Investment Strategy for the Inland Waterways

LLOYD G. ANTLE

A current assessment of the Inland Navigation Program is presented. The program sets forth a strategic planning process for the inland waterways. The plan includes consideration of the physical system, traffic growth, the performance of locks, the investment program, and the Inland Waterways Trust Fund.

Uncertainty has dominated decision making for the inland waterways. Capital and manpower resources for building new navigation structures, rehabilitating old ones, and operating and maintaining more than 200 navigation structures on the nation's waterways have been constrained by policies, priorities, and conflicts among competing claims for public and private resources.

Planning strategically—systematic and realistic assessment of needs and problems, formulation of alternatives, and evaluation and recommendation of measures that respond to needs and constraints—is as inevitable for the inland waterways as for any other transportation mode. Deregulation of prices and service requirements have made market forces a more active ingredient of decision making in both the private and public transportation sectors.

With the advent of the Water Resources Development Act of 1986 (WRDA 86) (P.L. 99-662), the pace of change has quickened and the U.S. Army Corps of Engineers and the waterways industry have begun the process of adapting strategically. WRDA 86 authorized construction of eight new inland navigation projects, established a cost-sharing policy for inland navigation projects (up to 50 percent of the cost of construction or rehabilitation from a trust fund consisting of fuel tax revenues and accrued interest), and created an Inland Waterways Users Board composed of representatives of the shippers and operators who utilize the waterway system to make recommendations to the Corps and Congress on priorities and projects.

Following an impasse of almost 20 years in getting waterway projects authorized, a 5-year period of lowered traffic levels, and overcapacity and low earnings in the waterway industry, WRDA 86 sparked many adjustments both in the process by which waterway investment decisions are made and in the outlook of the players in the private and public sectors. The Corps and the Users Board have educated each other at a rapid rate. The Users Board wants to be an active player in fashioning investment decisions and in influencing these decisions. Its members are impatient with the intricate planning and decision-making process, and they are amazingly quick to digest large quantities of technical and policy information.

U.S. Army Engineer Institute for Water Resources, Casey Building, Ft. Belvoir, Va. 22060.

The Corps has sought to listen to and respond quickly to the requests, suggestions, and recommendations of the Users Board. Study schedules, design schedules, and construction schedules have been altered to speed up work on projects that are high-priority investments from the Users Board's point of view. Although the Corps has slowed and stopped some studies that the Users Board has assigned lower priority, it is harder to slow or stop projects under construction. The Users Board has discovered that not only the Executive Branch priorities but the Legislative Branch priorities must be taken into account, because Congress carries the initiative in appropriating funds. It is now clear that the Users Board will express priorities in a more sophisticated way than in their first attempts, but projects that are not attractive in their perception of commercial navigation interests will probably continue to receive lower priorities.

It is now clear that the Inland Waterways Trust Fund will generate enough revenue to fund perhaps four to six navigation lock-and-dam replacement projects per decade. This assumes that the 20-cent fuel tax rate will be implemented by 1995, that fuel usage will increase at 1.5 percent per year, and that project costs will continue to inflate by 6 to 7 percent per year. Management of cost inflation on a number of projects in the investment backlog will ultimately control the rate at which projects can be replaced. This limited rate of replacement will result in a gradual increase in average project age and place greater emphasis on improved project maintenance. The Administration and Congress could decide to alter the cost-sharing ratio (now 50 percent from the IWWTF) or increase the fuel tax and therefore increase the replacement rate. Those decisions will be very hard to make.

This writer's view is that the political consensus that produced WRDA 86 is likely to remain unchanged for a substantial period, and therefore the challenge for the investment strategy is to find the best way to use sharply constrained funds.

With this background, the remaining parts of this paper will present a current assessment of the Inland Navigation Program. It is based primarily on the recently completed 1988 Inland Waterway Review (*1*).

PHYSICAL SYSTEM

The inland waterways include about 11,000 mi of commercially navigable bodies of water. The waterway segments subject to the fuel tax include 216 lock chambers at 167 projects. Open river fuel tax segments (i.e., those that have no locks and dams) include the Missouri River (735 mi), the White

River (255 mi), and the Lower Mississippi River (720 mi). Tables 1 (*2*) and 2 show the lock projects and fuel tax segments.

The locks and dams are aging. More than 90 lock chambers are at least 50 years old. Capital and manpower resources will continue to be necessary in making maintenance, rehabilitation, and replacement decisions. Table 3 shows the distribution of locks by age for each of the major fuel tax segments. Note that the Upper Mississippi, Illinois, and Ohio River System segments contain the majority of aged projects. On the Ohio River System, the main stem is generally improved with 1,200- by 110-ft locks (except the first three locks below Pittsburgh), but the tributaries are both predominately undersized and old.

About 5,000 towboats push more than 33,000 barges to transport 500+ million tons of traffic annually. No new towboats or barges have been constructed since the early 1980s, but investment in fuel- and labor-saving technology has continued.

TRAFFIC GROWTH

Moderate but irregular traffic growth has resumed on the inland waterways. Improved prospects for exports of grain and coal are now materializing. Currency reform, the grain export enhancement program, reduction in worldwide carryover stocks of grain, and other factors have contributed to a solid increase in exports. The waterways are well positioned to handle a significant flow of grain and coal exports.

As the rationalization of domestic manufacturing has moderated, domestic shipments on the waterways have increased. In fact, the Ohio River System has for several years increased its volume of coal traffic because of the location of coal-fired power plants and coal mines with respect to the navigation system.

Figures 1 (*3*) and 2 show some historical data and the overall traffic projection envelope to the year 2000. Table 4 gives projections by major segments of the inland waterways. The projection integrates the information about dispersion around the trends into the envelope and into the baseline from which growth rates are introduced.

PERFORMANCE OF LOCKS

The Inland Waterway Review (*1*) made a substantial effort at analyzing data from the Corps Lock Performance Monitoring System (LPMS). In general, the group of locks with the most delay, the slowest lock processing time, the most stall events, and the most down time is relatively small. Although the "top 40" in each performance indicator changes to a degree, the locks with the most significant performance problems are on the Upper Mississippi, Illinois, Ohio River System, and the Gulf Intracoastal Waterway (GIWW) at and west of New Orleans (including the Inner Harbor Lock). Table 5 gives those projects that have high capacity utilization as well as high delays and down times. The last column of Table 5 shows the rank of each project, giving equal weight to all performance indicators. These are believed to be the projects that deserve continuing study in terms of measures that would economically improve transit of traffic.

