PORTPITT

Port of Pittsburgh Commission

https://www.portpitt.com/

THE PORT OF PITTSBURGH: IMPACT, OPPORTUNITIES, AND CHALLENGES

Final Report, February 17, 2021

Prepared by
CENTER FOR PORTS AND WATERWAYS
TEXAS A&M TRANSPORTATION INSTITUTE
701 NORTH POST OAK, SUITE 430
HOUSTON, TEXAS 77024-3827

Texas A&M Transportation Institute

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

The authors appreciate the assistance provided by the Port of Pittsburgh Commission staff and the steering committee assembled for this project. Their time and thoughtful comments contributed greatly to the quality and accuracy of this document.

Port of Pittsburgh Commission staff:

- Mary Ann Bucci, Executive Director.
- Michael Brinza, Port Transportation Analyst.
- Scott Harshman, Marketing & Program Manager.
- Matt Pavlosky, Public Relations Manager.

Steering Committee:

- Peter Stephaich (Chairman), Campbell Transportation Company Inc.
- Deb Calhoun, Waterways Council Inc.
- John Doyle, Jones Walker LLP.
- Gwen DiPietro, Squirrel Hill Consulting and Carnegie Mellon University.
- Bob Hurley, GAI Consultants Inc.

Consultants:

- Emily Medine, EVA Inc.

PREFACE

This study was commissioned by the Port of Pittsburgh Commission (PPC). PPC is a Pennsylvania state government agency created by the legislature under Law 1992-133 and is responsible for promoting the Port of Pittsburgh. The PPC Board consists of four legislative appointees representing the four major political caucuses and 11 gubernatorial appointees representing various industry-related organizations, academia, and elected officials. It serves 11 contiguous counties in southwestern Pennsylvania plus Blair County.

Formed in 1992, the commission serves to promote the commercial use and development of the inland waterways and an intermodal transportation system, and to integrate that system into the economic, recreational, environmental, and intermodal future of the residents and industries in the region. The agency promotes economic development, functions as a clearinghouse of information, and connects businesses with the resources they need to make use of the waterways. The commission offers a variety of bonds, grants, and loans to fund waterway development.

Many key individuals in the Pittsburgh area took the time to discuss their thoughts on the Port of Pittsburgh and provide context for this report. The authors express their appreciation to the following:

- Lyn Doverspike, International Trade Administration
- Rich Fitzgerald, Allegheny County
- Kate Klaber, The Klaber Group
- James Guttman, Guttman Energy.
- Lenna Hawkins, U.S. Army Corps of Engineers (USACE)
- Michael Henderson, Pittsburgh Regional Alliance
- Patty Horvatich, Pittsburgh Regional Alliance
- Jim Lind, McKees Rocks Industrial Enterprise
- Robbie Matesic, Sen. Robert Casey's Office
- Matt Smith, Greater Pittsburgh Chamber of Commerce
- Mike Somales, American Consolidated Natural Resources
- Peter Stephaich, Campbell Transportation
- Mark Thomas, Pittsburgh Regional Alliance
- Scott Turer, Three Rivers Marine and Rail Terminals

At the time this report went to press, the nation was dealing with the coronavirus pandemic and a global oil glut, which obviously affect some of the findings in this report, especially in the energy sector. However, it is the opinion of the authors that the main effect is one of timing rather than the direction events will follow over time. For instance, the Shell ethane cracker under construction in Beaver County shut down for one month, but then resumed full construction activities. Some effects—such as the impact on the commercial real estate industry if enough people continue to telework or the effect on refinery/gasoline production if vehicle miles traveled do not rebound—may linger. Potential effects such as these are beyond the scope of this report.

EXECUTIVE SUMMARY

Introduction to the Port

The Pittsburgh Port District consists of 200 miles of commercially navigable waterways in southwestern Pennsylvania. These waterways extend throughout a nine-county area[1] and include three major rivers: the Allegheny, the Monongahela, and the Ohio. Three additional counties are also part of the district—Blair, Indiana, and Lawrence. There are 203 river terminals and barge industry service suppliers situated on these rivers that depend on the safe and stable operation of the Port of Pittsburgh for their economic success. Figure 1 illustrates the Pittsburgh Port District.

The Port of Pittsburgh is fourth in tonnage among the nation's inland waterways ports; it is the 33rd busiest port among all U.S. coastal and inland ports as a group. Over the last 10 years, an average of 30 million tons of freight passed through the Port of Pittsburgh annually, 70 percent of which was coal. For many years now, the Pittsburgh region's main export by weight has been coal (*1*).[2] According to the Pennsylvania Comprehensive Freight Movement Plan published in 2016, mines in Greene County are among the largest suppliers of North American coal to China (*2*).

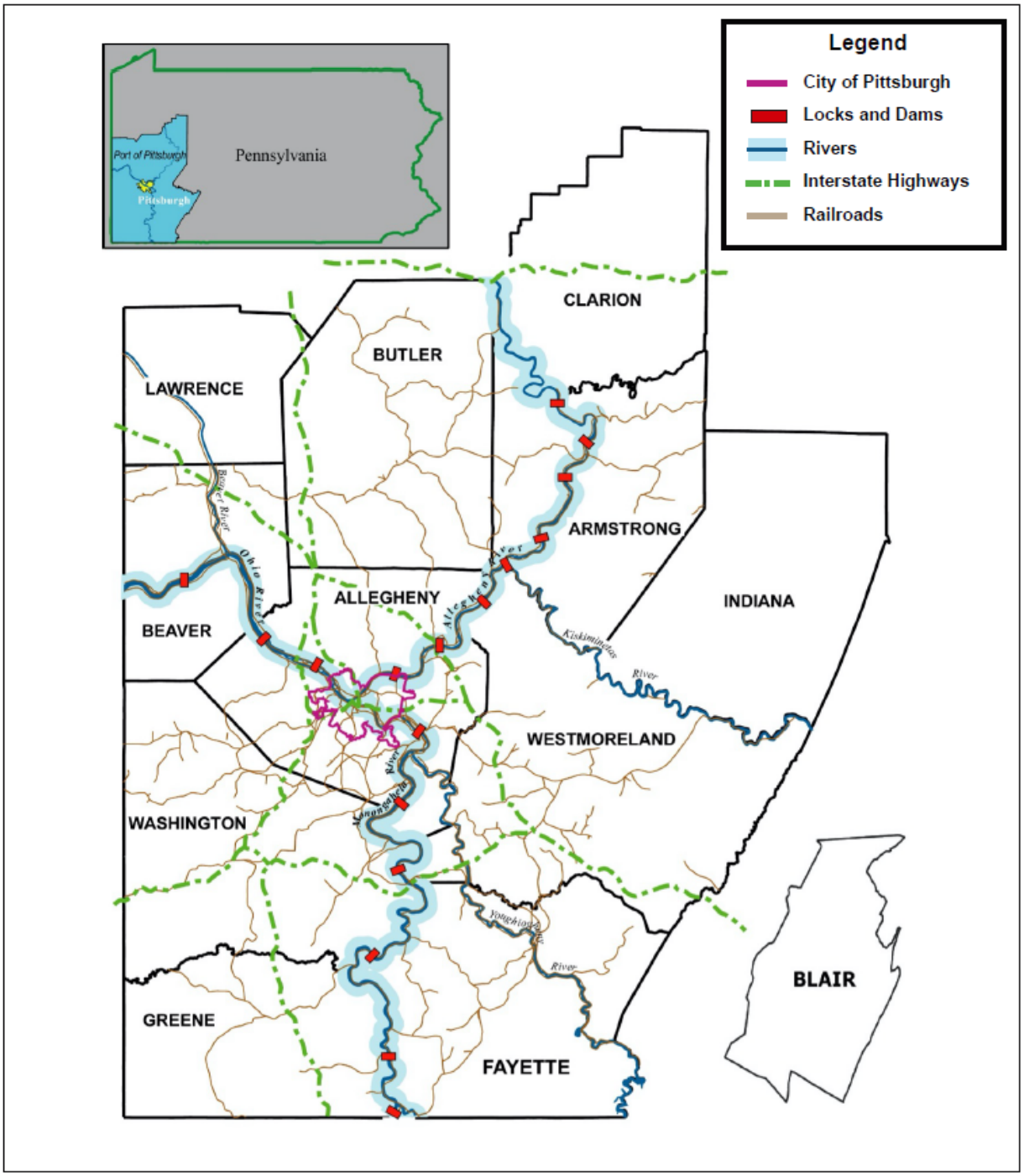
It is important to note that the three rivers in southwest Pennsylvania affect far more than Pennsylvania itself. Coal is shipped by water to large consumers in West Virginia, Ohio, and Kentucky. According to the Energy Information Administration (EIA), in 2019, power plants in Pennsylvania received coal shipments by barge from two counties in Ohio, Greene County in Pennsylvania, and two counties in West Virginia. Shipments from Pennsylvania coal mines are consumed in Pennsylvania, Ohio, Kentucky, and West Virginia (*3*).

The U.S. Maritime Administration has designated 25 Marine Highway routes that serve as extensions of the surface transportation system. Each all-water route is designated by the U.S. Secretary of Transportation and offers relief to landside corridors suffering from traffic congestion, excessive air emissions, or other environmental challenges. Pittsburgh is on the M-70 Route, which includes the Ohio, Mississippi, and Missouri Rivers and connects commercial navigation channels, ports, and harbors from Pittsburgh to Kansas City. The M-70 Route connects in turn to the M-55 Route, which includes the Mississippi and Illinois Rivers from New Orleans, to St. Louis, to Chicago through Louisiana, Mississippi, Arkansas, Tennessee, Missouri, and Illinois (*4*).

The Lock and Dam System

There are 17 locks and dams in southwestern Pennsylvania that make navigation possible on three major rivers—the Monongahela, Allegheny, and Ohio.[3] Should any of these lock and dam sites fail and cause a shutdown of the river system (especially those structures on the Ohio and Lower Monongahela Rivers) the effect on the nation's economy will be very noticeable. Steel, coal, power generation, and all related industries will experience severe detrimental effects if a lock that affects their shipments fails. In a recent study (*5*), it was noted that as many as 80 percent of industries that would be cut off from the water would either relocate or shut down.

[1] Counties include Allegheny, Armstrong, Beaver, Butler, Clarion, Fayette, Greene, Washington, and Westmoreland Counties.
[2] The category of "Coal" includes two main types of coal—steam coal and metallurgical coal. Unfortunately, the publicly available waterborne commerce statistics do not provide any detail below the level of coal.
[3] There are additional locks on the Monongahela River in West Virginia.



Source: Port of Pittsburgh Commission (PPC)

Figure 1. Port of Pittsburgh Commission District.

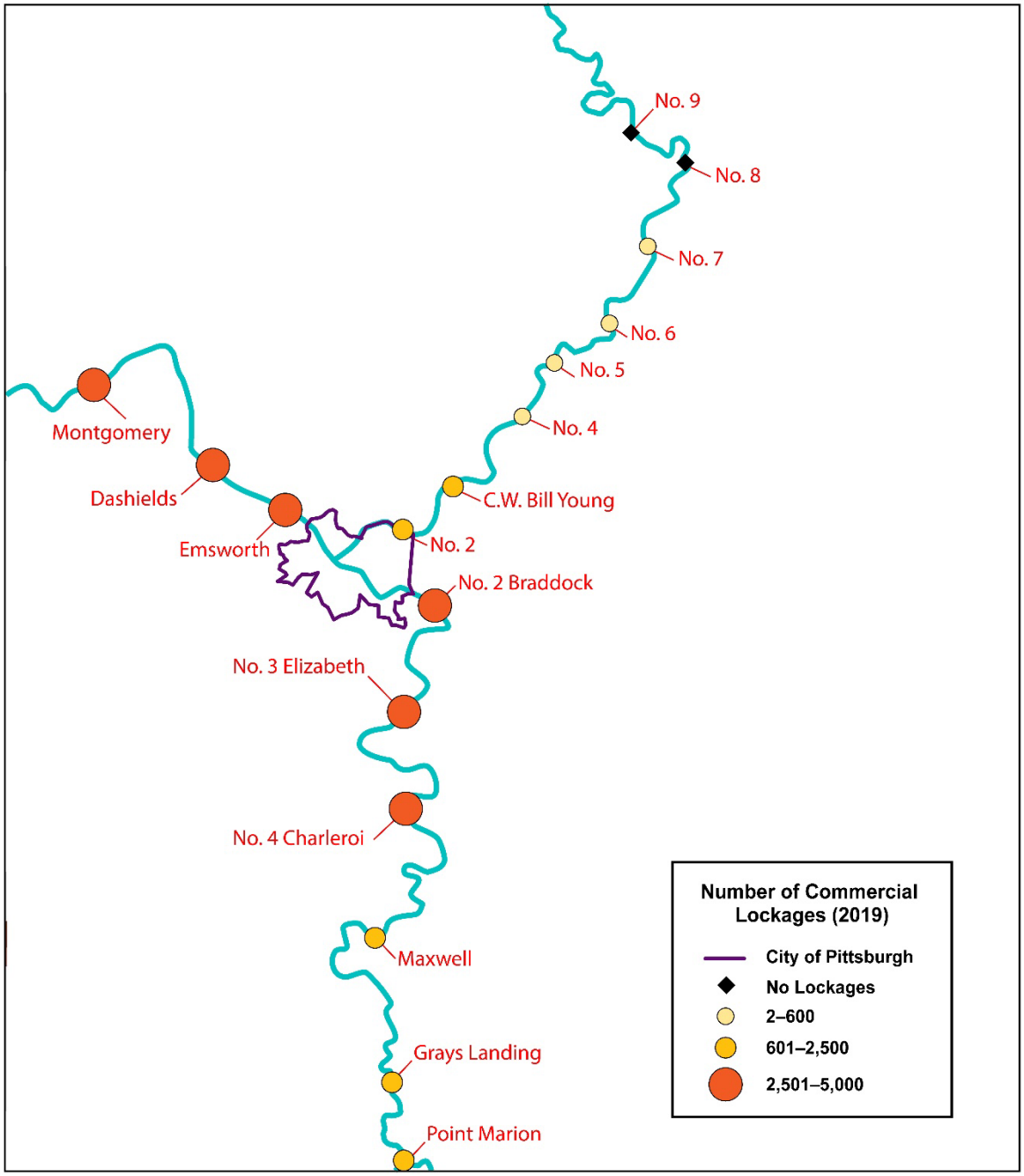
The lock and dam structures provide benefits beyond navigation to a broad array of stakeholders. These benefits include the following:

- Recreational uses (boaters and recreation facilities).
- Enhanced quality of life.
- Hydropower generation.

The lock and dam system benefits a wide variety of stakeholders in the area—not just navigation.

- Municipal and industrial water supply.
- Wastewater discharges.
- Congestion and safety impacts.
- Reduced environmental impacts.

Figure 2 displays the approximate location of the various locks in southwestern Pennsylvania and the volume of traffic in terms of lockages.



Source: (6)

Figure 2. Regional Waterways' Freight Flows Based on Commercial Lockages.

The restrictive size of many of the lock chambers creates inefficiencies in barge operations. Several lock and dam sites include a main chamber and a smaller auxiliary chamber. The auxiliary chambers are intended to serve as a backup when the main chamber is closed, but they are used frequently for recreational vessels and towboats without barges.

Most waterway structures in the region are 70 to 80 years old. A significant national backlog of repairs and modifications to navigation locks and dams is pending appropriations by Congress. Mechanical components at these sites are subject to increasingly frequent breakdowns, and because of the age of the locks, many replacement parts are no longer manufactured, which results in a high degree of difficulty and expense to maintain the locks.

Three lock facilities in Pennsylvania on the Ohio River—Emsworth, Dashields, and Montgomery (EDM)—provide navigable conditions on the first 31.7 miles of the 981-mile Ohio River. They serve as the only conduit between the Ohio River System and Pittsburgh area rivers. Unfortunately, they are the oldest and smallest on the Ohio River mainstem. Their capacity at full operation is approximately one-third the capacity of the other locks on the Ohio River (*7*).

The Allegheny River Navigation System consists of 70 miles of navigable channel from Brady's Bend, Pennsylvania, to the river mouth at Pittsburgh. The eight locks and dams on the Allegheny River were all built between 1927 and 1938. All these facilities feature a single lock chamber and a fixed-crest dam that maintains a minimum 9-ft-deep pool. These structures had long been on a "fix as fail" repair basis but are now managed as "fail and close." According to a study done by the U.S. Army Corps of Engineers (USACE), "All projects [on the Allegheny River] except L/D 5 operate with a net negative economic impact, and trends show that L/D 5's economic positive impact is declining. … [Systems] are rated as failed or failing for one or more component systems at each project [on the river]" (*8*).

USACE is in the process of replacing the structures at Monongahela River Locks and Dams 2, 3, and 4 (also known as Braddock, Elizabeth, and Charleroi, respectively) with two modern, high-capacity locks and dams, as authorized in the Water Resources Development Act (WRDA) of 1992 (P.L. 102-580). All existing structures were classified as "critically near failure," with the dam at Elizabeth classified as an "active failure." The project should be completed in 2023.

In addition to the physical condition and lack of reliability of the Monongahela River Locks, the chambers were designed to handle standard-size barges (175 ft long by 26 ft wide), but the predominant barge type used on the Ohio River is the jumbo barge (195–200 ft long by 35 ft wide). These locks on the Lower Monongahela River experience the highest volume of commercial traffic on the river in terms of both tonnage locked and lockages; further, the pools created by these facilities provide industrial and municipal water and are popular with recreational boaters (*9*).

Funding the System

Barge operators pay a fuel tax of $0.29/gal that is deposited in the Inland Waterways Trust Fund (IWTF). While previous new construction and major rehabilitation projects have typically been funded with 50 percent coming from the IWTF and the remainder coming from general revenues, for fiscal years 2021 through 2031, those projects will be 35 percent funded from the IWTF and 65 percent from general revenues.

There are 18 lock and dam projects on the inland waterway system already approved by Congress that would effectively modernize the entire inland waterways system for the next 20 years. For the Upper Ohio River, an estimated $1.8 billion is required to replace undersized and aging lock chambers at the EDM Locks and Dams. The Lower Monongahela (Lower Mon) Project (Locks and Dams 2, 3, and 4), which

encountered dramatic cost escalation and schedule delays, is funded to completion of construction. The lock will be operational in 2022 and completed in 2023. Inadequate funding forced USACE to complete the project one component at a time as funding allowed (*10*). The original estimate for this project in 1992 was $554 million. The latest published estimate (2020) for a scaled-down version of the project is $1.2 billion, which includes only one lock chamber and no railroad modification. (*11*).

Challenges

Several trends and developing issues that may become obstacles to the further development of industry that depends on the waterways should be factored into the strategic plans for the Port of Pittsburgh. These items include the following:

- **Market trends for coal.** A significant drop in waterborne coal shipments has occurred over the last 15 years; as a result, total tonnage has been trending down (significantly) for the Port of Pittsburgh. The United States produced 756 million tons of coal in 2018, 705 million tons in 2019, and is projected to produce 510 million tons in 2020, with a slight rebound to 536 million tons in 2021 (*12*). A decade ago, the total exceeded one billion tons per year (*13*). The decline can be attributed to multiple factors including no load growth, low natural gas prices, and growth in subsidized renewables. Without growth in demand, natural gas and renewables reduced the role for coal. Strong exports of coal partially offset the market decline in some of the years.
- **Barge surplus**. As of April 2018, an oversupply of barges existed—about 2,000 barges (*14*)—that was expected to last for at least five years (*15*). The fleet size is expected to shrink in the coming years.
- **Construction schedule for USACE.** Appropriations for inland waterway modernization projects have increased significantly since fiscal year 2015. Despite this funding improvement, a persistent shortfall in funding exists for lock and dam projects. If the shortfall in funding is not addressed, both current and future projects will suffer significant construction delays and cost escalations. More than 15 authorized, high-priority inland projects are awaiting construction funding. With no policy improvements, only about $230-$240 million per year will be available for inland waterways project modernization. At this funding level, too many of these projects will not even begin construction in the next 20 years, an outcome considered by users, operators, and shippers to be unacceptable. New construction and major rehabilitation projects are typically initially authorized with a 50/50 cost share—50 percent appropriations from the general treasury and 50 percent from the IWTF---but are actually constructed over time with more than 50% of the cost coming from the general treasury. Maintaining a 50/50 cost-share arrangement would allow only nine projects to be funded to completion in 20 years (*16*). Waterway industry proponents have argued that changing the cost share formula to 75% general revenue/25% IWTF would allow 13 projects to be funded to completion within 10 years and allow all the top 25 priority projects to be finished in 20 years (*17*). Congress took a middle-ground approach and included a provision in the 2020 Water Resources Development Act (WRDA 2020) to change the cost-share to 65% general revenues/35% IWTF. WRDA 2020 and the 65/35 cost-share language was part of H.R. 133, Consolidated Appropriations Act, 2021, that was approved by Congress and signed into law by the President on December 27, 2020.
- **Zoning issues**. Pittsburgh, as is the case in many U.S. cities, was established on a waterway—specifically, at the confluence of two rivers that form the Ohio River. The success of the port community has enabled the city to grow, resulting in a situation in which the port is now surrounded by non-port interests and activities. Many developers view the riverfront as an ideal location to develop businesses, residences, and recreational assets that will enhance the quality

of life for area residents. Although this is a good development for the community, at times the need to maintain commerce and provide an area for river-dependent industries to operate has been lost in planning activities—often inadvertently. Pittsburgh has not been immune to these situations.

- **Problems with benefit-cost analysis (BCA) methodology**. USACE is required to calculate a benefit-cost ratio (BCR) for all major rehabilitations and new construction projects. In simple terms, this is the ratio of the benefits the project offers to the cost of the project. This process is known as BCA. The current methodology focuses almost exclusively on transportation cost savings made possible by inland navigation in comparison to trucking or rail transportation. USACE recognizes that other benefits and uses are derived from the navigation system, such as hydropower, recreational boating, riverfront development, and water supply; however, USACE does not consider these benefits for funding determinations. As one report indicated, "BCA should consider the costs and benefits to society, not just the difference in transportation costs. When the public invests money in a project, it should benefit society to the greatest degree possible" (*18*).
- **Trade war**. In a poll conducted by Reuters, approximately 80 percent of the more than 60 economists who responded said they expect the U.S.-China trade fight to either worsen or stay the same throughout 2020. No historical precedent with which to compare this situation exists (*19*). The recent tariff increases are unprecedented in the post-World War II era. Their breadth, magnitude, and the sizes of the countries involved have never been seen before (*20*). Trade statistics show that Pennsylvania has been affected by the dispute with China. The percentage change in the state's exports to China for all merchandise dropped 9 percent year-to-date (YTD) (YTD September 2019 from YTD September 2018) (*21*).

Opportunities

Trends are taking place that may affect the volume and/or types of commodities handled on area waterways. Opportunities exist for the Pittsburgh industrial community to increase its traffic and expand the types of commodities handled in the following sectors:

- **Energy.**
  - **Fossil fuel demand.** Energy companies are important components of the Pittsburgh industrial complex. According to the International Energy Agency (IEA), fossil fuel will continue to play an important role in the decades to come. Fossil fuels are projected to account for almost 70 percent of world energy consumption through 2050. Natural gas is expected to be the fastest-growing fossil fuel, while coal is the world's slowest-growing energy source. After declining through 2030, the demand for coal is expected to flatten out and then increase slightly through 2050 (*22*). These trends vary by country. On another front, the IEA estimates that the United States will account for 70 percent of the increase in global petrochemical capacity through 2024—adding a total of 4 Mbd, with net exports reaching 9 Mbd (*23*). Chemical demand growth will outpace the growth in gross domestic product (GDP) through 2025. Global liquids demand will grow roughly 30 percent by 2040 (*24*).
  - **Fracking industry and industrial development**. Up to 95 percent of new wells drilled today are developed using hydraulic fracturing (fracking) (*25*). Pennsylvania has one of the larger shale plays[4] in the United States.

[4] A play is a geographic area that possesses oil and/or gas in sufficient quantity to make development economically viable.

Shell's Ethane Cracker

- Largest private investment in the history of Pennsylvania.
- Expected to produce 3.2 billion pounds of plastic pellets.
- Up to 6,000 estimated jobs at peak construction.
- 600 jobs once operational.
- First major U.S. project of its type built outside Gulf Coast region in 20 years.
- Approximately 1200 acres, when assembled.
- 30 miles from downtown Pittsburgh.
- 15 miles from Pittsburgh International Airport.

Source: Shell Says Yes to Greater Pittsburgh Region, https://www.pittsburghregion.org/shell/

The region could support up to four more crackers.

- **Natural gas production**. It is interesting to note how the shale plays in Pennsylvania differ from those in the Permian Basin in west Texas. The wells in the Permian Basin are drilled because of the oil they produce—gas is a byproduct of the drilling effort. In Pennsylvania's Marcellus and Utica Shale Plays, gas is the principal product. At the time of this report, activity in the Permian Basin had diminished significantly because of the low price of oil. The associated gas that would ordinarily be produced is shut in. The Marcellus and Utica Shale Plays can supply the gas that would have ordinarily come from the Permian Basin. Predictions estimate the natural gas from the Marcellus and Utica Shale Plays will account for more than 40 percent of the nation's natural gas production by 2030. The Appalachian region is now the third-largest natural gas-producing region in the world, trailing only "all of the U.S." and Russia (*26*). Pennsylvania is now a net energy exporter rather than an importer (*27*). Natural gas is a critical feedstock in the manufacture of many chemicals that are subsequently moved by both barge and rail (*28*). Furthermore, the abundance of gas in the region has contributed to a 41 percent drop in wholesale electricity prices since 2008, and natural gas prices for end-users are down by 56 percent, which makes the state more attractive to potential new business (*27*).[5] Prices continue to be volatile but have trended downward.
- **Petrochemicals**. The world's largest petrochemical facilities (e.g., Houston and Rotterdam) are located on the waterfront and use the water extensively to move products between facilities in the manufacturing process. Pittsburgh, which is also on the waterfront, is the largest metro area atop the Marcellus and Utica Shale Plays and stands to profit from its location within the production area. An IHS Markit report listed 12 primary-use sectors that could benefit significantly from the development of Pennsylvania's petrochemical value chain (*29*). They are an exceptional opportunity for regional development in southwestern Pennsylvania.

- **Water Resources Development Act (WRDA) provisions.**
  - **Water Resources Reform and Development Act (WRRDA) 2014**. WRRDA 2014 authorized many of the project delivery recommendations made by the Inland Waterways User Board (IWUB) and increased the threshold size of a rehabilitation project authorized to be cost-shared by the IWTF to $20 million plus an annual inflation amount. One of the most widely heralded provisions of the act was the reduction of the IWTF portion of the cost-sharing requirement for the Olmsted Locks and Dam Project from 50 percent to 15 percent (*30*).[6] Together with another provision enacted in 2014 to increase the inland waterway diesel fuel tax by 45%, this provision expedited

[5] Fourteen natural gas power plants have been built from the ground up, and six more have been retrofitted from coal to natural gas.

[6] Up to this point, the Olmsted Project had been requiring a large portion of IWTF balances.

completion of the Olmsted project by four years, saving $330 million (*31*), and allowed a much larger amount of IWTF funds to be spent on other projects. WRRDA 2014 encouraged completion of USACE studies within three years, limited study costs, and established new procedures intended to expedite USACE completion of environmental compliance requirements, including the National Environmental Policy Act (NEPA).

- **WRDA 2018**. WRDA 2018 contained one provision that was of enormous importance to the Port of Pittsburgh and the nearby Pennsylvania/West Virginia/Ohio region in the vicinity of the port in southwest Pennsylvania: Section 1401(1) authorized construction of the Upper Ohio Navigation Project in southwest Pennsylvania. Three additional provisions are noteworthy:
  - Section 1103 requires USACE to enter into an agreement with the National Academy of Sciences to carry out a study on the economic principles and analytical methodologies used by USACE for BCA and make recommendations on potential changes.
  - Section 1137 reauthorizes and increases the number of projects eligible for a pilot program that allows the Secretary to provide a non-Federal interest full project management control over a water resources development project, pursuant to section 1043 of WRRDA 2014.
  - Section 1204 requires the Comptroller General of the United States to conduct a study on benefit-cost procedures used by USACE and OMB to include an examination of the benefits and costs that each entity does or does not include. The study should provide recommendations for legislative and regulatory changes.

  Neither of the studies authorized in Sections 1103 and 1204 have been implemented to date.
- **WRDA 2020.** Congress has changed the cost share applicable to the construction and major rehabilitation of inland waterway modernization projects to 65% general revenue/35% IWTF.

- **Achieving a Better Life Experience (ABLE) Act/Tax Increase Prevention Act of 2014**. This legislation enacted one of the most widely heralded legislative accomplishments in 2014—an increase in the fuel tax from $0.20 to $0.29 per gallon. According to an analysis published by Waterways Council Inc. (WCI), the increase in the fuel tax will allow USACE to build out five projects and bring them online by 2024 versus the much later projections in place before these changes were made in funding and policy.
- **Energy and Water Development Appropriations**. The Energy and Water Development Appropriations bill for FY 2021 (P.L. 116-260) adjusted the cost share to a 65/35 federal/nonfederal split for all Inland Waterway Trust Fund (IWTF) projects. This cost share will now change the cost share for all projects for FY 2021-2031. This change will enable the acceleration of several high priority lock and dam projects.
- **Infrastructure construction legislation**. Despite ambitious statements about enacting major infrastructure funding legislation during the 116th Congress, agreement was not reached on the matter between the President and Congress before the 116th Congress adjourned sine die. Significant efforts to complete action on this important legislation have been promised for the new Congress that convenes in January of 2021.
- **Improvements in marine transportation operations.**
  - **Improved emissions**. The PPC has been actively involved in researching and developing design and technology improvements that will reduce towboat emissions. The port participated in a study that was funded by a grant from local foundations to Clean Fuels

Clean Rivers (CFCR), the western coalition of Pittsburgh Clean Cities, in 2015. The study recommended that the Coast Guard (a) create a more appropriate ruleset for smaller vessels with smaller fuel capacity that operate in a restricted geographic region, (b) allow for acceptance of cross-industry standards, and (c) revisit the classification of "Major Modifications" (*32*). There are also engine manufacturers actively marketing electric propulsion systems. Perhaps the biggest potential for efficiency changes in the inland towing sector is in the quality of barge construction and the energy efficiency of towboats.

- **Automation of locks and dams.** Automation of facilities that still serve authorized navigational needs may reduce operations costs and stretch the USACE O&M budget further. USACE is currently working on a design to enable remote operations at the Grays Landing Lock and Dam on the Upper Monongahela River. Additionally, USACE is conducting a study to establish remote operations for all locks on the Ohio River and its tributaries. Accelerating this effort will benefit Pittsburgh area waterway users.

- **Commodity mix**.
  - **Types of coal.** Two types of coal are moved in barges. Steam coal is coal that is used in power plants and other industrial applications. Despite the declines, considerable volumes of steam coal continue to move in the area. Metallurgical coal (met coal) is used to make coke. Coke is used as a fuel and reactant in the blast furnace process for primary steelmaking. As discussed below, the largest coke plant in the U.S. is U.S. Steel's Clairton works on the lower Monongahela River. At full capacity, it uses almost six million tons per year, all of which is barged to the Clairton works.
  - **New markets.** The decreased reliance on coal is causing barge operators to right-size their fleets dedicated to coal and to develop fleets appropriate to the new markets related to the growth in the petrochemical industry. One point of view is that "the decline of coal traffic can affect other commodities, as it could mean more empty backhaul movements of barges on the waterway, reducing overall efficiency. USACE data indicate that the ratio of empty barges to loaded barges moving on the Ohio River has increased from about 50% in the early 2000s to 60% to 65% over the last five years, while the average size of tows passing through the three locks proposed for enlargement has decreased by more than one and a half barges" (*33*). However, empty backhauls also provide the opportunity for very price-competitive shipments. Whether these backhauls remain empty and decrease efficiency or attract cargo and thereby promote the competitive position of the waterways remains to be seen.

CHAPTER 1: THE IMPORTANCE OF THE WATERWAYS IN THE PITTSBURGH AREA

Introduction to the Port of Pittsburgh

The Pittsburgh Port District consists of 200 miles of commercially navigable waterways in southwestern Pennsylvania. These waterways extend throughout a 9-county area[7] and include three major rivers: the Allegheny, the Monongahela, and the Ohio. Three additional counties are also part of the district—Blair, Indiana, and Lawrence. There are 203 river terminals and barge industry service suppliers based on these rivers that depend on the safe and stable operation of the Port of Pittsburgh for their economic success.

Figure 3 illustrates the Pittsburgh Port District, which is defined as the navigable rivers within southwestern Pennsylvania: Ohio River to milepost 40 (Pennsylvania/Ohio border), Monongahela River to milepost 91.5 (Pennsylvania/West Virginia border), and Allegheny River to milepost 69.5 (head of navigation). The political boundary of the port district includes 11 contiguous counties plus Blair County, nine of which border on a portion of a navigable river.

