The Navigation Economic Technologies Program

May 2006

NETS

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Hannibal Locks and Dam

Causes and Consequences of Lock Closures 21 October to 16 November 2005

US Army Corps of Engineers®

IWR Report 06-NETS-R-05

Navigation Economic Technologies

The purpose of the Navigation Economic Technologies (NETS) research program is to develop a standardized and defensible suite of economic tools for navigation improvement evaluation. NETS addresses specific navigation economic evaluation and modeling issues that have been raised inside and outside the Corps and is responsive to our commitment to develop and use peer-reviewed tools, techniques and procedures as expressed in the Civil Works strategic plan. The new tools and techniques developed by the NETS research program are to be based on 1) reviews of economic theory, 2) current practices across the Corps (and elsewhere), 3) data needs and availability, and 4) peer recommendations.

The NETS research program has two focus points: expansion of the body of knowledge about the economics underlying uses of the waterways; and creation of a toolbox of practical planning models, methods and techniques that can be applied to a variety of situations.

Expanding the Body of Knowledge

NETS will strive to expand the available body of knowledge about core concepts underlying navigation economic models through the development of scientific papers and reports. For example, NETS will explore how the economic benefits of building new navigation projects are affected by market conditions and/or changes in shipper behaviors, particularly decisions to switch to non-water modes of transportation. The results of such studies will help Corps planners determine whether their economic models are based on realistic premises.

Creating a Planning Toolbox

The NETS research program will develop a series of practical tools and techniques that can be used by Corps navigation planners. The centerpiece of these efforts will be a suite of simulation models. The suite will include models for forecasting international and domestic traffic flows and how they may change with project improvements. It will also include a regional traffic routing model that identifies the annual quantities from each origin and the routes used to satisfy the forecasted demand at each destination. Finally, the suite will include a microscopic event model that generates and routes individual shipments through a system from commodity origin to destination to evaluate non-structural and reliability based measures.

This suite of economic models will enable Corps planners across the country to develop consistent, accurate, useful and comparable analyses regarding the likely impact of changes to navigation infrastructure or systems.

NETS research has been accomplished by a team of academicians, contractors and Corps employees in consultation with other Federal agencies, including the US DOT and USDA; and the Corps Planning Centers of Expertise for Inland and Deep Draft Navigation.

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HANNIBAL LOCKS AND DAM

Causes and Consequences of Lock Closures 21 October to 16 November 2005

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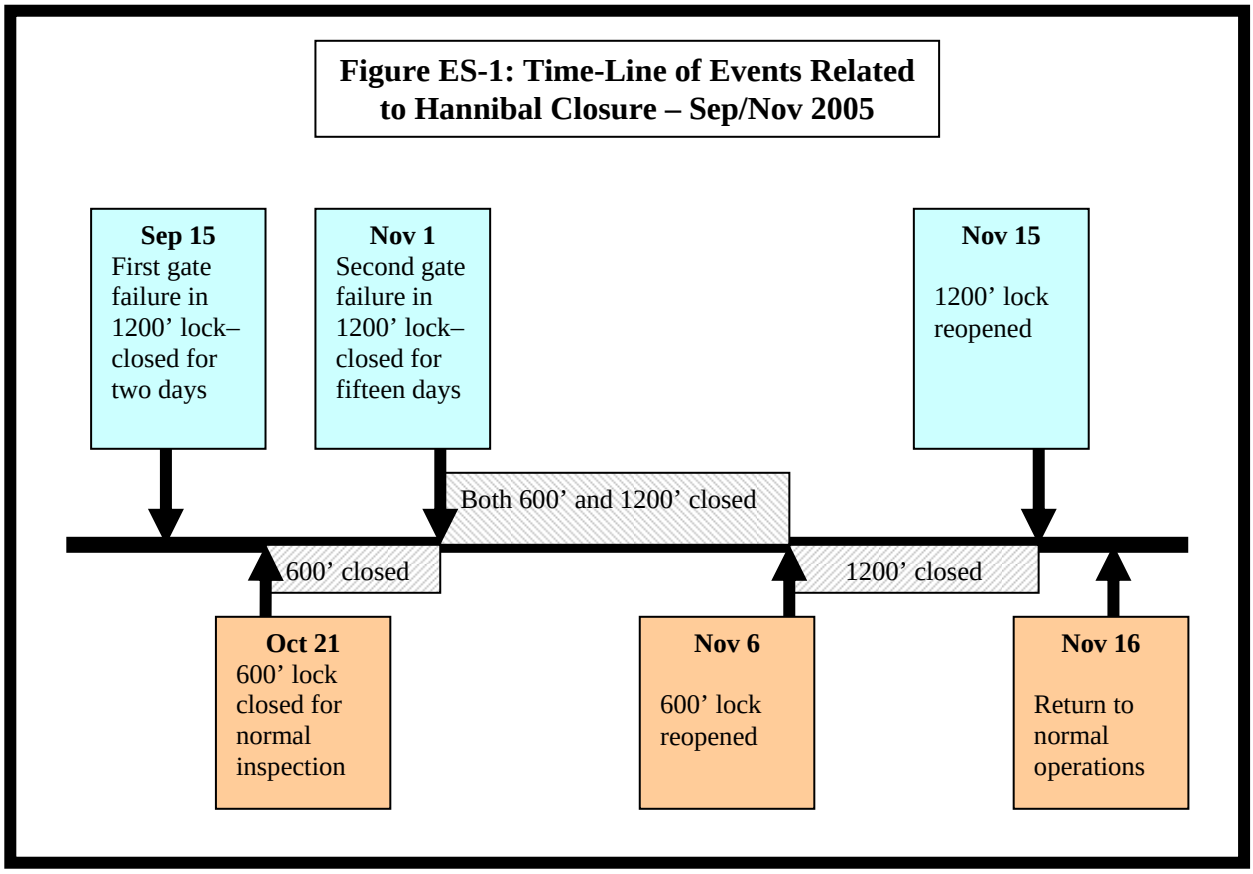
Hannibal Locks and Dam

Tows waiting near Ormet Corporation plant — 2.4 miles upstream of Hannibal Locks and Dam

Executive Summary

The purpose of this paper is to describe the series of events that led to the total closure for five days of the Ohio River at Hannibal Locks and Dam and to present the results of surveys and analysis designed to measure the economic impacts of the closure. The series of events is shown in Figure 1. The first event occurred on 15 September when the first of two gate failures in the 1200' lock occurred. Emergency repairs were made that limited the closure of the lock to two days. The second event was the closure of the 600' lock on 21 October for inspection and repairs. Nine days into the closure a second gate failure occurred in the 1200' chamber that put the entire project out of operation. The project remained closed to traffic for five days until the 600' chamber was put back into operation. The 1200' chamber remained out of service for repairs for another eleven days until 15 November at which time the project returned to full operational status.



The series of closures directly affected operations of the towing industry, riverside production facilities, and the Corps. The estimated cost to the towing industry in terms of idle equipment is $2.9 million; a partial estimate of the cost to riverside production industries is $1.6 million; and the cost to the Corps for emergency repairs is approximately $0.6 million. A conservative estimate of the cost based on limited responses to the survey is $5.1 million, as shown in Table ES-1.

Table ES-1: Closure Costs by Economic Entity		
	Cost	**Percent of Total**
Towing companies	$2,895,264	56%
Waterside production facilities	1,608,020	31%
Corps	646,600	13%
Cruise Line	7,000	0%
Total	$5,156,884	100%

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1. General

a. Purpose of Report

The purpose of this report is to describe the series of events that led to the total closure for five days of the Ohio River at Hannibal Locks and Dam and to present the results of surveys and analysis designed to measure the economic consequences of the closure. The report was prepared as part of a series of reports undertaken to develop a data base of costs related to lock closure impacts for possible future use in maintenance funding decisions.

