to invest in new coal washing equipment, plants, and labor, additional costs in a time of retrenchment. Management also began to turn to mechanization of the mining process to reduce costs; by the 1920s, coal often was mined with the aid of machines that undercut the coal beds, although miners still usually loaded it by hand into coal cars. Generally, mechanical loaders and continuous mining machines did not come into use until after the Second World War.

The 1920s was a time of consolidation among mine owners as fewer but larger companies owned more and more of the nation's coal resources. Of the 1,300 coal operators in Pennsylvania in 1930, just 100 of them produced 80 percent of the Commonwealth's coal output. In addition to the challenges to the supremacy of coal, the Great Depression that began in 1929 added only new misery and a further drop in coal prices.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places Continuation Sheet

Section number E Page 49

The price, labor, and management problems of Pennsylvania 1920's bituminous coal industry are reflected in Monongahela River freight statistics. The staggering amount of coal transported on the river in 1918 had declined by 51 percent by 1920. Decline continued during the next two years to a low point in 1922. In general, river coal shipments then increased to about 20,000,000 tons per year throughout the remainder of the decade (U.S. Army Corps of Engineers, *Annual Reports of the Chief of Engineers 1921-1930*).

Although growth of the coal industry had peaked by the early 1920s, the impressive freight tonnage carried on the Monongahela during and immediately following the First World War led Congress to authorize further improvements to the navigation facilities through the River and Harbor Act of 1922. This work included extending guard and guide walls, lengthening lock chambers, constructing new locks, and building whole new installations while, at the same time, eliminating older ones. Some reconstruction was intended to improve navigation in the upper portion of the river in Pennsylvania and to deepen the navigation pool by dredging to provide a low-water depth of nine feet.

The great increase in the length of one of the chambers of Lock No. 3 was the direct result of the coal trade. Most of the movement of coal on the Monongahela River by this time was "down-bound" trade, meaning that coal originating at mines up the river terminated farther down the same river. Specifically, most coal at this time was transported in barges from the Frick mines near navigation pools 4 to 6 and was shipped to the Clairton coke plant through Locks No. 3. It was the use of coal in making coke, and coke's use in the iron and steel plants on the Monongahela River, that generated the enormous river trade in bituminous coal (Tomer 1939: 44).

Conditions in the American coal fields worsened following the 1929 stock market crash, and these bleak years persisted into the early 1930s. The industry nearly collapsed altogether in 1932. Some 2,500 independently owned bituminous mines in Pennsylvania went out of business between 1920 and 1935. Unemployment in the coal-producing regions of southwestern Pennsylvania approached 40 percent in 1934 (Coode 1986: 103-104). Coal tonnage on the Monongahela River dropped precipitously, and 1932 was the low point for the value of all river shipping on the Monongahela (U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers 1932: 721-722*; U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers 1933: 677-678*). New Deal efforts to counteract the effects of the Depression at the national level had an immediate and positive impact on Monongahela River coal freight figures, however (U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers 1934: 703-704*; *1938: 843-844*; *1939: 887-888*).

To a large degree, the Monongahela River navigation improvements resulting from the 1922 Congressional act responded to the needs of the river's coal traffic and reflected the larger sizes of the coal barges then in use and the dominance of coal in the river's commerce. By 1935, more than 98 percent of the traffic passing through Lock No. 5 consisted of coal carried by an average of 56 barges per day. Most of this coal, about 96 percent of it, was destined for use by one or another of the steel mills in the lower part of the Monongahela River Valley. The large power plants of Duquesne Light and West Penn Power and the once vital coke plant of the Clairton Coke works, all located along the river, were other significant customers for Monongahela River Valley bituminous coal during these years.

Improvements at Locks and Dam No. 4 required further consideration under the River and Harbor Act of 1930 and passage of a joint resolution of the Senate and House in January 1931. All of the improvements originally called for in the 1920 River and Harbor Act were completed by the end of fiscal year 1935 (Gannett, Fleming, Corddry, and Carpenter, Inc. 1980: 30-32). This sustained program of modernization reflected the national importance Congress attached to maintaining and furthering successful navigation and commerce on the

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 50

Monongahela River. The perennial problem of insufficient water in the river during periods of seasonal draw-down also was addressed during the 1930s by the construction of several lakes and reservoirs. These included Tygart Dam at Grafton, West Virginia (1938), the Lynn Lake Reservoir on the Cheat River, and two reservoirs on the Youghiogheny River.

Navigation improvements could not reverse the declining importance of coal to the nation's energy supply after 1930. Although the downward trend slowed somewhat during the Second World War, by 1950 coal was providing just 39 percent of the nation's energy (DiCiccio 1996b: 151). Changes in the ways that coke was produced between 1920 and 1940 also affected coal river traffic on the Monongahela. Unprocessed coal rather than coke was now hauled in river barges to the Clairton coke works.

In 1948, the Chief of Engineers' report also commented on the actual and expected increases in coal production on the Monongahela River in the vicinity of Lock and Dam Nos. 10 and 11. By the late 1940s, then, all of the existing Upper Monongahela River navigation facilities from Lock and Dam Nos. 10 through No. 15 were determined to be inadequate to the needs of the contemporary coal business as well as other commercial interests in that segment of the river. Coal shipment figures for the Monongahela River in the post-war period justified the decision to upgrade the navigation facilities (U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers 1949*: 817; 1950: 910; 191: 972; 1952: 1019-1020).

The development of the steel, chemical, and sand and gravel industries in the Monongahela River Valley also played important roles in stimulating the Corps's program of navigation improvements. It was the growth of the bituminous coal industry in the upper reaches of the river and the need to get coal to Pittsburgh's coke plants and steel mills that was particularly critical to the nearly continuous improvement of locks and dams on the Monongahela before and immediately after World War II. Subsequent changes in the steel industry, however, especially the installation of electric steel-making furnaces, reduced the need for metallurgical coal and coke. Railroad demands for coal decreased not only with the adoption of the diesel engine but also with the decline of the nation's railroad system following the war. By 1981, the greatest users of southwestern Pennsylvania bituminous coal were the coal-fired electricity generating plants that supplied power to a growing and increasingly suburban population.

The Monongahela River Valley Coke and Iron Industries

Pennsylvania played a pivotal role in the development of the early American iron industry beginning in 1716. Pennsylvania's early iron industry was located in the eastern and central counties of the state, but as the American population spread from east to west near the end of the eighteenth century, Pennsylvania's iron industry also moved west across the Allegheny Mountains.

The use of coke in the production of American iron and steel reached its zenith in the Monongahela and Youghiogheny River Valleys of southwestern Pennsylvania in the second half of the nineteenth and the first half of the twentieth centuries. The bituminous coal found in southwestern Pennsylvania had been used for heating Pittsburgh-area homes and businesses since at least the 1760s and had also been used in the Monongahela River Valley's iron forges and mills to reheat pig iron. Little use was made of bituminous coal or coke in early iron making. At the time, it was difficult to identify specific bituminous coal that had the correct coke-making properties. Lack of knowledge about the correct blast of air needed in the iron furnaces of the day, impurities (especially sulfur) in bituminous coal, individual prejudices in favor of the continued use of charcoal iron, poorly-developed transportation systems, and the generally low-level of business organization among coal companies also helped delay the use of bituminous coal in the iron industry (Binder 1974: 76).

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 51

The first production of coke in a beehive oven seems to have occurred within the current limits of Connellsville, Fayette County, Pennsylvania, in 1833. The beehive coke that resulted from this early attempt was loaded into boats and floated down the Youghioghny River to McKeesport, then up the Monongahela River to Brownsville (Billinger 1954: 37; DiCiccio 1996b: 28).

Pittsburgh eventually came to be regarded as the iron and steel-making capital of the world; however, its earliest importance to the iron industry was rolling, shaping and fabricating iron and iron products, not its manufacture. Fayette County took the lead in the early southwestern Pennsylvania iron production and manufacturing industries, and most of these early industrial developments were situated on tributaries of the Youghioghny or Monongahela rivers (information abstracted from Bining 1973: Appendix A, pp. 171-176).

The Pittsburgh iron industry enjoyed a period of comparatively rapid growth in the early nineteenth century. This was due in part to the ample supplies of pig and wrought iron available from blast furnaces up the Monongahela River, primarily in Fayette County but also in Westmoreland County and Greene County. The War of 1812 spurred iron production in Pittsburgh and in the American iron industry in general as it temporarily cut off Britain as a source of relatively cheap iron and iron products.

A national economic recession began after the end of the War of 1812 and continued into 1819 with a period of general business retrenchment in Pittsburgh. By 1821 the manufacturing industry of the city began to revive, and by 1826 iron accounted for more than 50 percent of Pittsburgh's product value and greatly increased its lead as the single most important business in the town, far outstripping its closest competitor, textiles (Reiser 1951: 15, 19, 21-24).

The development of the Pittsburgh-area steamboat industry and the establishment of regular steamboat service in the late 1830s also facilitated the area's iron industry and its shipment on the rivers. Much of the ironware produced in Pittsburgh's factories was used locally, but it was also shipped down the Ohio River where the advancing frontier provided a ready market.

Coke-Iron Manufacture in the 1850s and the Civil War

Prior to the Civil War, the Pennsylvania iron industry, like that of the country as a whole, was characterized by technological conservatism and the retention of traditional forms of business organization (Paskoff 1983: 132-133). The conservatism of most in the iron business was bred in part by the financial uncertainties of a market that was largely beyond their control. National economic downturns such as that following the War of 1812, the one from 1837-1842, and again in 1857, could spell instant financial ruin for those who had over-expanded or over-invested in new technology. Moreover, there was no mass market that demanded increased production from the iron industry prior to the boom in railroad building after the Civil War. Increased consumer demand for iron products generated by a larger population was met by developing new rather than larger firms and by the extension of traditional iron-making techniques, so there was little incentive to increase iron production by adopting new technologies.

Protective tariffs helped to prop up the American iron industry in the first half of the nineteenth century, but the implementation of technological improvements—especially the development of coke-smelted iron, and the resulting economies of scale—allowed English iron producers to exploit the emerging American market for iron railroad rails in the 1830s and 1840s. Foreign competition and generally falling prices of iron products helped to repress the development of the American industry. Some Pennsylvania iron producers did adopt new

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 52

technologies, of course, including coke smelting, the use of hot blast and anthracite furnaces, and the integrated corporate (rather than individual ownership or partnerships) form of business organization during these decades, but they were in the minority.

This picture began to change about 1850 and was then accelerated by the production demands of the Civil War and the expansion of the American railroad system in the 1860s (Paskoff 1983: 134). The great quantities of iron demanded by the railroads for rails and boiler plate conferred economic advantage on iron manufacturers who could assure their customers an uninterrupted supply of relatively low-cost iron products. This change of emphasis in the iron market from production for household, commercial, and small-scale industry to large-scale industrial production of specialized products brought about fundamental changes in the organization and operation of the iron industry.

These changes included the concentration of greater amounts of capital in fewer hands, the implementation of labor- and cost-saving technologies, the integration of all facets of industrial production from the production of iron through the fabrication of finished product, the expansion of the labor force, control of production costs, and the development of complex forms of corporate management. In short, by the end of the Civil War the stage had been set for the emergence of the large integrated industrial firms epitomized by the Monongahela River Valley steel mills of the late nineteenth and early twentieth centuries.

About 1840, it was discovered that the coal of the Connellsville Coke District possessed special attributes that made it ideal in coke production. It was soft, porous, and easily mined, was relatively free of sulfur, required little processing before it was coked, had a hard metallic ring to it and a lustrous silver color, and also retained its physical strength after processing so that it withstood the physical crushing forces when dumped into a blast furnace with limestone and iron ore (Albert 1882: 405). Coke and bituminous coal could also be used in the iron puddling furnaces that were growing in number by the middle of the nineteenth century. The development of the puddling furnace and rolling mill complex had great importance for the rapidly developing American railroad industry.

Western Pennsylvania took the lead over older iron-producing firms in the eastern end of the state when it came to construction of rolling mills, and cut iron nails were their chief product. Efficient production and reduced transportation costs made western Pennsylvania iron products less expensive in the growing American West than iron wares from the eastern end of the state. The Allegheny, Monongahela, and Ohio rivers also afforded cheap inland transportation. Western Pennsylvania iron products were marketed both locally and down the Ohio and Mississippi rivers and were readily purchased by the rapidly increasing western population. In terms of wrought iron production, the more efficient Pennsylvania puddling furnaces and rolling mills were producing 80 percent of the state's wrought iron by 1849. This figure grew to 90 percent by 1856. In 1860 national production of rolled iron reached 500,000 tons per year from 250 rolling mills (Eggert 1994: 5, 11-12, 14, 48-50).

In the first half of the nineteenth century, the development of the puddling furnace increased the immediate utility of coke in iron manufacture. The two great advantages of coke-produced iron were its cheapness compared to charcoal-iron (about one-third the cost in the mid-1850s) and the fact that far less coke than charcoal was required to produce a ton of iron.

The number of Pittsburgh iron manufacturing firms continued to increase during the 1850s, by which time it truly had become the "Iron City." At mid-century—two years before the first railroad was completed to the city—

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 53

Pittsburgh already was the site of thirty large foundries and thirteen rolling mills, and iron continued to lead all other individual Pittsburgh industries in value (Reiser 1951: 191-192).

The opening of the Pennsylvania Railroad to Pittsburgh in 1852 was significant only indirectly as far as the transportation of coke was concerned. The arrival of the railroad in Pittsburgh, the absence of rail construction up the Monongahela River Valley, and the emergence of coal as the country's principal fuel actually increased the Monongahela River trade in this mineral.

Of much greater immediate importance for coke was the construction in 1855 of the Pittsburgh and Connellsville Railroad's line paralleling the northeast bank of the Monongahela and the east bank of the Youghiogheny River from Pittsburgh to Connellsville and then to Rockwood. This route led directly through the heart of the Connellsville Coke District, and branches of this line soon were completed to Uniontown and Mt. Pleasant, thus opening other sections of the coke district to the possibilities of exploitation. Probably due in no small part to the efficient transportation afforded by the Monongahela Navigation Company's system of locks and dams, no railroad had been constructed up the banks of that river until the mid 1850s, and only one, the Hempfield Railroad line from the Ohio River at Wheeling, (West) Virginia, through Washington, Pennsylvania, crossed the Monongahela above McKeesport (Warren 1973: 37-38).

The production of Pennsylvania iron received a major boost in 1857 when John Fritz developed the "three-high" rolling mill at the Cambria Iron Works in eastern Pennsylvania. This development produced iron rails by a continuous rolling process that dramatically cut the cost of American-made iron rails while increasing output. Fritz's process remained the industry standard until the introduction of the steel rail at the end of the Civil War (Eggert 1994: 52). The increased production and lower cost of American rails allowed the American iron industry to compete successfully with the British iron industry for the increasingly lucrative railroad-construction business.

A major contribution to the Pittsburgh iron industry came in 1859 when Graff, Bennett and Company constructed its Clinton Furnace on the south bank of the Monongahela River opposite Pittsburgh. In the spring of 1860, excellent coke from the Connellsville Coke District was brought to the furnace on the Baltimore & Ohio Railroad (Binder 1974: 83) and in river barges (DiCiccio 1996b: 39). The Clinton Furnace marked a major turning point in the history of the Pittsburgh and western Pennsylvania iron industry. After 1860, Pittsburgh was known not only as an iron products and processing center but also as a manufacturing location.

Coke, which previously had been used only in small quantities for re-heating iron in forges and bloomeries, was subsequently needed in vast quantities for the production of pig iron. Graff, Bennett and Company's experiment proved the reliability of Connellsville coke for this purpose and also demonstrated that Monongahela River Valley coke could be economically transported to Pittsburgh by rail or river and combined there with iron ore to manufacture pig iron. The raw iron could then be processed on the spot into ingots or finished products and shipped either east or west by rail or down the Ohio River. As a result of this urban centralization of iron making, rural iron production in southwestern Pennsylvania declined rapidly after 1860. By 1880, Pittsburgh was producing 80 percent of all the iron manufactured in the seven county area, including the old iron centers in Fayette County to the south and Armstrong County to the north.

The Civil War's demand for armaments greatly accelerated the growth of the American iron industry and of coke-iron in particular. The evolution of coke-produced iron increased Pennsylvania coal consumption dramatically in the five years leading up to the war, and a great amount of this came from the Connellsville Coal District.

United States Department of the Interior

National Park Service

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| Historic Resources of the Monongahela River Navigation System in Pennsylvania and West Virginia, 1838 - 1960 |
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**National Register of Historic Places
Continuation Sheet**Section number E Page 54

Pittsburgh's iron factories became the armorers of the Union. At the end of the war, national iron production dropped by 18 percent overall. Significantly, anthracite iron production dropped 30 percent at this time while coke-iron production fell only 10.2 percent (Warren 1973: 38).

Coke and Iron in the Late Nineteenth and Twentieth Centuries

The growth of the southwestern Pennsylvania coke industry after the Civil War was so great that while in 1870 one train per day was judged sufficient to transport the entire coke production of the Connellsville Coke District, by the early 1880s the output of just one coke works in the district required 60 rail cars per day. Pennsylvania was then producing about 84 percent of the country's supply of coke, overwhelmingly from Fayette and Westmoreland counties (Albert 1882: 406). All of the railroads, as well as Monongahela River barges, carried coke from the Connellsville area to the new iron-making center of the valley just upriver from Pittsburgh.

