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	FINANCING WATER RESOURCES DEVELOPMENT - A BRIEF HISTORY	
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Financing Water Resources Development

A Brief History

by
Martin Reuss
Paul K. Walker



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of Engineers**
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FINANCING WATER
RESOURCES DEVELOPMENT
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MARTIN REUSS
PAUL K. WALKER

HISTORICAL DIVISION
OFFICE OF ADMINISTRATIVE SERVICES
OFFICE OF THE CHIEF OF ENGINEERS

FOREWORD

By any reasonable indicator, the cost of future Civil Works projects exceeds the available Federal financial resources now and for the foreseeable future. Consequently, it is essential that we plot a new course for financing Federal water development -- one which takes the limited Federal dollars and stretches them over a larger number of projects by capitalizing on the capabilities of the project beneficiaries to assemble financing packages and at the same time weeds out the less feasible projects.

In order to have a better historical base with which to evaluate present water resources policies and to explore the potential for increased non-Federal participation in water resource development, the Office of the Assistant Secretary of the Army for Civil Works directed the Historical Division of the Army Corps of Engineers to prepare this brief history. Written by Doctors Martin Reuss and Paul K. Walker, this history is a summary of an extraordinarily complex subject. Not only the Federal Government, but private investors, states, local communities, and various governmental bodies have financed water resources development. The projects themselves are of many different kinds: dredging, snagging, locks, dams, levees, jetties, floodways, diversion channels, reservoirs, canals, and hydroelectric stations, to name only some. Also, many projects serve multiple purposes, including flood control, navigation, irrigation, water supply, hydroelectric power, and recreation. The primary and secondary project purposes often dictate the funding arrangement.

While the financial history of water resources development is a rather complicated story, certain general themes emerge. By reading this history, one will gain a better appreciation for the social, political, economic, and technological forces that helped to determine the past evolution of Federal water policy. I commend this work to all who wish a better understanding of a subject of continuing importance.



WILLIAM R. GIANELLI
Assistant Secretary of the Army
(Civil Works)

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THE FINANCIAL COST OF WATER RESOURCES DEVELOPMENT: AN OVERVIEW

As of 1955

In the mid-1950s, the Hoover Commission attempted to evaluate the role and impact of the federal government in the development of U.S. water resources. For two years, the task force reviewed data and held public hearings around the country. In 1955, it presented its report offering an overview of federal participation in the development of water resources.

The task force estimated that for the period 1824-1954 the total investment in water resources in this country amounted to about \$85 billion. No attempt was made to convert historical expenditures into 1955 dollars. Of the total amount, the federal government contributed approximately \$14.3 billion (17 percent). Nonfederal interests, including private investors and local and state governments and instrumentalities, accounted for the rest. About 80 percent of the \$14.3 billion had been invested in capital outlay. The rest had been used for planning, maintenance, and operation. Most of the federal expenditures for water resources development came after 1930. The task force's breakdown follows:

1824-1920	\$ 1.15 billion (8% of total)
1920-1930	.86 billion (6%)
1930-1945	2.58 billion (18%)
1945-1954	<u>9.73 billion (68%)</u>
	\$14.32 billion (100%)

Historically, navigation and flood control projects account for the bulk of federal water resources investment. Irrigation and hydropower development remained, as of 1955, still largely in the hands of private, local, or state entities; but federal investment and involvement in these areas were growing. In 1933, federally installed hydropower capacity was less than 1 percent of the total. Twenty years later, in 1953, the figure had climbed to 12.4 percent, accounting for a little over 13 percent of electrical energy produced in the United States. The federal government had become, by 1953, the largest single electrical producer in the country.

According to the Hoover Commission task force, more often than not, where the federal government did invest, it required little or no direct nonfederal contributions (irrigation was a major exception, although even here the amount of local contributions was declining). The federal government had borne almost the entire burden of clearing, channeling, and improving navigation in rivers and harbors. The major contribution of local interests was to provide free of cost to the federal government all necessary land, easements, and rights-of-way. The task force also noted that

nonfederal contributions had financed the larger share of several important navigation projects: the Houston Ship Channel, the Sabine-Neches Canal, the New York State Barge Canal, and several Great Lakes harbors. Altogether, the federal government had spent approximately \$4.5 billion to improve, maintain, and operate its navigation system. This system included 286 coastal harbors, 131 Great Lakes harbors and channels, the intracoastal canals, and numerous rivers. As of 1954, 22,500 miles of navigable rivers had actually been improved for navigation. An additional 6,000 miles had been authorized for improvement. The Corps of Engineers was operating and maintaining 312 locks and 219 dams for navigation purposes.

As of 1950, the federal flood control program comprised 996 projects in 46 states (all except Delaware and Maine) and in the District of Columbia, Alaska, and Hawaii. Most of these projects were multipurpose in nature. They ranged from small levee projects for local protection to the Mississippi River and Tributaries project to control flooding in the lower Mississippi basin. According to Corps figures, the federal government had spent about \$3.7 billion for flood control by 1950. Of this amount, \$3.2 billion had been spent on construction, \$212.5 million on maintenance and operation, and \$189.7 million on flood fighting, repair of damaged works, surveys, and contingencies. Local interests had spent about \$52.6 million through fiscal year 1950 on operation and maintenance of flood control projects. The Corps estimated that local contributions would total nearly \$480 million before the authorized flood control program was completed.

Most federally sponsored flood control projects required little investment from nonfederal sources, although local flood control projects generally required cost-sharing. The major nonfederal requirement for flood control projects remained the 1936 flood control act "a, b, c" requirements. Local investment in flood control projects averaged about 20 percent through the mid-1950s. If one totaled the nonfederal investment in both large and local-protection flood control projects, he would find the average nonfederal investment to be about 7.4 percent. If anything, the amount of nonfederal investment declined during the post-World War II period.

As of 1973

In its 1973 report to the President, the National Water Commission attempted to calculate the total historical expenditures for water resources development. It converted all figures to the 1972 dollar value. It estimated the total federal financial investment through 1969 for hydropower, flood control, navigation, and recreation to be approximately \$52.5 billion. State and local investment amounted to \$8.7 billion, while private investment totaled \$10.8 billion. (According to the Corps, total federal expenditures for navigation improvements from the early 19th century

to 1975 amounted to more than \$13 billion.) The National Water Commission pointed out that state and local interests have spent far more money than the federal government on municipal water and sewage facilities. Total state and local investment in these water projects amounted to about \$180 billion. The commission concluded that the federal government had spent a total of \$87.7 billion on water projects, whereas state and local interests had invested \$194.5 billion, and private interests had spent \$56.5 billion. The grand total for water resources investment through 1972 (in 1972 dollars) was about \$340 billion.

NAVIGATION IMPROVEMENTS BEFORE THE CIVIL WAR

Early internal improvements were hampered by two difficulties: the lack of capital and the absence of technical or engineering expertise and equipment. Americans were wealthy in ships and land, but as late as 1800 only three corporations in the United States had a capital of a million dollars--the Bank of the United States, the Bank of North America, and the Bank of Pennsylvania. After the American Revolution and before the creation of the present federal system in 1789, private investors carried out internal improvements. The role of state governments was limited to the chartering of specific projects and, usually, to providing some degree of funding, either through the direct granting of sums of money or through the purchase of shares of stock. The scope of internal improvements work within the states varied greatly. Customs revenues and other fees, duties, or tolls were generally the source of state monies for internal improvements.

During this period, Americans debated the federal government's relation to the states. In this regard, the question of the role of a central government in fostering commerce arose early, as did the question of its role in developing the western lands. In 1784 George Washington, writing to Richard Henry Lee, urged the necessity of surveying western waters (at this time, primarily the Ohio and Mississippi rivers). Washington's concern was partly defense, but he was also aware of the need for commercial routes to link west and east. Without such routes, Washington feared, the western settlers would direct their trade either down the Mississippi (to trade with the Spanish) or up it (to trade with the British in Canada).

At the Constitutional Convention, Benjamin Franklin became the principal advocate of federal sponsorship for internal improvements. He, too, urged the necessity of linking east and west in the newly founded republic. But Franklin lost the battle. The Constitution gave the new federal government the power to "provide for the common Defense and general Welfare of the United States"; but it limited explicit construction authority to military structures such as arsenals and fortifications, lighthouses, and--thanks in large measure to Elbridge Gerry of Massachusetts--post roads, post offices, dockyards, and "other needful buildings."

The Constitution basically reserved to the states the role of fostering internal improvements. Consequently, there was no appreciable difference in the way things were done in the 1790s from the way they were done in the 1780s. The new Constitution did have one significant negative effect upon state internal improvement programs. It deprived the states of an important source for their own funding of these improvements by reserving customs revenues to

the national government. By the end of the 1790s, state politicians and private investors exerted increased pressure for grants of federal aid to internal improvements. Many of the projects charted in the 1780s or early 1790s were foundering because of bad economic conditions. Federal assistance came to be viewed as a practical necessity.

In response, Congress in 1802 began the practice of appropriating money for specific internal improvement projects within the states. It authorized the Secretary of the Treasury, in that year, to pay a maximum of \$30,000 for the repair and erection of public piers in the Delaware River. In 1805 nearly \$6,000 more was appropriated for the project.

These appropriations scarcely opened a sluice gate of federal grants. President Thomas Jefferson and Congress retained doubts about the constitutionality of the appropriations. Nevertheless, political lobbying for aid increased, and Jefferson himself realized that some sort of national system for internal improvements was required. The states could not adequately provide the internal improvement necessary for American prosperity. In 1808, Jefferson's Secretary of the Treasury, Albert Gallatin, submitted his famous report recommending federal aid for a great system of roads and canals to link the Atlantic Ocean and the interior of the country. The following year, Congress appropriated the first sum strictly for water development--\$25,000 to lengthen the Carondelet Canal and to deepen the Mississippi channel at New Orleans. However, the project was justified as necessary for defense; no one spoke of commercial river and harbor improvements.

It was from the westernmost states and territories that Congress would hear most loudly the call for help with internal improvements, and the power of Congress to construct internal improvements in the territories was never seriously challenged. Typical of these appeals was an editorial in the Kentucky Gazette of Lexington on March 25, 1816: "The western waters are our canals and from the simplicity of their wanted improvements are entitled to the first application of moneys and subscriptions from the national treasury." The states formed from the interior were often conscious of a special responsibility to promote internal improvements. The Missouri state constitution (1820) stated that "Internal improvements shall forever be encouraged by the government of this state, and it shall be the duty of the General Assembly, as soon as may be, to make provision by law for ascertaining the most proper objects of improvements in relation both to roads and navigable rivers. . . ." Michigan and Arkansas expressed similar sentiments in their state constitutions. The state of Maryland recommended an amendment to the Constitution which would allow federal sponsorship of internal improvements and introduced, in 1823, a resolution calling for federal-state cooperation in developing internal improvements.

After a long period of inactivity, caused partly by the War of 1812, Congress once more authorized funding for water resources. In 1819 it appropriated \$6,500 for a survey of the tributaries of the Mississippi and Ohio rivers. The following year it extended the survey activities to include the lower Mississippi and appropriated \$9,500 more. In both cases, the funds were included in military appropriations bills.

Appropriations for the older sections of the country also increased. In 1821, Congress authorized a survey of the Maine-New Hampshire coast and appropriated \$2,500 to repair seawalls and build lighthouses. Another \$22,700 was appropriated the following year for similar projects elsewhere. In 1823, Congress authorized \$6,000 to remove obstacles in Gloucester Harbor and \$150 to survey the harbor entrance at Presque Isle, Pennsylvania. The total value for "river and harbor" projects from 1802 to 1823 was just over \$85,500. Most of these expenditures were clearly within the recognized purview of the federal government. The surveys in the territories, the lighthouse and seawall work, and the Carondelet Canal could all be justified as matters of national defense. A few projects did seem to stretch the limits of federal authority, but the first significant redefining of federal authority came in 1824.

