U.S. Army
Corps of Engineers

# Event Study
## 2012 Low-Water and Mississippi River Lock 27 Closures

**August 2013**

Cover photo by the Associated Press

# Event Study
## 2012 Low-Water and Mississippi River Lock 27 Closures

Prepared by
US Army Corps of Engineers,
Planning Center of Expertise for Inland Navigation

In Collaboration with
US Army Corps of Engineers
Institute for Water Resources

August 2013

Page intentionally left blank

# ACKNOWLEDGEMENTS

The River Industry Executive Task Force (RIETF), the River Industry Action Council (RIAC), the American Corn Growers Association, and the Waterways Council, Inc., offered valuable advice as the study team developed the survey instrument used in this study and provided greatly appreciated assistance in reaching waterway carriers and shippers with our survey. The U.S. Coast Guard was especially helpful in providing information on river conditions and the coordinated response of the towing industry, the U.S. Army Corps of Engineers, and the Coast Guard. Corps of Engineers' Operations personnel in Vicksburg, Mississippi; St. Louis, Missouri; and Louisville, Kentucky provided extensive assistance on the Corps' response to the 2012 low water event. Finally, the study team is indebted to the waterway industry and the firms that rely on the inland waterways for providing information invaluable to gaining a sense of the importance of the Nation's major inland navigation corridor and the consequences of serious disruptions in the services these waterways provide.

# Executive Summary

Navigating the Mississippi River and most of its navigable tributaries in 2012 was very difficult due to the low water conditions that began in April and, except for a short time in May, remained in-place for much of the year.[1] These conditions continued off and on until March 2013 when spring flooding returned the Lower Mississippi to normal flows and caused flows in the Middle and Upper Mississippi to reach near record levels, forcing another set of closures. Similarly, near record high flows in 2011 caused navigation disruptions. Relatively low precipitation levels in the following winter of 2011/12 provided very little moisture for much of the region, quickly changing its posture from flood to drought conditions by April 2012. This lack of region-wide precipitation led the entire Midwest and much of the Plains states into the most severe drought since 1988.

With flows falling throughout the summer, tow groundings began to occur; the first was reported on 11 May 2012 on the heavily used Lower Mississippi River. By July groundings were widespread, and a total of 19 were reported during that month in all sections of the Mississippi River. August had the highest number of groundings with 26. From June 2012 through January 2013 there were a total of 91 groundings on the main stem Mississippi. According to the U.S. Coast Guard, 18 groundings on the Lower Mississippi led to closure events with more than 25 tows in queues. In total, these events caused 1,130 tows and 17,640 barges to be delayed. Closures of the river occurred when tows needed to be pulled from bars or banks, reassembled after breaking-up upon running aground, or when channel work was required. Industry worked together to free and re-assemble tows.

Where groundings became frequent in specific areas, the U.S. Coast Guard, the U.S. Army Corps of Engineers, and industry jointly determined when a river closure was necessary to allow the Corps to survey and dredge the channel and the Coast Guard to reset buoys that mark the channel. By June draft restrictions were set at 10'6", northbound tow sizes were set to 42 barges per tow and southbound tows to 36 barges per tow. In early July drafts were down to 9'6" and tow sizes were further reduced; by late July drafts were restricted to 9', northbound tow sizes were set to 20 loaded barges per tow, and southbound tow sizes were set to 30 barges per tow. By mid-August one way traffic was instituted in problem reaches, drafts were limited to 9' and tow sizes were limited further. Draft and tow size restrictions were gradually relaxed, but it was not until 14 December 2012 that all restrictions were lifted.

On the Middle Mississippi between St. Louis, Missouri and Cairo, Illinois, low water conditions remained severe throughout the prime shipping season in the fall. The Corps worked to mitigate low water effects by initiating drawdowns of reservoirs in Minnesota to increase flows and raise pool levels. On 15 September 2012, both chambers at Mississippi River Locks and Dam 27 (LD27) closed when low water exposed the unarmored portion of a guide cell, which was subsequently damaged by an approaching tow. The damage to the cell hindered safe passage through the locks and caused an emergency closure of both lock

[1] Low water as defined by reaching a "Watch", "Action", or "Action; Extreme Low Water" condition as described in the 2004 *Waterway Action Plan* jointly prepared by the U.S. Coast Guard, the U.S. Army Corps of Engineers, and the waterway carriers.

chambers that lasted five days, resulting in delays that approached 100 hours per tow. December 2012 saw low water continuing to hamper navigation, with conditions worsening to a point that the U.S. Coast Guard ordered draft restrictions to 9' from 10' and restricted maximum tow size to help reduce groundings. Due to the possibility of even greater restrictions to include possible complete closure, the Corps of Engineers mobilized additional dredges and began blasting to remove rock ledges that threatened navigation at the two most critical points on the Middle Mississippi - Thebes and Grand Tower, Illinois - in January 2013. Rock removal was completed by the end of February 2013 and higher winter precipitation levels began to improve water levels and navigation conditions. By March increased flows returned navigation to normal, only to be hindered by high water and flooding in the spring of 2013.

Navigation on the lower Ohio River was maintained throughout this period. Corps of Engineers Operations personnel credit the cooperation of Federal agencies, effective communication between Federal agencies and stakeholders, improved forecasting tools and water control efforts, and the diligence of the Corps and Coast Guard in keeping the channel open and channel buoys set.

Both the drought and accompanying low water on the Mississippi River were widely reported by local and national media outlets throughout 2012. Agricultural and navigation interests were the focal point of the Nation's concern, as the Corp of Engineers and the U.S. Coast Guard employed extraordinary measures to keep shipping lanes safe and open. These measures, while mitigating the adverse circumstances to some extent, did not prevent waterway stakeholders from absorbing additional costs.

The Corps of Engineers decided to formulate an estimate of these costs in order to better understand the importance of these major waterways to commercial users. A major part of this effort was a survey of both waterway carriers and shippers dependent upon the high traffic volume waterways that experienced low water conditions (the affected waterways were the Mississippi River (the Mississippi River between St. Louis, Missouri and Cairo, Illinois and between Cairo and Baton Rouge, Louisiana), the lower Illinois River, and the lower Ohio River). Surveys sent to carriers and shippers were designed to elicit economic impact information related to this protracted period of low water, to include the river closure due to the accident at LD27.

The Corps surveyed 125 shippers and ten carriers. The 73 shippers that responded represent 42 percent of all shipper traffic transiting the affected waterways. Half of the respondents to the shipper survey indicated that they did not experience any significant effects on operations due to low water and an overwhelming percentage said they were unaffected by the LD27 closure. Ten carriers were surveyed. The six carriers responding represented 46 percent of all carrier traffic transiting the affected waterways. All but one of the carriers responding indicated that they were affected by both low water and the LD27 closure, with the low water being the more serious challenge. The difference in shipper and carrier responses suggests that the shippers were somewhat insulated from these events by the strategic and tactical actions taken by the carriers that minimized impacts on the shippers.

A telling indicator of the waterway carriers' determination to satisfy shipper needs is the fact that while waterway traffic through the lower Ohio, Illinois, Middle Mississippi, and Lower Mississippi was somewhat diminished due to reduced corn traffic (a result of drought-reduced production), traffic through the rock pinnacles at Thebes, Illinois and low

water at locations like Greenville, Mississippi was largely unchanged between 2011 and 2012. Moving cargo during this period required carriers to advance or delay shipments, light load vessels (necessitating additional trips), reposition barges throughout the system to accommodate the need for additional barges, restrict tow sizes (also necessitating more trips), and perform additional refleeting. It cost responding carriers an estimated $80.7 million to alter operations in this fashion. The carriers also faced $16.7 million in additional costs as a result of the LD27 closures and delays and tug costs of $0.2 million due to tow groundings. Despite these actions, shippers did not escape the effects of the low water. In an effort to meet their needs, shippers sought other sources for product, sought other waterway routes, and used overland transportation routes at a cost to responding shippers of $55.9 million. The effect of the drought on agricultural production combined with increased transportation costs resulted in temporary plant closures and lost sales that the responding shippers estimated at $79.0 million.

**Low Water Cost Impacts - 2012 Event**

**(Costs in $000)**

| Cost Category | Survey Responses | Estimate for Firms Not Responding, Not Surveyed | TOTAL |
|---|---|---|---|
| **Transportation cost impacts** | | | |
| Carrier cost impacts | | | |
| Delays due to LD27 closure 1/ | $ 16,100 | $ - | $ 16,100 |
| Other costs due to LD27 closure | $ 573 | $ 417 | $ 990 |
| Groundings | $ 164 | $ 119 | $ 283 |
| Altered operations | $ 80,723 | $ 58,719 | $ 139,442 |
| Shipper cost impacts | $ 55,860 | $ 64,277 | $ 120,137 |
| **SUBTOTAL** | **$ 153,419** | **$ 123,532** | **$ 276,951** |
| **Production cost impacts 2/** | **$ 79,000** | **$ 86,248** | **$ 165,248** |
| **TOTAL** | **$ 232,419** | **$ 209,780** | **$ 442,199** |

1/ Includes delay cost experienced due to LD27 main chamber closure Dec 2012 - Mar 2013 to remove damaged cell.

2/ Includes economic impact of reduced corn production and higher transportation costs due to low-water.

Low water, the five-day closure of LD27 in September 2012, and the subsequent 82 day closure of the main chamber between December 2012 and March 2013 imposed additional transportation costs of $153.4 million on the companies that responded to the Corps' surveys. Drought and/or low water accounted for another $79.0 million in production losses, bringing the total reported impact to $232.4 million. A simple extrapolation of the sample to the population of movements using the most affected waterways (the Middle Mississippi and Lower Mississippi River) either not sampled or not responding suggests that additional transportation costs totaled $277.0 million and production impacts amounted to $165.2 million, for a total impact of $442.2 million.[2]

The value of the inland waterway system is reflected in the extraordinary efforts of the Federal agencies and the waterway industry. On average, shippers using the affected waterways realize an average savings of $26 per ton over alternative transportation modes. In 2011 the total tonnage moving through these reaches was 227.3 million tons. From this

[2] It is important to remember that not all waterways affected by the drought were covered by this survey.

it is estimated that shippers using this segment of the inland waterway system save a total of $5.8 billion over the best alternative mode and/or route of transportation. The Coast Guard devoted additional resources to the helping manage the low water event, but did not incur measurable additional expenditures of funds. The three most affected Corps of Engineers districts expended $31.9 million to keep the lower Ohio, lower Illinois, Middle Mississippi, and Lower Mississippi river channels open to navigation in the face of a severe drought. While industry faced losses of an estimated $277.0 million due to increased transportation costs, shippers and the Nation were still able to realize a savings in transportation costs of an estimated $5.5 billion despite this extreme low water event. These savings would have been in even greater jeopardy without the cooperative and coordinated efforts of the Corps, the Coast Guard, and industry partners,

# Contents

# LIST OF TABLES



# LIST OF FIGURES

# 1. PURPOSE AND INTRODUCTION

Lower than normal precipitation in the Mississippi River Basin recorded in the winter and spring of 2012 was an early indicator of what evolved into drought conditions throughout much of the basin. Field crops in Midwestern states experienced extreme conditions of stress. Reservoirs provided maximum supplies under approved operating procedures to augment flow for water quality and supplies, and for inland navigation on the Mississippi River in particular. Both the drought and accompanying low water on the Mississippi River were widely reported by local and national media outlets throughout 2012. Agricultural and navigation interests were the focal point of the Nation's concern, as the Corp of Engineers and the U.S. Coast Guard employed extraordinary measures to keep shipping lanes safe and open. These measures, while mitigating the adverse circumstances to some extent, did not prevent waterway stakeholders from absorbing additional costs.