Railroads were essential to the exploitation of the Connellsville Coke District not only because the district was inland from the Monongahela River but also because railroad cars had been integrated into the beehive coke-making process almost from the beginning. Coal was dumped into the top of a battery of ovens built next to each other in long banks and "cooked" to reduce the coal to coke. When the process was complete, workers stationed in front of the coke batteries reached into each oven with long rods to pull the coke out, and it was transferred immediately into waiting railroad cars for transportation directly to blast furnaces.

By the early 1880s, there were perhaps 10,000 coke ovens in operation in and about the Connellsville Coke District. It was estimated that it would have required a single train of 250,000 cars extending almost 2,000 miles to carry its yearly output (Albert 1882: 407), and this was during the early years of the district's industrial operations. Many iron manufacturers in Pittsburgh were separate business enterprises from similar ventures up the Monongahela and Youghiogheny river valleys, but some Pittsburgh iron producers found it useful to establish their rolling mills in the heart of the coke field rather than bringing the coke down-river to the mill.

The rapid growth and geographic spread of American railroads during the 1850s through the 1870s created a need for hundreds of miles of affordable iron rails, and this need was met by the American iron industry. In thirty years, total American railroad miles more than tripled from just 30,000 in 1850 to 94,000 by 1880. Pennsylvania saw the establishment of a number of rail-producing mills during the 1850s, including the Bethlehem Iron Company in Bethlehem, the Cambria Iron Works in Johnstown, and Jones and Laughlin in Pittsburgh. By the mid-1850s, new American iron mills tended to be constructed west of the Allegheny Mountains and marked the movement of the epicenter in the American iron industry from the old iron-making centers in the East (Temin 1964: 119).

The increase in American coke-iron production between 1850 and 1870 lowered the cost of rails to the railroads. This, in turn, stimulated the construction of more railroad lines which further increased the demand for more iron rails, locomotives, railroad car wheels, iron bridges, and other metal products. The increased demand for iron products naturally required still larger supplies of coke as well as more coal, the fuel most of the locomotives were now burning in preference to wood.

The Age of Steel

Steel is made using iron; in fact, steel is iron in which the carbon has been first removed and then carefully added back in, sometimes with alloys. It has been known for centuries, but due to the difficulty of controlling the carbon content was made only in small quantities until the mid-nineteenth century.

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 55

The Bessemer process, invented in 1856 by Henry Bessemer, involved blowing air through a charge of molten iron under pressure to remove its carbon impurities, and it was an improvement over the techniques then in use. Its eventual implementation in U.S. mills led to a marked increase in the amount of steel that could be produced. Bessemer did not receive a U.S. patent on his process until 1865, and Pittsburgh-born William Kelly developed a similar steel-making process almost simultaneously at the Suwanee Furnace in Kentucky. Adoption of the Bessemer/Kelly process, however, did not become widespread until the 1880s (Bining 1954: 21).

One of the most important consequences of the adoption of the Bessemer process for mass steel production was the related development of steel rails, which could carry more weight than iron rails without deformation and therefore lasted much longer. Steel rails allowed the construction of larger railroad cars and engines that could carry greater freight loads. The older iron rails also could be torn up and recycled as scrap to produce the new steel rails, and this provided an additional incentive for the expanding railroad companies to adopt steel rails. Carnegie Steel Company's Edgar Thomson works on the Monongahela River at Braddock, Pennsylvania, had an integrated production line for the manufacture of Bessemer steel rails in operation by 1888 (Ingham 1991: 36). At its production peak later in the nineteenth century, this mill produced 3,000 tons of finished steel per day, roughly the equivalent of the annual production of a Pittsburgh-area iron puddling mill in the 1830s (Ingham 1991: 48).

The European Siemens-Martin open-hearth process for making steel was first employed in the United States at Cooper, Hewitt and Company's New Jersey Iron and Steel works in Trenton, New Jersey, in 1868, but the process did not gain wide use in the United States until after 1885 (Temin 1964: 140). This process grew out of the older iron puddling-furnace concept. It required more time than the Bessemer process but produced a generally superior product as its contents could be monitored more carefully. Open-hearth furnaces could also accept a larger percentage of scrap iron in their charge than Bessemer furnaces, and that lowered production costs to some extent (Temin 1964: 145). The process gradually grew in acceptance, and by 1908 it had become the dominant steel-making process in the country (Temin 1964: 143, Table 6.1).

Both the Bessemer and the open-hearth furnaces required a large amount of water during the steel-making process. This and the water requirements of coke plants provided another reason besides transportation to locate the modern steel mills and by-product coke plants on or near major rivers (Committee on Physical Chemistry of Steelmaking 1944: 18). Large amounts of water also were needed to quench the hot coke as it was pushed out of the ovens and to cool the by-product coke oven gas (Lankford et al. 1985: 346).

The integrated process that controlled all phases of steel making from ore to finished product and the speed at which steel could now be produced also required rethinking the organization and layout of industrial space. Blast furnaces increased in size, number, and output of pig iron, which consequently enabled steel production to expand prodigiously. Instead of blast furnaces and rolling mills being spread out along the Monongahela River Valley, as they often had been in the early years of the iron industry, a premium was now placed on erecting each of the elements in the steel-making and finishing process—blast furnace, coke oven, Bessemer furnace, rolling and other types of mills—close to each other so that transfer time among them was not wasted. Steel mill operations became much larger in size and industrial complexity. The physical layout of mills was rationalized so that raw materials "came in" one end and steel "came out" the other. The lower Monongahela River was transformed into an industrialized corridor of large steel mills and the smaller industrial businesses that supported them. The amount of iron and steel produced in Allegheny County mills increased from 757,273 tons in 1880 to 8,203,715 tons in 1900 when the Carnegie Steel Company, the area's single most important producer, controlled 25 to 35 percent of the nation's steel production (Keyes et al. 1991: 11).

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places Continuation Sheet

Section number E Page 56

Andrew Carnegie expanded his company's capabilities and capacities and simultaneously reduced competition by acquiring rival firms. By building the Edgar Thomson works and acquiring Homestead and Duquesne, in the few short years between the mid-1870s and 1889, Carnegie assembled an industrial juggernaut that quickly turned the Lower Monongahela River Valley into the steel making capital of the country. In 1892, the year of the mill workers' revolt at Carnegie's Homestead mill, American steel production surpassed that of iron for the first time (Sisson 1992: 79).

By the early twentieth century, virtually all of the Lower Monongahela River flood plain above Pittsburgh had been affected by industrialization and the construction and expansion of steel mills. Jones and Laughlin's blast furnaces, rolling mills, wharves, train yards and worker housing occupied large tracts on both sides of the river nearest Pittsburgh. Upriver were the Homestead, Edgar Thomson, and Duquesne works of United States Steel, the first one billion dollar company, formed in 1901 by financier J. P. Morgan with the former Carnegie Steel Company at its core. Farther upriver, other mills were located at McKeesport, Donora, Monessen, and many other towns (Keyes et al. 1991: 9; Magda 1985). To the west, the lack of additional land in the Monongahela River Valley forced industrial entrepreneurs to develop other areas such as McKees Rocks on the Ohio and Mansfield (later re-named Carnegie) on Chartiers Creek into densely populated "industrial suburbs" (Couvares 1984: 81).

The Competition Between the Railroads and Water Transportation

Prior to the passage of the Federal Control Act of 1918, there was little incentive for the coordination of rail and inland river transportation. Indeed, rail and water competition in the second half of the nineteenth century was fierce and usually involved rate cuts on the part of the railroads. The water-rail competition played itself out in a number of ways, emphasizing both cut-throat competition and a modicum of cooperation at various times.

In the early twentieth century, the federal government began to take much more of an interest in regulating the commerce involving the railroads and the water transportation industry. Water commerce interests were successful in getting the Mann-Elkins Act passed in 1910. This legislation stipulated that once a railroad carrier had reduced its rates between two points in order to compete with water transportation, it was then not permitted to raise those rates again unless it could show that the increase was the result of factors other than the elimination of water competition.

In 1912, the Interstate Commerce Commission was given the authority to establish the rules, routes, and maximum through-rate charges for freight moving by combined water and rail routes. The Commission also obtained jurisdiction over the establishment of rail-water transfer terminals. This was important to the water carriers as in their growth along the flat river valleys the railroads often had obtained title to waterfront property and had prevented the construction of water docking facilities (U.S. Department of Commerce 1923:8-10).

The Federal Control Act of 1918 established what eventually became known as the Division of Inland Waterways within the Railroad Administration. This division was charged with working out the problems of connecting rail and water transport, establishing rail and water transportation through-routes, and determining fair transportation rates. This legislation as well as the Transportation Act of 1920 and the Interstate Commerce Act attempted to "...break down the legislative wall hitherto built up between the transportation service by water and the transportation service by rail..." (Bureau of Railway Economics 1930: 74).

By the 1920s and 1930s, the Monongahela River occupied a unique position among the country's rivers due to the wealth of mineral and industrial businesses erected along its course and to the program of lock and dam

United States Department of the Interior

National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places Continuation Sheet

Section number E Page 57

construction and maintenance that had turned the river into a veritable "industrial canal." The volume of freight carried on the nation's railroads doubled between 1906 and 1929, but the freight tonnage carried on the Monongahela River then exceeded that of any other single river in the country. In 1922, the federal government set up the Federal Barge Line to stimulate the development of commerce carried on the Mississippi River and also allocated \$42,000,000 for navigation improvements on the Ohio River (Hogan 1971: 1367).

Increased freight commerce on the Monongahela and the completion of the federal government's 981-mile long Ohio River navigation system from Pittsburgh to Cairo, Illinois (opened on October 11, 1929), resulted in a 55 percent increase in river freight commerce in the Upper Ohio River drainage between 1925 and 1929 (Engineer's Society of Western Pennsylvania 1930: 153). The Monongahela was one of the few rivers in the country that showed an increase in the amount of freight carried in the face of railroad competition, particularly between 1892 and 1920 (U.S. Department of Commerce 1923: 45). Coal and coke made up the great bulk of this traffic (85 percent of total river tonnage in 1928), but many of the iron and steel companies also constructed docks and their own barges to move their raw materials and finished products.

The tonnage carried on Pittsburgh's rivers more than doubled between 1913 and 1926 (Harper 1931: 679). Still, iron, steel, and other metals transported on the river between 1924 and 1928 made up just 7.6 percent of the amount contributed by coal and coke (Bureau of Railway Economics 1930: 102, Table 17). After coal and coke, sand and gravel contributed the most to the area's river commerce. In 1931, Pittsburgh's water-borne commerce was larger than that of the Panama Canal (Harper 1931: 679). In stark contrast to the Monongahela River, by 1920 the Allegheny River was no longer considered to be a significant carrier of commerce. In 1921, the Allegheny carried only about 25 percent of the tonnage of sand, gravel, coal, and metal products that was transported on the Monongahela (U.S. Department of Commerce 1923: 45).

Steel rails accounted for most of the river tonnage in metals between 1885 and 1902. As a percentage of metal and metal products moved by river transport, steel rails then fell off sharply. In 1918, only 307 tons of rails were moved by river boat, according to figures in the U.S. Army Corps of Engineers Annual Reports. In contrast, relatively small amounts of iron ore were transported by river between 1885 and 1890, and only minor amounts of pig iron are recorded for the years 1885-1891. The drop in the tonnage of steel rails that were carried by water transportation after 1902 was offset by an increase in the category of "other iron products." In 1928, an all-time high of 1,774,024 tons was carried before the numbers began to decline somewhat during the 1930s. The 1,000,000-ton mark was exceeded again in 1939 and continued throughout the first four years of the Second World War. These figures declined somewhat in 1946 and 1947, but climbed again to over 1,000,000 tons annually every year from 1948 through 1951.

The "Pittsburgh Plus" Pricing System and Its Effect on Water Transportation

Pittsburgh and Monongahela River Valley industrial firms showed renewed interest in river shipping during the 1920s due to the demise of a price basis system known as "Pittsburgh Plus." Under this system, the price of a commodity, for example a ton of steel, was based on the price in Pittsburgh plus an average freight rate, no matter where it actually was made. Different segments of the iron and steel industry adopted "Pittsburgh Plus" at different times during the early twentieth century. This pricing system developed as a way of keeping older, more established eastern industries competitive with newer plants in the growing population centers of the Midwest and West. The "phantom freight" rates also supplied additional capital to help finance the construction of the newer and more costly mills, or at least that was one justification.

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 58

Naturally, many consumers opposed the Pittsburgh Plus system, especially distant consumers who otherwise could buy locally produced steel more cheaply. Pittsburgh steel itself actually cost more than an equivalent amount made in the more modern and efficient Chicago plants. The Pittsburgh Plus system thus made Pittsburgh businesses competitive for contracts in the Midwest, but it greatly increased the cost of buildings, ships, farm tractors, and anything else made of steel in the Midwest.

The pricing system also meant, however, that some customers were overpaying for shipment by railroad. Under such a non-competitive system, there was little incentive on the part of the iron and steel industry to utilize water transportation over railroads since there was no real industry competition to keep freight prices low. Thus, the lower costs that river transportation offered were factored out, and from the 1880s to the early 1920s most iron and steel freight moved by the faster and more direct rail routes, even though rail freight rates rose during the early twentieth century (Warren 1973: 199).

Opposition to Pittsburgh Plus pricing evolved in the early 1920s largely out of the great growth that occurred in Midwestern industry during World War I. In July 1924, the Federal Trade Commission ordered U.S. Steel Corporation to abandon Pittsburgh Plus, and it was replaced by a multiple-point price basing system. The combination of the sharp rail freight price increases and the dismantling of Pittsburgh Plus encouraged steel producers to look to water transportation as a way of competing with more advantageously positioned steel mills.

The process of shipping steel by river barge from mills along the Monongahela River was greatly facilitated by the Corps of Engineers' completion of the lock and dam system on the Ohio River, a project that had begun in 1879. By the middle of 1929—the year that the Corps finished the Ohio River work—two J&L barge tows a month—about 20,000 tons of steel—were being sent down the river, and the company reckoned several years later that it was saving \$2.00 to \$3.00 per ton shipping steel by river rather than by rail. J&L was generally regarded at the time as having taken the lead among Pittsburgh-area steel firms in river shipping

U.S. Steel began to ship steel by river in 1922 (Warren 1973: 204). In 1923, it built a waterway terminal at Munhall, Pennsylvania, on the Union Railroad Company line (which it owned) where its steel products were concentrated for loading onto barges (American Rolling Mill Company 1923: 77). This terminal had a gantry crane with a double hoist of fifteen tons capacity, a magnet, and chutes for transferring cement from railroad cars to river barges. A company terminal at Duquesne, Pennsylvania, was equipped with five electric locomotive cranes, each with a capacity of five tons. In addition to Clairton, Munhall, and Duquesne, the company also maintained river terminals at Bessemer, Pennsylvania, at its blast furnace locations in Pittsburgh and Etna, at a warehouse on the north side of the Ohio River at Pittsburgh and at Bellaire and Mingo Junction in Ohio. U.S. Steel also operated a number of river dock facilities that handled coal shipments from the company's Monongahela River mines. The H.C. Frick Coke Company's Colonial Dock forty-eight miles up the river from Pittsburgh, for example, was equipped with a conveyor belt system that brought coal excavated from mines six miles inland to the company's waiting barges. This dock facility then had the longest operating conveyor belt system in the world.

In a little over eleven years, U.S. Steel built up the largest fleet of Pittsburgh-area river boats and barges and probably carried the greatest tonnage of any of its steel producers. Originally, U.S. Steel developed the river fleet to carry coal to the company's by-product coke ovens situated on the Monongahela River at Clairton. This was then the largest by-product coke plant in the world, producing about 30,000 tons per day in the early 1930s. Situated along the river at the Clairton plant were four double hoists (each equipped with two six-ton grab buckets) for unloading the barges onto conveyor belts that carried coal to the coking ovens. Clairton also had

United States Department of the Interior

National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 59

equipment that was used to pump acid out of barges and for pumping creosote and tar (recovered in the by-product coking process) into barges for subsequent shipment to customers.

River craft also were used to move coke, steel plate, bars, ingots, pig iron, molds, scrap metal, stirring rods, and blast furnace flue dust among various U.S. Steel Company mills situated on the Monongahela, Allegheny, and Ohio rivers. Barges transported materials to water-rail terminals where they were shipped by train to other U.S. Steel facilities. A monthly Pittsburgh-to-New Orleans tow was in operation in the early 1930s while daily boat trips were made from the company's captive coal mines up the Monongahela to the Clairton coke plant and the steel plant at Duquesne, Pennsylvania, also on the Monongahela River.

The company also established a major presence in Houston, Texas, with the construction of a large terminal. A single river tow from Pittsburgh to New Orleans in the late 1920s and early 1930s might involve thirteen to seventeen barges loaded with 12,000-14,000 tons of steel. The trip took thirteen to twenty days to complete (Engineers' Society of Western Pennsylvania 1930: 164). In the early 1930s, U.S. Steel's river fleet included fourteen steamboats and four motorized towboats. The company's fleet also had 449 barges. Among these were twenty-six cargo barges and two barges for carrying acid (Harper 1931: 679-681).