In 1824, President James Monroe signed the General Survey Bill. It authorized him to have surveys made of routes for roads and canals "of national importance, in a commercial or military point of view, or necessary for the transportation of public mail." Within two months, Congress passed and the President signed the first true rivers and harbors bill. This act appropriated \$75,000 to improve navigation on the Ohio and Mississippi rivers by removing sandbars, snags, and other obstacles (as early as 1811 Congress had declared the Mississippi to be a "national public highway" and had forbidden states to levy tolls or duties upon its traffic). Military as well as commercial requirements justified the project. The War of 1812 had shown the importance of good interior lines of communication. The General Survey Act and the act to improve the Mississippi and Ohio rivers mark the beginning of continuous Corps of Engineers involvement in navigation improvement. Congress clearly intended that the involvement be ongoing; it ordered the engineers to report back their progress so that the need for further appropriations might be determined.

After 1824, federal programs on rivers and harbors increased, although states and private interests still carried the greater financial burden. Most of the federal focus was on the "public highways"--that is, the great rivers such as the Mississippi, Ohio, Missouri, and Arkansas--and on river and harbor work close to or on ocean ports. The period from 1824 to the Civil War is marked by a general inconsistency in national policy and a growing public debate over the federal role in internal improvements. The debate and

inconsistency must be set in the context of American expansion westward and increasing sectional and regional friction--and, after 1848, a rising national debt caused by the Mexican War. Commercial rivalries between river and canal interests on one hand and railroads on the other also fired the debate. By the 1850s, the issue of federal involvement in internal improvements was a partisan matter. In 1852, the Whig Party championed the cause of federal assistance by proclaiming Congress's power to improve and maintain all navigable rivers either for defense or for the protection of commerce. The Democrats maintained the positions set forth in their party platform of 1848, that Congress had no power to carry on a general system of internal improvements (one scholar notes wryly that the platform did not prevent Democratic congressmen from voting for appropriations). The Republican Party, by contrast, in 1856 declared that "appropriations by Congress for the improvement of rivers and harbors of a national character, required for the accommodation and security of our existing commerce, are authorized by the Constitution, and justified by the obligation of the government to protect the lives and property of its citizens." This national debate was sidetracked by the Civil War. Afterwards, the necessity of government involvement was uncontested.

In the 1820s and 1830s, the states and private investors also carried out a great deal of internal improvement work. The best known of these state projects is the Erie Canal, but there were other canal projects (some of them never completed) in New Jersey, Pennsylvania, Ohio, Illinois, Indiana, Michigan, and South Carolina. States also contributed to private canal projects by investing money in them--as did some of the larger cities, such as Baltimore and Philadelphia. In some instances, states took over a foundering canal enterprise (for example, the James River and Kanawha Canal Company in Virginia). In some states (for example, New York, Ohio, Pennsylvania, and Kentucky) internal improvements programs for canals or river work were substantial. To many of these programs, the federal government's assistance was limited mainly to the granting of financial aid or land, or to technical assistance. In a few cases there was state-federal cooperative development--as in the Dismal Swamp Canal project. The number of federal projects also grew, in part because of national expansion and in part because of growing political competition among congressmen for federal funds. During his term of office, President Andrew Jackson attempted to stem the rising tide of projects whose "general or national" character was dubious: he noted in 1834 that there were pending before Congress proposals which altogether must have exceeded in cost \$100 million. Equally important, however, for the rising cry for federal assistance was the Panic of 1837, which severely crippled the economies of many states and localities, as well as private investors. Still another factor, beginning in the 1840s, was the emergence of railroads.

Judicial interpretations significantly affected federal navigation policies. In 1824, the Supreme Court in Gibbons v. Ogden ruled that federal power over interstate commerce included riverine navigation "so far that navigation may be in any manner connected with commerce." The decision inevitably raised the question of the limits of state versus federal responsibilities for navigation. Common law furnished the original answer: only tidal streams were under federal jurisdiction. Andrew Jackson changed the policy by deciding that improvements below a port of entry would be made by the federal government and all others would be the responsibility of the states. Congress effectively subverted Jackson's policy when it began declaring inland ports to be "ports of entry" and appropriating money for their improvement. President Franklin Pierce resisted the practice in the mid-1850s, but he was the last President to do so.

In short, federal jurisdiction over rivers expanded. In the period from 1840 to 1870, Congress effectively extended federal jurisdiction over the inland waters. In a famous 1870 decision (Pennsylvania v. Wheeling Bridge Co.), the Supreme Court declared that

Those rivers must be regarded as public navigable rivers in law which are navigable in fact. And they are navigable in fact when they are used, or are susceptible of being used, in their ordinary condition as highways of commerce, over which trade and travel are or may be conducted in the customary modes of trade and travel on water. And they constitute navigable waters of the United States within the meaning of the acts of Congress, in contradistinction from the navigable waters of the States, when they form in their ordinary condition by themselves, or by uniting with other waters, a continued highway over which commerce is or may be carried on with other States or foreign Countries. . . .

In this decision the Supreme Court merely confirmed what Congress and private interests had long taken for granted: the right to regulate navigable waters includes the right to improve them.

Although federal jurisdiction was expanding, the states and other entities were still responsible for a great deal of the construction during the period before the Civil War, and they were often assisted by federal grants. The grants were generally land grants, or funds of money derived from the sale of public land. In 1819 Congress set aside 5 percent of the monies received from sale of public lands in Alabama to be returned to the state as a fund for internal improvements. It continued the practice (though generally

at 2 or 3 percent for other new states entering the union). In 1827 Congress initiated the practice of granting rights-of-way through public lands for state canal projects, granting such lands to Illinois and Indiana. In 1828 Congress granted 400,000 acres of public lands to Alabama to finance improvement of the Tennessee River at Muscle Shoals and Colbert's Shoals.

By the 1840s Congress had given substantial acreage to the states--over a million acres, for example, to Ohio and Indiana alone. In 1841, Congress enacted the 500,000-acre land grants for public improvements. Under this act, eight specific states and every public-land state thereafter admitted to the Union were to receive a grant of 500,000 acres of public lands to use for specified improvements. By the time the program was terminated in 1889, 15 states had each received the full 500,000 acres, and two more, Illinois and Alabama, had received 209,086 and 97,469 acres, respectively. The uses of this land were various--some states used it to finance public education, others for railroad construction or irrigation; some applied a portion to river improvements, canals, or roads; one state, Minnesota, liquidated state bonds previously loaned to railroads.

In 1849 and 1850, Congress authorized another series of land grants to aid states with internal improvements. The 1849 Swamp Lands Act granted to Louisiana all swamp and overflowed lands owned by the federal government within that state. The purpose of the act was to assist the state in the construction of levees and other flood protection measures and in the drainage and reclamation of the lands. In 1850, Congress extended the act to cover other states, and another extension in 1860 included Minnesota and Oregon in the act. Eventually 15 states received a total of 64,853,922 acres of land--or 101,334 square miles, an area slightly smaller than the state of Colorado.

Another form of federal assistance to state, local, or private internal improvements projects was the purchase of stock in canal companies. The first such investment came in 1825, when Congress authorized the purchase of 1,500 shares in the Chesapeake and Delaware Canal Company. This investment was followed by four others; the total investment was \$1.88 million. (In addition, the federal government eventually assumed some of the costs of constructing and operating at least one of these canals, the Great Dismal Swamp Canal.)

Gradually, as the role of states in internal improvements projects declined, the role of the federal government increased. According to the Hoover Commission Task Force on Water Resources and Power (1954), the role of states or their political subdivisions in navigation improvement projects has been, since 1850, "comparatively rare." The history of federal participation in water resources developments in the 19th century is one of increasing activity, in

terms of both kind and degree, in navigation improvement--and of increasing calls from the states and private interests for ever more assistance.

Just how large was the federal contribution to the development of internal improvements and, more specifically, to river, harbor, and canal improvements? Altogether, by 1860 Congress had appropriated about \$14.5 million for river and harbor improvements, and another \$2.5 million for canals. These amounts include the subscriptions to canal companies and the monies from the 2 and 3 percent funds. Of that \$14.5 million spent for rivers and harbors projects, roughly \$5 million had been spent on the Atlantic coast, \$1 million on the Gulf coast, \$3 million on the Great Lakes, and \$3 million on the great inland rivers--the Mississippi, Ohio, Missouri, and Arkansas. A small amount (about \$30,000) had been spent on the Pacific coast. Approximately \$1 million of appropriated funds had not been spent.

The value of the land grants is more difficult to calculate, since state records are not complete and since the lands were used, in some cases, for various (or multiple?) purposes. Certainly the federal government gave the states a substantial amount of acreage. Federal land grants for canals, according to figures compiled by the Department of Commerce, totaled 4,597,668 acres. Grants for river improvement projects amounted to 1,742,671 acres. The Swamp Land Act grants came to 64,853,922 acres, of which 51,252,945 acres seem to have been used at least partly for purposes of reclamation or flood control (13,600,977 acres of these lands were donated by the states to railroads). Of the 7,806,555 acres eventually granted under the 500,000-acre land grants described above, it can be safely assumed that a considerable part of the grant was used for river, harbor, and canal work.

These grants and appropriations were not insignificant; but they represent a modest amount of aid compared to the assistance which came after the Civil War. By the 1850s, indeed, river interests in the interior were agitating for far more aid than they were receiving. St. Louis rivermen calculated that river obstacles such as snags and sandbars resulted in the loss of boats and cargo in the amount of \$3,631,000 just for the years 1822-1841. This is more than the total federal appropriations, from 1824 to 1860, for the four great inland rivers. By the mid-1840s, the first of the river conventions had met at Memphis to organize lobbying efforts for more federal aid. It would be followed by many others. The Civil War brought almost all internal improvements projects to a halt. It also destroyed the commerce on the Mississippi River. When work resumed after the war, it would be on a scale far greater than before.

How large a share of the total burden for waterway development did the federal government actually bear during the pre-Civil War

period? Unfortunately, figures are simply not complete. Estimates, however, which vary, suggest that states and private interests spent well over \$185 million for canals by 1860. While it is true that the federal government assumed increasing responsibility for navigation improvements in this period, the federal work was concentrated mainly on ports and larger rivers. States, localities, and private interests continued to bear responsibility for improvements on minor rivers and all costs for flood control or the construction of terminals, wharves, and docks at ports. Nor was the federal government involved, except indirectly through land grants, in reclamation or drainage efforts. Although federal appropriations increased during this period, they never did so on a scale matching the work to be done--federal aid, moreover, was inconsistent: periods of (relative) generosity alternated with periods of stinginess. No appropriation, for example, was made for the lake ports after 1852; they were left, as the Chief of Engineers described them after the Civil War, "abandoned, and the works left to subserve the purposes intended as long as the timber and other material used in their construction might resist decay and the heavy storm waves for the lake." What seems most important in this period, however, is not the amount of federal assistance, but the practices which were being established.

NAVIGATION IMPROVEMENTS FROM THE CIVIL WAR TO WORLD WAR II

The years following the Civil War were heady for champions of rivers and harbors improvements. From 1866 to 1882, the President signed 16 rivers and harbors bills. The consequent increase in federal river and harbor work was enormous. The 1866 rivers and harbors act appropriated \$3.7 million for 49 projects and 26 surveys. The 1882 act appropriated \$18.7 million for 371 projects and 135 surveys. By 1882, federal appropriations for all rivers and harbors projects since the beginning of the century had escalated to over \$111 million. Of that amount, approximately \$95.5 million had been appropriated in the period since the Civil War ended. Actual expenditures over the entire period totaled about \$106 million, of which over \$91 million had been expended since 1866. By 1882, also, federal appropriations for canal construction totaled nearly \$2.8 million.

There were several reasons for the post-Civil War increase. Few denied the importance of commerce on the Mississippi to the economic health of the nation, and the river had suffered from years of neglect. Indeed, the last major rivers and harbors act had been passed in 1852. Since that time, there had been little done on the river in the way of snagging and clearing operations. Problems were compounded, moreover, by Confederate efforts to block the river by scuttling vessels, and by the Union Army's destruction of levees, which created both navigation and flood control problems. After the war, commercial interests along the Mississippi, Ohio, and Missouri rivers once again gathered at river conventions to petition Congress for aid. State legislatures likewise requested aid from Congress to improve the rivers.