b. Hannibal Locks and Dam

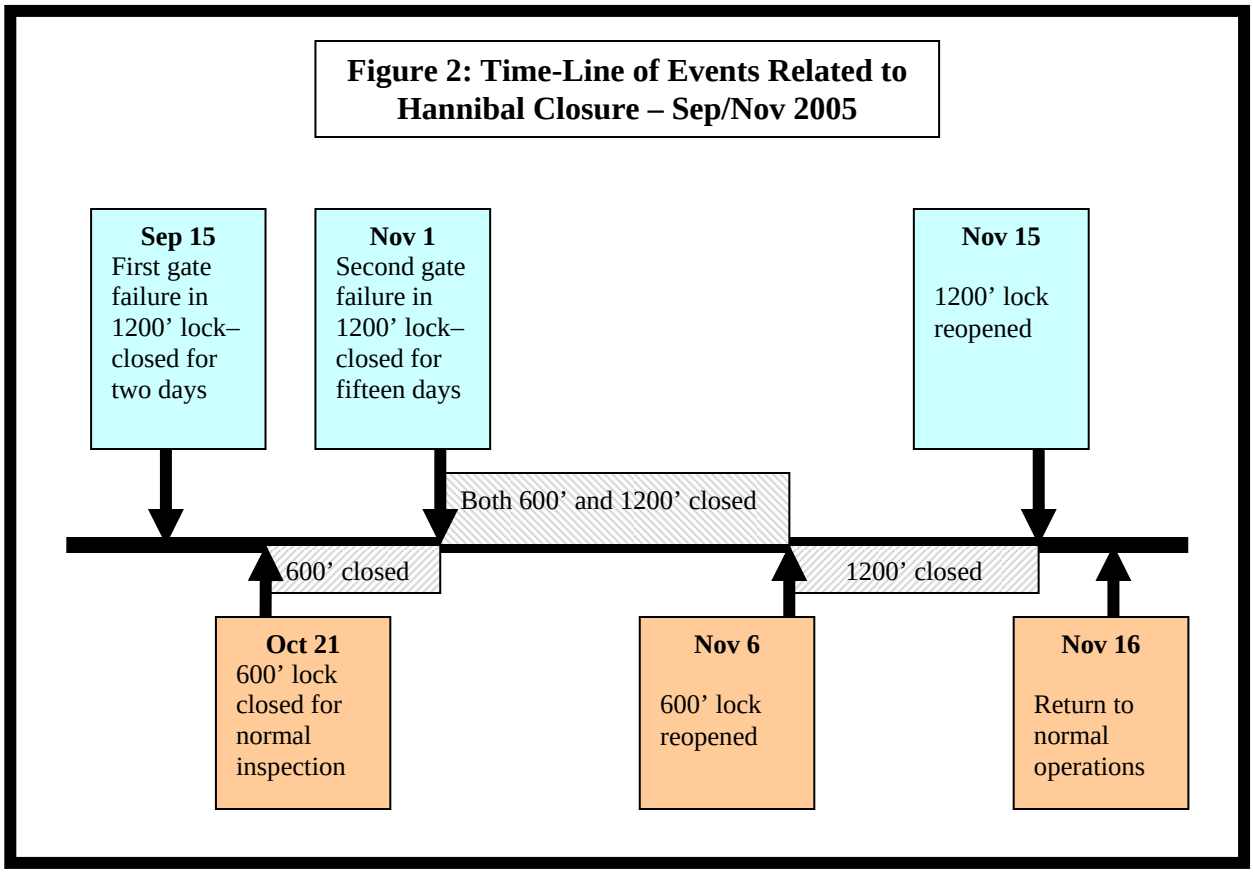
Hannibal Locks and Dam is an inland navigation project on the Ohio River consisting of two lock chambers measuring 600' x 110' and 1200' x 100' and a gated dam. The project is located 126.4 miles downstream from Pittsburgh, Pa, and 182.0 miles upstream from Huntington, WV. A photo and descriptive statistics of the project are provided in Figure 1.

Figure 1: Hannibal – Photo and Statistics

Statistics - Hannibal Locks and Dam Ohio River	
Location:	126.4 river miles down the Ohio from Pittsburgh, at New Martinsville, W. VA
Built:	Locks: 1967-1971; Dam: 1970-75; Total Cost: $87.6 million
Length of Dam:	1,098 feet
Length of Pool:	42.2 miles up to Pike Island Locks and Dam just above Wheeling, W.VA
Size of Lock(s):	Land Chamber: 110' wide by 600' long River Chamber: 110' wide by 1200' long
Hydropower Facility	34 MW Commercially Operated
Lift:	20.5 feet
Annual Traffic:	Over 53 million tons of freight

2. Description of Events Related to Failure

On 15 September a gate in the 1200' chamber experienced problems opening and closing. This was the first of a series of events that eventually resulted in the total and unplanned closure of the project and this section of the river for five days in November. The major events are described in the following paragraphs and shown in Figure 2.



a. Event 1 – First Gate Failure

On 15 September a lock operator observed that the quoin seal of the lower river wall gate leaf in the 1200' chamber was bent on the downstream side of the gate and angled toward the chamber (Photo 1).

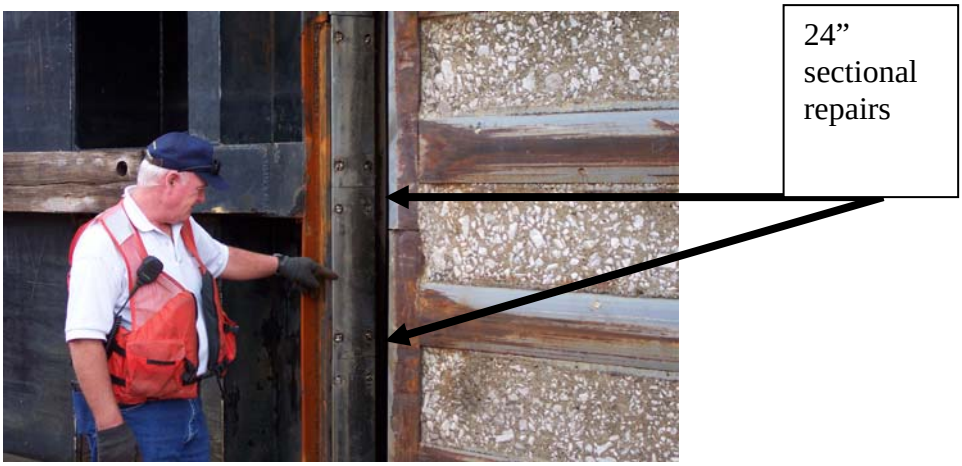
Photo 1: Quoin Seal Failure on 15 Sep 05

The bolts that hold the seal to the gate had broken, causing the seal to separate from the gate and preventing the gate from being properly mitered. It was decided to remove the damaged portion of the seal so that the gate could be mitered (Photo 2).

Photo 2: Removal of Damaged Quoin Seal

Analysis of the loss of load transfer during high pool led to a decision to close and repair quoin seal in the 1200' chamber. In order to minimize the closure of the 1200' chamber the quoin was installed in 24 inch sections rather than a single 12 foot section (Photo 3). This saved time but at the cost of reduced strength. The work was completed at 0500 on Saturday, 17 September. The chamber was cycled to check for bearing and leakage and reopened for lockage operations.

Photo 3: Sectional Repairs to Quoin Seal



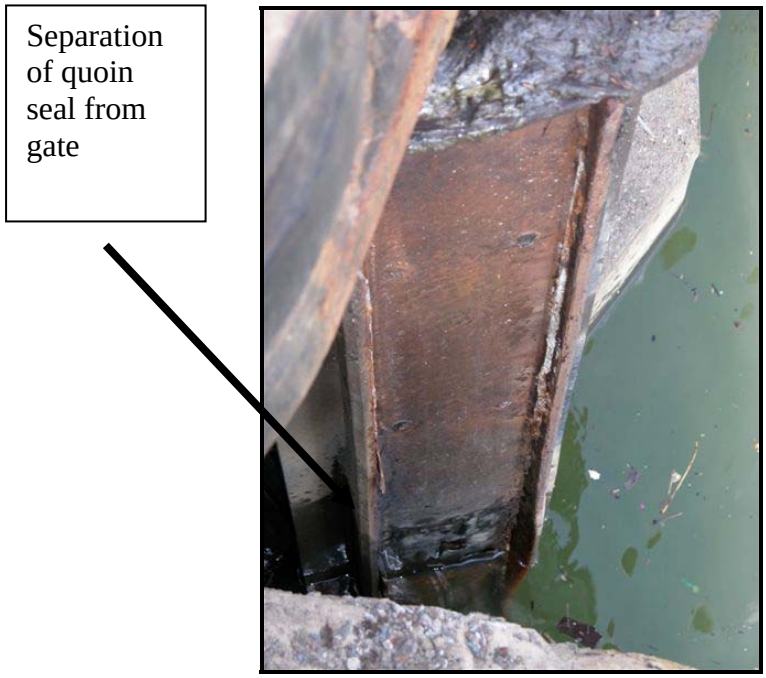
b. Event 2 – Scheduled Closure of 600' Chamber

Hannibal was scheduled for inspection and repairs even before the gate failure on 15 September. The normal procedure is to inspect and repair the 600' chamber prior to closure of the 1200' chamber. The rationale is to ensure that the less maintained 600' chamber is fit for extensive operations while the 1200' chamber is closed. Closure of the 600' chamber for twenty days beginning on 22 October was announced in navigation notice 05-25 dated 11 August. The notice was amended on 13 October to include the announcement of periodic closures in the 1200' chambers to repair the lock gate seals (quoins). The original and amended Navigation Notices 05-25 are provided in Attachment 1.

c. Event 3 – Second Gate Failure - Unscheduled Closure of the 1200' Chamber

On 01 November at 1540 hours a lock operator reported difficulty in operating the upper 1200' lock gates and that loud cracking and grinding noises were coming from the area of the middle wall when the miter gate was making the final movements into the closed position. An inspection by lock personnel revealed that the top section of quoin seal was loose from the lock gate and was rubbing against the wall during the final movement into the closed position (Photo 4). This was the same type of problem experienced on 15 September but with a different gate leaf.

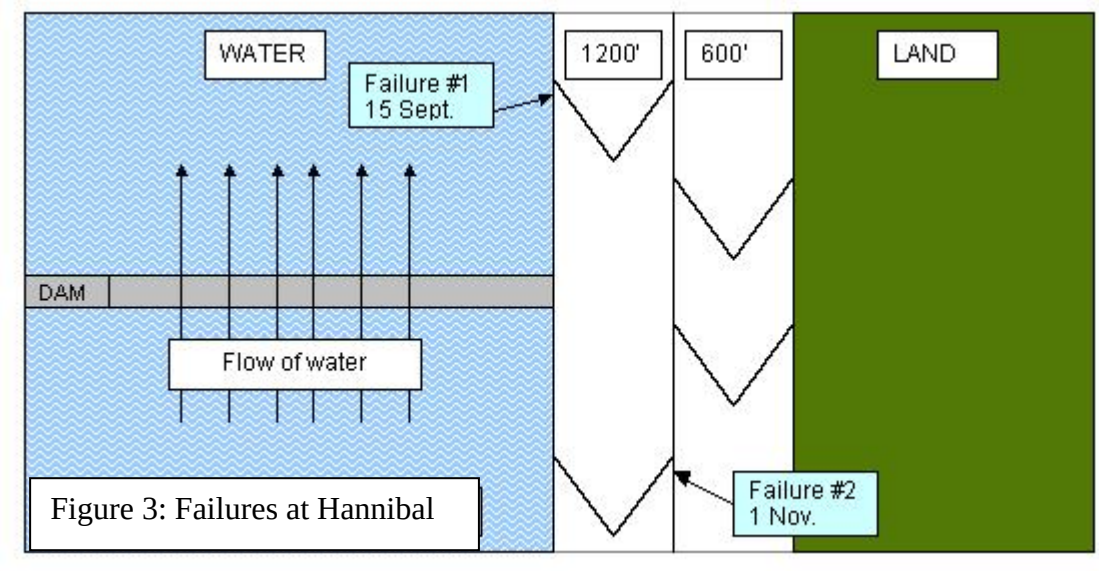
Photo 4: Second Failure – Quoin in 1200' Chamber on 1 Nov 05



The multiple gate failures within a six week period combined with the severity of the problem led to the decision to close the 1200' chamber for emergency inspection and repair even

though the 600’ chamber was already closed. The locations of each of the two failures are shown in Figure 3. The 1200’ lock closed to traffic at 1600 hours on 01 November, an action that also closed this section of the river to through traffic. The unexpected closure of Hannibal, the work required to return the 600’ chamber to operation, and the expected date of the 600’ reopening were announced in Navigation Notice 05-38 dated 2 November 05 (included in Attachment 1).

