

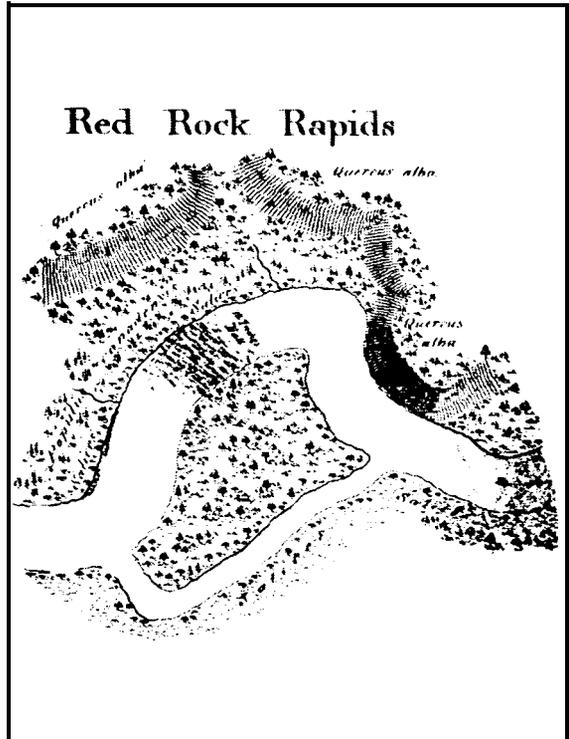
CHAPTER IV

Navigation

Most civil works transferred to the Topographical Bureau by the Engineer Department in 1838 through 1841, in accordance with Poinsett's order, involved rivers and harbors improvements. A large number of these were along the shores of the Great Lakes. In the years that followed, this activity declined. In 1841 Congress appropriated money only for the Potomac River aqueduct and bridge and for removal of the fallen trees and other debris that clogged the Red River of Louisiana. Work on the Red River "raft" had been suspended for some time. On Lieutenant Colonel Long's recommendation, a contract was let for the work. With these exceptions, 1841 was a lean year. "Other various works of river and harbor improvements," Abert wrote, "have been comparatively suspended, existing appropriations in reference to the same authorizing nothing more than the payment of arrearages, and such additional expenditures as should be necessary, in order to preserve the boats, machinery, and materials from destruction."

Prom 1838 until after the Civil War, only two significant rivers and harbors acts passed; one in 1844 and another in 1852. Some other acts authorized work on a few specific projects, but those were modest when compared with the laws passed in the early 1830s. Sometimes, as in 1841, Colonel Abert was forced to instruct his subordinates to suspend work and even to sell equipment to meet congressionally imposed funding limitations. In 1850 he told Captain Augustus Canfield, who was in charge of works near Detroit, that the money credited to him for his project came from funds "for the repair and construction of roads and bridges for the use of armies in the field." A decision by Secretary of War Jefferson Davis in 1853 allowed the use of local funds to continue projects that had already received some congressional appropriations. The ruling helped, but it was hardly a panacea.

John C. Fremont prepared a map of the Des Moines River, including this drawing of Red Rock Rapids, after surveying the stream in 1841. He had been assigned the job at the insistence of Missouri Senator Thomas Hart Benton, who tried unsuccessfully to disrupt the budding romance between his daughter Jessie and Fremont. Although 1841 was a lean year for rivers and harbors work, Abert somehow found the money to accommodate Benton.



