of the St. Louis public terminals, it will be imperative to achieve maximum efficiencies in unit-train/unit-tow and joint rail-water through rates. If modes are slow to opt for cooperation, they will impede a geographic and "facilities-in-place" locational advantage for the region for the key cargoes discussed above.

CONCLUSIONS

This paper has attempted to heuristically examine some practical aspects of forecasts of key commodity flows for a regional port. Data and forecasts are taken from an ongoing port district study in the Port of Metropolitan St. Louis. The study is oriented to matching commodity flows with detailed market study and regional economic forecasts. In the current national processes of inflation, economic scarcity, altered energy use and growth incentives, and the onset of new national financial policies for water transportation, it is pertinent for individual ports to reexamine their role in the total transportation context and refine their growth strategy around unique geographic, engineering, operational, and industrial features.

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Federal Interest in Effective Transportation Use of Major River Navigation Systems

WAYNE E. CALDWELL

The essential elements of major river navigation systems and the federal interests that have an impact on their effective use are discussed. Optimal use of these systems is stressed as a national goal in these energy-conscious times. The public and federal regime in which the waterways industry must operate and specific federal programs of interest are discussed. These include channel design and maintenance, water resources management, navigational aids, alteration of obstructive bridges, regulation of movable bridges, and bridge construction permits. The commercial vessel safety program of the U.S. Coast Guard and waterways improvement efforts of the U.S. Army Corps of Engineers are outlined. Coast Guard experience in preventing and responding to incidents of oil pollution and the growing concern about hazardous-materials accidents are examined.

In the summer of 1979, I returned to Washington after serving three years as Commander of the Second Coast Guard District. This inland empire, with headquarters in St. Louis, comprises all or part of 22 states and includes all of that major inland waterway system commonly referred to as the "western rivers". The Second Coast Guard District serves all who are associated with the great rivers; however, the towboat and barge industry is its most important, and sometimes noisiest, customer.

While serving as commander of the district, I became one of the local river rats and, like my predecessors, learned a good deal about the rivers, the people who make their living on them, and the unique language of the profession, and I became more convinced than ever of the important role the rivers play in our national economy. I departed with a clearer vision of the mutually supportive roles that the industry and the U.S. Coast Guard play in this vital area and with a deep respect for the professional in this interesting industry.

Although the basic aim of the Coast Guard is to facilitate commerce on the rivers, from time to time it seems to be accused of hindering it. Perhaps this occasional opposition can be placed in a better perspective if its aim is redefined by adding a word. The aim of the Coast Guard is to facilitate "safe" commerce. Sometimes its views of what is required for safe commerce vary a bit from the views of the industry, in terms of actual need, expected results, and above all the cost to the industry in both time and money. In spite of these minor variances, the Coast Guard shares with the industry a deep concern for safety.

Perhaps, before discussing what I mean by the effective use of a major river navigation system, I should first define my terms. The dictionary says that effective means "adequate to accomplish a purpose"; however, I doubt whether any of us would be satisfied with simple adequacy. Adequacy seems, more often than not, to imply marginal performance.

I support the premise that we must demand more than simple adequacy from our river systems. To my mind, effective use implies efficient use or perhaps could even be stretched a bit to mean optimal use. This should be the goal in the management of the river systems.

Optimal use of the river transportation system is of vital importance to the nation in the present energy crisis and will be in the coming decades of energy conservation. The river system has always provided a means for energy-efficient transportation, but never before has it had such an overriding advantage. The river system is a national asset that must be exploited and optimized. We must, as a national goal, do everything possible to strengthen this system and ensure that simple adequacy is replaced by optimal use.

How is the optimum to be achieved? What are the necessary elements in providing this kind of river navigation system, and who should be involved in this optimization effort? These are the subjects discussed in this paper.

THE RIVER NAVIGATION SYSTEM

The river navigation system is made up of many items, all tied closely together: (a) towboats and barges, (b) their crews, (c) the confines of the waterway and the water in it, (d) navigation aids, (e) obstructive or hindering elements such as bridges and locks, (f) terminals, (g) the cargoes transported or available to be transported, and (h) the interface with other transportation modes. This complex system must operate in an environment of legal constraints, public concerns, and competition that affect its every move. These consist of ever-expanding laws and regulations and

environmental concerns, the inability of the federal government to finance all needed improvements, and the need to compete for business in the real world of hard dollars and cents. In spite of these constraints, the waterways industry manages to thrive.