Although railroads opposed any significant aid for river improvements, the Civil War had demonstrated vividly that railroads alone were not adequate to handle the nation's freight and commerce. Congress expressed a general concern for the improvement of national transportation facilities, and in 1872 the Senate authorized the creation of a Select Committee on Transportation Routes to the Seaboard. Composed eventually of nine senators, the committee was headed by Senator William Windom of Minnesota and was known popularly as the Windom Committee. Its report of 1873 acknowledged the rivalry of waterways and railroads, and observed that "water routes, when properly located, not only afford the cheapest and best-known means of transport for all heavy, bulky, and cheap commodities, but . . . are also the natural competitors, and most effective regulators of rail way transportation."

The committee complained:

For the improvement of these great avenues of trade [20,000 miles of western rivers], which were designed by nature to afford the cheapest and most ample commercial facilities for the teeming millions who inhabit the richest country on the earth, we have expended an average of \$133,100 per annum; while for public buildings we have appropriated an average of over \$750,000 a year. Is it not high time that all expenditures not absolutely necessary be suspended, and that the imperative necessities of the country receive attention?

By 1907, federal rivers and harbors appropriations had climbed to over one-half billion dollars, more than four times the cumulative total in 1882. Rivers and harbors improvement work on the major rivers of the country, particularly those in the Mississippi basin, accounted for most of the expenditures. The Mississippi River Commission, created by Congress in 1879, directed Army Engineer officers in the construction of levees along the lower Mississippi. Beginning in the mid-1890s, this levee work (justified on the basis of navigation improvement, but obviously a major contribution to flood control) was complemented by dredging along selected portions of the river in order to prevent shoaling and reduce navigation hazards. In 1896, Congress not only first authorized, but required, the construction of dredges "with the view of ultimately obtaining and maintaining a navigable channel from Cairo down, not less than two hundred and fifty feet in width and nine feet in depth at all periods of the year except when navigation is closed by ice." Despite the levee-building and the dredging, disastrous floods continued to plague the residents along the lower Mississippi.

Meanwhile, in 1888 Congress authorized the extension of the six-foot navigation project down the Ohio River. This authorization came after the successful completion in 1885 of the Davis Island project, just five miles south of Pittsburgh, which employed moveable wickets and had a 100-by-600-foot lock. Following congressional authorization, the Corps began constructing other locks and dams along the Ohio. By 1904, two locks and dams had been completed, seven were under construction, and five more were funded. At this time, before further work was done, Chief of Engineers Alexander Mackenzie decided to conduct another complete review of the project (the first one had been done in the 1870s). At issue was extension of the project down the lower Ohio, particularly in view of generally declining commerce on inland waterways. The review board recommended a nine-foot channel along the entire course of the Ohio River, based upon its finding that the probable cost per ton-mile for a six-foot project would be .0653

cents, whereas for the nine-foot project it would be .0447 cents. In the 1910 Rivers and Harbors Act, Congress authorized the nine-foot project. At a cost of about \$125 million, the project was completed in 1929.

Authorizations and appropriations during this period reflect some of the worst evils of pork-barrel legislation. Projects were poorly chosen, piecemeal appropriations were commonplace, and the Corps of Engineers often gave very unreliable estimates. About the turn of the century, matters briefly took a turn for the better, mainly as a result of the work of Ohio Representative Theodore Burton. Burton, chairman of the Rivers and Harbors Committee, forced through Congress a bill establishing a Board of Engineers for Rivers and Harbors to examine "the amount and character of commerce existing or reasonably prospective which will be benefited by the improvement, and the relation of the ultimate cost of such work, both as to cost of construction and maintenance, to the public commercial interest involved, and the public necessity for the work and propriety of its construction, continuance, or maintenance at the expense of the United States." In the 1907 Act, Burton did not allow one new project to be added unless the entire cost of the project was authorized. Less than five hundred dollars was appropriated for local streams, and not one appropriation was made unless the project had the approval of the Engineers. Had this practice of avoiding piecemeal appropriations and unjustified projects continued, some of the worst examples of traditional pork-barrel legislation would no doubt have never been approved. Instead, after Burton's departure in 1909, Congress quickly reverted to its old ways. The 1910 Rivers and Harbors Act appropriated funds for projects in 226 of the 391 congressional districts.

One improvisation which took place under Burton was cost-sharing for navigation projects. Dallas, Texas, became the first political entity in the nation forced to contribute funds to a rivers and harbors project. The Rivers and Harbors Act of 1905 required the city to contribute \$66,000 toward the Trinity River project before the authorized federal appropriation of up to \$161,300 could be used. The idea of requiring local contributions to projects of essentially a local nature did not, however, entirely succeed. The promise of local cooperation induced Congress to approve many projects of dubious merit. Moreover, richer sections of the country could finance projects more easily than poorer ones. Twenty-one projects requiring local financial contributions were authorized by the 1910 Rivers and Harbors Act, and more were added in subsequent years; but no standard procedure was developed to determine which projects should entail local contributions. Partly in response to this situation, Congress in 1920 inserted a clause in the annual appropriations bill requiring Army Engineers to report the local benefits of a project as well as its general benefits, and to recommend whether local cooperation should be required.

In 1925, the policy of local cooperation for small navigation projects was discontinued. Instead, Congress declared in one of the few rivers and harbors acts passed that decade that whenever local interests advance funds for rivers and harbors work, such funds may be accepted and expended by the Secretary of War "in his discretion." Regardless, the Secretary was "hereby authorized and directed to repay without interest . . . the moneys so contributed and expended." By this time, Congress and the Executive Branch had carved out a new relationship that dramatically affected the future of rivers and harbors legislation. In 1921, the Bureau of the Budget was established. Generally, rivers and harbors appropriations were no longer considered separately. Rather, they were included in the Army Appropriation Bill as determined by the Bureau of the Budget, the President, and the Committees on Appropriations. Once the amount of the appropriations was approved, the Secretary of War and the Chief of Engineers apportioned the funds as they thought best. Under this procedure, there were annual appropriations for rivers and harbors work that ranged from \$40 million to \$60 million.

Although a significant amount was spent on navigation improvements during the last quarter of the 19th century, the general enthusiasm for internal waterway improvements actually declined. One major reason for the decline was railroad competition. However, by the turn of the century renewed interest in navigation improvements developed. The railroads continued to be inadequate for the country's growing needs, and a number of railroad companies were riddled with corruption and mismanagement. This was also a time when advocates of multipurpose river development first gained attention: rivers should be developed in a manner best suited to serve power, irrigation, water supply, and flood control, as well as navigation, needs. President Theodore Roosevelt, an active conservationist, appointed an Inland Waterways Commission in 1907 to study the issue of river development. Not unexpectedly, considering the commission's members and Roosevelt's own predilections, the commission strongly favored multipurpose development in its 1908 preliminary report to Congress. A National Waterways Commission, appointed in 1909, developed a more detailed plan for national waterways improvements. The Chief of Engineers, Brigadier General Alexander Mackenzie, opposed multipurpose river development because he felt that navigation must remain the paramount federal interest.

Waterway advocates pushed two grandiose schemes at this time. One was a deep intercoastal waterway from Boston to the Rio Grande via a sea-level cross-Florida canal. The other projected a deep channel from Chicago to the Gulf of Mexico capable of being navigated by ocean-going vessels. Although neither of these plans was fully realized, the interest they generated resulted in the expansion of the intracoastal waterway on the Atlantic and Gulf

coasts and, as we have noted, the 1910 authorization of the nine-foot Ohio River channel.

Of all U.S. navigation projects constructed prior to World War I, certainly the most impressive was the Panama Canal connecting the Atlantic and Pacific oceans. With Colonel George W. Goethals as chief engineer, Lieutenant Colonel William L. Sibert supervising construction on the Atlantic side, and Lieutenant Colonel David D. Gaillard in charge of construction on the Culebra Cut, Corps of Engineers officers were vital to the construction effort. However, final responsibility for building the canal rested with the Panama Canal Commission and not the Army Corps of Engineers.

After 11 years of effort, the Panama Canal was opened to traffic on 15 August 1914. The cost of construction was \$352 million, including \$10 million paid to Panama and \$40 million paid to the New French Panama Canal Company. If one were to include the expenditures of the two unsuccessful French companies that had attempted to build the Canal in the 1880s and 1890s, the total investment would climb to \$639 million. Although a relatively small sum by today's standards, the cost of the Panama Canal was four times more than for building the Suez Canal and far more than for any other previous American construction effort. Had Congress realized what the ultimate cost would be, it probably would never have approved building the canal. The excavating of the Culebra Cut alone cost \$90 million, or \$10 million per mile. Still, the final cost for the canal was \$23 million below what engineers had estimated in 1907.

By law, the Panama Canal is designed to be self-sustaining. Expenditures cannot exceed revenues. In 1914, about \$4 million was collected in tolls. By 1970, tolls exceeded \$100 million, even though the rates had remained unchanged. In 1973, the Panama Canal Company suffered its first loss as a result of rising operating and maintenance costs. Consequently, the following year the company raised the toll rate from 90 cents per cargo ton to \$1.08, a 20 percent increase. In the late 1970s, annual revenues from tolls exceeded \$140 million.

World War I deepened government concern with waterway development. Wartime exigencies demanded that rail transportation be supplemented by a reliable barge fleet on the major U.S. rivers. The Federal Control Act of 1918 authorized the government to commandeer vessels on the Mississippi and Warrior rivers and the New York Barge Canal. It also provided \$12 million for new construction. The Railroad Administration ran the barge fleet until 1920, when it was turned over to the Secretary of War. However, the War Department was no more successful in showing profits for the fleet, and in 1924 Congress authorized the creation of a wholly government-owned operation, the Inland Waterways Corporation (IWC), to run the barge fleet. The IWC made important advances in the

design and size of barges. It also successfully promoted the establishment of nonfederal terminal facilities. From 1924 to 1935, when the program ceased, the IWC loaned some \$1.1 million to states, municipalities, and private industries to support terminal construction. Most of this aid went for facilities on the lower Mississippi. Perhaps most impressive, the IWC actually showed a profit for the first 15 years of its existence. Its operations complemented Corps of Engineers river improvement projects and attracted private carriers to the Warrior, Mississippi, and other rivers. In a sense, its very success doomed it. Private barge companies and railroad interests began to oppose it vehemently. The expansion of private barge and railroad facilities did, in fact, beg the question of the necessity for the IWC's continued existence. In 1953, the entire fleet was sold to the Federal Waterways Corporation, and the name was changed to Federal Barge Lines, Inc.

It had taken over a hundred years for the federal government to spend the first half-billion dollars on river and harbor improvements. In the 13 years from 1907 to 1920, however, the government doubled the amount, so that by 1920 the total appropriations for river and harbor work exceeded one billion dollars. Within 13 years, this figure doubled again. By 1936, the cumulative appropriations figure for navigation improvements was \$2.1 billion. By that time, another \$800 million had been spent on flood control and nonnavigation related activities. During World War II, as part of the military construction program, several million dollars was spent on port improvements, including terminals, warehouses, docks, and wharves. This construction was not part of rivers and harbors work, although the facilities built under this program, justified in the interest of national defense, obviously benefited commerce after the war ended.

Expenditures by states and nonfederal interests are exceedingly difficult to calculate. One estimate places the total figure for state support of canal construction and maintenance alone at over one half million dollars by 1930. This figure, evidently, does not include any nonfederal monies spent for flood control and drainage.

The Great Depression ended hopes that the number and cost of navigation improvements might be reduced. In 1926, the Chief of Engineers reported that 139 projects had become obsolete or had never developed sufficient traffic to justify their maintenance. He recommended their abandonment. Congress did not respond to this recommendation at that time or any time thereafter. Three years later, when the depression began, both Congress and the administration sought ways to create jobs, although President Herbert Hoover opposed deficit spending for additional public works. In 1930, Congress increased the Corps' civil works budget, not only because of commercial demands, but "to carry out the purposeful plan of the administration to alleviate unemployment."

Although unable to give specific numbers, Chief of Engineers Lytle Brown maintained that Corps projects had "furnished employment to thousands of people who otherwise might have been idle." Pursuant to the 1930 Emergency Construction Act, the first public works legislation of the depression era, the Corps received \$22.5 million for rivers and harbors work and an additional \$3 million for the Mississippi River and Tributaries project, a flood control project initiated two years earlier. In the three years 1931-1933, the Corps received over \$270 million in work relief funds. With the beginning of the New Deal, this sum--and the number of projects funded--expanded considerably.