The Corps of Engineers decided to formulate an estimate of these costs in order to better understand the importance of these major waterways to commercial users. A major part of this effort was a survey of both waterway carriers and shippers dependent upon the high traffic volume waterways that experienced low water conditions (the affected waterways were the Mississippi River (the Mississippi River between St. Louis, Missouri and Cairo, Illinois and between Cairo and Baton Rouge, Louisiana), the lower Illinois River, and the lower Ohio River). Surveys sent to carriers and shippers were designed to elicit economic impact information related to this protracted period of low water, to include the river closure due to the accident at LD27.

This report focuses on the impact of the low flows on major commercial cargo arteries in the Mississippi River Basin – specifically the Mississippi, Ohio, and Illinois Rivers – and estimates economic impacts from drought-related low flows and associated unexpected closure of Locks and Dam 27. Costs incurred by the Federal government, specifically the Corps of Engineers, are reported to the extent they are available.

This study relied upon readily available data from public, Corps of Engineers, and U.S. Coast Guard sources to describe river conditions, events that occurred as a result of low water conditions, and efforts to manage vessel traffic. A targeted survey of inland waterway carriers and shippers was used to estimate the economic effects of interruptions and disruptions to navigation that occurred as a result of the drought and associated low water conditions.

# 2. BACKGROUND

## 2.1 Drought

The drought of 2012 affected much of the Mississippi River Basin, whose major streams are corridors of inland waterway commerce in the Midwest and Plains states (see **FIGURE 1**). Four waterway reaches that experienced low water conditions and carry bulk commodities in excess of 25 million tons annually were identified for closer examination in this study: 1) the Ohio River between Smithland LD and the mouth of the Ohio River, 2) the Illinois River between Peoria LD and the mouth of the Illinois, 3) the Mississippi River between the confluence of the Ohio River and Baton Rouge, Louisiana, and 4) the Mississippi River between St. Louis, Missouri and the confluence of the Ohio. In 2011 shippers in 20 states moved commodity through the four reaches, with ten different states (Arkansas, Illinois, Indiana, Kentucky, Louisiana, Missouri, Mississippi, Ohio, Tennessee, and West Virginia) in the top five in shipping or receiving commodities in one or more of these reaches.

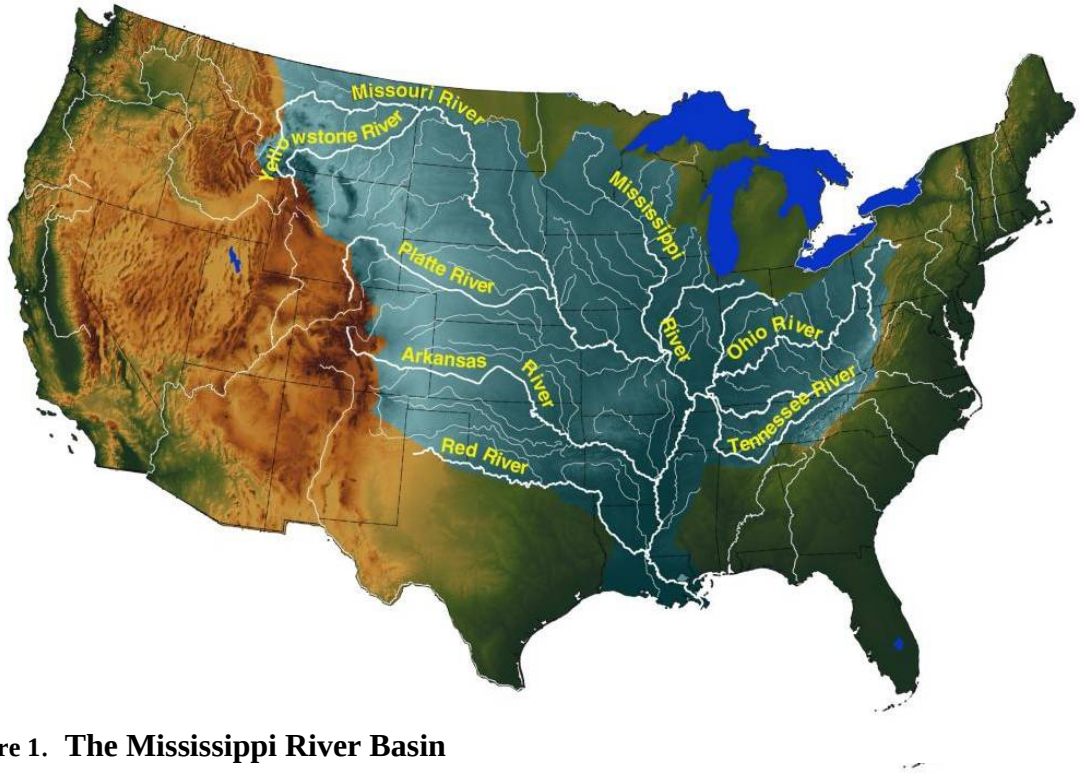


**Figure 1. The Mississippi River Basin**

The U.S Department of Agriculture estimated that nearly 80 percent of agricultural land was affected by drought in 2012, with 70 – 75 percent of the corn and soybean production affected by severe or greater drought. By September 2012 over 2000 counties were

designated disaster areas by USDA.[3] In the Midwest, the drought destroyed or damaged corn and soybean crops in particular – both the region and producers of these commodities being served by the inland waterway system. Corn production declined by 13 percent between the 2011 and 2012 marketing year, soybeans by 3 percent and corn exports fell by 51 percent (see **TABLE 1**).

**Table 1. U.S. Corn and Soybean Production and Exports**

(in millions of bushels)

| Market Year 1/ | Production | % Change from previous year | Exports | % Change from previous year |
|---|---|---|---|---|
| 2007/08 | 13,037.88 | -- | 2,437.40 | -- |
| 2008/09 | 12,091.65 | -7% | 1,848.95 | -24% |
| 2009/10 | 13,091.86 | 8% | 1,980.02 | 7% |
| 2010/11 | 12,446.87 | -5% | 1,834.17 | -7% |
| 2011/12 | 12,359.61 | -1% | 1,542.60 | -16% |
| 2012/13 | 10,780.30 | -13% | 750.00 | -51% |

Source: USDA, Economic Research Service, *Feed Outlook*

1/ market year is from September to August

**U.S. Soybean Production and Exports, 2007 to 2012/13**

(in millions of bushels)

| Market Year 1/ | Production | % Change from previous year | Exports | % Change from previous year |
|---|---|---|---|---|
| 2007/08 | 2,677.12 | -- | 1,158.83 | -- |
| 2008/09 | 2,967.01 | 11% | 1,279.29 | 10% |
| 2009/10 | 3,359.01 | 13% | 1,499.05 | 17% |
| 2010/11 | 3,329.18 | -1% | 1,500.94 | 0% |
| 2011/12 | 3,093.52 | -7% | 1,361.85 | -9% |
| 2012/13 | 3,015.00 | -3% | 1,345.00 | -1% |

Source: USDA, Economic Research Service, *U.S. Oilcrops Yearbook*

1/ market year is from September to August

Drought in western Texas spread throughout most of the Great Plains and into the lower Ohio Valley through the spring of 2012 (see **FIGURE 2**) and winter months of 2013. Extreme and Exceptional drought was persistent in the Great Plains states of South Dakota, Nebraska, Kansas, Oklahoma and northern Texas – all major agricultural producing areas. Extreme drought reached into the Midwest states, in particular, southern Minnesota, Iowa, Illinois, Indiana, and Missouri – all major producers of corn and soybeans.[4] The wheat crop

[3] See the USDA, Economic Research Service, "U.S. Drought 2012: Farm and Food Impacts" at http://www.ers.usda.gov/topics/in-the-news/us-drought-2012-farm-and-food-impacts.aspx.

[4] Extreme droughts are characterized by crop losses and widespread water shortages or restrictions. Exceptional droughts are characterized by widespread crop losses, shortages of water in reservoirs, streams and wells creating water emergencies. See http://droughtmonitor.unl.edu/classify.htm

was largely spared as it was harvested in late spring prior to the drought taking hold in these states.