Figure 3: Depiction of Location of Failures



The critical need was the return of at least one chamber to operational status as quickly as possible. It was decided that this could best be accomplished by completing repairs to an emptying valve in the 600’ chamber. While this effort was underway it was decided to dredge the downstream approach area to the 600’ chamber to allow passage of fully loaded barges.

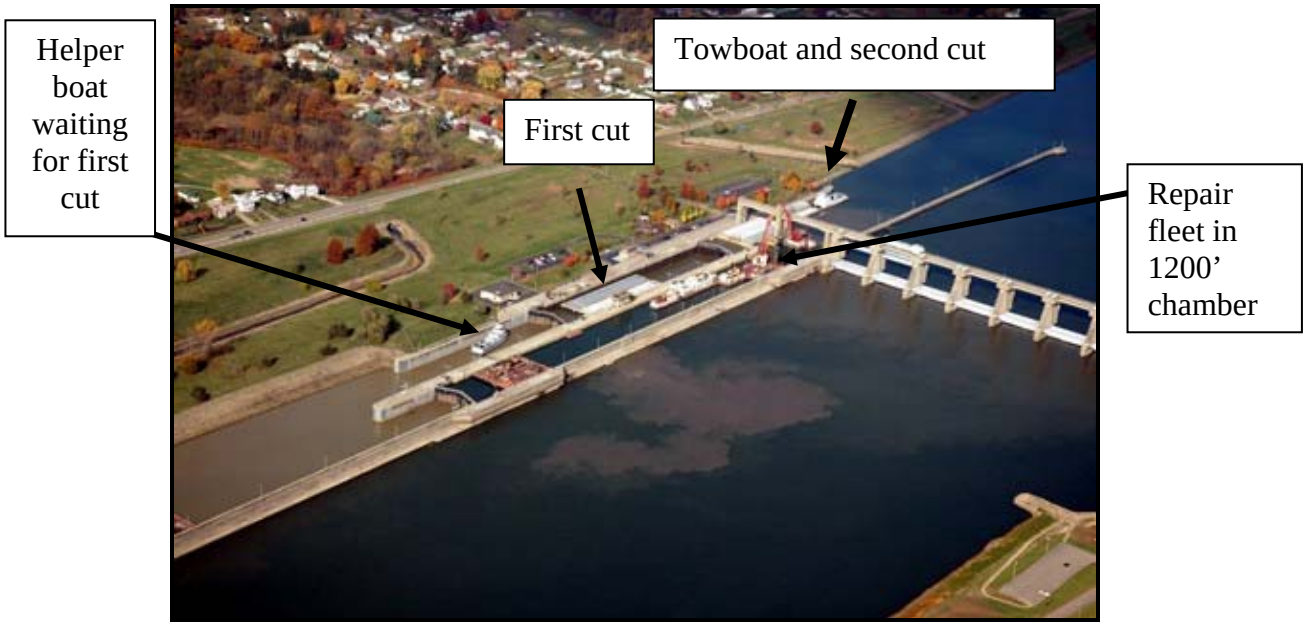
d. Event 4 – Reopening of 600’ Chamber

At 1415 hours on the 6 November the 600’ lock was placed back into operation. However because of its smaller size the 600’ lock cannot process traffic as efficiently as the 1200’ chamber. In order to increase the efficient use of the lock and reduce the forty tow queue as quickly as possible the industry instituted what is referred to as a self-help program.

Self-help generally works as follows. First the “helper” towboat is the towboat with barges at the end of the queue on the side of the project opposite from the side of the tow next in queue for lockage. The helper towboat disconnects from its own barges and moves to the project. Meanwhile the tow next in queue for lockage moves into the chamber where the forward barges are disconnected from the tow at the point where the chamber can accommodate the barges. The towboat and the barges that cannot be accommodated then back out of the chamber to the point where the lock gates can be closed. The gates are then closed and the

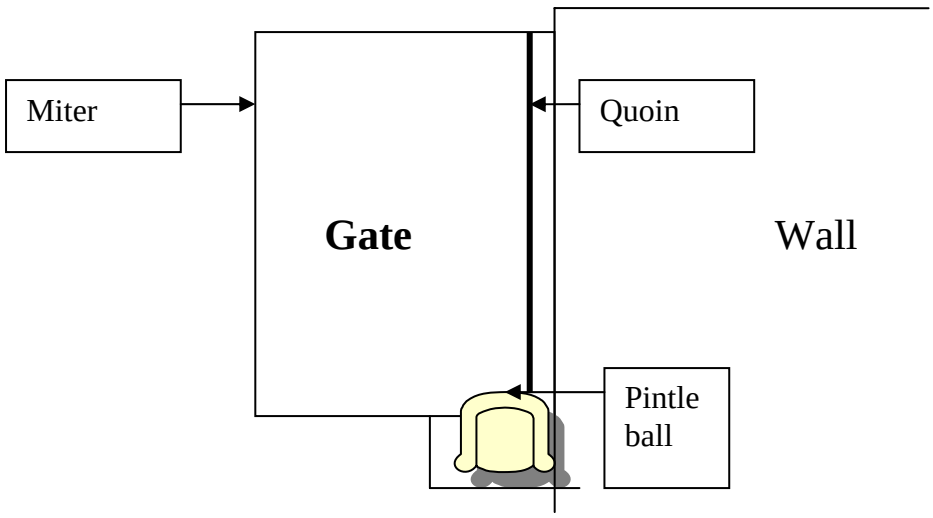
unpowered set of barges in the chamber are lowered or raised to the level of the destination pool. The gates are then opened and the helper boat extracts the unpowered set of barges from the chamber and positions them along the guide or guard wall. The gates are then closed and the water level within the chamber is raised or lowered to the level of towboat and remaining barges. The towboat with its second cut of barges then locks through the chamber and reconnects to the unpowered set of barges. It is estimated that the self help program reduces the average lockage time by 26 percent. Photo 5 shows the self-help program in operation.

Photo 5: Helper Boats assisting in Lockages through 600' Chamber



The project was operated in this manner for eleven days during which time the gates in the 1200' chamber were inspected and repaired. A depiction of the main components of the gates that were inspected and repaired is provided as Figure 4. The components include the quoin seals, the miter seals, the pintle ball, and the gate structure itself.

Figure 4: Depiction of Gate Components



e. Event 5 – Reopening of 1200' Chamber

The gate work in the 1200' chamber was completed on 15 November at 1500 hours and the lock was placed back into operation.

f. Event 6 – Return to Normal

The queue of tows at the project returned to normal levels eight hours after the 1200' chamber reopened.

Photo 6: Hannibal – Fully Operational

3. Surveys

Two surveys were conducted of industry to obtain their responses and the additional costs they expended because of the closure. The first survey was conducted within two weeks of the closure using a survey list of companies that were thought to ship through Hannibal and was intended to get a quick indication of the magnitude of the impacts of the Hannibal failure. The second survey was conducted three months after the event using a list of actual users of the project. The intent was to obtain more specific information regarding the impacts, responses, and costs incurred by the companies as a result of the gate failure and lock closure.

a. First Survey

The initial survey was conducted two weeks following the end of the closures on 15 November. A list of seventy-one companies was generated by the Port of Pittsburgh Commission from industry information in their files. The list was screened to forty companies based on the judgment of Port of Pittsburgh and Pittsburgh District personnel. The economic sectors and tonnage of the companies on the survey list are provided in Table 1. The forty companies shipped and/or received over 11 million tons. Ten of the forty contacted companies responded to the survey; the ten respondent companies accounted for 8.5 million tons. The questionnaire used for the survey is provided as Attachment 3.

Table 1: Number of Companies by Sector in First Survey

Industry	Number	Tonnage of Firms Surveyed	Responded	Tonnage of Firms Responding
Electric Generating	3	651,164	2	651,164
Coal Mining	1	79,045	1	79,045
Petroleum	1	n.a.	0	0
Chemical	6	77,142	2	53,537
Inter-modal Ports	14	2,485,214	1	169,574
Towing	0	n.a.	0	n.a.
Steel	6	6,831,449	3	6,753,970
Transfer docks	3	129,684	0	0
Mineral Plants	6	923,640	1	764,942
Total	40	11,177,338	10	8,472,232

The responses to the survey by the ten companies are listed in Table 2. Half of the respondent companies indicated that the closure had no effect on their operations.