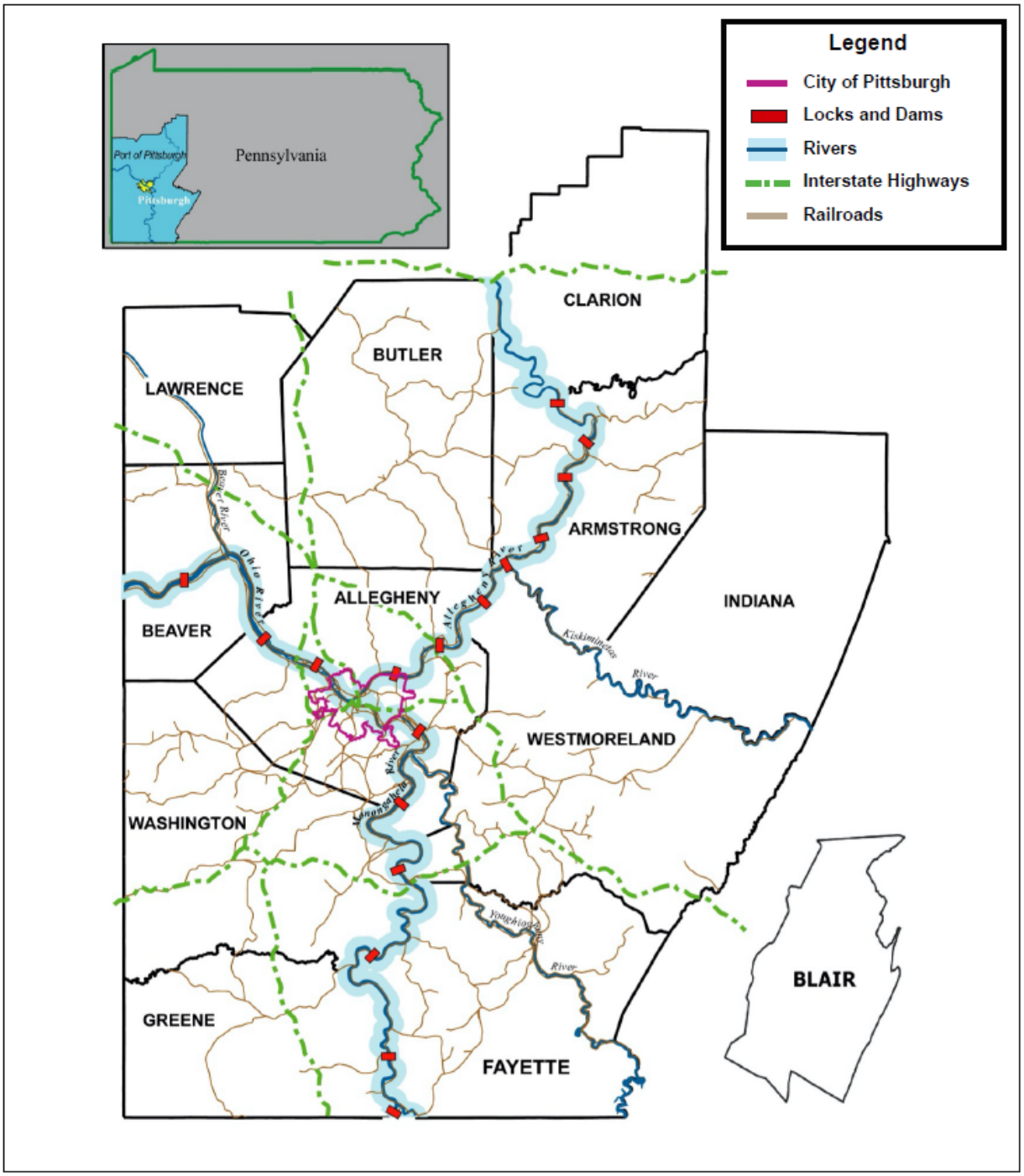
It is important to note that the Port of Pittsburgh's influence extends beyond these boundaries. The Upper Monongahela River in West Virginia and Pittsburgh industries depend on the Port of Pittsburgh's waterways to connect to markets both within the region and along the entire inland waterway system.

The Port of Pittsburgh's influence extends beyond its political boundaries.

The maintenance of the navigable river channel and routine lock maintenance are the responsibility of the USACE Pittsburgh District. Figure 4 shows the Pittsburgh District, which encompasses the entire Ohio River drainage basin above New Martinsville, West Virginia, and includes areas of Ohio, West Virginia, Maryland, and New York. On the Ohio River, the engineering district extends to the Hannibal Lock and Dam, and on the Monongahela River, it extends to the Opekiska Lock and Dam and beyond, including the upper tributaries of the Monongahela River and terminating at Stonewall Jackson Lake. Northward, the engineering district reaches to the headwaters of the Allegheny River in Coudersport, Pennsylvania, where it flows northwest into New York and then turns southwest back into Pennsylvania.

The maintenance of the navigable river channel and routine lock maintenance are 100 percent funded by the federal government. As for major construction or rehabilitation, with the passage of the Water Resources Development Act of 2020 (WRDA 2020), the cost share for major construction will shift to 65/35, with the majority coming from the general treasury, and the remaining 35 percent coming from the Inland Waterways Trust Fund (IWTF). New lock construction appropriations from the IWTF are funded by a tax of $0.29/gal on diesel fuel purchased by barge operators. Funding issues are described and explored in Chapter 2.

[7] Counties are Allegheny, Armstrong, Beaver, Butler, Clarion, Fayette, Greene, Washington, and Westmoreland Counties.



Source: PPC

Figure 3. Port of Pittsburgh Commission District.

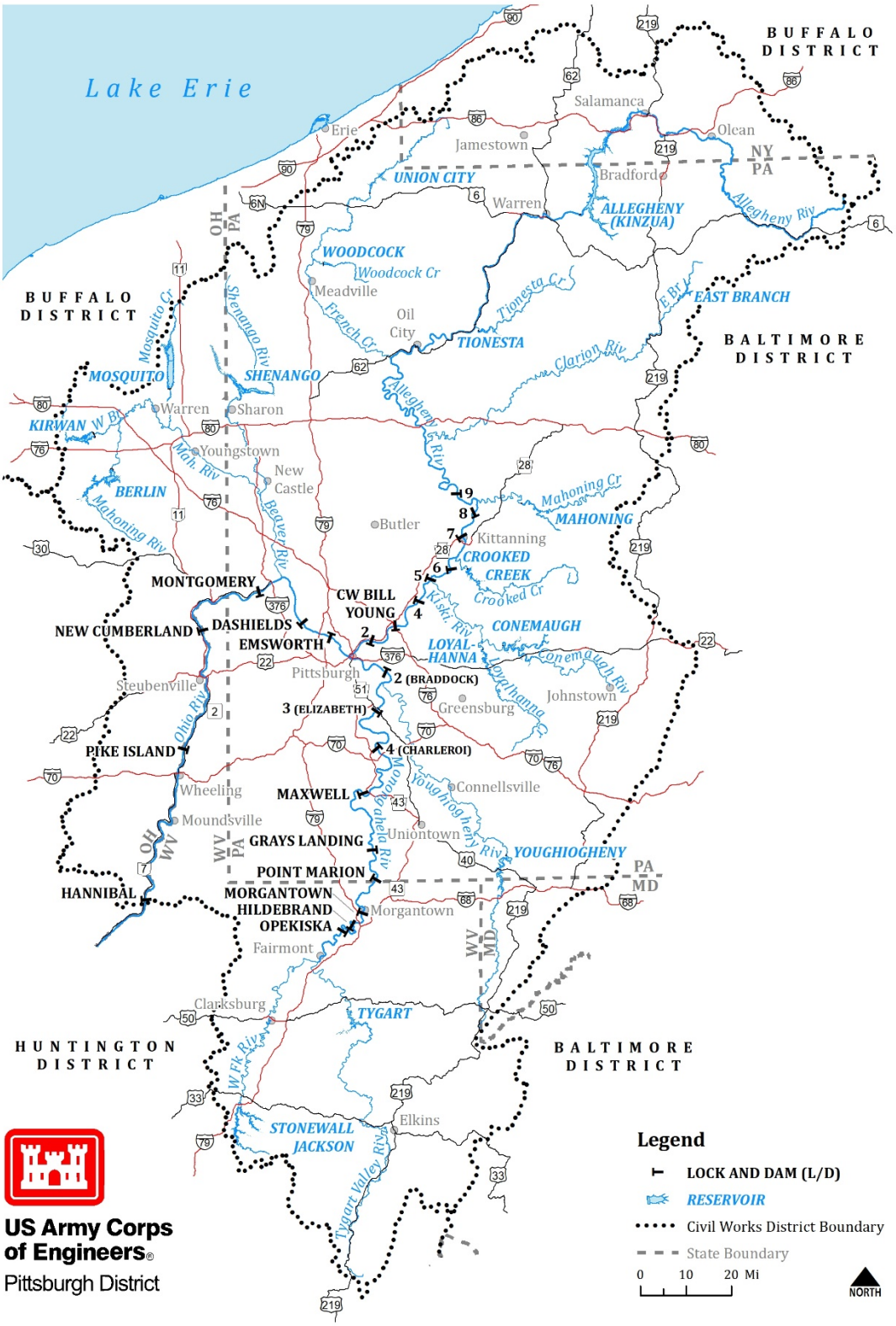


Figure 4. U.S. Army Corps of Engineers Pittsburgh District Boundaries.

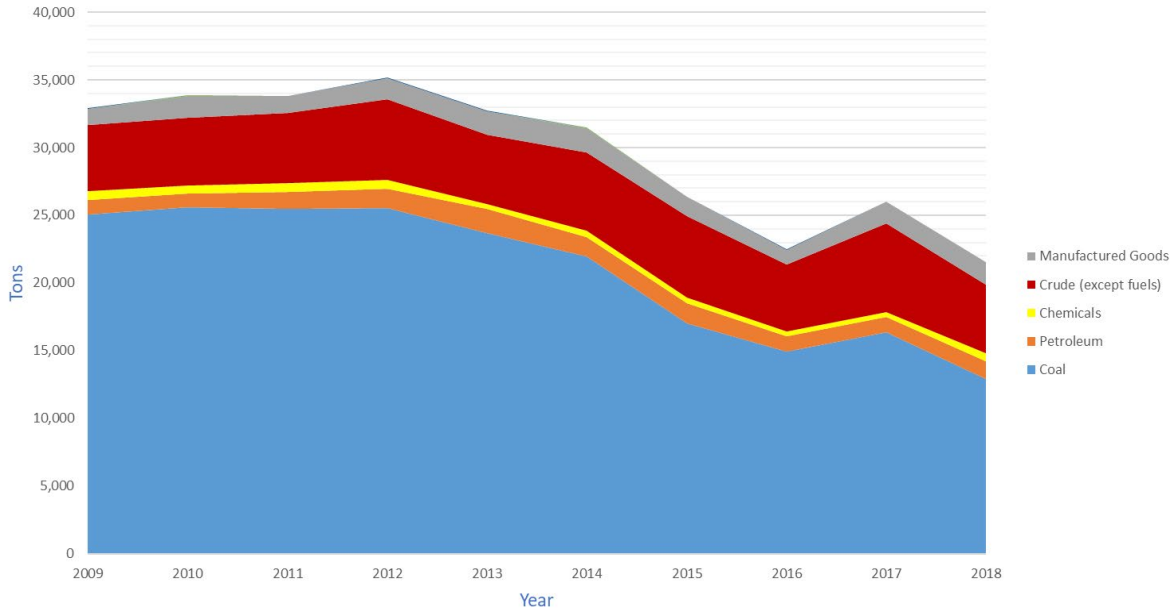
The Port of Pittsburgh is fourth in tonnage among the nation's inland waterways ports; it is the 33rd busiest port among all U.S. coastal and inland ports as a group. Over the last 10 years, an average of 30 million tons of freight passed through the Port of Pittsburgh annually, 70 percent of which was coal. For many years now, the Pittsburgh region's main export by weight has been coal (*1*).[8] According to the Pennsylvania Comprehensive Freight Movement Plan published in 2016, mines in Greene County are among the largest suppliers of North American coal to China (*2*).

Although coal is the dominant commodity, there are other very important commodities shipped via the rivers in the area. These commodities include "sand and gravel, … scrap, non-ferrous ores, road salt, jet fuel, gasoline, kerosene, fuel oils, asphalt, solvents, fertilizers, cement, … lime, glass, and iron and steel products. … Inbound and locally mined coal is used for electrical power generation; locally mined coal is also shipped out to be blended with coal from other sources; metallurgical coal is used in the production of coke for steel-making; building and construction materials are produced locally using sand and gravel, lime, gypsum, and asphalt; jet fuel arrives by barge for use at the Pittsburgh International Airport; plastics manufacturing is supported by petrochemicals shipped by barge; specialty steel products manufacturing benefits by being able to bring in basic steel materials and ship finished products out all by barge; and finally, Southwestern Pennsylvania's aggressive winter weather can always [be] dealt with in timely fashion due to plentiful road salt that can be procured less expensively by municipalities with restrictive financial resources" (*34*).

Because the cargoes moving through Pittsburgh are not agricultural in nature, severe seasonal peaks and troughs do not exist, thereby providing a fairly constant level of activity throughout the year.

Figure 5 shows the tonnages that moved through the Port of Pittsburgh over a 10-year period, as reported by the Waterborne Commerce Statistics Center (WCSC) (*1*). The figure reveals that there is significant capacity available on the waterways that can be an advantage to industries that might want to locate in the area. The barge industry has successfully managed greater volumes in the past.

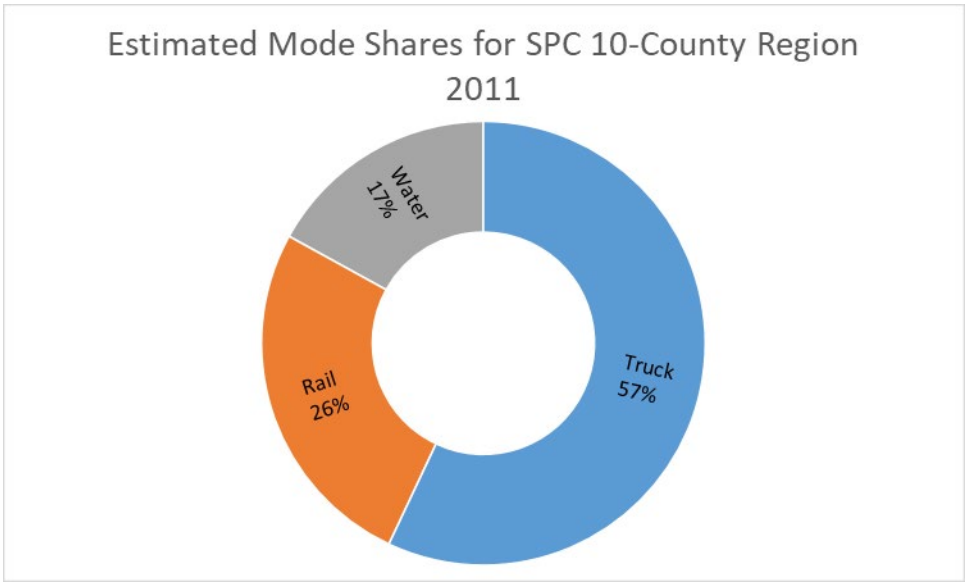
[8] The category of "Coal" includes two types of coal—steam coal and metallurgical coal. Unfortunately, the publicly available waterborne commerce statistics do not provide any detail below the level of coal.



Source: (1)

Figure 5. Port of Pittsburgh Commodity Tonnages, 2009–2018 (000s).

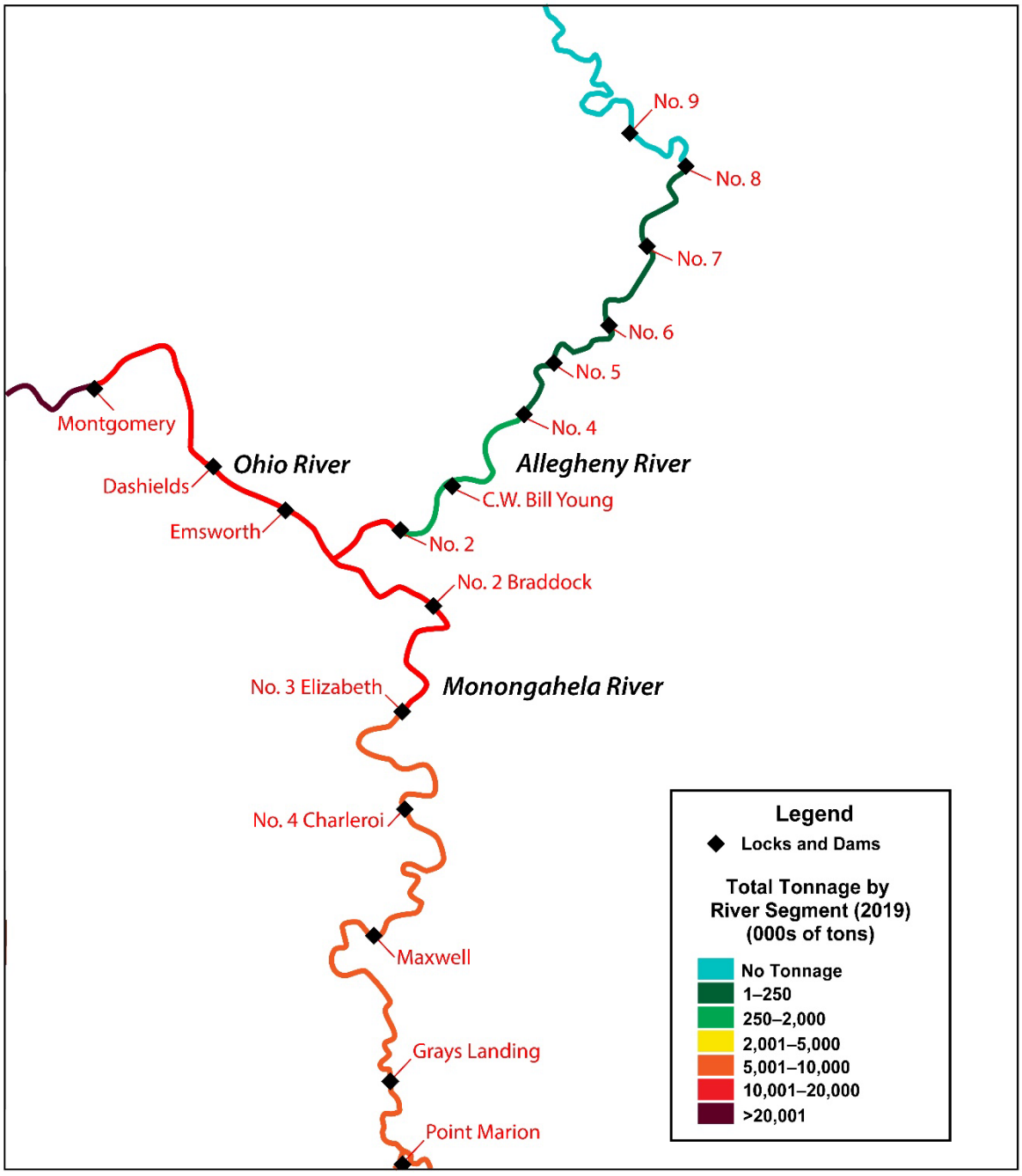
The Southwestern Pennsylvania Commission (SPC) published the Southwestern Pennsylvania Regional Freight Plan 2011. In that plan, SPC reported that the modal share of freight tonnage in the 10-county region it serves was as shown in Figure 6.



Source: (*35*)

Figure 6. Estimated Mode Shares for the Southwest Pennsylvania Commission 10-County Region.

The distribution of traffic on the rivers as of 2019 is shown in Figure 7.



Source: (36)

Figure 7. Waterways Freight Flows Based on Total Tonnage by River Segment.

The Waterways Council has published reports that indicate a value of $15 billion for the region's inland waterway cargo in 2016 (*37*). Table 1 lists some of the more widely recognized companies that ship on the waterways.

Table 1. Shippers Using Pittsburgh Waterways.

- Acme Metals
- All Metals Recycling
- Almatis, Inc.
- Alumisource
- American Consolidated Natural Resources (formerly Murray Energy)
- American Bridge Manufacturing
- American Steel Processing
- ArcelorMittal
- Arrow Material Services
- Asbury Graphite Mills
- Blank River Services
- Bryan Materials Group
- Buckeye Terminals
- Butler County Concrete & Supply
- Calgon Carbon Corporation
- Camelot Coal Company
- Cargill
- Cemex Co.
- Chess Coal Co.
- CONSOL Energy
- Alpha Metallurgical Resources, Inc.
- Dyno Nobel
- Eastman Chemical Co.
- FirstEnergy, Penn Power Co.
- Georgetown Sand & Gravel
- Greer Industries, Inc.
- Hanson
- Harsco Metals
- Heartland Fabrication
- Henwil Corporation
- Industry Terminals
- INEOS Composites Neville Island Plant
- Interstate Chemical Co.
- Kinder Morgan, Arrow Terminals
- Lane Construction
- Lindy Asphalt
- Lindy Paving
- Marathon Ashland Petroleum,
- Metals USA Plates & Shapes
- Mineral Processing Specialties, Inc.
- Mobil Oil
- Neville Aggregates
- Norfolk Southern Corp.
- Northeast Paving
- Nova Chemicals
- Petroleum Products Corporation
- R.I. Lampus
- Reliant Energy
- Shell Corporation
- Sippel Steel Fab
- Source One Transportation
- Stone & Co.
- Sunoco Logistics
- Triad Metals International
- U.S. Gypsum
- Union Railroad Co.
- United Refining Company Asphalt
- United States Gypsum Co.
- Univar
- United States Steel
- Valvoline
- Watco Terminal and Port Services
- West Penn Aggregates

Source: PPC

There are 37 companies with towboats that operate in the greater Pittsburgh area (*38*). Barge lines operating in the Port of Pittsburgh include:

- American Commercial Barge Lines
- Borghese Lane, LLC
- Campbell Transportation Company
- Canal Barge Company
- Crounse Corporation
- Grandview Barge Line
- Imperial River Transport
- Ingram Barge
- Marquette Transportation Company

- MG Transport
- American Consolidated Natural Resources (*formerly Murray American Transport*)
- River Salvage Company
- RJ Brown Towing
- Tow-Line River Services, Inc.

Major terminals located on the three rivers include:

- Aliquippa Terminals
- Allegheny River Terminal
- Armstrong Terminal
- BeeMac Port Services
- Colona Transfer
- Freeport Terminal
- Gordon Terminal Service
- Gulf Materials
- Industry Terminal and Salvage Co
- McGrew Welding
- McKees Rocks Industrial Enterprises
- Mol-Dok
- Pittsburgh Intermodal Terminal
- Riverlift Industries
- S.H. Bell
- Three Rivers Marine & Rail Terminals

Importance to Local Industry

The area waterways provide transportation cost advantages that incentivize the shipment of 30 million tons of cargo each year.[9] Most notably, shipping costs for raw materials average 0.97 cents per ton-mile by barge compared to 2.53 cents per ton-mile by rail or 5.35 cents per ton-mile by truck (*39*). Table 2 illustrates the economic advantage of being able to use the waterways. When USACE conducted the Upper Ohio Navigation System Study (revised version released in October 2016), it estimated the difference in the water rates for the standard commodity groups tracked by the WCSC versus the all-land rate (*40*). Table 2 presents the savings for shipments for certain waterborne commodity movements that were routed wholly or in part on the Upper Ohio River (the Emsworth, Montgomery, and Dashields Locks). Although this does not include movements that stayed within the region, it provides insight into the importance of the waterways in controlling transportation costs.

The primary cargo in the Port of Pittsburgh is coal, but millions of tons of other raw products are moved on area waterways, as described earlier. Thousands of jobs depend on the reliable and efficient functioning of these river supply lines.

[9] 10-yr average: 2009–2018.

Table 2. Transportation Savings Generated by Waterborne Transportation in the Upper Ohio River Region.

Group	Commodities	Average $ Per Ton*		
		Water Rate	All-Land Rate	Savings
1	Coal	18.65	24.03	5.37
2	Petroleum Fuel Products	16.87	54.51	37.64
3	Aggregates**	8.46	15.56	7.10
4	Food and Processed Food Products***	23.74	52.27	28.53
5	Chemicals and Related Products	40.48	94.90	54.42
6	Non-Metallic Minerals**	33.08	49.47	16.39
7	Ferrous Ores, Iron & Steel***	37.67	69.96	32.29
8	Manufactured Goods****	20.52	55.15	34.63
AVERAGE ALL COMMODITIES		**18.88**	**28.75**	**9.87**

**All rates and rate differentials are weighted averages based on commodity distributions for the Upper Ohio River (Emsworth, Montgomery, and Dashields Locks).*

***These are both included in the category of crude materials in Figure 5.*

****This category is negligible for the Port of Pittsburgh and does not appear in Figure 5.*

*****Iron and steel are the primary components of primary manufactured goods in Figure 5.*

Source: USACE (40).

Guttman Energy, a major distributor of distillates and gasoline, informed the researchers that if the rivers were to shut down, the company would be forced to acquire hundreds of new trucks and hundreds of new drivers—something which is not feasible. On top of these expenditures, the company would pay far more for the actual transportation than it pays today.

An example of the port's importance to the coal industry is the Cumberland Mine in Greene County, Pennsylvania. In 2019, 6.1 million tons were shipped from Cumberland by water—accounting for almost 99 percent of the waterborne coal shipments from Pennsylvania mines. The buyers of Cumberland coal are spread over a large geographic area. Table 3 lists the primary destinations of Cumberland Mine shipments (*3*).

Table 3. Ultimate Destinations of Shipments from Cumberland Mine—2019.

State	Plant
Kentucky	Duke Energy—East Bend
	Kentucky Utilities Co.—Ghent
	East Kentucky Power Coop—H. L. Spurlock
Ohio	Cardinal Operating Company—Cardinal
	Ohio Valley Electric Corp.—Kyger Creek
	Vistra Energy—Miami Fort
	Dynegy—W.H. Zimmer
Pennsylvania	GenOn Power Midwest—Cheswick Power Plant
	RRI Energy Services—Conemaugh Fuels LLC
	NRG—Homer City Generating Station
	RRI Energy Services—Keystone Fuels LLC
West Virginia	Duke Energy Florida—Ceredo
	Monongahela Power Co—FirstEnergy Fort Martin Power Station
	Longview Power—Longview Power Plant
	Appalachian Power Co—Mountaineer

Source: (3).

The complex ships the mined coal by barge directly or by rail via the Labelle Dock where the rail cars are loaded for delivery to plants which receive coal by rail.

The Fort Martin Power Plant at the Pennsylvania/West Virginia border relies on barge delivery. Coal originates on either the Monongahela River or the Ohio River. In 2019, a large portion (roughly half) of its coal came from the Cumberland Mine[10] on the Monongahela River at a location just below the Grays Landing Lock and Dam (*3*). This plant also depends on the river for cooling tower needs and the shipment of coal combustion ash for disposal.

The steel industry depends heavily on waterways and connects to many of the other regions of the country by using them. One salient example is U.S. Steel's Clairton Plant on the Lower Monongahela River, which alone receives approximately 5 million tons of metallurgical coal by barge annually. This plant is the largest coking facility in the country. It is 100 percent dependent on barges to deliver coal to the facility (*41*). Figure 8 is a photograph of the U.S. Steel waterfront facility.

[10]Alpha Metallurgical Resources, Inc., the owner of the Cumberland mine, has announced plans to either sell the mine or close it by the end of 2022. If the mine closes and Fort Martin and Longview continue to operate, the source of the coal would either come from the Ohio River or from a rail-served mine that moves the coal to a transloading facility on the Monongahela River, such as the Alicia Dock.

Figure 8. U.S. Steel Waterfront Facility.

Economic Impact

Two recent estimates of the economic impact of the Port of Pittsburgh were developed using two different approaches. One was produced by Cambridge Systematics for the National Waterways Foundation (NWF); the other was produced as part of this report. The NWF approach is a "broad brush" approach that essentially includes business establishments that handle any commodity categorized as waterways-dependent, even though a given business may not use the waterways. For example, a steel processor located 5 miles from the water that used truck and rail for its shipments could be included because it is in the commission boundaries and is labeled as part of a waterways-dependent industry. The data sources are primarily federal government data that are typically reported at a county- or census-block level. This approach results in upper boundary results for economic impact. The analysis calculated the total economic impact of all industries classified as waterways-dependent in the Port of Pittsburgh region.

In the case of the analysis performed for this report, the findings are limited to what can be definitively proven to be related to shipments on the waterways; thus, they primarily represent numbers that are lower boundary. What follows is a summary of the economic impact analysis for this report. Appendix B is the detailed report.

The research team determined the economic impact of the Port of Pittsburgh using IMPLAN, an input/output (I/O) model. An I/O model provides reliable estimates of the economic impacts of goods moving along the three rivers in the region, as well as estimates the impact of businesses that have located in the area due to the port. The analysis results in the total economic impact of the goods moving via water in the Port of Pittsburgh region. Additionally, the team assessed scenarios related to future growth in the region.

In order to run the model, employment statistics were taken from the Pittsburgh Prospector Business Database, which is supported by the Pittsburgh Regional Alliance. The Alliance provided a low and high number for each employment category. Additionally, waterborne commodity shipment data were acquired from USACE. The prices of these commodities were taken from a variety of sources.

Using the upper end of the ranges provided by the Prospector Database, the following model produced the economic impact results for the waterway system, as shown in Table 4.

Table 4. Summary Economic Impacts.

Category	Impact (Millions 2020$)
Employment	**15,181 jobs**
Labor Income	$1,092
Value Added	$2,435
Business Output	$5,048
Federal Taxes	$ 242
State/Local Taxes	$ 166

The upper boundary calculated by the NWF analysis resulted in employment of 76,500, labor income of $5.5 billion, and state and local tax revenues of $1.1 billion.

To see how sensitive the model is to fluctuations in business activity, the researchers looked at two different scenarios. The first scenario was a 5 percent increase in economic activity. Table 5 provides the incremental results—results that can be expected in addition to the results shown in Table 4.

Table 5. Incremental Effects of 5 Percent Increase in Economic Activity.

Category	Impact (Millions 2020$)
Employment	**704 jobs**
Labor Income	$ 52
Value Added	$118
Business Output	$249
Federal Taxes	$ 12
State/Local Taxes	$ 8

The second scenario looks at how an increase in one particular commodity—metallurgical coal—can affect the results. A 5 percent increase in metallurgical coal would create the incremental results shown in Table 6—results that can be expected in addition to the results shown in Table 4.

Table 6. Incremental Effects of 5 Percent Increase in Met Coal Shipments.

Category	Impact (Millions 2020$)
Employment	**193 jobs**
Labor Income	$15
Value Added	$34
Business Output	$60
Federal Taxes	$ 3
State/Local Taxes	$ 3

Importance to the Nation

The Port of Pittsburgh is linked to—and is a vital part of—the nation's inland waterways system. As noted earlier, there are very important mines, steel works, and power plants that use the waterways for shipping, cooling, material processing, and/or waste management. Many of these facilities are successful only because they have been able to access and utilize the rivers. Although the different industries use the rivers in different ways, the rivers are a critical resource for all of them. These entities are important parts of the overall U.S. economy.

As mentioned in the introduction to this report, the Port of Pittsburgh is fourth in tonnage among the nation's inland waterways ports. The greatest volumes of traffic consist of downbound steam coal produced in the Mon Valley coal fields moving to power plants along the length of the Ohio River, with some moving as far as the Tennessee Valley. Another major flow is metallurgical coal moving upriver from the Kanawha Valley and Big Sandy area coal fields near Huntington, West Virginia, to coke plants in the Pittsburgh area. Coke is a vital ingredient in the production of steel. Steel moves down the Ohio River to distant markets within the U.S. interior and to the Gulf Coast. Steel also moves upriver, much of which is imported steel coming from the Gulf Coast (*40*).

It is important to note that the three rivers in southwest Pennsylvania affect far more than Pennsylvania itself. As noted earlier, coal is shipped by water to large consumers in West Virginia, Ohio, and Kentucky. According to the EIA, in 2019, power plants in Pennsylvania received coal shipments by barge from two counties in Ohio, Greene County in Pennsylvania, and two counties in West Virginia. Shipments from Pennsylvania coal mines are consumed in Pennsylvania, Ohio, Kentucky, and West Virginia.

Table 7 shows how many steel-related facilities are located in Pennsylvania and West Virginia and how many of these facilities are located on a segment of the inland waterway system. This information is derived from state-by-state reports provided by the American Iron and Steel Institute.

Table 7. Pennsylvania and West Virginia Steel Plants.

States on Inland Navigation System	Steel Industry Jobs	Raw Steel Plants	Number on Inland System	Steel Products/ Added Process Plants	Number on Inland System	Other Facilities	Number on Inland System
Pennsylvania	34,124	4	1	13	6	11	5
West Virginia	3,550	1	1	1	1	3	0
TOTAL	37,674	5	2	14	7	14	5

Source: (42, 43).

Table 8 lists the plants that are included in Table 7.

Table 8. Listing of Steel Plants in Pennsylvania and West Virginia.

Firm	City
Pennsylvania	
AK Steel AK Coal Resources Inc.	Friedens
AK Steel Butler Works	Butler
ArcelorMittal North America ArcelorMittal Conshohocken	Conshohocken
ArcelorMittal North America ArcelorMittal Coatesville	Coatesville
ArcelorMittal North America ArcelorMittal Steelton	Steelton
ArcelorMittal North America ArcelorMittal Monessen	Monessen
Deacero, S.A.P.I. de C.V. Distribution Center U.S. Lansdale	Lansdale
Deacero, S.A.P.I. de C.V. Distribution Center U.S. Chambersburg	Chambersburg
Deacero, S.A.P.I. de C.V. Distribution Center U.S. Wayne	Indiana
Harsco Metals & Minerals	Fairless Hills
Harsco Metals & Minerals	Steelton
Harsco Metals & Minerals	Latrobe
Harsco Metals & Minerals	Sarver
Harsco Metals & Minerals	Butler
Harsco Metals & Minerals	Koppel
Harsco Metals & Minerals	Natrona Heights
Harsco Metals & Minerals	Braddock

Firm	City
Pennsylvania (Continued)	
Nucor Corporation Harris Rebar	Bethlehem
Nucor Corporation Skyline Steel	Camp Hill
Nucor Corporation Fisher & Ludlow	Wexford
Nucor Corporation Skyline Steel	Pittsburgh
United States Steel Corporation Mon Valley Works—Fairless Plant	Fairless Hills
United States Steel Corporation Mon Valley Work—Irvin Plant	West Mifflin
United States Steel Corporation Mon Valley Work—Edgar Thomson Plant	Braddock
United States Steel Corporation Headquarters	Pittsburgh
United States Steel Corporation Business Service Center	Pittsburgh
United States Steel Corporation Mon Valley Work—Clairton Plant	Clairton
United States Steel Corporation Research and Technology Center	Munhall
West Virginia	
AK Steel Mountain State Carbon, LLC	Follansbee
ArcelorMittal North America ArcelorMittal Weirton	Weirton
ArcelorMittal North America ArcelorMittal Princeton	Princeton
Harsco Metals & Minerals	Moundsville

Marine Highway

The U.S. Maritime Administration (MARAD) administers the Marine Highway Program. The program was established by Section 1121 of the Energy Independence and Security Act of 2007 to reduce landside congestion through the designation of Marine Highway routes. Section 405 of the Coast Guard and Maritime Transportation Act of 2012 further expanded the scope of the program to increase the utilization and efficiency of domestic freight or passenger transportation on Marine Highway routes between U.S. ports. The National Defense Authorization Act for FY 2016 then expanded the definition of short sea shipping to include freight vehicles carried aboard commuter ferry boats and cargo shipped in discrete units.