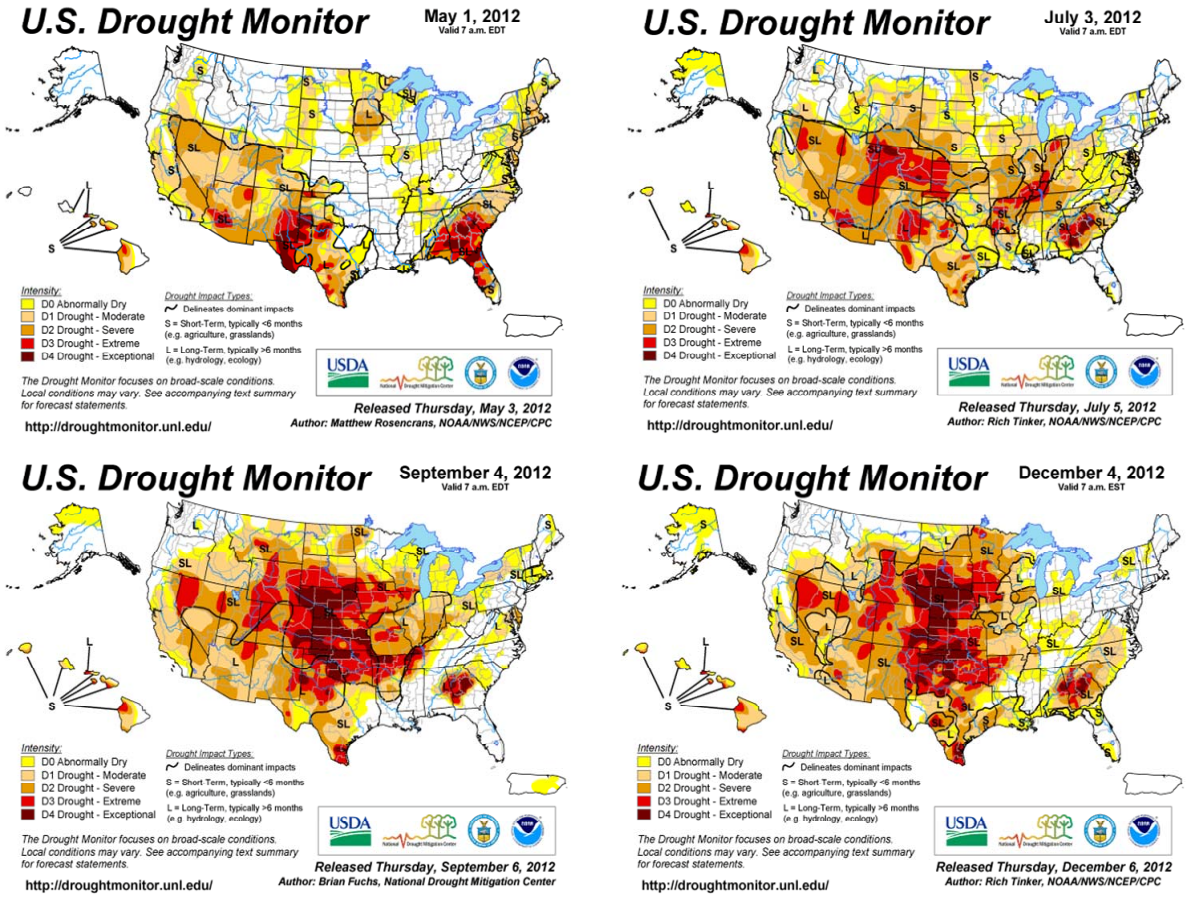


**Figure 2. Extent and Depth of 2012 Drought**

## 2.2 Low Water

In addition to agriculture, the 2012 drought affected water supplies for industrial and municipal uses, recreation, and the ability to navigate on the Mississippi River and its navigable tributaries. Small harbors and terminals saw rivers fall to levels not experienced in nearly 50 years (see **FIGURE 3**).


**Figure 3. Water Levels in Memphis – 2011 and 2012**

Low water conditions rivaled those observed during the 1988 drought event. By November 2012 water levels on the Mississippi River fell below those experienced in 1988 (see **FIGURE 4**). Beginning in May 2012, the Mississippi River stage reached the lowest level observed in the past 112 years. Heavy rain and flooding in the Mississippi River Basin ended the low water problems in March 2013.

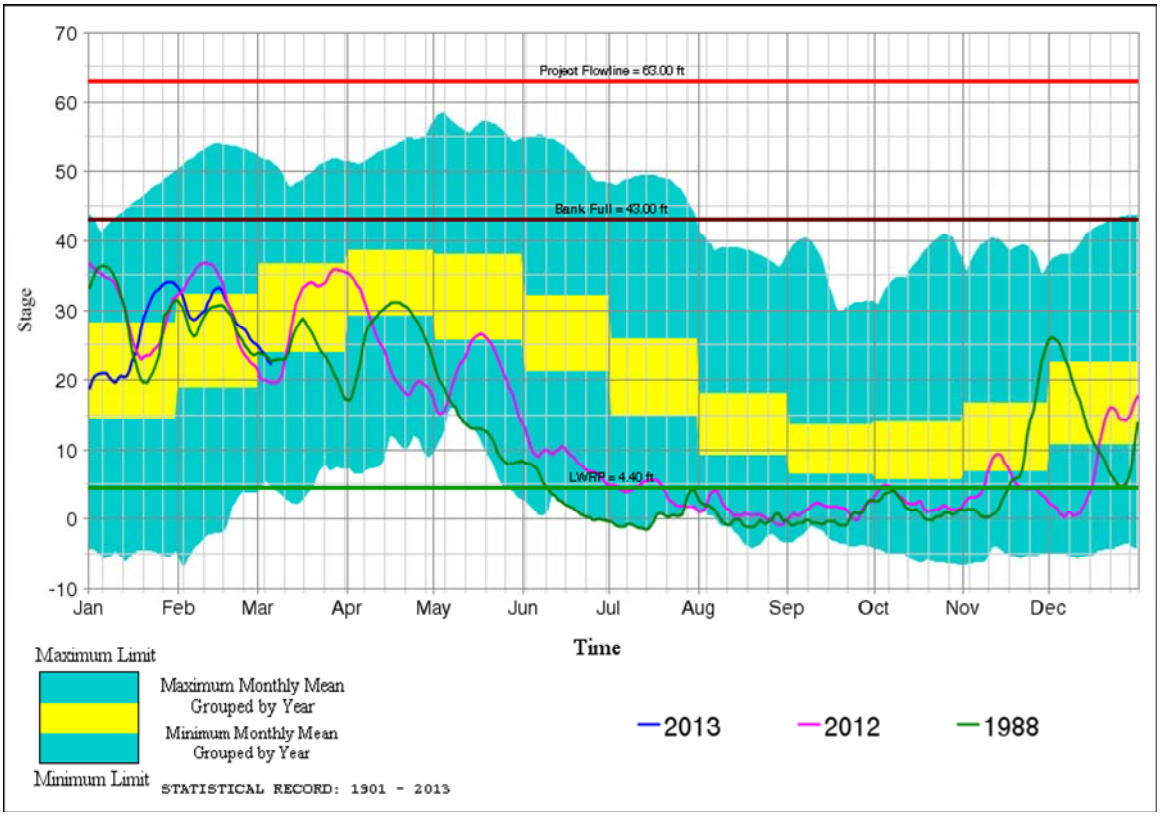


**Figure 4. Mississippi River Stages at Vicksburg, Mississippi**

Low water on these major waterway transportation arteries hampered navigation. Tows accustomed to wide and deep navigable channels began to suffer from groundings along the length of the Mississippi River (see **FIGURE 5**). At Mississippi River LD27, water levels fell below the armor-protected area of sheet pile guide cells. What would ordinarily be routine impacts on the guide cell as tows aligned to enter the locks, led to failure of the cell as impacts occurred on unprotected regions of the sheet pile protection/guide cell. Failure of the cell and subsequent clean-up of gravel spilled from the ruptured cell resulted in closure of the Mississippi River at the location of LD27 for approximately five days from 14 September 2012 until 20 September 2012.

Groundings of tows occurred along nearly the entire length of the Mississippi River, and were especially problematic along the border of northern Illinois, between Thebes and Grand Tower, Illinois and in the general vicinity of Greenville, Mississippi. According to the U.S. Coast Guard, 18 groundings on the Lower Mississippi led to closure events with more than 25 tows in queues. River closures became necessary when tows stuck in shallow water had to be removed, when tows broke apart and barges had to be retrieved and reassembled, or when it was determined that the channel needed to be surveyed, dredged, and channel buoys reset.

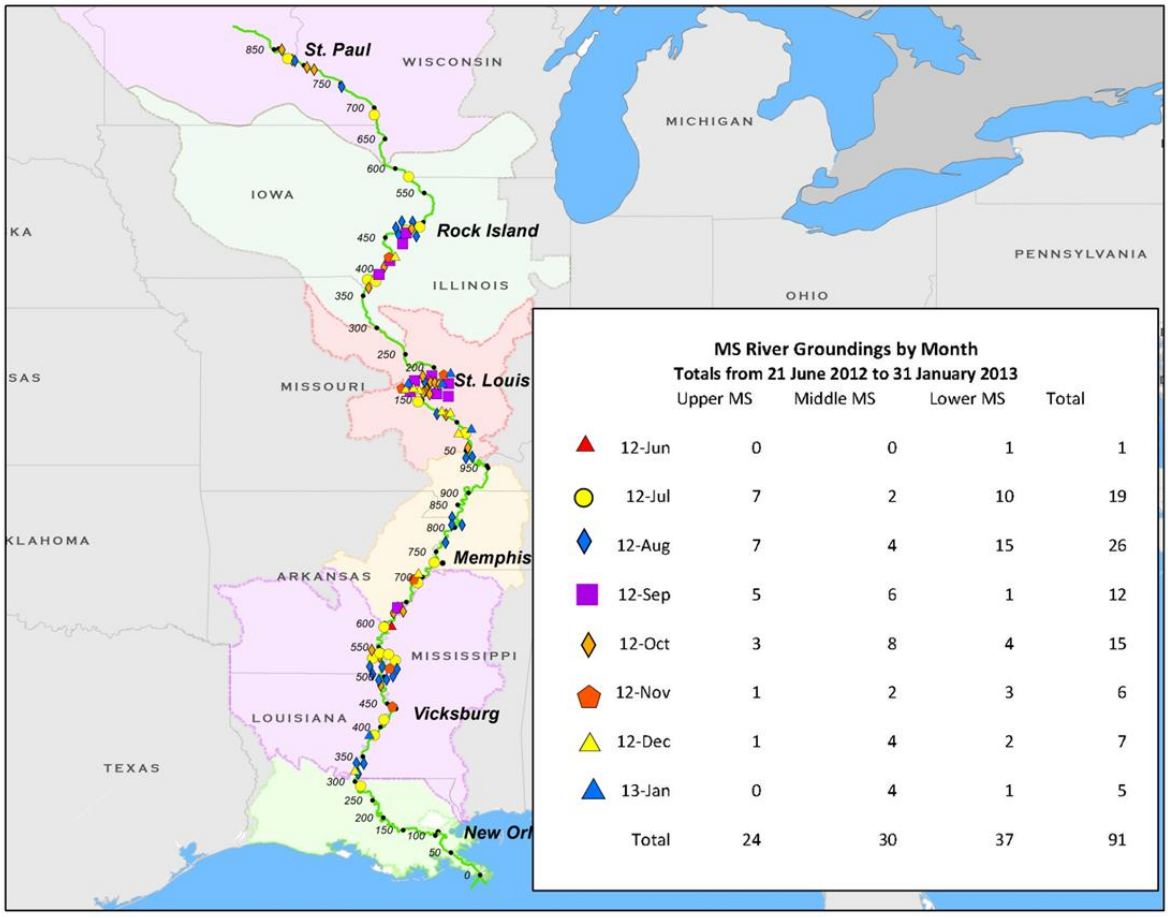


**Figure 5. Groundings through 28 November 2012 as reported by the U.S. Coast Guard**

Water levels on the Mississippi River at Thebes, Illinois and at Grand Tower, Illinois exposed rock ledges that reduced navigable drafts to 9 feet (well below customary drafts of 10 and 11 feet) and restricted the channel to one-way traffic.[5] The Corps removed these hazards in early 2013 (see **FIGURE 6**).