Table 2: Responses to First Survey		
Response	**Number of Responses**	**Cost**
No change in operations	5	n.a.
Drew down stockpiles	1	n.a.
Switched to an all overland mode of transportation for shipments/receipts	-	-
Switched to a combination waterway/overland routing that avoided Hannibal	1	n.a.
Switched sourcing of material inputs	-	-
Ceased operations	-	-
Altered production	1	n.a.
Switched production to another plant	-	-
Purchased intermediate or final products in lieu of production	-	-
Other	2	n.a.
Delays		
Responded	10	n.a.
No response	30	n.a.
Total	40	n.a.

Those companies responding with "no effect" on their operations generally stated that they transported commodities through Hannibal either infrequently or not at all. Two respondents indicated significant impacts on their operations, i.e. they used alternative modes or reduced production. The monetary costs of these effects were not requested at this time, but they were re-contacted during the second survey in order to obtain this information.

b. Second Survey

The second survey was conducted in March 2006 using a list of companies identified from a screening of the waterborne commerce data. The initial questionnaire for the survey was one developed for an unscheduled extended closure of the 1200' chamber at Greenup that occurred in 2003. Based on a review of the first Hannibal survey, the Greenup L&D and McAlpine L&D surveys, it was decided to reduce the survey from eight pages to one page. Furthermore, it was decided that the most meaningful responses seemed to come from telephone surveys and so the second survey was conducted entirely via telephone. Survey form number 2 is provided as Attachment 4.

The list evolved during the course of the survey as a result of the initial responses. For example, after surveying five towing companies it did not appear necessary to proceed since they all provided the same response – no impact other than delays. Likewise the response of the shippers, most of which were coal companies, indicated that the Hannibal closure had no

or minor effects on their operations. Again, further surveys of these types of companies did not appear necessary or warranted. The final category included those companies that receive cargo by barge; unlike towing companies and companies that were the origin of the shipments, the number of receiving companies on the list increased during the course of the survey as a result of survey responses. The increase consisted of the addition of more petro-chemical companies to the list. One additional is that many of the largest shipping and receiving port-docks were operated by subsidiaries of larger companies. For example, a receiving dock may be operated by a power plant which in turn is part of a company that operates several power plants so that it was not always necessary to survey each subsidiary. The same is true of shipping docks and coal mining operations. In most cases the company and not the plant was contacted. The final number of companies on the list numbered twenty-five of which seventeen were successfully contacted. The break-down by industry and tonnage of the companies on the survey list and of the companies that responded is provided in Table 3.

Table 3: Number of Companies by Sector in Second Survey

Industry	Number	Tonnage of Firms on Survey List	Responded	Tonnage of Firms Responding
Electric Generating	5	20,509,896	2	13,699,912
Coal Mining	3	17,297,804	1	6,211,983
Petroleum	2	788,226	2	788,226
Chemical	2	124,624	1	124,624
Inter-Modal Ports	2	355,129	2	355,129
Towing	5	n.a.	4	n.a.
Steel	2	5,237,440	2	5,237,440
Transfer Docks	2	7,605,841	2	7,605,841
Mineral Plants	2	1,093,138	0	0
Total	25	53,012,098	17	34,023,155

c. Combined Survey Coverage

The combined survey coverage in terms of tons shipped and/or received is listed in Table 4. A total of 58 individual companies were surveyed and 21 responded (36 %). The numbers are less than the sum of the numbers in each survey because several companies were contacted and/or responded twice, particularly if they indicated on the first survey that the closure had real effects on their operations. The total tonnage of the responding companies amounted to 58.9 million tons, which exceeds 52.3 million tons that moved through the project. The reason is double counting of some tons at both the shipping and receiving ends. Adjusting for double counting, the tonnage of responding companies totaled 31.3 million tons, or 60 percent of the total tonnage through Hannibal.

Table 4: Survey Coverage	
Surveyed companies	58
Responded	21
Responded as % of surveyed	36%
Shipments in tons of respondents	13.3
Receipts in tons of respondents	23.4
Net tons adjusted for double counting	31.3
Total tons thru Hannibal	52.3
Respondent tons as % of total tons	60%

d. Survey Results

The company responses and estimates of additional costs attributable to the closure are provided in Table 5. The total cost provided by the seventeen responding companies amounted to $1.6 million. Again these seventeen companies account for 60 percent of all Hannibal tonnage. Assuming the non-respondents were similarly affected the amount would equal $2.7 million.

Table 5: Responses to/and Costs of Closure		
Response	**Number of Responses**	**Cost**
No change in operations	3	0
Drew down stockpiles	3	$ 40,320
Switched to an all overland mode of transportation for shipments/receipts	1	87,500
Switched to a combination waterway/overland routing that avoided Hannibal	1	400,000
Switched sourcing of material inputs	0	0
Ceased operations	0	0
Altered production	2	1,076,000
Switched production to another plant	1	0
Purchased intermediate or final products in lieu of production	0	0
Other	2	4,200
Delays	4	0
Responded	17	1,608,020
No response	8	0
Total	25	$1,608,020

4. Closure Costs

The additional economic costs attributable to the closure at Hannibal in November of 2006 are provided in this section. The costs incurred by the Corps were obtained from District records provided by Operations Division. The increase in transportation costs borne by the towing companies were computed by the Corps based on data recorded during the closure. All other costs borne by private companies were obtained from the surveys.

a. Corps Costs

The costs of the Corps in repairing the project are actual costs recorded by the Operations program manager in the Pittsburgh District. The costs by line item are listed in Table 6 and amount to $646,600.

Table 6: Cost incurred by the Corps	
Line-Item	**Cost**
Administrative	50,000
Repair-labor	274,300
Repair-parts	267,300
Travel	55,000
Total	$646,600

b. Industry Costs

Industry costs in the form of higher transportation costs were calculated by Corps analysts based on actual data recorded at the project during the closure event. These costs have a fairly high degree of certainty. Other industry costs are obtained from surveys and are less certain for a multitude of reasons with one of the most important being the companies do not keep track of the costs but treat it as a normal business expense, in most cases. The computed delay costs and industry provided costs are discussed in the following paragraphs. Additional data related to Hannibal traffic is provided in Attachment 4.

i. Towing Companies

Towing companies suffered significant delays during the fifteen days that the 1200’ chamber was closed. Photo 7 shows a typical section of the river near Hannibal during the river closure from 1 November through 6 November. The photo shows tows waiting near the ORMET plant, which is 2.4 miles upstream of Hannibal.

Photo 7: Tows Waiting in Queue near Ormet Corp, Upstream of Hannibal

Traffic data were obtained for normal and closure periods at Hannibal in order to compute the incremental costs attributable to the closure. Data for five time periods were obtained:

1**) Normal** - thirty days prior to the scheduled closure of the 600' chamber;
2) **1200' Only** - nine days between the closure of the 600' chamber and the failure of the 1200' chamber;
3) **Total Closure** - five days of total closure;
4) **600' Only** - nine days when only the 600' chamber was operational; and
5) **Normal** - thirty days following the complete reopening of the project.

The number of tow arrivals, lockages, one-cut lockages and two-cut lockages during each time period are listed in Table 7. It should be noted that two tows are shown to have locked through the project during the period of total closure; one was the Corps dredge and the other the Corps repair boat. It is also worth noting that 100 of the 124 tows (81%) that locked through the 600' chamber during time period # 4 (600' only) required two-cut lockages.

Table 7: Tow Arrivals and Lockages during Normal Times and Time of Closure								
Time Period	**Start Day**	**Start Time**	**End Day**	**End Time**	**Number of Tow Arrivals**	**Number of Tow Lockages**	**Number of one-cut Lockages**	**Number of two-cut Lockages**
1	22-Sep	0	22-Oct	1300	444	444	444	0
2	21-Oct	1301	1-Nov	1600	145	141	141	0
3	1-Nov	1601	6-Nov	1415	37	2	2	0
4	6-Nov	1416	15-Nov	1500	91	124	24	100
5	15-Nov	1501	15-Dec	2400	454	460	460	0
Time Period	**Lock Status**		**Hours in Time Period**	**24-Hour Periods**	**Number of Tow Arrivals per 24 hour period**	**Number of Tow Lockages per 24 hour period**	**Percent of All Lockages that were one-cut**	**Percent of All Lockages that were two-cut**
1	Both open		733	30.5	14.5	14.5	100%	0%
2	600’ closed		243	10.1	14.3	13.9	100%	0%
3	Both closed		118	4.9	7.5	0.4	100%	0%
4	1200’ closed		217	9.0	10.1	13.7	19%	81%
5	Both open		729	30.4	14.9	15.1	100%	0%

The number of tow arrivals during the five days of total project closure was 7.5 per day or about one-half the normal 14.5 per day. It is important to note that the same tows travel twice through the project on its trip with the interval between arrivals depending on the length of the trip. On average, the same tow would move through the project once every 3.1 days, as shown in Table 8. This is the average number of days between the downbound and upbound lockages, or vice versa, of an individual towboat. During the total closure period the average interarrival time increased to 4.72 days, or 1.62 days (thirty-nine hours) longer, somewhat less than the expected increase of 58 hours, which was the average delay during closure. The increase in interarrival time is largely due to delays at Hannibal. These delays explain approximately 52 percent of the decrease in tow arrivals. The other 48 percent reduction in tow arrivals was due to rerouting of traffic and other actions.