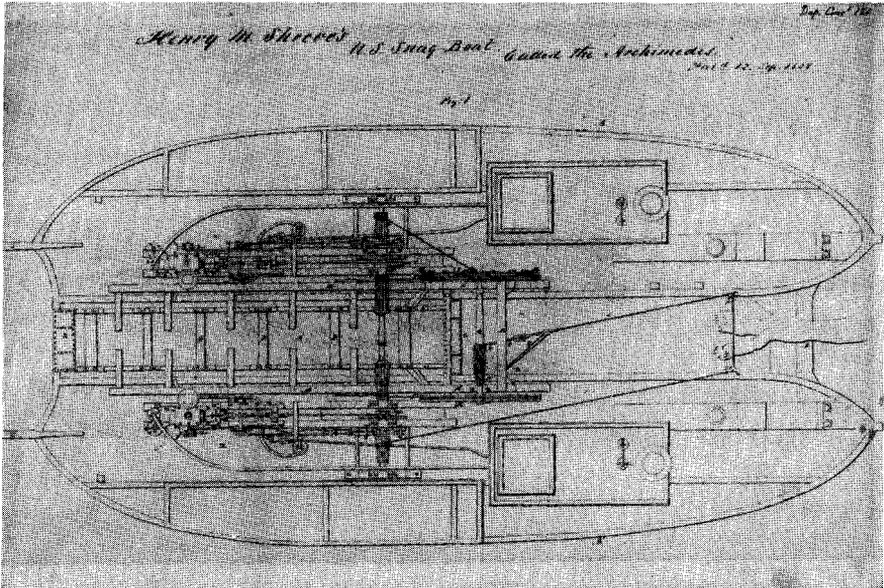
Congressional indifference was not the only problem. Successive Presidents continued to express doubts about the constitutional propriety of federal involvement in internal improvements, and several bills were vetoed during this period. The politics and personal predilections of the Secretary of War could also substantially alter the responsibilities of the Topographical Engineers. The most significant example of this came in 1852, when Secretary of War Charles Conrad decided that the Corps of Engineers would henceforth be responsible for rivers and harbors improvements on the Atlantic Coast, the Gulf of Mexico, and the rivers flowing into those two bodies of water. The Corps of Topographical Engineers retained the responsibility for improvements on the Great Lakes and the western rivers. Both organizations worked on the Mississippi River, with the Corps of Engineers concentrating on problems at the mouth of the river.

Conrad's decision largely resulted from passage of the 1852 Rivers and Harbors Act. Clearly, there were too few topographical officers to handle the increased work load, particularly when some had been detailed to other agencies and projects. The Secretary could have opted to use civilian engineers, but rejected that solution because he doubted their qualifications. He could have chosen to expand the Corps of Topographical Engineers, but he and Abert did not get along particularly well. Besides, at that

time the Corps of Engineers was relatively inactive because Congress had recently denied funds for fortifications construction and was investigating the system of coastal defenses upon which the Corps of Engineers had been working since 1816. Totten and Conrad agreed that the time had come to involve the Corps of Engineers once more in internal improvements. Hence, Conrad decided to split the work between the two corps. He also directed that each corps establish a board to supervise rivers and harbors projects. The Topographical Bureau's Board of Engineers for Lake Harbors and Western Rivers met from 1852 to 1855, when it was dissolved under Jefferson Davis, Conrad's successor as Secretary of War.

Although rivers and harbors improvements were carried out at an uneven rate, Topographical Engineers had an abiding faith in the importance of their work and in their ability to do it. "The improvement of rivers ... may justly be considered as the most difficult problem of solution in the whole science of civil engineering," Captain Hughes wrote in 1842. The answer to safe navigation was not construction of huge canals that drew water from the rivers but largely avoided natural watercourses. The answer, Hughes said, was to use human intelligence to "assist nature in her operations." It was a hopeful statement, full of that positivism characteristic of France during the Enlightenment a century earlier. Topographical Engineers deeply believed it, and even when the laws of nature seemed beyond their grasp, they sought to control the rivers.

They did so by constructing wing dams, jetties, and dikes. They built locks on some waterways and anticipated systems of locks and dams-slackwater navigation systems-on others. Actual work on many of these navigation systems, such as those on the Cumberland, Tennessee, and Ohio rivers, began only after the Civil War. Where structures proved ineffective, dredging was done. More often than not dredging was found to be necessary periodically no matter how well the structure worked. In their harbor projects, Topographical Engineers experimented with different types of cribs as breakwaters and as aids in the passage of water over sandbars. They tried to keep up with related work in Europe and were quick to borrow promising technology, such as the use of concrete in jetty construction, a practice pioneered by the French. They made substantial contributions to engineering, ever believing that science and technology eventually would



Overhead view of Henry Shreve's snagboat *Archimedes*, one of "Uncle Sam's tooth-pullers."

provide answers to the challenges of controlling the nation's waterways. And they felt that where theory failed, ingenuity would succeed. Theirs was a compelling faith, suited to a young, sinewy nation that sensed destiny was in its hands. It molded the nation's attitude toward water resources development and became part of the culture of the Corps of Engineers.