Another valley steel plant, Pittsburgh Steel, with its major plant at Monessen on the Monongahela River, was shipping about 40,000 tons of steel per year by river in 1925-1926, and the company acquired its own barges and warehouses in St. Louis and Memphis. Pittsburgh Steel was an integrated independent steel producer that had begun operations in Monessen, thirty miles upriver from Pittsburgh, in 1901. Part of its attempt to stay competitive in the 1920s was to make its steel tubing available to the growing oil and natural gas industries in Texas and Oklahoma, an objective for which its new seamless tube mill at Allenport on the Monongahela River was aptly suited (Workman 1996: 51). The company constructed its own wharves at both the Allenport and Monessen mills in 1919. The Monessen wharf was set up specifically to receive river shipments of raw materials, especially coal and coke, while the Allenport wharf was constructed for shipping out seamless tubing. The warehouse in Memphis on the Mississippi River was used to store the seamless tubing delivered by barge from Allenport. To further increase its advantage in the southern oil and gas industries, Pittsburgh Steel opened regional offices in Houston, Texas, and Tulsa, Oklahoma (Workman 1996: 52).

Some of the other Pittsburgh steel companies acquired their own barge fleets; other plants used independent river haulers. Even steel mills located some distance from the Monongahela began to incorporate river transport into their delivery schedules. In 1928 Bethlehem Steel Company's Cambria plant, for example, shipped 800 tons of steel by railroad a distance of fifty miles to Glassport on the Monongahela and then transferred the load to the river barges of the American Barge line to complete the trip to consumers in Louisville, Kentucky (Warren 1973: 204; Engineers' Society of Western Pennsylvania 1930: 174).

The marked increase in the amount of river commerce moving on the Monongahela and Ohio rivers in the 1920s and 1930s inspired businessmen near other rivers to seek federal assistance for slackwater navigation systems. A delegation from the Kiskiminetas and Conemaugh River Improvement Association, for example, was dispatched to Washington to seek federal help for navigation improvements on those rivers, and in the early 1930s, more than 400 businessmen in the Youghiogheny River Valley sought the aid of the War Department to rebuild the Youghiogheny River navigation system a distance of fifteen miles from McKeesport (at the junction of the Youghiogheny and Monongahela rivers) to West Newton (Engineers' Society of Western Pennsylvania 1930: 174).

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number E Page 60

One of the major problems confronting industries on the Monongahela at the time was the absence of freight terminals that could handle different types of river freight. Private companies constructed riverside terminals for specific types of freight, but there were no multi-use terminal facilities. In addition, there were no contractual provisions for the interchange of freight between rail and water in the Pittsburgh area even though the physical connections between these transportation modes were adequate (American Rolling Mill Company 1923: 77, 79). In the early 1930s, it was estimated that the river transport of steel and steel products resulted in an annual savings to Pittsburgh-area producers of about \$20,000,000 over rail transportation (Engineers' Society of Western Pennsylvania 1930: 166).

Two events in the 1920s, the demise of Pittsburgh Plus pricing and the completion of the lock and dam system on the Ohio River, came together to provide a major boost to the inland transport of Upper Ohio River steel and steel products by river. Water transportation provided an economy of scale that lowered steel freight charges and made Pittsburgh products cheaper at the same time that the Ohio River lock and dam system made year-round shipments on the Ohio River possible.

These advantages were short-lived, however, and the business of Pittsburgh-area steel firms generally declined during the 1930s. River shipping helped only with southern markets and with near-river markets in the Midwest. Generally, it did not make Pittsburgh steel products more competitive in the East or in markets in the Far West. For example, in 1920, (while Pittsburgh Plus was still in effect) Allegheny County steel producers manufactured 20.6 percent of the nation's finished rolled iron and steel. Yet, in 1930, (after the demise of Pittsburgh Plus and the completion of the Ohio River navigation system) they were responsible for just 14.9 percent of this market (Warren 1973: 205, Table 75). Much of Pittsburgh steel's business went to Chicago and Midwest firms who operated more modern and efficient plants and were closer to the major steel consumers, especially the growing Detroit automobile industry.

Although Pittsburgh steel producers generally emerged from the Depression in as good a condition as those in other areas of the country, the construction of new steel plants in those areas had a detrimental effect on Pittsburgh's steel markets. In 1935, steel production capacity in the seventy-five miles surrounding Pittsburgh was probably three times the demand for its product. The problem was eased temporarily by the needs of war production during the Second World War but began to return at the conclusion of the conflict and was exacerbated by increasing rail freight rates in the post-war period. Each increase in rail shipping rates further restricted the geographical sphere in which Pittsburgh-area steel firms were competitive. Economic recession in 1954 only emphasized just how far behind other steel-producing areas Pittsburgh now lagged.

In reaction to the increased rail rates, Pittsburgh-area steel firms again increased the amount of steel they shipped by water and also developed short-haul transportation by truck. By 1955, U.S. Steel shipments of finished steel by rail amounted to just 4.9 tons per year while truck shipments had increased to 13.4 tons. Some steel companies attempted to overcome Pittsburgh's competitive disadvantage by other means, such as product specialization or by shipping semi-finished products to mills closer to the consumer for final finishing (Warren 1973: 210-212).

MONONGAHELA RIVERSIDE COMMUNITY DEVELOPMENT, 1787-1960

Early Community Development

Town development along the Monongahela River and elsewhere in southwestern Pennsylvania was well underway before the construction of the Monongahela Navigation Company's initial navigation improvements in the 1840s. Nine towns had been established in Fayette County by 1796, and there were eight in Washington

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number E Page 61

County. According to Zadok Cramer, editor of *The Navigator*, there were ten communities worth mentioning along the Monongahela River between Morgantown and Pittsburgh in 1802: Morgantown, New Geneva, Fredericktown, Bridgeport, Brownsville, Williamsport, Elizabethtown [now Elizabeth], McKeesport, and Pittsburgh. Cramer described most of those communities positively and predicted that they would become great commercial centers. Most of these towns were already home to industrial enterprises, such as boat building, milling, glass making, and iron production⁴. Their riverside locations gave these towns many natural advantages, including the availability of water for drinking, waste removal, and water power; the presence of broad, flat and fertile floodplains where agricultural crops could be grown and industries established; and the presence of existing roads or trails, which tended to follow the level terrain along the river.

In 1814, *The Navigator* listed the same ten towns as in 1802, but added Clarksburg, [West] Virginia, as a community on the move. Cramer's descriptions suggest that business in all of these towns had increased substantially during the intervening twelve years. Most were the location of incipient manufacturing and/or boat-building operations.

Although boat building and manufacturing were early developments on the Monongahela and Upper Ohio River, the lack of safe navigation due to river snags, sandbars, and rock ripples, and the unpredictable and seasonal fluctuations in the depth of water in the rivers continued to restrain trade emanating from the Monongahela River communities until well into the nineteenth century. The situation became worse the farther upstream one went from Pittsburgh, where lack of navigational improvements impeded population and economic growth as well as community development. By the 1830s, growth in Monongahela River Valley commerce had led to wide recognition that improvement of navigation facilities on the Monongahela River was necessary to further community and regional prosperity. The continued absence of effective river navigation facilities was seen as a deterrent to regional economic growth in several ways: not only did it raise the cost of transportation to and from upriver communities, but it limited the markets available for the sale of Monongahela River Valley products. The opening of the Pennsylvania Main Line Canal in Pittsburgh afforded a greater potential market for Monongahela River Valley products and underscored the importance of improving river navigation. At the same time, there was great debate over the respective roles of private corporations, and the federal and state governments in paying for such improvements.

The opening of slackwater navigation between Pittsburgh and Brownsville in 1844 stimulated the development of river transportation companies and riverside facilities. The completion of the first four Monongahela River locks and dams provided greater outlets for local agricultural produce, livestock products, and a diverse array of goods manufactured in upriver communities. Coal extracted from the rich upriver seams became an increasingly important product for the navigation system as industrialization of the Pittsburgh area proceeded. With the completion in 1856 of Lock and Dam No. 5 at Denbo, and Lock and Dam No. 6 at Rice's Landing, slackwater navigation was extended as far upriver as the stoneware pottery-making towns of New Geneva in Fayette County and Greensboro on the opposite side of the river in Greene County.

George Thurston's 1859 *Directory of the Monongahela and Youghiogheny Valleys* reveals just how much development there had been on the Monongahela River in the three years following the extension of slackwater to

⁴ This historic context section is an edited and abridged version of "The Monongahela River Navigation System and Riverside Communities" prepared by Ronald C. Carlisle, Ph.D. as part of a collection of essays to examine historical themes of particular importance to the Monongahela River navigation system in preparation for the National Register nomination. Portions of the Carlisle manuscript have been used verbatim.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number E Page 62

New Geneva and Greensboro. In contrast to the ten towns listed by Zadok Cramer in 1814, Thurston mentions some twenty-one towns or communities (excluding a few ferry crossings) between Pittsburgh and Point Marion in Pennsylvania, as well as two additional towns, Granville and Hamilton, in (West) Virginia between Morgantown and the Pennsylvania line. The fourteen additional communities Thurston mentioned in 1859 represented "new" towns, not replacements or new names for older ones.

Until the expansion of the river navigation system and the opening of coal mines in the upper reaches of the river, towns upriver from New Geneva and Greensboro tended to remain small, with rudimentary agricultural economies oriented to local markets. The occupations compiled for various towns in Thurston's 1859 Monongahela River Valley directory paint an unambiguous picture that industry, mining, boat building, and economic development/expansion beyond the agricultural baseline paralleled the extension of the navigation system up the river.

The economic potential of Morgantown, the principal population center in the Upper Monongahela River Valley remained underdeveloped in the absence of river transportation and navigation facilities. Extensions of both the navigation system and the railroad to the town were interpreted in the mid-nineteenth century as important steps toward securing its economic future. As things stood, however, Morgantown had little manufacturing or mining, in contrast to smaller down-river towns that were directly on the navigation system, like Greensboro, New Geneva, Brownsville, or Rice's Landing.

Rice's Landing, located at Lock and Dam No. 6 of the Monongahela Navigation Company's system, was an even smaller town than New Geneva, consisting of about 300 inhabitants in 1859. Although settled in the late eighteenth century, the town's prosperity in the mid-nineteenth century was tied directly to its position at the head of the river navigation system. This had allowed Rice's Landing to develop into a redistribution point for goods brought by river to all of the interior communities in southwestern Greene County.

Only a few of the names that appear throughout Thurston's 1859 directory are of those who actually worked at the navigation system's locks. A cursory reading of this source might lead to the erroneous conclusion that the navigation system—as represented by the number of people employed at the locks—was economically unimportant. The true significance of the navigation system to the economy of the riverside communities is reflected indirectly in Thurston's directory by the number and diversity of mining and manufacturing jobs in those communities and by the number of people employed in one or another aspect of boat building, not by those employed directly at the locks.

Town and population growth in the Monongahela River Valley was stimulated greatly by the evolution of the coal and coke industries, which were in turn facilitated by navigation improvements to the Monongahela River. Coal was mined in small quantities near the river beginning in the late eighteenth century. National demand for it increased, however, as the region felt the full impact of the Industrial Revolution. New markets led to the opening of the Upper Monongahela River Valley coal fields and to the demand both for larger coal barges and locks to accommodate the large-scale exploitation of this valuable mineral. Industrial coal mining in the later nineteenth and early twentieth centuries required the establishment of coal patches and towns near the mines to accommodate workers and their families, and this is the origin of many of the coal towns that dot the Monongahela River's banks, especially in Washington, Fayette and Greene Counties.

Population growth and economic development in Pittsburgh and in adjacent industrial communities up the Monongahela during the second half of the nineteenth century were the result of many factors, including the

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places Continuation Sheet

Section number E Page 63

Monongahela River navigation system. A large percentage of this growth took place in the city, but the populations of adjacent Monongahela River Valley industrial towns also increased greatly during this period, due to the construction of huge steel plants in Braddock, Duquesne, McKeesport, Monongahela City, Monessen, and other river towns. The river and its excellent system of locks and dams contributed significantly to the choice of these towns as the sites of new plants, as did the railroad lines, as well as an ever-increasing supply of immigrant labor. The railroads and the river together connected the industrial process of making steel and allowed all of the essential materials to come together at one place. They then allowed the finished products to be shipped out at competitive prices.

Although the influence of the Monongahela River Navigation System on riverside community development in the nineteenth and early twentieth centuries was both broad and pervasive, it was perhaps most clearly expressed in three areas: boat-building, the coal trade, and steel production. The impact of each of these enterprises on the communities along the river is discussed briefly below.

Boat Building

The Monongahela River Valley became a center for boat construction early in its settled history. Boats of all kinds—flatboats, keelboats, arks, steamboats, barges, and ironclad naval ships—were turned out of Monongahela communities' boat yards beginning in the mid-eighteenth century. Although the boat-building industry in early Pittsburgh and up the Monongahela to Brownsville was greatly facilitated by the Monongahela Navigation Company's eventual construction of locks and dams, boat building had been going on in the Monongahela River Valley long before the earliest locks and dams were built. From the late eighteenth century through the early twentieth century, the Monongahela River and the towns along its banks attracted artisans skilled in the construction of river craft. Boat building (and its necessary companions, saw mills and nail factories) developed at many riverside towns, including Pittsburgh, McKeesport, Elizabeth and West Elizabeth, Monongahela City, Webster, North Charleroi (originally known as Lock No. 4), Belle Vernon, California, Brownsville, and West Brownsville. In addition, Fayette City, Rice's Landing, and Fredericktown also produced boats from time to time, but at a much lower level of production. Boatbuilding was an industry that offered successful entrepreneurs the opportunity to enlarge their enterprises by opening similar operations in other towns. By this means they contributed not only to private wealth formation but also to community development and economic growth.

Pittsburgh, advantageously situated where the Monongahela and Allegheny Rivers join to form the Ohio River, developed as the principal town and market for the smaller communities in the Monongahela River drainage basin. Virgin stands of oak and pine, early iron furnaces, and rolling and slitting mills all contributed materials that helped to develop boat production into a major Pittsburgh industry early in the nineteenth century. In 1803, boat building was the third largest industry in Pittsburgh and was exceeded in importance only by the value of the city's iron and textile (linen) manufacturing interests, both of which also relied upon river navigation for the distribution of their products (Reiser 1951: 13-14). Boat-building remained important after the opening of the Monongahela River Navigation System, but as the city's economy expanded and diversified in the latter half of the nineteenth century, the relative importance of boat-building diminished.

In the smaller river towns such as Elizabeth, West Elizabeth, Monongahela City, California, and Brownsville, boat-building continued to be an important economic pursuit for many more years. By the mid-nineteenth century, the Monongahela River Valley was one of the nation's leading centers of steamboat production. Hundreds of workers were engaged in this industry, which produced over half of the steamboats in use on western rivers. Steamboat construction in the Monongahela River Valley peaked in the 1840s and 1850s, but declined rapidly after the Civil War. By the 1870s, Monongahela River boatyards were producing mainly pool boats and

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number E Page 64

barges, but they continued to be economic mainstays of communities up and down the river for the rest of the century.

The progressive opening of the upper reaches of the Monongahela River, while good for the economic development of those towns, had the potential for also bringing business loss to the older boat-building towns down river. As slackwater navigation reached more of the towns along the upper river, technological change on the lower river did not keep pace. Failure to enlarge the locks there to provide for upriver construction of the larger, complete steamboats then being developed, certainly put a brake on community growth. Lock No. 3 was not enlarged until 1884, and Lock No. 4, in 1886, years after commercial interests had begun to demand larger boats (Gannett Fleming Corddry and Carpenter 1980: 8). In 1910, one firm at Monongahela City still produced a few small river craft, but most of the boat-building activity had moved away from the Monongahela River Valley by that time.

The Coal Trade

Coal was among the earliest commodities shipped on the Monongahela River, and the coal trade came to dominate the river's commercial traffic, especially between the 1880s and the end of World War I. Shipments of the mineral were numerous even before the construction of the first navigation improvements on the river, but river conditions directly affected whether coal was plentiful and cheap or scarce and unaffordable. As more and more businesses became dependent upon steam-generated power, coal and its predictable delivery had a greater impact on urban life. In one form or another, coal transportation underlay the development of many Monongahela River Valley businesses that offered employment to the residents of riverside communities and spurred the growth of their populations. The coal business also contributed to occupation specialization. Coal barge pilots, coal boat crews, and coal boat builders all developed craft specializations within their communities, and the merits of one town's practitioners with respect to those in other towns was a source of both speculation and local pride (Kudlik 1998: 57).

By 1850, the Monongahela River navigation improvements had proved to be an unqualified success as far as coal was concerned. The navigation system both directly and indirectly increased the population, capital, and land values in the lower section of the valley from Brownsville to Pittsburgh (Reiser 1951: 67). The establishment of numerous small coal towns, or patches, as they are called, along both banks of the Monongahela River in Washington, Fayette, and Greene Counties owe their existence first, to the presence of bituminous coal and second, to the river along whose banks companies could build coal tipples and fill their barges. It has been noted that "the western coal trade was not created by the Monongahela Navigation Company, but slackwater river improvements were responsible for greatly increasing the volume of the coal trade" (DiCiccio 1996: 32). The Monongahela River navigation system, therefore, contributed to the formation of these small coal towns indirectly by facilitating the coal companies' profitable extraction and transport of this valuable mineral.

Steel

The Monongahela River navigation system also facilitated the efficient and relatively inexpensive transportation of steel and its ingredients to Monongahela River towns such as Homestead, Braddock, Rankin, Duquesne, McKeesport, Clairton, and Monessen beginning in the second half of the nineteenth century. This development thus also indirectly supported the population and the economic well-being of the riverside communities.

The extension of railroad lines and the construction of steel mills, especially along the lower Monongahela River, created whole new industrial communities, such as Homestead and Monessen, during the last twenty years of the nineteenth century. The land upon which such communities developed remained rural until the 1870s, but was

United States Department of the Interior

National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number E Page 65

eyed by industrial developers who needed large, flat, open spaces for the construction of mills and worker housing, as well as abundant supplies of river water for industrial processes. The banks of the Monongahela between Pittsburgh and the Allegheny County line were ideal for such developments. Without a doubt, the presence of the Monongahela River navigation system was one of several very significant considerations in the formation—and even the naming—of some of the late nineteenth and early twentieth century industrial communities in the Monongahela River Valley (Magda 1985: 3-5).