Of prime importance in this system is the constantly changing waterway itself. Except in the case of passage through a lock, the maximum capacity of any waterway is not really known. Waterway capacity would appear to be limited only by the number of available towboats and the volume of commodities to be carried. It is obvious that this cannot be the case, but it is equally obvious that, with the exception of a few bottlenecks, there is massive unused transportation capacity available.

However, if the waterways are to operate safely, carrying high tonnage, they must have well-aligned and well-maintained channels with suitable dimensions. The U.S. Army Corps of Engineers is a vital partner in this area. We all need to know more about what constitutes an optimum channel. Important work is being done in real-time computer simulation of towboat maneuvers in restricted channels, and it is hoped that this may help in decision making on this important parameter. Although the Corps of Engineers has federally delegated responsibility for channel development and maintenance, the experience of pilots who daily travel the waterways is an essential need in support planning for improvements. The federal government must, with industry experience, seek out and eliminate the all-too-frequent bottlenecks in the inland navigation system.

Efficient water conservation, flood-management practices, and pool-level maintenance are also federally coordinated responsibilities that affect the water transportation industry.

The water resources of the United States are used for many purposes. In water-deficient areas, these multiple uses must compete with each other for the available water in the region. Congress responded to the need for comprehensive planning for the use of water resources by enacting the Water Resources Planning Act of 1965. This act established the Water Resources Council, a cabinet-level forum made up of top-management-level representatives from departments that are involved in the control and management of water at the federal level. Title 2 of the act established authority for regional coordination through the organization of river basin commissions composed of state and federal members from the affected area. In addition, Title 2 authorized financial assistance to individual states for water-related planning by means of matching grants.

The Commandant of the U.S. Coast Guard has been designated as the U.S. Department of Transportation (DOT) coordinator for water-resource activities and serves as the alternate for the Secretary of Transportation on the Water Resources Council. Appropriate officials in the various DOT operating agencies are designated to represent DOT views on the various regional river basin commissions.

One of the important Coast Guard roles is to provide a system of navigation aids in which individual aids are suitably placed, are dependable in operation, and are promptly serviced when outages occur. For the most part I feel that it meets this need, but the present system, with a few exceptions, is the historical result of meeting individual needs as they occur. I admit that the Coast Guard has not done as well as it should in providing uniform operational criteria for the best selection of the type and specific placement of navigational aids. The result of incremental growth is that some waterways are marked better than others. However, steps are being taken toward system uniformity and toward organizational provision for a waterway audit function to assess the problem.

The proper marking of waterways is a costly as well as an extensive operation. In the Second District, for example, the Coast Guard maintains aids to navigation over more than 6500 commercially navigable river miles, 4600 of which support navigation on a year-round basis. The 18 Coast Guard vessels stationed throughout the Second District maintain almost 4000 fixed aids and more than 9000 buoys. All of these are serviced regularly by about 450 Coast Guard personnel. The navigation-aids effort accounts for almost half of the total workload in the Second District, which had an operating budget of almost $25 million in fiscal 1979.

BRIDGES

Another type of waterway bottleneck, in addition to channel dimensions, exists in the form of bridges whose horizontal and/or vertical clearances provide unreasonable obstructions to navigation. Most of the existing railroad bridges in the Second District were built around the turn of the century. Some people have described such bridges as monuments to poor planning, but I would submit that the growth of inland waterway development since World War II has been far beyond what could have been foreseen by even the most perceptive planners at the turn of the century. Under Title 33 of U.S. Code 511 (the Truman-Hobbs Act), the Coast Guard maintains an active program for ordering the alteration of unreasonably obstructive bridges. Although the program results are sometimes criticized for being inadequate compared with evaluated needs, the Coast Guard takes pride in what has been accomplished. The average annual budget level for this activity has reached $8 250 000, but the competition for funds to alter obstructive bridges is high, costs continue to spiral, and real dollar resources are limited.

In the development and issuance of orders to alter bridges, there is now a backlog of nine projects that are partly funded and under way, four outstanding orders for which funding will be requested in FY 1981, and studies in progress that may soon lead to an additional four orders to alter. As navigation needs increase, the Coast Guard intends to be responsive in seeking elimination of this type of bottleneck.

In an ideal waterway, all bridges would be fixed, high-level structures that provide no interference with or obstruction to navigation. In the real world, however, we must live with the 1855 U.S. bridges that lift, swing, or otherwise move to allow the passage of navigation. Another Coast Guard program is the regulation of these bridges so that the terms, conditions, and hours of their operation satisfy the concerned waterway user without unduly penalizing the motor vehicles or trains that are also affected by their operation.