The Topographical Engineers did their best to meet the internal navigation needs of the nation. Through careful surveys, they helped chart the shores of the Great Lakes and the Atlantic Ocean. They did their construction work usually with modest, and often patently insufficient, appropriations. From Texas to Maine, from Minnesota to Florida, topogs constructed piers, breakwaters, and seawalls. They built dredges, snagboats, pile-drivers, and other machinery. Blasting rock, removing bars, and clearing river obstructions, the topographers remolded the land. Their rivers and harbors improvements dotted the landscape.

The Great Lakes

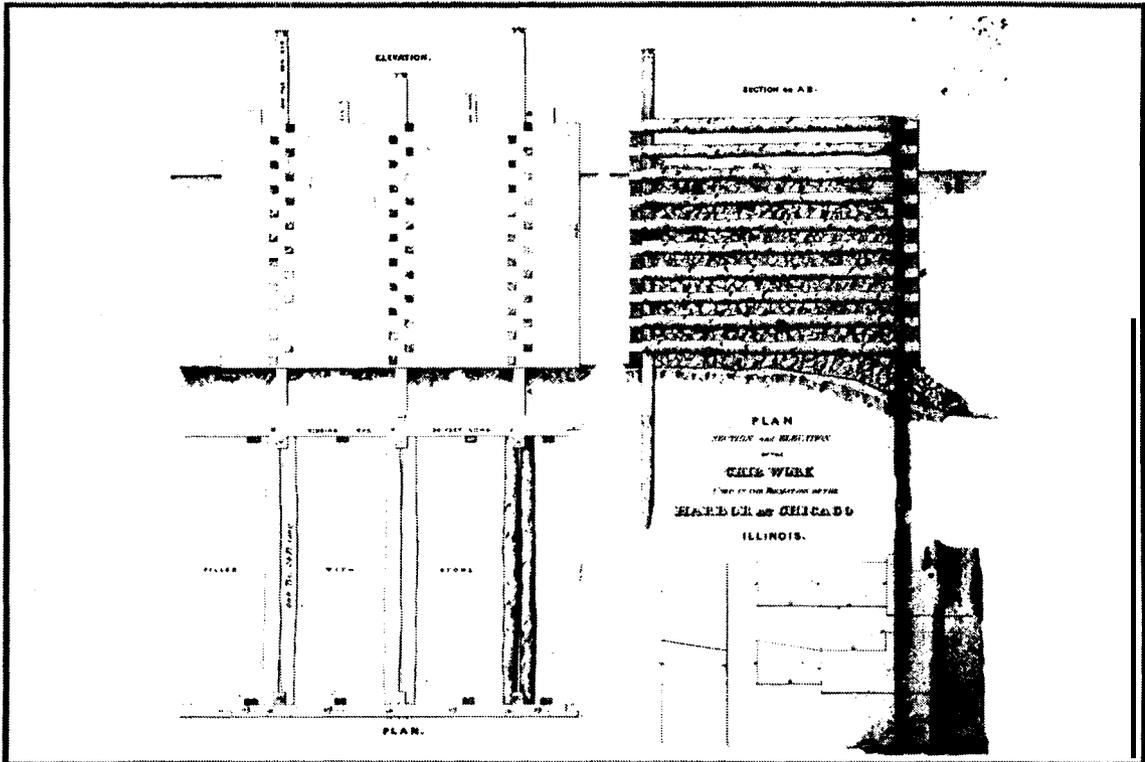
The topographers had strong support for their work on the Great Lakes from some secretaries of war. John M. Porter reminded Congress that the Great Lakes harbors and western

rivers were vital to safe commerce and naval operations on the lakes in time of war. Porter's successor, William L. Marcy, also tied public works to defense, particularly as related to the Great Lakes. If the nation ever had to put a naval force on the lakes, he argued, numerous and commodious harbors provided with federal aid would contribute to the fleet's safety and success.

In fact, the topographers always concentrated a large part of their efforts on the Great Lakes. Harbor work on the lakes began in the late 1820s and continued throughout the antebellum period. One of the earliest appropriations was for a breakwater at La Plaisance Bay, Michigan. However, Chicago Harbor received the most work and the most money. Indeed, about one-quarter of the approximately \$1 million spent for projects in the Huron-Michigan basin before the Civil War went to Chicago. Building a harbor there entailed dredging a navigation channel and constructing two piers. When congressional appropriations temporarily ceased after 1838, the city of Chicago provided some funds for continued dredging. Unfortunately, the timber piers rotted and crumbled and, without enough money, the topographers could not prevent the harbor's deterioration in the decade prior to the Civil War.