The main objective of this program is to expand the use of America's navigable waters. Under the auspices of this program, MARAD works with public and private organizations to (a) develop and expand marine highway service options and facilitate their further integration into the current U.S. surface transportation system; and (b) highlight the benefits of, increase public awareness of, and promote waterways as a viable alternative to landside shipping and transportation options.

MARAD has designated 25 Marine Highway routes that serve as extensions of the surface transportation system. Each all-water route is designated by the U.S. Secretary of Transportation and offers relief to landside corridors suffering from traffic congestion, excessive air emissions, or other environmental challenges. Pittsburgh is on the M-70 Route, which includes the Ohio, Mississippi, and Missouri Rivers and connects commercial navigation channels, ports, and harbors from Pittsburgh to Kansas City. The M-70 Route connects in turn to the M-55 Route, which includes the Mississippi and Illinois Rivers from New Orleans, to St. Louis, to Chicago through Louisiana, Mississippi, Arkansas, Tennessee, Missouri, and Illinois (*4*).e

MARAD periodically publishes a call for projects. The purpose of the calls for project designation is to seek eligible Marine Highway projects that may establish new or enhance existing Marine Highway services. Marine Highway projects must be attached to a Marine Highway corridor designated by the Secretary—thus, the importance of being on a designated marine highway route. Eligible projects may be designated Marine Highway projects by the U.S. Secretary of Transportation. This designation allows the Department of Transportation resources to be used to assist public project sponsors, ports, and other local transportation or economic development agencies in the development of their Marine Highway projects.

Congress has periodically appropriated funds for Marine Highway Program grants that are available to previously designated Marine Highway projects. Eligible projects represent concepts for new services or expansions of existing marine highway services on designated Marine Highway routes that use documented vessels and mitigate land congestion or promote short sea transportation. The first round of Marine Highway grants was in 2010. To date, MARAD has provided more than $40 million in grants for the America's Marine Highway Program.

The Effect on the Nation of Waterways Service Disruptions

There are 17 locks and dams in southwestern Pennsylvania that make navigation possible on the three major rivers—Monongahela, Allegheny, and Ohio.[11] The locks are discussed in detail in the next chapter. Should any of these lock and dam sites fail and cause a shutdown of the river system (especially those on the Ohio and Lower Monongahela Rivers) the effect on the nation's economy will be very noticeable.

[11] There are additional locks on the Monongahela River in West Virginia.

When shippers encounter an unplanned lock outage, they are immediately faced with difficult questions. Some of these include the following (*5*):

- Does the disruption affect more than one lock, and does it affect system operations?
- Is there available and reliable information about the probable closure duration?
- Is some portion of the waterway still useful and, if so, can the usual carrier(s) continue to provide service over open waterway segments?
- How large are existing user commodity inventories and how long will these last?
- What are the costs, characteristics, and availabilities of transportation alternatives?
- What are the potential penalties for delayed commodity delivery?
- Are rivals similarly affected and how will they respond?

As an example, if the Emsworth Lock and Dam structure on the Ohio River[12] fails, two major facilities dependent on river transportation will be impacted—the U.S. Steel Clairton Works (the largest coke plant in the United States) and the largest underground coal mine in the United States, located along the middle reach of the Monongahela River. Disruption in coal supply and transportation would have a negative impact on steel plants and coal-fired electric power plants. Approximately 11,700 jobs would be directly at risk due to loss of navigation and disruption to services and material. The estimated loss in wages alone would range from $1.5 to $2.2 million per day (*44*).

Any closure that affects the flow of coal will have a strong negative effect on the region's economy. An analysis (*45*) of the effects of a potential closure on the Lower Monongahela River revealed that several mines and power plants are dependent on the river and do not have rail capabilities to serve as a backup. Further, an extended outage will most likely cause an unexpected increased demand for rail, which in turn will create shortages in rail capacity and a spike in rail rates. The logistics associated with a mode shift from barge to truck are difficult to accomplish and will most likely not be feasible over the long term. The analysis concluded that there are several infrastructure challenges to moving large volumes by truck: (a) the plants and mines do not have truck off-loading and loading equipment, (b) there is insufficient trucking capacity to meet a sudden increase in demand, and (c) not all the roads and bridges between the mines and power plants have sufficient loadbearing ratings and capacity for this type of movement.

Given all these limiting factors, the private cost of an extended river closure due to catastrophic infrastructure failure at Braddock, Elizabeth, or Charleroi on the Lower Monongahela would be significant, particularly for those mines, power plants, and vessel owners in the near vicinity of the failure zone. The aggregate revenue losses due to the closure of mines and power plants that may not be able to adapt to the loss of navigation are estimated to range from $560 million to $1.7 billion over a yearlong river closure. Additional indirect costs for vessel and barge losses are about $35 million. These costs are comparable in magnitude to USACE's estimated cost for the ongoing and long delayed project to replace that infrastructure (*45*). Furthermore, other significant costs will be incurred by facilities in the affected region that continue to operate despite the lock failure. The lost revenues will be transferred to other power plants and fuel producers as they meet the region's demands, which will not change. The transfer of these revenues will result in a loss to the local economies that depend on and benefit from the closed facilities.

Additionally, a relatively small amount of diverted traffic can have a large impact on a region already experiencing traffic congestion, especially at choke points such as tunnels and bridges. Were one of the

[12] Emsworth is located near the towns of Emsworth, Avalon, and Ben Avon, PA.

three Ohio River locks in the Pittsburgh area[13] to fail, several highways would be heavily impacted by the additional truck traffic that would be generated (*46*).

A recent analysis of an unplanned closure at the Markland Lock (500 miles downstream between eastern Indiana and Kentucky) revealed how important navigation is to Pittsburgh and the nation's economy. The analysis concluded that such a closure will have the following results (*5*):

- Immediately affect commerce in 175 counties in 18 states.
- Cost the shipping public more than $1.3 billion annually in additional transportation charges.
- Disrupt the affordable delivery of electric power throughout the eastern United States.
- Require the availability and use of 40,000 additional rail carloads and 60,000 additional truckloads.
- Discourage 80 percent of users from ever returning to the waterway.

Non-navigation Beneficiaries of the Lock and Dam System

The lock and dam structures provide benefits beyond navigation to a broad array of stakeholders. These benefits include:

The lock and dam system benefits a wide variety of stakeholders in the area—not just navigation.

- **Recreational uses (boaters and recreation facilities).**
    - Typical non-navigation uses include pleasure boating activities, such as motorboating, rowing, kayaking, and canoeing; commercial boating operations, such as excursions, guided tours, and educational programs; and passenger services, such as water taxis and shuttles.
    - High school teams, college teams, and adult leagues all use the navigation pools for rowing (crewing) activities.
    - Allegheny County has led the state in the number of boat registrations for a number of years. Armstrong County residents and the Armstrong Tourist Bureau claim the navigable waterways as their main tourist attraction, and they rely on tourism for economic stability (*8*). Table 9 shows the number of recreational lockages and the number of vessels handled in 2019 on the three major rivers.[14]
    - Pittsburgh's three rivers host the largest inland regatta in the nation, the EQT Three Rivers Regatta.
- **Enhanced quality of life.**
    - Waterfront properties are in demand because of the attractiveness of living close to a body of water. An example is the Southside Works neighborhood development. It advertises that it is "uniquely positioned on Pittsburgh's Monongahela riverfront and nestled in Pittsburgh's historic and bustling Southside neighborhood on the site of the former J&L Steel Works" (*47*). The development includes retailers, restaurants, and fitness and lifestyle shops, in addition to "some of the country's most notable companies and nonprofits" and the SouthSide Flats residential units. Similar projects have been developed or are currently being developed.

[13] EDM.

[14] Note that the locks are only available on designated weekends.
Allegheny: Late May to late September, Allegheny Locks 4 and 5 are open each Saturday and Sunday from 8 a.m. to 8 p.m. with exceptions for holidays and events. Locks 6, 7, 8, and 9 are open each Saturday and Sunday from noon until 8 p.m., except for holidays.
Monongahela—Hildebrand and Opekiska: Mid-May to early October, locks are open from 7 a.m. to 4 p.m.

    - Efforts by the Pittsburgh community to revitalize its downtown waterfront district have been extensive. Should the Emsworth Locks and Dams fail the river level in the downtown area will drop dramatically and exhibit wide variations in water levels depending on rainfall, which will be detrimental to riverfront development.
- **Hydropower generation.**
    - Table 10 lists hydropower plants in the Pittsburgh area with active licenses that are located at locks and dams.
    - The University of Pittsburgh plans to purchase all the power produced by a proposed low-impact hydropower station to be built at Allegheny Lock and Dam No. 2. This station will meet 25 percent of the university's electricity needs and will be the first of eight potential hydropower facilities planned by Rye Development to capture energy from Pittsburgh's three rivers.
- **Municipal and industrial water supply.**
    - The area's abundance of water provides a resource for many industries.
    - Dams create pools that allow for reliable intake of water.
    - Water is critical for the generation and cooling of more than $2.4 billion in electricity from the region's thermoelectric plants.
    - Overall, water is used in a variety of ways for the extraction and production of energy as well as for transporting materials and cleaning the emissions from this activity. Without this abundant supply of water, the region could not sustain the $13.7 billion energy sector (*48*).
    - Table 11 provides a list of greater Pittsburgh water utilities that draw water from the three rivers. Over 1.2 million customers are served by these utilities.
- **Wastewater discharges**.
    - The navigation pools created by the dams are critically important for wastewater discharges, both from industry and municipalities.
- **Congestion and safety impacts.**
    - Barges remove a significant number of truck trips from area highways. Every loaded barge removes anywhere from 48 to 70 trucks from area roadways. The rate of accidents and fatalities per ton-mile[15] is much less for inland barge traffic than for rail or highway traffic; therefore, a reduction in highway miles traveled results in a direct reduction in accidents and fatalities. Specifically, trucks have a fatality rate that is 95 times greater than the rate for inland barges; the rail rate is 26 times greater. The difference in injury rates is even more dramatic—the rate for trucks is 696 times greater, while the rate for rail is 81 times greater (*49*).
- **Reduced environmental impacts.**
    - In every category of emissions, barge transportation compares favorably with rail or truck. The emissions rates for barges range from 10 percent to 22 percent of the rate for trucks, depending on the specific pollutant. When compared to rail, the range is from 73 percent to 75 percent.

[15] Ton-miles are calculated by multiplying the tons being transported by the distance. This is a method frequently used to normalize the measurement of activity involved across modes.

Table 9. Recreational Lockages on the Three Rivers (2019).

River	Lock and Dam	# of Recreational Lockages
Allegheny	2	1,091
	3	916
	4	424
	5	281
	6	129
	7	152
	8	176
	9	145
Monongahela	2	449
	3	391
	4	249
	Grays Landing	271
	Maxwell	581
	Point Marion	168
Ohio	Emsworth	992
	Dashields	400
	Montgomery	178

Source: (50).

Table 10. Locks with Hydropower Plants with Active Licenses.

River/Lock	Authorized Capacity	Licensee
Allegheny		
Lock and Dam 2	17 MW*	Ffp Missouri 12, LLC
Lock and Dam 5	9.5 MW	All Dams Generation, LLC
Lock and Dam 6	8.6 MW	All Dams Generation, LLC
Lock and Dam 8	30.4 MW together	Allegheny Hydro, LLC
Lock and Dam 9		
Monongahela		
Braddock Lock and Dam (L/D 2)	5.3 MW	Lock+hydro Friends Fund Xlii
Maxwell Lock and Dam	13 MW	Solia 5 Hydroelectric, LLC
Lock and Dam 4	12 MW	Solia 4 Hydroelectric, LLC
Grays Landing Lock and Dam	12 MW	Ffp Missouri 13, LLC
Point Marion Lock and Dam	5 MW	Solia 8 Hydroelectric, LLC
Ohio		
Emsworth Lock and Dam	36 MW	Ffp Missouri 5, LLC
Montgomery Lock and Dam	42 MW	Solia 6 Hydroelectric, LLC

**Measured in megawatts (MW)*
Source: (51).

Table 11. Water Utilities Drawing Water from the Three Rivers.

Utility	River Source	Customers Served
Authority of Borough of Charleroi	Monongahela	26,000
Fox Chapel Authority	Ohio[1]	19,000
Moon Township Municipal Authority	Ohio	38,000
Oakmont Water Authority	Allegheny	30,000
American Water—Uniontown	Monongahela	23,000
American Water—Brownsville	Monongahela	12,000
Pennsylvania American Water Pittsburgh	Ohio	508,000
Pittsburgh Water & Sewer Authority	Ohio	225,000
Robinson Township Municipal Authority	Ohio	12,000
Tri County Joint Municipal Authority	Monongahela	10,000
West View Water Authority	Ohio	200,000
Wilkinsburg-Penn Joint Water Authority	Allegheny	120,000

[1] Fox Chapel buys its water from Pittsburgh Water and Sewer Authority, which draws from the Ohio River.

CHAPTER 2: WATERWAYS INFRASTRUCTURE

Locks and Dams in Southwest Pennsylvania

The lock and dam system is necessary for year-round barge transportation because it maintains the river depth at 9 ft. The USACE Pittsburgh Engineering District manages 23 locks and dams and 16 major flood control reservoirs that make the river basins navigable. Seventeen of those locks and dams and 11 of those reservoirs are in western Pennsylvania. The Pennsylvania locks and dams are on three rivers: the Ohio, Allegheny, and Monongahela. Table 12 lists the Pittsburgh District's locks.

Table 12. Locks and Dams in Pittsburgh District.

River	Asset Name	Main Chamber Dimensions	Has Auxiliary Lock	Auxiliary Dimensions	Open Year	Rehab Year
Allegheny River (8)	Lock and Dam 2	360' x 56'	—		1934	—
	C.W. Bill Young Lock and Dam	360' x 56'	—		1934	—
	Lock and Dam 4	360' x 56'	—		1927	—
	Lock and Dam 5	360' x 56'	—		1927	—
	Lock and Dam 6	360' x 56'	—		1928	—
	Lock and Dam 7	360' x 56'	—		1930	—
	Lock and Dam 8	360' x 56'	—		1931	—
	Lock and Dam 9	360' x 56'	—		1938	—
Monongahela River (6)	Lock and Dam 2 (Braddock)	720' x 110'	X	360' x 56'	1905	1953—New dam in 2004
	Lock and Dam 3 (Elizabeth)*	720' x 56'	X	360' x 56'	1907	1980
	Lock and Dam 4 (Charleroi)**	720' x 84	X	360' x 56'	1932	1967
	Maxwell Locks and Dam	720' x 84'	X	720' x 84'	1963	—
	Grays Landing Lock and Dam	720' x 84'	—		1993	—
	Point Marion Lock and Dam	720' x 84'	—		1926	1994
	Morgantown Lock and Dam	600' x 84'	—		1950	—
	Hildebrand Lock and Dam	600' x 84'	—		1960	—
	Opekiska Lock and Dam 29	600' x 84'	—		1964	—
Ohio River (3)	Emsworth Locks and Dams	600' x 110'	X	360' x 56'	1921	2014
	Dashields Locks and Dams	600' x 110'	X	360' x 56'	1929	1990
	Montgomery Locks and Dam	600' x 110'	X	360' x 56'	1936	1989
	New Cumberland Locks and Dam	1200' x 110'	X	600' x 110'	1959	—
	Pike Island Locks and Dam	1200' x 110'	X	600' x 110'	1963	—
	Hannibal Locks and Dam	1200' x 110'	X	600' x 110'	1972	—

* This will be removed as part of the Lower Mon Project.

**The new lock will be 84 feet wide.

Note: Shaded entries are not in Pennsylvania. "—" means either no auxiliary lock exists or no rehab has been performed.

Source: (6, 40, 52).

Figure 9 shows the locations of these locks and dams.

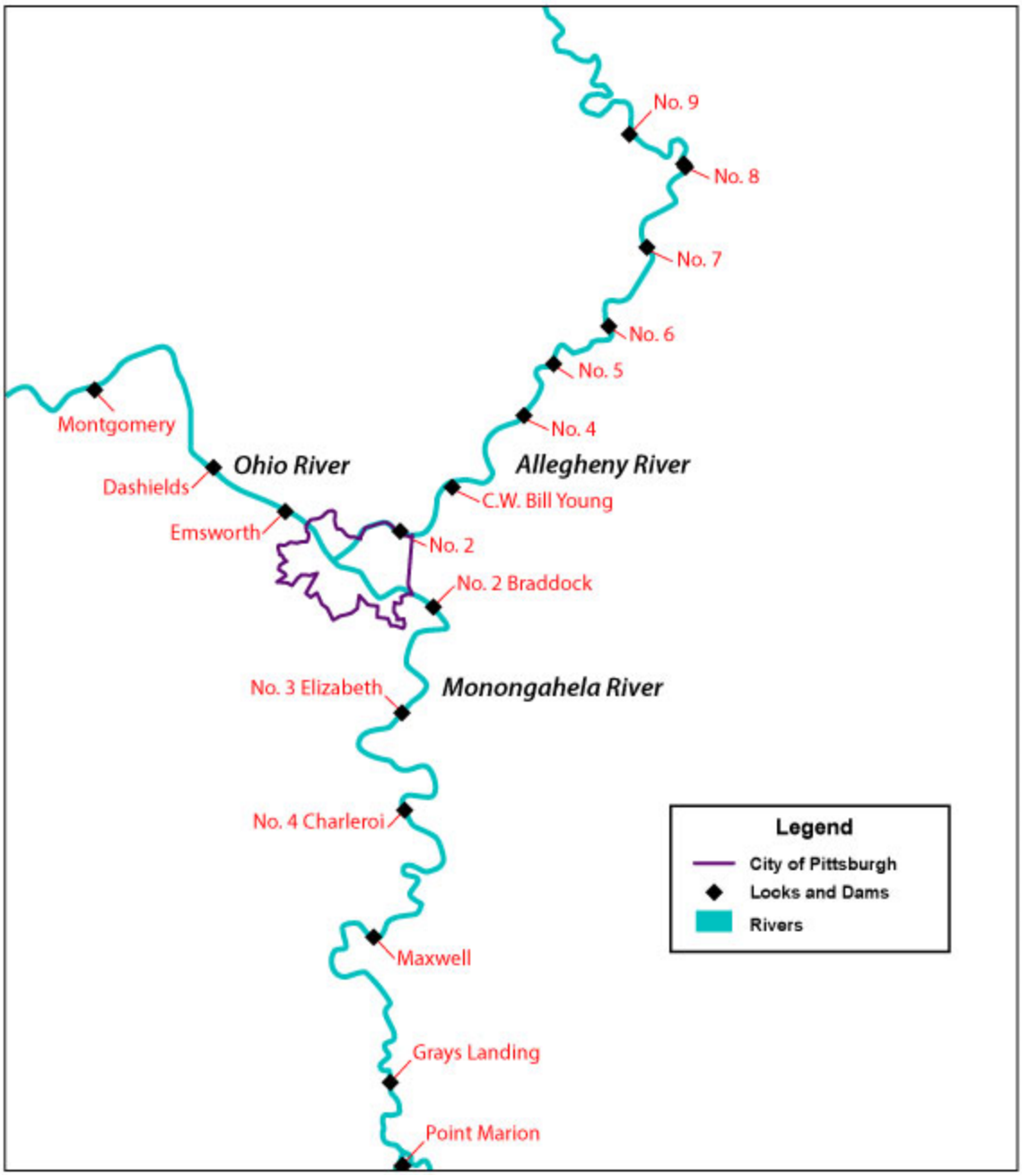
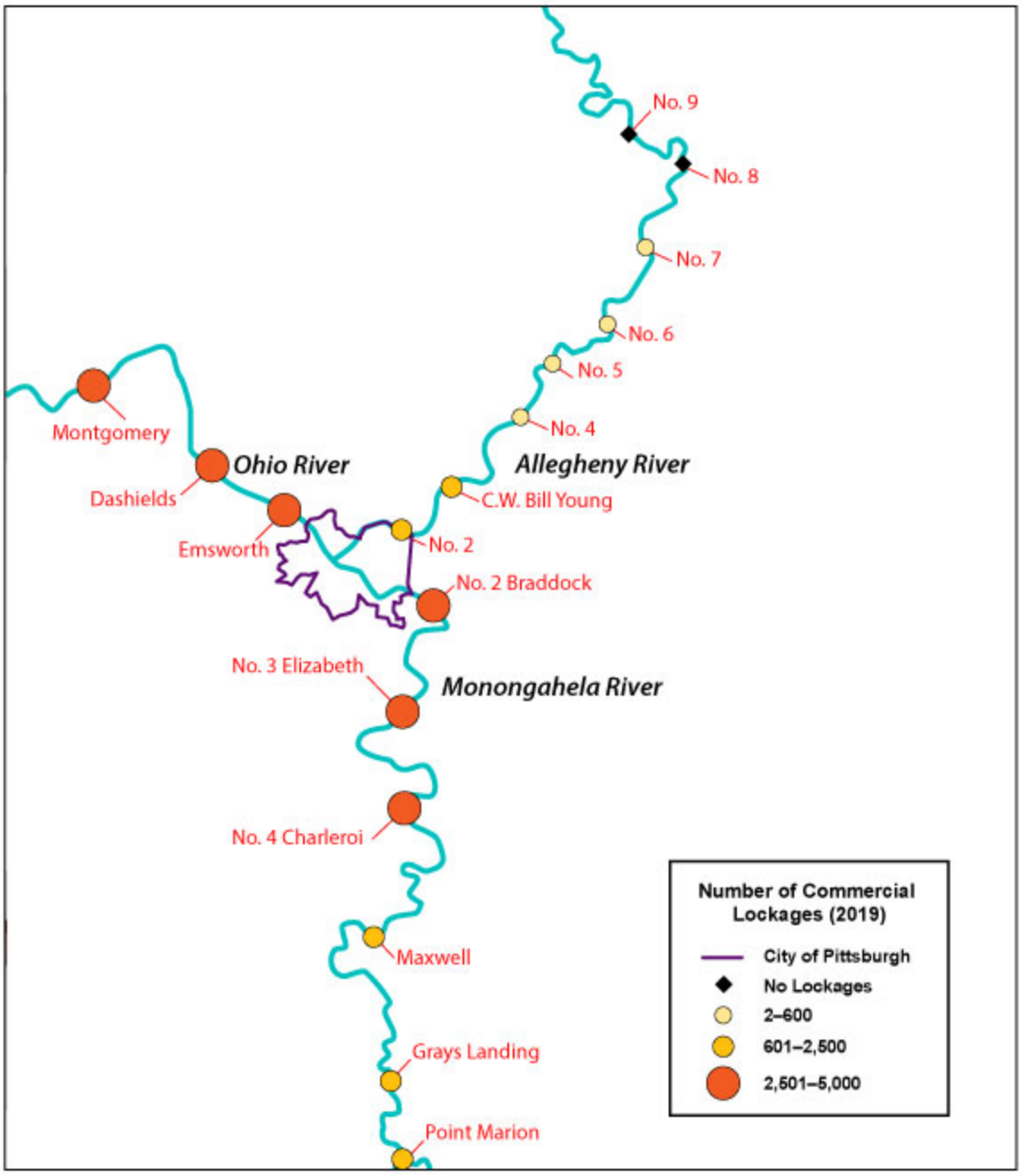


Figure 9. Location of Pennsylvania Locks and Dams in the Pittsburgh Port District.

Figure 10 displays the volume of traffic in terms of lockages at the various locks.



Source: (6)

Figure 10. Regional Waterways Freight Flows Based on Commercial Lockages.

The restrictive sizes of many of the lock chambers creates inefficiencies in barge operations. For example, as indicated in Table 12, several lock and dam sites include a main chamber and a smaller auxiliary chamber. The auxiliary chambers are intended to serve as a backup when the main chamber is closed, but they are being used frequently for towboats without barges and recreational vessels. At the Emsworth and Dashields Locks, industry is restricted to bringing five-barge tows through auxiliary chambers, and lockages are restricted to a single 195 ft x 35 ft barge. Each barge takes up to one hour to lock through, which means a five-barge tow takes five hours to pass the entire tow through the lock—

15 barges require 15 hours. Using the main chamber, a 15-barge tow can move through the lock in two to three hours (*53*).

This inefficiency is particularly troublesome if a lock is closed a lengthy period for repairs. At the Montgomery Lock on the Ohio River, the main chamber was closed for 320 days in 2015 and 200 days in 2016, indicating that the industry was required to operate at reduced efficiency for more than half that period (*33*).

Another example is the lock system on the Monongahela River. All the main chambers below Elizabeth are 110 ft wide, whereas the Elizabeth and Charleroi Locks are only 56 ft wide. In addition, as shown in Table 12, chamber lengths vary significantly as well. This causes smaller barges and flotillas to be used on the Monongahela above the Braddock Lock and Dam than what are typically used on other waterways. Table 13 shows the maximum number of barges that can be processed in a single cut (transit) at each of the locks. In a study done in 2014, it was calculated that the average barge capacity in the USACE Pittsburgh District is 1,200 tons, while the average for the downriver Huntington District is 1,670 tons (*54*). The differences in lock sizes causes transitions between vessels where lock sizes change (e.g., between New Cumberland and Montgomery and between Braddock and Elizabeth), which adds time and expense to the movement.

Table 13. Maximum Number of Barges in a Single Cut.

River	Lock*	Maximum Standard Barges (175' x 26')	Maximum Jumbo Barges (195–200' x 35')
Ohio	Emsworth	12	9
	Dashields	12	9
	Montgomery	12	9
	Next 9 locks	24	18
Monongahela	Braddock	16	9
	Elizabeth	6	3
	Charleroi	6	3
	Maxwell	12	6
	Grays Landing	12	6
	Point Marion	12	6
	Morgantown	9	6
Allegheny	Lock and Dam 2	4	1
	CW Bill Young (L&D 3)	4	1
	Lock and Dam 4	4	1
	Lock and Dam 5	4	1
	Lock and Dam 6	4	1
	Lock and Dam 7	4	1

** Locks with no commercial lockages in 2018 are not shown.*
Source: (54).

Condition/Status of Locks and Dams

Overall Assessment

Locks and dams have been used in southwest Pennsylvania for almost 200 years. The navigation system has been redesigned and updated numerous times since the rivers were first tamed. Each of the locks and dams has a different story, but they often share state-of-the-art technology at construction,

multiple cycles of rehabilitation, and in some cases replacement with the latest construction and design techniques.

The funding needed to maintain the functionality and efficiency of this system is determined by Congress. From 2009 to 2014, limited funding was available for the Pittsburgh District, which caused dramatic slowdowns in existing projects in the region and deferred maintenance across the inland waterways. Through the diligent lobbying and education efforts of the PPC, WCI, and other stakeholders, in 2014, legislation was enacted that reduced the IWTF's contribution for Olmsted construction costs from 50 to 25 percent in FY 2014 and then to 15 percent in subsequent years. The fuel tax was also increased from $0.20 per gallon to $0.29 per gallon. These changes greatly improved the funding streams for existing priority projects, such as the Upper Ohio Project and the Lower Mon Project. The three rivers are discussed separately in sections that follow.

Most waterway structures in the region are 70 to 80 years old. A significant national backlog of repairs and modifications to navigation locks and dams is pending appropriations by Congress. Mechanical components at these sites are subject to increasingly frequent breakdowns, and because of the age of the locks, many replacement parts are no longer manufactured, which results in a high degree of difficulty and expense to maintain the locks.

Figure 11 and Figure 12 illustrate the condition of area locks.

Figure 11. Allegheny River Lock 2.

Figure 12. Interior Condition of Allegheny Lock 3 and Looking Down on Elizabeth Lock.

Ohio River

Three locks in Pennsylvania are on the Ohio River: EDM (see Table 12). These facilities provide navigable conditions on the first 31.7 miles of the 981-mile Ohio River. They serve as the only conduit between the Ohio River System and Pittsburgh area rivers. Unfortunately, they are the oldest and smallest on the Ohio River mainstem. Their capacity at full operation is approximately one-third the capacity of the other locks on the Ohio River (*7*).

> Without proper maintenance, there is a 50 percent probability that one or more of the EDM Locks will fail by 2028, cutting Pittsburgh off from the entire Inland Waterways System.

Two major problems associated with the three locks are their deteriorated structural condition—leading to reduced service reliability—and insufficient auxiliary lock capacity when the main lock chamber is closed for maintenance or repair. USACE officials have reported a 50 percent chance that one of those three sites, which make up the Upper Ohio River Navigation system in Pennsylvania, will experience a catastrophic failure by 2028 if not rehabilitated (*55*). To address this threat, USACE completed a $154-million major rehabilitation of the Emsworth project in 2017. Major maintenance work also has been completed in the past two years at Montgomery Lock, increasing that project's reliability.

Structural deficiencies limit the economic opportunities for efficient river transportation. The type of barge most commonly used on the inland waterways system is the jumbo barge, with dimensions of 195 to 200 ft in length by 35 ft in width and a capacity that USACE calculated at 1,669 tons. On the rest of the Ohio River mainstem, the towing industry has adopted a maximum tow size of 15 jumbo barges (3 across and 5 long), which can carry 25,000 tons when fully loaded. This is over twice the capacity of a tow consisting of 11 standard-sized barges[16] carrying 11,750 tons, sized to pass through the EDM Locks (*40*). When a maximum tow of 15 jumbo barges encounters any of the EDM Locks, it must be broken apart and moved through the main locks in two separate tows. This activity adds to operating time and expense.

> Major Project Features for Ohio River Locks:
> - Similar at all three sites.
> - Demolish existing auxiliary chamber.
> - Construct new 110 ft x 600 ft main chamber.
> - Modify dams.

The USACE Upper Ohio Navigation Study released in October 2016 (7) recommended a series of repairs and improvements that are critical to the health of the system:

- Replacing each of the auxiliary 56 ft x 360 ft river chambers at EDM Locks and Dams with new 110 ft x 600 ft lock chambers.
- Removing one dam gate bay at the Emsworth Main Channel Dam and at the Montgomery Dam.
- Constructing a new Montgomery Dam Pier #1 with new gate and operating equipment, access bridge, and other dam sill, apron, and scour protection modifications.
- Shortening Dashields' fixed-crest dam and installing one hydraulically operated gate and appurtenant facilities.
- Constructing new guard walls, middle wall operations buildings, and other dam modifications to accommodate the new locks.
- Providing all necessary measures to maintain navigation through the existing main chambers while supporting demolition and construction activities of the new facilities.

[16] A standard barge as a specific barge category is 175 ft long by 26 ft wide. This is not the industry standard across the nation, which is 195 ft long by 35 ft wide.

- Implementing the environmental compensatory mitigation and associated monitoring and adaptive management plan. Monitoring will continue until the mitigation is determined to be successful based on the identified criteria within the monitoring and adaptive management plan. Monitoring is expected to last five years following implementation, with an additional final inspection of the aquatic mitigation at the conclusion of construction.

Congress authorized construction of the Upper Ohio Navigation project in the Water Resources Development Act of 2016. Since then, the project has received significant appropriations for preconstruction engineering and design (PED). In 2021, due to funding made available from WRDA 2020, the US Army Corps of Engineers (USACE) Work Plan has been updated to include $22 million available for construction to begin on the three locks and dams on the Ohio River (*56*).

Allegheny River

The Allegheny River Navigation System consists of 70 miles of navigable channel from Brady's Bend, Pennsylvania, to the river mouth at Pittsburgh. The eight locks and dams on the Allegheny River were all built between 1927 and 1938. All these facilities feature a single lock chamber and a fixed-crest dam that maintains a minimum 9-ft-deep pool.

The Allegheny sees far less traffic than the other rivers. Less traffic has led to less investment, and any rehabilitation will require up to $50 million per site (*10*). These structures have long been on a "fix as fail" repair basis but are now managed as "fail and close." According to a study done by USACE, "All projects except L/D 5 operate with a net negative economic impact, and trends show that L/D 5's economic positive impact is declining. … [Systems] are rated as failed or failing for one or more component systems at each project [on the river]" (*8*).

Currently, Lock and Dam 4 and Lock and Dam 5 are operated at a Level of Service 3—"Limited Service–Single Shift."[17] Locks and Dams 6–9 (the upper reaches of the river) are operated at a Level of Service 6—"Service by Appointment"—which is essentially caretaker status. Table 14 shows the full range of possible service levels. Commercial traffic through Allegheny Locks 6 to 9 is almost non-existent, and traffic through Lock 5 has dropped substantially since its peak in 2004 (*8*). Lock operations for recreational boaters on the Upper Allegheny River is no longer supported by USACE (*35*).

[17] Levels of service are an attempt to prioritize lock operations and maintenance across USACE's total portfolio to ensure appropriate expenditures given limited federal resources.

Table 14. Guidelines for Levels of Service.

Level #	Title	Guidelines for Range of Lock Operation Data
1	Full Service 24/7/365	More than 1,000 commercial lockages per year.
2	Reduced Service—Two Shifts per Day	Between 500 to 1,000 commercial lockages per year.
3	Limited Service—Single Shift	Less than 500 commercial lockages per year or greater than 1,000 recreational lockages per year.
4	Scheduled Service—Set times per Day	Limited commercial and/or substantial recreational traffic, more consistent daytime pattern of lockage.
5	Weekends & Holidays	Little to no commercial lockages with significant recreational lockages (500 or more per year).
6	Service by Appointment	Limited commercial traffic with no consistent pattern of lockage.

Source: (8).

According to USACE, "The decrease in overall traffic can be attributed to a combination of factors: a prohibition of dredging for aggregates in the Allegheny River, closure of remaining commercial terminals and river-dependent industry, and a lack of new investment in river-dependent industry over the last 30 years" (*8*).

Meanwhile, an agreement—the first of its kind nationally—has been negotiated between USACE and the Allegheny River Development Corp., a Kittanning, Pennsylvania, nonprofit organization, for the nonprofit to raise money to pay USACE to open the Armstrong County locks on summer weekends and holidays for recreational boaters. This arrangement was made possible by provisions included in the WRDA of 2014[18] that allowed for contributed funds to be used to pay for weekend/holiday lockages. These provisions were made possible because of lobbying efforts by the Port of Pittsburgh and the local nonprofit. According to USACE officials, operating these locks costs somewhere between $1 million and $1.5 million annually (*57*). Table 15 shows the number of recreational vessels that have been handled at Locks 5 to 9 over the last few years.