In a related program, the Coast Guard processes and issues permits for the construction of almost 300 new bridges each year. The aim of the program is to ensure that permits are issued only for bridges that have clearances that are sufficient to meet the reasonable needs of navigation. On most of the waterways systems, minimal guide clearances are established, and all bridges on the waterway are constructed to meet these requirements.

SAFETY

The Office of Merchant Marine Safety is another member of the Coast Guard team whose activities have an impact on the river systems. The commercial vessel safety (CVS) program is especially worth mentioning here.

The objective of the CVS program is to minimize deaths, personal injuries, and property loss or damage associated with vessels and other facilities engaged in commercial activity in the marine environment. This objective is pursued through the administration of federal laws and the development and enforcement of federal standards. Efforts in promoting the safety of life and property can be divided into three basic areas: vessel inspection, the licensing and documentation of seamen, and the investigation of marine casualties. The CVS program uses a network of 50 field offices, supported by district and headquarters staffs, in performing the following functions:

1. Plan review of all U.S. commercial vessels engaged in certain trades,
2. Inspections of all such vessels while they are under construction,
3. Periodic inspections of all such vessels after they are placed in service,
4. Licensing and/or documentation of seamen to serve on such vessels, and
5. Investigations into marine casualties and personnel misconduct, negligence, or incompetence.

Another area of federal involvement--and a responsibility of the Corps of Engineers--is the construction, operation, and maintenance of the numerous locks along U.S. waterways. These, like bridges, have been built in one era and sometimes do not meet the increasing needs of the commerce of a later time. Typical of these is Locks and Dam 26 at Alton, Illinois, which is now proceeding toward a completion date of 1989 at an estimated cost of $491 million. Another example is the Tennessee-Tombigbee Project, which will be completed by the Corps of Engineers in 1986 at a cost of more than $1.6 billion. Other projects could be mentioned, such as those on the Red River, but the point is that the Corps of Engineers plays an all-important part in the improvement and extension of the nation's waterways system. There is little doubt that the vitality of the river systems and of the towing industry today is largely due to the efforts of the Corps of Engineers.

Yet another area of federal involvement is navigation safety. In a 1979 report prepared for the Coast Guard (1), casualty statistics covering a four-year period were enumerated for the western rivers and the Gulf intracoastal waterways. They included 245 bridge rammings and 61 groundings. Each of these incidents was routinely investigated by a Coast Guard marine inspection office, and in each case an attempt was made to determine the cause. The results of work of this type provide input for Coast Guard program managers and give them a basis for remedial action. This is one of the means by which the Coast Guard assesses the adequacy of its navigation aids, inspection programs, bridge program, and regulatory activities. It is interested in where a particular system fails and what can be done to correct it in order to prevent similar failures.

Collisions, rammings, and groundings can be of considerable concern to parties other than the people immediately involved. Sailors say, "A collision in the morning can spoil your whole day". But times have changed, and now we find that a collision involving a tank barge that results in a major pollution incident can spoil a whole day for a whole lot of people, some as far away as Washington, D.C.

With the advent of the Federal Water Pollution Control Act of 1972 and a host of other environmental legislation, the Coast Guard and the U.S. Environmental Protection Agency have come down hard on the problems of oil spills in U.S. waterways. In dealing with the situation, a number of approaches are used:

1. Maximum emphasis is placed on prevention of spills through a regulatory regime that covers barges and terminal facilities and how both are operated. The Coast Guard is interested only in reasonable standards that it feels will produce concrete and visible results.
2. The Coast Guard has set up the necessary organization, communications equipment, personnel, and open contracts with private firms to promptly respond to spills and potential spills, not only to clean them up but also to minimize environmental harm.
3. Legal penalties are imposed on spillers to provide an incentive for compliance with the regulations and perhaps to urge a bit more environmental concern on the part of industry. Traditionally identified for its search-and-rescue efforts in protecting people and property from the sometimes hostile actions of the marine environment, the Coast Guard is now busily engaged in protecting the marine environment from the sometimes hostile actions of mankind.

Unfortunately, the message is not always hitting home. Each year since 1974 has seen an increase in the number of known spills in inland waters, from 2000 in 1974 to almost 5000 in 1978 (2). We have been in the habit of rationalizing this on the basis that the reporting is getting more accurate each year. I personally think that such reasoning is wearing thin. If the figures are accurate, we are faced with a serious problem that must inevitably lead to tighter federal control and greater federal involvement.

We must reduce pollution by oil. The only preventive means at hand are controls on the equipment, the people, and the operating methods. It is quite probable that the existing body of regulations is adequate and that the situation can be considerably improved by a greater effort on the part of waterway operators and facility managers as well as more rigid enforcement and inspection activity by the Coast Guard.