**Figure 6**. **Removal of stone at rock pinnacle.**

[5] According to the US Army Corps of Engineers, St. Louis District, River Projects Manager, there was one-way traffic at the pinnacles with 12 hour closures each day during the removal from 1 Jan 2013 to roughly 15 February 2013. There were also other reaches of the river where there was insufficient channel width of the required depth to permit two-way traffic.

# 3. WATERWAY TRAFFIC

## 3.1 General

Waterway traffic examined in this section focuses on the Lower Mississippi River and lower reaches of the Upper Mississippi, Illinois and Ohio Rivers. While the drought also seriously affected waterways in the southwest and the Missouri River, traffic flows on these other rivers is relatively small in comparison with the Mississippi, Illinois, and Ohio Rivers. Comparable data through December 2012 was available from the U.S. Army Corps of Engineers Waterborne Commerce Statistics (WCS) and Lock Performance Monitoring System (LPMS) data sets; for convenience of comparison, only data through December 2012 is examined in this section of the report.

## 3.2 Traffic Patterns

With the exception of Minnesota, major grain and oilseed producing states saw sharp percentage declines in production that exceeded what was a national decline (See **TABLE 2**). All of these major producing states are touched by navigable waterways. The expectation is that this diminished production of corn and soybeans should be reflected in decreased waterway traffic in these commodities.

**Table 2.** U.S. Corn and Soybean Production, 2010 – 2012

| | IL | IN | IA | MN | MO | NE | OH | US |
|---|---|---|---|---|---|---|---|---|
| Corn (000s bushels) | | | | | | | | |
| 2,010.00 | 1,946,800 | 898,040.00 | 2,153,250 | 1,292,100 | 369,000 | 1,469,100 | 533,010 | 12,446,865 |
| 2,011.00 | 1,946,800 | 839,500 | 2,356,400 | 1,201,200 | 349,980 | 1,536,000 | 508,760 | 12,359,612 |
| 2,012.00 | 1,286,250 | 596,920 | 1,876,900 | 1,374,450 | 247,500 | 1,292,200 | 448,950 | 10,780,296 |
| % change 2011 - 12 | -33.9% | -28.9% | -20.3% | 14.4% | -29.3% | -15.9% | -11.8% | -12.8% |
| Soybeans (000s bushels) | | | | | | | | |
| 2,010.00 | 466,075 | 258,505 | 496,230 | 328,950 | 210,405 | 267,750 | 220,320 | 3,329,181 |
| 2,011.00 | 423,225 | 240,695 | 475,345 | 274,560 | 190,165 | 261,360 | 217,920 | 3,093,524 |
| 2,012.00 | 383,560 | 223,590 | 413,850 | 300,570 | 155,170 | 207,085 | 206,100 | 3,014,998 |
| % change 2011 - 12 | -9.4% | -7.1% | -12.9% | 9.5% | -18.4% | -20.8% | -5.4% | -2.5% |

Source: *Crop Production 2012 Summary,* USDA, National Agricultural Statistics Service, January 2013

### 3.2.1. Waterway Reaches and States

Four waterway reaches that experienced low water conditions and carry bulk commodities in excess of 25 million tons annually were identified for closer examination in this study: 1) the Ohio River between Smithland LD and the mouth of the Ohio River, 2) the Illinois River between Peoria LD and the mouth of the Illinois River, 3) the Mississippi River between the confluence of the Ohio River and Baton Rouge, Louisiana, and 4) the Mississippi River between St. Louis, Missouri and the confluence of the Ohio. In 2011 shippers in 20 states moved commodity through the four reaches, with ten different states (Arkansas, Illinois, Indiana, Kentucky, Louisiana, Missouri, Mississippi, Ohio, Tennessee, and West Virginia) in the top five in shipping or receiving commodities in one or more of these reaches (see **TABLE 3**).

**Table 3. Shipments and Receipts by State**

| State | Ohio River - Smithland LD to Cairo, IL | | Illinois River - Peoria LD to the Mouth | | Mississippi R. - Cairo, IL to Baton Rouge, LA | | Mississippi River - St.Louis to Cairo, IL | |
|---|---|---|---|---|---|---|---|---|
| | ship | receive | ship | receive | ship | receive | ship | receive |
| AL | 1,435 | 4,049 | 214 | 489 | 1,340 | 2,351 | 337 | 1,840 |
| AR | 470 | 972 | 139 | 157 | 6,634 | 6,628 | 235 | 1,336 |
| FL | - | 41 | - | 6 | 30 | 151 | 2 | 64 |
| IA | 292 | 308 | 23 | 5 | 5,088 | 1,532 | 5,380 | 2,397 |
| IL | 27,819 | 4,477 | 19,170 | 11,428 | 45,735 | 10,171 | 49,496 | 14,764 |
| IN | 5,738 | 14,523 | 686 | 863 | 4,994 | 2,713 | 595 | 3,794 |
| KY | 26,306 | 10,540 | 214 | 438 | 20,197 | 6,953 | 902 | 1,465 |
| LA | 16,743 | 37,420 | 6,782 | 13,629 | 44,026 | 114,919 | 14,816 | 58,194 |
| MN | 173 | 122 | 14 | 149 | 4,860 | 2,384 | 5,048 | 3,021 |
| MO | 1,992 | 683 | 938 | 152 | 21,414 | 3,750 | 25,302 | 5,681 |
| MS | 697 | 1,383 | 175 | 104 | 4,473 | 4,508 | 264 | 1,005 |
| NE | - | - | - | - | 8 | 13 | 8 | 13 |
| NY | - | - | - | - | 2 | - | - | - |
| OH | 2,940 | 9,188 | 126 | 112 | 2,011 | 4,956 | 710 | 1,939 |
| OK | 192 | 260 | 138 | 88 | 2,795 | 2,391 | 189 | 240 |
| OT | - | - | - | - | - | 10 | - | 10 |
| PA | 1,143 | 2,266 | 12 | 54 | 860 | 1,848 | 240 | 101 |
| TN | 2,494 | 9,005 | 82 | 719 | 5,770 | 9,870 | 257 | 6,200 |
| TX | 2,930 | 954 | 874 | 1,257 | 5,034 | 5,046 | 1,017 | 2,996 |
| WI | 29 | 2 | - | 4 | 633 | 243 | 664 | 975 |
| WV | 7,984 | 3,184 | 146 | 79 | 6,650 | 2,117 | 1,115 | 542 |

Source: US Army Corps of Engineers, Waterborne Commerce Statistics Center

Note: OT (Other) designates moves to unidentified states.

Between 2011 and 2012 the Illinois reach experienced the greatest percentage decline in traffic (4.7 percent) and the Mississippi River between St. Louis and Cairo, Illinois experienced the greatest tonnage decline at just over 3.2 million tons (see **TABLE 4**). The Mississippi River below Cairo, Illinois actually showed an increase in traffic between 2011 and 2012.

**Table 4. Traffic by Reach**

**(ktons)**

| Waterway Reach | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 1/ | % Change 2011 to 2012 | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | ktons | % Change |
| Ohio River - Smithland LD to Cairo, IL | 108,746 | 113,329 | 94,639 | 101,756 | 99,378 | 98,328 | (1,049) | -1.1% |
| Illinois River - Peoria LD to the Mouth | 32,868 | 30,212 | 29,569 | 29,267 | 29,735 | 28,324 | (1,411) | -4.7% |
| Mississippi River - Cairo, IL to Baton Rouge, LA | 185,872 | 176,329 | 166,557 | 176,879 | 182,551 | 184,779 | 2,228 | 1.2% |
| Mississippi River - St.Louis to Cairo, IL | 109,763 | 98,572 | 104,275 | 102,896 | 106,579 | 103,359 | (3,219) | -3.0% |

Source: US Army Corps of Engineers, Waterborne Commerce Statistics Center

1/ preliminary 2012

Many of the movements represented in the table above transit more than one of the waterway reaches being considered, therefore total tonnage cannot be calculated simply by summing the traffic reported for individual reaches. This value was drawn from the 2011 Waterborne Commerce Statistics, which indicate that in 2011 the total tonnage moving through these reaches was 227.3 million tons. Using available transportation rate studies conducted for navigation improvement studies on the Upper Mississippi, Illinois, and Ohio River, it is estimated that this

tonnage moves at an average transportation rate savings of $25.58 a ton. It is therefore estimated that shippers using this segment of the inland waterway system save a total of $5.8 billion over the best alternative mode and/or route of transportation.

### 3.2.2. Commodities

Coal is the predominant commodity moving through the Ohio reach (see **FIGURE 7**). Corn is the single most dominant commodity moving through the Illinois River reach, though products in the "all other" group represent the majority of this Illinois River reach's tonnage. Petroleum products at 4.5 million tons, chemicals and fertilizers at 5.2 million tons, and iron and steel products at 2.2 million tons are the primary commodities in this group. On both reaches of the Mississippi River coal is the largest single commodity by tons, closely followed by corn. Agricultural products (all grains, oilseeds, vegetable products, and feeds) amounted to 61.8 million tons, or 34 percent of Cairo to Baton Rouge tonnage and 36.9 million tons, or 35%, of St. Louis to Cairo tons.