Table 15. Number of Recreational Vessels Handled at Each Lock.

Lock	2015	2016	2017	2018	2019
Lock 5	1,461	1,145	705	594	467
Lock 6	784	500	366	346	228
Lock 7	1,500	1,027	598	567	324
Lock 8	1,121	889	439	534	341
Lock 9	1,350	919	544	375	274
TOTAL	6,216	4,480	2,652	2,416	1,634

Source: (50).

The decline in the vessel count correlates with boat registrations and fishing license sales within this area, both of which have declined significantly (*8*).

As shown in Table 10 earlier, five locks on the Allegheny River have hydropower facilities with a total authorized capacity of 65.5 megawatts (MW). As determined by the EIA, four of the five stations produced electricity in 2019—a total of 308 million kilowatt hours (kWh) (*3*), which is enough energy to power approximately 29,600 homes, or 2.9 percent of the homes in the Pittsburgh Metropolitan

[18] See Sec. 1017. Acceptance of Contributed Funds to Increase Lock Operations.

Statistical Area (*58*). Moreover, a proposal to put a private hydropower facility at Lock and Dam 7 that would increase the capacity by another 16.5 MW has been put forth (*8*).

The hydropower operators have expressed interest in continued discussion on a potential transfer of facilities. They are the only entities under consideration that can hold property and have the financial capability to maintain the dams. Transfer to a nonfederal hydropower partner will likely result in the permanent closure of the locks.

Monongahela River

Similar to Locks 5–9 on the Allegheny River, the Morgantown, Hildebrand, and Opekiska Locks and Dams on the Upper Monongahela River (all in West Virginia) have also experienced reduced operating hours.

USACE is in the process of replacing the structures at Lock and Dam 2, 3, and 4 (also known as Braddock, Elizabeth, and Charleroi, respectively) with two modern, high-capacity locks and dams, which were authorized in the WRDA of 1992 (P.L. 102-580). All were classified as critically near failure, with the dam at Elizabeth classified as an active failure. (Elizabeth Lock and Dam is one of the oldest structures on the entire inland waterways system, built in 1907.)

In addition to the physical condition and lack of reliability of the locks, the chambers were designed to handle standard-size barges (175 ft long by 26 ft wide), although the predominant barge type used on the Ohio River is the jumbo barge (195–200 ft long 35 ft wide). These locks on the Lower Monongahela River experience the highest volume of commercial traffic on the river in terms of both tonnage locked and lockages; further, the pools created by these facilities provide industrial and municipal water and are popular with recreational boaters (*59*). The major project features of the Lower Mon Project are as follows (*60*):

- New Dam at Braddock.
- New (larger) Lock Chamber at Charleroi.
- Dredging.
- Removal of Locks and Dam 3.
- Relocations.

Figure 13 illustrates how the project will affect the Lower Monongahela River system.

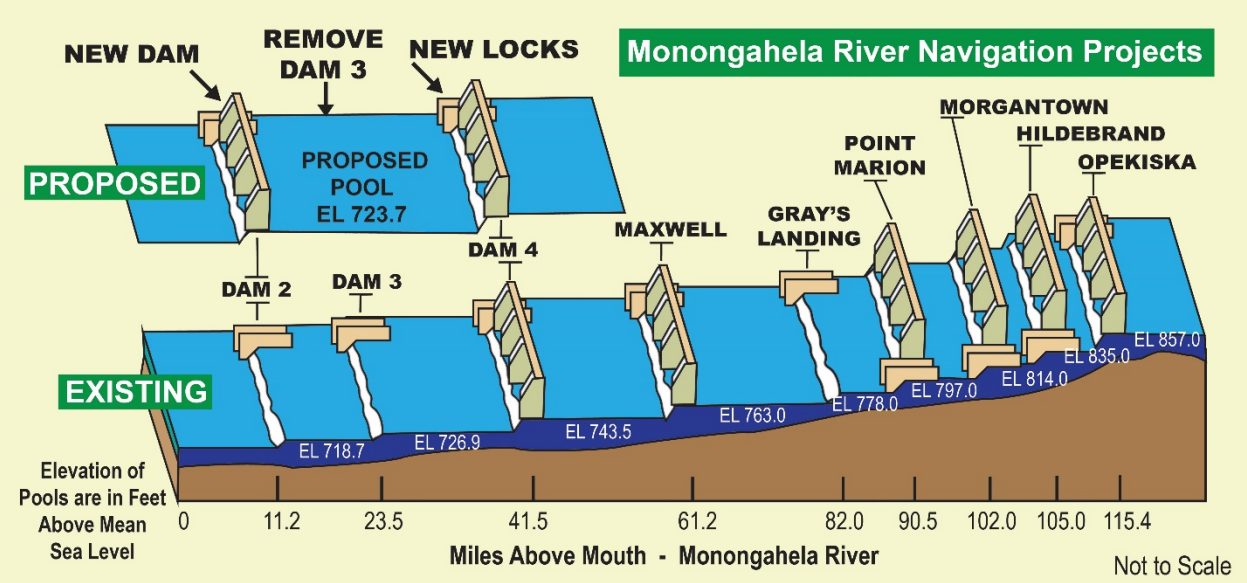


Figure 13. Monongahela River.

USACE completed the replacement of the Braddock Dam (Lock and Dam 2) in 2004. Replacement of the locks at Charleroi (Locks and Dam 4) with a larger chamber (84 ft x 720 ft) is in progress. The original plan for Charleroi included two new locks, but after determining that 90 percent of the originally calculated project benefits could be achieved with one lock, one of the locks was postponed to an indeterminate date decades away. Removal of Locks and Dam 3 (Elizabeth) is still in the design phase. The pool between Elizabeth and Charleroi is one of the region's most important; it provides the availability of access to the Ohio River that is vital to several important industrial concerns. The nation's largest coke works (Clairton Coke), numerous coal mines, and a large power plant at Fort Martin on the Pennsylvania/West Virginia border all depend on its availability.

Funding for Locks and Dams

Inland Waterways Trust Fund

USACE water resources projects are subject to a two-step legislative process. First, they must receive congressional authorization through a federal WRDA, usually as the result of a formal study conducted by USACE. Next, they must receive project funding through a separate annual appropriations process. Authorizations do not provide a plan or timeline for funding appropriations. The process of partial project funding through the annual appropriations process results in many projects moving forward in a piecemeal, start-stop manner, resulting in inefficient project delivery and higher overall costs.

As of January 2021, new construction or major rehabilitation will be funded under the Water Resources Development Act of 2020 (WRDA 2020). The cost share for major construction will shift to 65/35, with the majority coming from the general treasury, and the remaining 35 percent coming from the IWTF. Previously, new construction and major rehabilitation projects were 50 percent funded by the IWTF and 50 percent from general appropriations from the federal treasury. Barge operators pay a fuel tax of $0.29/gal that is deposited in the IWTF. O&M costs are 100 percent funded by general appropriations.

The IWTF was initially authorized by the Inland Waterways Revenue Act of 1978 (Public Law 95-502, October 21, 1978, Sec. 1801 et seq) (*61*). This act created the IWTF within the U.S. Treasury for the purpose of "making construction and rehabilitation expenditures for navigation on the inland and coastal waterways of the United States as provided in appropriations acts" (*61*). The U.S. Congress

funded the IWTF with a "tax on fuel used in commercial transportation on inland waterways" (*61*). The act defined 26 specific segments of the inland and intracoastal waterways to be subject to the tax and to be eligible for construction and rehabilitation expenditures from the IWTF. (An additional segment, Tennessee-Tombigbee Waterway, was added later in WRDA 1986, P.L. 99-662.) (*62*) Pursuant to both the 1978 Inland Waterway Revenue Act and WRDA 1986, IWTF monies must be appropriated and must be used to finance specifically authorized construction and major rehabilitation projects on fuel-taxed waterways.

The inland fuel tax began on October 1, 1980, at the rate of $0.04 per gallon and gradually increased to $0.20 per gallon in 1994. It rose to the current $0.29 per gallon in April of 2015 as a result of Public Law 113-295, which is discussed later in the report. The last increment of $0.09 was requested by industry in order to accelerate projects in the pipeline.

Funding Needs

There are 18 lock and dam projects already approved by Congress that would effectively modernize the entire inland waterways system for the next 20 years. However, it is becoming increasingly difficult to obtain administration support for appropriations for new construction or major rehabilitation projects. OMB will not request funding for a project unless the estimated economic benefit is at least 2.5 times the expected cost (*33*). The increase in the tax rate will increase the funds available for such projects and will have a very positive effect on the timelines of the most important projects. Table 16 shows how this increased funding stream might affect the completion dates of new construction projects.

Table 16. Acceleration of Project Timelines for New Construction Projects.

Project	Estimated Completion Date Was…	New Projected Completion Date Is…
Olmsted	2024	Operational in 2018
Lower Mon 2,3, & 4	2027	2023/2025*
Kentucky Lock Addition	2041	Operational in 2025
Chickamauga Replacement	2051	Operational in 2023
L/D 25 Upper Mississippi Lock Addition	2064	2032
Lagrange Lock Addition	2070	2028
L/D 22 Upper Mississippi Lock Addition	2083	2035
L/D 24 Upper Mississippi Lock Addition	2090	2038

**The Charleroi Chamber will be completed in 2023; the removal of Lock and Dam 3 will be completed in 2025.*
Source: (11, 63, 64).

For the Upper Ohio River, it will cost an estimated $1.8 billion to replace undersized and aging lock chambers at the EDM Locks and Dams. The Lower Mon Project (Locks and Dams 2, 3, and 4), which encountered dramatic cost escalation and schedule delays, is funded to completion of construction in 2023. Inadequate funding forced USACE to complete the project one component at a time, as funding allowed (*10*). The project was authorized in the Water Resources Development Act of 1992 with an original authorization amount of $556.4 million. The latest published estimate (in FY 2020) for a scaled-down version of the project is $1.2 billion (*11*).

Particularly for the Allegheny River, the lack of funding has been further aggravated by the implementation of Inland Marine Transportation System (IMTS) ratings in 2012 that designated certain rivers as low-use rivers and reduced their funding priority. Waterways are classified as follows:

- High Use: at least 3 billion ton-miles per year.
- Medium Use: 1 to 3 billion ton-miles per year.
- Low Use: less than 1 billion ton-miles per year.

The Allegheny River has been designated as low use. It provides an example of the effect of such a designation on a waterway. As one study noted, "The Allegheny River has been considered a 'low-use waterway' by USACE since the implementation of IMTS ratings in 2012 because of low volumes of commercial traffic, which has resulted in budget reductions. Certain steps have already been taken to reduce the costs of operating and maintaining the projects including: 1) eliminating scheduled de-watering for inspections and repairs; 2) reducing the number of shifts; 3) reducing service by reducing the number of hours per day, days per week and/or the number of months per year of operation; and 4) reducing or eliminating maintenance items" (*8*).

In January 2020, the USACE Pittsburgh District office requested a charter from USACE Headquarters to establish a national-level committee to reevaluate the metrics, value, and budgeting for low-use river systems.

Some discussions have taken place about removing low-use locks and dams. A rough estimate of the cost to remove a lock and dam is about $2 million (*65*), but other factors must be considered, such as municipal water supply and recreational use of the waterways.

The use of ton-miles as a metric fails to consider whether reasonable alternatives to the waterways exist or how important the waterways are to the health of the regional economy; nor does it consider potential development.

Definition of Abbreviations Used in the Status Tables

GI-PED: General Investigation and Preliminary Engineering and Design—the study and design component.

CG: Construction General—the construction component.

IWTF: Inland Waterway Trust Fund—the fuel tax contribution to funding.

ARRA: American Recovery and Reinvestment Act of 2009—special one-time funding.

Status of New USACE Capital Projects

Ohio River

The Upper Ohio Navigation Project was authorized for construction by Congress in WRDA 2016 and is currently in the Preconstruction Engineering and Design (PED) phase. The IWUB has identified this project as one of its highest priority projects, falling immediately behind the Olmsted, Lower Mon, Chickamauga, and Kentucky Lock Projects (*66*).[19] Table 17 shows the amounts budgeted for each phase/funding source for the Upper Ohio Navigation Project.

Table 17. Upper Ohio Project Funding and Status.

Current Project Estimate*	GI-PED	CG	IWTF	Total
FY 2017 Allocation:	$5,525,000			$5,525,000
FY 2018 Allocation:	$2,353,000			$2,353,000
FY 2019 Allocation:	$2,500,000			$2,500,000
FY 2020 Allocation:	$7,700,000			$7,700,000
Total Allocations to Date:				$18,078,000
Remaining Balance:				$1,791,922,000

**As of January 2019.*
Source: (67, 68).

[19] Olmsted has been fully funded to completion.

In January 2021, the US Army Corps of Engineers released its FY21 Work Plan, allocating $323 million nationwide in project funding, with $22 million designated for the Ohio River Navigation Project, specifically for the Montgomery Lock and Dam (*56*).

Allegheny River

There are no ongoing projects on the Allegheny River, primarily due to the low usage of the locks and the subsequent low priority of the river in the USACE project hierarchy.

Monongahela River

In both the 2010 Capital Development Plan (IMTS Capital Projects Business Model) and USACE's Inland and Intracoastal Waterways 20-Year Capital Investment Strategy published in 2016, the Lower Mon Project was designated as one of the top three priority projects on the inland waterway system (*69*). USACE initiated the Lower Mon Project to address issues with lock and dam structures at the Braddock, Elizabeth, and Charleroi Locks and Dams. When authorized in 1994, the project initially anticipated a 12-year schedule. The plan was to replace the Braddock Dam; replace the locks at Lock and Dam 4, located in Charleroi, Pennsylvania; and remove Locks and Dam 3, located in Elizabeth, Pennsylvania. Unfortunately, inadequate and intermittent funding forced USACE to complete the project one component at a time, as funding allowed. This delay, of course, also resulted in dramatic cost escalations.

Although the original completion date for the Lower Mon Project was 2004, the latest projection is that it will be operational in 2023 and completed by 2024. The original estimate for this project in 1992 was $556.4 million for the construction of two new lock chambers and a railroad bridge modification, while the latest approved estimate for the project is $1.2 billion which includes the construction of just one new lock chamber. (*59*, *60*). This project is funded to completion.

The December 2019 IWUB report (*66*) noted that USACE considers the project to be very close to being finished and is coming in under the latest budget estimates. Table 18 shows the status of the components of the Lower Mon Project that are yet to be completed.

Table 18. Status of Lower Mon Project Components.

Project Component	Status
Charleroi (L/D 4) River Wall	Substantially complete.
Charleroi Middle Wall	Estimated completion—February 2021
In Chamber Work	Follows completion of middle wall and dewatering of chamber. Estimated completion—late 2023.
Charleroi Stilling Basin	Estimated completion—November 2022
Dredging of Monongahela Pool 3	Underway, estimated completion—July 2021.
Elizabeth (L/D 3) Removal	Pending completion of operational testing of Charleroi river chamber. Removal will achieve 90% of $220M annual estimated benefits. Benefits will begin in late 2023.

Source: (11).

As noted in Table 18, the project is programmed to be operational by 2023. Table 19 provides the funding status for the Lower Mon Project.

Table 19. Funding Status for Lower Mon Project.

Current Project Estimate	ARRA	CG	IWTF	Total
Allocations Through FY 2014	$68,402,740	$281,175,646	$281,175,652	$630,754,038
FY 2015 Allocation:	($141,437)	$28,015,000	$28,015,000	$55,888,463
FY 2016 Allocation:	NA	$29,450,000	$29,450,000	$58,900,000
FY 2017 Allocation:	NA	$41,005,000	$41,005,000	$82,010,000
FY 2018 Allocation:	NA	$48,150,000	$48,150,000	$96,300,000
FY 2019 Allocation:	NA	$44,606,606	$44,606,606	$89,213,213
FY 2020 Allocation:	NA	$55,500,000	$55,500,000	$111,000,000
Total Allocations to Date:	$68,261,203	$527,902,252	$527,902,252	$1,124,065,714

NA = Non-Available
Source: (60, 68).

The Lower Mon Project is funded to completion; the FY 2020 allocation of $111 million is sufficient for completing the work required to make the project operational. The funds can be spent across multiple FYs as needed, although the district is pushing the project as fast as its capabilities will allow. The USACE Pittsburgh District has indicated that the final price tag may reach $1.2 billion, but the funding is in place to meet the schedule indicated in Table 18.

One aspect of this project that is not discussed in official briefings is that the auxiliary lock for Charleroi was deferred. This modification has the effect of reducing the resiliency of the system and will lead to disruptions when the lock must be closed for maintenance or repairs.

CHAPTER 3: POTENTIAL OBSTACLES AND CONCERNS

Several trends and developing issues that might become obstacles to the further development of industry that depends on the waterways may need to be factored into the strategic plans for the Port of Pittsburgh. This chapter summarizes the most significant items, which are as follows:

- Market trends for coal
- Regional Greenhouse Gas Initiative
- Barge surplus
- Construction schedule for USACE
- Zoning issues
- Problems with BCA methodology
- Trade war

Trends that may present opportunities for development, such as a possible change in commodity focus or project development processes, are discussed in Chapter 4.

Market Trends for Coal

Coal has played an important role in the Pittsburgh area economy for decades. As the largest city in the Northern Appalachian coal supply region, the Pittsburgh area has been the home of many coal and coal-related enterprises. CONSOL Energy, Inc.'s Pennsylvania Mining Complex in Greene and Washington Counties is the world's largest underground mining complex (*70*).

The decline in demand for coal has affected barge traffic volumes in the Port District. The degree of the decline can be estimated by reviewing EIA's Coal Distribution Reports.[20] As shown in Table 20, the estimated coal moving through the Port District declined by about 20 percent between 2010 and 2019.

Table 20. Estimated PPC Barge Shipments (000 tons)—2010, 2015, and 2019

ORIGIN/DESTINATION	Coke Plant	Electric Power Sector	Other	Total
2019				
Ohio	**--**	**10,345**	**--**	**10,345**
Kentucky	--	1,190	--	1,190
Ohio	--	6,469	--	6,469
Pennsylvania	--	206	--	206
West Virginia	--	2,480	--	2,480
Pennsylvania (Bituminous)	**2,917**	**6,176**	**--**	**9,093**
Illinois	159	--	--	159
Kentucky	--	320	--	320
Maryland	--	54	--	54
Ohio	319	2,139	--	2,458
Pennsylvania	2,239	287	--	2,526
West Virginia	200	3,376	--	3,576
Virginia	**322**	**--**	**--**	**322**
Pennsylvania	322	--	--	322
West Virginia (Northern)	**415**	**19,245**	**--**	**19,660**
Ohio	--	10,755	--	10,755
Pennsylvania	415	534	--	949

[20] The Coal Distribution reports contain state of origin, state of destination, mode of transportation, and tonnage. All Pennsylvania river tons are included. For the remaining origins, only the tons that could be moving through the Port District are included.

Table 20. Estimated PPC Barge Shipments (000 tons)—2010, 2015, and 2019 (Cont'd).

ORIGIN/DESTINATION	Coke Plant	Electric Power Sector	Other	Total
West Virginia	--	7,956	--	7,956
West Virginia (Southern)	**2,103**	**--**	**46**	**2,149**
Ohio	483	--	46	529
Pennsylvania	1,620	--	--	1,620
TOTAL	**5,757**	**35,766**	**46**	**41,569**
2015				
Ohio	**6**	**15,162**	**156**	**15,324**
Kentucky	--	1,008	--	1,008
Ohio	--	9,994	--	9,994
Pennsylvania	6	79	--	85
West Virginia	--	4,081	156	4,237
Pennsylvania (Bituminous)	**786**	**5,482**	**--**	**6,268**
Indiana	--	73	--	73
Kentucky	--	98	--	98
Ohio	205	2,812	--	3,017
Pennsylvania	553	1,422	--	1,975
West Virginia	27	1,078	--	1,105
Virginia	**1,251**	**--**	**--**	**1,251**
Pennsylvania	1,251	--	--	1,251
West Virginia (Northern)	**1,248**	**18,952**	**36**	**20,236**
Ohio	--	6,176	36	6,212
Pennsylvania	1,248	5,204	--	6,452
West Virginia	--	7,571	--	7,571
West Virginia (Southern)	**3,159**	**142**	**148**	**3,449**
Ohio	328	142	148	618
Pennsylvania	2,831	--	--	2,831
TOTAL	**6,449**	**39,738**	**340**	**46,528**
2010				
Ohio	**--**	**18,195**	**112**	**18,307**
Kentucky	--	2,177	--	2,177
Ohio	--	7,375	--	7,375
Pennsylvania	--	1,551	--	1,551
West Virginia	--	7,091	112	7,203
Pennsylvania (Bituminous)	**403**	**6,792**	**97**	**7,292**
Florida	--	15	--	15
Indiana	--	1,229	--	1,229
Michigan	--	--	97	97
Mississippi	--	5	--	5
Ohio	--	1,491	--	1,491
Pennsylvania	71	3,316	--	3,387
Tennessee		49	--	49
West Virginia	331	687	--	1,018
Virginia	**1,091**	**--**	**--**	**1,091**
Pennsylvania	1,091	--	--	1,091
West Virginia (Northern)	**347**	**13,659**	**3**	**14,009**
Ohio		5,974	3	5,977
Pennsylvania	347	6,271	--	6,618
West Virginia		1,414	--	1,414
West Virginia (Southern)	3,829,324	4,507	44	8,381
Ohio	423	4,449	35	4,907
Pennsylvania	3,406	58	9	3,474
TOTAL	**5,670**	**43,153**	**256**	**49,080**

Source: (71)

Additional declines are expected with future coal plant retirements. The extent to which the decline affects the Port District is tied to the specific plants that are retired.

Regional Greenhouse Gas Initiative

Pennsylvania is expected to join the Regional Greenhouse Gas Initiative (RGGI). RGGI, established in 2005, is a cooperative effort among Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, and Vermont to reduce carbon dioxide emissions from the electric power sector. RGGI was the first mandatory market-based CO2 cap-and-trade program in the U.S. The RGGI Model Rule sets an annual cap for each region's aggregate CO2 emissions from the power sector, which declines each year. Allowances are regularly auctioned and all fossil fuel power plants over 25 megawatts are required to hold one allowance for each ton of emitted CO2 to achieve compliance. Participants may buy excess allowances and bank them for future use or choose to meet up to 3.3% of compliance obligations using offset allowances.

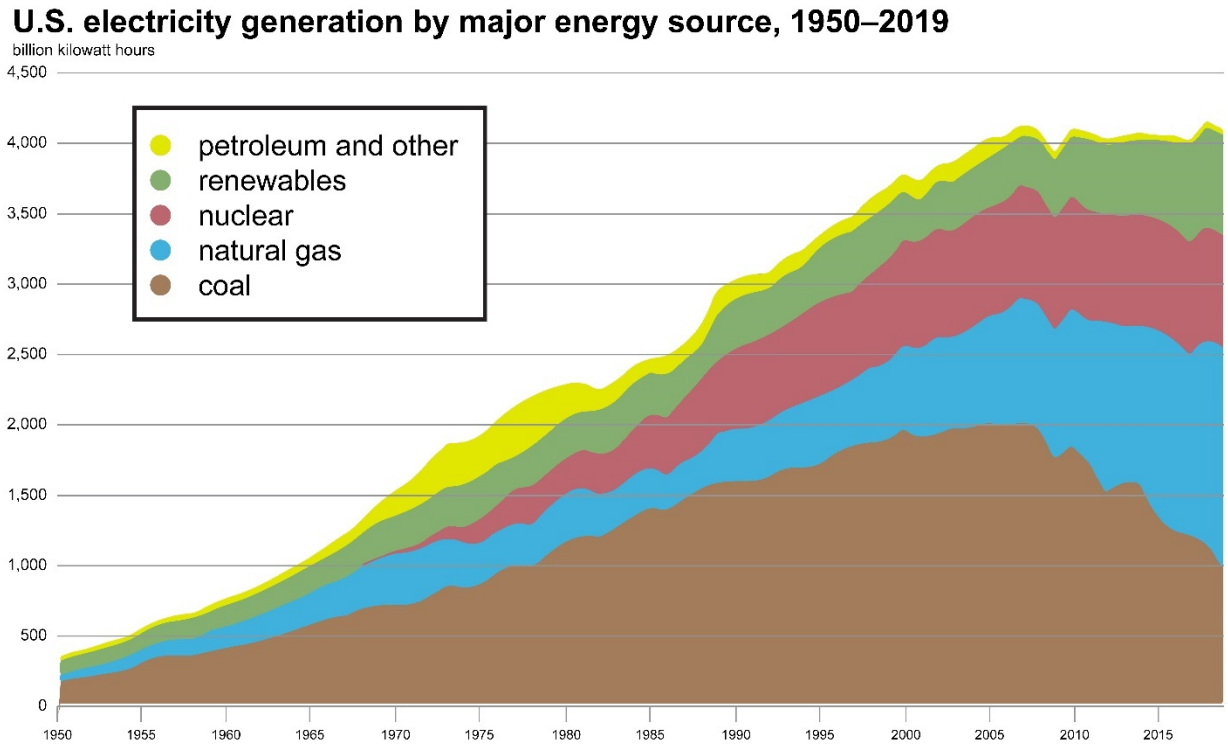
RGGI's first auction was held in 2008. New Jersey dropped out of the initiative in 2011 under then-Governor Chris Christie's administration, but rejoined in January 2020. Virginia has joined effective 2021. The Governor of Pennsylvania is attempting to join RGGI but is facing pushback from the legislature. If Pennsylvania joins, its membership would likely be effective in 2023 and would likely result in the closure of the remaining coal-fired power generation in the state. A possible consequence of Pennsylvania joining RGGI would be increased power generation from the coal plants in West Virginia and Ohio, many of which accept coal delivered by barge (*72*).

Longer term there may be an increased push towards a Federal Renewal Portfolio Standard (RPS) or its equivalent. The plan proposed by President Biden during the campaign calls for net zero carbon emissions in the power market by 2035. While unlikely at the Federal level due to a split Congress, many states are considering their own plans with a similar structure that could gradually erode the domestic market for coal. There has been some interest in retrofitting carbon capture technology on both coal and natural gas plants that could allow continued operation even under a net zero requirement.

Figure 14 indicates that electricity generation in the U.S. has effectively been flat for the last 15 years, but there has been a dramatic shift in the fuel used over the last 11 years. As a result, low natural gas prices and subsidized renewables have squeezed coal generation.[21] While there is a general expectation this trend will continue, factors that could alter the pace of change include higher natural gas prices, potential loss of subsidies to keep existing nuclear plants in service, and renewable integration constraints. Higher load growth could change resource needs and planning.[22]

[21] The Midcontinent Independent Service Operator (MISO) has indicated renewable integration above 30 percent will cause a steep increase in power pricing.

[22] Utilities are beginning to recognize a significant increase in demand could occur with the penetration of electric vehicles for fleet traffic.



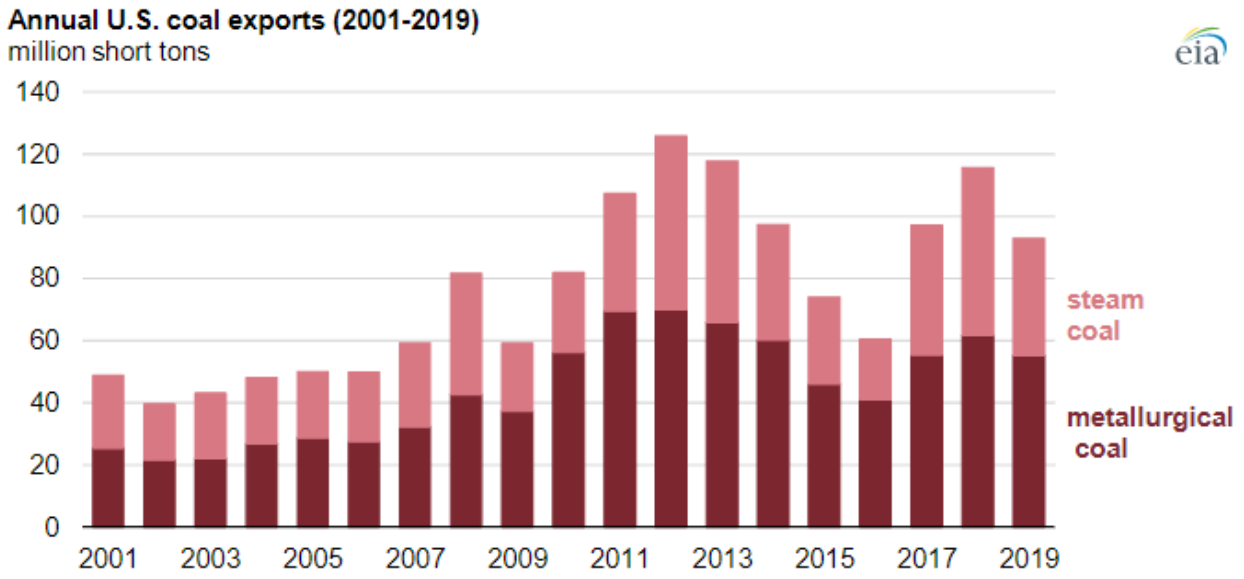
Source: (73)

Figure 14. U.S. Electricity Generation by Major Energy Source: 1950–2019.

The decline in the domestic market has been partially offset with increased exports. Most exports from Northern Appalachia are rail origin coal shipped through the East Coast terminals. Exports from the Illinois Basin, however, are largely barge shipments through the U.S. Gulf. While not moving through the PPC, excess barge capacity could be diverted to this market.

For 2019, India, Japan, the Netherlands, Brazil, and South Korea were the top five destinations for U.S. coal exports. Together, these countries accounted for 53 percent of coal exports (*74*).

Figure 15 shows the historical trend in U.S. coal exports. The volume of imports for these countries remained significantly higher over the last three years than the trough that was experienced in 2016.



Source: (74)

Figure 15. Annual U.S. Coal Exports (2001–2019).

Barge Surplus

There is an oversupply of barges due to the lack of older equipment being scrapped. This is a direct result of scrap metal prices that are not elevated enough to incentivize the replacement of aging equipment. Additionally, the barge capacity surplus has been brought on by declines in domestic coal and soybean shipments (*75*). Although agricultural shipments do not account for a significant portion of the shipments taking place in the Port of Pittsburgh, the effect of the decline in coal is important. Although agricultural shipments do not account for a significant portion of the shipments taking place in the Port of Pittsburgh, the effect of the decline in coal is important.

As a result of market reaction, the fleet size is expected to shrink in the coming years. Tax laws now allow used equipment to be expensed at 100 percent, so it is no longer necessary to purchase new equipment for bonus depreciation. When steel prices are high, the price of a new covered hopper barge may be difficult to support long term.

During 2020, amid the COVID-19 pandemic, the overall barge market remained relaxed, due to lighter cargo volumes, with a slight uptick in tanker usage. The COVID-19 pandemic has caused short-term shifts away from waterways and toward trucks as supply chains scrambled to adapt to pandemic-driven drops in demand and changes in consumption. Industry is hoping that 2021 will bring market stability and a rebound where more normal patterns of travel and consumption will be resumed.

Construction Schedule for U.S. Army Corps of Engineers

Issues with construction delays have been explored in Chapter 2. According to testimony given to the U.S. House of Representatives Transportation and Infrastructure Committee's Subcommittee on Water Resources and Environment in April 2019, more than 15 authorized high-priority inland projects awaited construction.

With the passage of WRDA 2020, there is the expectation that projects will begin to advance more quickly. With the new provisions, the cost share of construction will shift to 65/35, with

> At the current funding level, many projects will not even begin construction in the next 20 years.

the majority coming from the general treasury, and the remaining 35 percent coming from the Inland Waterways Trust Fund (IWTF). Previously, new construction and major rehabilitation projects were authorized with a 50/50 cost share, meaning only about $230 million a year would have been available. Under the new funding, an estimated $332 million will be available for FY 2021. The new cost-share is effective from January 2021 through December 31, 2031.

The new 65/35 percent cost share will provide more than $330 million in new construction and rehabilitation funding yearly.

Failing to accelerate project delivery increases the probability of a major lock failure. Waterways are most often the least expensive shipment mode. Industries that use the waterways are typically located where they can take advantage of the river and are designed specifically for that purpose. Because of this feature, inability to use the river will have serious economic repercussions for the region. In a recent study on the Ohio River (*5*), it was noted that as many as 80 percent of industries that would be cut off from the water would either relocate or shut down.

Failing to accelerate project delivery increases the probability of a major lock failure.

Because waterways tend to connect remote regions with each other and the international market, a closure affects much more than just the local traffic; the effects will be felt in multiple states. Power generation might very well be disrupted because of the lack of coal. It will also add to the already burdened highway and rail systems in large sections of the country.

Zoning Issues (Waterfront Development)

Pittsburgh, as is the case in many U.S. cities, was established on a waterway—specifically, at the confluence of two rivers that forms the Ohio River. The connection the three rivers offered to other major population and economic centers was and continues to be important; the city has traditionally relied on port infrastructure and services to fuel its economy. The success of the port community has enabled the city to grow, resulting in a situation where the port is now surrounded by non-port interests and activities. Many developers view the riverfront as an ideal location to develop business, residences, and recreational assets that will enhance the quality of life for area residents. Although this is a good thing for the community, at times the need to maintain commerce and provide an area for river-dependent industries to operate has been lost in planning activities—often inadvertently. Pittsburgh has not been immune to these situations.

In December 2015, the Pittsburgh Mayor's Office issued a press release promoting a change to the zoning laws regarding riverfront development within city borders. The change involved the creation of an interim Riverfront Overlay District that would institute stricter zoning controls. Port stakeholders were quick to point out that limiting the type of industry that locates in the zone would hinder industrial development because industries needing the river would be barred from river access. They expressed concern that the groundwork would be laid to push undesirables off the river and out of the city.

Interestingly, a lack of maintenance may lead to the unintended consequence of losing the stable pools on the rivers that make them attractive and that draw many of these new stakeholders to the city's waterfronts in the first place.