Another concern is competition between commercial and recreational craft for lock capacity, which is increasing on several segments of the inland waterways. The problem is primarily peak use on summer weekends. Projects that had more than 50 percent lockages by recreational craft are shown in Table 6.

INVESTMENT PROGRAM

The 11,000 mi of inland waterways received outlays of $771 million in FY 1988 for construction and operations and maintenance. O&M outlays averaged 1.5 mills per ton-mile in 1986. Figure 3 shows the average O&M costs per ton-mile for the nine major waterway segments.

TABLE 1 INLAND WATERWAY LOCK PROJECTS ON FUEL TAX SEGMENTS (*2*)

Segment Number and Name	Lock Projects	Lock Chambers	Status: Under Construction with Fuel Tax Funding	Status: Undergoing P.E.&D.[a]
1, Upper Mississippi	28	33	1[b]	0
2, Middle Mississippi	2	3	0	0
3, Lower Mississippi	24	24	0	0
4, Illinois Waterway	8	8	0	0
5, Ohio River System	58	95	4[c]	1[d]
6, Gulf Intracoastal Waterway	16	18	0	0
7, Mobile River and Tributaries	19	19	1[e]	0
8, Atlantic Intracoastal Waterway	3	3	0	0
9, Columbia-Snake-Willamette	9	13	1[f]	0
Total	167	216	7	1

[a]P.E.&D. = preconstruction engineering and design.
[b]Locks and Dam 26.
[c]Gallipolis, Grays Landing, Point Marion, and Winfield.
[d]Olmsted.
[e]Oliver.
[f]Bonneville.

TABLE 2 FUEL TAX WATERWAY SEGMENT LENGTHS

Segment/Waterway	Length (miles)
1. UPPER MISSISSIPPI	
Mississippi, Mpls, MN to Mo. R.	663
2. MIDDLE MISSISSIPPI	
Mississippi, Mo. R. to Ohio R.	195
Kaskaskia River	36
Missouri River, Sioux City to Mouth	735
3. LOWER MISSISSIPPI	
Mississippi River, Ohio R. to Baton Rouge, LA.	720
McClellan-Kerr Arkansas River	448
White River to Newport, AR	255[2]
Ouachita - Black Rivers	351
Red River to Shreveport, LA	236[2]
Atchafalaya River and Old River	220
4. ILLINOIS WATERWAY	357
5. OHIO RIVER SYSTEM	
Ohio River	981
Monongahela River	129
Allegheny River	72
Kanawha River	91
Kentucky River	82[2]
Green River[3]	149
Cumberland River	387
Tennessee and Clinch Rivers	652
6. GULF INTRACOASTAL WATERWAY	
GIWW: St. Marks, FL to N.O., LA	437
GIWW: N.O. to Brownsville, TX	690
GIWW: Morgan City-Port Allen	65
Apalachicola, Chattahoochee and Flint	297
Pearl River	58[2]
7. MOBILE RIVER AND TRIBUTARIES	
Mobile, Black Warrior, and Tombigbee Rivers	453
Tennessee-Tombigbee	234
Alabama River	305
8. ATLANTIC INTRACOASTAL WATERWAY	
AIWW: Norfolk-Jacksonville, FL (2 routes)	793
IWW: Jacksonville to Miami, FL	370
9. COLUMBIA-SNAKE WATERWAY	
Columbia R.: The Dalles to Richland, WA	135[1]
Snake R. to Lewiston, ID	230
Willamette River to Corvallis, OR	118[2]
Total U.S. Fuel Tax Segments	10,944
Segments not suject to fuel tax	
Minnesota, St. Croix and Black R.	52
Okeechobee Waterway	154
Cape Fear River	111
New York State Waterways	522
Total	11,783

NOTE: [1] Deep Draft Segment is not subject to fuel tax.
[2] Depths less than 9 feet.
[3] 149 miles are taxed; however, navigation is possible for only 103 miles. Lock # 3 is no longer operable.

TABLE 3 AGE DISTRIBUTION OF LOCK CHAMBERS ON FUEL TAX WATERWAYS BY SEGMENT

River Segment	No. of Chambers by Age (years)								
	0–10	11–20	21–30	31–40	41–50	51–60	61–70	>70	Total
Upper Mississippi	0	0	3	1	17	11	1	0	33
Middle Mississippi	0	1	0	2	0	0	0	0	3
Lower Mississippi	4	19	1	0	0	0	0	0	24
Illinois	0	0	1	0	2	5	0	0	8
Ohio	4	19	20	6	11	21	4	7	92
GIWW	1	0	3	16	0	1	0	0	21
Mobile	10	4	3	1	1	0	0	0	19
AIWW	0	0	0	0	2	1	0	0	3
C-S-W	0	4	2	1	1	0	0	5	13
Total	19	47	33	27	34	39	5	12	216

NOTE: Ages are as of 1987. See Table 1 for complete river segment names.

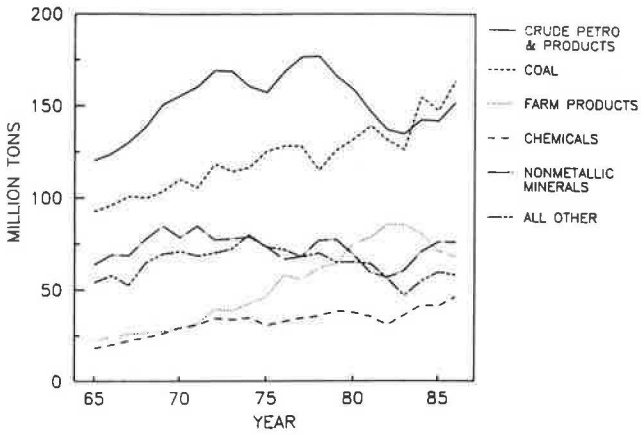

FIGURE 1 U.S. inland waterway traffic by commodity, 1965–1986 (*3*).

Construction or preconstruction engineering for eight replacement locks, funded in part by the Inland Waterways Trust Fund, was under way in FY 1988. Twelve rehabilitation projects were under way in FY 1988. Seven navigation projects started before WRDA 86 are continuing.

The Corps study program has identified 12 potential construction projects in the Ohio River System (four on the Ohio River main stem, three on the Monongahela, one on the Kanawha, and four on the Tennessee River). New studies are being programmed on the Upper Mississippi and Illinois systems, and continuing studies are under way on the GIWW (Inner Harbor Lock and the GIWW west of New Orleans). Table 7 gives an overall summary of projects under construction or rehabilitation, or both, or potentially available for construction and rehabilitation.