Table 8: Interarrival Trip Times at Hannibal Normal and during Closure			
		Trips	**Cycle in Days**
Normal	1 July – 31 Oct	1,388	3.10
Closure	1 Nov – 15 Nov	63	4.72
Source: LPMS data provided by LRD Navigation Planning Center			

Persistently high delays remained a problem even after the 600’ chamber was reopened on 6 November because of the necessity of tows to undergo two-cut lockage operations to pass through the project. Because of the time spent in decoupling, moving, and recoupling barges, a two-cut lockage time takes triple the time of a one-cut time if industry self-help is not in place, and double the one-cut lockage time with industry self-help and the n-up/n-down lockage scheme. Industry self-help and the n-policies were in effect during the closure period

(time period 4) so that the average lock processing time increased by only a factor of 2.3 to 1 as shown in Table 9.

Table 9: Average Processing Time during different Time Periods
(in minutes)

Time Period	Average Processing Time - one-cut Tows (	Average Processing Time - two-cut Tows (	Average Processing Time - All Tows
1	57.5	NA	57.5
2	55.5	NA	55.5
3	117.5	NA	117.5
4	45.2	106.2	94.4
5	57.2	NA	57.2

Finally, delay statistics were recorded during each of the five time periods as listed in Table 10. The normal average delay is about 30 minutes per tow. The delay increased to a relatively low 47.8 minutes per tow during time period # 2, when all traffic passed through the 1200' chamber. Delay data for tows locking through time period # 3 are listed in the table but are not meaningful since only two vessels locked through the project, both to assist in the work effort to bring the project back on-line. The delays incurred during time period # 3 actually appear in time period # 4 when commercial tow lockages resumed. The average delay of tows locked during timer period # 4 was 58.3 hours. Time period # 5 shows average delays when the project was fully operational. The average delay during this period of full operational status is somewhat higher than normal, but again this is due to the residual effects of the closure.

Table 10: Delays for Tows Locking Through during Specified Time Periods

Time Period	Minimum Delay (minutes)	Maximum Delay (minutes)	Average Delay (minutes)	Average Delay (hours)
1	0	361.0	29.3	0.5
2	0	231.0	47.8	0.8
3	0	7,223.0	3,611.5	60.2
4	531	8,410.0	3,499.9	58.3
5	0	1,099.0	51.6	0.9

The cost of tow delays was computed by the Corps analysts using the average delay per tow over the fifteen day period, the number of tows that were delayed, and an average operating cost per tow per hour computed from vessel operating cost data and current fuel prices. The average delay was 58.3 hours, the number of tows delayed was 125 and the average cost per tow was $396.98 per hour. The result is an estimated delay cost of $2.9 million (see Table 11). The survey indicated that administrative costs were negligible since the tows were dispatched as normal.

Table 11: Costs incurred by the Carriers (Towing Companies)	
Line-Item	**Cost**
Delays	$2,895,264
Administrative	negligible
Total	$2,895,264

ii. Waterside Production Facilities

Waterside production facilities are facilities that produce raw materials and/or finished goods that are located adjacent to the river system. The principal reasons for locating riverside are access to large quantities of water and an economical transportation system.

According to survey responses, the impact of the closure was minimal because of its relatively short duration. The duration of the closure or, more specifically, the increase in travel times and the decrease in delivery cycles are important to each company in relation to the amount of its inventories. The companies in the most critical situation are those with insufficient inputs for their production processes. The maintenance of production schedules is a key objective of all companies. The first option to maintaining production is to draw-down inventories. When inventories are near or in danger of exhaustion, the company will arrange to have input materials re-routed or resourced. Short-term rerouting costs that are double or triple normal transportation costs are acceptable because the losses due to production cuts were cited by several survey respondents as several magnitudes higher than increased transportation costs. The survey responses indicated that petro-chemical plants are at greatest risk because of limited inventories. Power plants are generally at the lowest risk since they maintain stockpiles sufficient for 10 to 30 days of production. Steel, other companies, and intermodal ports fall somewhere between the two extremes.

The impacts on industry in monetary terms were obtained from the responses to the survey. The administrative impacts for most shipping/receiving companies were minimal because of the short duration of the closure with exceptions as noted later. In most cases the administrative impacts are not separately accounted by industry since they are considered a routine cost of business. The dollar figures obtained from the survey are listed in Table 12 and total $1.6 million. Revenues foregone due to altered production and the cost of rerouting traffic account for nearly 95 percent of the total.

Table 12: Reactions of Industry and Additional Costs due to Closure		
Response	**Number of Responses**	**Cost**
No change in operations	3	$0
Drew down stockpiles	3	40,320
Switched to all overland mode for shipments/receipts	1	87,500
Switched to a combination waterway/overland to avoid Hannibal	1	400,000
Switched sourcing of material inputs	0	0
Ceased operations	0	0
Altered production	2	1,076,000
Switched production to another plant	1	0
Purchased intermediate or final products in lieu of production	0	0
Other	2	4,200
Delays	4	0
Responded	17	1,608,020
No response	8	0
Total	25	$1,608,020

c. Recreational Craft and Cruise Vessel Costs

There were no delays to recreational craft during the closure and therefore no cost to recreational craft for delays. There was one recorded diversion of a cruise ship due to the closure. The cruise line was contacted during the survey and provided an estimate of additional costs for busing and related activities at $7,000. The company indicated a suspected but unquantifiable cost in terms of lost future bookings which, if it was available, would have been included as a closure related cost.

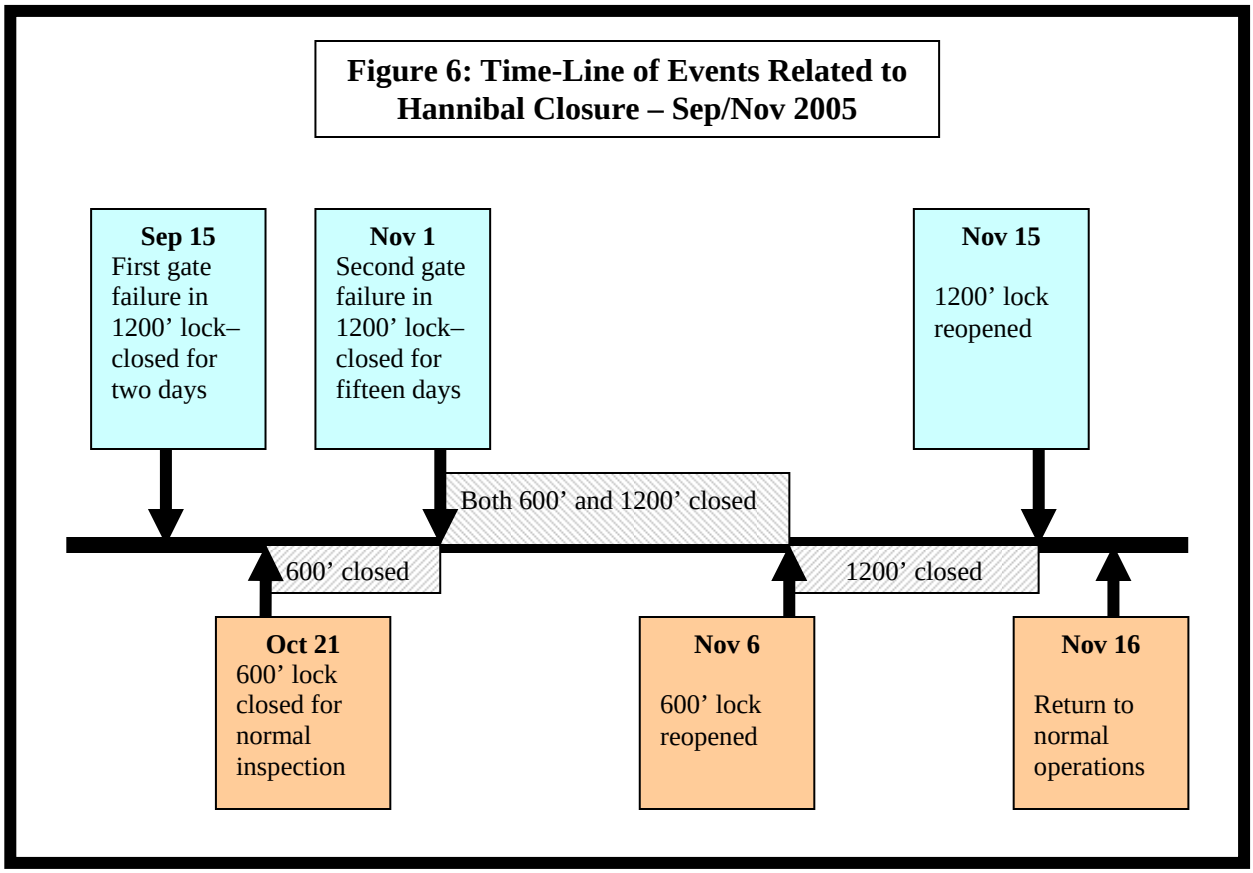
d. Total Costs

The total costs are actually partial costs since there was only a 60 percent response (measured in tons) from industry. The costs amount to over $5.1 million. Delay costs account for 56 percent of the total, waterside industry costs for 31 percent, and Corps of Engineer costs for 13 percent (Table 13).

Table 13: Hannibal Closure Costs by Response Category		
Towing Industry	**Cost**	**Percent of Total**
Delays	$2,895,264	56%
Subtotal	2,895,264	56%
Waterside Industry		
Altered production	1,076,000	21%
Reroutes	487,500	9%
Stockpile drawdown	40,320	1%
Other	4,200	0%
Subtotal	1,608,020	31%
Corps		
Admin	50,000	1%
Repair-labor	274,300	5%
Repair-parts	267,300	5%
Travel	55,000	1%
Subtotal	646,600	13%
Cruise Line	7,000	0%
Total	$5,156,884	100%

5. Summary

The purpose of this study was to describe the events that led to the total closure for five days of the Ohio River at Hannibal Locks and Dam and to present the findings of surveys and analysis designed to measure the economic impacts of the closure. The series of events is shown in Figure 6.