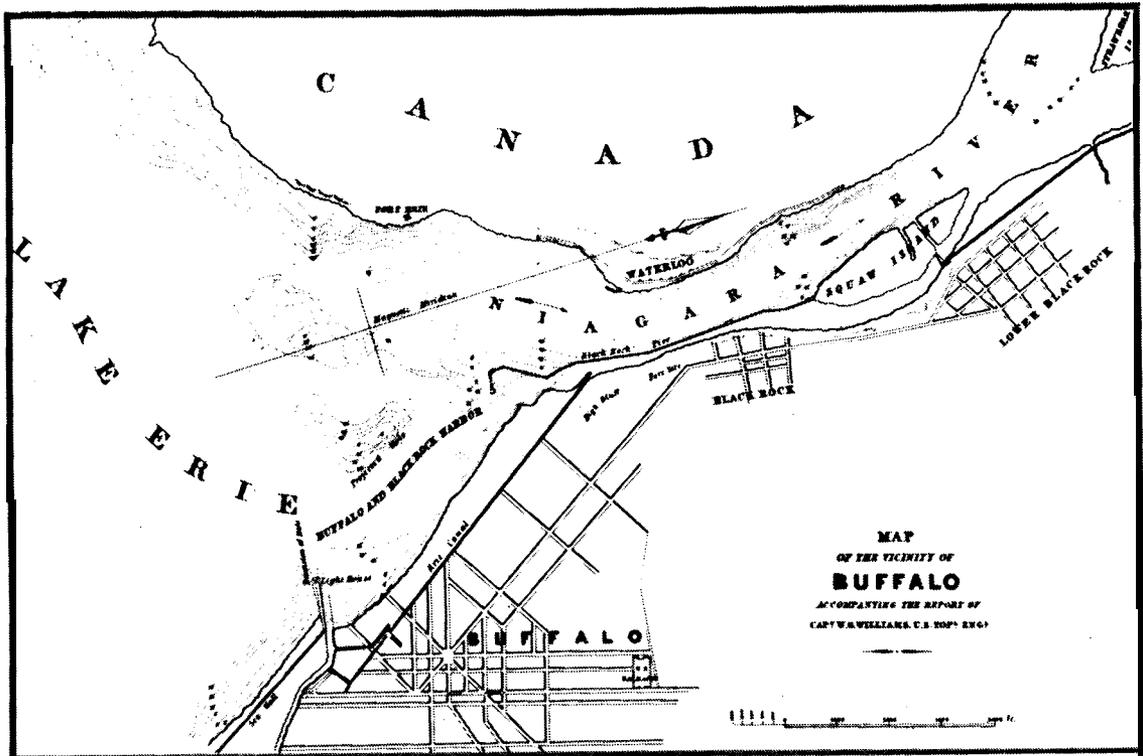
The corps worked on numerous other harbors around the Great Lakes. These included Waukegan, Illinois; Michigan City, Indiana; La Plaisance and St. Joseph, Michigan; Milwaukee, Kenosha, Racine, and Sheboygan, Wisconsin; Cleveland and Sandusky, Ohio; Presque Isle (Erie), Pennsylvania; and Buffalo, New York. The Presque Isle project—a double row of stone-filled cribs extending out into the bay—was a case in which the officers of the Corps of Engineers bequeathed to their topog rivals a project that had been destroyed by storms and shoaling and that required substantial modification. But, again, without congressional funding such work was impossible, and Colonel Abert could do little in response to the pleas of Erie citizens.