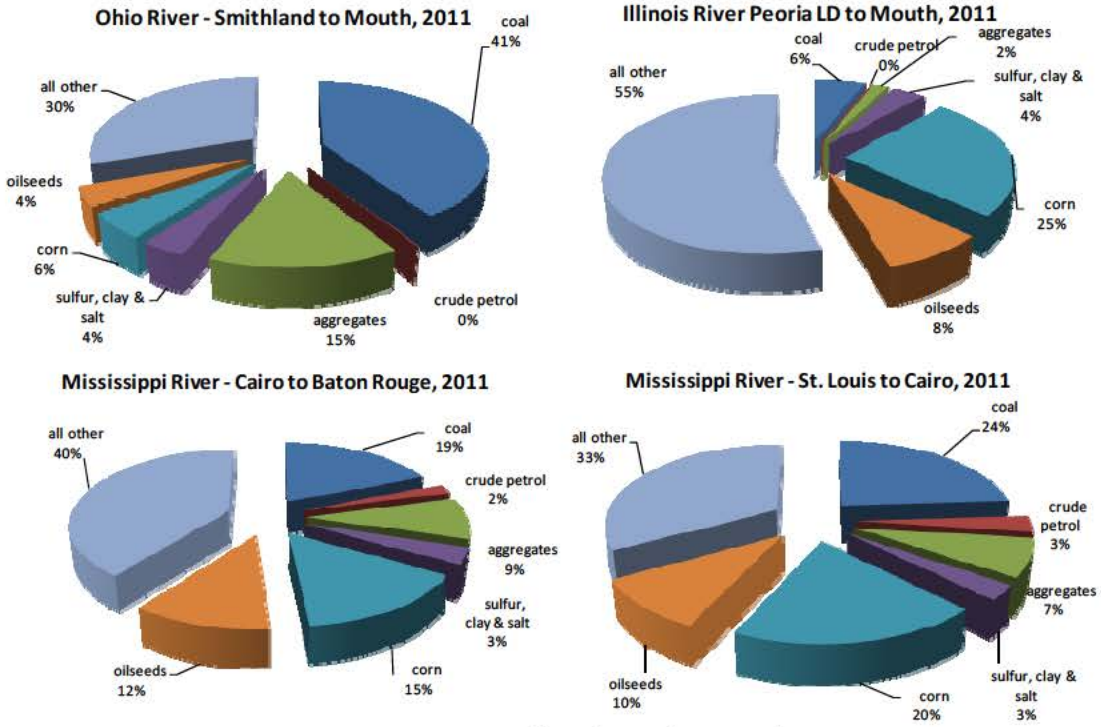


**Figure 7.** Commodity Shares by Reach

Traffic figures by reach and by commodity, shown in **TABLE 5,** begin to display the impact of both lower agricultural production and low water levels on waterway traffic. The Ohio River waterway reach showed only a slight decline (1 percent), but commodities with markets or sources on the lower Mississippi and Gulf Coast showed declines in traffic between 2011 and 2012, typified by the sulfur, clay and salt group.[6] Salt, corn, and stone all showed significant

[6] According to LPMS data, coal traffic at LD53 declined from 14.2 million tons to 12.9 million tons (a 13.6 percent decline) the latter half of 2012 compared with the same period of 2011. This followed an 0.9 million ton increase (7.2 percent) for the first six months of 2012 compared with the same period in 2011.

declines. While corn shipment declines could be tied to decreased production, lower stone and salt shipments were likely the result of low water conditions that affected the cost of shipment or an ability to delay shipment. Oilseeds traffic grew by 25 percent, reflecting a late season improvement in soybean harvest.

**Table 5**. Traffic by Major Commodity, 2007 - 2011
**(ktons)**

| Waterway Reach | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 1/ | % Change 2011 to 2012 ktons | % Change |
|---|---|---|---|---|---|---|---|---|
| **Ohio River - Smithland LD to Cairo, IL** | **108,746** | **113,329** | **94,639** | **101,756** | **99,378** | **98,328** | **(1,049)** | **-1.1%** |
| coal | 37,737 | 46,943 | 37,792 | 38,433 | 40,526 | 41,949 | 1,423 | 3.5% |
| crude petroleum | 106 | 53 | 44 | 46 | 145 | 590 | 445 | 307.2% |
| aggregates | 18,394 | 17,445 | 15,703 | 17,303 | 15,437 | 13,569 | (1,868) | -12.1% |
| sulfur, clay & salt | 2,468 | 3,352 | 3,387 | 3,717 | 3,552 | 2,427 | (1,125) | -31.7% |
| corn | 7,320 | 6,961 | 6,616 | 7,013 | 5,518 | 4,632 | (886) | -16.1% |
| oilseeds | 4,058 | 3,969 | 5,004 | 5,176 | 4,189 | 5,221 | 1,033 | 24.7% |
| all other | 38,664 | 34,607 | 26,093 | 30,067 | 30,012 | 29,941 | (70) | -0.2% |
| **Illinois River - Peoria LD to the Mouth** | **32,868** | **30,212** | **29,569** | **29,267** | **29,735** | **28,324** | **(1,411)** | **-4.7%** |
| coal | 1,597 | 1,548 | 777 | 919 | 1,727 | 1,150 | (576) | -33.4% |
| crude petroleum | 15 | 1 | 21 | 6 | 30 | 583 | 554 | 1863.5% |
| aggregates | 874 | 499 | 495 | 232 | 564 | 743 | 178 | 31.6% |
| sulfur, clay & salt | 1,169 | 2,090 | 2,282 | 881 | 1,125 | 882 | (243) | -21.6% |
| corn | 9,839 | 8,017 | 9,643 | 9,137 | 7,549 | 4,934 | (2,615) | -34.6% |
| oilseeds | 1,940 | 1,650 | 2,637 | 2,769 | 2,503 | 3,808 | 1,305 | 52.1% |
| all other | 17,434 | 16,407 | 13,715 | 15,323 | 16,237 | 16,224 | (13) | -0.1% |
| **Mississippi River - Cairo, IL to Baton Rouge, LA** | **185,872** | **176,329** | **166,557** | **176,879** | **182,551** | **184,779** | **2,228** | **1.2%** |
| coal | 22,208 | 26,629 | 23,326 | 23,648 | 34,122 | 37,163 | 3,041 | 8.9% |
| crude petroleum | 1,383 | 1,848 | 1,852 | 1,901 | 3,984 | 5,764 | 1,780 | 44.7% |
| aggregates | 17,923 | 18,009 | 17,741 | 18,474 | 16,035 | 14,575 | (1,460) | -9.1% |
| sulfur, clay & salt | 5,304 | 7,863 | 7,962 | 6,322 | 6,648 | 4,639 | (2,010) | -30.2% |
| corn | 35,465 | 28,293 | 30,872 | 31,835 | 28,065 | 20,842 | (7,223) | -25.7% |
| oilseeds | 17,966 | 17,648 | 23,807 | 25,216 | 21,324 | 28,369 | 7,045 | 33.0% |
| all other | 85,622 | 76,039 | 60,998 | 69,483 | 72,373 | 73,427 | 1,055 | 1.5% |
| **Mississippi River - St.Louis to Cairo, IL** | **109,763** | **98,572** | **104,275** | **102,896** | **106,579** | **103,359** | **(3,219)** | **-3.0%** |
| coal | 26,428 | 26,228 | 27,127 | 22,262 | 25,589 | 22,290 | (3,299) | -12.9% |
| crude petroleum | 375 | 725 | 677 | 891 | 3,229 | 4,847 | 1,617 | 50.1% |
| aggregates | 9,735 | 8,691 | 8,425 | 8,335 | 7,947 | 8,799 | 852 | 10.7% |
| sulfur, clay & salt | 2,726 | 4,389 | 4,475 | 2,481 | 3,136 | 2,160 | (976) | -31.1% |
| corn | 26,951 | 19,755 | 23,504 | 23,824 | 20,760 | 14,273 | (6,487) | -31.2% |
| oilseeds | 9,687 | 8,642 | 12,531 | 12,471 | 10,682 | 15,354 | 4,672 | 43.7% |
| all other | 33,861 | 30,142 | 27,536 | 32,632 | 35,236 | 35,638 | 402 | 1.1% |

Source: US Army Corps of Engineers, Waterborne Commerce Statistics Center

1/ Preliminary 2012

The Illinois River reach showed the greatest percentage decline between 2011 and 2012 (5 percent), with declines in corn (35 percent), coal (33 percent), and salt (22 percent) showing the largest decreases. Coal declines were influenced by the closure of a coal-fired electric utility

plant in late 2011.[7] Like the Ohio, commodities moving to and from the lower Mississippi were most affected. The Mississippi River between Cairo and Baton Rouge had sizable declines in salt (30 percent) and corn (26 percent), while oilseed traffic grew (33 percent). The Mississippi River between St. Louis and Cairo declined the most in tonnage (3.2 million tons), with salt and corn both declining by 31 percent. Oilseeds increased by 44 percent and stone by 10 percent. Given the 51 percent decrease in U.S. corn exports (refer to **TABLE 1**), it is not surprising that corn traffic to the Gulf would decline when approximately half of all U.S. corn exports move by barge to the lower Mississippi and Gulf Coast. The "all other" commodity group was the least affected by the drought. All four river reaches experienced sharp percentage increases in crude oil movements, though the tonnages were relatively small in each reach. These increases likely reflected the first significant movement of shale gas liquids on the inland waterway system.

### 3.2.3. Monthly Shipping Patterns

The Corps' Lock Performance Monitoring System (LPMS) data has reliable information on tow transits, commodity tonnages, and barge counts by month at all Corps lock and dam projects. Three locks– Ohio River LD53, Mississippi River LD27, and Peoria LD – were selected for closer examination of shipping patterns (discussed in this section) and fleet utilization (discussed in the next section). Ohio River LD53 is the closest Ohio River lock to the mouth of the Ohio River, so it offers a fair representation of traffic on the lower reach of the Ohio. Similarly, Peoria LD is closest to the mouth of the Illinois River and Mississippi River LD27 is the furthest downstream lock on the Mississippi. Each offers fair representations of the Peoria to the mouth of the Illinois and St. Louis to Cairo reaches of these two rivers, respectively.

As seen in **FIGURE 8**, monthly traffic at Ohio River LD53 ranged between 5.0 million and 7.0 million tons per month in the years selected for analysis (2007, 2011, and 2012).

[7] Ameren Energy closed the Meredosia plant in late 2011. See www.futuregenalliance.org/community-cogen/2013/03/ accessed 26 July 2013.