INLAND WATERWAYS TRUST FUND

The Inland Waterways Trust Fund was authorized by the Inland Waterways Revenue Act of 1978 (P.L. 95-502) and amended by WRDA 86. These laws establish the Trust Fund, fuel taxes (ranging from $0.10 per gallon of fuel before 1990 to $0.20 per gallon after 1994) for tows operating on 27 waterways, and appropriations from that fund. According to the law, the fund will be available "for making construction and rehabilitation expenditures for navigation on the inland and coastal waterways." To date, $99.8 million has been appropriated by Congress, $7.8 million in FY 1985, $26 million in FY 1987, and $66.2 million in FY 1988. FY 1988 expenditures are helping to fund the construction of five lock projects authorized by WRDA 86: Bonneville, Gallipolis, Lock and Dam 26 (second chamber), and Oliver and Grays Landing.

Trust Fund fuel taxes were first collected in FY 1981 at the rate of $0.04 per gallon. The first year's revenue was $20.4 million. Because waterway traffic has shown no sustained growth since 1981, annual fuel consumption has not increased. Taxes received have grown annually because of the increasing tax rate, not because of greater traffic levels. The balance in the Trust Fund grew rapidly in the early years because no expenditures were authorized by Congress until FY 1985. The fuel tax rate continued to increase, and interest earned on the Trust Fund balance increased as the balance increased. FY 1987 Trust Fund receipts were about $48.3 million. Interest on these receipts and the prior balance amounted to about $16.5 million.

Future receipts are linked to both the fuel consumption and the applicable tax rate. The forecast future receipts shown in Table 8 are based on an analysis using traffic growth rates of 1.0 and 2.0 percent per year, which it is assumed will be matched by a similar growth rate in fuel consumption. No inflation factor is applied to the calculation of receipts. The forecast future annual revenues without accrued interest grow from $48.3 million in FY 1987 to $111 million in FY 2000 at a 1 percent growth rate or to $124 million if total traffic grows closer to 2 percent annually. These revenues will be supplemented by interest earned on the balance in the Trust Fund. The balance will be affected by the number and cost of projects funded in a particular fiscal year. The increase in receipts is heavily influenced, as in previous years, by the doubling of the tax from $0.10 per gallon in FY 1989 to $0.20 per gallon in 1995. The rate is scheduled to increase from $0.10 to $0.11 in 1990, $0.13 in 1991, $0.15 in 1992, $0.17 in 1993, $0.19 in 1994, and $0.20 in 1995 and beyond.

Figure 4 shows the Trust Fund receipts, expenditures, and balance through 2000. The graph incorporates a 1.5 percent growth rate in receipts (the middle range cited above and in Table 8) and 50 percent funding of eight authorized projects and one anticipated project on the fuel tax waterways. Receipts include accrued interest on the balance from each previous year.

There is considerable uncertainty in estimates relating to forecasts of ton-miles. The impact of the fuel tax increases

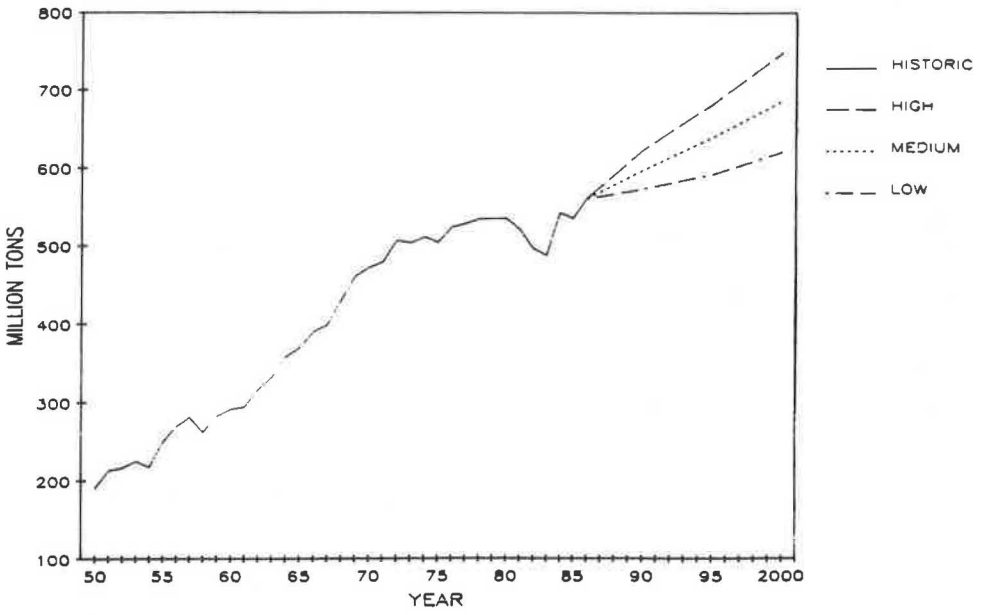

FIGURE 2 U.S. total internal waterborne commerce: historic, 1950–1986, and projected, 1990, 1995, and 2000.

TABLE 4 U.S. INTERNAL WATERWAY TRAFFIC PROJECTIONS BY SEGMENT: LOW AND HIGH, 1990, 1995, AND 2000

Waterway Segment	Actual, 1986	1990		1995		2000		Growth Rate (%)	
		Low	High	Low	High	Low	High	Low	High
Upper Mississippi	73.7	82.5	92.0	87.6	102.1	93.3	112.4	1.7	3.1
Middle Mississippi	97.7	106.3	117.4	112.9	130.3	120.3	144.8	1.5	2.9
Missouri River	7.0	6.8	7.6	6.5	8.5	6.2	9.4	−0.9	2.1
Lower Mississippi	156.2	168.5	187.8	178.3	209.6	189.5	234.0	1.4	2.9
Arkansas River	8.4	8.9	11.5	9.1	13.5	9.6	15.5	1.0	4.5
Illinois Waterway	42.3	44.5	49.9	47.2	54.9	50.1	60.1	1.2	2.5
Ohio River System	222.2	232.3	254.2	248.2	288.1	266.8	327.0	1.3	2.8
Ohio River (mainstem)	195.6	204.1	224.3	217.7	253.9	233.7	287.7	1.3	2.8
Monongahela River	29.5	38.5	42.1	40.5	48.6	43.1	56.2	2.7	4.7
Kanawha River[a]	16.8	18.1	21.4	19.5	24.6	21.2	28.4	1.7	3.8
Cumberland River[a]	14.2	15.7	18.0	16.2	20.8	17.0	23.7	1.2	3.5
Tennessee River	39.6	41.3	44.4	44.0	50.1	47.1	56.6	1.2	2.6
Gulf Intracoastal WW	105.7	102.0	112.4	99.9	121.3	101.7	131.0	−0.3	1.5
Black Warrior-Tombigbee	17.9	22.1	24.1	23.6	26.9	25.3	30.2	2.5	3.8
Atlantic Intracoastal	4.4	4.7	5.2	5.2	6.5	5.7	8.1	1.9	4.5
Columbia River	14.1	15.8	21.5	16.4	22.6	17.3	24.7	1.5	4.1
Total U.S. Internal	560.5	572.7	622.3	591.6	681.6	620.1	748.2	0.7	2.1