One well-known project that involved the topographers in a somewhat unusual way was the construction of the locks at Sault Ste. Marie, Michigan. Secretary of War Porter proposed the Soo locks in his 1843 report. In 1852 Congress agreed to help Michigan connect the upper and lower lakes by granting \$20,000 and 750,000 acres of federal land to build a channel and locks between Lakes Huron and Superior. Although it was to be a state project, Captain Canfield volunteered his services. Not only



Captain John McClellan drew this plan for cribwork during his 1843-1846 tour of duty on Lake Michigan. An 1826 graduate of the Military Academy and artillery officer for 10 years, McClellan resigned from the Army in 1836, then returned as a topog during the 1838 expansion of the corps. He served in the Seminole War before working on the Great Lakes. Later he won a brevet promotion for “gallant and meritorious conduct” in the Mexican War battles of Contreras and Churubusco and worked on the Mexican boundary survey. Known as a hard drinker throughout his career, McClellan died in 1854.

did Abert allow Canfield to direct the project as a nominal employee of the state of Michigan, but he also permitted use of most of the \$20,000 appropriated by Congress to have a dredge boat built. Canfield’s design for the canal conformed to the congressional stipulation that the passage should be not less than 100 feet wide and 12 feet deep, with two locks at least 250 feet long and 60 feet across. When Canfield died unexpectedly in 1854, his responsibilities were assumed by Lieutenant Colonel James D. Graham, who was headquartered in Chicago and responsible for improvements on Lake Michigan. In 1856 Captain Amiel W. Whipple took charge of the project. He used private funds and an additional \$45,000 congressional appropriation to complete in 1858 a rough channel connecting Lakes Superior and Huron. After the Civil War, the state transferred title to the canal to the United States. The Corps of Engineers took over the canal and lock operations and considerably improved them.



Captain William G. Williams, who included this map with one of his reports on Buffalo Harbor, worked for many years on the Great Lakes.

Great Lakes Survey

Perhaps the best-known work of the Topographical Engineers on the Great Lakes was not a construction project, but the Great Lakes Survey. The need for the work had long been recognized, for the uncharted lakes posed significant navigation hazards. Work actually began with a \$150 survey of the harbor at Presque Isle on Lake Erie in 1823, but Congress did not provide funds for a systematic survey until 1841. The appropriation made at that time was a predictably modest \$15,000. Colonel Abert assigned direction of the survey to Captain William G. Williams, who had been general superintendent of harbor improvements on Lake Erie. Williams operated out of Buffalo, with four Topographical Engineers under his command.

Despite the modest and belated support given to the Great Lakes Survey, the subsequent years revealed a rare congressional consensus on the importance of the work. From 1841 to 1860, Congress voted a total of \$640,000 for the survey; funds were provided in 18 of those 20 years. The work itself was daunting. Some 6,000 miles of shoreline needed to be surveyed. The surveyors had to determine latitude and longitude; measure

the discharge of rivers into the lakes; survey rivers, narrows, and shoals; develop charts and maps; and mark points of danger.

For the survey, Williams built the first iron-hulled steamer on the upper lakes. The 95-foot vessel was commissioned the *Abert* in May 1844 and renamed *Surveyor* the next year. The survey used the vessel for 30 years. Survey parties built triangulation stations, from 10 to 25 miles apart, and preferably on elevated land for visibility. The surveyors traced a chain of triangles over the lakes, connected where a lake was too wide by a series of smaller triangles along the shore. The days were long, the weather was often poor, and the summertime flies and mosquitoes swarmed around the men. But the work progressed, and in his four-year tenure Williams oversaw the survey of all Great Lakes harbors except those on Lake Superior.

The first surveying was somewhat crude, but as better instruments and more manpower became available, the quality improved. Lieutenant Colonel Kearney, Williams' successor, took over in 1845. The focus of the survey was shifting westward by that time, and the office's move to Detroit bore witness to the change. Kearney oversaw the completion of the first comprehensive chart of Lake Erie in 1849. The same year also saw the publication of the first atlas of charts of the portions of the lakes covered to that time. Survey offices in Buffalo, Cleveland, and Detroit issued the maps to navigators without charge up to the Civil War. Captain John N. Macomb, who took over from Kearney in 1851, had a second steamer built and started the survey of the Straits of Mackinac, perhaps the most difficult part of the Great Lakes to chart. By 1855 the survey fleet included five steam-driven dredges and accessory discharging scows.

With characteristically broad vision, Colonel Abert saw the survey in the most far-reaching terms. "These lakes," he wrote, "constitute a great northern sea-board." At almost every turn, he urged Congress to provide more money, buttressing his arguments for increased support by reminding the legislators of the thriving lake trade and backing his claim with the commercial statistics that he required the head of the survey to collect.