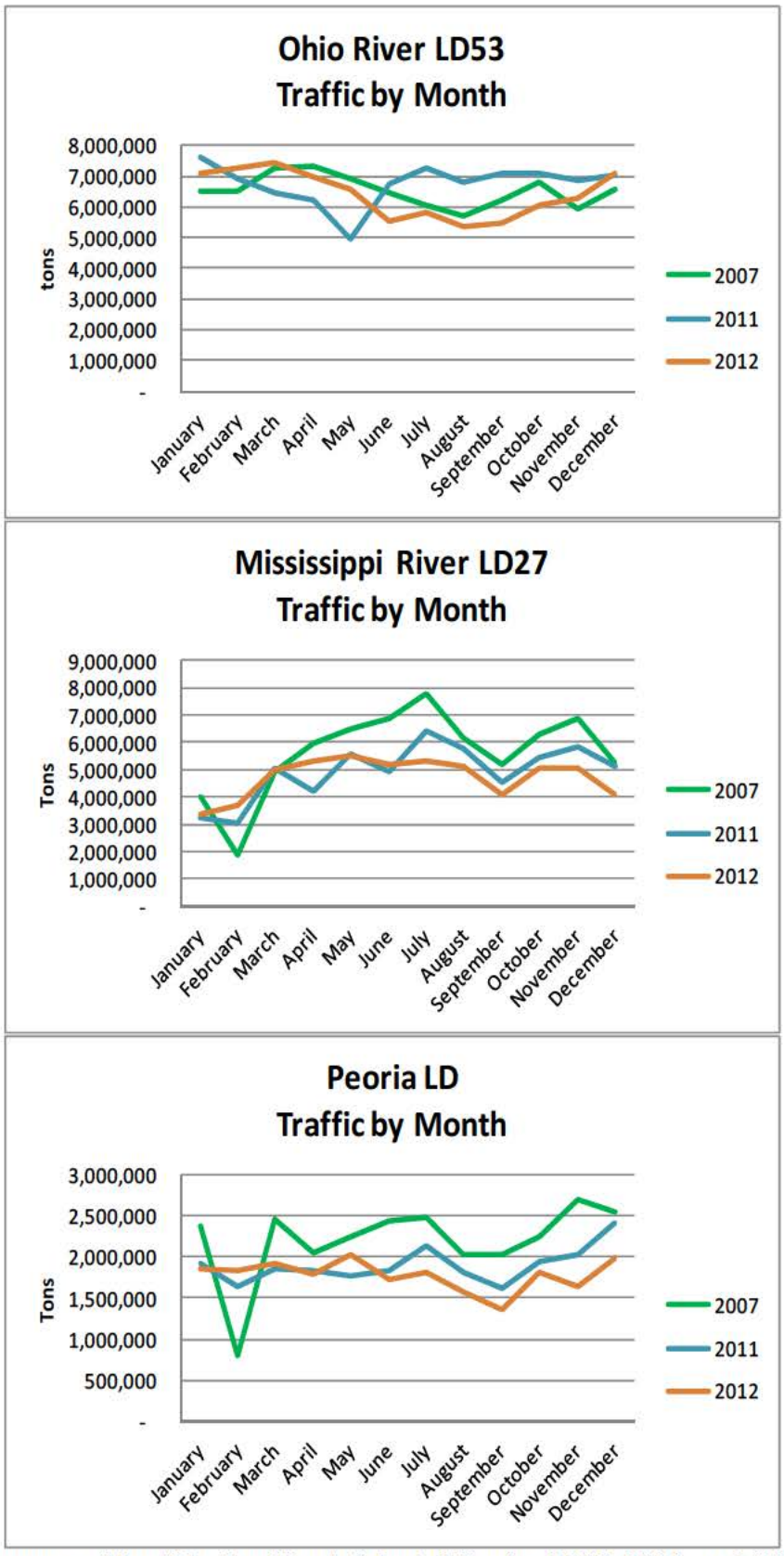


**Figure 8. Monthly Traffic at Selected Locks, 2007, 2011, and 2012**

The range of variation would likely have been tighter except for the high water event in the spring of 2011 (see **FIGURE 9**), which caused a sharp drop in traffic in May of that year. Traffic at Mississippi River LD27 and Peoria LD follows a more cyclical pattern than that shown on the Ohio River. July and November are typically peak months at LD27 and July and November/December at Peoria LD. Monthly volumes in 2012 mirrored those of 2011 at both locks, though at lower levels, particularly in the summer and fall when the drought was most intense.

**Figure 9. Powerhouse at Ohio River LD53, Spring 2011**

## 3.3 Middle Mississippi - Traffic Past Thebes, Illinois

Navigating the Middle Mississippi River between St. Louis and Cairo, Illinois, especially in the vicinity of Thebes, Illinois and Grand Tower, Illinois was a serious challenge for vessel operators.[8] These two stretches experienced low water that exposed rock ledges, called pinnacles, which exposed vessels to grounding and damage. Traffic was restricted to one way for periods in the fall of 2012, and the U.S. Coast Guard imposed tow size and draft restrictions. Large towboats that customarily move through these reaches could not navigate the restricted draft around Thebes and Grand Tower, Illinois, necessitating the shuttling of barges through this reach and refleeting above and below the constrictions.

Waterway carriers were apparently determined to satisfy shipper needs as traffic through the restricted reaches at Thebes, Illinois was largely unchanged between 2011 and 2012 ( see **TABLE 6**). Declines in corn traffic related to lower corn production were replaced with higher downbound moves of soybean, aggregates, and crude petroleum.

[8] See http://www.stltoday.com/news/local/metro/low-water-on-mississippi-river-causes-barge-companies-to-lighten/article_2b1505f1-ab93-5e73-9a36-d43ff5c8c0b6.html

**Table 6. Waterway Traffic Past Thebes, Illinois**

| LPMS Name | 2011 | | | 2012 | | |
|---|---|---|---|---|---|---|
| | Up | Down | Total | Up | Down | Total |
| Coal,Lignite & Coal Coke | 2,274,342 | 20,849,891 | 23,124,233 | 2,092,647 | 18,825,680 | 20,918,327 |
| Crude Petroleum | 22,853 | 3,206,496 | 3,229,349 | 29,239 | 4,780,424 | 4,809,663 |
| Distillate,Residual & Other Fuel Oils; Lube Oil & Greases | 730,648 | 2,305,378 | 3,036,026 | 614,765 | 2,113,449 | 2,728,214 |
| Petroleum Pitches, Coke, Asphalt, Naptha and Solvents | 335,480 | 2,427,538 | 2,763,018 | 342,221 | 3,161,000 | 3,503,221 |
| Fertilizers | 6,004,043 | 249,240 | 6,253,283 | 5,905,454 | 229,606 | 6,135,060 |
| Other Chemicals and Related Products | 2 800 138 | 2 417 289 | 5 217 427 | 2 760 812 | 2 127 573 | 4 888 385 |
| Sand, Gravel, Stone, Rock, Limestone, Soil, Dredged Material | 729,938 | 5,715,696 | 6,445,634 | 807,605 | 7,380,288 | 8,187,893 |
| Iron Ore and Iron & Steel Waste & Scrap | 331 790 | 1 042 578 | 1 374 368 | 252 297 | 918 336 | 1 170 633 |
| Sulphur (Dry), Clay & Salt | 3,020,775 | 114,884 | 3,135,659 | 2,091,825 | 100,469 | 2,192,294 |
| Slag | 226,099 | 150,649 | 376,748 | 362,250 | 113,363 | 475,613 |
| Building Cement & Concrete; Lime; Glass | 69,839 | 3,343,391 | 3,413,230 | 76,587 | 3,914,565 | 3,991,152 |
| Primary Iron and Steel Products (Ingots,Bars,Rods,etc.) | 2,077,909 | 414,447 | 2,492,356 | 2,498,038 | 456,312 | 2,954,350 |
| Wheat | 3,366 | 1,640,911 | 1,644,277 | 5,418 | 1,406,811 | 1,412,229 |
| Corn | 8,956 | 20,548,560 | 20,557,516 | 327,740 | 13,783,421 | 14,111,161 |
| Oilseeds (Soybean, Flaxseed and Others) | 68,755 | 10,534,468 | 10,603,223 | 91,354 | 15,187,093 | 15,278,447 |
| Animal Feed, Grain Mill Products, Flour, Processed Grains | 52,619 | 2,972,138 | 3,024,757 | 79,030 | 2,537,614 | 2,616,644 |
| All Others | 1,817,209 | 953,399 | 2,770,608 | 1,833,834 | 976,248 | 2,810,082 |
| **TOTAL** | **20,574,759** | **78,886,953** | **99,461,712** | **20,171,116** | **78,012,252** | **98,183,368** |

*Source: Waterborne Commerce Statistics*

Note: Orange shaded cells denote commodities where declines greater than 1,000,000 tons were experienced between 2011 and 2012, while green shaded cells denote growth of greater than 1,000,000 tons between 2011 and 2012.

## 3.4 Lower Mississippi - Traffic at Greenville, Mississippi

With flows falling throughout the summer on the heavily used Lower Mississippi River, tow groundings began to occur - the first being reported on 11 May 2012. Groundings led the U.S. Coast Guard to restrict drafts and tow sizes on the Lower Mississippi, where some reaches required dredging in order for vessels to safely navigate.[9] One of the more widely reported events occurred on an 11-mile stretch of the river near Greenville, Mississippi, where intermittent river closures occurred to accommodate the freeing of grounded tows, surveying of channel, and dredging to open channel. It was reported that on August 20, 2012 that nearly 100 tows had been delayed near Greenville waiting for the channel to reopen.[10] Similar events occurred along the Lower Mississippi in locations including Memphis, Tennessee; Helena, Arkansas; and Natchez, Mississippi.

According to the U.S. Coast Guard, 18 groundings led to closure events with more than 25 tows in queues. In total, these events caused 1,130 tows and 17,640 barges to be delayed. Closures of the river occurred when tows needed to be pulled from bars or banks, reassembled after breaking-up upon running aground, or when channel work was required. Industry worked together to free and re-assemble tows. Where groundings became frequent in specific areas, the U.S. Coast Guard, the U.S. Army Corps of Engineers, and industry jointly determined when a river closure was necessary to allow the Corps to survey and dredge the channel and the Coast Guard to reset buoys that mark the channel. By June draft restrictions were set at 10'6", northbound tow sizes to 42 barges per tow, and southbound tows to 36 barges per tow. In early July drafts were down to 9'6" and tow sizes further reduced; in late July drafts were restricted to 9', northbound tow sizes to 20 loaded barges per tow, and southbound tow sizes to 30 barges per

[9] http://cornandsoybeandigest.com/issues/forced-barge-light-loading-low-mississippi-river accessed 31 July 2013.

[10] http://earthobservatory.nasa.gov/IOTD/view.php?id=78927 accessed on 31 July 2013.

tow. By mid-August one way traffic was instituted in problem reaches, drafts were limited to 9' and tow sizes limited further. Draft and tow size restrictions were gradually relaxed, but it was not until 14 December 2012 that all restrictions were lifted.