CANAL DEVELOPMENT

Even before achieving nationhood, Americans linked internal improvements with westward expansion, defense, and national union. Thus, after 1789 attention focused increasingly on developing better transportation routes along the eastern seaboard and in the interior. Projects included roads, turnpikes, bridges, and canals. In Maryland and Virginia the Potomac Canal Company and the Dismal Swamp Company completed canal projects by the mid-1790s. A flurry of canal building activity followed in Pennsylvania, New York, Massachusetts, South Carolina, and Ohio.

As they sought to improve transportation through canals, Americans looked to earlier successes in Britain. The British had built their canal system almost entirely without government assistance, but the United States did not enjoy the conditions which had made this possible. In America the terrain, existing patterns of settlement, and a shortage of investment capital and skilled engineers assured public participation in internal improvement projects. As a result, by the turn of the 19th century state governments began to assist private investors in canals by authorizing lotteries and subscribing stock.

The possible role of the federal government came under scrutiny in 1807 when Congress authorized Secretary of the Treasury Albert Gallatin to conduct a study of the nation's transportation problems. The result was Gallatin's "Report on Roads and Canals" issued in 1808. In presenting the first comprehensive plan for internal improvements, Gallatin identified a series of canals along the Atlantic coast, canals to connect the Atlantic with rivers in the West and with the Great Lakes, and roads and additional canals in the interior whose completion he deemed essential to the nation's future. In most cases Gallatin concluded that the financial requirements of these projects exceeded private resources. He proposed financing them with surplus funds from the United States treasury either through loans or stock subscriptions.

Beset by state and local jealousies and required to draw upon the budget surplus in preparing for war, Congress failed to enact Gallatin's plan. However, the War of 1812 underscored the importance of developing the nation's transportation system. A "Transportation Revolution" began after the war ended in 1815 and lasted until the Civil War. Canal development was a major factor in that revolution. At the beginning of the period canals totaling barely 1,000 miles in length notched the landscape from New Hampshire to South Carolina. By 1860 this figure had ballooned to more than 4,200 miles for projects that ranged west to Illinois, north to the Upper Michigan peninsula, and south to Texas.

Both private and public sources, including the federal government, provided the \$188 million invested in canals between 1815 and 1860. Aid from state and local governments was the decisive factor. New York, Pennsylvania, Ohio, Indiana, Illinois, and Virginia invested \$114.3 million in constructing and operating their own canals. Local municipalities joined eight states and the federal government and through stock subscriptions, gifts, and loans invested another \$22.2 million in mixed enterprises. Of this amount the federal government made \$1.9 million in stock purchases and \$400,000 in loans. The \$136.5 million public investment represented 73.4 percent of the total \$188-million investment in canals.

The 365-mile-long Erie Canal, completed between 1817 and 1825, was the largest of the state-owned ventures. After failing to get federal support, New York State financed the entire project through special taxes, loans, and toll revenues. For all projects, including the Erie, loans were the largest single source of funds. Loans accounted for about \$127 million, or more than 90 percent of government contributions to canal building. At least three-fourths of the loan money was obtained through bond sales to financial institutions, both domestic and foreign.

Toll revenues on the Erie Canal were substantial. New York collected more than \$1 million in tolls before the canal was finished. The tolls, usually based on the weight of the cargo, became part of the Canal Fund and as such were used to reduce the debt, make repairs, construct new canals, and enlarge the original canal. By 1836 toll income from the Erie and Champlain canals exceeded expenditures by more than \$1 million annually.

The federal purchases of stock in canal companies, all made between 1825 and 1829, followed renewed debate on the federal role in internal improvements. After 1815, John C. Calhoun, first as a congressman from South Carolina and then as Secretary of War, was a leading advocate of internal improvements. In 1816-1817, he pushed through Congress the so-called Bonus Bill to provide funds for the improvements. The bill, vetoed by President James Madison on constitutional grounds, would have created a permanent fund for building roads and canals using the bonus and annual dividends from the Second Bank of the United States.

In 1819, Calhoun, as Secretary of War, presented his own plan for constructing public works. His proposal drew heavily upon the earlier Gallatin plan. Like Gallatin, Calhoun conceded that many projects could be left to local entities, but he maintained that certain essential projects were beyond the capacities of the individual states. Calhoun, as had Gallatin, placed primary emphasis on the need to develop the line of communications along the Atlantic coast. "It must be perfected by the general government," Calhoun maintained, "or not be perfected at all." In regard to

communications with the interior, Calhoun argued that the government ought to "at least bear a proportional share of the expense of their construction." Again echoing Gallatin, Calhoun proposed that federal funds be channeled through stock subscriptions to state or privately owned companies that were undertaking approved projects. When Congress finally made the stock purchases, it viewed them favorably. The appropriations required were comparatively small; and, with private investors involved, Congress hoped the projects would be chosen wisely and the funds would be spent economically.

The largest mixed enterprise was the Chesapeake and Ohio Canal to which the federal government subscribed \$1 million in stock; Maryland \$6 million; Georgetown, Alexandria, and Washington \$1.6 million; and Virginia \$820,000. The Chesapeake and Delaware Canal, another mixed enterprise, sold \$1.2 million in stock, about two-thirds of which came from state and private sources. The federal share was \$450,000. The United States also purchased \$200,000 in Dismal Swamp Canal stock and \$235,000 in Louisville and Portland Canal stock. In 1837 Congress agreed to loan \$300,000 to the Alexandria Canal Company in exchange for stock in the company provided by the city of Alexandria, Virginia. This loan, in addition to an earlier \$100,000 loan to the Alexandria company, was the only instance of a federal loan to finance canal development.

The legislation authorizing stock purchases in canal companies stipulated that the federal government would periodically receive its proportion of the canal tolls. In reality, however, dividends were rare. One exception among the canals in which the federal government invested was the Louisville and Portland Canal. In the first 10 years of the canal's operation, the government received \$257,778 in dividends on its stock. This amount was greater than the original purchase price. From the record, "it appears the United States collected more in tolls at the Louisville Canal prior to 1860 than it expended on the improvement of the entire Ohio River."

During Andrew Jackson's presidency, the federal government abandoned the practice of purchasing stock in improvement companies. Land grants, another form of federal canal aid, had begun in 1827 and continued until after the Civil War. These grants were made in addition to rights-of-way and were designed to give the states and private companies involved the means to raise capital for canal construction through the sale of land. The first grant of 1.5 million acres of public land went to Indiana for the Wabash River-Lake Erie Canal. The last grant for 100,000 acres went to Michigan for the Lac La Belle Ship Canal in 1866. In total, the government gave away nearly 4.6 million acres to Indiana, Ohio, Illinois, Wisconsin, and Michigan.

In making these grants Congress stipulated that each canal was "to remain a public highway for the use of the government of the United States, free from any toll, or other charge, whatever, for any property of the United States, or persons in their service passing through." This policy predated the Constitution. The Ordinance of 1787, which provided territorial government for the Old Northwest, declared that the Mississippi River, the navigable waters leading into it and the Saint Lawrence, and "the carrying places between the same, shall be common highways, and forever free." Broadening this language, the Constitution stated: "No preference shall be given by any regulation of commerce or revenue to the ports of one State over those of another; nor shall vessels bound to, or from, one State, be obliged to enter, clear, or pay duties in another." Later, enabling acts admitting new states and state constitutions carried on the policy. The canal land grants were contingent upon construction commencing within five years and reaching completion within twenty years.

Calculating the value of the federal land grants for canals is difficult given the lack of information on actual land prices at the time of sale. One method is to determine the price of public land per acre in each year that a grant was made and multiply that price by the percent of total land which was granted in that year. The result is a weighted average price of \$1.058 per acre which should be regarded as the low estimate. Using this price, the total value of federal land grants for canal construction through 1866 is calculated to have been at least \$4.9 million. Thus, for the first grant of 1.5 million acres to Indiana for the Wabash and Erie Canal, the lowest value of the grant was \$1.57 million. Compare this to the \$8.2 million total cost of completing the canal.

Beginning in 1841 Congress also made land grants of 500,000 acres that were used for improvements that sometimes included canals. Acts admitting states with public lands to the Union also included provisions that set aside 5 percent of net proceeds from the sale of the lands for improvements, which for the acts passed before 1836 usually included canals.

Calhoun's 1819 plan for internal improvements had also included a proposal that federal assistance include using Army Engineers to make the surveys and plans for the projects contemplated. Such technical advice was a particularly valuable form of assistance during the canal-building period because skilled civilian engineers were in scarce supply. Before Congress approved the idea in 1824, Calhoun used the existing Board of Engineers for Fortifications to make surveys along the Atlantic coast. Also, in 1823 President Monroe recommended that Army Engineers survey routes for the Chesapeake and Ohio and other canals. Monroe affirmed his support of federal aid for improvements of national value, but he drew the line when it came to construction and operation of the works.

In 1824 Congress finally passed the General Survey Act. The act authorized the President to obtain surveys, plans, and cost estimates for the road and canal routes he deemed of national importance. He had authority to employ two or more civil engineers, Engineer officers, and line officers detailed to the Corps of Engineers to make the surveys. The initial appropriation was for \$30,000. Notably, the act did not authorize federal construction.

To implement the surveys, President Monroe appointed a Board of Internal Improvements. Petitions for surveys flooded Washington. During its first year the board concentrated on canal surveys, with the Chesapeake and Ohio Canal given the most attention. The board also made reports on the Dismal Swamp and the Chesapeake and Delaware canals and examined proposed canal routes in Pennsylvania, Maryland, Indiana, Florida, and New England. By 1827 the area of consideration had broadened; it stretched from New England to Florida and from Lake Erie to the Gulf of Mexico.

For the period through 1 December 1828, nearly \$74,000 was expended for surveys on the Chesapeake and Ohio Canal route; \$20,000 for surveying a canal to link the Atlantic and Gulf of Mexico across Florida; and nearly \$17,000 for surveys in Indiana that included mapping possible canal routes and clearing river obstructions. Before the Topographical Bureau took over the surveys from the Board of Internal Improvements in 1831, government surveyors had examined all the main routes proposed by Gallatin and Calhoun and numerous others. The number of officers engaged in the surveys, initially authorized at 24, increased to 53 in 1826.

The Topographical Bureau continued surveys under the General Survey Act until Congress repealed the act in 1838. During these last years, the nature of the surveys changed considerably. In 1831 most surveys were for canals, but by 1835 surveys for roads, railroads, and river and harbor improvements predominated. There was one canal survey in 1836 and none the following year. Several factors accounted for the virtual disappearance of the canal surveys. President Jackson and his Secretary of War did not generally support such activity; and the growth of railroads, not canals, became the most significant manifestation of the ongoing transportation revolution.

Despite the growth of canals in the pre-Civil War period and their impact on the developing American economy, the number of abandoned canals exceeded those constructed in the decade before 1860. During the Civil War railroads enhanced still further their position as the preeminent mode of inland transportation, but the strongest canals survived. In fact both the Erie and the Chesapeake and Delaware canals experienced their highest tonnage to date in 1872. Afterwards, however, a decline was also noted on these popular routes.

After the Civil War the appeal of waterways transportation persisted. In 1874 the Senate's Select Committee on Transportation Routes to the Seaboard, the Windom Committee, issued a report recommending the improvement of specific water routes to lessen overall transportation costs. In essence the committee saw competition from waterborne commerce as a means of checking railroad rates which were already deemed excessive. The committee envisioned a transportation network that would still include canals and rivers improved through canalization.

In part the committee report focused attention on a water passage from the Tennessee River to the Atlantic, known as the Southern Route. Improvements at Muscle Shoals, Alabama, were an essential element of this project. The state had completed a canal at Big Muscle Shoals in 1837, but subsidiary canals above and below this location were not finished. Now, with Congress's blessing, the Army Corps of Engineers undertook to rebuild and expand the old canal and construct the subsidiary canals. The Muscle Shoals Canal opened in 1890, by which time federal expenditures totaled approximately \$3.1 million.