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places Continuation Sheet

Section number F Page 1

F. ASSOCIATED PROPERTY TYPES

All of the historic contexts established for the Monongahela River Navigation System are related in terms of the property types associated with them. The focus of all of these narratives is the Monongahela River itself supported by the history of its relationship with the commercial and industrial enterprises that took place on it or along its banks and with the communities that grew up beside it. The property types defined for the navigation system all are related in some way to the historic contexts discussed above, and all are directly associated with the navigation system constructed by the Monongahela Navigation Company (MNC) and the U.S. Army Corps of Engineers (COE). Although other types of properties related to river transportation, such as terminals, wharfs, ferries, marinas, bridges, privately-owned boatyards, and riverside industries, might be significant under one or more of the defined historic contexts, they are not included as property types under this multiple property registration.

Three principal property types are defined for this multiple property registration, and these encompass all of the components of the navigation system: **Lock and Dam Facilities for Slackwater Navigation; Maintenance Facility;** and **Water Storage Reservoir**. Included under these property types are the nine operational lock complexes on the river and the remnants of abandoned lock and dam facilities; the former MNC/federal boatyard and repair facility at North Charleroi; and the Tygart Dam near Grafton, West Virginia.

The property type "**Lock and Dam Facilities for Slackwater Navigation**" is divided into four subtypes: Monongahela Navigation Company Locks and Dams (1840-1890); Early U.S. Army Corps of Engineers Locks and Dams (1879-1904); Middle-Period U.S. Army Corps of Engineers Locks and Dams (1904-1930); and Post-World War II Locks and Dams (after 1945). Each property of this type includes some or all of the following: locks, dams, guidewalls, guardwalls, bulkheads, esplanades, powerhouses, workshops, offices, and locktenders' houses. The type includes both functioning facilities and abandoned sites that might include anything from remnants of walls to extant buildings, and range in date from 1840 to 1960. Three of the nine operational facilities are less than fifty years old.

Another property type, "**Maintenance Facility**," associated directly with the Monongahela River Navigation System is the former MNC/Corps of Engineers repair facility and boatyard in North Charleroi, Pennsylvania. As a "**Water Storage**" property type, Tygart Dam in West Virginia is also considered part of the system, since it was constructed in 1938 primarily to augment low flows in the upper river to maintain navigation. Both of these represent separate property types which are distinct in form and function from the twenty-six MNC/COE lock and dam sites located along nearly 125 miles of the Monongahela River.

Lock and Dam Facilities for Slackwater Navigation

Description

Overview

The Monongahela River Navigation System, a series of dams, locks, and slackwater pools to facilitate navigation of the Monongahela River in Pennsylvania and West Virginia, was begun over 170 years ago and remains in active operation today. The system extends from the mouth of the Monongahela at Pittsburgh, Pennsylvania, to river mile 124.2 near Fairmont, West Virginia. Although originally developed by private enterprise, the system was acquired by the United States government in 1897, and is operated by the U.S. Army Corps of Engineers. It presently consists of nine locks and associated dams, the oldest of which was completed in 1907, and the most

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number F Page 2

recent in 1996. Six of the operating facilities are located in Pennsylvania, and three in West Virginia. Extant remains of earlier, abandoned components of the system also survive at various locations along the river.

A navigational lock is essentially a box fixed to the riverbed equipped with two matching gates at each end that close at an angle directed upriver against the river flow¹. Originally, the boxes were constructed of cut stone; presently they are constructed of concrete. Because of water pressure, the lock gates can open or close only when the water level is the same on both sides. This is done by gravity moving water through a system of valves that fill and empty the lock chamber. One set of gates opens to let boats enter and then closes to allow the water level in the chamber to be raised or lowered depending on the boat's direction of travel.

The same basic principles have been employed on the Monongahela River since the initial construction of navigation locks. Changes have occurred in the specifics of the filling and emptying systems and the sources of power for lock operation. The original locks of the Monongahela Navigation Company were filled and emptied by a series of hand-operated wickets located at the bottom of the wood-framed lock gates. Lock gates themselves were operated by a capstan system using chains and hand power.

As locks became larger, wickets were inadequate to empty and fill locks in a reasonable amount of time. The primary method of filling and emptying the later lock chambers was, and remains, the culvert system, in which water is taken in by ports located upstream of the upper lock gates, let into and drained from the chamber with valves, and discharged back into the river by ports downstream of the lower lock gates. Early locks generally used a large number of relatively small filling valves, while modern locks use a smaller number of valves, each larger in size. A variety of types of emptying valves have been used on the Monongahela including horizontal and vertical butterfly, Stoney, cylindrical, and Tainter valves. Today's locks generally use either butterfly or Tainter valves, although cylindrical valves remain in one chamber of Locks No. 3.

As noted, the original Monongahela Navigation Company locks were hand-operated. This technology was feasible with the small locks and relatively lightweight wood lock gate leafs of the original system, but it was not feasible as lock gates increased in size and weight. The first improvement in lock power technology on the Monongahela involved the installation of turbines, generally on the river wall of the outside lock. These turbines harnessed power of the water to mechanically operate gate and valve mechanisms. No turbines are presently in use in the Monongahela River Navigation System, although turbines continue to be used on several of the smaller, older locks on the Allegheny River. The next evolution was the installation of air-powered machinery to operate lock gates and valves. Air power was then supplanted by hydraulic-operated mechanisms.

All locks on the Monongahela River are now operated by an electric-hydraulic system. Electric power obtained from the outside power grid and distributed through electrical panels located in the operations building provide the power to operate hydraulic pumps. The pumps force oil through a series of pipes to the lock gate and valve mechanisms. These mechanisms are operated by means of a hydraulic piston. In the most recently constructed locks, Grays Landing and Point Marion, the central hydraulic pumps and piping system have been supplanted by package hydraulic plants. These plants are self-contained systems, each of which operates a single valve or lock

¹This section is an edited and abridged version of a portion of the *Monongahela River Navigation System Historical Engineering Evaluation* prepared by John Milner Associates for the Pittsburgh District (McVarish 1999: 22-24). This study evaluated the system's engineering significance. Portions of the Milner document have been used verbatim.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number F Page 3

gate. These package systems are designed to reduce the cost and maintenance inherent in the earlier hydraulic systems.

The earliest Monongahela River dams were stone-filled timber cribs forming fixed weirs. With one exception (the 1879 masonry Dam No. 9), all COE dams have been constructed of concrete. River dams provide pools with navigable depths, except in periods of extreme low flow. Prior to the late 1930s, periods of drought necessitated that the pools be drained to fill the locks for lockages. Eventually the dams would stand out of the water, and no navigation would be possible.

To provide navigation in times of low flow, the first approach to conserve water was to install temporary flashboards, i.e. horizontal boards fastened to vertical posts anchored in holes in the dam crest. These flashboards, which had to be installed and removed by hand, could increase dam and pool height by a few feet. The labor-intensive nature of this method led to searches for a mechanized solution to provide temporary increases in dam height. In the early twentieth century, two types of movable crests were tried on the Monongahela River: the Chittenden drum (Dams 2 and 3) and the Betwa wicket (Dams 1 and 5). The technology of both types proved unreliable, and by 1921, the movable crests were replaced with permanent concrete caps.

Since 1950, gated dams have been installed at all but one of the replacement facilities. Presently, Dam 3 (1907) and Grays Landing (1996) have fixed crest concrete weirs, while the others (Braddock, Dam 4, Maxwell, Point Marion, Morgantown, Hildebrand, and Opekiska) are gated movable structures. All of the gated structures on the Monongahela use Tainter gates, which is the predominate gate type used by the COE at navigational dams. On the Monongahela, these gates are in one or a combination of three forms, the single-leaf, double (split)-leaf, or the Sidney gate. The concept of the double-leaf design was to allow the upper leaf to be raised for skimming ice and floating debris from behind the dam while the lower, overflow leaf remained in place on the submerged sill. In practice this is rarely done in part due to problems with paint erosion and reestablishing a good seal when lowering the upper leaf. These gates are raised and lowered to control pool height and are moved by individual, electric motor-driven winches.

Several structures are located below the crest of the dam and are designed to reduce undermining of the dam and turbulence in the dam vicinity. These include the dam apron and stilling basin, and in more recently constructed dams, baffles. Aprons are concrete structures built downstream from the dam to prevent scouring of the river bottom. These structures are generally thicker near the dam and thinner further downstream. A stilling basin is a concrete bottomed structure located adjacent to the downstream side of the dam to dissipate the energy of falling water. Baffles are rows of concrete structures located downstream from the dam placed to dissipate turbulence.

Other major elements of the lock and dam complexes include guidewalls and guardwalls, and bulkheads and bulkhead hoists. Guardwalls are upstream and downstream extensions of the lock river wall of the lock to prevent traffic from being swept towards the dam. Guidewalls extend upstream and downstream from the land wall of the lock and are designed to align traffic in and out of locks as well as prevent shoreline erosion. Bulkheads are of two general types. Lock bulkheads are designed for installation above and below the lock chamber to permit chamber dewatering, while dam bulkheads are installed upstream of a dam gate to relieve pressure on the gate for inspection and repair.

Defining Physical Characteristics

The Monongahela River Navigation System consists of 27 individual properties (Table 1) located along the length of the river (17 in Pennsylvania and 10 in West Virginia), including both functioning facilities and remnants of

United States Department of the Interior

National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places Continuation Sheet

Section number F Page 4

abandoned locks and dams. Three of the nine functioning facilities are modern, less than 50 years old, while the others were originally constructed between 1902 and 1960. Of the remaining eighteen properties, seventeen are portions of earlier, abandoned locks and dams, ranging from barely-visible land walls (even this is absent in one case) to lock walls and esplanades with extant buildings. The final property is the former MNC/Corps of Engineers repair facility and boatyard in North Charleroi, Pennsylvania. Tygart Dam Reservoir in West Virginia is also considered part of the system, since it was constructed in 1938 to augment flow in the upper river for navigation. Other than the boatyard and reservoir, which are separate property types functionally distinct from the others, the components of the Monongahela River Navigation System share certain defining physical characteristics, which are summarized below:

Lock walls occur in nearly every property. These may include **land walls**, **river walls**, and in cases of two adjacent chambers, **middle walls**. At abandoned facilities, all but the lock land walls were typically removed as navigation hazards. The one exception is MNC/COE No. 4 at North Charleroi, which retains the land, middle, and river walls. Constructed of cut stone (pre-1900) or concrete resting on wooden stone-filled cribs or anchored to bedrock, the land walls typically are parallel to and integrated with the river bank. **Guide walls** are extensions of the land wall. At abandoned facilities, most remnants still exhibit gate pockets and anchors, but others have been covered with fill or capped with concrete for use as a wharf. Concrete **river walls** occur at all nine operating properties and form the river side of the lock chambers. For properties with double locks, a middle wall situated between the river and land walls is common to both lock chambers. River walls often contain duplicate controls for the gates and valves, and conduits and hatchways for servicing them. **Guardwalls** are extensions of the river walls, found only at operating facilities; these consist of concrete walls or cylindrical sheet piling, filled with stone and capped with concrete.

All operating locks have steel **miter gates**, which consist of a pair of symmetrical leaves, movable about a vertical axis, shutting against each other at one end and against the miter-sills at the bottom, and abutting the hollow quoins at the other end. The gates were originally constructed of wood, but steel provided a lower maintenance alternative. The steel gates are horizontally framed with a steel plate skin.

Nine concrete **dams** impound the river at the operating lock facilities. All are gated structures, except for one, Grays Landing, a fixed crest concrete weir. When facilities are replaced, the old dams are removed as navigation hazards, although the base of the structure and the abutment wall may remain.

A paved or gravel-covered **esplanade**, placed on fill between the land wall and the river bank, occurs in many properties. The esplanade provides a work area for the locktenders and maintenance personnel, and often is the location of the operations buildings.

Each lock and dam facility required support buildings. These included locktender's houses, workshops, powerhouses, boiler and engine houses, lock offices, etc., all of which were necessary for the lock's daily operations. The number and types of buildings that were needed, and their physical arrangement at the site, varied according to the construction date of the lock, the builder (MNC or Corps of Engineers), and the technology employed.

Reinforced concrete or brick **powerhouses** occur at all operating properties and at two abandoned facilities (MNC/COE No. 4, COE No. 7). The powerhouses, as their name implies, originally housed steam engines or turbines to provide the power to open and close gates and valves. They were also used as operations buildings, with an office for the lockmaster. The modern properties all have separate **operations buildings**. At facilities

United States Department of the Interior

National Park Service

Historic Resources of the Monongahela River Navigation System in Pennsylvania and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**

Section number F Page 5

constructed in the early twentieth century, the lock **office** was a small frame structure, always in a central location overlooking the esplanade.

Workshops, constructed of reinforced concrete, brick, or wood, provided an area for routine repairs. Larger repairs required specialized crews and equipment. In the past, the workshops were generally stand-alone structures, but modern lock and dam complexes usually include them within the operations or maintenance buildings.

Frame, brick or tile **locktenders' houses** were built for the lock employees and their families. The early MNC facilities generally had only one dwelling. Facilities built or upgraded by the COE between 1879 and 1927 generally had a pair of houses for the lockmaster and mechanic, identical but built on reverse plans. The need for 24-hour staffing and the remote locations of many of these earlier facilities necessitated the provision of dwellings and other outbuildings, gardens and orchards for the locktenders. The Pittsburgh District built no houses on the Monongahela River after 1927 as accessibility was less of a problem. All of the COE Monongahela dwellings have either been demolished or sold as excess.

TABLE1. Monongahela River Navigation System Properties

| <i>Name</i> | <i>Location (R.M., lock side)</i> | <i>Built by</i> | <i>Original Constr./ Rehab./ Closure Dates</i> | <i>Description</i> | <i>National Register Eligible ?</i> |
|--------------|-----------------------------------|-----------------|--|--|-------------------------------------|
| L/D 1 | 1.9, RB | MNC/COE | 1838-1841; 1847; 1909-1912; closed 1938 | Land wall and dam abutment remain | Y |
| L/D 2 | 11.2, RB | COE | 1904-1906; 1949-1953; 2000-2004 | Operational; Locks replaced 1953; Dam replaced 2004 | Y |
| L/D 2, Orig. | 11.8, RB | MNC | 1838-1841; 1854; closed 1906 | Submerged archaeological remains identified | Y |
| L/D 3 | 23.8, RB | COE | 1905-1907; 1981 | Operational, locks rehabilitated 1981 | Y |
| L/D 3, Orig. | 25.0, RB | MNC | 1840-1844; 1884; closed 1907 | Land wall and modified esplanade remain | Y |
| L/D 4, Orig. | 41.2, LB | MNC/COE | 1840-1844; 1886; 1913-1917; closed 1933 | Lock walls, powerhouse, esplanade remain | Y |
| Boatyard | 41.4, LB | MNC/COE | 1840s?; closed 1946 | Office/warehouse, sheds remain | Y |
| L/D 4 | 41.5, RB | COE | 1931-1933; 1967; 2005- | Operational, dam replaced 1967; first of two new locks under construction 2005-? | Y |
| L/D 5 | 56.5, RB | COE | 1907-1910; closed 1966 | Land wall, esplanade, two houses remain | Y |
| L/D 5, Orig. | 58.3, LB | MNC | 1854-1856; closed 1909 | Land wall remains | Y |
| Maxwell L/D | 61.2, RB | COE | 1960-1965 | Operational | N (age) |
| L/D 6 | 68.3, LB | MNC/COE | 1854-1856; 1913-1915; closed 1967 | Land wall, esplanade, two houses remain | Y |

United States Department of the Interior

National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places Continuation Sheet

Section number F Page 6

TABLE1 (cont'd). Monongahela River Navigation System Properties

| <i>Name</i> | <i>Location (R.M., lock side)</i> | <i>Built by</i> | <i>Original Constr./ Rehab./ Closure Dates</i> | <i>Description</i> | <i>National Register Eligible ?</i> |
|-------------------------------|---|-----------------|--|---|---|
| Grays Landing L/D | 82.0, RB | COE | 1988-1996 | operational | N (age) |
| L/D 7, Orig. | 82.3, LB | MNC | 1882-1883; closed 1925 | Land wall, house foundations remain | Y |
| L/D 7 | 85.0, LB | COE | 1923-1926; closed 1994 | Land wall, esplanade, powerhouse remain | Y |
| L/D 8, Orig. | 87.1, RB | COE | 1882-1889; closed 1925 | Land wall, esplanade, office remain | Y |
| L/D 8 Point Marion | 90.8, LB | COE | 1923-1926; 1958- 1959; 1989-1994 | Operational; dam replaced 1959, new lock and operations bldg 1996 | Y |
| L/D 9 | 92.4, RB | COE | 1874-1879; closed 1926 | Land wall, esplanade, two houses, carpenter shop, blacksmith shop remain | Y |
| L/D 10 | 101.5, LB | COE | 1897-1903; closed 1950 | Land wall, esplanade, two houses, carpenter shop, blacksmith shop remain | Y |
| Morgantown L/D | 102.0, LB | COE | 1948-1950 | Operational | Y |
| L/D 11 | 104.1, RB | COE | 1901-1903; closed 1950 | Land wall, esplanade, carpenter shop, blacksmith shop, storehouse remain | Y |
| Hildebrand L/D | 108.2, LB | COE | 1956-1960 | Operational | Y |
| L/D 12 | 109.1, LB | COE | 1901-1903; closed 1960 | One house, office, carpenter shop, blacksmith shop, coal house storehouse remain; land wall and esplanade submerged | Y |
| L/D 13 | 111.6, LB | COE | 1901-1903; closed 1960 | Land wall, esplanade, two houses, office, carpenter shop, blacksmith shop, storehouse remain | Y |
| L/D 14 | 115.0, LB | COE | 1901-1903; closed 1967 | Land wall, esplanade remain | Y |
| Opekiska L/D | 115.4, RB | COE | 1961-1967 | Operational | N (age) |
| L/D 15 | 124.2, LB | COE | 1901-1903; closed 1967 | Land wall, esplanade remain | Y |
| <i>L/D = Lock and Dam</i> | <i>RB/LB = Right/Left Descending Bank</i> | | <i>The COE acquired all MNC facilities in 1897</i> | | |

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number F Page 7

Subtype: Monongahela Navigation Company Locks and Dams (1840-1890)

Similar topographic settings were selected for all of the Monongahela Navigation Company's early navigational facilities on the lower and middle sections of the Monongahela River in Pennsylvania (MNC Locks and Dams Nos. 1-7). All of the sites were at existing shoals or ripples, where there was a solid foundation for the dam and where shallow water posed special hazards for river traffic. At each location, the facility occupied a narrow terrace between steep mountain slopes and the river.