It is important to note that from a navigation perspective, reducing the use of the waterways by local industry will reduce the priority status of area locks and dams for maintenance. It is doubtful that stakeholders along Pittsburgh's riverfronts will be willing to pay to keep locks and dams in good repair should industrial

users and freight traffic cease to use the rivers. It will almost certainly result in higher costs to repair roads that will be damaged by the increase in truck traffic. Furthermore, a lack of maintenance may lead to the unintended consequence of losing the stable pools on the rivers that make them attractive and that draw many of these new stakeholders to the city's waterfronts in the first place (*76*).

Because of stakeholder concerns, the Planning Commission revised the language of the zoning ordinance. It added that one of the goals was "preserving existing industry"—language that suggests more active governmental support and encouragement of industry. At a minimum, it recognizes the important role played by industry (*77*).

The Interim Planning Overlay District was in effect for approximately two years, at which time (July 2018) permanent zoning standards were put into place via the Riverfront Zoning District, known as "RIV, Riverfront" (*78*). Judging by the lack of opposition to the new district ordinance, industry's main concerns appear to have been adequately addressed. [23] However, this process highlights the fact that as urban populations grow and as communities focus on reclaiming brownfield sites and putting the land to what the community considers to be the highest and best use, the demand for riverfront space will increase, and industry will need to be aware of such pressure to avoid losing access to the riverfront. Further, as more people take to the water, serious safety concerns will need to be addressed as untrained and uninformed boaters interact with barge tows moving on the river.

Problems with Benefit-Cost Analysis Methodology

USACE is required to calculate a BCR for all major rehabilitations and new construction projects. In simple terms, this is the ratio of the benefits the project offers to the cost of the project. (This process is known as BCA.) A threshold ratio (or BCR)—currently 2.5—is used to qualify or eliminate projects for further consideration by the Administration in the formulation of its annual budget proposal. Several problems with the way this ratio is currently determined are having a strong negative impact on the prioritization and funding of inland navigation projects within the Pittsburgh region and across the entire inland waterway system. Although the ratio of benefits to costs is not a meaningful indicator of the actual value of net benefits and should not be used for ranking purposes, this is precisely what is often done in the current Administration ranking process.

The current methodology focuses almost exclusively on transportation cost savings made possible by inland navigation in comparison to trucking or rail. USACE recognizes that other benefits and uses are derived from the navigation system, such as hydropower, recreational boating, riverfront development, and water supply; however, these benefits are not considered for Administration budget development determinations. Thus, for example, the economic benefits of attracting megaprojects like the Shell ethane cracker, discussed in the next chapter, are not included. Guidance for the Upper Ohio Navigation Study provided by USACE Headquarters limited the non-navigation benefits that can be considered in the economic evaluation to roadway congestion (*40*).[24]

As one report noted, "BCA should consider the costs and benefits to society, not just the difference in transportation costs. When the public invests money in a project, it should benefit society to the greatest degree possible" (*18*). Several externalities are commonly used in BCA for non-USACE infrastructure projects that could be but are not included in the USACE guidance. In addition to the

[23] The Port of Pittsburgh Commission did not support the Riverfront Zoning decision due to the negative impact on industrial development.

[24] The roadway congestion costs were calculated to be approximately 25 percent of the traditional transportation benefits measured as the cost savings of waterway-routed shipments compared to the least cost of all overland routing.

benefits that are excluded, the manner in which the costs and benefits are presented makes it virtually impossible for the reader to evaluate the validity of the benefit and cost streams in such analyses.

For example, the Transportation Investment Generating Economic Recovery (TIGER) grant program (now the Better Utilizing Investments to Leverage Development, or BUILD, program) has demonstrated that a range of externalities can be feasibly incorporated into benefit-cost analyses. TIGER guidance went so far as to encourage the analyst to include benefits that are not monetizable and even benefits that are not quantifiable. (However, it did not discuss how this consideration would influence final project selection.)

The singular focus on transportation cost savings results in USACE's BCRs and investment priorities being greatly influenced by the amount of traffic at a lock. A drop in waterway tonnage in the Pittsburgh area might threaten funding opportunities for critical lock and dam investment needs. In its Upper Ohio Navigation Study, USACE stated, ""The question then becomes whether the continued maintenance of the navigation system is warranted given the potentially large investment that will be needed to modernize the aged projects." The USACE report also noted that the movement to minimize the use of coal-fired plants for electricity generation could lead to even less coal being moved by barge and that the "effects on barge transportation of coal could be negative and greatly diminish the utility of the waterborne transportation system" (7). Such an analysis does not consider the broader effects on society and the economy; instead, it creates a negative spiral as less traffic leads to less investment, which in turn causes industry to lose confidence in the system, which in turn leads to less traffic, and so on.

In BCA, all project benefits must be stated in today's dollars by discounting future flows. The farther out a financial flow occurs, the more heavily it is discounted. Navigation projects are at an immediate disadvantage because costs are immediate, but the benefits will occur over a long time period, resulting in heavy discounting of benefits. Additionally, the interest rate that is used for the discounting procedure affects the results dramatically—the higher the rate, the lower the present value. The OMB uses interest rates that are much higher than what financial markets indicate are reasonable. The current discounting practice reduces the number of long-term projects that pass the BCR test.

When evaluating risks, USACE will often adjust costs to reflect the risk of uncertain funding but does not consider the cost of delaying benefits or whether a delay might even eliminate benefits. Although they are not a formal part of the BCA, delays in funding can have a devastating effect on a project's viability by significantly increasing costs without increasing benefits. Delays as short as three years can double the social cost of a project by increasing costs while delaying benefits (*18*). When projects are delayed and then re-evaluated, their BCR tends to suffer a dramatic decline.

WRDA 2018 contains provisions that require studies by the National Academy of Sciences and Government Accountability Office (GAO) that will evaluate potential reforms to the USACE BCA process and the project delivery process. One specific requirement is that the studies must examine the idea of counting lost ecosystem services as a project cost for purposes of BCA.[25]

For USACE's BCA procedures to be modified, legislative changes and high-level policy changes will have to occur. Several national associations are focused on providing influence in this area.

[25] It does not appear that these provisions have been implemented.

Trade War

In a recent presentation at the 2019 WCI Waterways Symposium held in Pittsburgh in November 2019, Tom Scott, Global Director of Agribusiness Consulting for IEG Vantage, pointed out that (what was then) the strong U.S. economy could suffer a strong negative impact from U.S./China trade tensions, trade conflicts among other players, conflicts in the Middle East, and a hard Brexit. The unwinding of global trade agreements requires a global resetting of trade relations, and this reset has caused what Scott said was a level of social protests around the world unmatched since the late 1960s and early 1970s (*27*).

However, Scott said the future growth engine of the world economy lies not in China—which is carrying a corporate debt load of 150 percent of GDP, as opposed to the United States' 75 percent—but in the rest of Southeast Asia. Indonesia can anticipate a 5 percent growth rate (*27*). The longer the U.S.-China trade war continues, the more tempting it will become for global companies to restructure their supply chains.

This much is clear: As the fourth quarter of 2019 opened, U.S.-China trade volumes continued to drop. China is no longer the United States' largest bilateral trading partner—now ranking third after Mexico and slightly below Canada. In July 2019, U.S.-China bilateral trade totaled $50.2 billion, compared to a U.S.-Mexico bilateral trade volume of $52.2 billion (*79*).

Foreign resentment about Chinese trade practices that built up during previous U.S. presidencies eventually "broke loose under the Trump administration." Widespread belief exists that China's current regime, led by President Xi Jinping, "has really gone backwards in terms of its commitment to markets. … There is a growing sense [that China] really wants to dominate the world" (*79*).

In a poll conducted by Reuters, approximately 80 percent of the more than 60 economists who responded said they expect the U.S.-China trade fight to either worsen or stay the same throughout 2020. No historical precedent with which to compare this situation exists (*19*). The recent tariff increases are unprecedented in the post-World War II era. Their breadth, magnitude, and the sizes of the countries involved have never been seen before (*20*).

In August 2019, Goldman Sachs warned that the trade war could spark a recession. It had already lowered GDP by 0.6 percent (*80*). In September 2020, Tax Foundation estimated that if other countries follow through on their threats to impose tariffs on U.S. exports, U.S. GDP would fall another 0.04 percent ($9.79 billion) and cost an additional 30,300 full-time equivalent jobs (*81*).

Trade statistics show that Pennsylvania has been affected by the dispute with China. The percentage change in the state's exports to China for all merchandise dropped 9 percent YTD September 2019 from YTD September 2018. The 2018 top export to China was in the category of "Coal, Petro Gases" (*21*).

Steel has been one of the specific targets of tariffs imposed by the Trump administration. Tariffs on imported steel caused prices in the United States to climb to near 10-year highs during the summer of 2018, followed by a nearly yearlong price "skid from July 2018 to July 2019, with 10-year highs replaced by three-year lows. The drop pushed steel prices to levels not seen since the collapse of oil prices in 2015-2016" (*82*).

It appears that the sudden decline was due in part to an overreaction to the 25 percent tariffs. Fear of a supply crunch and uncertainty of how the markets would react led to a spike in buying activity. The spike caused a spiral in which buyers bought significant amounts earlier than they normally would, fearing higher prices if they waited. The need to consume this excess inventory caused a decline in demand in 2019 since inventories had to be reduced. As one blog noted, "Another factor, which was actually a goal

of the tariff regime, was a pickup in supply from restarted domestic capacity and higher mill run rates. Domestic steelmakers looked to capitalize on the high steel prices by bringing back previously shuttered capacity. Restarted capacity was coupled with higher mill utilization rates following the tariffs, leading to the highest annual domestic steel production since 2014 at 95.47 million [short tons]. Despite the price slide in the second half of 2018, domestic steelmakers recorded record profits" (*82*).

The increases in capacity may have direct effects on steel production in Pennsylvania. The new mills, with their modern technology, will enable the U.S. steel industry to compete on the global stage more effectively. However, this same market dynamic will mean that higher-cost mills will have to either shut down or consolidate. The effect it could have on Pittsburgh may merit further detailed analysis.

While tariffs might help domestic steel producers, they hurt the segment of the industry that buys steel and processes it. Although there are no statistics on how significant this effect is, reports indicate that NLMK Pennsylvania laid off 100 of its 430 steelworkers and cut 35 salaried office positions in early December 2019, citing higher import costs (*83*).

CHAPTER 4: TRENDS AND OPPORTUNITIES

This chapter provides an overview of trends taking place that may affect the volume and/or types of commodities handled on area waterways. It also identifies opportunities for the Pittsburgh industrial community to increase its traffic and expand the types of commodities handled. Specifically, this chapter covers the following themes:

- Energy
- Legislation
- Improvements in marine transportation operations
- Commodity mix
- Marine highway funds

Energy

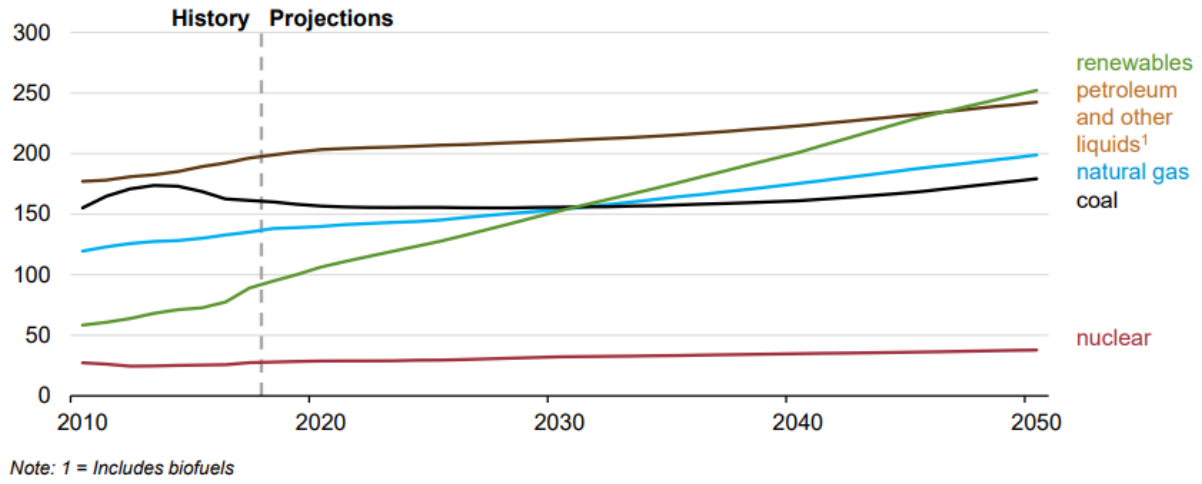
Energy Demand

Energy companies are important components of the Pittsburgh industrial complex. Several very well-known companies are located in the area (*70*):

- CNX Resources
- CONSOL Energy
- Duquesne Light Company
- FirstEnergy
- Mitsubishi Electric
- American Consolidated Natural Resources *(formerly Murray Energy Corporation)*
- Peoples Natural Gas
- Range Resources
- Shell Chemical Appalachia
- Westinghouse Electric Company

Dramatic changes in global energy consumption are expected over the next 30 years. Renewables are expected to grow 250 percent from about 100 quadrillion Btu in 2020 to over 250 quadrillion Btu in 2050, at which time renewables are expected to overtake petroleum and other liquids for the largest share of world energy consumption. Natural gas is also expected to increase, though at a slower rate. Coal, on the other hand, is expected to decline slightly from 2020 levels over the next decade and then increase slightly through 2050 (*84*).

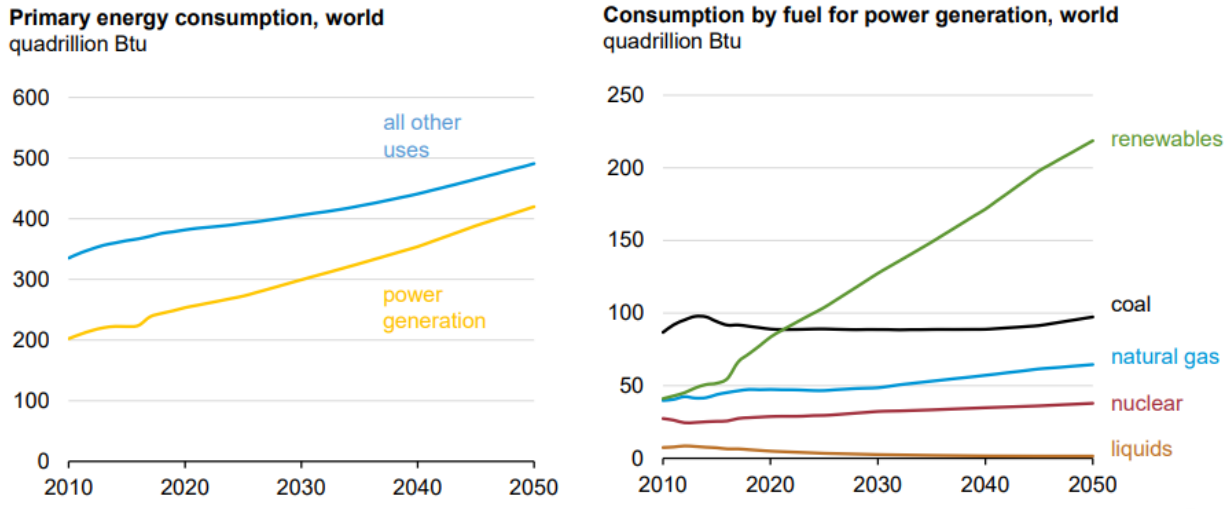
Figure 16 shows the expected trends in world energy consumption by type.



Source: (84)

Figure 16. World Energy Consumption by Fuel, 2010-2050 (quadrillion Btu).

The power sector is the largest source of energy consumption globally. The global dominance of renewables is imminent. Coal, however, remains the second largest source through 2050 according to the EIA International Energy Outlook's most recent (2020) forecast. Figure 17 shows the expected fuel-mix for power generation through 2050.



Source: (84)

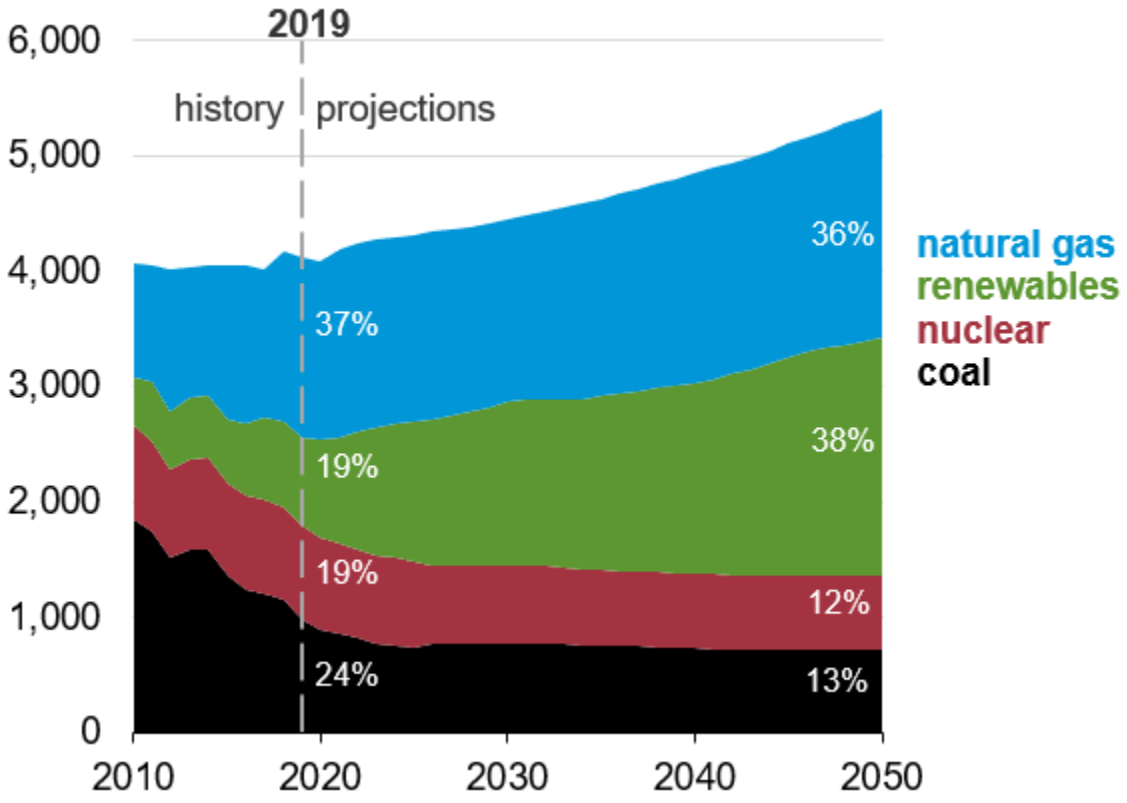
Figure 17. Forecast of Electric Power Generation Fuel-mix.

The near-term decline in coal reflects several factors including declines in the U.S. and Europe which have an aging coal fleet competing against low priced natural gas, subsidized renewables, and, in some cases, carbon regimes. In Asia, Latin America, and elsewhere, coal-fired generation continues to be economic. If there is global adoption of carbon capture technologies, coal could remain viable even under a strong carbon control protocol.

In the U.S., the outlook is somewhat different. In the most recent Annual Energy Outlook, the Energy Information Administration (EIA) forecasts that renewables will account for most power generation by

2050 but not at the same level of dominance. EIA shows natural gas to be a close second. There are several reasons for this outlook, not the least of which is that the primary EIA forecast is not allowed to reflect regulations that do not yet exist. Nevertheless, coal use continues in the EIA forecast through 2050 (85). There is considerable uncertainty about the rate of decline in coal generation in the U.S., much of which is driven by the price of natural gas. Higher gas prices result in a swing to coal as long as the capacity is still available.

Figure 18 shows the projected share of fuel types used for electricity generation through 2050.



Source: (85)

Figure 18. Forecast of Electricity Generation from Selected Fuels in the United States (billion KWh).

In the EIA outlook, the surviving coal plants, generally speaking, are those which are considered to be more efficient and less damaging to the environment. Many have super-critical boilers and are equipped with pollution control equipment that achieves full compliance with existing regulations. Lower ratios of Btu's consumed per kilowatt of electricity produced combined with access to lower-priced coal allow them to retain their competitiveness under normal conditions. The surviving coal plants include the Fort Martin and Longview plants on the Monongahela River, the Sammis, Cardinal, Mitchell, Pleasants, Mountaineer, Gavin, Kyger Creek, Spurlock, Zimmer, and Beckjord plants on the Ohio River between Pittsburgh and Cincinnati, and the Amos plant on the Kanawha River. These plants take either all or a majority of their coal via barge. Collectively these plants burned over 30 million tons of coal in 2019 (*3*).

Refining locations are unlikely to change, and importantly, these locations are often (if not universally) more easily served by barge than by rail. Again, while pipelines are the preferred mode for shipping crude oil to refineries, they often are not available or do not have adequate capacity for growth from new sources of production (*28*).

The IEA estimates that the United States will account for 70 percent of the increase in global petrochemical capacity through 2024—adding a total of 4 Mbd, with net exports reaching 9 Mbd. Chemical demand growth will outpace the growth in GDP through 2025. Global liquids demand will grow by roughly 30 percent by 2040 (*23*).

Fracking Industry and Industrial Development

Up to 95 percent of new wells drilled today are developed using hydraulic fracturing (fracking) (*25*). The abundance of oil and natural gas produced by the fracking industry has led to the United States becoming a net exporter of oil and natural gas and to explosive growth in the petrochemical industry. While the current drop in demand and the oversupply of oil on the world market are putting the brakes on fracking development, this condition is considered to be short term and will correct itself over the next few years.

It is interesting to note how the shale plays in Pennsylvania differ from the shale plays in the Permian Basin in west Texas. The wells in the Permian Basin are drilled because of the oil they produce—gas is a byproduct of the drilling effort. In the Marcellus and Utica Shale Plays, gas is the principal product. At the time of this report, activity in the Permian Basin had diminished significantly because of the low price of oil. The gas that would ordinarily be produced is shut in. The Marcellus and Utica Shale Plays can supply the gas that would have ordinarily come from the Permian Basin.

Pennsylvania has one of the larger shale plays[26] in the United States. The Marcellus Shale formation, located in Pennsylvania, New York, Ohio, and West Virginia, is the second largest such shale formation in the world, covering more than 95,000 square miles (*86*). The Marcellus formation extends under three-fifths of Pennsylvania and parts of West Virginia, New York, Ohio, and Maryland (*87*). The Marcellus Shale Play and the Utica Shale Play, which underlies the Marcellus, have become major fracking locations. The Marcellus Play is found 4,000 to 8,500 ft below the surface; the Utica Shale Play lies 4,000 to 6,000 ft underneath the Marcellus Play. According to the Pennsylvania

What is Fracking?

"Put simply, hydraulic fracturing is the process of injecting liquid and materials at high pressure to create small fractures within tight shale formations to stimulate the production and extract energy from an underground well after the drilling has ended and the rig and derrick are removed from the site. The process takes about three to five days, on average, to complete from start to finish. Once the fracturing operation is finished, the well is considered "completed" and is now ready to safely produce American oil or natural gas for years, even decades, to come."

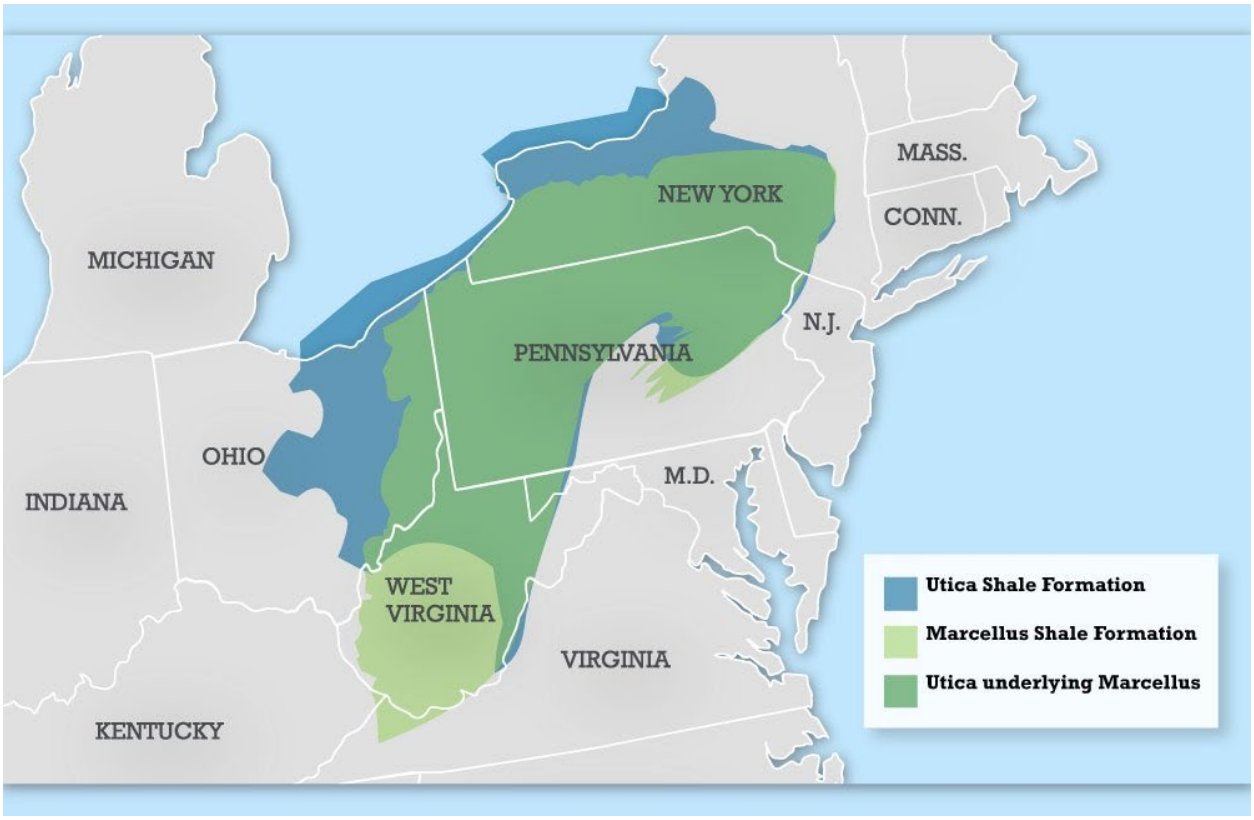
"Hydraulic fracturing involves safely tapping shale and other tight-rock formations by drilling a mile or more below the surface before gradually turning horizontal and continuing several thousand feet more. Thus, a single surface site can accommodate a number of wells. Once the well is drilled, cased, and cemented, small perforations are made in the horizontal portion of the well pipe, through which a typical mixture of water (90%), sand (9.5%) and additives (0.5%) is pumped at high pressure to create micro-fractures in the rock that are held open by the grains of sand. Additives play a number of roles, including helping to reduce friction (thereby reducing the amount of pumping pressure from diesel-powered sources, which reduces air emissions) and prevent pipe corrosion, which in turn help protect the environment and boost well efficiency."

Source: *Hydraulic Fracturing*. Independent Petroleum Association of America, Washington, DC. https://www.ipaa.org/fracking/

[26] A play is a geographic area that possesses oil and/or gas in sufficient quantity to make development economically viable.

Independent Oil & Gas Association, "If only 10% of the gas is recovered [in the Marcellus], it would be enough to fuel the entire United State for two years and would be worth over $1 trillion" (*88*). A map depicting the extent of these plays is shown in Figure 19.

It is predicted that the natural gas from the Marcellus and Utica Shale Plays will account for more than 40 percent of the nation's natural gas production by 2030. The Appalachian region is now the third-largest natural gas-producing region in the world, trailing only "all of the U.S." and Russia (*26*). Thus, Pennsylvania is now a net energy exporter rather than an importer (*27*).



Source: (89)

Figure 19. Location of Marcellus-Utica Shale Formation.

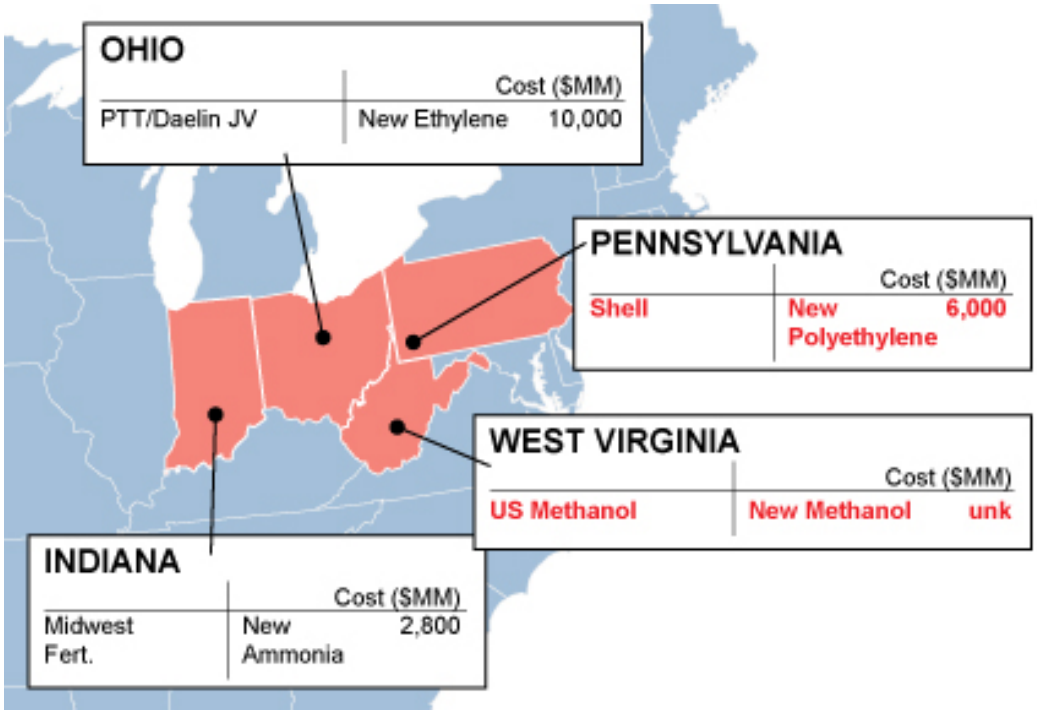
Fracking requires significant amounts of sand and water. At first glance, it appears the Marcellus Shale Play provides opportunities to move significant volumes of sand and water on area rivers (*10*). (The literature indicates that for barges to compete for sand shipments, the quarries need to be within 40 miles of the waterways [*90*].) Cargo statistics for the Port of Pittsburgh show a mild spike in sand and gravel movements in 2014–2015, followed by significant declines in the following years. Cement and concrete shipments have been fairly consistent to earlier years in the decade. These numbers indicate that Pittsburgh's navigation interests have not been able to benefit from the shipments of sand to drilling sites. In fact, a large portion of fracking sand shipments offload in southeastern Ohio rather than Pennsylvania. Industry had hoped that the Coast Guard would promulgate regulations that would make it feasible to move wastewater by barge, but the Coast Guard decided to handle the permission for such moves on a case-by-case basis that requires testing of the composition of each load, which makes such moves infeasible.

The majority of the drilling and production activity in the Marcellus Shale Play continues to take place in northeast and southwest Pennsylvania, especially in Susquehanna and Washington counties (*91*). To

date, logistics support for the Marcellus Play has been almost exclusively by rail and truck. Natural gas is not routinely moved by barge, nor is that likely to change. However, natural gas is a critical feedstock in the manufacture of many chemicals that are subsequently moved by both barge and rail (*28)*. The world's largest petrochemical facilities (e.g., Houston and Rotterdam) are located on the waterfront and use the water extensively to move products between facilities in the manufacturing process.

Pennsylvania is well positioned to take advantage of these shale plays and strengthen its economy because it offers several advantages: freight advantages driven by the availability and abundance of natural gas and natural gas liquids (NGL), proximity to high-demand North American end-use markets, existing and planned infrastructure investments, a skilled workforce and specialized talent pipeline, and a well-established plastics manufacturing industry (*29*). Pittsburgh is the largest metro area atop the Marcellus and Utica Shale Plays and stands to profit from its location within the production area.

"Up to 40% of natural gas produced in the Marcellus and Utica Shale Plays is rich in NGL, more than 70% of which is ethane and propane. This has important economic consequences for existing and potential petrochemical manufacturing companies in the region as ethane and propane are important raw materials for petrochemical production" (*29*). In fact, major industrial developments are taking place in southwest Pennsylvania and southeastern Ohio as a result of the fracking industry boom. Figure 20 shows major chemical investments announced for the midwest and northeast regions of the country that are expected to come online in the near future. Several are in Pennsylvania and Ohio.



Source: (24)

Figure 20. Major Petrochemical Investments in the Region.