In 1874 the United States also took over full control of the Louisville and Portland Canal for \$1.7 million. Ownership of the canal had actually passed to the United States in 1855 because the private investors involved had used the dividends due the federal government to buy out all but five shares of their stock. When Congress refused to take a greater role, the remaining stockholders continued to oversee the canal's operation. This canal had been the most profitable of those in which the United States held stock, but the high cost of recent improvements and strong objections to the tolls charged led to a complete federal takeover. In accordance with established practice on federally owned waterways, Congress eliminated the tolls on the Louisville and Portland Canal in 1880. Thereafter Congress paid the cost of operation and maintenance from the Treasury.

In 1894 attention focused again on another canal in which the federal government held stock, the Chesapeake and Delaware. A movement began to construct a ship (lock-free) canal linking the Delaware and Chesapeake bays. After much debate it was decided that the ship canal would follow the route of the existing lock canal. The canal had seen little use since the 1880s and had not paid dividends since 1877. The Chesapeake and Delaware Canal Company lacked the funds to make the necessary enlargements for a ship canal. Thus in 1919 the federal government purchased the old canal in full for \$2.5 million. The Corps of Engineers' Wilmington District Engineer directed reconstruction which was completed in 1927 at a cost of \$10.1 million for a 12-foot depth. No tolls were charged on the new waterway.

Another private company, the Cape Cod Canal Company, also lacked the funds to maintain its canal which stretched 17 miles between Buzzard's and Barnstable bays. After determining the canal's military and commercial value, the United States purchased the Cape Cod Canal in 1928 for \$11.5 million. The government immediately abolished tolls on the waterways, and cargo tonnage rose dramatically in response. Between 1935 and 1940 the Corps of Engineers reconstructed the canal with Public Works Administration, Emergency Relief Administration, and regular improvement funds, which, when added to the original cost and maintenance, brought federal investment in the project to nearly \$37 million by 1940. By 1975 the federal investment had more than doubled, making the Cape Cod Canal the most costly single civil works project of the Corps of Engineers in New England. Today the Cape Cod Canal is the widest sea-level canal in the world and in the 1970s was carrying about 11.7 million cargo-tons annually.

The inability of the state of Illinois to complete improvements on its portion of the original Illinois Waterway between Lockport and Utica led to federal takeover without charge in April 1930. Thus the United States gained full control of an important water route from Lake Michigan to the Mississippi River, a route which included the canals of the Chicago Sanitary District. The state had appropriated \$20 million for its portion of the waterway. Congress added \$7.5 million and completed the project in 1933.

During the New Deal the federal government also became involved in the project to enlarge the existing network for New York canals, including the Erie, known then as the Barge Canal. In 1935 the Emergency Relief Appropriation Act allotted federal funds to New York to deepen the portion of the canal from Waterford on the Hudson to Oswego Harbor on Lake Ontario from 12 to 14 feet and to widen the canal so that it could be fully used at the new depth. The estimated cost of the project was \$27 million of which \$20 million was to come from the federal government. New York District of the Corps of Engineers supervised the work and completed it in 1968.

As this study of canal development has shown, although America's great canal age occurred before the Civil War and even then gave way to a railroad boom, federal investment in canals in the late-19th and 20th centuries far outdistanced investment in the earlier period. Not only did the federal government make loans and outright grants of funds, direct construction to enlarge existing canals, and contribute to operation and maintenance, but the federal government also purchased several major canals and has continued to operate them. As held true earlier, state and local investment in canals continued to exceed federal investment.

Obtaining complete figures on canal expenditures is extremely difficult. According to statistics reported by the Federal

Coordinator of Transportation in 1939, state costs for construction, maintenance, and other charges relating to canals, less the amount of tolls collected, were \$530 million. Of this amount \$330 million was expended after 1890 and most of that was for construction and operation of the New York State Barge Canal and the Chicago Sanitary and Ship Canal. As of 30 June 1929, the Chief of Engineers reported total federal expenditures of \$96 million as a separate item, "operating and care of canals." This figure is below the amount actually spent because some canal costs have been included in categories with noncanal expenditures and cannot be extracted.

THE EVOLUTION OF FEDERAL FLOOD CONTROL POLICY

The development of the federal government's role in flood control is largely the story of attempts to control the devastating floods along the lower Mississippi River. Aside from the swampland acts and whatever incidental alleviation of flooding resulted from snagging and clearing operations, the federal government did not involve itself in flood control on the Mississippi until the 1870s. In 1874, after a severe flood had wrought tremendous suffering on lower Mississippi basin residents, Congress appropriated \$90,000 for relief work. That same year Congress also authorized the President to establish a commission of three Army Engineers and two civilian engineers to study the best system for the "permanent reclamation and redemption" of the alluvial basin of the Mississippi River. Three years later, Chief of Engineers Andrew A. Humphreys created a board to improve low-water navigation of the Mississippi and Missouri rivers. Both boards were eliminated upon the creation of the Mississippi River Commission (MRC) on 28 June 1879.

Congress established the MRC to coordinate river improvement work on the Mississippi and to insure that both civilian and military advice was obtained on the subject. The seven-member board was to be chosen by the President of the United States and confirmed by the Senate. The commission president and two other members were selected from the Corps of Engineers. The United States Coast and Geodetic Survey provided one member. The remaining three members, two of whom had to be civil engineers, came from civilian life. Among the duties Congress assigned the MRC were to prepare plans to deepen the channel and protect the banks of the Mississippi; "improve and give safety and ease" to Mississippi navigation; prevent destructive floods; and promote and facilitate commerce, trade, and postal service. Within a year, the MRC had reached the important conclusion that "levees only" could control the Mississippi's floods. Commission members rejected any suggestion of dispersing floods through controlled outlets. This conclusion reaffirmed the position of Humphreys and Lieutenant Henry L. Abbot who had expressed their faith in "levees only" in their Report Upon the Physics and Hydraulics of the Mississippi River, published in 1861. The authors had specifically questioned the value of reservoirs for flood control on the lower Mississippi.

Despite efforts by the MRC and local interests to construct levees fast enough and high enough to prevent flooding, periodic floods continued to devastate the lower Mississippi basin. Severe floods came in 1882, 1884, 1890, 1897, 1912, 1913, and 1916. Less severe floods, but still enormously disrupting, occurred in other years. The Corps of Engineers did the levee construction for the MRC, but the Corps was often more involved with emergency flood

relief activities than with construction. The Corps' first flood relief operation took place on the lower Mississippi in 1882. The 1912 and 1913 floods brought into question a system of levees that had clearly shown itself incapable of affording reliable protection. They also showed the inability of local interests to provide adequate protection to complement the work of the federal government.

Until 1917, all work done on the Mississippi had been justified on the basis of navigation, mainly in order to satisfy the constitutional scruples of those congressmen who thought the federal government had no business in flood control. However, on 1 March 1917, Congress passed the first federal flood control legislation. The measure authorized \$45 million for flood control between the mouth of the Mississippi and the mouth of the Ohio; no more than \$10 million was to be spent in any one year. Essentially the 1917 act allowed the MRC to expedite the implementation of already existing plans. No new flood control plans were authorized. The act, however, did stipulate that local interests must contribute at least one-half of the cost for the construction and repair of the levees and must provide rights-of-way free to the federal government. The act also appropriated \$5.6 million for flood control work on the Sacramento River. At least in these two sections of the country, Congress had declared its commitment to flood control.

More flooding occurred on the lower Mississippi in the early 1920s. The flood that finally brought a reevaluation of policy--and of financing--happened in 1927. Between 250 and 500 people were killed, over 16 million acres flooded, and 41,000 buildings destroyed. The Red Cross cared for over 600,000 people at one time, of whom half lived in temporary Red Cross camps. The flood finally convinced the Corps that levees could not sufficiently control the Mississippi's waters: a mix of levees, floodways, and spillways would be necessary. Major General Edgar Jadwin, Chief of Engineers and author of this new flood control plan, continued to oppose reservoirs for flood control, however. A specially appointed reservoir board of Engineer officers concluded that the Jadwin plan was "far cheaper than any method the board has been able to devise for accomplishing the same result by any combination of reservoirs."

The flood control act passed on 15 May 1928 authorized this new plan, which came to be called the Mississippi River and Tributaries project. The act released lower Mississippi residents from all local cooperation requirements except those to maintain certain flood control works after completion, to accept certain lands condemned for the project, and to provide rights-of-way. The reason for this generous federal commitment is that many congressmen judged that the residents of the lower Mississippi had borne enough suffering; they had spent a substantial amount of money on nonfederal levee construction, and it was unreasonable to expect them to bear this burden longer.

In light of this congressional largesse, it is worthwhile to examine how much lower Mississippi basin residents had contributed to flood control and navigation improvement. According to one MRC document, state and local organizations spent over \$175 million on nonfederal levees up to the year 1928. In addition, they contributed \$19 million to federal levee and revetment projects, bringing the total nonfederal expenditure prior to 1928 to just under \$200 million. Federal appropriations during this same period totaled \$174 million. Of this amount, \$93 million was spent prior to the passage of the 1917 flood control act. The remainder was appropriated either as special emergency flood relief funds or as amendments to the 1917 act. Under the provisions of the 1928 act, as amended, the federal government appropriated \$1.1 billion through the fiscal year 1955. Local interests contributed \$3.2 million.

The 1928 flood control act paved the way for much more ambitious planning, and the depression convinced many congressmen that federal flood control not only was justified in itself, but also could serve as an important means of providing work relief. In 1935, Congressman Riley Wilson of Louisiana introduced a bill to authorize a large number of flood control projects throughout the United States. Most of these projects had been suggested in the Corps' "308 reports" prepared pursuant to the 1927 Rivers and Harbors Act. Succumbing to the lure of work relief projects, the House of Representatives passed Wilson's bill; but opposition in the Senate was stronger. Senator Millard Tydings of Maryland blocked a vote by what supporters of the legislation called a "filibuster." In the next session, consequently, the Senate Committee on Commerce devoted a great deal of attention to drawing up a national policy on flood control.

The most controversial point was whether the federal government should assume the entire cost of flood control projects, as it had for the lower Mississippi under the 1928 flood control act. In the end, committee members agreed that the local interests should provide lands, rights-of-way, and easements and should hold and save the United States free from damages due to the construction work. Later, another stipulation was added: local interests should maintain and operate all the works after completion of the project in accordance with regulations prescribed by the Secretary of War. The three provisions--to provide land, rights-of-way, and easements; to stand the cost of damages; and to maintain and operate the works--became known as the "a,b,c" requirements. The decision that local interests should bear part of the burden resulted in part from the efforts of Senator Royal Copeland of New York and Senator Arthur Vandenberg of Michigan. Another factor was Chief of Engineers Major General Edward Markham, who was outspoken in his opinion that the federal government should not bear the entire cost.

A close reading of committee documents and congressional speeches makes clear the legislative intent to extend federal assistance only to prevent "catastrophic" and "dramatic" flood damages. It was not the intent to reclaim lands in rural areas. The Roosevelt administration, however, expressed its desire to have the bill broadened to provide for investigations by the Secretary of Agriculture of the value to flood control of reforestation, soil conservation, and other floodplain management measures. The subsequent changes made it clear that the Secretary of Agriculture would be responsible for investigating watersheds and recommending measures to control water retardation and run-off, while the Secretary of War would investigate and improve rivers for flood control, as directed by Congress.

After defeating efforts to have the federal government assume the full financial burden, the Senate passed the bill. In conference the bill was not significantly modified. On 22 June 1936, President Franklin D. Roosevelt signed the bill into law. It authorized the expenditure of \$320 million for 250 projects and a number of examinations and surveys.

The 1936 act was the real beginning of comprehensive federal flood control work. It recognized that flood control was a "proper activity of the Federal Government in cooperation with States, their political subdivisions, and localities thereof." Since 1936, the Corps has built, pursuant to congressional authorizations and appropriations, over three hundred reservoirs whose primary benefit is flood control. Most of these reservoirs are multipurpose, however; many of them would not have been built had flood control been the only benefit.