[a]Kanawha total shown is 1986 data from the Corps of Engineers Waterborne Commerce Statistics Center (WCSC). Ohio River Division estimates actual tonnage at 18.2 million. Cumberland total shown is 1985 data. Preliminary 1987 data from WCSC show 16.1 million tons.

NOTE: These projections were calculated in millions of tons by the Institute for Water Resources using

1. National growth rates by commodity group adapted from Data Resources, Inc.; Wharton Economic Forecasting Associates; U.S. Department of Agriculture; U.S. Department of Energy; and Institute for Water Resources. Waterway segment projections based on an average share of commodity traffic from national projections, which varied by waterway depending on historic patterns and commodity group. Projections are preliminary and subject to revision.

2. Linear adjusted projections calculated by adding the difference (positive or negative) between the original base and the linear adjusted base to each projected number. Linear adjusted base is 1986 calculated value using linear trend analysis for 1965–1986 data by waterway and for the national total. Only selected waterways were calculated because of a lack of data or because historic data exhibited no linear relationship over time.

3. Trend projections based on linear regression analysis of time series tonnages from 1965–1986 and are only shown for those segments that displayed a linear relationship over time.

4. For waterways with nonlinear historic data or incomplete data, two standard deviations of the historic data were calculated. This range was then applied to mean values of the high and low projections to generate new projections for the year 2000. Intermediate projections were the interpolated.

5. These waterway projections account for the maximum range of forecasts, low to high, calculated by using all of the above techniques.

TABLE 5 CAPACITY UTILIZATION: LOCKS WITH HIGH DELAYS AND DOWN TIME

Top 40 Locks and Rivers	Estimated Lock Capacity (ton millions) Low	High	Lock Traffic (ton millions)	Percent Capacity Used Low	High	Avg Delay Time (min)	Avg Process Time (min)	Total Delay Time (hrs)	Total Stall Time (hrs)	Performance Monitoring System Rank Equal Basis
Inner Harbor (GIWW)[a]	31	35	26.3	87.7	75.1	548	592	106,551	1616	103
L&D 26 (Upper Mississippi)[a]	70	75	69.3	99.0	92.4	465	552	56,165	377	86
No. 20 (Upper Mississippi)[b]	53	57	31.9	60.2	56.0	867	961	46,030	244	84
Gallipolis (Ohio)[a]	45	55	34.5	76.7	62.7	291	392	20,608	1141	83
No. 17 (Upper Mississippi)	53	54	29.2	55.1	54.1	334	420	15,981	62	73
Winfield (Kanawha)[a]	18	22	17.3	96.1	78.6	244	416	13,066	785	70
McAlpine (Ohio)[c]	82	116	55.9	68.2	48.2	296	356	26,186	287	69
Meldahl (Ohio)	97	133	46.3	47.7	34.8	200	269	14,387	3235	68
L&D 52 (Ohio)[a,b]	100	115	N.A.	N.A.	N.A.	169	216	27,523	1834	68
LaGrange (Illinois)[b]	46	49	30.3	65.9	61.8	295	371	15,384	230	64
Kentucky (Tennessee)[c]	35	39	30.1	86.0	77.2	247	356	15,786	194	62
No. 24 (Upper Mississippi)	59	60	35.5	59.8	58.8	246	335	13,328	62	56
Algiers Lock (GIWW)	26	29	26.7	102.7	92.1	217	262	36,565	165	56
No. 25 (Upper Mississippi)	59	60	35.3	59.8	58.8	231	315	12,285	141	50
No. 16 (Upper Mississippi)	48	49	27.2	56.7	55.5	216	294	11,256	158	44
Pickwick (Tennessee)	75	80	17.8	23.7	22.3	130	231	5,448	1255	43
No. 22 (Upper Mississippi)[b]	44	52	34.2	77.8	65.8	204	300	11,132	105	43
No. 21 (Upper Mississippi)[b]	52	57	33.4	64.2	58.6	135	218	7,264	692	40
Montgomery (Ohio)[b,c]	37	39	23.0	62.2	59.0	104	157	7,383	6652	39
Chickamauga (Tennessee)[c]	5	7	3.3	66.0	47.1	106	419	1,365	65	35
No. 15 (Upper Mississippi)	49	50	25.2	51.4	50.4	121	188	8,288	389	30
Lockport (Illinois)[b]	33	33	13.9	42.1	42.1	127	198	7,259	336	28
No. 18 (Upper Mississippi)	55	56	29.8	54.2	53.2	111	193	5,385	513	26
Port Allen (GIWW)	32	35	19.2	60.0	54.9	77	136	6,688	2402	25
Watts Bar (Tennessee)[c]	5	7	1.9	38.0	27.1	42	332	275	27	22
Peoria (Illinois)[b]	44	52	26.4	60.0	50.8	125	188	6,947	155	22
Kaskaskia	30	35	3.1	10.3	8.9	58	83	289	1558	18
Maxwell (Monongahela)	59	95	16.3	27.6	17.2	2	37	249	1301	17
London (Kanawha)	18	22	3.9	21.7	17.7	39	140	2,267	1039	17
Calcasieu Lock (GIWW)	N.A.	60	N.A.	N.A.	70.3	68	95	15,661	265	16
Racine (Ohio)	107	138	31.6	29.5	22.9	18	71	1,631	1008	13
L&D 2 (Monongahela)[c]	50	74	17.7	35.4	23.9	15	59	1,065	981	12
Leland Bowman (GIWW)	N.A.	N.A.	42.2	N.A.	N.A.	51	74	12,111	5	10
Hannibal (Ohio)	110	132	N.A.	N.A.	N.A.	12	65	605	769	10
Ft. Loudon (Tennessee)[c]	5	7	0.6	12.0	8.6	52	188	245	163	9
Marmet (Kanawha)[c]	18	22	10.1	56.1	45.9	35	183	3,300	96	8
Markland (Ohio)	89	133	53.9	60.6	40.5	32	87	2,509	552	8
No. 14 (Upper Mississippi)[b]	51	52	24.4	47.8	46.9	78	146	3,969	79	7
L&D 27 (Upper Mississippi)	142	158	78.0	46.2	41.7	49	88	9,125	246	7
Bonneville (Columbia)[a]	12	12	8.9	74.2	74.2	69	165	2,373	18	7