Support complexes at the MNC locks and dams (Nos. 1-7) were not built according to standard specifications. The arrangement of structures varied considerably, according to constraints imposed by terrain and property lines. These complexes tended to include a large number and variety of structures. There sometimes were buildings on the middle lock wall, including an office, engine house and one or more sheds. On the bank adjacent to the lock were one or two brick or frame houses for the collector and locktenders, together with some or all of the following: carpenter shop, blacksmith shop, coal shed, stable, tool shed, warehouse, ice house, wash house, poultry house, and lock office. No MNC-era support structures are known to have survived, with the possible exception of the MNC No. 5 dwelling.

Subtype: Early U.S. Army Corps of Engineers Locks and Dams (1879-1904)

The facilities constructed by the COE, beginning at Lock and Dam No. 9 at Hoards Rock, West Virginia, in 1874-1879, were more standardized. Each generation of Corps facilities embodied certain general common characteristics. The earliest of the Corps' Monongahela River lock complexes included Original Lock and Dam No. 8 in Pennsylvania (built 1882-1889), and No. 9-15 in West Virginia. Except for No. 9 (built 1874-1879), all of the West Virginia complexes were constructed within a very short time span (1897-1904), according to standard plans. The original buildings at No. 9 were destroyed by a flood in 1888, and replacements were built in 1893. As a result, the support structures at all seven early West Virginia facilities share a basic similarity of design. Except for No. 8, which had a timber-crib dam like the MNC facilities, and No. 9, which had a solid masonry dam, all of the early Corps locks and dams used concrete as the primary structural material, an important technological advance. Each facility contained a single 56 by 182-ft lock chamber, a concrete fixed-crest dam, and a similar complement of support buildings.

Because Locks and Dams Nos. 9-15 all were hand-operated until World War II, none of these facilities had powerhouses. Instead, hand-operated capstans, levers, and winches were used to open and close the gates and fill the locks. Since most of the facilities were in remote locations, a full complement of support structures was needed. These invariably included two houses for the lockmaster and lockman, a carpenter shop, blacksmith shop, coal house, office, a storehouse, and one or more privies. There was little variation in their physical layout. The site plans of Locks and Dams Nos. 10, 13, and 14 were identical, and those for Locks and Dams Nos. 11 and 12 were the reverse of Nos. 10, 13, and 14. The plans of Nos. 9 and 15 were slightly different from the others. At Lock and Dam No. 9, the carpenter shop and blacksmith shop were oriented perpendicular to the lock and esplanade instead of being parallel to it. At No. 15, the shops were at opposite corners of the property instead of standing in a row. However, these minor variations are less important than the overall consistency of design that is characteristic of these facilities.

At each location, there were two lockkeepers' houses so that the lock could be manned around-the-clock. The two houses were virtually identical, but built on reverse plans. Although the houses at Nos. 9 and 10 were distinctive because of their date (No. 9) or location (No. 10 in Morgantown), those at Nos. 11-15 all were built on the same plan by the same contractor. Only those at Nos. 9, 10, 12 (one house) and 13 are extant. The pair of houses at No. 9 slightly predates the others, and was built on a different plan. The Queen Anne-style structures at

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places Continuation Sheet

Section number F Page 8

No. 10 were the most architecturally distinctive locktenders' houses to be constructed at any of the Monongahela River locks and dams, probably because of their highly-visible location at Morgantown. The others were comfortable but architecturally-undistinguished vernacular structures with little ornamentation and few amenities.

The lock office and a storehouse typically stood between the two houses, and seem to have been identical at each facility. The office was a small one-story frame building with lap siding and a steep hipped roof; a curved bay window on the river elevation overlooking the esplanade allowed the lockmaster to monitor locking operations. The nearby storehouse was a small one-story gabled structure with multiple doors. In West Virginia, the office has survived only at Nos. 12 and 13; the former is completely unaltered, but the latter has been modified. A similar office also survives at COE Original Lock and Dam No. 8 in Pennsylvania, but is in ruinous condition. Extant storehouses are located at Nos. 9, 11, 12 and 13; all are unmodified and in fair condition.

At a rear corner of the property was a row of three utilitarian buildings: the two-story carpenter shop, the one-story blacksmith shop, and a coal house. All were simple frame buildings with lap siding and gable roofs. The carpenter shop at No. 9 was different from the others in that it was only one-story in height; this may be due to its slightly earlier date. Unmodified carpenter shops have survived at Nos. 9 and 12, while extant shops at Nos. 10, 11 and 13 have been altered. Blacksmith shops survive in unaltered form at Nos. 9, 10, and 12, but those at Nos. 11 and 13 have been modified. Intact coal houses survive at Nos. 9 and 12, and privies at Nos. 9 and 10.

All of the support structures were grouped on a level platform situated above the esplanade, which was accessed by several flights of stone or concrete steps. The esplanade generally was paved with concrete, although brick was used at Nos. 10, 12 and 13, and stone at No. 9. All of the landwalls at the West Virginia complexes were constructed of concrete, except No. 9, which was cut stone.

Subtype: Middle-Period U.S. Army Corps of Engineers Locks and Dams (1904-1930)

The second generation of Corps facilities date to the first period of modernization on the lower and middle river between 1904 and 1930. These include COE Locks and Dam Nos. 1-3, COE Original Locks and Dam No. 4, and COE Locks and Dam Nos. 5-8. Locks and dams constructed or modernized during this period had fewer buildings, usually two brick or frame houses for the lockmaster and lockman, a power house, an office, and a warehouse. The concrete and brick powerhouses were of standard design, distinguished by a bow front overlooking the locks and esplanade. Some were two-stories in height, others were one-story, and they could be located either on any of the lock walls. Complexes on the lower river had two 56-foot by 360-foot concrete locks, while those above No. 6 had a single lock of the same dimensions. Except for a few short-lived experiments with movable-crest dams, fixed-crest concrete dams were standard. Timber or concrete aprons were added on the downstream side. The new locks (Nos. 2, 3 and 5) all had steel miter gates, with culverts and cylindrical or butterfly valves to fill and empty the chambers.

A variety of original structures have survived at the second generation facilities, including powerhouses at Original No. 4 and No. 7, and locktenders' houses at Nos. 5 and 6. COE New No. 4 was built in 1931-1933, at the end of this period. It included no houses (the Pittsburgh District built no locktenders' houses on the Monongahela River after 1927), but had two powerhouses and an operations/administration building. In the types and arrangement of buildings that were present, it can be considered a transitional facility between those of the second and third generations. Examples of property subtypes built during this period survive at several facilities in Pennsylvania, both operational complexes and abandoned ones.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number F Page 9

Subtype: Post-World War II Locks and Dams (after 1945)

The third generation facilities date to the Corps' second major modernization program, beginning after World War II. They include the facilities at Braddock, Maxwell, Grays Landing, Point Marion, Morgantown, Hildebrand, and Opekiska. All of these facilities incorporated larger locks (typically measuring 84 feet by 720 feet), with Braddock having the largest at 110 feet by 720 feet. In comparison to the earlier facilities, these have fewer support buildings. Associated structures typically include only an operations/administration building and a service/maintenance building. These tend to be architecturally-undistinguished box-like structures of concrete block construction, faced with stucco or brick. Examples survive at most of the operational facilities. With the exception of the concrete weir of Grays Landing Dam, all of the Monongahela River dams constructed after World War II are of the gated, non-navigable type.

Boundaries

At operating facilities, the boundaries will be the limits of federal lands associated with the facility, which tend to be the minimum required for operations. At former, abandoned lock sites that retain strong visual integrity—where the original landscape design is apparent and there are few modern intrusions to detract from the historic setting—the boundaries should include the entire parcel of land historically owned by the Monongahela Navigation Company and/or federal government, encompassing all of the associated buildings, structures, and features. For sites where there have been significant landscape modifications, such as the addition of intrusive non-historic buildings, the boundaries should encompass only the buildings and features related to the Monongahela River Navigation System, and not the entire property.

Significance

More than 170 years after its initial construction, the Monongahela River Navigation System continues to function as originally conceived and designed, maintaining the slackwater pools that allow transport of raw materials and manufactured goods on one of the nation's busiest inland waterways. The modern system is composed of nine operational lock complexes between the mouth of the Monongahela River at Pittsburgh and its headwaters near Fairmont, West Virginia. Remnants of earlier, abandoned lock complexes are visible at various locations along the river. Although the system has been continually upgraded and modified over the years, its operational and abandoned components together illustrate the evolution of lock and dam technology and maritime transportation in the nineteenth and twentieth centuries. Despite changes to individual features, the system possesses integrity of location, design, setting, materials, workmanship, feeling and association. Based on its regional historical significance and national engineering significance, the Monongahela River Navigation System (and examples of associated property types which meet the registration requirements defined below) is eligible for listing in the National Register of Historic Places under Criteria A and C. The period of significance is defined as 1838-1960, beginning with the construction of the first locks and dams by the Monongahela Navigation Company, and ending 50 years from the date of documentation (2010). With the passage of time, the 50-year threshold date stipulated by the National Register criteria may extend the period of significance forward.

Eligibility of lock and dam facilities under Criterion A is based on the system's important role in the long-term industrial, commercial, and residential development of the region. The construction of the Monongahela River Navigation System continued the development of the river as a vital transportation resource. This development added industrial capacity to the evolving use of the Monongahela, first as a route for canoes, then flatboats and keelboats. Boatbuilding was among the industries that benefited the most from the slackwater system, and it exhibited a well-defined evolution that corresponded with river improvements. The revolutionary developments in the design and production of steam-powered riverboats on the Monongahela River made this industry integral to the development of Pittsburgh and the lower Monongahela Valley. The locks and dams of the navigation

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number F Page 10

system are significant within the context of "The Boat Building Industry in the Monongahela River Valley, 1758-1950". The system also played a critical role in the exploitation of the region's coal resources, which in turn made possible the large-scale expansion of southwestern Pennsylvania's iron and steel industry during the late nineteenth and early twentieth centuries. Coal interests provided much of the impetus for the system's initial construction and subsequent expansion, and were a driving force behind the federal government's acquisition of the Monongahela Navigation Company's navigation facilities in 1897. The volume of river traffic and the size of tows influenced the number of lock chambers and their dimensions. Continued shipping of coal in the twentieth century ensured the viability of this system even as other early navigation systems in the United States were failing. Because of the close relationship between the navigation system and the coal industry (and related industries), the locks and dams of the system are significant within the context of "The Influence of the Monongahela River Navigation System on the Development of the Coal, Coke, Iron and Steel Industries in the Monongahela River Valley, 1787-1950". Finally, by improving transportation access and making intensive industrial development along the river possible, the navigation system contributed to the growth of existing towns, as well as the creation of new ones. For this reason, the locks and dams also are significant within the context of "Monongahela Riverside Community Development, 1787-1950".

Lock and dam facilities of the Monongahela River Navigation System are eligible under Criterion C, both for individually notable engineering features and as a group of properties that clearly shows the evolution of lock and dam technology from the early twentieth century to the present. Individually-notable elements are concentrated primarily in Locks and Dam No. 3, the complex that most clearly retains elements of its original early twentieth-century character. These elements include the survival and continued use of cylindrical valves in its river chamber, the use of electrically operated gate wickets, and the probable survival of elements of the Chittenden drum movable crest system. Lock No. 3 is the only lock on the Monongahela, Allegheny, or Ohio that still retains use of cylindrical valves, and it is one of only two complexes on the Monongahela to use wickets in lock gates. The machinery for the Chittenden drum weir in the central dam pier, and the drums themselves (some segments were found disposed immediately downstream of the dam) may be the only surviving example of this machinery in the United States.

The system is significant for its history of technological innovations, innovations ranging from the use of McCarty's patented gate-operating mechanism, introduced in the 1840s, to improved methods of providing power for locks developed in the late nineteenth and early twentieth centuries, to the first use of Stoney valves in the United States at Lock No. 9, to early uses of concrete for lock and dam construction, to the recent use of package hydraulic plants to eliminate the need for separate hydraulic pumps and long webs of piping. The in-the-wet, float-in construction of the replacement Braddock Dam, completed in 2004, represents an innovative construction technology that may not be repeated at that scale.

The Monongahela River Navigation System is notable for the breadth of time and technology represented in its present navigational structures. The range in technology can be seen in the contrast between Locks and Dam No. 3 (Elizabeth) and the Grays Landing and Point Marion complexes. Its components are significant under Criterion C for exhibiting the distinctive characteristics of several periods of lock and dam construction and technology. Together, these surviving complexes enable the industrial and technological historian to document much of the evolution of twentieth-century lock and dam technology.

Registration Requirements

In order to be eligible for registration, individual properties must be at least 50 years old and directly associated with the navigation system constructed by the Monongahela Navigation Company or the U.S. Army Corps of

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number F Page 11

Engineers. They must be examples of one of the identified subtypes. Other types of properties related to river transportation, such as terminals, wharfs, ferries, marinas, bridges, privately-owned boatyards, and riverside industries, are not included. Eligible properties must include some or all of the defining physical features common to the navigation structures constructed during the system's period of significance, thus exhibiting the distinctive characteristics of historic lock and dam technology as represented by the historic components of the Monongahela River Navigation System. Whether the site contains a complete lock complex or merely an intact land wall, surviving features must possess integrity of location, design, setting, materials, workmanship, feeling, and association. Although changes have occurred to many components of the system over time, evidence of the original design and materials must be apparent, including elements related to function. Properties must retain their original riverside location and setting, although the appearance and use of the site may have changed dramatically over time. Support complexes (locktenders houses and workshops) must exhibit evidence of the original physical and functional relationships among structures. Eligible properties must include extant above-ground, or documented underwater or archaeological components which relate to the defined historic contexts, and which convey the character and feeling of an historic lock facility.

Three operating facilities in Pennsylvania (COE Locks and Dam Nos. 2, 3, and 4) and one in West Virginia (Morgantown Lock and Dam) contain important early-to-mid-twentieth century buildings and structures, and clearly illustrate various aspects of historic navigational technology. Many abandoned facilities also retain features and structures associated with their original function, although none retain their dams, as these would be impediments to navigation. Some of the abandoned sites in Pennsylvania—MNC/COE No. 4, COE No. 5, MNC/COE No. 6, COE No. 7, and COE Original No. 8—still contain extant support structures in addition to a land wall and esplanade. In West Virginia, Locks and Dams Nos. 9-13 all retain various combinations of houses, shops and offices, in addition to a land wall and esplanade. The original design of each complex is still apparent, even though some structures and features have not survived, and others have been altered. The appearance and use of most of these abandoned facilities have changed over time, but all retain their original riverside location and setting.

The sites of MNC Locks and Dams Nos. 1, 3, 5 and 7 contain no extant historic structures other than a land wall and in several cases a dam abutment (No. 1) or building foundations (No. 7), but each site retains sufficient integrity to be recognizable as an historic navigation facility with visible features from its period of use. The same is true of COE Lock and Dam Nos. 14 and 15 in West Virginia, both of which retain only a concrete land wall and esplanade. Each of these sites, with all of its extant features and structures, represents part of the story of the Monongahela River Navigation System and meets the registration requirements. Each represents one or more of the subtypes defined for this property type. However, three operating facilities—Maxwell (1964), Grays Landing (1996), and Opekiska (1964)—were constructed within the past fifty years and do not meet the National Register age requirement. The site of MNC No. 2 has no visible remains, and thus does not meet the registration requirements under Criterion C, but has documented underwater archaeological remains that may qualify for registration under Criterion D.

Maintenance Facility

Description

This property type is represented by a single property: the Monongahela Navigation Company/U.S. Army Corps of Engineers repair facility and boatyard at North Charleroi (formerly Lock Four), Pennsylvania. This facility was responsible for the maintenance of boats, locks and other equipment throughout the Monongahela River

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number F Page 12

Navigation System. This was an obvious location for the maintenance facility, since it was located at almost the precise midpoint of the system as it was constituted in the 1880s. The original structures were constructed by the Monongahela Navigation Company to support their original 1840s Lock and Dam Nos. 1-4, and the federal government greatly expanded the scope of the operation after it assumed control of the navigation system in 1897. As part of the Corps' post-World War II modernization and consolidation program for the system, the functions of the North Charleroi facility were transferred to the Corps' Ohio River repair shops on Neville Island. In 1949, the Monongahela boatyard land and buildings were sold as excess government property, and today the facility is privately-owned and operated as a manufacturing plant.