Captain George G. Meade, later the commander of Union forces at the Battle of Gettysburg, headed the lakes survey from 1857 to 1861. Under his guidance, the surveyors improved their scientific procedures and began to take meteorological readings. In 1859 Meade set up 19 weather stations on the five lakes. In

James D. Graham (1799-1865) worked on the Great Lakes from 1854 to 1864, much of that time as superintendent of harbor improvements with his office in Chicago. A thinker as well as an engineer, Graham discovered the existence of a lunar tide on the Great Lakes. After graduating from the Military Academy in 1817, he became an artillery officer and assisted Long on the 1819 expedition to the Rockies. Graham worked on four major boundary surveys: the northeastern boundary with Canada, the border between the United States and the Republic of Texas, the Mexican boundary, and the resurvey of the Mason-Dixon Line.



addition to gauging the weather, he also sought to predict it and warn mariners of impending storms. At the beginning of the Civil War, the lakes survey was the most active of any topog field office, although only the survey of Lake Huron was complete. In 1863, when the Corps of Topographical Engineers was reincorporated into the Corps of Engineers, the lakes survey became the only topog office to outlive the parent organization. The lakes survey retained its identity, and its superintendent reported to the Chief of Engineers. The survey office continued until 1970, when many of its functions were transferred to the National Oceanic and Atmospheric Administration. The Detroit District of the Corps of Engineers assumed the responsibility for forecasting lake levels.

U.S. Coast Survey

Like the Great Lakes Survey, the Coast Survey predated the establishment of the Topographical Bureau. The effort had started within the Treasury Department in 1816 under Swiss-born Ferdinand R. Hassler. This was the first contact between that department and the topogs, who in later years undertook much construction for the Treasury Colonel Abert then a major, worked for the survey for two years. In 1818, after temporarily being taken over by the Army and Navy, work was suspended for

lack of funds. As soon as he secured the independence of the Topographical Bureau in 1831, Abert expressed the need for a coastal survey. Topographical Engineers, Abert claimed, were the only ones with sufficient technical knowledge and the **requisite discipline** for the job. As to the work, Abert claimed it had great value for commerce and science as well as for defense. Moreover, he would have been eager to do it, but Congress rebuffed his efforts to add the survey to the missions of the bureau.

Appropriations resumed in 1832, and Abert detailed Captain William H. Swift to the project at Treasury's request four years later. However, it was not until the reorganization of 1843 that **the topogs** began to play a major part in the survey. The law of 1843 set up a board of officers to design a plan for the project. This board consisted of four "from among the principal officers" of the Corps of Topographical Engineers, the superintendent of the survey and his two main assistants, and the two naval officers then in charge of hydrographical parties. The topogs were assigned implementation of the topographical portions of the plan. From that time until the Civil War, one topog officer was always detailed to the survey.

The Coast Survey itself had only a small staff and relied on Army and Navy personnel to accomplish much of its surveying in the antebellum period. Several officers represented the topogs with the survey, including Joseph E. Johnston, Thomas Lee, Thomas Jefferson Cram, and James H. Simpson. For almost a decade, 1833 to 1834 and 1836 to 1843, Captain Swift was the Coast Survey's disbursing officer. Captain Humphreys served as Assistant in Charge from 1844 to 1850. Those officers who worked with the survey added their surveying and exploration background and skills to the project while gaining experience with instruments and equipment peculiar to the coastal survey.

The Mississippi River System

The Topographical Engineers also were active on the Mississippi and its major tributaries. Work on these streams was initiated in 1824 by Stephen Long, so it was fitting that Abert appointed Major Long to head up the Office of Improvements of Western Rivers in 1842. This large rivers and harbors office, with far-flung responsibilities, never had much success. Abert had

envisioned dividing Long's operation into "five district sections or commands:' each with a topog in charge, but these were never created. Long's office was established with an appropriation of \$100,000 for the improvement of the Ohio, Mississippi, Missouri, and Arkansas rivers.

Contrary to Abert's wishes, Secretary Spencer established a separate office to supervise improvements on the upper Ohio River. This was apparently in deference to political pressure from that part of the country. In any case, the arrangement proved administratively awkward. Long assumed that the superintendent of improvements on the upper Ohio, Captain John Sanders, temporarily detailed from the Corps of Engineers to Abert's command, would be subject to Long's authority. Abert disabused Long of that notion, but not without periodic complaints from the unhappy major.