NOTE: GIWW = Gulf Intracoastal Waterway.
[a]Construction of replacement scheduled or under way.
[b]Major rehabilitation recently completed or under way.
[c]Replacement or improvement under study.

on waterway traffic share is not known with certainty and may affect the movement of different commodities in different ways. Other sources of uncertainty include the overall increase in grain exports, which are generally long-haul movements, and the application of fuel efficiency measures to vessels.

As noted, outlays from the Trust Fund shown in Figure 4 are based on specific appropriations for nine authorized projects on the fuel tax waterways. Table 9 shows the estimated cost of these projects and an estimate of the year in which construction could begin. Five of these projects actively drew from the Trust Fund in FY 1988. There are 12 additional candidate projects currently under study. In addition, problems may emerge in the next few years with projects not yet under study, creating another wave of funding needs.

According to Section 102a of P.L. 99-662, one-half of construction costs "shall be paid only from amounts appropriated from the Inland Waterways Trust Fund." Table 9 displays starting and estimated completion dates (some projects may be open to navigation earlier), total costs, and Trust Fund contributions for projects authorized to receive Trust Fund appropriations. The total expenditure of $2,626 million for these nine projects includes an allowance for inflation during construction. Out-year projections are best estimates prepared by the Corps of Engineers and do not reflect fixed commitments or budget amounts for specific years. Looking at expenditures for these nine projects only, outlays are scheduled to peak in FY 1995 at $147 million, and the Trust Fund balance dips accordingly.

Several studies now under way for the Ohio River System are likely to result in favorable recommendations for construction of replacement projects. Table 10 shows the estimated cost of these projects and an estimate of the year in which construction could begin. These studies are targeted to the parts of the Ohio River System where age and capacity

TABLE 6 RECREATION USE OF THE INLAND WATERWAY SYSTEM

WATERWAY/LOCK NAME OR NUMBER	LOCK UTILIZATION RATE IN 1986 (%)	RECREATION LOCKAGES 3RD QTR 1986 (MAIN/AUX) (%)[1]	RECREATION UTILIZATION RATE (%)[2]
Upper Mississippi			
No. 1	69	51/25	35.2/17.3
No. 2	61	49	29.9
No. 3	60	56	33.6
No. 4	59	52	30.7
No. 5	57	50	28.5
No. 5a	57	56	31.9
No. 6	59	56	33.0
No. 7	60	57	34.2
No. 8	60	51	30.6
No. 9	59	52	30.7
No. 10	58	53	30.7
No. 11	56	55	30.8
No. 12	54	55	29.7
No. 13	52	48	25.0
No. 14	62	28/99	17.4/61.4
No. 15	45	6/86	2.7/38.7
No. 16	57	32	18.2
No. 17	58	26	15.1
Arkansas River			
L&D 3	21	53	11.1
L&D 4	18	48	8.6
L&D 5	21	64	13.4
David T Terry	23	77	17.7
Murray	20	79	15.8
Toad Suck	19	46	8.7
Arthur V Ormond	16	47	7.5
Dardanelle	18	53	9.5
Ozark	17	46	7.8
James W Trimble	21	42	8.8
W D Mayo	22	53	11.7
Robert S Kerr	25	56	14.0
Webbers Falls	27	51	13.8
Illinois Waterway			
Starved Rock	53	37	19.6
Marseilles	64	35	22.4
Dresden Island	53	35	18.6
T J O'Brien	38	77	29.3
Tennessee River			
Chickamauga	41	54	22.1
Watts Bar	29	60	17.4

[1] The number of recreational lockages during July, August, and September expressed as a percent of all lockages in these months.

[2] Utilization rate times percent of recreation lockages.

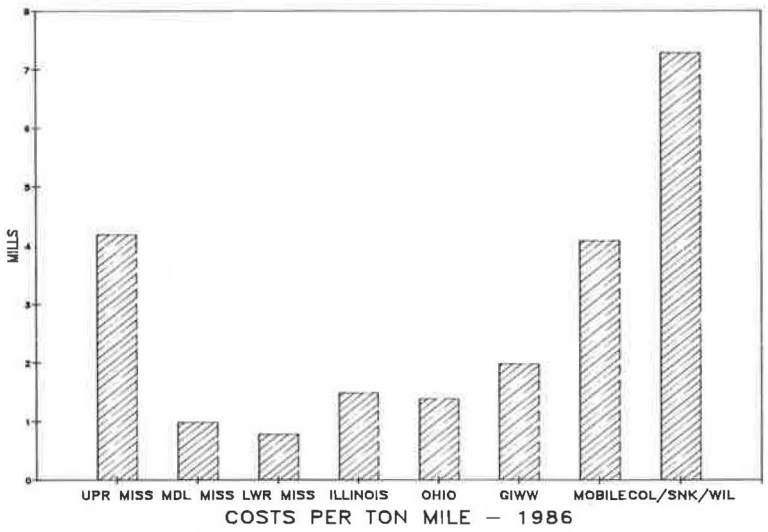

FIGURE 3 Operations and maintenance costs per ton-mile in 1986 for inland waterways subject to fuel tax.

TABLE 7 SUMMARY OF PROJECTS UNDER CONSTRUCTION OR REHABILITATION OR POTENTIALLY AVAILABLE

	Funding FY 1988 ($ millions)	Balance to Complete ($ millions)
Waterway projects under construction before WRDA 86	304	3,135
Projects started as a result WRDA 86 (partly funded by Trust Fund)	174	2,535
Projects authorized in WRDA 88 (partially funded by Trust Fund)	—	775
Potential projects under study (12)	—	2,295
Rehabilitation projects under way	NA	111.2

TABLE 8 FUTURE INLAND WATERWAY TRUST FUND FUEL TAX RECEIPTS

Fiscal Year	Tax Rate (¢/gal)	Receipts Under Alternative Growth Rates of Fuel Consumed[a] ($ millions)		
		1 Percent	2 Percent	Difference
1987	10	48	48	0
1990	11	55	56	1
1995	20	105	113	8
2000	20	111	124	13
2005	20	116	137	21
Cumulative total, 1981–2005		1,946	2,117	171

[a]Based on forecasts prepared by the Corps Institute for Water Resources.