It is noteworthy that so many Army Engineers maintained their skepticism of the value of flood control reservoirs despite the windfall of work Congress had given the Corps. Brigadier General Harley B. Ferguson, president of the Mississippi River Commission and a recognized expert in flood control, stated that reservoirs in the lower Mississippi basin "never were justified except for work relief." Some Corps engineers, both military and civilian, simply shared the skepticism of many private civil engineers who thought it difficult, if not impossible, to operate a flood control reservoir as a multipurpose project. According to Gerard H. Matthes, the senior engineer with the Mississippi River Commission, even single-purpose flood control reservoirs posed significant "practical operating difficulties." While such reservoirs can perform quite well in small watersheds such as the Miami Valley in Ohio, they were ill suited in "large drainage basins, or in any flood-control system in which a large number of dams and reservoirs are required, or where the tributary system is at all complex." A pamphlet entitled "Notes on Flood Control," which was circulated within the Office of the Chief of Engineers in August 1936, two months after passage of the flood control act, identified four methods of flood control:

building levees, enlarging the discharge capacity, providing additional channels, and constructing reservoirs. The pamphlet then noted:

Of the four methods of controlling floods mentioned above, construction of levees is the most direct and surest method . . . Works, such as reservoirs, constructed at localities distant from areas damaged by floods are not so determinate as to effects, and the benefits of reservoirs become smaller and smaller as distances from the reservoir sites increase. As a consequence, a dollar spent for levee construction is more likely to be a dollar well spent than a dollar spent for other methods of flood control.

Humphreys' and Abbot's influence waned very slowly. Only after World War II did the Engineer school at Fort Belvoir, Virginia, publish a booklet which listed reservoirs as a flood control option, without suggesting that it was necessarily the least attractive alternative.

FEDERAL INVOLVEMENT IN PORT AND HARBOR DEVELOPMENT

Although previous sections of this study have touched upon the subject of port and harbor development, some additional observations need to be made. Federal policies affecting port and harbor development have evolved in a very fragmentary manner. The United States Constitution mandates in Article I, section 9, that the federal government must not discriminate in its treatment of ports: "No preference shall be given by any regulation of commerce or revenue to the ports of one State over those of another: nor shall vessels bound to, or from, one State, be obliged to enter, clear, or pay duties in another." This statement reflected the prevailing belief that the regulatory power of the federal government should be strictly limited. Subsequent congressional legislation similarly mirrored this view.

Since the beginning of the 19th century, most politicians have agreed that harbor improvements are necessary for national defense. As we have noted, the first federal waterways appropriations were for lighthouses, piers, jetties, and a few canals that seemed necessary for military purposes. After 1824 and the passage of the General Survey Act, the federal government did an increasing amount of harbor maintenance. As early as the late 1820s, the Corps of Engineers was using crude dredges to keep certain Great Lakes and eastern ports clear of sediment accumulation and floating debris. In 1837, a general financial panic and increasing sectional rivalry resulted in decreased congressional enthusiasm for internal improvements. The following year Congress repealed the General Survey Act. Except for one year, Congress suspended harbor appropriations from 1838 to 1852, when the last significant pre-Civil War rivers and harbors bill was passed.

In 1887, Congress established the Interstate Commerce Commission. Although the commission's establishment resulted mainly from concern with railroad management, it was also a consequence of Congress's belief that a national transportation policy was needed. The act creating the commission declared it to be federal policy "to provide for fair and impartial regulation of all modes of transportation . . . to the end of developing, coordinating, and preserving a national transportation system by water, highway, and rail as well as other means." Nevertheless, the 1887 act exempted inland waterway transport services from federal regulation. The idea of creating a Department of Transportation to coordinate all forms of transportation appealed to many congressmen. Between 1874 and 1966, there were over thirty legislative proposals to create such a department.

It was not until the 20th century that port maintenance and construction became a major burden. At the turn of the century, there was renewed federal interest in developing the inland waterway system. The Inland Waterways Commission espoused, as part of that development, the comprehensive planning of port facilities at inland and deepwater ports. In the 1919 Rivers and Harbors Act, Congress declared it to be federal policy "that water terminals are essential at all cities and towns located upon harbors or navigable waterways and that at least one public terminal should exist, constructed, owned, and regulated by the municipality, or other public agency of the State and open to use of all on equal terms." The act authorized the Secretary of War to withhold work on harbor improvements whenever he judged that inadequate water terminals existed or unless he received adequate assurances that such facilities would be built. In the 1920 Federal Transportation Act, Congress charged the Secretary of War to assist states in developing water terminals, to gather statistics on inland waterways traffic, and "to investigate any other matter that may tend to promote and encourage inland water transportation." The Merchant Marine Act, passed the same year, charged the four-year old U.S. Shipping Board to work with the Corps in investigating and planning water terminal facilities.

By 1932, the federal government had spent approximately \$166 million for the construction of water terminals. States, municipalities, and other governmental entities had spent \$810 million for terminal construction and incidental dredging. During the New Deal, the federal government spent considerably more money on terminal facilities, partly to provide work relief. Between 1932 and 1937, various federal relief organizations provided a total of some \$70.5 million for terminal facilities. As mentioned in an earlier section, the Inland Waterways Corporation had loaned over a million dollars to support water terminal construction. Clearly, by 1937, if all expenditures on terminal facilities were ascertained, the total would run over a billion dollars.

Even though there was significant expansion of port facilities between World Wars I and II, most water terminals lost money, according to the Federal Coordinator of Transportation in 1939. Certainly their chief justification was their contribution to the general rise of commerce in the local area. Ports did--and still do--rely heavily on state and local subsidies, direct or indirect, to stay in the black. Over the long run, federal contributions to port facility construction have been marginal. Corps of Engineers navigation improvements and Coast Guard maintenance are still the major indirect federal subsidies. From the end of World War II to 1965, when the Economic Development Administration was created, there was no direct assistance with capitalization of terminal facilities. In the 1960s and 1970s, the Economic Development Administration did give some grants and loans to ports. The amount given, however, consisted of less than 7 percent of total U.S. port financing for port facility improvements from 1965 through 1972.

Furthermore, the grants and loans, amounting to about \$100 million, were largely dispersed to only five ports--Panama City, Lake Charles, San Diego, Oakland, and Seattle.

During the period from 1946 to 1980, public seaports invested over \$5 billion in constructing or modernizing terminal facilities. They expect, according to a Maritime Administration (MARAD) study, to invest another \$5 billion by 1990. Inland ports anticipate spending about \$4.8 billion during this decade, making the total investment by local port entities during the 1980-1990 period about \$9.8 billion. According to MARAD, U.S. ports have been spending about \$200 million annually, or some 6 percent of their available operating funds, to satisfy federal environmental, security, and employee health and safety standards. Through the mid-1970s, seaport agencies concentrated their capital outlays on conventional, break-bulk general cargo facilities. This was particularly true of the South Atlantic, Gulf, and Great Lakes ports. Modern container terminals have, however, been built on the North Atlantic and Pacific coasts, as well as in Hawaii, Puerto Rico, and Alaska.

According to a 1980 MARAD study, there are presently 189 major U.S. seaports, with 1,456 terminals and 2,939 deep-draft berths. There are 95 major inland river ports with 1,198 terminals and 1,894 barge-berthing facilities. The ports are located on the great inland river system (primarily, the Mississippi basin, Gulf Intracoastal Waterway, Alabama River system, and the Columbia-Snake rivers system) covering 26 navigable rivers in 17 states. An estimated 49 percent of these berthing facilities are publicly owned and 51 percent are in private hands. In the public sector, 25 percent are controlled by state governments, and the remainder are run by local governments or their legal instrumentalities. A 1974 MARAD study indicated that the federal government's holdings in terminals, mainly military facilities, amount to 43, or about 1.75 percent of the total.

The burden of harbor maintenance has been borne almost entirely by the federal government. There are exceptions, of course. Port agencies are responsible for dredging berths or minor terminal channels, but the federal government has done almost all of the navigational work--over 99 percent, according to the best estimates of both the Hoover Commission in 1954 and the Maritime Administration in 1974. This federal work has become increasingly expensive, not simply because of dollar inflation, but also because of technological innovation. Bigger ships require deeper channels. In 1900, most ships required a channel depth of 30 feet or less. Today, port officials need at least a 45-foot depth to accommodate most vessels; the largest vessels require even more. Some supertankers require 90 feet. Containerization, too, has

required deepening of port channels on a large scale. In the late 1970s, the Corps of Engineers had about 380 million cubic yards dredged annually.

More and deeper dredging is not the only cost. The problem of dredge disposal has become serious, especially when the material to be disposed is polluted. In the last few years, some forms of cost-sharing have emerged. Ports may bear the cost for disposing polluted dredge material. Since 1981, the Corps has specified that local port interests must provide dredged material retention levees for new construction projects (Congress can delete this requirement on a case-by-case basis).

Surprisingly little is known on how federal navigation improvements benefit commerce and the local and regional economies. Estimates vary widely. We do know, however, how much the Corps spends for navigation projects. In 1973, to take one example, the cost relating to ocean port operations amounted to approximately \$141 million, consisting of almost \$60 million for 23 new construction projects and \$81 million for 998 maintenance projects. Dredging entails the biggest expense covered by these funds. The increasing cost of these activities has aroused concern among federal officials. In a 1982 report to Congress, Secretary of Transportation Drew Lewis noted that "the traditional Federal system of navigation maintenance and development has not been adequately funded for several years and cannot be depended upon to meet future port development needs." While the administration seeks greater nonfederal contributions for harbor maintenance and improvement, port agencies are expressing the need for more and more financial aid. The idea of cost-sharing or user-fees has been actively discussed both by Congress and port officials. According to Secretary Lewis, port officials are divided about the kind and degree of cost-sharing, but there is universal agreement among port officials that they want a basic port system, with depths up to 45 feet, provided and maintained by the federal government as at present. The dispute centers on what to do when channel depths greater than 45 feet are required.

THE DEVELOPMENT OF HYDROELECTRIC POWER

In the early 1880s the first central power-generating station opened in New York City, and a plant in Appleton, Wisconsin, first utilized falling water in combination with a generator to produce electricity. Similar works opened in Minneapolis and at Niagara Falls, New York. New technology, such as the introduction of alternating current and advances in power transmission, followed. Rising industrial, municipal, and residential demands for this new energy source fostered the growth of power companies interested in potential profits. Earlier advances in dam materials and construction equipment made it possible to build the higher dams required for power production.

Soon private dam-building proceeded at a pace that threatened navigation, so the federal government stepped in. Congress began to regulate dams in the Rivers and Harbors Acts of 1890 and 1899. The legislation required that the Secretary of War and the Corps of Engineers approve the sites and plans for all dams and issue permits for their construction. Congress also required the developers to allow the United States to control a dam without making compensation "so far as shall be necessary for purposes of navigation." At any time the United States could require the owners to make changes in their dam to facilitate navigation. Between 1894 and 1906 Congress issued 30 permits for construction of private dams. The bulk of this power development was on the Mississippi River.

The Corps of Engineers' role also extended to assuring compliance with permits during construction. Much of this activity occurred at Niagara Falls. In the General Dam Act (1906), Congress standardized the regulations regarding private power development. Under this measure, when navigation facilities were required, the federal government could compel the owners to construct, operate, and maintain the facilities without compensation. If the United States built the facilities, the owners were required to contribute the necessary land and provide power to operate the facilities without charge. Ultimate title to the project remained with the United States.

Several fundamental views regarding hydroelectric power development emerged by the end of the first decade of the 20th century. One was that hydropower should be linked to a comprehensive plan for waterway improvement. Thus, a 1910 amendment to the General Dam Act required the Corps of Engineers to take such considerations into account when evaluating plans submitted for dam construction permits. Furthermore, Congress stipulated that all Engineer preliminary examinations and surveys--not just those relating to specific hydropower permits--must include information on how the development and utilization of hydropower for industrial and

commercial purposes would affect navigation and lessen the costs of navigation improvements. Hydropower, then, was seen as a factor in financing navigation and flood control projects involving dams. By including hydropower as part of a project built for another purpose, the overall cost of that project might be reduced. President Theodore Roosevelt expressed this view in 1903 when he vetoed a bill authorizing private construction of a dam and power stations at Muscle Shoals, Alabama. Private development, Roosevelt contended, would deprive the government of potential power revenues that might be used to offset navigation improvements in the area. Similarly, in another veto message Roosevelt stated that power revenues could pay all or part of navigation costs at a specific location and that any surplus could be applied elsewhere.