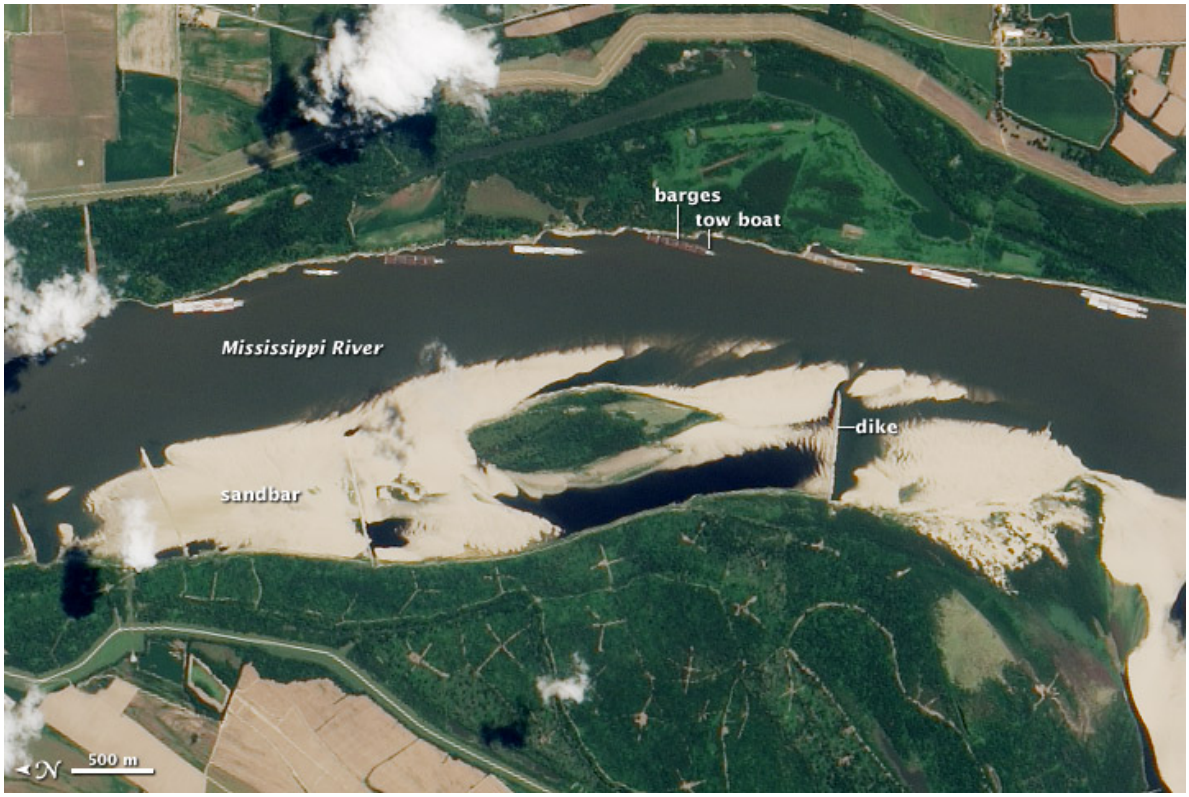


**Figure 10. Tows delayed due to low-water at Greenville, Mississippi, August 20, 2012**
Source: NASA. See footnote number 7.

Like the Thebes, Illinois constriction point, the Greenville, Mississippi constriction did not affect traffic levels, in fact, traffic increased by 2 million tons between 2011 and 2012 (see **TABLE 7**). The effects of the low water can be seen in the tons per loaded barge, which declined by 46 tons on average for the entire year. As with the constriction at Thebes, waterway carriers were apparently determined to satisfy shipper needs, though this came at higher transportation costs. Corn harvests along the Lower Mississippi were less affected by the drought than in the traditional Corn Belt regions served by the Upper Mississippi, Ohio, and Illinois Rivers, which coupled with stronger soybean traffic, led to increased traffic through this reach as opposed to more steady traffic through Thebes.

**Table 7**. Loaded Barges Past Greenville, Mississippi – 2011 and 2012

| | 2011 | 2012 | Difference 2011 - 2012 |
|---|---|---|---|
| **Loaded Barges** | 92,108 | 95,760 | 3,652 |
| **Tons** | 163,314,542 | 165,384,334 | 2,069,792 |
| **Tons per Loaded Barge** | 1773.1 | 1727.1 | (46) |

Source: U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center

## 3.5 Fleet Utilization

The Corps' Lock Performance Monitoring System (LPMS) data was examined at the three gateway locks discussed above, this time for evidence of altered vessel operation patterns. As seen in **FIGURE 11**, the effect of the 2011 high water event on the lower Ohio River is reflected in lower tow counts in April and May of that year; otherwise tow counts are fairly similar between 2011 and 2012. The drought's effect was more apparent at Mississippi River LD27 and at Peoria LD where tow counts were down significantly between 2011 and 2012 during the summer and fall months.

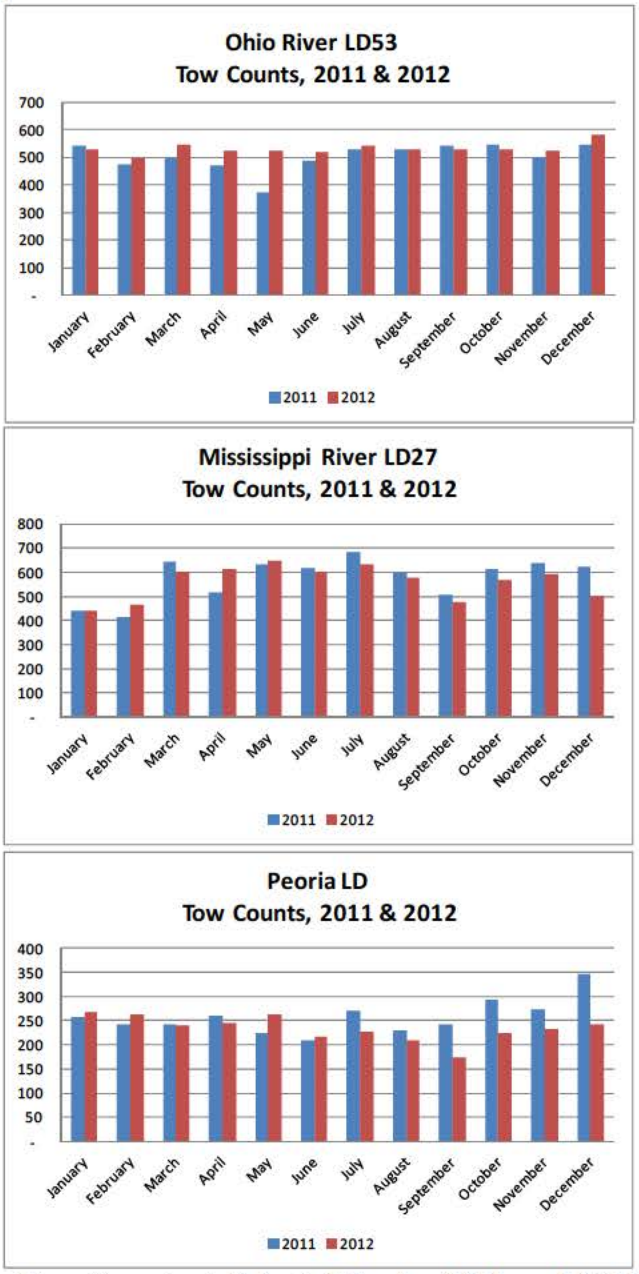


**Figure 11. Tow Counts at Selected Locks, 2011 and 2012**

Barges per tow and composition of tows did not change dramatically at any of the three locks between 2011 and 2012 (see **TABLE 8**). The most significant change occurred at LD53 where barges per tow dropped from 11.7 per tow to 11.1 per tow, while the percentage of empties increased by 3 percent. Tow sizes at LD27 remained around 7.5 barges per tow and grew slightly from 6.4 to 6.7 barges per tow at Peoria LD. Significantly fewer loaded barges were processed at each of the three locks.

**Table 8. Barges, Tows and Barges per Tow, Selected Locks**

| | Barges | | | | | TOTAL | Barges |
|---|---|---|---|---|---|---|---|
| | Loaded | % Loaded | Empty | % Empty | Total | Tows | per Tow |
| **LD 53** | | | | | | | |
| 2007 | 48,592 | 68% | 23,187 | 32% | 71,779 | 7,039 | 10.2 |
| 2008 | 48,009 | 68% | 22,434 | 32% | 70,443 | 6,624 | 10.6 |
| 2009 | 40,352 | 65% | 21,706 | 35% | 62,058 | 5,489 | 11.3 |
| 2010 | 47,030 | 67% | 23,602 | 33% | 70,632 | 5,984 | 11.8 |
| 2011 | 47,465 | 67% | 22,863 | 33% | 70,328 | 6,021 | 11.7 |
| 2012 | 45,064 | 64% | 25,656 | 36% | 70,720 | 6,352 | 11.1 |
| **LD 27** | | | | | | | |
| 2007 | 41,019 | 67% | 20,574 | 33% | 61,593 | 7,217 | 8.5 |
| 2008 | 35,391 | 70% | 15,343 | 30% | 50,734 | 6,456 | 7.9 |
| 2009 | 37,259 | 64% | 20,868 | 36% | 58,127 | 6,753 | 8.6 |
| 2010 | 35,647 | 65% | 19,299 | 35% | 54,946 | 6,792 | 8.1 |
| 2011 | 34,799 | 68% | 16,709 | 32% | 51,508 | 6,909 | 7.5 |
| 2012 | 34,237 | 67% | 16,904 | 33% | 51,141 | 6,713 | 7.6 |
| **Peoria** | | | | | | | |
| 2007 | 15,336 | 67% | 7,519 | 33% | 22,855 | 3,264 | 7.0 |
| 2008 | 13,526 | 69% | 5,981 | 31% | 19,507 | 3,063 | 6.4 |
| 2009 | 13,376 | 64% | 7,677 | 36% | 21,053 | 3,028 | 7.0 |
| 2010 | 13,452 | 65% | 7,402 | 35% | 20,854 | 3,044 | 6.9 |
| 2011 | 13,265 | 67% | 6,621 | 33% | 19,886 | 3,087 | 6.4 |
| 2012 | 12,702 | 67% | 6,185 | 33% | 18,887 | 2,803 | 6.7 |

The effect on total tons of fewer loaded barges through these locks was heightened by lighter loadings measured in tons per barge (see **FIGURE 12**), which occurred in the late summer and fall of 2012. At LD27 loadings were down approximately 100 tons per barge in October, November, and December of 2012 when compared with the same months in 2011, and down approximately 75 tons per barge in October and November at Peoria LD.