TABLE 9 KNOWN POTENTIAL EXPENDITURES FROM TRUST FUND, FY 1987–FY 2002

Waterway	Authorized Project	Date		Costs[c] ($ millions)	
		Start[a]	Complete[b]	Total	Trust Fund
Columbia River	Bonneville Lock, Oregon and Washington	1986	1992	200	100
Ohio River	Gallipolis Lock and Dam, West Virginia and Ohio	1986	1995	335	167
Middle Mississippi River	Lock and Dam 26, second lock, Illinois and Missouri	1986	1991	214	107
Black-Warrior River	Oliver Lock and Dam, Alabama	1986	1991	122	61
Monongahela River	Grays Landing, Lock and Dam 7, Pennsylvania	1986	1995	146	73
Monongahela River	Point Marion, Lock and Dam 8, Pennsylvania	1986	1993	94	47
Kanawha River	Winfield Lock and Dam, West Virginia	1987	1997	190	95
Gulf Intracoastal Waterway	Missouri River Gulf Outlet, Inner Harbor, Louisiana	1986	2000	580	193[d]
Ohio River	Olmsted Lock and Dam, Illinois and Kentucky	1986	2000	775	373
Total				2,626	1,216

[a]Includes PED (Planning, Engineering and Design) start date.
[b]Or earliest date open to navigation.
[c]Cost estimates in Oct. 1986 dollars include allowance for inflation during construction.
[d]Allocation tentative, cost sharing yet to be determined.

of locks and dams are likely to produce significant delays to waterway traffic or where capacity constrains movement of potential traffic.

The balance in the Trust Fund was about $300 million at the end of FY 1987, the first year in which new projects actually drew from this fund. The nine scheduled projects will reduce the balance to approximately $200 million in the period FY 1991 through FY 1993. If no other projects are started, the balance would increase to reflect revenues and interest on the Trust Fund balance, as shown in Figure 4. However, there are other potential claims for funding from the Trust Fund. WRDA 86 specifically authorizes, which is also the policy of the Corps, 50-50 funding for both rehabilitation and construction of inland navigation payments from the Trust Fund. At this time, 12 projects are being rehabilitated and there is the potential for several additional projects by the year 2000. If the rehabilitation program is funded on a 50-50 basis from the Trust Fund, outlays from the Trust Fund would increase accordingly. This would reduce the Trust Fund balance but could be essentially accommodated from anticipated revenues. However, funding of the nine scheduled projects and the projected rehabilitation program could limit the capability to fund additional capacity-related replacement needs for the 11,000-mi system. The 12 projects under study on the Ohio River System may cost about $4.7 billion, fully funded. (Fully funded means total estimated outlays required to build the 12 projects. This is calculated by adding projected inflation to the yearly outlays required to fund the scheduled construction.) The Trust Fund balance will not contain enough to fund 50 percent of the costs of these projects if construction starts as soon as planning, engineering, and design permit. Other parts of the fuel tax segments appear at this time to warrant

TABLE 10 INLAND WATERWAYS TRUST FUND: ANALYSIS OF ESTIMATED INCOME AND OUTLAYS

Year	Estimated Outlays ($)	Tax Revenues ($)	Interest Earnings ($)	Year-End Balance ($)
1987	33,658,000	48,000,000	0	279,000,000
1988	66,245,000	48,720,000	22,320,000	283,795,000
1989	87,371,000	49,450,800	23,838,780	269,713,580
1990	129,600,000	55,211,818	23,195,368	218,520,766
1991	116,750,000	66,229,086	18,792,786	186,792,638
1992	96,399,000	77,564,448	16,250,959	184,209,045
1993	114,645,000	89,224,970	16,210,396	174,999,412
1994	113,088,000	101,217,856	15,224,949	178,354,216
1995	169,599,229	108,143,288	15,338,463	132,236,739
1996	159,494,229	109,765,438	11,372,360	93,880,307
1997	155,739,229	111,411,919	8,073,706	57,626,704
1998	150,739,229	113,083,098	4,840,643	24,811,216
1999	140,739,229	114,779,344	2,059,331	910,663
2000	106,138,229	116,501,035	75,585	11,349,054
2001	73,674,076	118,248,550	930,622	56,854,150
2002	65,704,076	120,022,278	4,662,040	115,834,393
2003	153,428,827	121,822,613	9,498,420	93,726,598
2004	153,428,827	123,649,952	7,685,581	71,633,304
2005	153,428,827	125,504,701	5,873,931	49,583,109
2006	167,859,792	127,387,272	4,065,815	13,176,403
2007	121,685,716	129,298,081	1,080,465	21,869,233
2008	121,685,716	131,237,552	1,793,277	33,214,346
2009	119,184,569	133,206,115	2,723,576	49,959,469
2010	119,184,569	135,204,207	4,096,676	70,075,783
2011	119,184,569	137,232,270	5,746,214	93,869,697
2012	104,753,604	139,290,754	7,697,315	136,104,162
2013	104,753,604	141,380,115	11,160,541	183,891,214
2014	225,555,462	143,500,817	15,079,080	116,915,649
2015	120,801,857	145,653,329	9,587,083	151,354,204
2016	188,029,601	147,838,129	12,411,045	123,573,778
2017	188,029,601	150,055,701	10,133,050	95,732,928
2018	188,029,601	152,306,537	7,850,100	67,859,964
2019	223,816,459	154,591,135	5,564,517	4,199,157
2020	103,014,601	156,910,002	344,331	58,438,888

NOTE: Scenario based on number of projects that may be found justified, construction timing determined by available fund balances, ultimate cost determined by timing of construction and interest/inflation assumptions. Anticipated projects include nine authorized to draw from the Trust Fund and 12 additional projects under study.

studies for consideration of replacement projects. These will add to the claims for funding.