Of further importance for the future was the view expressed in the 1908 Preliminary Report of the Inland Waterways Commission that, unlike flood control and navigation, hydropower should yield a return that would cover "the cost of producing and transmitting . . . electric energy, including the amortization of the capital investment allocated to power over a reasonable period of years." The "reasonable period" has since been determined to be 50 years.

Prior to World War I, hydropower development remained in private hands under government regulation. The Corps did install a power station substructure as part of Lock and Dam 1 on the upper Mississippi River. After completing the dam in 1917, the government leased the power facility to the Ford Motor Company. Ford installed the equipment and began operations in 1924.

In response to the wartime need for nitrates to manufacture ammunition, the federal government finally began constructing a power facility at Muscle Shoals in 1918. President Woodrow Wilson chose Muscle Shoals because its waterpower potential was already well known. In February 1918 he approved construction of Dam #2, later known as Wilson Dam; an auxiliary power plant; and locks on the Tennessee River at Muscle Shoals. The Corps of Engineers took charge of the project. However, with the abrupt end of hostilities later that year, much of the support for the federal presence at the Shoals eroded. Throughout the 1920s a fierce debate over the project's future raged in Congress with Senator George Norris of Nebraska as the leading advocate of continued government ownership. Bills sponsored by Norris cleared Congress twice but were vetoed.

While the debate over retaining Muscle Shoals continued, the Corps of Engineers pushed forward with construction of Wilson Dam and the related facilities. By June 1923 the dam was 60 percent complete and the powerhouse 40 percent complete. Two years later both structures were substantially finished. Operations commenced on 1 April 1926, and the navigation locks opened the following year.

At the time it was completed, Wilson Dam was the world's largest masonry structure, a permanent monument to the Corps' engineering ability.

In the 1920s the investigations related to hydroelectric power development continued to be a significant part of the Corps' mission. At the beginning of the decade Congress created the Federal Power Commission (FPC) as the licensing agency for all nonfederal hydropower activity affecting or potentially affecting navigable waterways. At the time, it was estimated that under this criteria about 85 percent of remaining water power development would fall under FPC authority. Lieutenant Colonel William Kelly, a Corps officer, became the commission's first chief engineer. The FPC lacked its own field staff, so Kelly called on the Engineers to help examine applications, conduct field investigations and hearings, and prepare reports before licenses and permits were issued. Once an application was approved and a license granted, Corps officers along with engineers in the Departments of Agriculture and Interior helped superintend project construction.

The Corps' workload in support of the FPC was heavy. In fiscal year 1926 alone, the Corps made 48 examinations and reports for the FPC and supervised construction by 56 licensees. By 1931 the Corps had completed 276 engineering reports, held 69 hearings, and was overseeing 129 licensees.

Under the Federal Power Act the Corps constructed several dams in partnership with private companies. In such cases licenses were granted to develop the power components at navigation dams. The first project of this type, licensed in 1921, was at Green Island, New York, on the Hudson River. The Corps built the dam with the government providing a little more than \$1.4 million out of the total cost of about \$3.2 million. In exchange for its license and its own investment of about \$1.4 million, the private developer could sell the power and had to pay a yearly rental of \$5,000. Between 1921 and 1951, the FPC licensed nine similar projects. In some cases, even when no federal investment was involved, the license placed special requirements on the developer. For example, the City of Seattle got a license to build a dam on the Skagit River but was required to reserve a certain amount of storage capacity for flood control.

A dramatic change in Corps activities in the hydropower field began when Congress endorsed multiple-purpose planning in the Rivers and Harbors Act of 1925. Initially the Corps and the Federal Power Commission were to prepare cost estimates for surveys of navigable streams and tributaries "whereon power development appears feasible and practicable." The aim was a general plan to improve the navigation of the stream selected "in combination with the most efficient development of the potential water power, the control of floods, and the needs of irrigation." The Corps responded with a

recommendation for 24 surveys at an estimated cost of \$7.3 million. In 1927 Congress appropriated the funds for the studies, whereupon the Corps of Engineers launched its most comprehensive river survey to date. The resulting reports, submitted to Congress beginning in 1930, became known as the 308 Reports after the House document in which the survey estimates first appeared. The initial 308 reports, as later updated, became the basis for widespread multipurpose development undertaken by the federal government after World War II.

A shift in emphasis in federal hydropower development took hold during the New Deal. The Coolidge administration had fostered a policy of purposely producing surplus power at federal plants to provide funds for other projects. President Franklin Roosevelt viewed surplus power not just as a source of revenue to offset the costs of a particular project but as a means of providing cheap energy to a wide market. He also saw public works projects as a source of jobs in a time of economic depression and as an opportunity to put his power philosophy to a practical test.

During the New Deal, the Corps of Engineers participated in three major public works enterprises involving hydroelectric power: Bonneville Dam, Fort Peck Dam, and the Passamaquoddy Tidal Power Project. The Corps, for the first time since Wilson Dam, was engaged in building hydropower facilities. In 1933 Congress resolved the longstanding debate over Muscle Shoals when it created the Tennessee Valley Authority (TVA). The authority was charged with assuming broad responsibilities for administering Wilson Dam, constructing new dams and power plants, and marketing surplus power. In line with principles developed earlier, the TVA power projects were to be self-supporting and self-liquidating.

The Corps of Engineers completed the main dam and powerhouse facilities at Bonneville in 1937, but as work progressed Congress debated the issue of who would administer the facility. The result was the Bonneville Power Act signed by President Roosevelt on 20 August 1937. Under a compromise formula, the Corps of Engineers, which had built the dam, obtained the right to operate the dam and its power generators and to deliver the current to a substation. The act gave authority to dispose of the power and to set the rates to a civilian administrator under control of the Department of the Interior.

The Bonneville legislation directed that rates be set to encourage "the widest possible use of all electric energy that can be generated and marketed." In addition, the rates were to enable the government to recover the cost of producing and transmitting power, including amortization of the capital investment over a reasonable period of years. Power facilities were to benefit the general public, particularly domestic and rural customers. Furthermore, the Bonneville administrator was required to take the

steps necessary to transmit the available electric energy to existing and potential markets and "to interconnect the Bonneville project with other Federal projects and publicly owned power systems now or hereafter constructed." To carry out the purposes of the act, the power administrator was authorized "to acquire, by purchase, lease, condemnation, or donation, such real and personal property, or any interest therein, including lands, easements, rights-of-way, franchise, electric transmission lines, substations, and facilities and structures appurtenant hereto."

In later years the authority of the Bonneville Power Administration to market power expanded to include 32 additional federal projects. To carry out its marketing authority as effectively and efficiently as possible, by 1973 the power administration had constructed more than 13,000 miles of high voltage transmission lines. The Bonneville Power Administration services a seven-state area in the Pacific Northwest, where, as of 1973, it supplied 55 percent and transmitted more than 80 percent of the region's power.

As flood control became a primary purpose for constructing dams and reservoirs in the 1930s, hydropower potential was considered in relation to these projects. The Flood Control Act of 1938 included a provision "that penstocks or other similar facilities adapted to possible future use in the development of hydro-electric power shall be installed in any dam herein authorized. . . ." All subsequent legislation authorizing flood control projects included a similar provision.

The Flood Control Act of 1944 contained the first general provisions for the sale of power produced at Corps and other federal projects. The power generated was to be delivered to the Secretary of the Interior for disposal and transmission "at the lowest possible rates to consumers consistent with sound business principles." In selling established power, preference was to be given to public bodies and cooperatives. The pattern established with the Bonneville Power Administration was soon repeated as all federal power marketing, except for TVA projects, fell under control of agencies of the Department of the Interior. The agencies, in addition to the Bonneville Power Administration, were the Southeastern Power Administration, the Southwestern Power Administration, and the Alaska Power Administration (all under control of the Department of Energy since 1977), and the Bureau of Reclamation. The 1944 act again included the statement that "rate schedules shall be drawn having regard to the recovery . . . of the cost of producing and transmitting such electric energy, including the amortization of the capital investment allocated to power over a reasonable period of years."

The key to recovering costs has been the rate structure established by the power marketing agencies. The rates are based on recovery costs which include all applicable Corps of Engineers

reservoir costs, operation, maintenance, replacement, interest, and amortization. Under current practice, the power marketing agency in most cases markets the output of several projects together through a pooling arrangement. Thus, an individual project is not required to recover all of its own costs but may draw on revenues produced by other projects. The power administrations allocate revenues according to established priorities which place current year operations and ordinary maintenance costs first, followed by current year interest expense, prior operating deficits, and federal investment as the lowest priority. In paying back federal investment, the power marketers have given projects with higher interest rates their attention first. Thus some of the more recent projects show a higher percentage of costs recovered than older low interest projects.

Where provision is made for future installation of hydropower in accordance with the Flood Control Act of 1938, cost recovery procedures are less well defined. At projects already having initial power installation, like Chief Joseph Dam in the Pacific Northwest, all costs including future unit bays are recovered from present power revenues. At projects without initial power installations, however, the cost of provisions made for future power units is sometimes included as a joint-use cost with no recovery required.

As multipurpose projects blossomed after World War II, federal hydropower facilities expanded markedly. Congress authorized several new schemes on the Columbia and Snake rivers in the Pacific Northwest, and hydropower was part of comprehensive plans for the Missouri and Arkansas river basins. Between 1945 and 1959, initial power production occurred at 25 new sites. The bulk of these developments took place during the last six years of the period. If Congress refused to include power in the initial authorization, the continuing practice of installing penstocks at least made the introduction of power features possible in the future. Federal expenditures were not limited to construction. The Corps continued extensive 308 and FPC survey work.

During the Eisenhower administration, an attempt was made to trim federal expenditures. Goals were set early. In 1952 a Republican Study Group proposed slashing \$400 million from the budget for rivers and harbors, flood control, irrigation, and power projects between 1953 and 1957. New starts, according to the study group, should be limited to cases where defense needs were "clear and compelling." Private participation in power projects was deemed essential.

Promoting partnership arrangements was central to President Dwight D. Eisenhower's water resources policy. This approach seemed the only viable one because the federal government alone could not provide the \$96 billion investment projected in 1956 as necessary to

meet the nation's power needs for the next 20 years and because state and local resources could not afford to develop the complex projects required. In many ways the basis of this policy resembled that stated by Treasury Secretary Albert Gallatin in 1808: certain essential development would not occur unless the federal government took charge.

The Eisenhower partnership policy actually made little headway. Despite the administration's budget trimming goals, overall power development increased between 1953 and 1960. Installed capacity at all electric utilities rose 77 million kilowatts. Federally installed capacity doubled, from 11 to 22 million kilowatts. The quantity added by the Corps of Engineers, at existing and new projects, accounted for nearly 50 percent of the gain at federal facilities. In fiscal year 1958 alone, the Corps added 792,000 kilowatts at its multipurpose projects, a figure which represented 67.4 percent of the combined federal and nonfederal increase in hydropower capacity for that year.

During the 1960s and the 1970s, the Corps continued to expand upon the 27 projects with hydroelectric capabilities that it had built the preceding decade. Power was added at 17 multipurpose sites in the 1960s and planned at 20 new locations by 1980. The total electric output from Corps generators rose from 27.9 billion kilowatt hours in 1960 to 61.1 billion in 1970 and to more than 80 billion in 1975. The electricity generated at 53 Corps reservoirs in fiscal year 1970 represented 23 percent of the total U.S. hydroelectric power production for that year.

In statistics released by the Federal Power Commission in 1970, Corps hydroelectric power facilities represented the largest segment of installed capacity at federal hydroelectric projects (13,000 megawatts). Bureau of Reclamation and TVA projects accounted for all but a trace of the remaining 10,000 megawatts of installed federal hydroelectric capacity. While the Corps is the largest single producer of hydroelectric power and total federal hydroelectric power capacity nearly equals nonfederal hydroelectric capacity, the position of the federal government changes significantly when total electric energy capacity from all sources is considered. Hydroelectric power actually accounts for a small portion of total power capacity. Privately owned facilities clearly dominate the nonhydroelectric power field. For example, in 1970 power systems owned by private investors (at the time there were approximately two hundred major utilities) accounted for 77 percent of the nation's generating capacity and served 78 percent of the customers. The federal segment accounted for about 12 percent of capacity and 13 percent of output.