The repair facilities originally constructed by the Monongahela Navigation Company were not extensive, consisting of a repair shop, launchway, wharf, railroad tracks, and several houses. After its acquisition by the federal government in 1897, the boatyard's scope of operations was greatly expanded. By 1902, the U.S. Army Corps of Engineers added a large corrugated iron/frame warehouse, a heavy machine and carpenter shop, a small machine shop, and a small carpenter shop. The riverbank was used as a launchway and for barge building. Over the next few decades, the Corps added an office, planing mill, boiler house and blacksmith shop, paint shop, and lumber shed. A large brick office and warehouse was built in the 1930s. The buildings were all located between Monongahela Avenue and the river, and sited so as to facilitate optimal work flow for the activities that occurred there.

Despite the loss of many buildings and features from the period when it served as a boatyard and repair facility for the Monongahela River Navigation System, the property still contains many notable remnants of that complex. Surviving historic structures include the 1930s brick office and warehouse building, the paint shop and oil house, the early twentieth century office and carpenter shop/garage, and an 1891 employees' house. A retaining wall and remnants of storage racks along the riverbank also survive. Several modern metal buildings have been added to the complex in recent years.

The boundaries should correspond to the historic boundaries of the main boatyard complex, together with adjacent lots containing the employees' house and the early twentieth century office and carpenter shop/garage.

Significance

The "Maintenance Facility" property type is closely associated with the "Locks and Dams for Slackwater Navigation" property type, and as a supporting component of the navigation system it shares the system's significance under Criterion A. Due to its connection with MNC Locks and Dam 4 situated at the community of Lock Four, it may also be significant under Criterion A in association with the "Monongahela Riverside Community Development, 1787-1960" historic context. Since this property was not as directly involved with river navigation as were the locks and dams, it would not be significant under the other historic contexts: "The Boat Building Industry in the Monongahela River Valley, 1758-1960;" and "The Influence of the Monongahela River Navigation System on the Development of the Coal, Coke, Iron and Steel Industries in the Monongahela River Valley, 1787-1960." The architectural characteristics of the property would be eligible under Criterion C, in exhibiting characteristics of earlier MNC ownership, followed by the use and evolution of structure types and layouts when under Corps ownership. The period of significance is defined as 1838-1945, beginning with the construction of the first locks and dams by the Monongahela Navigation Company, and extending through the period the facility when it was acquired (1897) and operated by the Corps at that site.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number F Page 13

Registration Requirements

In order to be eligible for registration, individual properties must be at least 50 years old and directly associated with the navigation system constructed by the Monongahela Navigation Company and the U.S. Army Corps of Engineers. Privately-owned boatyards and repair facilities are not included. Eligible properties must possess integrity of location, design, setting, materials, workmanship, feeling, and association. Although changes may have occurred to structures and features over time, evidence of the original design and materials must be apparent, including elements related to function. Properties must retain their original riverside location and setting, and must exhibit evidence of the original physical and functional relationships among structures, although the appearance and use of the site may have changed. Eligible properties must include extant above-ground, or documented archaeological components which convey the character and feeling of an historic boatyard and repair facility.

Despite the loss of many buildings and features from the period when it served as a boatyard and repair facility for the Monongahela River Navigation System, the North Charleroi facility still contains many notable remnants of that complex. While some historic buildings have been removed, and modern buildings added, enough of the early twentieth century complex remains to convey a sense of the historic land use and functional relationships among buildings and features. In addition, there is continuity of use between the site's historic and current functions. It retains integrity of location, design, setting, materials, workmanship, feeling and association

Water Storage Reservoir

Description

This property type is represented by a single property: Tygart Dam near Grafton, Taylor County, West Virginia. The U.S. Army Corps of Engineers constructed Tygart Dam in 1935-1938 in order to provide a water storage reservoir to augment low flow and maintain an adequate navigation pool on the upper Monongahela River. It also provides flood storage for flood risk reduction, but its construction predated the landmark 1936 Flood Control Act, which authorized federal construction of reservoirs for flood control purposes. The dam impounds the Tygart River, one of the principal tributaries of the Monongahela River. Funded by the National Industrial Recovery Act, it was the first of a series of 16 reservoirs constructed by the Corps' Pittsburgh District to provide flood control, water supply, low flow augmentation and recreation in the Pittsburgh region. The property consists of a concrete dam and various support buildings, including two damtenders' houses constructed in 1938-1939.

Significance

In June 1995, Tygart Dam was listed in the National Register of Historic Places. It is significant as the largest concrete gravity dam built east of the Mississippi upon its completion, for its use of hydraulic modeling in the design of its spillway, and for its connection with the Monongahela River Navigation System.

Registration Requirements

The only example of this property type, Tygart Dam, is currently listed in the National Register of Historic Places. There remain no other features to be registered under this property type.

United States Department of the Interior

National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places Continuation Sheet

Section number G & H Page 1

G. GEOGRAPHICAL DATA

The geographical area covered by this multiple property listing consists of the Monongahela River from its mouth at Pittsburgh to mile point 124.20 at Lock and Dam No. 15 at Hoult, West Virginia. The political boundaries incorporate the West Virginia counties of Marion, Monongalia, and Taylor, and the Pennsylvania counties of Allegheny, Fayette, Greene, Washington, and Westmoreland. Property boundaries are specific to the lands owned by the United States and under the jurisdiction of the U.S. Army Corps of Engineers, past and present, relating to the twenty-six lock and dam sites, maintenance facility, and reservoir of the Monongahela River Navigation System, is included.

H. SUMMARY OF IDENTIFICATION AND EVALUATION METHODS

This multiple property listing of historic resources of the Monongahela River Navigation System in Pennsylvania and West Virginia draws information from several sources, including research conducted in 1996 for the National Register of Historic Places Eligibility Evaluation, Monongahela River Locks and Dams 2, 3, and 4, prepared by the U.S. Army Corps of Engineers, Pittsburgh District. Much of the technological information was derived from various studies completed by the Pittsburgh District, especially the *Monongahela River Navigation System Historical Engineering Evaluation*, prepared for the U.S. Army Corps of Engineers, Pittsburgh District, by Douglas C. McVarish of John Milner Associates, Inc. in 1999. The McVarish study provides a detailed account of the construction history and technological characteristics of the past and present navigation facilities on the Monongahela River. General historical information concerning the development of the system was derived from Gannett Fleming Corrdry and Carpenter, Inc.'s *History of Navigation Improvements on the Monongahela River* (1980). Other useful sources included the Pittsburgh District's *Draft Historic Contextual Overview of the Locks and Dams on the Monongahela River* (1994), prepared by Christine Davis Consultants, and *Thematic Study of Civil Works Residences for U.S. Army Corps of Engineers Pittsburgh District* (1998), prepared by Hardlines, Inc. Information also was gathered from primary documents, including Annual Reports of the U.S. Army Corps of Engineers officer in charge of the Monongahela River. Other documents in the Pittsburgh District's files and archives were reviewed, as were related documents from local and regional repositories.

In 1998-2000, the Pittsburgh District commissioned a study to examine several historical themes of particular importance to the Monongahela River Navigation System. The three historians who contributed essays to the volume entitled *Contextual Essays on the Monongahela River Navigation System*, were charged with investigating the role that the system played in four areas: westward migration in the United States (Judith A. Heberling); regional town-building and development (Ronald C. Carlisle); the regional coal, coke, iron and steel industries (Ronald C. Carlisle); and the regional boat-building industry (John J. Kudlik). Based on this detailed work, four historic contexts were developed at that time for the Monongahela River Navigation System: 1) Systematic Navigation Improvements to the Monongahela River, 1840-1950; 2) Boat-Building Industry in the Monongahela River Valley, 1758-1950; 3) Influence of the Monongahela River Navigation System on the Development of the Coal, Coke, Iron and Steel Industries in the Monongahela River Valley, 1787-1950; and 4) Monongahela Riverside Community Development, 1787-1950. The geographic focus of these contexts is inherent in the nature of the historic property being considered, while the chronological focus is based on the period of significance for each theme. Three sub-contexts were developed for the context "Systematic Navigation Improvements to the Monongahela River, 1840-1950", corresponding to the three major phases of improvements.

In 1998-1999, an inventory of all past and present Monongahela River navigation facilities was completed by Douglas Dinsmore and Scott Heberling of Heberling Associates, Inc., under contract to the Pittsburgh District.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number G & H Page 2

The inventory was based on background research, review of previous studies, and field survey, and was an expansion of a preliminary inventory undertaken in 1994. All twenty-seven sites were visited and documented through mapping and 35 mm black-and-white photography. The present use, condition and integrity of abandoned facilities were recorded, and any surviving navigation-related features were documented. At many of the operational sites, interviews with Corps personnel were conducted to gather information concerning general operations and recent modifications. Pennsylvania and West Virginia state historic inventory forms were completed for all properties, and were submitted to the appropriate State Historic Preservation Offices.

Based on the inventory, representative property types were selected which best represent the historic contexts which were developed for the system. Property types were organized both by function and by chronology. Additional property types relating to the defined historic contexts may be added in the future. The registration and integrity requirements were based on knowledge of the condition of existing properties, derived from the systematic inspection of all past and present navigation facilities on the Monongahela River.

Due to the passage of time between the initial form submittals to the Pennsylvania Bureau for Historic Preservation, receiving their review comments, and responding to their comments, the Pittsburgh District, Corps of Engineers, revised and updated the forms to reflect current condition of the property types and extending the period of significance from 1950 to 1960.

United States Department of the Interior

National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960National Register of Historic Places
Continuation SheetSection number 1 Page 1

I. MAJOR BIBLIOGRAPHICAL REFERENCES

Primary location of data:

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|--|---|
| <input checked="" type="checkbox"/> State historic preservation office | <input type="checkbox"/> Local government |
| <input type="checkbox"/> Other state agency | <input type="checkbox"/> University |
| <input checked="" type="checkbox"/> Federal agency | <input type="checkbox"/> Other |

Specify repository: U.S. Army Corps of Engineers, Pittsburgh District
1000 Liberty Avenue, Pittsburgh, PA 15222

SOURCES

Abbott, Walter S. and William E. Harrison

1876 *The First One Hundred Years of McKeesport: An Historical and Statistical Description of the City until Its Centennial in 1894.* Press of McKeesport Times, McKeesport, PA.

Albert, George Dallas, Editor

1882 *History of the County of Westmoreland, Pennsylvania, with Biographical Sketches of Many of Its Pioneers and Prominent Men.* L.H. Everts & Company, Philadelphia, PA.

Albig, W. Espy

1919 Early Development of Transportation on the Monongahela River. *Western Pennsylvania Historical Magazine* 2: 115-124.

Ambler, Charles Henry

1932 *A History of Transportation in the Ohio Valley.* The Arthur H. Clark Company, Glendale, CA.

American Canal Society (ACS)

1988 *The American Canal Guide: A Bicentennial Inventory of America's Historic Canal Resources.* American Canal Society, Freemansburg, PA.

American Rolling Mill Company

1923 *River Shipping and Industry: A Compilation of Historical and River Shipping Data on the Ohio River and Its Tributaries.* The American Rolling Mill Company, Middletown, OH.

American Society of Civil Engineers, Waterways Division (ASCE)

1930 *Manual on Lock Valves.* Manuals of Engineering Practice No. 3. Committee on Lock Valves, Waterways Division, American Society of Civil Engineers, New York, NY.

Andrist, Ralph K.

1962 *Steamboats on the Mississippi.* American Heritage Publishing Company, New York, NY.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number 1 Page 2

Armstrong County Department of Economic and Community Development

- 1980 *Preliminary Research Report for Armstrong County, Pennsylvania, Historic Sites Survey, 1980-81.* Armstrong County Department of Economic and Community Development, Kittanning, PA.

A. Warner and Company, Publishers

- 1889a *History of Allegheny County, Pennsylvania. Volume I.* A. Warner and Company, Chicago, IL.
- 1889b *History of Allegheny County, Pennsylvania. Volume II.* A. Warner and Company, Chicago, IL.

Baer, Christopher T.

- 1981 *Canals and Railroads of the Mid-Atlantic States, 1800-1860.* Regional Economic History Research Center, Eleutherian Mills-Hagley Foundation, Inc., Wilmington, DE.

Baldwin, Leland D.

- 1933 *The Rivers in the Early Development of Western Pennsylvania.* *Western Pennsylvania Historical Magazine* 16: 79-98.
- 1938 *Pittsburgh: The Story of A City.* University of Pittsburgh Press, Pittsburgh, PA.

Billinger, Robert D.

- 1954 *Pennsylvania's Coal Industry.* Pennsylvania Historical Association, Historical Studies No. 6, Gettysburg, PA.

Billington, Ray Allen

- 1974 *Westward Expansion: A History of the American Frontier.* Macmillan Publishing Company, New York, NY.

Binder, Frederick Moore

- 1974 *Coal Age Empire: Pennsylvania Coal and Its Utilization to 1860.* Pennsylvania Historical and Museum Commission, Harrisburg, PA.

Bining, Arthur Cecil

- 1954 *Pennsylvania's Iron and Steel Industry.* Pennsylvania History Studies No. 5. The Pennsylvania Historical Association, Gettysburg, PA.
- 1973 *Pennsylvania Iron Manufacture in the Eighteenth Century.* Second edition. Pennsylvania Historical and Museum Commission, Harrisburg, PA.

Birdsall, Stephen S. and John W. Florin

- 1978 *Regional Landscapes of the United States and Canada.* John Wiley & Sons, New York, NY.

Bissell, Richard

- 1952 *The Monongahela.* Rinehart and Company, New York and Toronto.

United States Department of the Interior**National Park Service**

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number 1 Page 3

Blackford, Mansel G., and K. Austin Kerr

1990 *Business Enterprise in American History*. Second edition. Houghton Mifflin Company, Boston, MA.

Bomberger, Bruce, and William Sisson

1991 *Made in Pennsylvania: An Overview of the Major Historical Industries of the Commonwealth*. Pennsylvania Historical and Museum Commission, Bureau for Historic Preservation, Harrisburg, PA.

Bomberger, Bruce, William Sisson, and Diane Reed

1991 Iron and Steel Resources of Pennsylvania, 1716-1945: Multiple Resource Nomination. National Register of Historic Places nomination form on file, Bureau for Historic Preservation, Pennsylvania Historical and Museum Commission, State Museum of Pennsylvania, Harrisburg, PA.

Bridge, James Howard

1991 *The Inside History of the Carnegie Steel Company: A Romance of Millions*. Pittsburgh Series in Social and Labor History. University of Pittsburgh Press, Pittsburgh, PA.

Brown, Eliza Smith, Daniel Holland, Laurence A. Glasco, Ronald C. Carlisle, Arthur B. Fox, and Diane C. DeNardo

1994 *African American Historic Sites Survey of Allegheny County*. Pennsylvania Historical and Museum Commission, Harrisburg, PA.

Brown, Ralph H.

1948 *Historical Geography of the United States*. Harcourt Brace Jovanovich, New York, NY.

Buck, Solon J., and Elizabeth Hawthorn Buck

1939 *The Planting of Civilization in Western Pennsylvania*. University of Pittsburgh Press, Pittsburgh, PA.

Bureau of the Census

1840 *Sixth Census of the United States, Statistics of Manufactures*. U.S. Government Printing Office, Washington, DC.1850 *Seventh Census of the United States, Statistics of Manufactures*. U.S. Government Printing Office, Washington, DC.1860 *Eighth Census of the United States, Statistics of Manufactures*. U.S. Government Printing Office, Washington, DC.

Bureau of Railway Economics

1930 *An Economic Survey of Inland Waterway Transportation in the United States*. Bureau of Railway Economics Special Series 56. Washington, DC.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number 1 Page 4

Butcher, Bernard L., editor

- 1912 *Genealogical and Personal History of the Upper Monongahela Valley West Virginia*. Vol. I. Lewis Historical Publishing Company, New York, NY.

Byington, Margaret F.

- 1974 *Homestead: The Households of a Mill Town*. Reprint edition. The University Center for International Studies, University of Pittsburgh, Pittsburgh, PA.

Callahan, James Morton

- 1923 *History of West Virginia Old and New in One Volume*. The American Historical Society, Inc., Chicago and New York.

- 1926 *History of the Making of Morgantown, West Virginia: A Type Study in Trans-Appalachian Local History*. West Virginia University Studies in History, Morgantown, WV.

Carlisle, Ronald C.

- 1995 Daybook Entries for the Albert Gallatin Sawmill and the New Geneva Lumber Trade. In *Archaeological Assessment and Data Recovery of the Gallatin Sawmill at 36 Fa 428: The Eberhart Grist Mill, Dam, and Sawmill*, by Lori Ann Frye, Ronald C. Carlisle, J. Steven Kite, Paula A. Zitzler, and Eric Davis with contributions by Denise Grantz and Joe Wakeman, pp. 25-32. Report submitted by Archaeological Services Consultants, Inc., Columbus, Ohio, to Woolpert Consultants, Dayton, Ohio and the U.S. Army Corps of Engineers, Pittsburgh District.

- 1994 Introduction. In *Canals and American Cities: Assessing the Impact of Canals on the Course of American Urban Life*, edited by Ronald C. Carlisle, pp. 5-10. Canal History and Technology Press, Easton, PA.

Carlisle, Ronald C.