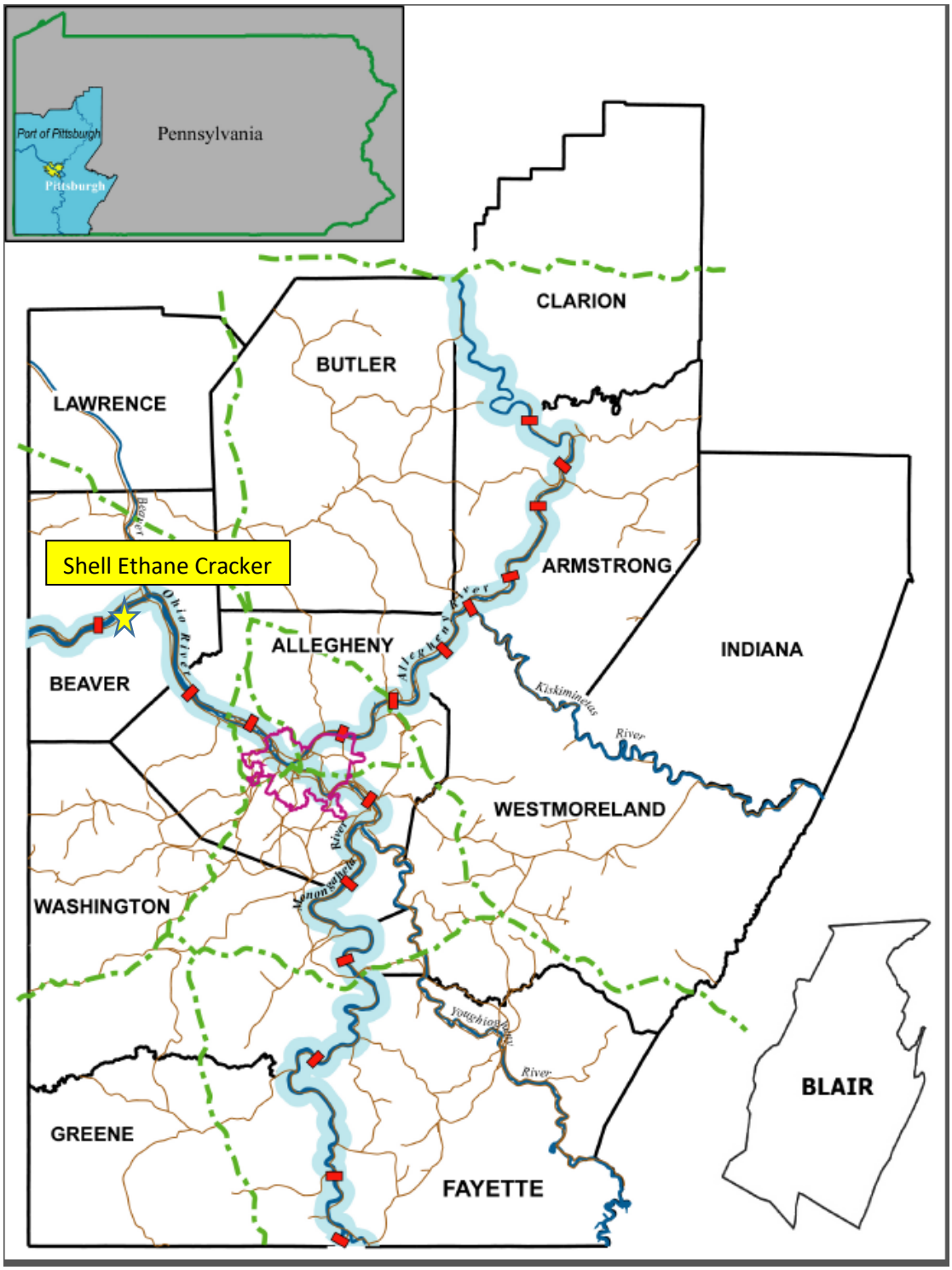
Shell is investing $6 billion dollars in an ethane cracker plant on the Ohio River within the port, which is the largest private investment project in the history of Pennsylvania (*29*). A photo of the plant under construction is shown in Figure 21, and its location is shown in Figure 22. The plant will produce polyethylene and polypropylene for sale on the world market. Shell has noted that more than two-thirds of U.S. and Canadian demand for polyethylene and polypropylene is located within 700 miles of southwestern Pennsylvania and that the location will be more cost effective for its customers than existing facilities along the Gulf Coast (*92*).

Shell's Ethane Cracker

- Largest private investment in the history of Pennsylvania.
- Expected to produce 3.2 billion pounds of plastic pellets.
- Up to 6,000 estimated jobs at peak construction.
- 600 jobs once operational.
- First major U.S. project of its type built outside Gulf Coast region in 20 years.
- Approximately 1200 acres, when assembled.
- 30 miles from downtown Pittsburgh.
- 15 miles from Pittsburgh International Airport

Source: Shell Says Yes to Greater Pittsburgh Region, https://www.pittsburghregion.org/shell/

Figure 21. Shell Ethane Cracker Under Construction.



Source: Google Maps

Figure 22. Location of Shell Ethane Cracker.

Shell executives have emphasized that the proximity of a reliable waterway system was absolutely vital to the Shell project's site selection. At least 60 percent of its heavy equipment was moved by water, including a quench tower that was installed in one piece instead of two because it was possible to ship it by water instead of by rail or truck (*27*). Moreover, as discussed in Chapter 1, the Ohio River connects Pittsburgh to a large section of the United States, and it provides a relatively inexpensive method for delivering product within that zone.

At least 60 percent of Shell's heavy equipment was moved by water, an important factor in attracting other major plant investments.

Ethane is the primary raw material for a cracker. The plant will first "crack," or break apart, ethane molecules and rearrange the carbon and hydrogen atoms to create ethylene. This is accomplished by heating the ethane to very high temperatures (greater than 1500°F [800°C]) in one of the cracker's seven furnaces. Natural gas and "tail gas" (a hydrogen and natural gas combination from the furnace that is recycled) fuel the process.

The proximity of a reliable waterways system was absolutely vital to the Shell project's site selection. See the *Petrochemical Case Study* in Appendix D for further details.

The ethylene will be further processed to create different types of polyethylene. The Shell plant is slated to produce 1.5 million metric tons per year of ethylene, which will be converted to more than one million metric tons per year of high-density polyethylene and 550,000 metric tons per year of linear low-density polyethylene. These products are two of the fastest-growing and largest-volume plastic resins globally. Polyethylene pellets then will be shipped to manufacturers via railcar and truck to make many of the plastic products used every day. As has been noted, "Ethylene is the root chemical for a [wide variety] of plastics, resins, adhesives and synthetic products used in virtually every aspect of modern life. [It provides] the basis for plastics like beverage containers, food wrap, polyvinyl chloride (PVC), polyester, and chemicals like those found in antifreeze, solvents, urethanes and pharmaceuticals" (*29*, *93*). Appendix A contains information on typical downstream industries in the petrochemical product chain.

IHS Markit expects construction to be completed by 2021–22, including the significant feedstock and transportation infrastructure required (*29*).

PPTGC America

- Site has been selected.
- $200 million has already been spent.
- An environmental review has been completed by the Ohio EPA.
- A precedent agreement has been reached with Mountaineer NGL Storage related to the project.
- A long-term ethane feedstock agreement has been reached with Range Resources.

Source: PPTGC America Project Facts, http://pttgcbelmontcountyoh.com/project-facts/

Meanwhile, Thailand-based PTT Global Chemical (PPTGC) has been studying the feasibility of building a cracker plant in Belmont County, Ohio, which is about 75 miles southwest of Beaver County. The Final Investment Decision (FID) for this project is expected in 2021. The price tag for the potential cracker stands at about $10 billion, with an expected output of 1.5 million metric tons per year (*94*).

In addition to what Shell and PPTGC are doing, ExxonMobil is talking to local interests about the possibility of building a second cracker in the area. Local officials stress that ExxonMobil would likely need a large tract of flat land with river access to accommodate construction. The company has declined to confirm or deny reports that Beaver County may be a strong possibility for the plant (*95*).

A report by IHS Markit says the region could support up to four more ethane crackers like the one Shell is building, given the proximity to Marcellus Shale deposits (*29*). One site that is often mentioned because of its size and proximity to the river is the Robena site on the Monongahela River.

The region could support up to four more ethane crackers like the one Shell is building.

Multiple crackers in the region would provide redundancy to the nation if the Gulf region were to suffer a catastrophe.

According to USACE officials, the U.S. Department of Energy has expressed a desire to see multiple ethane crackers in the region to provide redundancy to the nation if the Gulf region is devastated for some reason (*57*).

The IHS Markit report lists 12 primary-use sectors that can benefit significantly from the development of Pennsylvania's petrochemical value chain *(29*). They provide an exceptional opportunity for regional development in southwestern Pennsylvania. Table 21 provides a brief overview of these sectors.

Table 21. Primary-Use Sectors for Ethane Cracker Output.

NAICS* Code	Code Description	Industry Description	Type of Products Produced	Forward Links to Other Sectors
Non-plastics sectors				
325211	Plastics Material and Resin Manufacturing	Establishments primarily engaged in (1) manufacturing resins, plastics materials, and non-vulcanizable thermoplastic elastomers and mixing and blending resins on a custom basis, and/or (2) manufacturing non-customized synthetic resins.	Intermediate process for the plastics industry	
325991	Custom Compounding of Purchased Resins	Establishments primarily engaged in (1) custom mixing and blending plastics resins made elsewhere, or (2) reformulating plastics resins from recycled plastics products.	Intermediate process for the plastics industry	

Table 21. Primary-Use Sectors for Ethane Cracker Output (Cont'd).

NAICS* Code	Code Description	Industry Description	Type of Products Produced	Forward Links to Other Sectors
Plastics Manufacturing sectors				
326111	Plastics Bag and Pouch Manufacturing	Establishments primarily engaged in: (1) converting plastics resins into plastics bags or pouches; and/or (2) forming, coating, or laminating plastics film or sheet into single-web or multi-web plastics bags or pouches. Establishments in this industry may print on the bags or pouches they manufacture.	Grocery bags, reclosable bags, food packaging pouches, shipping sacks	42, 44 Wholesale & Retail Trade; 561910 Packaging and Labeling Services; 311 Food Mfg.; 31199 Other misc. food mfg.
326112	Plastics Packaging Film and Sheet (including Laminated) Manufacturing	Establishments primarily engaged in converting plastics resins into plastics film and unlaminated sheet (except packaging).	Household appliance wrapping, automotive parts, household products, portions medical devices, construction film	3363 Automobile parts mfg.; 325 Chemical mfg.; 3352 Household appliance mfg.; 3254 pharmaceutical and medical mfg.
326113	Unlaminated Plastics Film and Sheet (except Packaging) Manufacturing	Establishments primarily engaged in converting plastics resins into plastics film and unlaminated sheet (except packaging).	Household appliance wrapping, automotive parts, household products, portions medical devices, construction film	3363 Automobile parts mfg.; 325 Chemical mfg.; 3352 Household appliance mfg.; 3254 pharmaceutical and medical mfg.
326121	Unlaminated Plastics Profile Shape Manufacturing	Establishments primarily engaged in converting plastics resins into nonrigid plastics profile shapes (except film, sheet, and bags), such as rod, tube, and sausage casings.	Household appliances, automotive parts, pharmaceutical bottles, wire & cable wrapping, extruded products	3352 Household appliance mfg.; 3363 Automobile parts mfg.; 3254 Pharmaceutical and medical mfg.; 33592 Communication and energy wire and cable manufacturing
326122	Plastics Pipe and Pipe Fitting Manufacturing	Establishments primarily engaged in converting plastics resins into rigid plastics pipes and pipefittings.	Flexible piping, such as those used for lawn & garden care, and municipal water & sewer, natural gas distribution	2213 Water & Sewer Utilities; 3331 agricultural, construction, and mining machinery mfg.; 23711 water and sewer line & related structure construction
326130	Laminated Plastics Plate, Sheet (except Packaging), and Shape Manufacturing	Establishments primarily engaged in laminating plastics profile shapes such as plate, sheet (except packaging), and rod. The lamination process generally involves bonding or impregnating profiles with plastics resins and compressing them under heat.	Plastic lawn inserts and tools, rigid automotive parts (such as dashboards), household consumables	3331 Agricultural, construction, and mining machinery mfg.; 1114 Greenhouse and nursery supplies; 325620 Personal care product mfg.
326160	Plastics Bottle Manufacturing	Establishments primarily engaged in manufacturing plastics bottles.	Bottles for carbonated water, juice, soda, milk, etc., medical/ pharmaceuticals bottles, chemical bottles	3121 Beverage mfg.; 311511 Fluid Milk mfg.; 325 Chemical mfg.

Table 21. Primary-Use Sectors for Ethane Cracker Output (Cont'd).

NAICS* Code	Code Description	Industry Description	Type of Products Produced	Forward Links to Other Sectors
326191	Plastics Plumbing Fixture Manufacturing	Establishments primarily engaged in manufacturing plastics or fiberglass plumbing fixtures. Examples of products made by these establishments are plastics or fiberglass bathtubs, hot tubs, portable toilets, and shower stalls.	Consumer products for home improvement, lawn & garden	3331 Agricultural, construction, and mining machinery mfg.; 332913 Plumbing fixtures and trim mfg.
326199	All Other Plastics Product Manufacturing	Establishments primarily engaged in manufacturing plastics products (except film, sheet, bags, profile shapes, pipes, pipefittings, laminates, foam products, bottles, and plumbing fixtures).	Drums, consumer goods, industrial liners, packaging, food containers, medical/ pharmaceuticals	31199 Other misc. food mfg., 561910 Packaging services; 32619 Containers mfg.; 339930 Toy mfg.; 3254 Pharmaceutical and medical mfg.
Wholesale trade				
424690	Other Chemical and Allied Products Merchant Wholesalers	Establishments primarily engaged in the merchant wholesale distribution of chemicals and allied products (except agricultural and medicinal chemicals, paints and varnishes, fireworks, and plastics materials and basic forms and shapes).	Intermediate process for the plastics industry	

**North American Industry Classification System.*
Adapted from (29).

Pennsylvania is favorably located in respect to the northeast and midwest markets. In addition to proximity, the area offers low-cost waterborne transportation and industrial sites for development.[27]

Interviews conducted for this report indicate that this downstream activity is not expected to create significant additional demand for barge services. However, the waterways and existing barge services are what make this type of development and the continued maintenance and operations of these facilities possible; the entire region is benefiting tremendously from the existence of the waterways' infrastructure.

> The entire region is benefitting tremendously from the existence of the waterway infrastructure.

One infrequently mentioned benefit of the fracking activity in the region is that the abundance of gas in the region has caused wholesale electricity prices to drop 41 percent since 2008, and natural gas prices for end-users are down by 56 percent, which makes the state more attractive to potential new business (*27*).[28]

Legislation

The Process

According to a Congressional Research Service report, "For USACE studies and projects, congressional study and project authorization generally is required prior to being eligible for federal appropriations. Congress generally considers an omnibus USACE authorization bill biennially. The bill is typically titled a

[27] The 473-acre Bruce Mansfield Power Plant, less than 5 miles from the Shell site, was recently closed and is available for redevelopment.
[28] Fourteen natural gas power plants have been built from the ground up, and six more have been retrofitted from coal to natural gas.

Water Resources Development Act (WRDA). Agency action on an authorization typically requires funding; that is, both an authorization and an appropriation are needed to proceed. Most water resource project authorizations in WRDAs fall into three general categories: project studies, construction projects, and modifications to existing projects" (*96*).

WRRDA 2014

The Water Resources Reform and Development Act of 2014 (WRRDA 2014, P.L. 113-121) became law on June 10, 2014. The legislation authorized USACE to establish programs to evaluate the effectiveness and efficiency of allowing nonfederal applicants to carry out certain authorized project activities. For example, WRRDA 2014 included the following (*96*):

- Section 1043 authorized the transfer of federal funds to nonfederal entities to use for the construction of authorized USACE projects.
- Section 5014 authorized a Public-Private Partnership (P3) pilot program for USACE water projects and set the general parameters for that program.[29]
- Various provisions that expanded opportunities for crediting for nonfederal work, financial contributions, and study and project management, including a requirement for the Assistant Secretary of the Army for Civil Works to establish a five-year pilot program for nonfederal management of studies and a five-year pilot program of 15 projects for nonfederal management of project construction.

WRRDA 2014 authorized many of the project delivery recommendations made by the IWUB and updated for the first time in more than 20 years the threshold above which the IWTF is authorized to cost share a rehabilitation project (now an inflation-adjusted $20 million). One of the most widely heralded provisions of the act was the reduction of the IWTF portion of the cost-sharing requirement for the Olmsted Locks and Dam Project from 50 percent to 15 percent (*30*).[30] This change allowed a much larger amount of IWTF funds to be spent on other projects, while also helping expedite completion of the Olmsted project by four years and lowering the then-projected completion cost by $330 million (*31*).

WRRDA 2014 also authorized, through the Water Infrastructure Finance and Innovation Act (WIFIA), a program to provide direct loans and loan guarantees for USACE and EPA water projects. Although the WIFIA program administered by the U.S. Environmental Protection Agency is operational, the USACE WIFIA program for navigation, flood risk reduction, and ecosystem restoration projects has not been implemented (*96*).

Finally, WRRDA 2014 encouraged completion of USACE studies within three years, limited study costs, and established new procedures intended to expedite USACE completion of environmental compliance requirements, including the NEPA. Most of these provisions intended to expedite the following:

- USACE studies by establishing deadlines, schedules, or funding limits for feasibility studies and eliminating certain study requirements.

[29] P3 arrangements for lock projects are strongly opposed by barge industry and shipper interests. A P3 arrangement implies the existence of a revenue stream to compensate the private investor, which involves some type of lockage or other fee or tax. In simple terms, some companies operate on parts of the system where there are few locks and others operate where there are a great many. A lockage fee, for example, unfairly disadvantages those parts of the country where consumers must pay more for their goods or electricity because shippers are paying more for transportation and must recover the additional cost in the prices they charge. In addition, there are other beneficiaries of the waterways—commercial boaters and fishermen, hydropower plants, municipal and industrial water supplies, flood control—all of which justify expenditures from the general treasury for the welfare of society at large.

[30] Up to this point, the Olmsted Project had been requiring a large portion of the IWTF balances.

- Environmental compliance requirements, including primarily provisions intended to expedite USACE compliance with the NEPA and outside agency issuance of any permit, review, or other approval required under any applicable federal law.
- USACE permitting (*96*).

WRDA 2016

WRDA 2016 is Title I of the Water Infrastructure Improvements for the Nation Act (P.L. 114-322), which became law in December 2016. Most importantly, particularly to the Port of Pittsburgh and the entire Southeast Pennsylvania/West Virginia/ Ohio region affected by the project, WRDA 2016 authorized construction of the Upper Ohio Navigation Project.

"(Both) WRRDA 2014 and WRDA 2016 expanded the authorities for nonfederal entities to perform studies and construct projects (or elements of projects) that typically would have been undertaken by USACE. These statutes also provided that the costs of these nonfederal-led activities are shared by the federal government largely as if USACE had performed them. That is, nonfederal entities advancing water resources projects may be eligible to receive credit or reimbursement (without interest) subject to the availability of federal appropriations for their investments that exceed the required nonfederal share of project costs. These authorities typically require that the nonfederal entity leading the project comply with the same laws and regulations that would apply if the work were being performed by USACE" (*96*). Sections 1127, 1166, and 1171 of WRDA 2016, for example, changed authorities for crediting and reimbursing nonfederal entities for project-related expenditures.

WRDA 2018

WRDA 2018 is titled America's Water Infrastructure Act of 2018 (AWIA 2018, P.L. 115-270) and was enacted in October 2018. Three specific sections are relevant to this report.

1. Section 1103. Study on economic and budgetary analyses.

   This section requires USACE to enter into an agreement with the National Academy of Sciences to carry out a study on the economic principles and analytical methodologies used by USACE for BCA and make recommendations on potential changes.[31]

2. Section 1137. Nonfederal implementation pilot program.

   This section reauthorizes and increases the number of projects eligible for a pilot program that allows the Secretary to provide a non-Federal interest full project management control over a water resources development project, pursuant to section 1043 of WRRDA 2014.

3. Section 1204. GAO study on BCA reforms.

   This section requires the Comptroller General of the United States to conduct a study on benefit-cost procedures used by USACE and OMB to include an examination of the benefits and costs that each entity does or does not include. The study should provide recommendations for legislative and regulatory changes.[32]

[31] Researchers were not able to locate such a study; it does not appear that the provision has been implemented.

[32] Researchers were not able to locate such a study; it does not appear that the provision has been implemented. GAO issued a brief letter report that included comments on this section on December 18, 2019, which essentially summarized process steps. It did not address benefit and cost elements that are included or excluded, nor did it recommend legislative or regulatory changes. The letter may be accessed at https://www.gao.gov/assets/710/703345.pdf.

WRDA 2020

Congress passed the Water Resources Development Act of 2020 (WRDA 2020), which changed the inland waterway construction cost share formula to 65% general treasury/35% IWTF. This change can be expected to lead to an annual lock and dam construction program exceeding $340 million per year, roughly a $100 million increase each year for capital development projects. WRDA 2020 was part of H.R. 133, Consolidated Appropriations Act, 2021, that was approved by Congress and signed into law by the President on December 27, 2020. The Upper Ohio Navigation Project was granted a $22 million Construction New Start award from the U.S. Army Corps of Engineers. This $22 million award will enable the Army Corps to finish the pre-construction engineering and design phase and begin construction work on the Montgomery Locks and Dam.

Achieving a Better Life Experience (ABLE) Act/Tax Increase Prevention Act of 2014

The Tax Increase Prevention Act (P.L. 113-295) became law on December 19, 2014. It enacted one of the most widely heralded legislative accomplishments in 2014—the increase in the fuel tax from $0.20 to $0.29 per gallon. According to an analysis published by WCI, the increase in the fuel tax will allow USACE to build out five projects and bring them online by 2025 versus the much later projections in place before these changes were made in funding and policy. The Olmsted Locks Project was delivered in August 2018, four years ahead of schedule and $330 million under the then-latest budget estimate. The Kentucky Lock and Chickamauga Lock Projects on the Tennessee River are scheduled to be operational in 2025 and 2023, respectively. Both the Lower Mon Project and the LaGrange major rehabilitation project on the Illinois Waterway have been funded to completion.

Energy and Water Development Appropriations

The Energy and Water Development Appropriations bill for FY 2021 (P.L. 116-260) adjusted the cost share to a 65/35 federal/nonfederal split for all Inland Waterway Trust Fund (IWTF) projects. This cost share will now change the cost share for all projects for FY 2021-2031. This change will enable the acceleration of several high priority lock and dam projects.

Infrastructure Construction Legislation

Congress and the Administration were unable to reach agreement on major infrastructure investment legislation during the 116th Congress and will try again beginning in January of 2021 when the 117th Congress convenes. Inland waterway system stakeholders can be expected to again work to be included in this important national investment legislation.

Improvements in Marine Transportation Operations

Equipment and Propulsion Advances

The PPC has been actively involved in researching and developing design and technology improvements that will reduce towboat emissions. The port participated in a study that was funded by a grant from local foundations to Clean Fuels Clean Rivers, a coalition of Pittsburgh Clean Cities, in 2015. It was a pilot project in the Pittsburgh region to study the conversion benefits of a liquefied natural gas (LNG) harbor tugboat.

The study investigated (a) natural gas engine availability and adaptation; (b) engine technology to customer need and fit; and (c) top-level regulatory, safety, and training requirements. It found that a dual fuel conversion was preferable to a retrofit to LNG. The two primary determinants of usage of LNG technology are the differential in gas prices between diesel and LNG and U.S. Coast Guard safety regulations, the latter being the most difficult to overcome. The study recommended that the Coast Guard (a) create a more appropriate ruleset for smaller vessels with smaller fuel capacity that operate in

a restricted geographic region, (b) allow for acceptance of cross-industry standards, and (c) revisit the classification of "major modifications" (*32*).

A similar project was undertaken in St. Paul, Minnesota. In 2018, the *Itasca*, a vessel operated by St. Paul-based Upper River Services, received a $400,000 renovation with the help of the Minnesota nonprofit Environmental Initiative for the replacement of the 65-ft towboat's two engines and two generators with newer, greener alternatives. The president of Upper River Services claims that this one project accomplished the equivalent of taking 16,000 cars off the road in terms of annual pollution reduction. The *Itasca* is the second Upper River Services towboat that has been remodeled (*97*).

Engine manufacturers are also actively marketing electric propulsion systems. Leading players in the inland sector investigated diesel electric propulsion a decade ago but decided that the time was not ripe. However, "The new regulations covering emissions from U.S. inland vessels have major cost implications for owners looking to build new vessels, at a time when there is a significant requirement to replace an aging river fleet. The costs involved are significant enough to prompt considering the [Return on Investment] of alternative technologies. The 'conventional' option involves installing two large EPA Tier 4 main engines supplemented by an after-treatment system—either the costly EGR (Exhaust Gas Recirculation) option or SCR (Selective Catalyst Reduction) that features additional piping, its own refill and urea storage tank and demand separate maintenance. There is no likelihood that investments in after treatment technology can be recovered from shipping contracts." ABB claims that with diesel electric propulsion EPA Tier 4 emissions requirements can be met using a solution that includes multiple EPA Tier 3 generator sets, with no anticipated need for costly upgrades (*98*).

Perhaps the biggest potential for efficiency changes in the brownwater (inland towing) sector are in the quality of barge construction and the energy efficiency of towboats. Improvements in steel alloys and coatings have increased the physical life spans of barges. The old 20-year economic service life for dry cargo barges is now closer to 30 years based on quality of construction and maintenance. Technology advances also mean fuel and tow speeds can be measured and synchronized for maximum efficiency of speed and fuel consumption (*99*).

Traffic Management Technologies

The PPC has participated in three attempts to develop and deploy new technologies and software on the waterways in the Upper Ohio region that originated as part of a joint effort between the PPC and Carnegie Mellon University—SmartLock, Wireless Waterways, and RiverNet (the last one was focused more on data exchange between stakeholders rather than new technologies or operations concepts).

The PPC retains the patent rights for the SmartLock technology. For a system like SmartLock to be of value, it needs a network that extends throughout the system; transmitters would have to be installed on all the locks.

Remote Operation of Locks

As the need for river facilities increases, the ability of USACE to staff facilities is decreasing. The technology and procedures required for the automation and remote control of navigation and flood control dams are already in use at numerous locations, including several USACE projects. The dam gates at Hildebrand and Opekiska have been successfully operated from Morgantown since 1983. This system has since been upgraded to operate all three dams from the Point Marion location.

Automation of facilities that still serve authorized navigational needs may reduce operations costs and stretch the USACE O&M budget further. USACE is currently working on a design to enable remote operations at the Grays Landing Lock and Dam. Additionally, USACE is seeking funding and authorization

to conduct a study on establishing remote operations for all locks on the Ohio River and its tributaries. Accelerating this effort would be a benefit to Pittsburgh area waterway users.

Commodity Mix

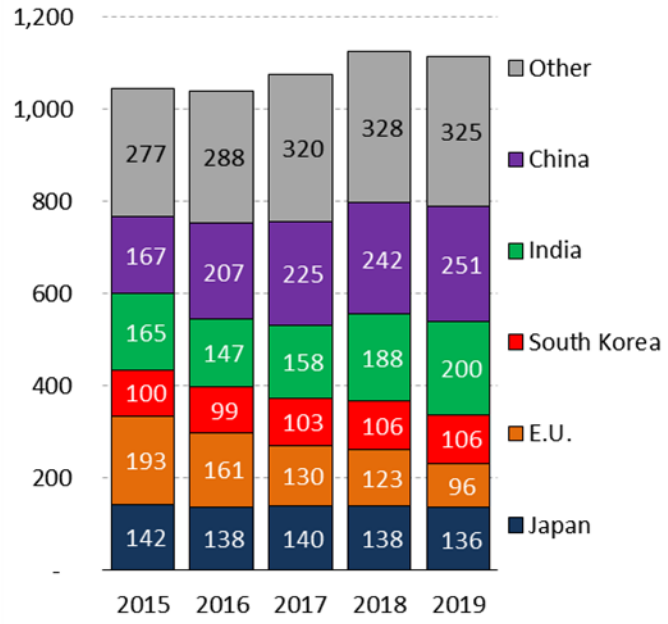
Coal

The decreased reliance on coal is causing barge operators to right-size their fleets dedicated to coal and to develop new markets related to expansion of the petrochemical industry.

Two types of coal are moved in barges. Steam coal is coal that is used in power plants and other industrial applications. Despite the declines, considerable volumes of steam coal continue to move in the area. Metallurgical coal is used to make coke. Coke is used as a fuel and reactant in the blast furnace process for primary steelmaking. The largest coke plant in the U.S. is U.S. Steel's Clairton works on the lower Monongahela River. At full capacity, it uses almost six million tons of metallurgical coal per year, all of which is barged to the Clairton works.

U.S. demand for coal to generate electricity is expected to continue to decline. Estimates vary but some expect a drop of 50 percent in U.S. power sector demand by 2030. The decline is due to multiple factors including low natural gas prices and subsidized renewable additions. With little to no load growth, coal generation has been squeezed. In addition, several states and regional organizations are adopting Renewable Portfolio Standards (RPS) that require reductions in carbon emissions over time.

The world market is more of a mixed bag. The global market for steam coal is continuing to grow with declining demand from Europe more than offset by increased demand from Asia. Figure 23 shows global steam coal imports by country for 2015-2019.

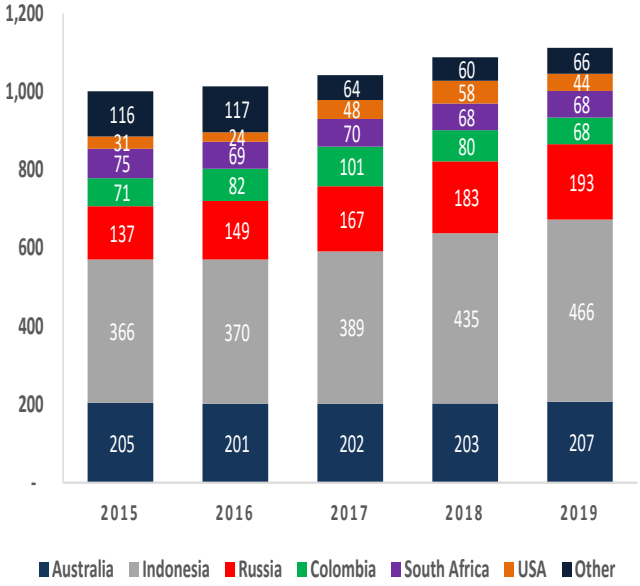


Source: (100)

Figure 23. Global Steam Coal Imports by Country (million metric tons).

The majority of steam coal exports originate from Indonesia. While not high quality, Indonesian coal has a significant transportation advantage to Asian destinations. Australia and Russia are also significant exporters. The U.S. is often referred to as the swing supply in the global steam coal market. When

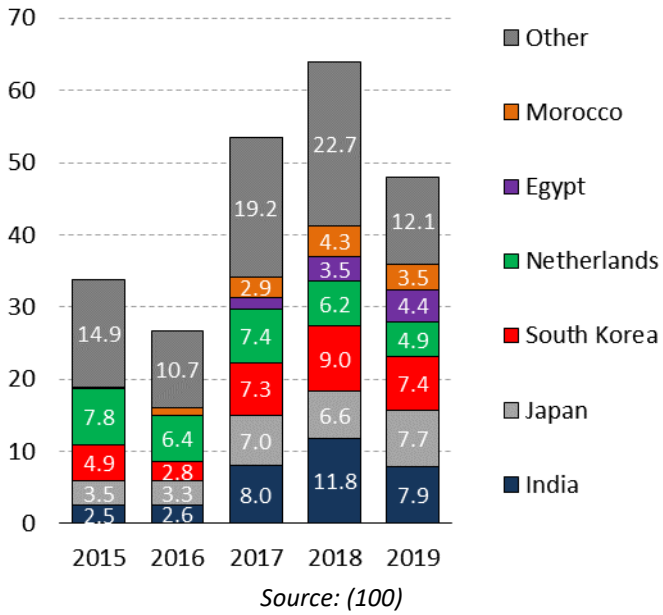
demand is strong, the U.S. benefits. Conversely, when the demand is weak, exports suffer. Figure 24 shows global steam coal exports by country for 2015-2019.



Source: (100)

Figure 24. Global Steam Coal Exports by Country (million tons).

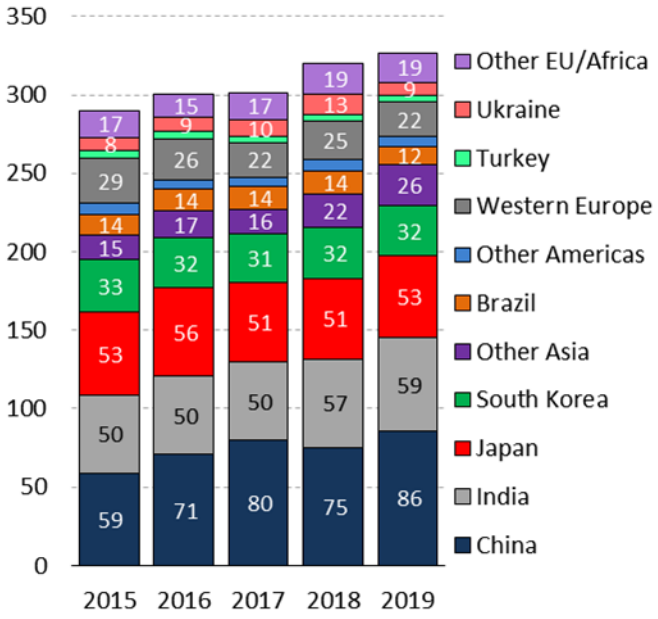
U.S. steam coal is exported to a number of countries. The largest market until recently has been Europe but with declines in that market due both to plant closures and Russian imports, Asia has become the most important market for U.S. coal exports. Figure 25 shows U.S. steam coal exports by destination country for 2015-2019.



Source: (100)

Figure 25. U.S. Steam Coal Exports by Destination Country (million metric tons).

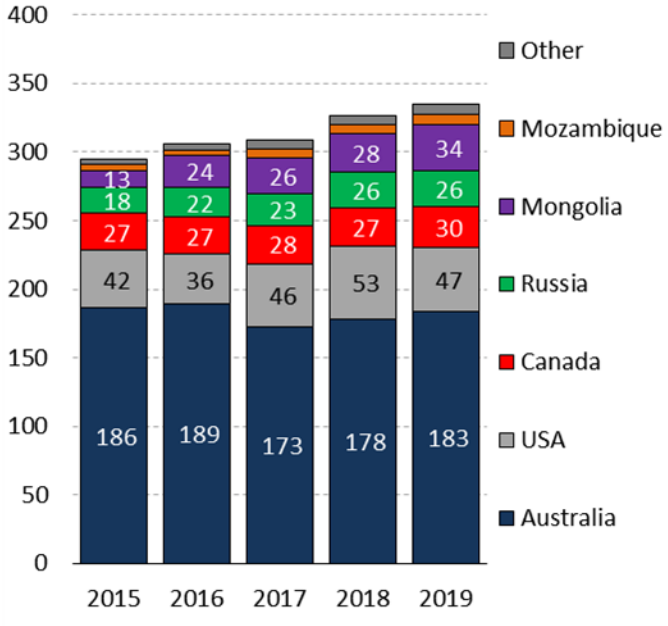
The global market for metallurgical coal is about a third the size of the steam coal market. The largest importers of metallurgical coal are China, India, and Japan. Figure 26 shows global metallurgical coal imports by world region for 2015-2019.