According to the Hoover Commission's 1955 report, out of the total \$14.3 billion federal investment in water resources development, \$3.9 billion was for hydropower. Of that amount \$1.4

billion was for Corps power and \$1.3 billion for TVA power. Figures provided in 1973 by the National Water Commission extended the period of consideration through 1968. By that time the cost of federally owned or financed hydropower development had climbed to \$9.3 billion (stated in 1972 dollars). This figure represented one-half of total expenditures for hydropower. State and local governments provided \$3.2 billion; private companies invested \$6.2 billion.

TABLE 1

U.S. ARMY CORPS OF ENGINEERS;
ANNUAL EXPENDITURES ON AIDS TO NAVIGATION, 1936-1975
(in thousands of dollars)

Year	Multiple Purpose				Flood Control	MR-T 3/	FY Total
	Navigation 1/		Projects 2/				
	New Work	Maintenance	New Work	Maintenance	New Work	Maintenance	
1936	\$ 99,851	\$ 30,341	\$ 5,279	\$ 38	\$ 7,001	\$ 761	\$ 143,271
1937	96,592	32,103	5,486	60	6,335	708	141,284
1938	77,134	32,753	2,988	75	5,793	490	119,133
1939	60,544	34,619	2,068	100	6,435	835	104,601
1940	101,993	44,266	1,942	132	8,344	551	157,228
1941	36,203	37,370	2,452	96	6,223	1,575	83,869
1942	35,220	37,444	3,546	164	4,608	1,716	82,698
1943	30,722	40,134	9,531	221	3,501	2,852	86,961
1944	22,969	40,285	4,923	362	4,450	2,397	75,586
1945	3,011	45,670	1,418	286	6,014	2,102	61,501
1946	17,078	50,188	1,864	333	4,574	2,395	76,432
1947	23,805	43,548	6,139	415	7,600	3,208	86,715
1948	39,161	59,425	11,791	458	8,001	3,206	122,042
1949	58,059	64,574	22,506	555	12,834	4,270	162,798
1950	60,007	72,376	33,846	549	13,985	3,948	184,711
1951	53,093	65,011	35,701	666	12,738	3,272	170,481
1952	37,000	55,491	37,414	720	11,503	3,794	155,922
1953	52,270	70,855	44,005	770	15,897	4,163	187,960
1954	34,564	66,713	37,431	1,137	9,669	3,514	153,028
1955	4,779	69,607	33,682	1,370	8,194	3,603	161,235
1956	70,324	73,025	25,347	1,502	9,779	4,176	184,153
1957	119,445	79,446	23,096	1,664	11,375	3,974	239,900
1958	143,925	78,691	24,170	2,194	11,322	4,010	266,312
1959	117,373	82,804	28,514	2,438	13,525	4,874	309,528
1960	205,878	86,122	33,968	2,734	13,575	4,329	346,606
1961	198,924	96,534	37,884	2,778	13,543	4,329	353,992
1962	713,893	106,357	36,983	2,795	12,518	4,698	377,252
1963	227,503	117,712	38,377	3,109	14,183	6,323	407,207
1964	226,564	116,273	36,935	3,468	13,329	5,740	402,509
1965	285,385	121,592	34,704	3,828	12,064	6,777	464,350
1966	303,470	130,047	44,015	4,256	15,041	7,087	503,916
1967	277,211	124,834	46,492	4,657	14,959	6,811	474,964
1968	245,396	137,867	45,929	5,322	12,950	6,819	434,283
1969	221,075	150,492	38,439	5,990	11,308	6,642	434,846
1970	196,487	182,289	37,801	7,238	11,614	7,339	442,768
1971	197,658	199,429	45,774	8,496	14,150	8,340	473,847
1972	237,846	221,164	51,435	10,465	15,256	7,661	543,827
1973	213,542	252,411	46,373	11,439	14,453	6,750	544,728
1974	236,239	293,507	44,739	14,604	21,993	10,050	621,012
1975	271,118	368,888	46,263	13,485	41,865	12,139	753,758
TOTALS	5,259,211	4,023,837	1,071,170	120,969	462,701	178,226	11,116,114

1/ These numbers include that part of Corps expenditures classified as direct aids to navigation.

2/ These numbers include that part of the expenditures on multiple purpose projects (those with benefits to flood control, hydro power, recreation) which can be construed as aids to navigation. The figures presented are derived by computing 13.6% of all multiple purpose project expenditures. This percentage was supplied by the Corps.

3/ These numbers include that part of expenditures on flood control on the Mississippi River and its tributaries (MR-T) which can be construed as aids to navigation. The numbers presented are derived by computing 23% of all Mississippi River and tributaries flood control expenditures. This percentage was supplied by the Corps.

SOURCE: U.S. Army Corps of Engineers.

TABLE 2

FEDERAL LAND GRANTS IN AID OF CANAL CONSTRUCTION
AND RIVER IMPROVEMENT

<u>Canal Construction Grants</u>			
<u>Name of Canal</u>	<u>Date</u>	<u>State</u>	<u>Acres Granted</u>
Wabash and Erie	1827	Indiana	1,480,419
		Ohio	265,815
Illinois and Lake Michigan	1827	Illinois	324,283
Miami and Dayton	1828	Ohio	438,301
General	1828	Ohio	499,997
Milwaukee and Rock River	1838	Wisconsin	138,996
St. Mary's	1852	Michigan	750,143
Portage Lake and Lake Superior	1865	Michigan	400,081
Sturgeon Bay and Lake Michigan	1866	Wisconsin	199,631
Lac La Belle	1866	Michigan	<u>100,012</u>
Total			4,597,678
<u>River Improvement Grants</u>			
<u>Name of River</u>	<u>Date</u>	<u>State</u>	<u>Acres Granted</u>
Tennessee, Coosa, Cahawaba, and Black Warrior Rivers	1928	Alabama	400,018
Fox and Wisconsin Rivers	1846	Wisconsin	683,722
Des Moines River	1846 & 1862	Iowa and 1862	<u>1,161,594</u>
Total			2,245,334

Source: U.S. Department of the Interior. General Land Office. Transportation: Information Concerning Land Grants for Roads, Canals, River Improvements and Railroads. Washington, U.S. Govt. Print. Off., 1940, p. 4.

BIBLIOGRAPHY

- Albjerg, Victor L. "Internal Improvements Without a Policy (1789-1861)." Indiana Magazine of History 28 (September 1932): 168-179.
- Barsness, Richard W. "Maritime Activity and Port Development in the United States Since 1900: A Survey." Journal of Transport History 2 (February 1974):167-184.
- Chittenden, Hiram M. "Detention Reservoirs with Spillway Outlets as an Agency in Flood Control." American Society of Civil Engineers Transactions 83 (1918):1473-92.
- Clemens, George R. "The Reservoir as a Flood-Control Structure." American Society of Civil Engineers Transactions 100 (1935): 879-927.
- Commission on Organization of the Executive Branch of the Government, Task Force on Water Resources and Power. Report on Water Resources and Power. 3 vols. Washington, DC, 1954.
- Cranmer, H. Jerome. The New Jersey Canals. State Policy and Private Enterprise, 1820-1832. New York, 1978.
- Farrell, Richard T. "Internal-Improvement Projects in Southwestern Ohio, 1815-1834." Ohio History 80 (Winter 1971):4-23.
- Federal Power Commission. The 1970 National Power Survey. Part 1. Washington, DC, 1971.
- Ferrell, John R. "From Single- To Multi-Purpose Planning: The Role of the Army Engineers in River Development Policy, 1824-1930" (Draft). Baltimore, Historical Division, OCE, 1976.
- "Final Report of the Special Committee on Floods and Flood Prevention." American Society of Civil Engineers Transactions 81 (1917):1218-1310.
- Goodrich, Carter, ed. Canals and American Economic Development. New York, 1961.
- _____. Government Promotion of American Canals and Railroads, 1800-1890. New York, 1960.
- Gray, Ralph D. The National Waterway. A History of the Chesapeake and Delaware Canal, 1769-1965. Urbana, IL, 1967.
- Harrison, Joseph Hobson, Jr. "The Internal Improvement Issue in the Politics of the Union, 1783-1825." Ph.D. dissertation. University of Virginia, 1954.

Haveman, Robert H. Water Resource Investment and the Public Interest. An Analysis of Federal Expenditures in Ten Southern States. Nashville, 1965.

Hays, Samuel P. Conservation and the Gospel of Efficiency: The Progressive Conservation Movement, 1890-1920. Cambridge, MA, 1959.

Heath, Milton S. Constructive Liberalism. The Role of the State in Economic Development in Georgia to 1860. Cambridge, MA, 1964.

Hull, William J. and Robert W. The Origin and Development of the Waterways Policy of the United States. Washington, DC, 1967.

Kelso, Harold. "Inland Waterways Policy in the United States." Ph.D. dissertation. University of Wisconsin, 1942.

Lippincott, Isaac. "A History of River Improvement." Journal of Political Economy 22 (July 1914):630-660.

McCullough, David. The Path Between the Seas. The Creation of the Panama Canal, 1870-1914. New York, 1977.

Marcus, Henry S., et. al. Federal Port Policy in the United States. Boston, 1976.

Marshall, Dr. Harold E. "Federal Cost-Sharing Policies for Water Resources." National Bureau of Standards Report NWC-SBS-72-039.

National Water Commission. Water Policies For the Future. Final Report to the President and to the Congress by the National Water Commission. Washington, DC, 1973.

President's Water Resources Policy Commission. Water Resources Law. The Report of the President's Water Resources Policy Commission, vol. 3. Washington, DC, 1950.

Pross, Edward L. "A History of Rivers and Harbors Appropriation Bills, 1866-1933." Ph.D. dissertation. Ohio State University, 1938.

Ransom, Roger L. "Canals and Development: A Discussion of the Issues." American Economic Review 54 (May 1964):365-389.

Reuss, Martin. "The Army Corps of Engineers and Flood-Control Politics on the Lower Mississippi." Louisiana History 23 (Spring 1982):131-148.

Shaw, Ronald E. Erie Water West. A History of the Erie Canal, 1792-1854. Lexington, KY, 1966.

Taylor, George Rogers. The Transportation Revolution, 1815-1860. The Economic History of the United States, vol. 4. New York, 1951.

Thompson, Stephen; Maffel, Barbara; and Lipford, William. "Federal Aid to Domestic Transportation." Congressional Research Service Report 77-112-E. May 1977.

U.S. Army Corps of Engineers, Office of the Chief of Engineers, "Notes on Flood Control." Washington, DC, 1936.

U.S. Congress. Senate. Preliminary Report of the Inland Waterways Commission. S. Doc. 325, 60th Cong., 1st sess., 1908.

U.S. Department of Commerce, Maritime Administration. "Public Port Financing in the United States." June 1974.

. "National Port Assessment 1980/1990: An Analysis of Future U.S. Port Requirements." June 1980.

U.S. Department of the Interior, Census Office. Transportation. Tenth Census of the United States, 1880, vol. 4. Washington, DC, 1883.

U.S. Department of Transportation, Maritime Administration. "A Report to the Congress on the Status of the Public Ports of the United States." August 1982.

U.S. Department of the Treasury. Statement of Appropriations and Expenditures for Public Buildings, Rivers and Harbors, Forts, Arsenals, Armories and other Public Works from March 4, 1789 to June 30, 1882. Sen. Exec. Doc. 196, 47th Cong., 1st sess., 1882.

U.S. Office of the Federal Coordinator of Transportation. Aids to Railroads and Related Subjects and Public Aids to Transportation by Water. Public Aids to Transportation, vols. 2 and 3. Washington, DC, 1938-1939.

Viessman, Warren, Jr. "Coordination of Federal Water Resources Policies and Programs." Congressional Research Service, Washington, DC, 1978.

Walker, Paul K. "Building American Canals: Part 1--The Federalist Period" and "Part 2--From Erie to the Present." Water Spectrum 12 (Winter 1979-1980):18-25 and (Summer 1980):12-23.

Werlein, Q. E. "Financial History of the Flood Control,
Mississippi River and Tributaries Project."
Typescript copy, Mississippi River Commission,
Vicksburg, MS.