One of Long's principal duties was to supervise snagboat operations. In the 1840s, the six to ten snagboats that worked on the western rivers removed over 160,000 obstacles, ranging from snags, stumps, and logs to overhanging trees. The crews numbered from 40 on the largest boats to 30 on the smallest. To ensure a just and consistent administration of the crews and boats, Long authored a set of *Rules and Regulations*. The document prescribed the rights and duties of the crew and specified rules relating to pay, furloughs, gambling, drinking, medical treatment, and food. Despite this attempt at imposing a fair policy, snagboat captains-themselves not always free of guilt-experienced numerous cases of desertion and insubordination from their crews.

Long's office did little after the Mexican War, until the 1852 Rivers and Harbors Act appropriated \$500,000 for improvements on western rivers. He then started an intensive program for removing obstructions from the principal waterways under his authority. This effort lasted four years. He also supervised the improvement of the harbor at Dubuque, Iowa; work on the especially difficult stretches of water at the Des Moines and Rock River rapids on the upper Mississippi and Illinois rivers, respectively; the removal of the Red River raft; and the repair of the Cumberland Dam on the Ohio River. While Long supervised this work, he also had to address a controversy with Secretary of War Jefferson Davis, who was upset that Long employed John Russell, a Whig and therefore politically unacceptable to Davis.

Long claimed to be ignorant of the order to fire his long-time assistant. He nevertheless incurred sizable displeasure from the Secretary, who temporarily relieved him of his position in 1853.

Long returned to his headquarters in Louisville in 1855, but soon afterward he was involved in another dispute with Davis. A delay in dredging operations at Dubuque, which resulted from interference with Long's operations by a private contractor employed by the city, irritated the Secretary of War. To appease Davis, Long entered into a contract that proved unfavorable to the government. This time Abert was upset, and he recommended to Davis that Long be removed. Davis needed no urging. With Long's removal in 1856, the Office of Improvements of Western Rivers was effectively abolished. During its life, it had exhibited all the characteristics of topog field offices: dependence on erratic congressional appropriations; alternate periods of intense activity followed by little or no work; political interference; shortages of qualified personnel; and lack of overall planning and continuity.

Long's office was one of five topog field offices that carried out rivers and harbors work during the 1850s. Captain John McClellan ran the Office of Tennessee River Improvements at Knoxville, while Graham's office in Chicago worked on Lakes Michigan and St. Clair. Two other offices also oversaw Great Lakes operations. Captain Howard Stansbury at Cleveland managed work on Lake Erie west of the port of Erie; Major Trunbull at Oswego, New York, had the rest of Erie and Lakes Ontario and Champlain. Lieutenant Colonel Kearney's Board of Engineers for Lake Harbors and Western Rivers, established in 1852, oversaw the whole operation from an office in Washington.

The Mississippi Delta Survey

The Topographical Engineers performed one especially significant waterway survey, one atypical in organization and important far beyond the funds and time invested in it. This was the Mississippi Delta Survey. In September 1850, responding to the pleas of southern congressmen for federal assistance in dealing with periodic disastrous flooding at New Orleans and other lower Mississippi River communities, Congress appropriated \$50,000 for a topographical and hydrographical survey of the Mississippi Delta. The survey was to include a study of the

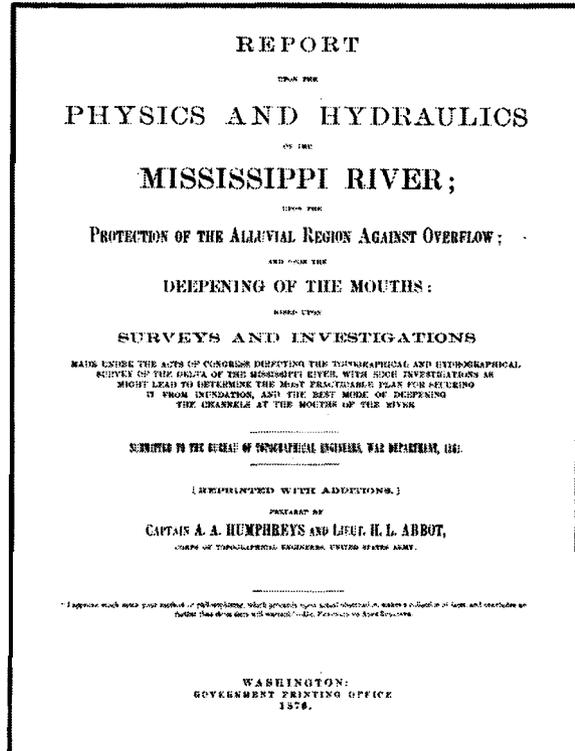
best means of securing a 20-foot navigation channel at the Mississippi's mouth. Captain Humphreys and Lieutenant Colonel Long were placed in charge of the survey. However, Long was preoccupied with the construction of marine hospitals and other duties, so Humphreys assumed overall supervision of the project.