Source: (100)

Figure 26. Global Metallurgical Coal Imports by Region (million metric tons).

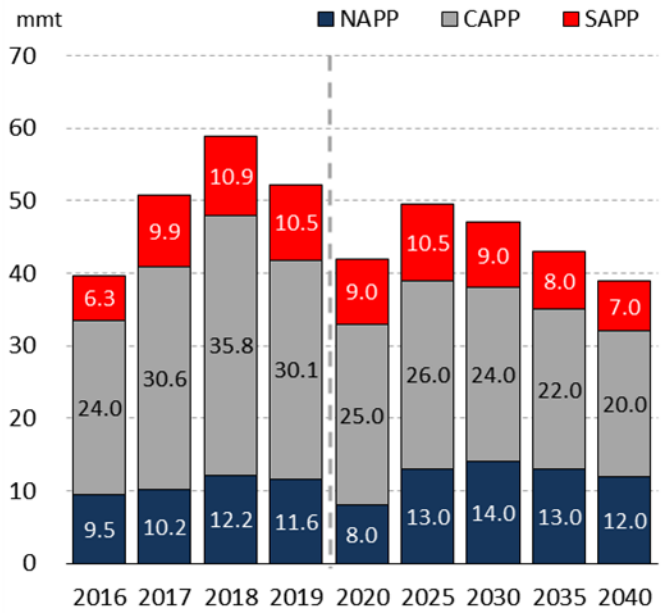
Fewer countries export metallurgical coals due to the quality of their reserves. The largest exporter by far is Australia with the U.S. being a distant second. Mongolia has now displaced Canada for third. Figure 27 shows the global metallurgical coal exports by world region for 2015-2019.



Source: (100)

Figure 27. Global Metallurgical Coal Exports by Region (million metric tons).

U.S. metallurgical coal exports in the last three years have ranged between 50 and 60 million short tons in the last three years. The expectation is for metallurgical coal exports to rebound after COVID to the 50-million-ton level by 2025 and slowly decline over time due to reserve depletion. Figure 28 shows the forecast for U.S. metallurgical coal exports through 2040.



Note: NAPP = Northern Appalachia
CAPP = Central Appalachia
SAPP = Southern Appalachia

Source: (100)

Figure 28. U.S. Metallurgical Coal Export Forecast by Basin.

Ethane Crackers

On another front, with the construction of the Shell ethane cracker, chemical and plastics products will experience very large increases in production. One report indicated, "Assuming that all of the announced liquid river terminals are constructed (new and expanded terminals), inland river liquids traffic could expand by 75 million tons. This represents an increase of roughly 80% from current levels of liquids traffic and an overall system traffic increase of more than 13%. However, it is almost certain that the geography and economics of new traffic will be different from that associated with coal" (*28*).

Despite the pending boom in chemicals and plastics products, forecasts are bearish on the Upper Ohio region's prospects for profiting from this increase. Industry sources interviewed for this report concurred with this assessment.

The Upper Ohio Navigation Study stated, "The forecast for petroleum fuels on the Upper Ohio reach diminishes under every forecast scenario. … Aggregates traffic forecasts for the Upper Ohio increase under every scenario" (*40*).

One message is clear: "As older markets shift, the region must be prepared to adapt to new possibilities, including, for example, timber and wood products in traditional coal areas, offshoots of the oil and gas industry, growth in e-commerce, or a continued emphasis on advanced manufacturing and unique supply chain roles" (*35*).

Marine Highway Funds

Chapter 1 discussed the Marine Highway Program sponsored by MARAD. Because Pittsburgh is on an officially designated corridor—M-70—projects associated with the corridor are eligible for grants from MARAD. MARAD periodically publishes a call for projects that represent concepts for new services or expansions of existing marine highway services on designated Marine Highway routes that use documented vessels and mitigate land congestion or promote short sea transportation. If the Secretary of Transportation accepts a project proposal and designates it as a Marine Highway project, federal resources may be used to assist project sponsors, ports, and other local transportation or economic development agencies in the development of their project. Since 2010, MARAD has provided more than $40 million in grants for America's Marine Highway Program.

APPENDIX A: TYPICAL PETROCHEMICAL DOWNSTREAM INDUSTRIES

A 2018 report by the Maxine Goodman Levin College of Urban Affairs at Cleveland State University, listed 27 typical petrochemical downstream industries, which are shown in Table 22 (*101*).

Table 22. Typical Petrochemical Downstream Industries.

Petrochemical manufacturing	Printing ink manufacturing
Industrial gas manufacturing	Explosives manufacturing
Synthetic dye and pigment manufacturing	Custom compounding of purchased resins
Other basic inorganic chemical manufacturing	Photographic film and chemical manufacturing
Other basic organic chemical manufacturing	Other miscellaneous chemical product manufacturing
Plastics material and resin manufacturing	Plastics packaging materials and unlaminated film and sheet manufacturing
Synthetic rubber manufacturing	Unlaminated plastics profile shape manufacturing
Artificial and synthetic fibers and filaments manufacturing	Plastics pipe and pipe fitting manufacturing
Nitrogenous fertilizer manufacturing	Laminated plastics plate, sheet (except packaging), and shape manufacturing
Phosphatic fertilizer manufacturing	Polystyrene foam product manufacturing
Fertilizer mixing	Urethane and other foam product (except polystyrene) manufacturing
Pesticide and other agricultural chemical manufacturing	Plastics bottle manufacturing
Paint and coating manufacturing	Other plastics product manufacturing
Adhesive manufacturing	

APPENDIX B: ECONOMIC IMPACT ASSESSMENT OF THE PORT OF PITTSBURGH

The research team determined the economic impact of the Port of Pittsburgh using IMPLAN, an input/output model (I/O). An I/O model provides reliable estimates of the economic impacts of goods moving along the three rivers in the region, as well as estimates the impact of businesses that have located in the area due to the port. The team estimated the total economic impact associated with the port as well as assessing scenarios related to future growth in the region.

Economic Impact Overview

The Port of Pittsburgh supports the regional economy through commodities that are shipped along the waterways and businesses that choose to locate in the region due to the connection to the port. Table 23 shows the total economic impact attributed to the port through both the movement of goods and adjacent businesses. The port currently supports between 14,000 to over 15,000 jobs and a total output between $4–5 billion.[33]

Table 23. Total Economic Impact.

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	4,897–5,311	$414–$439	$1,314–$1,344	$3,045–$3,151
Indirect Effect	4,593–4,921	$367–$390	$608–$640	$1,079–$1,138
Induced Effect	4,675–4,950	$250–$265	$426–$451	$717–$759
Total Effect	**14,165–15,181**	**$1,031–$1,092**	**$2,357–$2,435**	**$4,842–$5,048**

Note: Dollar values are in millions of 2020 dollars.

The economic impacts cover a range of industries supporting jobs and sales in coal mining, manufacturing, and the petrochemical industry. This employment then impacts the regional economy through sales of goods and services. Figure 29 shows the total economic activity supported by the Port of Pittsburgh.

Figure 29. Total Economic Impact.

Methodological Approach

The completed economic analysis was a multistep process involving definition of the study area, creation of regional models, collection of input data for the I/O model, refining and matching that data

[33] The ranges reflect high and low employment estimates at adjacent businesses.

with IMPLAN industry categories, and finally the application of the economic multipliers through IMPLAN. Figure 30 lists the steps in order.

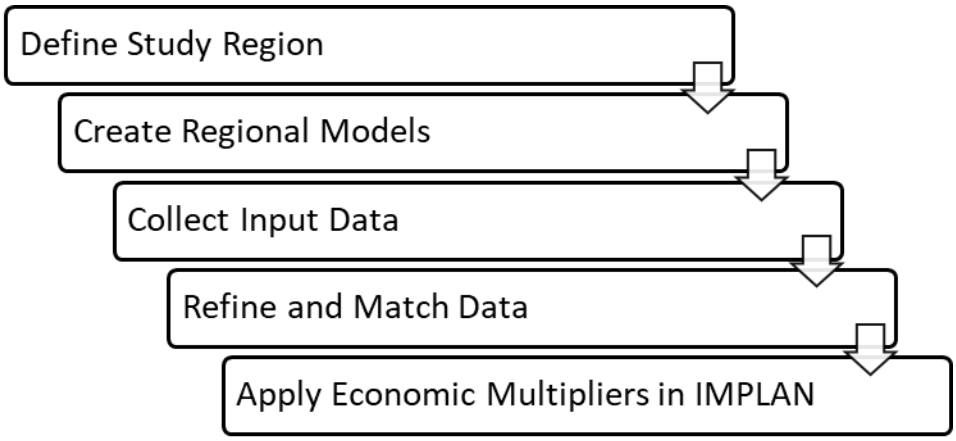


Figure 30. Methodological Approach.

Study Region

The study region encompasses nine counties: Allegheny, Armstrong, Beaver, Butler, Clarion, Fayette, Greene, Washington, and Westmoreland. This region differs from the Port of Pittsburgh region by only including counties directly adjacent to the waterways. From this study area, researchers developed a regional model in IMPLAN to calculate the economic impact details the study region used for the analysis. Figure 31 shows the study region.

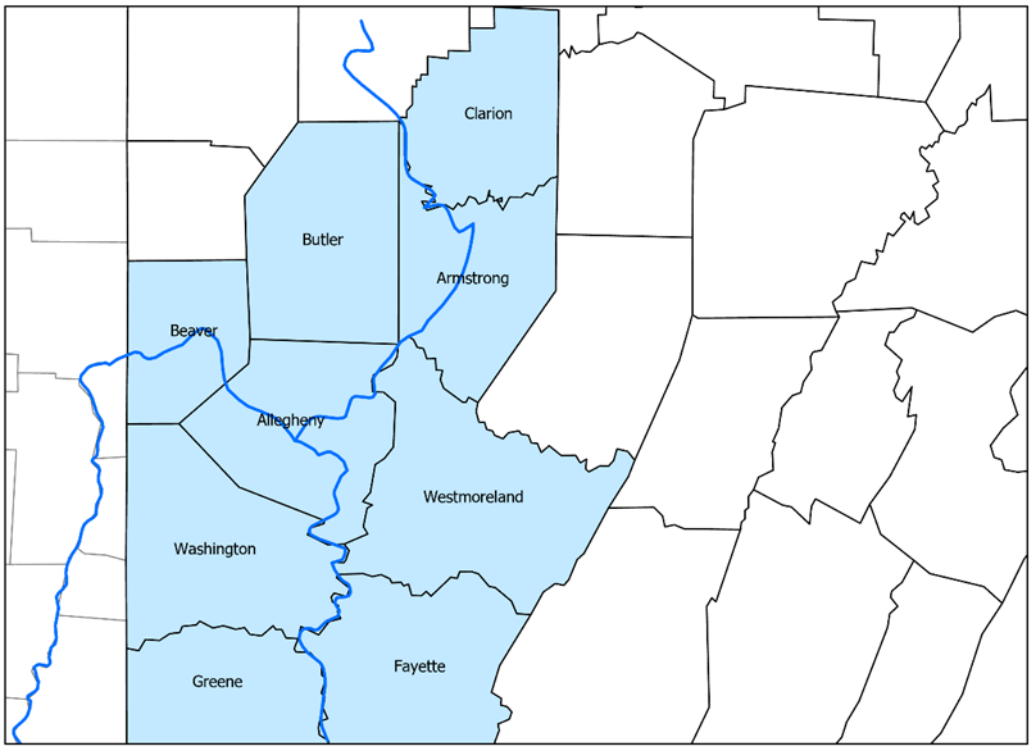


Figure 31. Study Region.

Data Inputs and Organization

After the creation of the regional models, data inputs were needed to estimate the impact. The primary data sources for economic impact assessment were as follows:

- Commodity movements from the WCSC operated by USACE.
- Commodity price data from various industry sources.
- Employment information from regional economic development agencies.

Researchers calculated the value of the commodity movements using the price data collected. By calculating the value, the researchers derived an estimate of the total value of production occurring within the various economic sectors. IMPLAN was then used to apply economic multipliers to estimate the total economic impact of the commodity movements associated with the Port of Pittsburgh. IMPLAN was also applied to employment data from local businesses to determine their impact on the region.

Waterway Movements

The economic analysis relied on the waterborne commerce statistics to understand the important industries in the area and the commodities being moved in the Pittsburgh region. The waterborne commerce statistics are collected by USACE's Institute for Water Resources (IWR), as authorized by the Rivers and Harbors Act of 1922. The act authorized USACE to collect, process, distribute, and archive waterborne commercial vessel movement and cargo data (*102*). This legislation also requires that domestic waterborne commercial vessels report their movements to USACE in order to facilitate the processing of these data.

The types of vessel movements included in these statistics are dry cargo ships and tankers, barges (both loaded and empty), towboats (except harbor assistance and barge shifting), crew boats and supply boats, and the first move of a newly constructed vessel. Recreation, commercial fishing, emergency services, and military vessels, as well as vessels used for construction activities are not included within these data (*1*). Table 24 provides an overview of the processes used by the IWR in collecting and reporting these data.

Table 24. Waterborne Commerce Statistics Data Flow Process.

Collection	Input	Data Processing	Distribution
Partnership with: • Carriers • Customs • Port & Terminal Operators • USACE Operators • USACE Regulatory • USACE Navigation Decision Center (NDC) Staff	Supported by: • Contractors • USACE Offices • USACE NDC Staff • Customs • Census • Coast Guard	Internal Activities: • Editing • Enforcement • Routing • Information Generation • Decision Support • Publishing	• Fact Card • Waterborne Commerce of the U.S. • Lock Information • Port Facilities • Dredging Statistics • Other Business Line Products

Source: (1).

The research team used the IWR data for shipments, receipts, and intraport traffic to get a full picture of the commodity movements along the three rivers. The movements are reported by broad commodity categories following the Standard International Trade Classification (SITC) commodity code guidelines.[34]

In collecting the data inputs for the model, the research team obtained traffic data for the Port of Pittsburgh from the IWR. The most recent traffic movements for the port were collected, which are FY 2018. The data set includes the total tonnage, tonnage by commodity, and whether the movement was a shipment, receipt, or an intraport movement. Tonnage data is in short tons. The research team used the total combined movement tonnage for each commodity.

Commodity Price

The tonnage data from the WCSC do not include the value of the commodity, so the research team collected price data for the various commodities to determine the total value of commodity movements at the port. The value of these movements was required in order to conduct the IMPLAN analysis.

Commodity price data were collected from a variety of sources using a baseline year of 2018 in accordance with the tonnage data year. If 2018 prices were not available, the Producer Price Index (PPI) from the Bureau of Labor Statistics (BLS) was used to adjust the price to 2018 dollars. The BLS estimates PPIs for a number of industries; researchers utilized the closest industry to the commodity to ensure an accurate adjustment to 2018 dollars. A PPI can be seasonally or non-seasonally adjusted. Seasonally adjusted PPIs were used when possible to reduce the impact of price volatility throughout the year. In order to match the commodity data, dollars per short ton were used. If the commodity prices were not available by short ton, a conversion was made to ensure consistency. Finally, the team attempted to collect price data for the Pittsburgh region or the state of Pennsylvania if possible; if Pennsylvania data were not available, a national average was used.

Prices for coal and petroleum products were collected from the EIA. The EIA has historic price data in dollars per short ton, barrel, or gallon for both Pennsylvania and the Central Atlantic Region; if Pennsylvania data were not available, the average of the Central Atlantic region was taken. A number of the petroleum-derived products did not have prices available through EIA; in these cases, spot prices provided by the Independent Chemical Information Service (ICIS) were used.

ICIS also provided prices for a number of the chemicals and organic materials through their market analysis and commodity reports. ICIS collects information, including price, on over 190 commodities in the petrochemical sphere, including energy and fertilizer products. These prices are generated through reports from both buyers and sellers of the commodities (*103*). The research team obtained spot prices from ICIS that were converted into 2018 dollars where necessary.

Metals, minerals, and related product prices were found at the U.S. Geological Survey National Minerals Information Center (*104*). The Mineral Industry Survey and the Commodity Summaries have price data either by region or for the United States as a whole. The Mineral Industry Survey collects data from key industry members monthly, quarterly, or annually. The Commodity Summary is a more comprehensive report that compiles information on reserves, domestic industry breakdown, and value for over 90 minerals annually. The information is partially derived from the industry survey.

The U.S. Department of Agriculture's Economic Research Service (ERS) collects information on agricultural commodities, such as wheat and corn (*105*). Conversions were made from cents per bushel

[34] The WCSC publication codes correspond with the Lock Performance Monitoring System (LPMS) commodity codes. Both LPMS and WCSC codes were standardized to reflect the hierarchical structure of the SITC Revision 3 commodity codes. Using SITC, Rev. 3 allows direct comparisons with U.S. imports and exports, as well as with commodity movements of other countries.

to dollars per short ton for the analysis. ERS collects data through producer surveys every four to eight years and then estimates annual changes to production and price; the team used the most recent price information from ERS and inflated to 2018 dollars.

For the remaining commodities, the research team used the Freight Analysis Framework (FAF) produced by the Federal Highway Administration (*106*). The FAF uses data from the Census Bureau's Commodity Flow Survey (CFS) as the baseline for its model and develops a forecast. The FAF also includes businesses that are not generally included in the CFS to provide a clearer picture of both freight value and movement.

Business Data

In addition to modeling the impact of the commodity movements, the research team wanted to include key businesses that were located along the waterway in the economic analysis. To do this, employment data were collected from businesses along the waterway using the Pittsburgh Prospector Business Database, which is supported by the Pittsburgh Regional Alliance (*107*). The database provides a ranged estimate of jobs for each business. The research team constructed models using both the low and high end of those ranges.

Data Organization and Matching

Once the commodity and price data for goods moved through the Port of Pittsburgh and the businesses surrounding the waterways were collected, researchers calculated the total value of goods moving on the waterway to be used as a measure of the total industry activity supported within the port region. This involved taking the total commodity tonnage and multiplying it by the 2018 price.

Once the value of the commodities was calculated, the commodities and businesses were matched with IMPLAN industry codes to facilitate the analysis. IMPLAN converts the NAICS into a 546-sector model. The values calculated using the commodity movements data represent a value of production in that economic sector, so the commodities had to be matched with the appropriate IMPLAN industry sector for the model. For example, IMPLAN Sector 21, Coal Mining, was matched with coal and lignite tonnage.

Model Assumptions

The research team used the IMPLAN Model tool to complete the economic impact analysis. IMPLAN is an advanced modeling tool that expands on the traditional I/O approach by integrating industry to institution[35] transactions within a region, as well as the transactions that occur between institutions (*108*). This allows for the capture of all market transactions within a given period of time.

The research team used IMPLAN to estimate the direct, indirect, and induced economic impacts of industry sectors associated with the port. These impacts are calculated by taking the data input of either commodity values or employment at key businesses and applying specific multipliers. In a similar manner to traditional I/O models, direct impacts, which are the impacts from a change in production, are calculated through multipliers on a per-million-dollar basis. This means that employment estimates are based on the number required for $1 million worth of production for each specific industry (*109*).

The direct impact in terms of output is the commodity value; in order to calculate indirect and induced impacts, multipliers are applied to the direct impact. Indirect effects are the business-to-business transactions that contribute to the creation or final production of a good but do not produce the final good itself. This spending back and forth through the economic supply chain adds value before the

[35] In IMPLAN, institutions include households (broken down into nine income categories), administrative government, enterprises (basically corporate profits), capital, inventory, and foreign trade.

money “leaks” out of the local economy and into other regions. The spending of labor income results in induced impacts. Spending of labor income is a result of workers in the relevant industry sectors spending their wages on goods and services in the regional economy, such as purchases made in the service and retail sectors.

In calculating the indirect and induced impacts, IMPLAN uses regional social accounting matrices, which provide information on nonmarket financial flows. Nonmarket financial flows include inter-industry spending, tax payments, and transfers.

The three types of impact—direct, indirect, and induced—are presented in terms of jobs, labor income, value added, and total output.

- Employment numbers represent the total annual average jobs. This number includes self-employed, wage, and salary positions, and all full-time, part-time, and seasonal jobs. The total is based on a count of full-time/part-time averages over a 12-month period (*110*).
- Labor income is the total amount paid to workers in that region, which is calculated using both employee and proprietor income; this amount is used for determining induced impacts.
- Value added is the combination of labor income, property income, and indirect business taxes. It is a representation of the difference in value of production over the cost of purchasing goods and services to produce a good.
- Output represents the total value added and any intermediate expenditures made on materials and services.

Results

The results are presented by commodity impact and business impact; the commodity impact reflects goods moved along the three rivers in the region, and the business impact reflects key industries that may not move products along the waterway but rely on the connection to the waterways.

The results, summarized in Table 25, indicate that the combined economic impact supported between 14,100 and 15,200 jobs and between $4.8 and 5.0 billion in total output in the region, depending on the estimated direct jobs. The tables below show the economic impact of the Port of Pittsburgh, and all figures are presented as annual totals in 2020 dollars.

Table 25. Total Economic Impact.

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	4,897–5,311	$414–$439	$1,314–$1,344	$3,045–$3,151
Indirect Effect	4,593–4,921	$367–$390	$608–$640	$1,079–$1,138
Induced Effect	4,675–4,950	$250–$265	$426–$451	$717–$759
Total Effect	14,165–15,181	$1,031–$1,092	$2,357–$2,435	$4,842–$5,048

Note: Employment is in actual numbers and not rounded. Dollar values are in millions of 2020 dollars.

The total annual economic impact associated with the commodities utilizing the three main rivers in the Pittsburgh region is estimated to be more than 13,000 jobs and a total economic output of nearly $4.7 billion. Table 26 breaks down each impact by category and type.

Table 26. Commodity Economic Impact.

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	4,557	$393.5	$1,289.3	$2,963.2
Indirect Effect	4,342	$350.6	$583.3	$1,033.7
Induced Effect	4,454	$237.9	$405.6	$683.3
Total Effect	13,353	$982	$2,278.2	$4,680.2

Note: Employment is in actual numbers and not rounded. Dollar values are in millions of 2020 dollars.

The economic impact from commodity movements impacts a variety of industries. Table 27 and Figure 32 show the top 10 industries, in terms of employment numbers, that are impacted by commodities moving along the waterway. Coal mining and various types of manufacturing round out the top sectors. The top 10 industries (ranked by employment) equate to 35 percent of the total employment, 43 percent of the total labor income, and 52 percent of the total economic output supported by the commodity analysis.

Table 27. Top 10 Industries Influenced by Commodity Activity in Order of Employment.

Description	Employment	Labor Income	Output
Coal Mining	1,711	$150.3	$812.1
Oil and Gas Extraction	425	$37.9	$508.4
Iron and Steel Mills and Ferroalloy Manufacturing	424	$48	$418.3
Custom Computer Programming Services	382	$38.8	$61.6
All Other Miscellaneous Manufacturing	355	$17.6	$56.2
Management of Companies and Enterprises	299	$46	$72.2
Full-Service Restaurants	277	$6.7	$18
Hospitals	275	$20.4	$46.4
Petroleum Lubricating Oil and Grease Manufacturing	275	$31.2	$385.8
Truck Transportation	247	$23.7	$48.9
Total	**4,670**	**$420.6**	**$2,427.8**

Note: Employment is in actual numbers and not rounded. Dollar values are in millions of 2020 dollars.

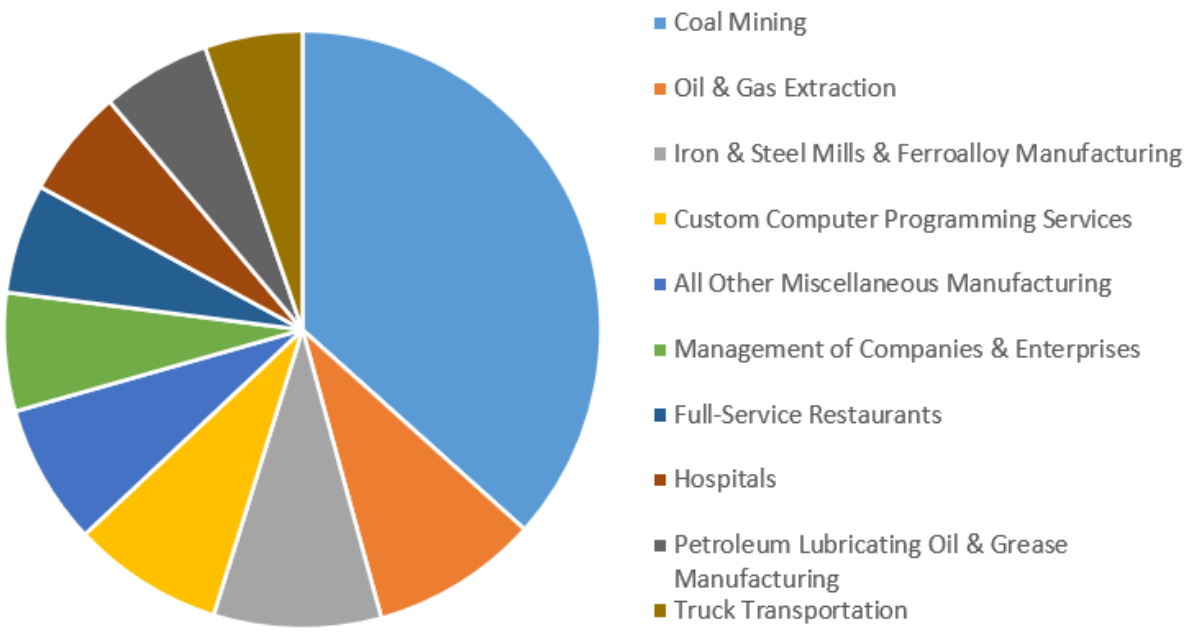


Figure 32. Top 10 Industries by Employment—Commodity Activity.

The economic activity of the commodities utilizing the port also generate tax impacts. Taxes generated total more than $220 million to the federal government and more than $150 million to state and local entities, as shown in Table 28.

Table 28. Tax Impact—Commodity Activity (Millions 2020$).

Tax	Total Federal Tax	Total State and Local Tax
Employee Compensation	$109.9	$0.6
Tax on Production and Imports	$16.4	$117.4
Households	$67.8	$22.2
Corporations	$25.7	$13.7
Total	$219.8	$153.9

In addition to estimating the impact of the commodities moved on the waterways, the impact of key businesses was also analyzed. As shown in the Table 29, the economic impact for businesses along the rivers were estimated to range from 800 to 1,900 jobs and from $160 to $370 million in output. Table 29 uses data from the Pittsburgh Prospector map of businesses; data are provided in ranges, so the low and high estimates correspond to the low and high ends of those ranges.

Table 29. Business Economic Impact.

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	340–754	$20–$45	$25–$55	$82–$188
Indirect Effect	251–579	$17–$39	$25–$57	$45–$104
Induced Effect	221–496	$12–$27	$20–$45	$34–$76
Total Effect	812–1,828	$49–$110	$70–$157	$162–$368

Note: Employment is in actual numbers and not rounded. Dollar values are in millions of 2020 dollars.

The business impacts affect some industries to a greater extent than others. Table 30 and Figure 33 show the top 10 industries impacted in terms of employment numbers; the ranges reflect the high and local estimates of direct jobs. Service industry sectors make up the majority of the top 10. The top 10 industries (ranked by employment) equate to 56 percent of the total employment and 53 to 59 percent of both the total labor income and economic output supported by the business activity analysis.

Table 30. Top 10 Industries by Employment—Business Activity.

Industry Sector	Employment	Labor Income	Output
Scenic and sightseeing transportation and support activities for transportation	163–371	$10.4–$23.6	$25.3–$57.7
Warehousing and storage	119–245	$7.6–$15.8	$15.7–$32.4
All other food manufacturing	51–121	$2.0–$4.6	$17.2–$40.8
Water transportation	40–98	$1.9–$4.7	$25.4–$62.2
Other real estate	19–42	$0.5–$1.2	$3.8–$8.5
Couriers and messengers	14–34	$0.6–$1.4	$1.5–$3.5
Full-service restaurants	14–32	$0.3–$0.8	$0.9–$2.1
Hospitals	14–31	$1.0–$2.3	$2.3–$5.2
Postal service	12–30	$1.2–$2.8	$1.3–$3.1
Employment services	11–25	$0.6–$1.3	$1.3–$2.9
Total	**457–1,029**	**$26.1–$58.5**	**$94.7–$281.4**

Note: Employment is in actual numbers and not rounded. Dollar values are in millions of 2020 dollars.

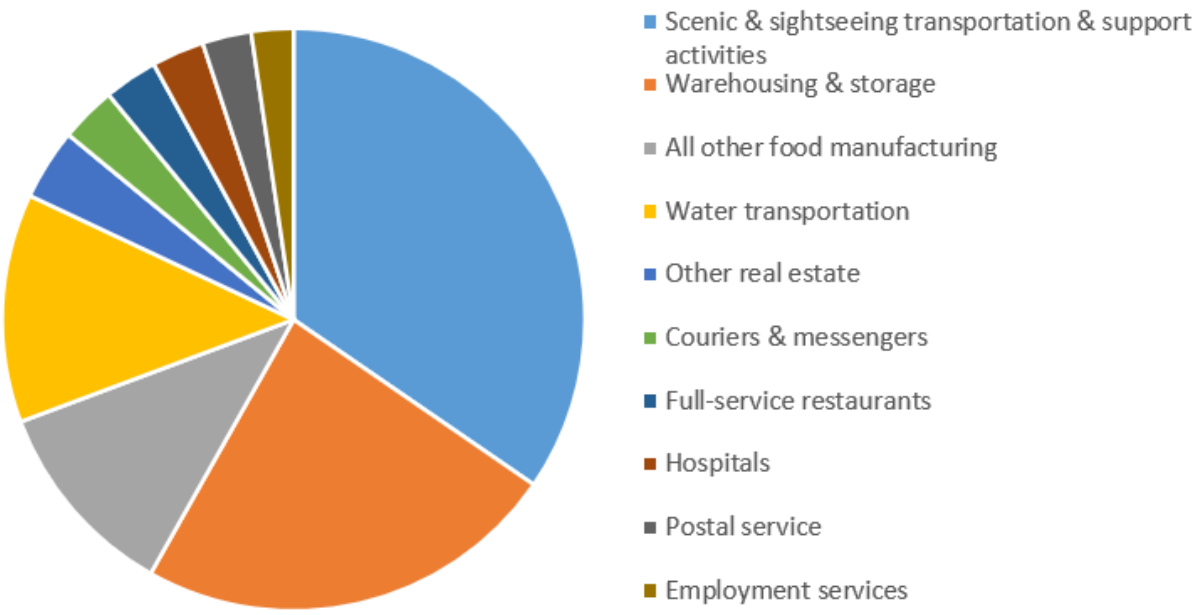


Figure 33. Top 10 Industries by Employment—Business Activity.

The economic activity of the businesses along the waterway also generates federal as well as state and local tax impacts. Taxes generated total $10–$22 million to the federal government and $5–$12 million to state and local entities, as shown in Table 31.

Table 31. Tax Impacts—Business Activity (Millions 2020$).

Tax	Total Federal Tax	Total State and Local Tax
Employee Compensation	$5.6–$12.6	$0.03–$0.06
Tax on Production and Imports	$0.5–$1.2	$3.7–$8.7
Households	$3.4–$7.5	$1.1–$2.5
Corporations	$0.5–$0.8	$0.4–$0.5
Total	**$10.0–$22.1**	**$5.2–$11.8**

Sensitivity Analysis

The Port of Pittsburgh is uniquely situated to capitalize on future opportunities in several industry sectors and experience future economic growth. To that end, researchers ran a sensitivity analysis by creating two scenarios to illustrate the potential economic impact of various commodity changes.

Scenario 1 is based on increased activity and economic growth across all industry sectors utilizing the waterways. Scenario 1 assumes a 5 percent increase in commodities moving along the waterways in the Pittsburgh region.[36] Table 32 shows only the incremental impacts of the 5 percent increase.

Table 32. Economic Impact—Future Scenario 1.

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	234	$20.4	$65.2	$157.1
Indirect Effect	235	$18.8	$31.1	$55.5
Induced Effect	235	$12.5	$21.4	$36
Total Effect	**704**	**$51.7**	**$117.7**	**$248.6**

Note: Employment is in actual numbers and not rounded. Dollar values are in millions of 2020 dollars.

.

Table 33 shows the top 10 industries, in terms of employment numbers, for Scenario 1. A 5 percent increase in the commodities utilizing the port would result in increased jobs and economic activity, mainly in the coal and manufacturing sectors.

Table 33. Top 10 Industries by Employment—Future Scenario 1 (Millions 2020$).

Industry Sector	Employment	Labor Income	Output
Coal mining	86	$7.5	$40.7
Iron and steel mills and ferroalloy manufacturing	29	$3.3	$28.4
Oil and gas extraction	21	$1.9	$25.5
Custom computer programming services	19	$1.9	$3.1
All other miscellaneous manufacturing	18	$0.9	$2.8
Management of companies and enterprises	15	$2.4	$3.7
Wholesale—Other durable goods merchant wholesalers	15	$1.2	$4
Full-service restaurants	15	$0.4	$1
Hospitals	15	$1.1	$2.4
Truck transportation	14	$1.4	$2.8
Total	**247**	**$22.0**	**$114.4**

Note: Employment is in actual numbers and not rounded. Dollar values are in millions of 2020 dollars.

[36] This increase is limited to commodities moving along the three rivers and assumes no change in employment at surrounding businesses.

Table 34 lists the estimated tax impacts of Scenario 1. Additional taxes generated would total $11.6 million to the federal government and $8.0 million to state and local entities.

Table 34. Tax Impacts—Future Scenario 1 (Millions 2020$).

Tax	Total Federal Tax	Total State and Local Tax
Employee Compensation	$5.8	$0.03
Tax on Production and Imports	$0.9	$6.1
Households	$3.6	$1.2
Corporations	$1.3	$0.7
Total	**$11.6**	**$8.0**

Scenario 2 is based on a change in activity in metallurgical coal utilizing the waterways. A 5 percent change in metallurgical coal moving along the waterways in the Pittsburgh region was assumed. Metallurgical coal comprises 51.6 percent of total coal moved along the waterways in the state of Pennsylvania, according to the EIA (*111*). (See Appendix C for an explanation of how the percentage was derived.) This analysis presents the possible impacts if this type of coal movement were to increase or decrease by 5 percent.