One should not yet conclude that there is a funding crisis that cannot be solved. There will emerge convincing evidence either that the fuel tax rate should be increased or that budget priorities should stretch funds by delaying new starts, choosing not to fund lower-priority projects, increasing funding of low-cost capacity-increasing measures, or all three of these alternatives, which, along with other alternatives, will undoubtedly receive serious attention in planning studies and in the budget priority process.

CONCLUSION

The nation's inland waterway industry is showing renewed strength and vigor after laboring through declines during the recession years earlier in the 1980s. Coal traffic is booming and grain exports have surged. Traffic growth is reflecting the increased strength in many sectors of the economy. Now the question becomes whether the waterway infrastructure will be able to keep pace with future demand.

The Inland Waterways Trust Fund will be a critical part of maintaining the physical integrity of the system. The Trust Fund can provide 50 percent funding for nine new lock-and-dam projects now scheduled. Under projected growth in revenue, it could also fund rehabilitation projects now under way and several new ones. It is also clear that several additional construction projects could exhaust the Trust Fund if scheduled as rapidly as current studies anticipate.

Therefore, an inland navigation budget priority process is unavoidable. There will undoubtedly be a significant budget constraint, surely from the Trust Fund and very likely from the general tax funds available to the U.S. Treasury. The budget priority system should be systemwide and based primarily on net system benefits available for each budget alternative, subject to budget constraints. This will inevitably lead to emphasis on lowering the capital intensity of many of the alternatives prepared for funding. Smaller-scale investments for measures with high immediate payoff will attract funding priorities.

FIGURE 1 Principal deep-draft channel improvement projects authorized or under way (November 1988).

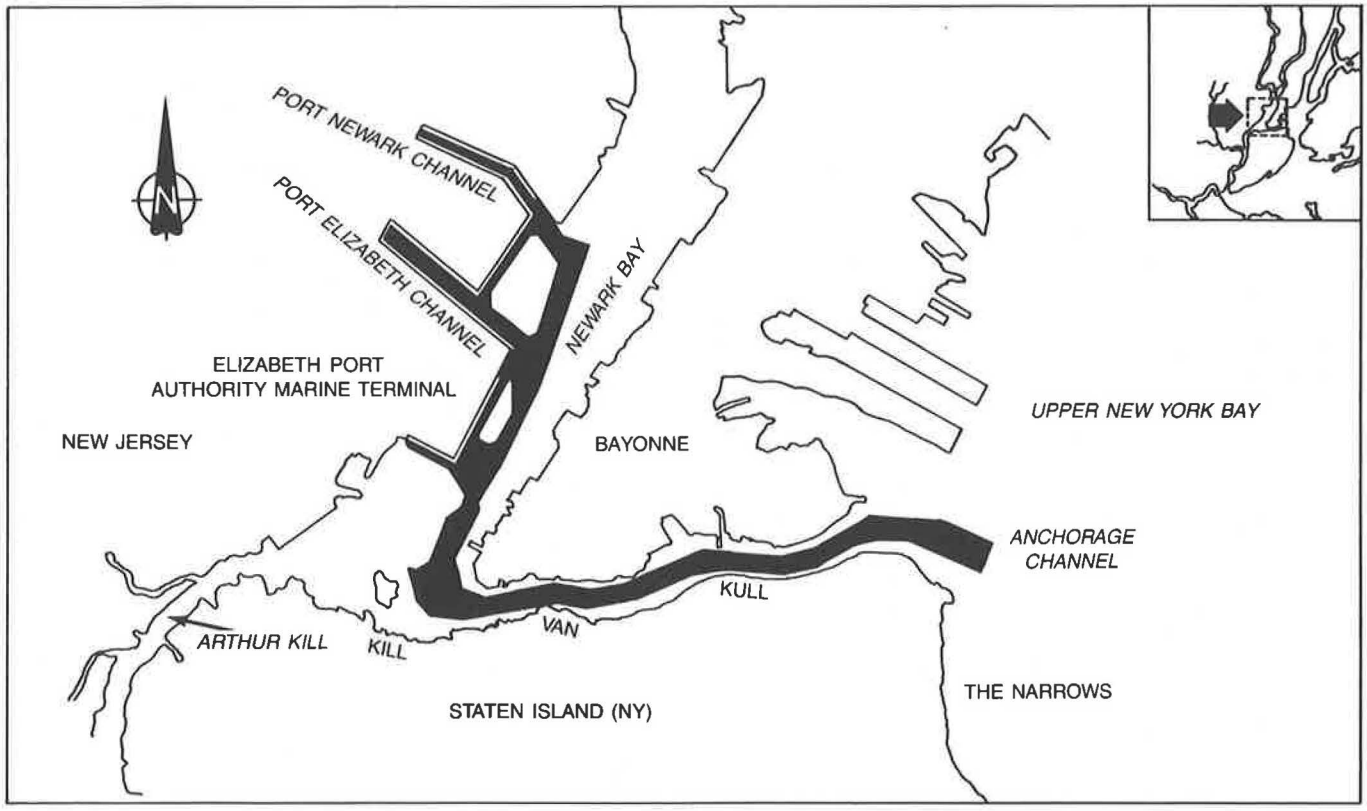

FIGURE 2 Kill Van Kull-Newark Bay channels, New York and New Jersey deepening project.

WRDA 86 also authorized four other projects in the New York–New Jersey area: Arthur Kill Channel, Howland Hook Marine Terminal, New York; Arthur Kill South to Fresh Kills and Carteret, New Jersey; Gowanus Creek Channel, New York; and Port Jersey Channel, New Jersey. All are currently in the design stage and LCAs have yet to be negotiated. The first Arthur Kill segment would deepen the existing 35-ft channel to 40 to 41 ft from its junction with the Kill van Kull for about 3 mi to Howland Hook Marine Terminal on Staten Island and Exxon Bayway, New Jersey, at a cost of about $43 million (with a federal share of $27.5 million). Construction is tentatively scheduled to begin in 1990. Current channel depths on the Arthur Kill require extensive lightering of tankers before they can proceed to refineries on the waterway. The second Arthur Kill segment would continue a 40-ft channel another 4.5 mi southward to Carteret, New Jersey, at a cost of about $26 million (about $19.5 million for the federal share). Design of this stretch is scheduled for completion in 1993, with construction to start in 1994.

The deepening project at Port Jersey would serve the Global Marine Container Terminal on the New Jersey side of the Hudson River. It is authorized to be deepened to 45 ft, but current plans anticipate deepening only to 40 ft initially. The total estimated cost is $13.4 million. The project is currently in the design stage, which is scheduled to be completed during 1991.