- 1999 Historic Context. In, SR0019, Section NOO Corridor Project, Washington, Pennsylvania: Historic Resources Inventory and Preliminary Determination of Eligibility Report, pp. 5-81. Revised draft report prepared by Brown, Carlisle & Associates, Inc. for Landmarks Design Associates, Inc., Triline Associates, and PaDOT, District 12-0, E.R. No. 95-0229-125-A.

Carlisle, Ronald C., Verna L. Cowin, and Jack B. Irion

- 1994 Pennsylvania Canal Pittsburgh; Excavation, Preservation, and Interpretation. In *Canals and American Cities: Assessing the Impact of Canals on the Course of American Urban Life*, edited by Ronald C. Carlisle, pp. 31-46. Canal History and Technology Press, Easton, PA.

Carlisle, Ronald C., Barbara J. Gundy, and Arthur B. Fox

- 1991 Phase I Archaeological Reconnaissance in the Crawford-Roberts Redevelopment Area, Lower Hill District, Pittsburgh, Pennsylvania. A report prepared by the Cultural Resource Management Program, University of Pittsburgh for the Urban Redevelopment Authority of Pittsburgh, Pennsylvania Bureau for Historic Preservation file number ER 90-0753-003.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number 1 Page 5

Carlson, Fred A., and Frank Seawall

1962 *Coal Traffic on the Ohio River System*. Ohio State University, College of Commerce and Administration, Bureau of Business Research Monograph 107. Columbus, OH.

Carnegie-Illinois Steel Corporation

1938 *Weekly Bulletin* (September 1938).

Carnegie Steel Company River Service

1934 *Voyage Number One Hundred* (September 10, 1934), Pittsburgh, PA.

Colten, Craig E.

1996 *Adapting the Road to New Transport Technology*. *The National Road*, edited by Karl Raitz. The Johns Hopkins University Press, Baltimore, MD and London, UK.

Commercial Gazette

September 16, 1885

Committee on Physical Chemistry of Steelmaking, Iron and Steel Division. A.I.M.E.

1944 *Basic Open Hearth Steelmaking*. The American Institute of Mining and Metallurgical Engineers, New York, NY.

Consolidation Coal Company – River Division

1977 Company Information Sheet. Elizabeth, PA.

Consolidation Coal Marine Ways

1977 Company Information Sheet. Elizabeth, PA.

Coode, Thomas

1886 *Bug Dust and Black Damp and Work in the Old Patch Town*. Comart Press, Uniontown, PA.

Couvares, Francis G.

1984 *The Remaking of Pittsburgh: Class and Culture in an Industrializing City 1877-1919*. The State University of New York Press, Albany, NY.

Craig, Neville B.

1917 *The History of Pittsburgh with a Brief Notice of its Facilities of Communication and Other Advantages for Commercial and Manufacturing Purposes*. New edition. J.R. Weldin Company, Pittsburgh, PA.

Cramer, Zadok.

1802 *The Ohio and Mississippi Navigator... Together with a Description of the Monongahela and Allegheny Rivers*. Third corrected edition. John Scull, Pittsburgh, PA.

1814 *The Navigator; Containing Directions for Navigating The Monongahela, Allegheny, Ohio, and Mississippi Rivers....* Eighth edition. Cramer, Spear and Eichbaum, Pittsburgh, PA.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number 1 Page 6

Cramer, Zadok.

1987 *The Navigator*. Reprint, Karl Yost, Editor. Morrison, IL.

Daily Advocate and Advertiser (Pittsburgh)

January 15, 1839

May 7, 1839

May 19, 1843

July 18, 1843

July 19, 1843

Daily Pittsburgh Gazette

April 5, 1834

Daniels, Rudolph

1997 *Trains Across the Continent: North American Railroad History*. Pacific City Graphics, Sioux City, IA.

Davis, Christine

1994 *Draft Report: Monongahela River Navigation System*. U.S. Army Corps of Engineers, Pittsburgh District, Pittsburgh, PA.

DiCiccio, Carmen

1996a *The Rise and Fall of King Coal: A History of the Bituminous Coal and Coke Industry of Pennsylvania from 1740-1945*. Ph.D. dissertation, Department of History, University of Pittsburgh, PA.

1996b *Coal and Coke in Pennsylvania*. Pennsylvania Historical and Museum Commission, Harrisburg, PA.

Dodge, Clifford H. (compiler)

1985 *Coal Resources of Allegheny County*. Pennsylvania Geological Survey, Harrisburg, PA.

Donovan, Frank Robert

1966 *River Boats of America*. Crowell, New York, NY.

Drago, Harry Sinclair

1967 *The Steamboaters: From the Early Side-Wheelers to the Big Packets*. Bramhall House, New York, NY.

Dunbar, Seymour

1937 *A History of Travel in America*. Tudor Publishing Company, New York, NY.

Durrenberger, Joseph Austin

1968 *Turnpikes: A Study of the Toll Road Movement in the Middle Atlantic States and Maryland*. John E. Edwards, Cos Cob, CT.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number 1 Page 7

DuPae, Ralph

1995 *The Germania. Egreious Steamboat Journal* (December 1995).

Durrenberger, Joseph Austin

1968 *Turnpikes: A Study of the Toll Road Movement in the Middle Atlantic States and Maryland.* John E. Edwards, Cos Cob, CT.

Eavenson, Howard N.

1942 *The First Century and a Quarter of American Coal Industry.* Privately printed, Pittsburgh, PA.

Edmunds, William, and Edwin Koppe

1970 *Coal in Pennsylvania.* Commonwealth of Pennsylvania, Department of Environmental Resources, Harrisburg, PA.

Eggert, Gerald G.

1994 *The Iron Industry in Pennsylvania.* Pennsylvania Historical Studies 25. The Pennsylvania Historical Association, Middletown, PA.

Ellis, Franklin, Editor

1882 *History of Fayette County, Pennsylvania with Biographical Sketches of Many of Its Pioneers and Prominent Men.* Volume I. L.H. Everts & Company, Philadelphia, PA.

Elizabeth Herald

Bicentennial Edition, June 7, 1900
September 1, 1900

Engineer School

1940 *Canalization.* Two Volumes. The Engineer School. Fort Belvoir, VA.

Engineers' Society of Western Pennsylvania

1930 *Pittsburgh: Commemorating the Fiftieth Anniversary of the Engineers' Society of Western Pennsylvania.* Engineers' Society of Western Pennsylvania, Pittsburgh, PA.

Enman, John Aubrey

1962 *The Relationship of Coal Mining and Coke Making to the Distribution of Population Agglomeration in the Connellsville (Pennsylvania) Beehive Coke Region.* Ph.D. dissertation, University of Pittsburgh, PA.

Eskew, Garnett Laidlaw

1929 *The Pageant of the Packets: A Book of American Steamboating.* Holt, New York, NY.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number 1 Page 8

Flood Commission of Pittsburgh

- 1930 Letter and Review of Report of the U.S. Army Engineers on Flood Control Survey, Allegheny and Monongahela Rivers. Typewritten. April 30, 1930. In Collection of Library & Archives Division, Historical Society of Western Pennsylvania, Pittsburgh, PA.

Fogel, Robert W. and Stanley L. Engerman, Editors

- 1971 *The Reinterpretation of American Economic History*. Harper & Row, New York, NY.

Folmar, John Kent

- 1981 "The Monongahela River Steamboat Industry: California, 1852-1879." *Western Pennsylvania Historical Magazine* 64: 391-400.

- 1994 California and Steamboats: Mon River History. *Voice of the Mon.* 24 (May 1994): 8-11.

Frese, Joseph R., S.J. and Jacob Judd, Editors

- 1980 *An Emerging Independent American Economy, 1815-1875*. The Sleepy Hollow Press, Tarrytown, NY.

Fritz, Wilbert G., and Theodore A. Veenstra

- 1935 *Regional Shifts in the Bituminous Coal Industry*. University of Pittsburgh Press, Pittsburgh, PA.

Gallatin, Albert

- 1808 *Report of the Secretary of the Treasury on the Subject of Public Roads and Canals*. Washington, DC

Gannett Fleming Corddry and Carpenter, Inc.

- 1980 *A History of the Navigation Improvements on the Monongahela River*. Report prepared for the U.S. Army Corps of Engineers, Pittsburgh District.

Goodrich, Carter et al

- 1960 *Government Promotion of American Railroads 1800-1890*. Columbia University Press, New York, NY.

- 1961 *Canals and American Economic Development*. Columbia University Press, New York, NY.

Gould, E.W.

- 1889 *Fifty Years on the Mississippi*. Nixon-Jones Printing Company, St. Louis, MO.

Haites, Erik F., James Mak, and Gary M. Walton

- 1975 *Western River Transportation: The Era of Early Internal Development, 1810-1860*. Johns Hopkins University Studies in Historical and Political Science, 93rd Ser., No. 2, Baltimore, MD.

Harper, Frank C.

- 1930 *Pittsburgh of Today: Its Resources and People*. Volume II. The American Historical Society, New York, NY.

United States Department of the Interior

National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number 1 Page 9

Harper, R. Eugene

1991 *The Transformation of Western Pennsylvania 1770-1800*. University of Pittsburgh Press, Pittsburgh, PA.

Harris, Isaac

1837 *Directory of Pittsburgh and Vicinity*. Isaac Harris, Pittsburgh, PA.

Hart, J. Percy

1904 *History and Directory of the Three Towns: Brownsville, Bridgeport and West Brownsville*. J. Percy Hart, Cadwallader, PA.

Hartz, Louis

1968 *Economic Policy and Democratic Thought: Pennsylvania 1776-1860*. Quadrangle Books, Chicago, IL.

Heald, Sarah H., Editor

1990 *Fayette County, Pennsylvania: An Inventory of Historic Engineering and Industrial Sites*. U.S. Department of the Interior, National Park Service, America's Industrial Heritage Project, Washington, DC.

Heyman, Louis

1968 Coal. In *Geology of the Pittsburgh Area*, by Walter R. Wagner, Louis Heyman, Richard E. Gray, David J. Belz, Richard Lund, Addison S. Cate, and Curtis D. Edgerton, pp. 108-111. Pennsylvania Geological Survey, Fourth Series, General Geology Report 59. Second Printing. Harrisburg, PA.

Hilton, Suzanne

1976 *The Way It Was—1876*. Westminster Press, Philadelphia, PA.

Historic American Buildings Survey/Historic American Engineering Record

1990 *Fayette County, Pennsylvania: An Inventory of Historic Engineering and Industrial Sites*. America's Industrial Heritage Project, National Park Service, U.S. Department of the Interior, Washington, DC.

Historic American Buildings Survey/Historic American Engineering Record

1994 Monongahela River Lock and Dam No. 7. HAER documentation. Reduced photocopies in the collection of the Historical Society of Western Pennsylvania Library, Pittsburgh History Center.

1994 *Westmoreland County, Pennsylvania: An Inventory of Historic Engineering and Industrial Sites*. America's Industrial Heritage Project, National Park Service, U.S. Department of the Interior, Washington, DC.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number I Page 10

Historical Magazine of Monongahela

1908 Old Home Coming Week: September 6-13, 1908. Monongahela, PA.

Historical Society of Western Pennsylvania Library

n.d. Postcards of Locks and Dam 1, Monongahela River. Historical Society of Western Pennsylvania Library, Pittsburgh History Center.

Hogan, William T.

1971 *Economic History of the Iron and Steel Industry of the United States*. Lexington Books, D. C. Heath and Company, Lexington, MA.

Hornbake, Nan

1949 *History and Development of California, Pa.* Sutton Printing Co., Waynesburg, PA.

Horsman, Reginald

1970 *The Frontier in the Formative Years 1783-1815*. Holt, Rinehart and Winston, New York, NY.

Hull, William J., and Robert W. Hull

1967 *The Origin and Development of the Waterways Policy of the United States*. National Waterways Conference, Washington, DC.

Hunter, Louis C.

1949 *Steamboats on the Western Rivers*. Harvard University Press, Cambridge, MA.

Hunter, Louis C.

1985 *A History of Industrial Power in the United States 1780-1930, Volume Two: Steam Power*. Published for the Hagley Museum and Library by the University Press of Virginia, Charlottesville, VA.

Ingham, John N.

1991 *Making Iron and Steel: Independent Mills in Pittsburgh, 1820-1920*. Ohio State University Press, Columbus, OH.

Innes, Lowell

1974 *Pittsburgh Glass 1797-1891: A History and Guide for Collectors Illustrated with Photographs*. Houghton Mifflin Company, Boston, MA.

Jakle, John A.

1996 Travelers' Impressions of the National Road. *The National Road*, edited by Karl Raitz, The Johns Hopkins University Press, Baltimore, MD and London, UK.

Jansen, Carl B.

1948 Century of Progress Marks Many Improvements in Construction of Locks and Dams. *Civil Engineering*. October 1948: 26-31, 70.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number I Page 11

Jardini, David

- 1992 *Coal Road: The History of the Monongahela Railway, 1900-1992*. National Park Service, Historic American Buildings Survey/Historic American Engineering Record, Washington, DC.

Johnson, Leland R.

- 1979 *The Headwaters District: A History of the Pittsburgh District, U.S. Army Corps of Engineers*. U.S. Army Corps of Engineers, Pittsburgh District, Pittsburgh, PA.

Jones and Jones

- 1993 Steel Heritage Management Action Plan, Phase I Technical Report, Natural Resource and Recreation. Rivers of Steel Management Action Plan (1995), Appendix F. Steel Industry Heritage Corporation, Pittsburgh, PA.

Kehl, James A.

- 1956 *Ill Feeling in the Era of Good Feeling: Western Pennsylvania Political Battles, 1815-1825*. University of Pittsburgh Press, Pittsburgh, PA.

Keyes, William, editor

- 1991 Historic Site Survey of the Greater Monongahela River Valley. Report prepared by the Historical Society of Western Pennsylvania for the National Park Service, Pennsylvania Historical and Museum Commission, and the Steel Industry Heritage Task Force.

Klose, Nelson

- 1964 *A Concise Study Guide to the American Frontier*. University of Nebraska Press, Lincoln, NE.

Kudlik, John J.

- 1998 Monongahela River Navigation System National Register of Historic Places Inventory Project: Locks, Dams, Steamboats and Monongahela River Navigation. Draft report submitted to the U.S. Army Corps of Engineers, Pittsburgh District.

Kussart, Serepta

- 1937 *Navigation on the Monongahela River*. Printed collection of newspaper files, on file at the Pennsylvania Room, Carnegie Library of Pittsburgh and Library of the Historical Society of Western Pennsylvania.

- 1938 *The Allegheny River*. Burgum Printing, Pittsburgh, PA.

Lankford, William T., Jr., Norman L. Samways, Robert F. Craven, and Harold E. McGannon

- 1985 *The Making, Shaping and Treating of Steel*. Tenth edition. Association of Iron and Steel Engineers, Pittsburgh, PA.

Lass, William C.

- 1962 *A History of Steamboating on the Upper Missouri River*. University of Nebraska Press, Lincoln, NE.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number 1 Page 12

Lewis, Peirce

- 1996 *The Landscapes of Mobility. The National Road*, edited by Karl Raitz. The Johns Hopkins University Press, Baltimore, MD and London, UK.

Livingood, James Weston

- 1947 *The Philadelphia-Baltimore Trade Rivalry 1780-1860*. The Pennsylvania Historical and Museum Commission, Harrisburg, PA.

Longenecker, Charles

- 1941 *Jones & Laughlin Steel Corporation in the Service of the Country for Almost a Century*. Jones & Laughlin Steel Corporation, Pittsburgh, PA.

Mace, Ellis Clarence

- 1944 *River Steamboats and Steamboat Men: A History with Articles and Pictures from My Scrapbook*. The Hobson Press, Cynthiana, KY.

Magda, Matthew S.

- 1985 *Monessen: Industrial Boomtown and Steel Community 1898-1980*. Pennsylvania Historical and Museum Commission, Harrisburg, PA.

Majumdar, Shyamal, and E. Willard Miller, editors

- 1983 *Pennsylvania Coal: Resources, Technology, and Utilization*. Pennsylvania State University Press, State College, PA.

Martinet, George C.

- 1990 *Charleroi—The First 100 Years*. Charleroi Area Historical Society, Charleroi, PA.

May, Colonel John

- 1921 *Journal of Col. John May, of Boston, Relative to a Journey to the Ohio Country, 1789*. *Pennsylvania Magazine of History and Biography* 45(2): 101-179.

McCarty, Henry

- 1844 *Manner of Suspending, Opening, and Closing Canal-Lock Gates*. Letter Patent No. 3,493. March 16, 1844. Microfilm of document in the Patent Collection, Government Documents Department, Free Library of Philadelphia.

- 1845 *Assignment of patent for Manner of Suspending, Opening and Closing Lock Gates to the Monongahela Navigation Company*. Document in RG77. National Archives, Philadelphia, PA.

McKeesport Daily News

- April 3, 1891
January 7, 1896
January 28, 1896
February 1, 1896
July 8, 1897

United States Department of the Interior

National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number I Page 13

McVarish, Douglas

1999 Monongahela River Navigation System, Historical Engineering Evaluation. Report prepared for U.S. Army Corps of Engineers, Pittsburgh District. John Milner Associates, Inc., West Chester, PA.

Meinig, D.W.

1993 *The Shaping of America: A Geographical Perspective on 500 Years of History, Volume 2, Continental America 1800-1867.* Yale University Press, New Haven, CT and London, UK.

Miller, Al

1999 *Tin Stackers: The History of the Pittsburgh Steamship Company.* Wayne State University Press, Detroit, MI.