The estimated cost to the towing industry in terms of idle equipment is $2.9 million; a partial estimate of the cost to riverside production industries is $1.6 million; and the cost to the Corps for emergency repairs is approximately $0.6 million. A conservative estimate of the cost based on limited responses to the survey is $5.1 million, as shown in Table 14.

Table 14: Closure Costs by Economic Entity

	Cost	Percent of Total
Towing companies	$2,895,264	56%
Waterside production facilities	1,608,020	31%
Corps	646,600	13%
Cruise Line	7,000	0%
Total	$5,156,884	100%

6. Recommendations

It is recommended that a comprehensive review be performed of all recent survey results to determine if general equations could be developed to describe the relationship between closures and industry costs. The review should further determine the most efficient way to conduct future surveys in order to minimize the time and cost to both the Corps survey team and industry. The review should also identify deficiencies in the coverage of closure events.

a. Survey Review

A number of surveys have been conducted in the past several years related to the effects of lock closures on industry operations and costs. These surveys should be reviewed and analyzed as a whole. A possible first step could be the categorization of the closures according to a number of important factors. Based on discussions with industry personnel during the Hannibal survey, these may include the following:

1) Was the closure scheduled or unscheduled?
2) What was the duration of the closure?
3) What is the normal traffic level at the project?
4) What was closed – the main chamber, the auxiliary chamber, or both chambers?
5) What were the market conditions at the time of closure?

The consensus is that an unscheduled closure has a greater negative impact than a scheduled closure since it does not allow industry time to develop alternatives, such as building stockpiles or arranging for alternative modes of transportation. Likewise the longer the closure the greater the negative impact since the stockpiles of more companies become depleted to the point where production is affected. In general, but somewhat depending on the commodity mix, the impacts increase as traffic increases. The total closure of both chambers has the greatest negative impact, followed by the closure of the main and then the closure of the auxiliary since these affect delivery schedules to different extents. Finally market conditions are a factor since this affects the ability to utilize tows elsewhere, to find alternative transportation modes at a competitive cost, and to shift production to other plants within the company. There may be other relevant factors, but these should be considered as a first step in the categorization process.

The review should take the available information from the existing surveys to determine if some general relationships can be discerned. The information may indicate that different industries are affected differently and that separate equations should therefore be developed for different commodities. The equations may include as their dependent variable the industry costs and as their independent variables, whether the closure was unscheduled or scheduled, the capacity of project during the closure, the level of traffic during the closure, market conditions during the closure, and any other factors that are determined to be relevant.

b. Survey Efficiency

Surveys should be conducted efficiently in order to minimize the Corps and industry time and cost. The first step might be to develop an industry contact list categorized by shipping companies, receiving companies, and towing companies. The shipping and receiving companies could be subcategorized by industry or functions, e.g. electric generating company or public port. The contact list should include the name of the contact, e-mail address, phone number and company address. Linked to this information should be the waterway tonnage of the company and a list of its waterside facilities with the tonnage handled at each facility. The tonnage data would allow the high use shippers and/or receivers to be contacted at the earliest possible date while the incident is still on their minds. The contact list could be used

to send e-mails to the high use shippers/receivers with the simple question: “Were your operations affected by the closure?” Positive responses could then be followed by phone calls or mailed surveys. Similar e-mails could be sent to smaller shippers/receivers that indicated in the past that closures affected their operations – such as public ports and petro-chemical companies. Again, the detailed surveys could then focus on those that indicated a real effect on their operations.

c. Survey Deficiencies

The review should also consider whether the range of closure events provides sufficient coverage. For example, most of the recent surveys were conducted in response to an unscheduled closure; it should be considered whether surveys are warranted for scheduled closures.

d. Survey Importance

The Corps operates and maintains an aging set of navigation projects that would be expected to experience both unscheduled and scheduled closure of longer duration and increased frequency. Given funding constraints it is important for the Corps to prioritize maintenance plans over the entire system of projects. Prioritization needs to take into account two factors: 1) the condition of lock components that require maintenance; and 2) the impact of service disruptions on industry. The traditional way of measuring the impact of service disruptions on industry was to calculate the delay costs during the closure period. However, the results of the recent set of surveys indicates that the impacts on shippers and receivers of waterborne commerce may be significantly higher than delay costs, depending on the factors related to the closure event. The development of standardized industry costs during closures could assist in prioritizing maintenance work. It would also provide more complete information on the impact of closures than currently exists. This is important in allowing those responsible for developing and approving Corps budgets to realize the importance of the navigation system to the nation’s economy.

Attachment 1: Notices to Navigation

Notice to Navigation Interests

In reply refer to Notice No. below

US Army Corps of Engineers, Pittsburgh District
1000 Liberty Avenue, Pittsburgh, PA 15222-4186
(412) 395-7640
http://www.lrd.usace.army.mil/navigation/notice/

Notice No. 05-25 Date: August 11, 2005

HANNIBAL LOCKS AND DAM, OHIO RIVER, MILE 126.4
Replace Land Wall Emptying Valve and
Renovate Operating Machinery in the
110-ft x 600-ft Land Lock Chamber

1. **To All Whom It May Concern:** Notice is given that the U.S. Army Corps of Engineers' Repair Fleet will replace the land wall emptying valve and renovate its operating machinery in the 110-ft x 600-ft land lock chamber at Hannibal L/D, Ohio River, Mile 126.4. The work is scheduled to begin at 1:00 A.M. on October 22, 2005 and be completed by about 11:00 P.M. on November 10, 2005.

2. The 110-ft x 600-ft land lock chamber will be closed to river traffic during this time period. All traffic will pass through the 110-ft x 1200-ft river lock chamber. Minor delays are expected.

3. General wear and deterioration of the valve and its operating machinery have made it necessary to schedule this work.

4. Navigators are requested to use caution while entering or leaving the lock chamber and approaches during the repair period.

FOR THE DISTRICT ENGINEER:
/signed/
Richard C. Lockwood
Chief, Operations Division

Notice to Navigation Interests

In reply refer to Notice No. below

US Army Corps of Engineers, Pittsburgh District
1000 Liberty Avenue, Pittsburgh, PA 15222-4186
(412) 395-7640
http://www.lrd.usace.army.mil/navigation/notice/

Notice No. 05-32 Date: October 13, 2005

HANNIBAL LOCKS AND DAM, OHIO RIVER, MILE 126.4
Replace Land Wall Emptying Valve in the
110-ft x 600-ft Land Lock Chamber
and
Repair Lock Gates in the 110-ft x 1200-ft Lock Chamber

1. Notice to Navigation Interests No. 05-25 has been revised due to a change in the scope of work. Additional work needs to be accomplished to repair the lock gate seals in the 110-ft x 1200-ft river lock chamber. This additional work is necessary following a structural failure that occurred on September 15, 2005.

2. **To All Whom It May Concern:** Notice is given that the U.S. Army Corps of Engineers' Repair Fleet will replace the land wall emptying valve and renovate its operating machinery in the 110-ft x 600-ft land lock chamber at Hannibal L/D, Ohio River, Mile 126.4. The work is scheduled to begin at 1:00 A.M. on October 22, 2005 and be completed by about 11:00 P.M. on November 10, 2005.

3. The 110-ft x 600-ft land lock chamber will be closed to river traffic during this 20-day repair period. All traffic will pass through the 110-ft x 1200-ft river lock chamber.

4. The 110-ft x 1200-ft river lock chamber will also be closed for three (3) 8-hour periods during the 20-day timeframe to weld the miter and quoin seals on both the upstream and downstream lock gates.

5. General wear and deterioration of the tainter valve and lock gates have made it necessary to schedule this work.

6. Navigators are requested to use caution while entering or leaving the lock chamber and approaches during the repair period.

FOR THE DISTRICT ENGINEER:
/signed/
James J. Rockovich, P.E.
Acting Chief, Operations Division

US Army Corps of Engineers
Pittsburgh District

Notice to Navigation Interests

In reply refer to Notice No. below

US Army Corps of Engineers, Pittsburgh District
1000 Liberty Avenue, Pittsburgh, PA 15222-4186
(412) 395-7640
http://www.lrd.usace.army.mil/navigation/notice/

Notice No. 05-38 Date: November 2, 2005

HANNIBAL LOCKS AND DAM, OHIO RIVER, MILE 126.4

Emergency Repairs to the Lock Gates in the 110-ft x 1200-ft Lock Chamber

Replace Land Wall Emptying Valve in the110-ft x 600-ft Land Lock Chamber

1. **To All Whom It May Concern:** Notice to Navigation Interests No.05-32 has been revised due to an unscheduled emergency closure of the primary 110-ft x 1200-ft lock chamber at Hannibal L/D, Ohio River. This emergency closure was caused by a structural failure of the upstream middle wall lock gate at approximately 3:20 P.M. on 1 November 2005.

At the time of the failure on the upstream lock gate in the primary lock chamber, the auxiliary 110-ft x 600-ft lock chamber was closed while the U.S. Army Corps of Engineers' Repair Fleet was replacing the land wall emptying tainter valve and renovating its operating machinery. This valve repair work was originally scheduled to close the auxiliary lock chamber for a twenty (20) day period beginning on 22 October through 10 November 2005.

At the present time both locks are closed at Hannibal L/D, Ohio River and no traffic can pass thru the locks.

2. The U.S. Army Corps of Engineers' Repair Fleet has accelerated it repair effort to the valve in the 110-ft x 600- ft auxiliary lock and anticipates that **the 110-ft x 600-ft lock will be reopened to navigation by 11:00 P.M. on Sunday, 6 November 2005.**

3. From 3 thru 6 November 2005, the U.S. Army Corps of Engineers contractor Madison Coal and Supply Company, will dredge the lower approach to the 110-ft x 600-ft lock chamber to assure adequate draft (approximately10 feet) for tows entering and leaving the small lock.