Gowanus Creek is a tidal estuary of Upper New York Bay in Brooklyn, New York. The project would deepen the current 30-ft channel to a maximum of 40 ft in certain locations. The cost is estimated at $3.9 million and design is scheduled to be completed in 1990.

DELAWARE RIVER IN THE VICINITY OF CAMDEN, NEW JERSEY

Deepening of the Beckett Street Terminal in Camden, New Jersey, from 34 to 37 ft was completed in 1987 under earlier authorizations at a cost of about $2.2 million. The project involved deepening a trapezoidal-shaped area connecting the terminal with deeper water in the Delaware River closer to the Pennsylvania shore. This configuration allows arriving vessels to swing alongside the terminal and then depart again in a forward direction. The terminal handles a variety of bulk commodities including coal, lumber, gypsum, iron ore, and titanium slag. Many bulk ships currently calling at the terminal cannot enter or leave fully loaded, requiring costly lightering, light loading, and waiting for high tides. The problem is projected to worsen with increasing vessel sizes in the dry bulk and general cargo fleets (*2*). WRDA 88 authorized additional deepening from 37 to 40 ft. Preconstruction engineering and design is under way for the 40-ft project and is expected to be completed by July 1990. Construction is estimated to cost $5.3 million, with the federal share being about $3.2 million. The local sponsor is the South Jersey Port Corporation, which is expected to sign an LCA during the design stage. The additional deepening to 40 ft at the Beckett Street Terminal will involve removal of about 550,000 yd^3 of material.

An additional project along the Delaware authorized by WRDA 88 would deepen the lower Schuylkill River at Philadelphia from 33 to 40 ft. This $8.5 million project is currently unscheduled. The local sponsor is the City of Philadelphia, which would pay the difference between the total project cost and the estimated $6.1 million federal share. About 1.5 million yd^3 of material would be dredged (U.S. Army Engineer District—Philadelphia, Public Affairs Office, unpublished data).

BALTIMORE HARBOR AND CHANNELS, MARYLAND AND VIRGINIA

The project to deepen channels connecting Baltimore Harbor with the Atlantic Ocean began construction in February 1987. It was authorized by the River and Harbor Act of 1970 and amended in the Supplemental Appropriations Act of 1985 and WRDA 86 to meet cost-sharing provisions. The project authorizes deepening from 42 to 50 ft, with channel widths generally 800 ft in Maryland waters and 1,000 ft in lower Chesapeake Bay in Virginia waters. Baltimore Harbor is located 175 mi from the entrance to Chesapeake Bay at the Virginia Capes. A total of about 57 mi requires dredging to achieve project depths, including the Cape Henry, York Spit, and Rappahannock Shoal channels in Virginia and the Craighill, Brewerton, Curtis Bay, Fort McHenry, and Northwest Branch channels in Maryland (see Figure 3).

Dredging of the entire authorized project will require the removal of 66 million yd^3 of material (32 million in Virginia and 34 million in Maryland) at a cost of about $330 million. An LCA was signed in June 1986 with the State of Maryland acting as the local sponsor. Maryland proposed phased construction of the project, with the first phase providing fully authorized depths in all channels but with channel widths reduced from 1,000 to 800 ft in the York Spit and Rappahannock Shoal channels; 800 to 700 ft in the straight reaches of the main approach channels in Maryland; and 600 to 400 ft in the Curtis Bay branch channel (*4*).

Construction of the initial phase will result in a reduction in dredging quantities from 66 to 52 million yd^3 (25 million in Virginia and 27 million in Maryland). Costs for the first phase are estimated at $246 million (versus $330 million for the full project), of which about $107 million will be the federal share. Dredging is proceeding under six separate contracts, three of which have been completed. The remaining work is scheduled to be completed by September 1990. Incremental dredging to the full project dimensions is not currently scheduled. Dredged material from the Maryland channels is being disposed of at the Hart–Miller Island Containment Facility in Chesapeake Bay at the mouth of the Patapsco River. Open water disposal areas in Chesapeake Bay are being used for material from York Spit and Rappahannock Shoal channels, and the Dam Neck ocean disposal area is being used for material from the Cape Henry Channel. In addition, 964,000 yd^3 of material from the Cape Henry Channel will be deposited on Virginia Beach as a beach nourishment project. The federal government and Virginia will cost-share this effort 50-50 under terms of an LCA between Virginia and the Assistant Secretary of the Army (Civil Works).

NORFOLK HARBOR AND CHANNELS, VIRGINIA

In December 1988, the port of Hampton Roads dedicated newly deepened 50-ft outbound channels serving coal terminals in Norfolk and Newport News. The 50-ft outbound

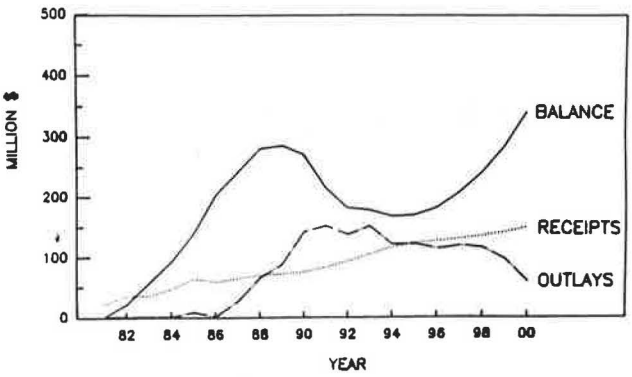

FIGURE 4 Inland Waterways Trust Fund receipts, outlays, and balance for nine projects.

Keeping the inland waterway system operating with the maximum efficiency possible while facing inevitable budgetary constraints will be a major challenge, but not an insurmountable one. By establishing sensible budget priorities, and with guidance from the Inland Waterways Users Board, the Corps will work to ensure a future waterway system that best serves the needs of the nation.

REFERENCES

1. *The 1988 Inland Waterway Review*. IWR Report 88-R-7. U.S. Army Engineer Institute for Water Resources, Ft. Belvoir, Va., 1988.
2. *Annual Report FY86 of the Secretary of the Army on Civil Works Activities*, Vol. 2, Appendix C: *Navigation Locks and Dams Operable September 30, 1986*. U.S. Department of the Army, 1986.
3. *Waterborne Commerce of the United States*. Water Resources Support Center, U.S. Army Corps of Engineers, New Orleans, La., annual.

Publication of this paper sponsored by Committee on Ports and Waterways.