Monongahela Navigation Company

1838-1897 Annual Reports of the Board of Managers of the Monongahela Navigation Company to the Stockholders: with Accompanying Documents. Monongahela Navigation Company, Pittsburgh, PA.

Monongahela Valley Review

July 1994

Muller, Edward K., Ronald C. Carlisle, Christine Davis, and Carmen DiCiccio

1994 *Westmoreland County, Pennsylvania: An Inventory of Historic Engineering and Industrial Sites.* Gray Fitzsimons and Kenneth D. Rose, editors. Historic American Buildings Survey/Historic American Engineering Record, America's Industrial Heritage Project, National Park Service, Washington, DC.

Mulrooney, Margaret M.

1988 *A Legacy of Coal: Coal Company Towns of Southwestern Pennsylvania.* U.S. Department of the Interior, National Park Service, America's Industrial Heritage Project, Washington, DC.

Newcomer, Major H.C.

1910 Movable Tops for Fixed Dams. *Professional Memoirs* 2:202-212.

Parkman, Aubry

1983 *History of the Waterways of the Atlantic Coast of the United States.* National Waterways Study, U.S. Army Engineer Water Resources Support Center, Institute for Water Resources, Washington, DC.

Parker, Arthur

1999 *The Monongahela: River of Dreams, River of Sweat.* Pennsylvania State University Press, University Park, PA.

Paskoff, Paul F.

1983 *Industrial Evolution: Organization, Structure, and Growth of the Pennsylvania Iron Industry, 1750-1860.* The Johns Hopkins University Press, Baltimore, MD and London, UK.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number I Page 14

Peterson, Florence

1945 *American Labor Unions: What They Are and How They Work*. Harper & Row, New York, NY.

Peyton, Billy Joe

1996 *Surveying and Building the Road. The National Road*, edited by Karl Raitz. The Johns Hopkins University Press, Baltimore, MD and London, UK.

Pitkin, Timothy

1835 *A Statistical View of the Commerce of the United States of America Including also an Account of Banks, Manufactures and Internal Trade and Improvements: Together with that of the Revenues and Expenditures of the General Government: Accompanied with Numerous Tables*. Durrie & Peck, New Haven, CT.

Pittsburgh Advocate

January 5, 1838

August 3, 1841

Pittsburgh City Directories

1920-1960 Various Publishers

Pittsburgh Commercial

September 21, 1867

October 26, 1869

Pittsburgh Commercial Journal

August 11, 1857.

Pittsburgh Gazette

September 2, 1786

November 24, 1787

March 22, 1788

February 7, 1789

July 21, 1798

May 19, 1818

January 18, 1822

March 19, 1824

December 3, 1833

January 30, 1835

April 2, 1839

December 25, 1844

September 18, 1857

Pittsburgh Gazette and Manufacturing and Mercantile Advertiser

March 14, 1823

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number 1 Page 15

Pittsburgh History and Landmarks Foundation

1982 Allegheny County Survey, Phase IV, Preliminary Research Report. Pittsburgh History and Landmarks Foundation, Pittsburgh, PA.

Pittsburgh Morning Post

January 21, 1856

Pittsburgh Post

September 11, 1843

March 18, 1845

February 27, 1852

October 1, 1862

Pittsburgh Telegraph

November 12, 1885

Puth, Robert C.

1988 *American Economic History*. Dryden Press, Chicago, IL.

Raitz, Karl

1995 *The National Road* (ed). The Johns Hopkins University Press, Baltimore, MD and London, UK.

1996 *The Face of the Country. The National Road*, edited by Karl Raitz. The Johns Hopkins University Press, Baltimore, MD and London, UK.

Raitz, Karl B. and Richard Ulack with Thomas R. Leinbach

1984 *Appalachia: A Regional Geography*. Westview Press, Boulder, CO, and London, UK.

Reiser, Catherine Elizabeth

1951 *Pittsburgh's Commercial Development 1800-1850*. Pennsylvania Historical and Museum Commission, Harrisburg, PA.

Rice, Otis K.

1972 *West Virginia: The State and Its People*. McClain Printing Company, Parsons, WV.

Richardson, James B., III, and Ronald C. Carlisle

1977 *Ohio River Environmental Assessment: Cultural Resource Reconnaissance Pennsylvania*. Report prepared for the U.S. Army Corps of Engineers, Huntingdon District, West Virginia, in fulfillment of contract number DACW69-77-M-1201.

Roberts, T.P.

1908 *The Monongahela River: Some of Its Characteristics and Brief Sketch of Methods Undertaken for the Improvement of Its Navigation*. Proceedings of the Engineers Society of Western Pennsylvania XXIV (May 1908): 193-217.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number I Page 16

Roberts, W. Milnor

1838 Map of Monongahela River.

Robinson, Michael C.

1983 *History of Navigation in the Ohio River Basin*. National Waterways Study, U.S. Army Engineer Water Resources Support Center, Institute for Water Resources, Washington, DC.

Rogers, G.W.

1845 *Shipwright's Own Handbook*. G.W. Rogers, Freedom, PA.

Rose, Gregory S.

1996 *Extending the Road West. The National Road*, edited by Karl Raitz. The Johns Hopkins University Press, Baltimore, MD and London, UK.

Rubin, Julius

1961 *Canal or Railroad: Initiation and Innovation in the Response to the Erie Canal in Philadelphia, Baltimore, and Boston*. American Philosophical Society, New Series, 57, Part 7. Philadelphia, PA.

Sabadasz, Joel

1992 *The Development of Modern Blast Furnace Practice: The Monongahela Valley Furnaces of the Carnegie Steel Company, 1872-1913*. *IA: The Journal of the Society for Industrial Archeology* 18 (1 and 2): 94-105.

Saward, F.E. (editor)

1887-88 *The Coal Trade* [journal].

Scheiber, Harry N.

1969 *Ohio Canal Era: A Case Study of Government and the Economy, 1820-1861*. The Ohio University Press, Athens, OH.

Shank, William H.

1976 *Three Hundred Years with the Pennsylvania Traveler*. American Canal and Transportation Center, York, PA.

Sharp, Myron B., and William H. Thomas

1966 *A Guide to the Old Stone Blast Furnaces in Western Pennsylvania*. The Historical Society of Western Pennsylvania, Pittsburgh, PA.

Shaw, Ronald E.

1966 *Erie Water West: A History of the Erie Canal 1792-1854*. The University Press of Kentucky, Lexington, KY.

1990 *Canals for a Nation: The Canal Era in the United States 1790-1860*. The University Press of Kentucky, Lexington, KY.

United States Department of the Interior

National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number 1 Page 17

Sisson, William

- 1992 A Revolution in Steel: Mass Production in Pennsylvania, 1867-1901. *IA: The Journal of the Society for Industrial Archeology* 18 (1and 2): 79-93.

Skempton, A.W.

- 1996 *Civil Engineers and Engineering in Great Britain, 1600-1830*. Variorum, Aldershot, UK.

Snyder, Charles McCool

- 1958 The Jacksonian Heritage: Pennsylvania Politics 1833-1848. Pennsylvania Historical and Museum Commission, Harrisburg, PA.

Stevenson, J. J.

- 1876 *Second Geological Survey of Pennsylvania: Greene and Washington District of the Bituminous Coal-Fields of Western Pennsylvania*. Board of Commissioners, Harrisburg, PA.

Stickle, Lt. Col. Horton W.

- 1919 Monongahela River Navigation. *Professional Memoirs, Corps of Engineers, U.S. Army and Engineers at Large 2* (November/December 1919): 695-713.

Stotz, Charles Morse

- 1958 Defense in the Wilderness. In *Drums in the Forest*, by Alfred Procter James and Charles Morse Stotz, pp. 59-191. The Historical Society of Western Pennsylvania, Pittsburgh, PA.

Stover, John F.

- 1980 Canals and Turnpikes: America's Early-Nineteenth Century Transportation Network. *An Emerging Independent American Economy, 1815-1875*, edited by Joseph R. Frese, S.J. and Jacob Judd. The Sleepy Hollow Press, Tarrytown, NY.

Swartzwelder, James

- n.d. Miscellaneous Papers and Unpublished Manuscripts. Collection of John J. Kudlik.

Swetnam, George

- 1951 *Pittsylvania Country*. Duell, Sloan, and Pierce, New York, NY.
- 1968 *Pennsylvania Transportation*. Pennsylvania History Studies: No. 7, The Pennsylvania Historical Association, Gettysburg, PA.

Tarr, Joel A.

- 1989 Infrastructure and City-Building in the Nineteenth and Twentieth Centuries. In *City at the Point: Essays on the Social History of Pittsburgh*, edited by Samuel P. Hays, pp. 213-263. University of Pittsburgh Press, Pittsburgh, PA.

Taylor, George Rogers

- 1968 *The Transportation Revolution, 1815-1860*. Harper & Row, New York, NY.

United States Department of the Interior
National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places
Continuation Sheet

Section number I Page 18

Temin, Peter

- 1964 *Iron and Steel in Nineteenth Century America: An Economic Inquiry*. MIT Press, Cambridge, Massachusetts.

Thurston, George H.

- 1859 *Directory of the Monongahela and Youghiogheny Valleys: Containing Brief Historical Sketches of the Various Towns Located on Them; with a Statistical Exhibit of the Collieries Upon the Two Rivers*. A.A. Anderson, Pittsburgh, PA.
- 1859 *Directory of Pittsburgh and Vicinity for 1859-60*. George H. Thurston, Pittsburgh, PA.
- 1888 *Allegheny County's Hundred Years*. A.A. Anderson and Son, Pittsburgh, PA.

Tomer, Martha Kennedy

- 1939 The Trade in Transportation on the Monongahela River in the Past Fifteen Years. M.A. thesis, University of Pittsburgh.

U.S. Army Corps of Engineers (COE), Pittsburgh District

- 1885-1967 Reports of the Chief of Engineers. Annual Reports of the Secretary of War/Defense to the United States Congress. U.S. Government Printing Office, Washington, DC.
- 1903-63 Photographs of locks and dams on the Monongahela River. In files of U.S. Army Corps of Engineers, Pittsburgh District, Pittsburgh, PA.
- 1913-23 Engineering drawings of the Monongahela River Navigation System. Original and microfiche copies in the offices of the U.S. Army Corps of Engineers. Pittsburgh District, Pittsburgh, PA.
- 1938 Report, Definite Project for Flood Protection at and Above Abutment of Dam No. 7, Allegheny River, Kittanning, Armstrong County, Pa., Under Provisions of Flood Control Act Approved June 28, 1938. U.S. Engineer Office, Pittsburgh, PA., December 31, 1938.
- 1975 *Monongahela River: Final Environmental Statement on the Operation and Maintenance of the Navigation System*. U.S. Army Corps of Engineers, Pittsburgh District, Pittsburgh, PA.
- 1979 *Ohio River Navigation: Past, Present, Future*. U.S. Army Corps of Engineers, Ohio River Division, Cincinnati, OH.
- 1994 *The Monongahela River Navigation System: An Historical Contextual Overview of the Locks and Dams on the Monongahela River Allegheny, Washington, Westmoreland, Greene and Fayette Counties, Pennsylvania, Monongalia and Marion Counties, West Virginia*. Draft report, U.S. Army Corps of Engineers, Pittsburgh District, Pittsburgh, PA.
- 1996 *Monongahela River Locks and Dams 2, 3, and 4, National Register of Historic Places Eligibility Evaluation*. U.S. Army Corps of Engineers, Pittsburgh District, Pittsburgh, PA.

United States Department of the Interior

National Park Service

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| Historic Resources of the Monongahela River Navigation System in Pennsylvania and West Virginia, 1838 - 1960 |
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National Register of Historic Places Continuation Sheet

Section number I Page 19

U.S. Army Corps of Engineers (COE), Pittsburgh District

- 1997 *Monongahela River Locks and Dams 2, 3, and 4, Cultural Resource Effect Determination and Mitigation Plan.* U.S. Army Corps of Engineers, Pittsburgh District, Pittsburgh, PA.

U.S. Department of Commerce

- 1906 *38th Annual List of Merchant Vessels of the United States.* Washington, DC.
- 1923 *Inland Water Transportation in the United States.* Bureau of Foreign and Domestic Commerce, Transportation Department, Government Printing Office, Washington, DC.

U.S. Department of the Interior, National Park Service, Denver Service Center (cited as National Park Service)

- 1991 *Reconnaissance Survey Brownsville/Monongahela Valley Pennsylvania/West Virginia.* U.S. Department of the Interior, National Park Service, Denver Service Center, Denver, CO.
- 1992 *Coal and Coke Resource Analysis Western Pennsylvania Northern West Virginia.* U.S. Department of the Interior, National Park Service, Denver Service Center, America's Industrial Heritage Project, Denver, CO.
- 1994 *The Evolution of Transportation in Western Pennsylvania.* Denver Service Center, National Park Service, U.S. Department of the Interior, Denver, CO.
- 1994 *The National Road: Maryland, Pennsylvania, West Virginia, Ohio, Indiana, Illinois.* Special Resource Study, Denver Service Center, National Park Service, Southwestern Pennsylvania Heritage Preservation Commission, U.S. Department of the Interior, Denver, CO.

U.S. House of Representatives (U.S. House)

- 1903 *Pennsylvania. Locks and Dams Nos. 1, 3, 4 and 5, Monongahela River.* House Document No. 209. 58th Congress, 2nd Session. Microcard copy in the Government Documents Department, Free Library of Philadelphia.

Valley Independent (Monessen, PA)

May 5, 1973

Van Voorhis, John S.

- 1893 *The Old and New Monongahela.* Nicholson, Pittsburgh, PA.

Veech, James

- 1873 *A History of the Monongahela Navigation Company by an Original Stockholder.* Bakewell & Marthens, Pittsburgh, PA.
- 1974 *The Monongahela of Old.* Reprinted. Parsons, WV.

United States Department of the Interior

National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

National Register of Historic Places Continuation Sheet

Section number I Page 20

Wagner, Walter R.

- 1970 Stratigraphy. In *Geology of the Pittsburgh Area*, by Walter R. Wagner, Louis Heyman, Richard E. Gray, David J. Belz, Richard Lund, Addison S. Cate, and Curtis D. Edgerton, pp. 41-59. Pennsylvania Geological Survey, Fourth Series, General Geology Report 59. Second Printing. Harrisburg, PA.

Walker, Joseph E., Editor

- 1975 *Pleasure and Business in Western Pennsylvania: The Journal of Joshua Gilpin 1809*. Pennsylvania Historical and Museum Commission, Harrisburg, PA.

Wall, J. Sutton

- 1884 *Report on the Coal Mines of the Monongahela River Region, From the West-Virginia State Line to Pittsburgh, Including the Mines on the Lower Youghioghene River*. Second Geological Survey of Pennsylvania, Report of Progress K4, Harrisburg, PA.

Wallace, Paul A. W.

- 1971 *Indian Paths of Pennsylvania*. Second printing. Pennsylvania Historical and Museum Commission, Harrisburg, PA.

Warren, Kenneth

- 1973 *The American Steel Industry 1850-1970: A Geographical Interpretation*. University of Pittsburgh Press, Pittsburgh, PA.

Waterman, Watkins & Co.

- 1884 *History of Bedford, Somerset and Fulton Counties, Pennsylvania*. Waterman, Watkins & Co., Chicago, IL.

Watson, Ken

- 1985 *Paddle Steamers*. Norton, New York, NY.

Way, Frederick, Jr. and Joseph W. Rutter

- 1983 *Way's Packet Directory*. Ohio University Press, Athens, OH.

- 1990 *Way's Steam Towboat Directory*. Ohio University Press, Athens, OH.

Wayman, Norbury

- n.d. *Life on the River: A Pictorial History of the Mississippi, the Missouri, and the Western River System*. Crown Publishers, New York, NY.

West, Henry E.

- 1990 Webster, Rostraver Township, Westmoreland County on the Monongahela River, Pennsylvania, The United States of America: A Community and Its People are One. Typescript, Carnegie Library of Pittsburgh, Pennsylvania Room.

United States Department of the Interior

National Park Service

Historic Resources of the Monongahela
River Navigation System in Pennsylvania
and West Virginia, 1838 - 1960

**National Register of Historic Places
Continuation Sheet**Section number 1 Page 21

Wiley, Richard T.

1936 *Elizabeth and Her Neighbors*. The Ziegler Company, Butler, PA.1937 *Monongahela: The River and Its Region*. The Ziegler Company Butler, PA.

Wiley, Samuel T.

1883 *History of Monongalia County, West Virginia: From Its First Settlements to the Present Time with Numerous Biographical and Family Sketches*. Preston Publishing Company, Kingwood, WV.

Wilhelm, Hubert G.H.

1996 *The Road as a Corridor for Ideas. The National Road*, edited by Karl Raitz. The Johns Hopkins University Press, Baltimore, MD and London, UK.

Wilson, Herbert M.

1903 Automatic Drop Shutters for the Betwa Irrigation Dam, India. *Engineering News* XLIX (June 4, 1903).

Wood, Joseph S.

1996 *The Idea of a National Road. The National Road*, edited by Karl Raitz. The Johns Hopkins University Press, Baltimore, MD and London, UK.

Workman, Michael E., with Assistance by Cassandra Vivian

1994 *A History of Pittsburgh Steel Company's Monessen Works*. Report prepared for the Historic American Engineering Record, National Park Service, Richard O'Connor, Ph.D., Project Manager.

Writer's Program of the Works Projects Administration in the Commonwealth of Pennsylvania

1941 *The Story of Old Allegheny City*. The Allegheny Centennial Committee, Pittsburgh, PA.