Humphreys came from an assignment with the Coast Survey. Earlier, he had worked on the extension of the Capitol in Washington and on the construction of Chicago Harbor. He met this new challenge with his customary vigor, organizing three teams of surveyors-hydrographical, hydrometrical, and topographical-and putting a civilian engineer in charge of each of them. The laborious work in the hot climate exhausted Humphreys. He had to go home to Philadelphia to recuperate, and the survey remained uncompleted. He returned to the survey in 1857, the intervening time being taken up principally with supervising the Pacific railroad surveys. When he resumed work, he had a new associate, Lieutenant Henry L. Abbot. Abbot proved so indispensable that when the final report was published, Humphreys added his name as coauthor. Officially titled the *Report Upon the Physics and Hydraulics of the Mississippi River*, the survey is often called the Humphreys-Abbot report.

In 1861 Humphreys and Abbot closed the office and submitted their report, which was full of new details about the lower Mississippi basin. From just south of the junction of the Mississippi and Ohio rivers to the mouth of the great river, they obtained data on river flow, channel cross sections, and general topographical and geological features. Survey teams took similar measurements on some of the major tributaries of the lower Mississippi. The two officers then examined all available literature on channel resistance and water flow, altogether examining some 15 different formulas. They found every calculation lacking in some respect. So they developed their own formula to measure the flow of water in rivers, which also proved faulty. Most significantly, it did not take into account the roughness of the slopes of a river channel. Still, their work inspired other hydraulic engineers, and further research led to important theoretical discoveries. The report won the respect of engineers around the world.

Unlike other West Point graduates, Humphreys and Abbot had actually tested the European theories they had learned at West Point. Moreover, they did so in a comprehensive and lucid

The 1876 edition of the Humphreys-Abbot report appeared when Humphreys, then Chief of Engineers, was feuding with a famous civil engineer, James B. Eads, about the effectiveness of jetties at the mouth of the Mississippi. Eads thought jetties could ensure navigable passage at the river's mouth. Humphreys clung to the analysis in his report and insisted they could not. In 1879, Eads completed jetties at the South Pass of the Mississippi and showed them to be effective. Eads' triumph partially discredited the Humphreys-Abbot report, but the report's insistence on "levees only" to control the river remained a canon of Corps flood control theory.



fashion that was unprecedented. Their publication not only helped validate their education and training, but it suggested that the Topographical Engineers could make technical contributions that were as important as those of their fellow officers in the Corps of Engineers. The report also affirmed the faith articulated in 1842 by Captain Hughes: careful observation and experimentation leads to an understanding of the laws of nature.

Humphreys received numerous international honors, including honorary memberships in the Imperial Royal Geological Institute of Vienna and the Royal Institute of Science and Arts of Lombardy, appointment as a fellow of the American Academy of Arts and Sciences, and an honorary doctorate of laws from Harvard College. In 1866, following an impressive performance during the Civil War in which he advanced to the rank of brevet major general, Humphreys was appointed Chief of Engineers. He served in that capacity until 1879.

Although the formula offered by Humphreys and Abbot was flawed, their conclusions influenced the development of river engineering and the evolution of the Army Corps of Engineers. The authors believed that using levees only could control flooding along the lower Mississippi; neither costly reservoirs nor cutoffs were needed. The Corps of Engineers accepted these conclusions for nearly 60 years, not just for the lower Mississippi

but for other large rivers as well. The “levees only” policy profoundly affected the manner in which the United States developed its water resources. Indeed, the influence of the Humphreys-Abbot report extended past World War II, despite the fact that by then Congress had authorized hundreds of reservoir projects.