4. The **110-ft x 1200-ft primary lock chamber at Hannibal L/D will remain** closed for an estimated minimum period of 2 weeks while repair crews implement emergency structural repairs to the lock gates.

5. After reopening of the 110-ft x 600-ft lock chamber and during the continued closure of the 110-ft x 1200-ft lock chamber, a double lockage will be the maximum acceptable tow through the 110-ft x 600-ft lock chamber.

6. It may be necessary for tows to follow one another on the guide wall when a series of lockages are being made in one direction. Each tow should be aware of the tow that they follow and be on the guide wall as soon as that tow enters the lock chamber. While this practice will speed up the lockage process, it is imperative that tows exercise extreme caution when encountering outdraft or backlash conditions.

7. Boat locking order will be determined by arrival time at Hannibal L/D, Ohio River or as needed to reduce queue. No adding or swapping of barges will be allowed once the tow's lock turn has been established. All tows must be ready to lock when put on the waiting list.

8. Information concerning lockages will be broadcast on Channel 13 and any towboat not answering the radio call from the locks will be dropped to the end of the waiting list.

9. In an effort to reduce delay time at the locks, a program of "self-help" by navigation interests is necessary. A "self-help" program will allow waiting towboats to assist tows out of the lock chamber. The Lockmaster will designate the helper boats as tows arrive for position.

10. Other specific procedures to facilitate double lockage operations through the small chamber have been developed in partnership with the towing industry. The Corps is asking for everyone's cooperation and help in making the locking operations go as smoothly as possible during the closure of the large lock chamber.

a. It is recommended that waiting tows have a "break coupling" prepared and in place in their tow configuration to expedite multiple lockages.

b. All excess rigging will be removed prior to entering the lock chamber. Remaining rigging should be ready to be knocked loose after the cut is secured in the lock chamber.

c. Two (2) locking lines, with bow and stern lines leading in the opposite directions, must be available on each cut to prevent the vessel from "running" in the lock. Each line must be at least 75 feet long and 1-1/2" in diameter. To minimize locking time, all lines will stay with each cut. Lines will not be permitted to be carried from one cut to the other. It is the responsibility of the vessel operator to provide adequate mooring lines to assure safe lockage.

d. At least two (2) deckhands are required during double lockages on the first cut.

e. The second cut of tows will be made up in the lock approaches, clear of the lock gates, so as not to interfere with lockage operations. Final make up of tows will be done clear of the lock gates.

11. The Corps will make the final determination whether to change procedures as conditions and situations develop. In accordance with standard Corps policy, the Lockmaster may also vary the lock procedures in an effort to equalize waiting times.

12. The Waterways Association of Pittsburgh have agreed to have a point of contact available should an unusual circumstance arise and the Lockmaster or their representative need immediate assistance from the Waterways Association to deal with the situation. The Waterways Association of Pittsburgh's point of contact for this closure is Dick Ehringer, Work (724)483-8051; Cell (412)848-5544.

13. All towboats are to stay with their tows while waiting for lockages unless designated to assist other tows through the small chamber.

14. Pleasure boaters are discouraged from locking through the Hannibal L/D, Ohio River during this time period. You may encounter long delays since priority will be given to the scheduled commercial passenger vessels and commercial tows.

15. Navigators are requested to use caution when entering or leaving the small lock chamber during this closure of the large lock chamber to prevent a complete shutdown of navigation.

FOR THE DISTRICT ENGINEER:

/signed/

James J. Rockovich, P.E.
Acting Chief, Operations Division

Attachment 2: Survey #1 - Hannibal

HANNIBAL LOCK CLOSURE CANVASS OF WATERWAY USERS

Canvass by: _____ Date: _____

1. Company name _____

Contact name _____ Title: _____

Phone number: _____ Fax: _____

Location for shipping/receiving waterway traffic _____

2. Briefly, how does your company use the inland waterway system? How much tonnage do you move through the Hannibal lock?

_____

_____

_____

3. Was your company affected by the closure of Hannibal Lock during the week of November 1, 2005? **YES** **NO**

If **YES**, please describe how _____

_____

_____

_____

_____

If **NO**, why not? (skip to question #10) _____

_____

If **YES** (questions 4 through 9):
4. Did it cause disruption in production or reduced sales for either your company or for a supplier or customer?

_____

_____

5. Did it require you to use alternate transportation? What were the additional costs?

_____

_____

6. Did it cause your company to deplete stockpiles or inventory? _____

_____

7. Did you incur additional costs for any other reason? _____

_____

_____

8. What other steps did your company take to deal with the closure?

_____

_____

_____

9. Has this closure or similar problems with waterway transportation affected your company's decision to continue to use waterway transportation?

_____

_____

10. If a similar failure (total river closure) were to occur at Emsworth, or on the lower Mon (Elizabeth or Charleroi), how would your company be affected?

_____

_____

_____

_____

11. Do you have any other comments on inland waterway transportation?

_____

Attachment 3: Survey #2 - Hannibal

Shippers/receivers

Respondent Name:
Position:
Phone number:
Email address if not returned via email:

During the period of the closure of the river from 1 November 2005 to 6 November 2005 at Hannibal, what was your company's response?

_____ 1. No change in operations
_____ 2. Drew down stockpiles
_____ 3. Switched to an all overland mode of transportation for shipments/receipts
_____ 4. Switched to a combination waterway/overland routing that avoided Hannibal
_____ 5. Switched sourcing of material inputs
_____ 6. Ceased operations
_____ 7. Altered production
_____ 8. Switched production to another plant
_____ 9. Purchased intermediate or final products in lieu of production
_____ 10. Other

Where there any effects due to the use of the 600' chamber from 6 November to 15 November?_____

_____ Would it be ok for me to call you if necessary for details?

Could you summarize how the closure affected your operations, if at all.
_____
_____

Carriers

Respondent Name:
Position:
Phone number:
Email address if not returned via email:

During the period of the closure of the river from 1 November 2005 to 6 November 2005 at Hannibal, what was your company's response?

_____ 1. Tows were kept at docks/ports during all or most of the closure period
_____ 2. Towboats were dispatched as normal
_____ 3. Barges were tied up at fleeting areas and towboats were used elsewhere
_____ 4. Other

Where there any effects due to the use of the 600' chamber from 6 November to 15 November?_____

_____ Would it be ok for me to call you if necessary for details?

Could you summarize how the closure affected your operations, if at all.
_____
_____

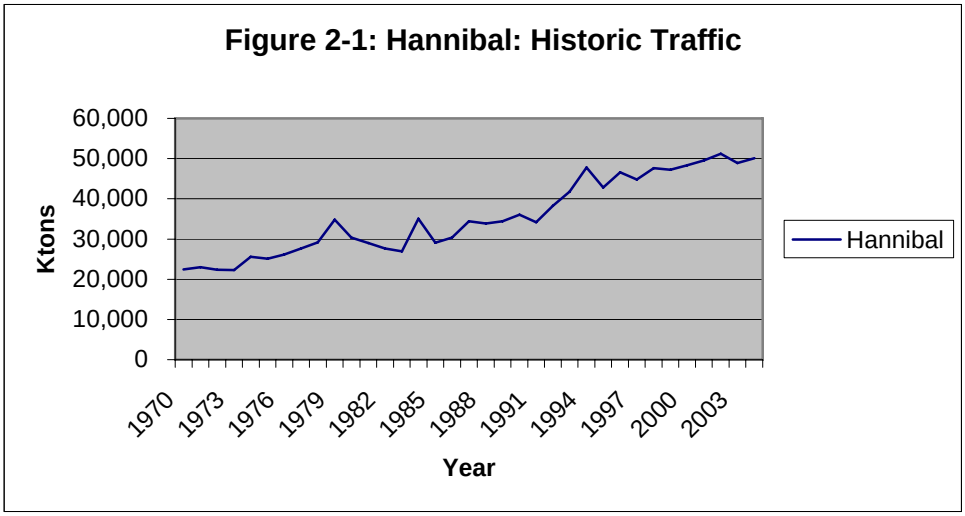
Attachment 4: Hannibal Traffic

Hannibal is one of the most heavily utilized projects on the inland navigation system, annually processing over 5 thousand tows and over 50 million tons of cargo. Most of the cargo is coal coming out of the Appalachian coal fields and moving to electric generating plants located along the banks of the Ohio River.

1. Commercial Traffic

a. Cargo

Tonnage through Hannibal increased steadily from 1970, when the locks became operational, through the present (2005) as shown in Figure 2-1. The annual rate of growth over this time period was 3.6 percent.



Other high volume shipments through Hannibal are ores and steel products. These are largely imported goods that enter the country at New Orleans where they are offloaded from ocean freighters onto barges for distribution throughout the interior of the country. Iron and steel products account for 7.2 percent of the tonnage shipped through Hannibal.

It is not always possible to identify critical commodities based on tonnage alone. Low volume commodities such as lime (aggregates group) are critical to power plant operation since it allows them to comply with air emission regulations. A complete list of grouped traffic through Hannibal is provided in Table 4-1.

Table 4-1: Commodity Group Traffic thru Hannibal in 2005

	Commodity	Tons	Percent of Total
1	Coal	40,686,254	76.4%
2	Petro	1,990,557	3.7%
4	Aggregrates	1,949,205	3.7%

5	Grains	143,160	0.3%
6	Chemicals	2,091,731	3.9%
7	Ores/Minerals	1,099,242	2.1%
8	Iron/Steel	3,826,975	7.2%
9	Other	1,497,048	2.8%
Total		53,284,172	100.0%

b. Vessel Fleet

Most tows are configured to fit into the 1200' x 110' chamber. This is important in situations where the 1200' chamber is closed and all tows must process through the 600' auxiliary chamber. In order for large tows to process through the 600' chamber, the tow must go through a time-consuming process of disconnecting and reconnecting barges. This significantly increases processing times and therefore delays.