Scenario 2 models an increase in metallurgical coal by estimating 52 percent of the total coal tonnage in the Pittsburgh region as metallurgical coal. The 5 percent increase is then applied to only the metallurgical coal tonnage. While the previous analyses of all commodities applied the average price for all types of coal, Scenario 2 utilized the higher average price of metallurgical coal (*112*). Table 35 shows the incremental impact of a 5 percent change in metallurgical coal activity for Scenario 2.

Table 35. Economic Impact—Future Scenario 2.

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	39	$3.4	$10.3	$18.4
Indirect Effect	24	$2.0	$3.5	$6.2
Induced Effect	32	$1.7	$2.9	$4.9
Total Effect	**95**	**$7.1**	**$16.7**	**$29.5**

Note: Employment is in actual numbers and not rounded. Dollar values are in millions of 2020 dollars.

Table 36 shows the top 10 industries, in terms of employment numbers, for Scenario 2. Increased metallurgical coal activity would result in increased jobs and economic activity not only to coal but also to various service industries supported through local wages.

Table 36. Top 10 Industries by Employment—Future Scenario 2.

Industry Sector	Employment	Labor Income	Output
Coal mining	39	$3.4	$10.4
Management of companies and enterprises	3	$0.4	$0.5
Other financial investment activities	2	$0.07	$0.1
Hospitals	2	$0.1	$0.2
Full-service restaurants	2	$0.04	$0.07
Other real estate	1	$0.04	$0.1
Limited-service restaurants	1	$0.03	$0.04
Maintenance and repair construction of nonresidential structures	1	$0.09	$0.1
Monetary authorities and depository credit intermediation	1	$0.1	$0.2
Services to buildings	1	$0.04	$0.04
Total	54	$4.31	$11.75

Note: Employment is in actual numbers and not rounded. Dollar values are in millions of 2020 dollars.

Table 37 lists the estimated tax impacts of Scenario 2. Additional taxes generated would total $1.8 million to the federal government and more than $1.2 million to state and local entities.

Table 37. Tax Impacts—Future Scenario 2 (Millions 2020$).

Tax	Total Federal Tax	Total State and Local Tax
Employee Compensation	$0.9	$0.004
Tax on Production and Imports	$0.2	$1
Households	$0.5	$0.2
Corporations	$0.2	$0.09
Total	**$1.8**	**$1.29**

The Port of Pittsburgh is a vital economic connection for industries and businesses in the region in terms of sourcing materials and moving finished products. The port supports economic activity across a variety of industry sectors, not just energy and petrochemical sectors but storage, various manufacturing industries from iron and steel to food, and coal mining. These industries are key to other sectors of the regional economy, such as the service industry, which is supported by employee spending. Looking to the future, the port region, and the state as whole, has potential for growth in industries such as metallurgical coal. Additionally, as the United States continues its movement toward energy independence, the port's connection to two major shale plays and the petrochemical industry will prove

important to the regional economy. If the region capitalizes on the energy sector expansions now and in the future, the economic importance and impact of the port system will certainly grow.

APPENDIX C: METALLURGICAL COAL CALCULATION

The second future scenario discussed in Appendix B involves an increase in the movement of metallurgical coal that required the research team to determine the amount of metallurgical coal currently moved along the waterways in the Pittsburgh region. For the purposes of the main economic impact model, the team used USACE's Institute for Water Resources data to determine all waterborne commodities. These data are published annually by the Waterborne Commerce Statistics Center (WCSC). In order to determine the proportion of coal that was metallurgical coal, the research team utilized the U.S. Energy Information Administration's (EIA's) annual coal distribution report.

The annual coal distribution report provides detailed information on the distribution of coal domestically, including origin and destination states, method of transportation (e.g., river), and consumer category. Metallurgical coal is also known as coking coal and is used in the production of coke. Therefore, researchers designated any coal destined for a coke plant as metallurgical coal (*112*). The 2018 EIA report showed that 5,442,000 tons of coal moved along the river destined for Pennsylvania coke plants. In addition, 548,000 tons of coal originated in Pennsylvania and traveled along the rivers to coke plants in other states. This led to a total of 5,990,000 tons of coal moving by river with a coke plant final destination.

The total amount of coal moving by river through Pennsylvania in 2018 was 11,611,000 tons. This consisted of 7,164,000 tons of coal with a Pennsylvania origin and 6,931,000 tons of coal with a Pennsylvania destination. The research team subtracted 2,484,000 tons that were counted twice as having both a Pennsylvania origin and destination to avoid double counting. This ensured that coal that remained in the state was only counted once. To perform the analysis, researchers needed to understand the percentage of coal being moved that was metallurgical coal. The tons of metallurgical coal moving by river was divided by the total tons of coal moved via rivers, which yielded a result of 51.6 percent of the coal moving by river through Pennsylvania being designated as metallurgical coal.

$$5{,}990{,}000/11{,}611{,}000 = 51.6.$$

The research team then took 51.6 percent of the total coal tonnage in 2018 to utilize in the sensitivity analysis for metallurgical coal. The analysis assumes a 5 percent change in metallurgical coal activity and presents the results. If metallurgical coal were to change by 10 percent instead of 5, these results could be doubled to gain an understanding of the economic impact of that change.

APPENDIX D: PETROCHEMICAL CASE STUDY

PORT PITT | Port of Pittsburgh Commission
Good things flow from here.

ELLIOTT GROUP
EBARA CORPORATION

Petrochemical Case Study

ELLIOTT GROUP
EBARA CORPORATION

901 North Fourth Street
Jeannette, PA 15644-1473
Telephone: 724-527-2811
Fax: 724-600-8442
Email: info@elliott-turbo.com
www.elliott-turbo.com

Elliott Group is a global leader in the design, manufacture, and service of technically advanced centrifugal compressors, steam turbines, power recover expanders, cryogenic pumps and expanders, and axial compressors used in the petrochemical, refining, oil & gas, liquified gas, and process industries, as well as in power applications.

Elliott was founded in 1910 in Pittsburgh, moved to nearby Jeannette in 1914, and have been operating continuously at this location ever since. Elliott is a wholly-owned subsidiary of Ebara Corporation, a major industrial conglomerate headquartered in Tokyo, Japan. With their U.S. headquarters and main manufacturing facility in Jeannette, the Elliott Group is one of the largest employers in Westmoreland County with 900 employees locally and 1,500 globally.

The Market & Opportunity

Elliott is a global leader in making centrifugal compressors for ethylene production. Nearly 50 percent of the world's ethylene production capability uses Elliott compressors. Over 700 Elliott compressors are installed in ethylene service in more than 100 plants and more than 60 countries throughout the world. As petrochemical production plants grow ever larger in size and capacity, custom-engineered cracked gas, propylene and ethylene compression trains from Elliott continue to meet the demand for increased throughput and reliability worldwide. In 2014, Elliott began working with Shell on a new mega petrochemical plant being built in Elliott's own backyard in the Pittsburgh region.

PORT PITT | Port of Pittsburgh Commission

Good things flow from here.

ELLIOTT GROUP
EBARA CORPORATION

Petrochemical Case Study

The Challenge

In addition to the compressors, Elliott secured a contract to design, manufacture, and deliver a 171-ton steam turbine to drive the new Shell Petrochemicals Complex being built just 44 miles away as the crow flies in Pennsylvania. This would be the largest turbine ever built by Elliott. While significant infrastructure improvements by the local, state, and federal governments in southwestern Pennsylvania to rail, highway and waterway access have helped advanced manufacturers like Elliott remain competitive in today's global economy, the size and weight of this new turbine would present its own logistical challenges in making the final delivery to the Shell facility in Monaca, PA just a short-distance away.

Elliott's U.S. Headquarters and manufacturing facility in Jeannette, Pennsylvania.

Elliott's largest-ever steam turbine arrives at a dock on the Monongahela River for transport downriver by barge.

The Solution

After more than 18 months in planning, Elliott successfully shipped and delivered the turbine by barge to Shell in Monaca over a two-day period in the summer of 2018. After a short but complicated over-the-road transport to the river loading dock in Donora, the turbine was then moved by water down the Monongahela and Ohio Rivers, passing through four locks and the City of Pittsburgh, before reaching its final destination. Other components manufactured by Elliott for the Shell Pennsylvania Petrochemical Complex including crack gas compressors, a steam turbine driver, and a propane string were also transported along the U.S. inland waterways system.

REFERENCES

1. *Waterborne Commerce Statistics Center*. U.S. Army Corps of Engineers, New Orleans, LA. https://www.iwr.usace.army.mil/About/Technical-Centers/WCSC-Waterborne-Commerce-Statistics-Center/.
2. *Pennsylvania Comprehensive Freight Movement Plan*. Pennsylvania Department of Transportation, 2016. https://www.penndot.gov/ProjectAndPrograms/Planning/Documents/PennDOT-CFMP%20-%20FINAL%20August%202016.pdf
3. *Form EIA-923 Detailed Data with Previous Form Data (EIA-906/920)*. Energy Information Administration. https://www.eia.gov/electricity/data/eia923/
4. *America's Marine Highway*. U.S. Maritime Administration, Washington, DC. https://www.maritime.dot.gov/grants/marine-highways/marine-highway
5. *The Impacts of Unscheduled Lock Outages*. National Waterways Foundation and U.S. Maritime Administration, Washington, DC, October 2017. http://www.nationalwaterwaysfoundation.org/documents/low%20res%20Lock%20Outage%20NWF_FINAL_REPORT%202017.pdf
6. *Lock Characteristics General Report*. U.S. Army Corps of Engineers, Institute for Water Resources, 2014. https://usace.contentdm.oclc.org/digital/collection/p16021coll2/id/2601
7. *Upper Ohio Navigation Study, Pennsylvania, Final Feasibility Report and Integrated Environmental Impact Statement*. U.S. Army Corps of Engineers Pittsburgh District, October 2016. https://www.lrp.usace.army.mil/Missions/Planning-Programs-Project-Management/Key-Projects/Upper-Ohio-Navigation-Study-Documents/
8. *Upper Allegheny River Study, Locks and Dams 5, 6, 7, 8, and 9, Armstrong County, Pennsylvania*. U.S. Army Corps of Engineers Pittsburgh District, May 2018. https://www.lrp.usace.army.mil/Portals/72/docs/Allegheny%20River%205-9%20Disposition%20Study%20FINAL_REDACTED.pdf
9. *Monongahela River Locks and Dams 2, 3, and 4 Project (Lower Mon)*. U.S. Army Corps of Engineers Pittsburgh District. https://www.lrp.usace.army.mil/Missions/Planning-Programs-Project-Management/Key-Projects/Lower-Mon-Project/
10. *Infrastructure Status and Needs in Southwestern Pennsylvania: A Primer*. University of Pittsburgh Institute of Politics, Infrastructure Policy Committee, Pittsburgh, PA, Fall 2014. https://iop.pitt.edu/sites/default/files/Reports/Other/Infrastructure%20Status%20and%20Needs%20in%20Southwestern%20Pennsylvania%20-%20A%20Primer.pdf
11. Stephen R. Fritz. *Lower Monongahela River 2-3-4 Project Update,* Inland Waterways Users Board Meeting No. 95, October 30, 2020. https://www.iwr.usace.army.mil/Portals/70/docs/IWUB/board_meetings/meeting95/UB95%20Lower%20Mon%202-3-4%202020-304%2030Oct20%20V2.pdf?ver=CPgjAIUP9-TE2Vwai-n9yw%3d%3d
12. *Short-Term Energy Outlook: Coal*. Energy Information Administration, July 7, 2020. https://www.eia.gov/outlooks/steo/report/coal.php
13. Chuck Devore. China Goes All-In on Coal While Telling the Rest of the World to Reduce Emissions. *Forbes Online*, December 16, 2019. https://www.forbes.com/sites/chuckdevore/2019/12/16/china-goes-all-in-on-coal-while-telling-the-rest-of-the-world-to-reduce-emissions/#6168aebfadd6
14. Andrew Suhon. Campbell CEO Stephaich Weighs in on All Things Inland. *Campbell Transportation Company Inc.*, Houston, PA, October 17, 2017. https://www.barges.us/news/campbell-ceo-stephaich-weighs-things-inland/
15. John Shoulberg. End of an Era: Jeffboat Launches Last Barge. *The Waterways Journal*, April 30, 2018. https://www.waterwaysjournal.net/2018/04/30/end-of-an-era-jeffboat-launches-last-barge/
16. Michael E. Ott. Status of Inland Waterways 2020 Capital Investment Strategy, Inland Waterways Users Board Meeting No. 94, July 22, 2020. https://www.iwr.usace.army.mil/Portals/70/docs/IWUB/board_meetings/meeting94/UB94%20CIS%202020%20Update%20for%20IWUB%2022Jul20.pdf?ver=2020-07-17-142927-020

17. *Statement of Peter Stephaich on Behalf of Waterways Council, Inc.* Subcommittee on Water Resources and Environment Transportation and Infrastructure Committee, U.S. House of Representatives, April 20, 2019. https://transportation.house.gov/imo/media/doc/Stephaich%20Written%20Statement%20-%204-10-19.pdf
18. *How Project Selection in the Corps of Engineers Is Affected by Benefit-Cost Ratio (BCR) Analysis*. National Waterways Foundation, January 2018, Revised August 2018. http://www.nationalwaterwaysfoundation.org/TTI%20BCR%20FINAL%20STUDY.pdf
19. Shrutee Sarkar. U.S.-China trade war risks driving Fed policy, not Trump's carping – economists. Reuters.com, September 12, 2020. https://www.reuters.com/article/uk-usa-economy-poll/u-s-china-trade-war-risks-driving-fed-policy-not-trumps-carping-economists-idUKKCN1VY006
20. *U.S. Consumers Have Borne the Brunt of the Current Trade War*. National Bureau of Economic Research Digest, Cambridge, MA, May 2019. https://www.nber.org/digest/may19/w25672.shtml
21. Anita Sharpe. It's Not Just Farmers—U.S. Exports May Never Recover from the Trade War. *Bloomberg*, November 15, 2019. https://www.bloomberg.com/news/articles/2019-11-15/see-the-states-where-trump-trade-war-is-hammering-china-exports
22. *Global coal trade to grow through 2050, driven by Asia and industrial coal use: EIA*. S&P Global Platts, September 24, 2019. https://www.spglobal.com/platts/en/market-insights/latest-news/coal/092419-global-coal-trade-to-grow-through-2050-driven-by-asia-and-industrial-coal-use-eia
23. *Oil 2019*. International Energy Agency, https://webstore.iea.org/download/direct/2447
24. *Investor Presentation*. Kirby Corporation, Houston, TX, June 2019. http://docplayer.net/137061202-Investor-presentation-nyse-kex-june-2019.html
25. *Shale Gas 101*. U.S. Department of Energy, Office of Fossil Energy, Undated. Last accessed on April 30, 2020. https://www.energy.gov/fe/shale-gas-101
26. Brian Walzel. No Signs of Slowing the Marcellus-Utica. *Hart Energy*, September 4, 2018. https://www.hartenergy.com/exclusives/no-signs-slowing-marcellus-utica-31343
27. David Murray. Waterways Symposium: Global Risks, Positive Energy News. *The Waterways Journal*, November 18, 2018. https://digital.waterwaysjournal.net/Waterways-Journal-11182019-e-Edition/6/
28. *Inland Navigation in the United States: An Evaluation of Economic Impacts and the Potential Effects of Infrastructure Investment.* National Waterways Foundation, Washington, DC, November 2014. http://www.nationalwaterwaysfoundation.org/documents/INLANDNAVIGATIONINTHEUSDECEMBER2014.pdf
29. *Prospects to Enhance Pennsylvania's Opportunities in Petrochemical Manufacturing.* Prepared by IHS Markit for Pennsylvania Department of Community & Economic Development, Harrisburg, PA, March 2017. https://teampa.com/wp-content/uploads/2017/03/Prospects_to_Enhance_PAs_Opportunities_in_Petrochemical_Mfng_Report_21March2017.pdf
30. *In Focus: Inland Waterways Trust Fund*. Congressional Research Service, Washington, DC, January 29, 2015. https://www.everycrsreport.com/reports/IF10020.html
31. *After Three Decades, Olmsted Is Dedicated*. Capitol Currents, Waterways Council, September 28, 2018. https://waterwayscouncil.org/file/35/September-28-2018-Capitol-Currents-1.pdf
32. *Lessons Learned Regarding Research Demonstration Natural Gas Conversion Project of Inland Waterways Marine Vessels*. PIOGA Educational Workshop, November 6, 2019. https://pioga.org/wp-content/uploads/2019/11/Workshop-Lessons-Learned-on-Research-Demonstration-NG-Conversion-of-Inland-Waterway-Marine-Vessels.pdf
33. John Frittelli. Prioritizing Waterway Lock Projects: Barge Traffic Changes. *Congressional Research Service*, Washington, DC, June 1, 2018. https://fas.org/sgp/crs/misc/R45211.pdf
34. Mike Brinza. The Economic Value of the Port of Pittsburgh. *Pittsburgh Engineer*, Fall 2011. https://www.yumpu.com/en/document/read/4575409/pittsburgh-engineer-rivers-of-steel-national-heritage-area
35. *Southwestern Pennsylvania Regional Freight Plan*. Southwestern Pennsylvania Commission, Pittsburgh, PA, December 16, 2016. https://www.spcregion.org/wp-content/uploads/2019/09/SWPA-FinalPlan_2016.pdf

36. *Public Lock Commodity Report Files, Calendar Years 1999–2019*. U.S. Army Corps of Engineers Institute for Water Resources, Navigation Data Center, Alexandria, VA. https://publibrary.planusace.us/#/series/Lock%20Performance%20Monitoring%20System%20(LPMS)
37. *Pennsylvania.* Waterways Council, Washington, DC. https://waterwayscouncil.org/file/114/Pennsylvania-2016.pdf
38. *Waterborne Transportation Lines of the United States Calendar Year 2017*. Institute for Water Resources, U.S. Army Corps of Engineers, Alexandria, VA. https://publibrary.planusace.us/#/document/8ea9a049-4352-4ef6-97b4-68923bb1f898
39. *Navigation. Who Uses the Rivers?* U.S. Army Corps of Engineers Pittsburgh District, Pittsburgh, PA. https://www.lrp.usace.army.mil/Missions/Navigation.aspx
40. *Upper Ohio Navigation Study, Pennsylvania, Draft Feasibility Report, Appendix B, Project Economics.* U.S. Army Corps of Engineers Pittsburgh District, October 2016. https://www.lrp.usace.army.mil/Missions/Planning-Programs-Project-Management/Key-Projects/Upper-Ohio-Navigation-Study-Documents/
41. Chris Masciantonio. Presentation on Behalf of US Steel to Pennsylvania House of Representatives. *Republican Majority House Policy Committee*, November 16, 2017. http://www.pagoppolicy.com/Display/SiteFiles/112/2017hearings/Munhall/Chris%20Masciantonio-%20United%20States%20Steel%20Corporation.pdf
42. *The Steel Industry in Your State: Pennsylvania*. American Iron and Steel Institute, Washington, DC, 2018. https://steel.guerrillaeconomics.net/reports//3e5dafba-cdd1-426b-9b14-4eb5861caae8
43. *The Steel Industry in Your State: West Virginia*. American Iron and Steel Institute, Washington, DC, 2018. https://steel.guerrillaeconomics.net/reports//a79b62e6-c085-466f-a612-ce900c77d101
44. *Emsworth Locks & Dams Major Rehabilitation Project*. U.S. Army Corps of Engineers Pittsburgh District. https://www.lrp.usace.army.mil/Missions/Planning-Programs-Project-Management/Key-Projects/Emsworth-Locks-Dams-Major-Rehabilitation-Project/
45. Gwen S. DiPietro, H. Scott Matthews, and Chris T. Hendrickson. Estimating Economic and Resilience Consequences of Potential Navigation Infrastructure Failures: A Case Study of the Monongahela River. *Transportation Research Part A 69*, 2014, pp. 142–164.
46. Larry Bray. Pittsburgh Area Lock Closure Externality Study. *Presented at Transportation Research Board Summer Meeting*, Minneapolis, MN, July 12, 2010. http://onlinepubs.trb.org/onlinepubs/mb/Joint_Meeting/Larry_Bray.pdf
47. *Southside Works*. Visit Pittsburgh. https://www.visitpittsburgh.com/directory/southside-works/
48. *Pittsburgh's H2Opportunity: An Assessment of Southwestern Pennsylvania's Water Sector*. Pittsburgh World Environment Day Partnership, Pittsburgh, PA, January 2011. https://www.cmu.edu/steinbrenner/images/WaterReport_January2011.pdf
49. C. James Kruse, Jeffery E. Warner, and Leslie E. Olson. A Modal Comparison of Domestic Freight Transportation Effects on the General Public: 2001–2014. *National Waterways Foundation*, Washington, DC, January 2017. http://www.nationalwaterwaysfoundation.org/Research.html
50. *Public Lock Usage Report Files, Calendar Years 1993–2019*. U.S. Army Corps of Engineers Institute for Water Resources, Navigation Data Center, Alexandria, VA. https://publibrary.planusace.us/#/series/Lock%20Performance%20Monitoring%20System%20(LPMS)
51. *Complete List of Active Licenses.* Federal Energy Regulatory Commission, Washington, DC, updated 10/10/2019. https://www.ferc.gov/industries/hydropower/gen-info/licensing.asp
52. *TRB Special Report 315: Funding and Managing the U.S. Inland Waterways System: What Policy Makers Need to Know*. Transportation Research Board, Washington, DC, 2015. http://www.trb.org/Main/Blurbs/172741.aspx
53. Heather Ervin. The Port of Pittsburgh: A Vast River Traffic Region. *The Waterways Journal*, April 2, 2018. https://www.waterwaysjournal.net/2018/04/02/the-port-of-pittsburgh-a-vast-river-traffic-region/
54. Gwen S. DiPietro, Chris T. Hendrickson, and H. Scott Mathews. Alternative Methods to Assess Inland Waterways Efficiency: Case Study of Barge Shipments on the Upper Ohio River System. *Transportation Research Board 94th Annual Meeting*, 2015.

55. Jason Cato. Corps of Engineers Completes Study That Calls for Replacing Aging Locks, Dams on Upper Ohio. *TribLIVE*, September 12, 2016. https://archive.triblive.com/local/pittsburgh-allegheny/corps-of-engineers-completes-study-that-calls-for-replacing-aging-locks-dams-on-upper-ohio/
56. Army Civil Works Program, FY 2021 work plan. U.S. Army Corps of Engineers. https://usace.contentdm.oclc.org/digital/collection/p16021coll6/id/2149
57. Personal communication with Lenna Hawkins, Deputy District Engineer, USACE Pittsburgh District, April 3, 2020.
58. *Pittsburgh, PA Metro Area (2018)*. Census Reporter. https://censusreporter.org/profiles/31000US38300-pittsburgh-pa-metro-area/
59. *Monongahela River Locks and Dams 2, 3, and 4 Project (Lower Mon)*. U.S. Army Corps of Engineers Pittsburgh District. https://www.lrp.usace.army.mil/Missions/Planning-Programs-Project-Management/Key-Projects/Lower-Mon-Project/
60. Lenna Hawkins. Lower Monongahela River 2-3-4 Project Update. *Presented to Inland Waterways Users Board Meeting No. 91*, New Orleans, LA, May 23, 2019. https://www.iwr.usace.army.mil/Portals/70/UB91_09_Lower_monogahela_River_Hawkins_1.pdf
61. *Public Law 95-502*. October 21, 1978. https://www.govinfo.gov/content/pkg/STATUTE-92/pdf/STATUTE-92-Pg1693.pdf#page=10
62. *Public Law 99-662*. November 17, 1986. https://www.govinfo.gov/content/pkg/STATUTE-100/pdf/STATUTE-100-Pg4082.pdf
63. Mike Toohey. Presentation to Gulf Intracoastal Canal Association. *GICA Annual Seminar*, August 7–9, 2019. https://1sa722nsy9q46gdcm172hjd2-wpengine.netdna-ssl.com/wp-content/uploads/2019/09/toohey-final-gulf-intracoastal-canal-association-2019.pdf
64. Mark R. Pointon. Financial Report & Project Summaries. Inland Waterways Users Board Meeting No. 95, October 30,2020. https://www.iwr.usace.army.mil/Portals/70/docs/IWUB/board_meetings/meeting95/UB95%20Financial%20Report%20and%20Proj%20Summaries%2030Oct20%20V2.pdf?ver=Ilud_ChnZWXzwfP0UCvaig%3d%3d
65. *Removal of Lightly Used Allegheny River Locks. Dams Mulled*. United States Society on Dams, Westminster, CO, March 2017. https://www.ussdams.org/our-news/removal-of-lightly-used-allegheny-river-locks-dams-mulled/
66. *Inland Waterway Users Board 32nd Annual Report to the Secretary of the Army and the United States Congress*, December 2019. https://waterwayscouncil.org/file/257/IWUB%20Annual%20Report%2032nd%20for%202019%20Jan2020.pdf
67. Lenna Hawkins. Upper Ohio Navigation Project Update. *Presented to Inland Waterways Users Board Meeting No. 91*, New Orleans, LA, May 23, 2019. https://www.iwr.usace.army.mil/Portals/70/UB91_06_Upper_Ohio_Hawkins_1.pdf
68. *A Tale of Two Budgets*. Capitol Currents, Waterways Council Inc., March 3, 2020. https://waterwayscouncil.org/file/275/2020-03_Capitol_Currents.pdf
69. *Inland and Intracoastal Waterways Twenty-Year Capital Investment Strategy.* Inland Waterways Users Board, March 2016. https://www.iwr.usace.army.mil/Portals/70/docs/IWUB/WRRDA_2014_Capital_Investment_Strategy_Final_31Mar16.pdf
70. *Pittsburgh's Energy Assets at a Glance*. Pittsburgh Regional Alliance. Undated.
71. *Annual Coal Distribution Report*. U.S. Energy Information Administration. https://www.eia.gov/coal/distribution/annual/#:~:text=Highlights%20for%202019,tons%20(MMst)%20in%202019.&text=Total%20domestic%20coal%20distribution%20was,lower%20than%20the%202018%20value.
72. The Regional Greenhouse Gas Initiative. https://www.rggi.org/
73. *Monthly Energy Review, Table 7.2a, March 2020 and Electric Power Monthly, February 2020, preliminary data for 2019*, U.S. Energy Information Administration. https://www.eia.gov/energyexplained/electricity/electricity-in-the-us.php
74. *Today in Energy: U.S. Coal Exports Declined in 2019*. Energy Information Administration, March 18, 2020. https://www.eia.gov/todayinenergy/detail.php?id=43195

75. Eric Haun. US Barging Industry Navigating Black Swan Events. *MarineLink*, May 7, 2020. https://www.marinelink.com/news/us-barging-industry-navigating-black-swan-478301
76. *Proposed Zoning Changes Could Harm Efforts to Maintain Navigable Rivers*. Allegheny Institute for Public Policy, March 2, 2016. https://www.alleghenyinstitute.org/proposed-zoning-changes-could-harm-efforts-to-maintain-navigable-rivers/
77. *Riverfront Zoning Proposal Much Improved by Revisions*. Allegheny Institute for Public Policy, May 26, 2016. https://www.alleghenyinstitute.org/riverfront-zoning-proposal-much-improved-by-revisions/
78. *Section 905.04 of the Pittsburgh Zoning Code*. https://pghriverfrontzoning.files.wordpress.com/2018/04/riv-zoning-text-915-bonuses.pdf
79. Alan M. Field. The US-China Trade War: Where We Go from Here. *IHS Markit, Journal of Commerce White Paper*, November 2019.
80. Martha C. White. Trump's trade war could spark a recession, Goldman Sachs warns. *NBC News*, August 12, 2019. https://www.nbcnews.com/business/economy/trump-s-trade-war-could-spark-recession-warns-goldman-sachs-n1041501
81. Erica York. Tracking the Economic Impact of U.S. Tariffs and Retaliatory Actions. *Tax Foundation*, Washington, DC, September 18, 2020. https://taxfoundation.org/tariffs-trump-trade-war/
82. *Tariffs and Tribulations: Recasting US Metals Industries*. Platts Insight, December 4, 2019. https://blogs.platts.com/2019/12/04/tariffs-us-metals-industries/
83. *New Trump Tariffs Stoke Fears for Steel and Port Jobs in Pennsylvania*. PortandTerminal.com, December 4, 2019. https://www.portandterminal.com/new-trump-tariffs-stoke-fears-for-steel-and-port-jobs-in-pennsylvania/?utm_source=sendinblue&utm_campaign=The%E2%80%A6
84. *International Energy Outlook 2020*. U.S. Energy Information Administration, Washington, DC, October 14, 2020. https://www.eia.gov/outlooks/ieo/pdf/ieo2020.pdf
85. *Annual Energy Outlook 2020*. U.S. Energy Information Administration. https://www.eia.gov/outlooks/aeo/pdf/AEO2020%20Full%20Report.pdf
86. Shaun M. Seydor, Eric Clements, Spyros Pantelemonitis, and Vinay Deshpande. Understanding the Marcellus Shale Supply Chain. *University of Pittsburgh Katz Graduate School of Business*, Pittsburgh, PA, May 15, 2012. https://www.slideshare.net/MarcellusDN/understanding-the-marcellus-shale-supply-chain
87. *The Marcellus Shale: Pennsylvania's Homegrown Energy Source*. Pennsylvania Oil & Gas Association. http://northerntier.org/upload/9-8PIOGA%20Marcellus%20Brochure.pdf
88. *Marcellus and Utica Shale Resources*. Pennsylvania Independent Oil & Gas Association, 2020. https://pioga.org/education/marcellus-utica-shale-resources/
89. *Marcellus and Utica Shale Formation Map*. Marcellus Shale Coalition, Pittsburgh, PA. https://marcelluscoalition.org/pa-map/
90. *Shale Gas Outlook for Great Lakes and Ohio River Basin States: Production, Production Facilities, Products, and Methods of Delivery*. Prepared by CDM Smith & the Tioga Group for U.S. Army Corps of Engineers, May 15, 2013. https://www.lrd.usace.army.mil/Portals/73/docs/Navigation/PCXIN/Shale%20Final%20Report.pdf
91. Nicholas Woodroof. Susquehanna County drives natural gas production in Marcellus Shale in US. Oilfield Technology. *GlobalData*, July 4, 2019. https://www.oilfieldtechnology.com/drilling-and-production/04072019/globaldata-susquehanna-county-drives-natural-gas-production-in-marcellus-shale-in-us/
92. *Shell Pennsylvania Petrochemicals Complex*. Wikipedia. https://en.wikipedia.org/wiki/Shell_Pennsylvania_Petrochemicals_Complex
93. Frequently Asked Questions about Ethane Crackers. *The Allegheny Front*, 2015. http://archive.alleghenyfront.org/story/frequently-asked-questions-about-ethane-crackers.html
94. Jared Stonesifer. Plans for Ohio Cracker Plant Get Bigger, More Expensive. *The Times*, Aliquippa, PA, March 14, 2018. https://www.timesonline.com/news/20180314/plans-for-ohio-cracker-plant-get-bigger-more-expensive
95. Chrissy Suttles. ExxonMobil Corp. Considering Cracker Plant in Beaver County. *The Times*, Aliquippa, PA, October 16, 2019. https://www.timesonline.com/news/20191016/exxonmobil-corp-considering-cracker-plant-in-beaver-county

96. *Army Corps of Engineers: Water Resource Authorization and Project Delivery Processes*. Congressional Research Service, Report R45185, Washington, DC, April 19, 2019. https://fas.org/sgp/crs/natsec/R45185.pdf
97. Katie Galioto. Old Mississippi River Towboat Gets New Eco-Friendly Engine. *Star Tribune*, July 9, 2018. https://www.startribune.com/old-mississippi-river-towboat-gets-new-eco-friendly-engine/487708031/
98. Edward Schwarz and Richard Rozok. The ABB ETB (Electric Towboat): The U.S. Inland River Market Is Ready for Electric Propulsion. *ABB*, 2018. https://new.abb.com/docs/librariesprovider91/leaflets-brochures/inland_whitepaper_webversion.pdf
99. Kevin Horne. Barges: Why Bigger Is Not Necessarily Better. *WorkBoat*, August 30, 2016. https://www.workboat.com/blogs/maritime-matters/barges-bigger-not-necessarily-better/
100. FUELCAST, Energy Ventures Analysis, Fall 2020.
101. Iryna Lendel. *2018* Downstream Challenges and Opportunities*. Maxine Goodman Levin College of Urban Affairs*, Cleveland State University, October 20, 2018. https://engagedscholarship.csuohio.edu/cgi/viewcontent.cgi?article=2585&context=urban_facpub
102. *Navigable Waters Generally*, 33 U.S.C. Sections 1–55, 1952.
103. *Price Data*. Independent Commodity Intelligence Services. https://www.icis.com/explore/services/market-intelligence/price-reports/?intcmp=mega-menu-explore-services-market-intelligence-price-reports.
104. *National Minerals Information Center*. U.S. Geological Survey. Home. https://www.usgs.gov/centers/nmic.
105. *Economic Research Service*. United States Department of Agriculture. https://www.ers.usda.gov.
106. *Freight Analysis Framework Version 4*. Federal Highway Administration. https://faf.ornl.gov/fafweb/.
107. *Business Reports*. Pittsburgh Prospector. http://www.pittsburghprospector.com/businesses.html.
108. *Key Assumptions of IMPLAN & Input/Output Analysis*. IMPLAN Group, LLC, 2018. https://implanhelp.zendesk.com/hc/en-us/articles/115009505587-Key-Assumptions-of-IMPLAN-Input-Output-Analysis.
109. *Explaining the Type SAM Multiplier*. IMPLAN Group, LLC, 2018. https://implanhelp.zendesk.com/hc/en-us/articles/115009674768-Explaining-the-Type-SAM-Multiplier.
110. *IMPLAN Group*. https://www.implan.com.
111. *Annual Coal Distribution Report 2018*. U.S. Energy Information Administration. October 2019. https://www.eia.gov/coal/annual/pdf/table31.pdf.
112. *Metallurgical Coal.* Kentucky Geological Survey. University of Kentucky, 2002. https://www.uky.edu/KGS/coal/coal-met.php.