This problem of prevention and response in relation to oil pollution is far from a satisfactory conclusion, and yet another element is being added. Oil spills harm the environment but only indirectly affect people. The new problem, that of accidents involving hazardous materials, strikes directly at the people in the industry and the public at large. An incident involving a chlorine barge can spoil the days for everyone in the affected area for a long time. Here again, there has been a steady increase in incidents since record keeping started.

We have just begun to scratch the surface of this problem. However, everyone should be aware that federal involvement, particularly in the absence of adequate industry concern, will expand and become more pervasive until a reduction in these incidents takes place.

The Cargo and Hazardous Materials Division in the Office of Merchant Marine Safety approaches these problems from the standpoint of vessel construction standards, by using the following means:

1. Drafts rules and regulations for the transportation, handling, loading, discharging, stowage, storage, and use of explosives or other dangerous cargoes;
2. Determines the kind and degree of hazard inherent in the water shipment of dangerous substances;
3. Reviews regulations, international standards, and proposals that relate to (a) protection of the environment in water transportation of hazardous materials and (b) vessels and waterfront facilities from the standpoint of environmental pollution hazards;
4. Makes studies of the behavior and effects of pollutants released to the environment under normal and accident conditions; and
5. Predicts trends in the transportation of hazardous materials and their evaluation in terms of future environmental hazards.

SUMMARY

Federal interest in effective transportation use of major river navigation systems has manifested itself in actions to facilitate safe commerce. Today's need for the conservation of energy will unquestionably attract greater federal interest because of the recognized energy efficiency of waterway transportation. Reasonable people also recognize that a balanced capability among all modes of transportation (water, air, rail, and truck) is essential to meet the nation's needs. Industry as well as the federal government will be challenged to identify national transportation needs and to promote a homogeneous interface among the modes. It is conceivable that such efforts will work changes in the predominant bulk shipment of coal, grain, fertilizers, petroleum products, and chemicals on U.S. inland waterways. It is reasonable to assume that container and roll-on/roll-off cargo-handling facilities will begin to emerge on the riverbanks much as they were introduced to ocean ports as the result of transportation technology.

Whatever the future holds, energy efficiency as well as the need for safe commerce will be an important factor in shaping federal interest in effective transportation use of major river navigation systems.

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Analysis of Towboat and Barge Use on Inland Waterways

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In 1975, the U.S. Army Corps of Engineers instituted the Performance Monitoring System (PMS) at locks on inland waterways. PMS data, collected at each lock, allow the Corps to monitor the use of navigation locks and traffic movements and to analyze tow operating characteristics. Based on data derived from PMS, the Corps developed a computer program called VESUSE to analyze inland-waterways use of towboats, barges, and flotillas by simulating their movements. The elements of the VESUSE program are described and are found to be reliable. The information on the characteristics of vessel utilization is useful for studies related to inland-waterways operations and planning.

The VESUSE computer program, developed by the Navigation Analysis Center of the U.S. Army Corps of Engineers, makes it possible for the first time to assess and analyze the characteristics of tow-equipment use on inland waterways. These characteristics are significant for various studies of operations and planning for inland waterways. Input to VESUSE are Performance Monitoring System (PMS) data on the movements of tows and barges through navigation locks. The program infers the movements that have taken place between the locks and from them estimates how many operational vessels of various types are present on a given section of inland waterway during a given time period. An operational vessel is defined as one that moves through a lock during the time period. The program also estimates the fraction of the time an average vessel of each type is in use or idle.

This paper presents a description of the various elements of the program.

PERFORMANCE MONITORING SYSTEM

PMS is a system of data collection at navigation locks whose purpose it is to monitor lock operations and the passage of commercial vessels through the locks (1). From a PMS data record, VESUSE extracts the lock code, direction of the lockage (upstream or downstream), identification number of the towboat, times and dates when the flotilla arrived in the lockage queue and completed the lockage, whether or not the flotilla had stopped since its last lockage, and the horsepower of the towboat. It also obtains the number of light boats in the lockage (commercial towboats that are not carrying cargo or pushing barges and that passed through the lock at the same time as the main flotilla). Finally, VESUSE obtains a table describing barges from the record. For each group of barges, the table gives the type of the barges, what commodity and how many tons they were carrying, and how many barges constituted the group. The data that PMS supplies on vessel movements between locks are very sketchy. Moreover, PMS data are not entirely reliable. These facts may limit the accuracy of the program's results.

CLASSES OF VESSELS

The classifications of the vessels used are the 9 barge categories used in PMS, 11 categories of towboats (distinguished by horsepower range), and the