The vessel fleet that moved the 53 million tons in over 5,000 tows recorded at the project in 2005 consists of barges and towboats. Individual barges are loaded with cargo and connected to other barges with cables. The set of barges is then connected to a towboat, which is positioned at the rear. The towboat with barges is referred to as a tow or flotilla.

The number of barges in a tow depends on a number of factors including the width, configuration and flow velocity of the river. On the Ohio River these are generally not the limiting factor to the size of tows. Rather the limiting factor is a Corps restriction that limits tows to one-cut operations through a 1200' chamber. While the typical Ohio project has two locks, a 1200' and a 600', the 1200' chamber is normally used to process commercial freight traffic. The most efficient size tow for a 1200' lock chamber is a fifteen barge tow measuring 195' x 35' arranged into five rows and three columns pushed by a towboat of about 3,200 horsepower and measuring 130' in length. The total length of the tow is 1,105' (5 x 195' + 130') and the total width is 105' (3 x 35') which provides a safety cushion of 95' lengthwise and 5' widthwise. Loaded with cargo to the authorized draft of 9-feet, the tow could transport 22,500 tons (15 barges x 1,500 tons/barge).

Selected fleet data for Hannibal are listed in Table 4-2. In the year 2005 the average tow consisted of 11.1 barges loaded with 10,600 tons and pushed by a 3,200 horsepower towboat. Given that many commodities such as chemicals are restricted to smaller tows for safety reasons, the 11.1 barges per tow is a relatively high average. Also if the tows are empty on one leg of their round-trip then the tons on the loaded leg would be twice the average of 10,626, or 21,252. This is near the maximum load per tow of 22,500 tons.

Table 4-2: Traffic thru Hannibal from 2001 to 2005

	2001	**2002**	**2003**	**2004**	**2005**
Tons/tow	11,197	11,307	10,931	10,836	10,626
Barges/tow	11.0	11.1	10.8	10.6	11.1
Horsepower/tow	3,332	3,387	3,382	3,274	3,256

The numbers and percentages of tows that measured 600' or less and greater than 600' are listed in Table 4-3. The 600' length is critical since most tows greater than 600' in length would have to double lock through the 600' chamber. The double lock operation begins with the nine leading barges pushed into the lock chamber which are then disconnected from the rest of the tow with quick-disconnect rigging such as pelican hooks. The towboat then backs out of the chamber with the six remaining barges, allowing the gates to be closed and the first cut of nine barges (585') to be locked through the 600' chamber. After the pool change in the chamber and opening of the miter gates, this first cut of nine barges must be extracted from the chamber using a powered tow haulage system, capstan or helper boat. After the first cut is locked through, the cycle is repeated for the second cut consisting of the remaining six barges and the towboat (520'). After the second cut locks through, it is joined with the first cut and the complete tow continues on. Eighty-six percent of the tows locked through the 600' chamber required a double lockage. The effect in terms of processing times is discussed in the section on economic impacts of the closure.

Table 4-3: Length of Tows thru Hannibal				
	2001-2005 Average		2005	
Length	Number	Percent	Number	Percent
=< 600'	694	15%	707	14%
> 600'	3,915	85%	4,306	86%
Total	4,609	100%	5,013	100%
Source: extracted from LPMS data by the LRD Navigation Planning Center of Expertise				

c. Vessel Trips

The fleet used to transport commodities on trips that transit the Hannibal project is a fleet configured for high volume / long distance movements. The average one-way distance is over 600 miles and round-trip distance is 1,200 miles. At an average speed of 150 miles per day, the average round trip takes eight days. At eight days per round trip, the tow would transit Hannibal once every four days. Therefore short duration river closures of less than four days would cause the average tow to be delayed one time. If the river was closed for eight days, then the same tow would have transited twice. However it can only be delayed once since a total closure restricts it to one side of the project. The same tow can be delayed multiple times if only one lock is closed with the number of times depending on trip distances. A tabulation of one-way trip distances is provided in Table 4-4.

Table 4-4: One-Way Trip Distances for Hannibal Traffic – 2005		
One way Mileage	**Number of Loaded Barges**	**Percent of Total**
=<100	1,897	5.9%
101-200	4,428	13.9%
201-300	6,447	20.2%
301-400	7,916	24.8%
401-500	2,527	7.9%
501-600	847	2.7%
601-700	322	1.0%

701-800	97	0.3%
801-900	30	0.1%
901-1,000	257	0.8%
>1,000	7,175	22.5%
Total	31,943	100.0%
Average miles	605.9	
Source: Waterborne commerce data provided by PCXIN.		

2. Industry

The principle industries affected by inland navigation disruptions in the Ohio Valley are the towing industry, the petro-chemical industry, the coal mining industry, and the electric generating industry. The towing industry is a service provider typically hired by a manufacturing facility (e.g. electric generating plants) to move cargo from production sites (e.g. coal mines) to their generating plant. Statistics showing the number and concentration of firms within the towing industry and production/consuming companies can be derived from the waterborne commerce data which lists shipments and receipts from individual port docks. The port docks can be linked to manufacturing firms using the Corps' navigation charts. The towing and port-dock data extracted from the waterborne commerce data are summarized below.

a. Towing Companies

Forty-two different towing companies moved cargo through Hannibal locks in 2003, the most recent year that detailed data were available at the time of this study. However 96 percent of all cargo shipments were transported by just ten companies, as shown in Table 4-5. The second of the two Hannibal surveys used the towing company/tonnage data to develop a list of the companies to be contacted to obtain their reactions to the lock closure. The surveys are discussed in detail in Section 3.

Table 4-5: Towing Companies and Tonnage Hauled
(Through Hannibal in 2003)

Number of Towing Companies	**Tons Hauled**	**Percent of Total Tons**
Top 10	50,257,942	96%
All 42	52,293,159	100%

b. Shipping Facilities

The shipments that transit Hannibal were extracted from the waterborne commerce data and sorted by the tons shipped from each port-dock. A summarization of the data is provided in Table 4-6. There were a total of 731 port-dock shipments of 52.3 million tons. Fifteen port-docks or 2 percent of the total shipped 72 percent of the tonnage. Coal accounted for 66 percent of the tonnage shipped. The companies that owned the docks were obtained from Corps' navigation charts and other sources. This information was used to develop a representative survey list of shipping companies within different industries for the second Hannibal survey.

Table 4-6: Major and Total Numbers of Shipping Docks				
	Million Tons	**Percent**	**Number**	**Percent**
Coal shipments of 500,000 tons or more	34.6	66%	13	2%
All shipments of 500,000 tons or more	37.6	72%	15	2%
All shipments	52.3	100%	731	100%

c. Receiving Facilities

The shipments that transit Hannibal were extracted from the waterborne commerce data and sorted by the tons received at each port-dock. The data are summarized in Table 4-7. There were a total of 735 port-docks shipments of 52.3 million tons. Sixteen port-docks or 2 percent of the total received 68 percent of the tonnage. Coal accounted for 62 percent of the tonnage received. This information was used to develop a representative survey list of receiving companies within different industries for the second Hannibal survey.

Table 4-7: Major and Total Numbers of Receiving Docks				
	Million Tons	**Percent**	**Number**	**Percent**
Coal receipts of 500,000 tons or more	32.5	62%	14	2%
All receipts of 500,000 tons or more	35.5	68%	16	2%
All receipts	52.3	100%	735	100%

3. Recreational Traffic and Passenger Vessels

a. Recreational Craft

The number of recreational craft that normally passes through Hannibal ranges from 1,000 to 1,500 per year. Most of this traffic occurs in the summer and on weekends/holidays. Early November is not the most popular time of year for recreational boaters and there were none recorded at the project during this time period.

b. Passenger Vessels

A cruise ship full of passengers was approaching Hannibal enroute north to view fall foliage immediately preceding the gate failure at Hannibal. When it was about 100 miles downstream of Hannibal, the gate failure occurred and the river was closed to all traffic. Unlike a commercial tow, the cruise ship could not wait an indefinite amount of time to continue on its journey. It therefore was forced to reroute around Hannibal by loading the passengers onto buses and transporting them by bus to Pittsburgh. At Pittsburgh the passengers were loaded onto local cruise vessels for a voyage up the Allegheny River. The return trip was the reverse of this routing with the passengers loaded onto buses at Pittsburgh and transported to the main cruise ship which was docked downstream of Hannibal. The costs to the cruise line are discussed in the section on closure costs.

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The NETS research program is developing a series of practical tools and techniques that can be used by Corps navigation planners across the country to develop consistent, accurate, useful and comparable information regarding the likely impact of proposed changes to navigation infrastructure or systems.

The centerpiece of these efforts will be a suite of simulation models. This suite will include:

- A model for forecasting **international and domestic traffic flows** and how they may be affected by project improvements.
- A **regional traffic routing model** that will identify the annual quantities of commodities coming from various origin points and the routes used to satisfy forecasted demand at each destination.
- A **microscopic event model** that will generate routes for individual shipments from commodity origin to destination in order to evaluate non-structural and reliability measures.

As these models and other tools are finalized they will be available on the NETS web site:

http://www.corpsnets.us/toolbox.cfm

The NETS bookshelf contains the NETS body of knowledge in the form of final reports, models, and policy guidance. Documents are posted as they become available and can be accessed here:

http://www.corpsnets.us/bookshelf.cfm

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