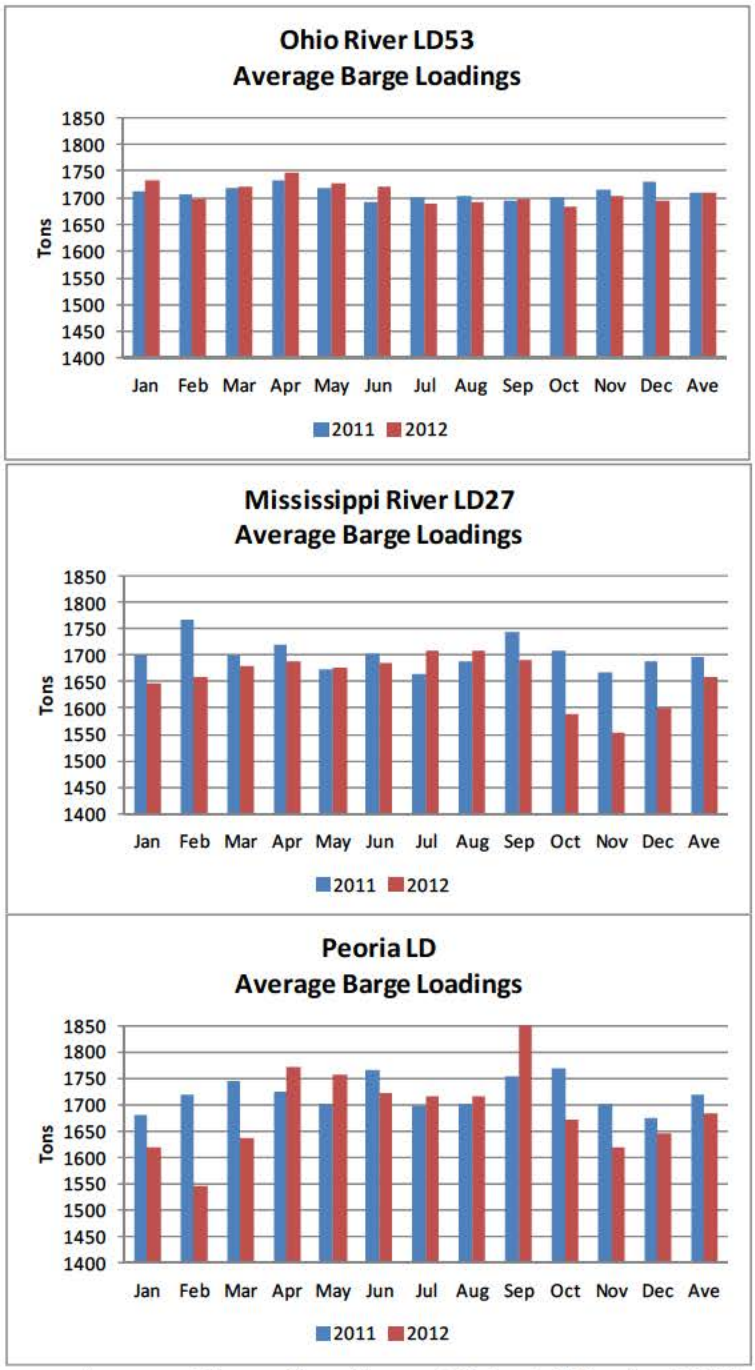


**Figure 12. Average Barge Loadings at Selected Locks, 2011 & 2012**

The combination of fewer barges per tow and lighter loadings at LD27 and Peoria continued a trend at these two locks of fewer tons per tow (see **FIGURE 13**). A distinct pattern emerges at LD27, one that mirrors the pattern of grain shipments. Significantly larger tons per tow occur during the peak grain shipping season. These cyclical variations occur each year, though the peaks and valleys have smoothed with each passing year. In 2012 the cyclical pattern is all but unnoticeable. At LD53 the combination of smaller tows, a greater percentage of empty barges,

and somewhat lighter loadings caused tons per tow to drop steeply toward the end of 2012 despite an increase of over 300 tow transits that year.

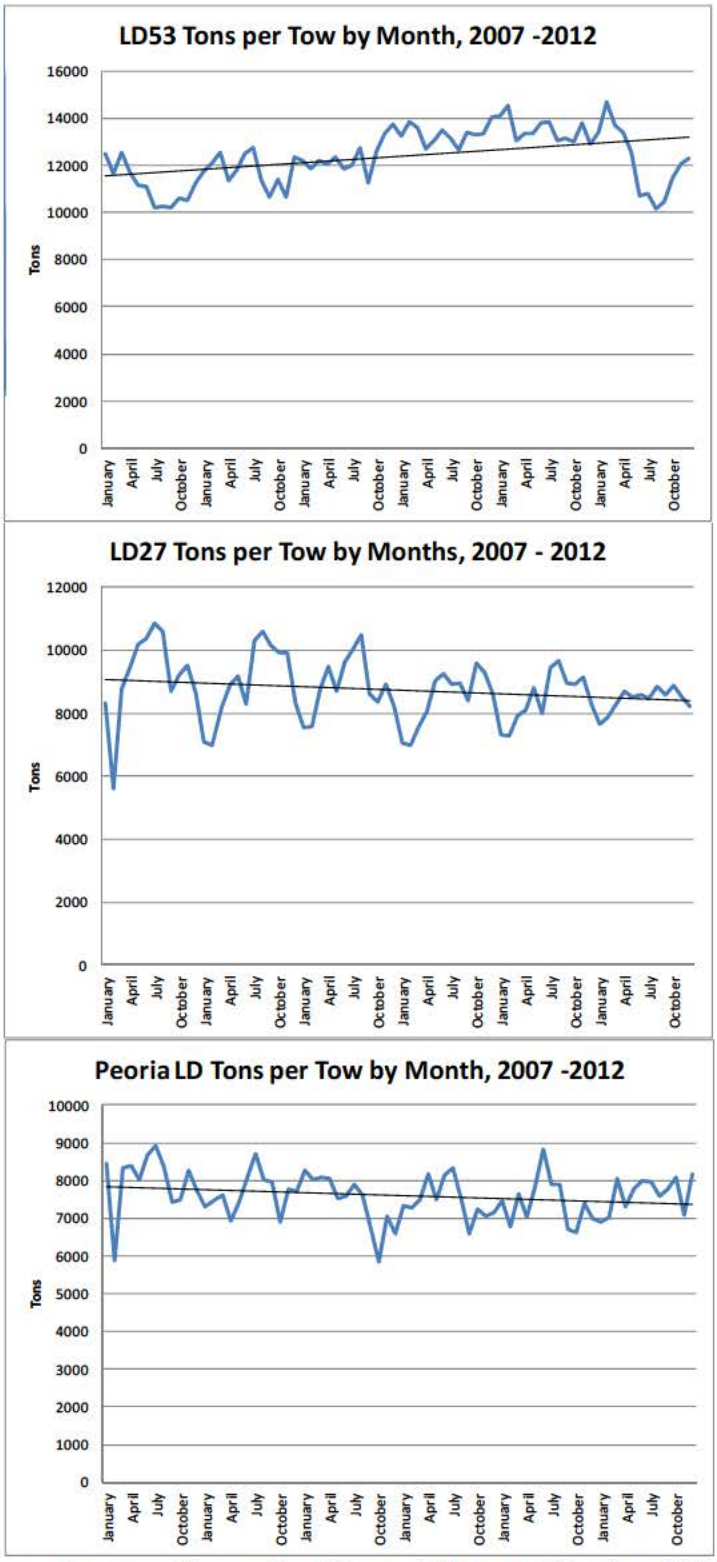


**Figure 13. Average Barge Loadings at Selected Locks, 2007 - 2012**

## 3.6 Summary and Conclusions

Traffic patterns were examined on the four high volume waterway segments affected by low water in 2012. With the exception of the Lower Mississippi from Cairo, Illinois to Baton Rouge, Louisiana, each segment experienced lower traffic in 2012 than in 2011. Sharp declines in corn traffic, undoubtedly related to a greatly diminished harvest, explain most of the traffic decline, though carriers continued to maintain volumes otherwise.

When looking at monthly traffic levels reported in the LPMS data for the gateway locks to the Ohio, Illinois, and Upper Mississippi (Ohio River LD53, Peoria LD and LD 27), typical cyclical patterns of shipment are apparent in 2012, but at lower levels. Vessel operators ran significantly fewer tows in the summer and fall, moved fewer barges at LD27 and Peoria, but more barges at OH53 – this increase being explained by the increased movement of empty barges. Tows pushed fewer loaded barges that were more lightly loaded (100 tons per barge less than average at LD27). The end result was lower traffic at each of these three projects.

Unfortunately, there is no data equivalent to LPMS available at the constriction points on the Mississippi River at Thebes and Grand Tower, Illinois that will describe how vessel operators configured their tows. We do know that there were vessel draft restrictions that affected both loadings and the size of towboats, as well as tow size restrictions. According to the Waterborne Commerce Statistics, waterway traffic at Thebes, Illinois and Greenville, Mississippi changed only slightly between 2011 and 2012, declining by 1.2 percent at Thebes and increasing by 1.2 percent at Greenville. Average tons per barge declined at both locations for the year. We also know from surveys and discussions with vessel operators (discussed in subsequent sections) that fleeting operations were initiated above and below the Middle Mississippi reach between Thebes and Grand Tower, Illinois in order to optimize the use of a limited number of smaller towboats required through this reach, while still utilizing the larger towboats that typically move through this area.

# 4. LD27 CLOSURE ANALYSIS

## 4.1 General

Mississippi River Locks and Dam 27 (LD27) is located on the Upper Mississippi River at mile 184.5 near Granite City, Illinois and just above St. Louis, Missouri. It is the 4th busiest lock in terms of tonnage, processing 25.0 million tons of agricultural products, 10.1 million tons of chemicals, and 10.1 million tons of petroleum products in 2012. Three closures of special note occurred at this project in 2012. The first was a main chamber closure which occurred in January of 2012. The second was an emergency closure of both chambers caused by an accident related to low water conditions at the lock. The third outage was a planned closure of the main chamber to remove the guide cell damaged during the September accident.

The U.S. Army Corps of Engineers, Lock Performance Monitoring System (LPMS) collects traffic and processing data from each of its lock projects. LPMS data for LD27 was analyzed in order to estimate the cost impact on waterway carriers of all three closures, the latter two being directly related to the low-water experienced in 2012. The January 2012 closure analysis offers some perspective when evaluating the economic impact on carriers of the five day outage of the project that was related to low water. Section 4.2 examines the first two closures and Section 4.3 the third closure that began in 2012 and ended in 2013.

## 4.2 January and September 2012 Outages

The January 2012 closure was a scheduled closure of the 1200' x 110' main chamber. The outage began on 4 January 2012 at 0433 hours and ended when the chamber was reopened on 15 March 2012 at 0039 hours. The closure allowed for an embedded metal repair to be completed. The main chamber was closed for 1700 hours, or approximately 70 days and 20 hours. The second closure occurred on 15 September 2012 at 0232 hours when a guide cell was ruptured by a tow allision. The resulting gravel spill from within the cell and damage to the guide cell prohibited safe passage through the main chamber. A little over 15 hours later, at 1527 hours, the auxiliary chamber closed, resulting in a total river closure. Both the main and auxiliary chambers were reopened 20 September 2012 at 0330 hours; therefore, for 5 days and 3 hours the Mississippi River was completely closed to waterway traffic at LD27.

### 4.2.1 Tow Arrivals

**FIGURE 14** shows the arrivals per day at LD27 for the months of January – September 2012. Average tow arrivals per day for the period outside the closures, 15 March through 15 September 2012, was 19.0 tows per day. Average arrivals per day for the first closure period, 4 January through 15 March 2012, decreased from the 19.0 tows per day outside the closure period to 15.2 tows per day. Average arrivals per day for the second closure period, 15 September through 20 September 2012, were 11.6 tows per day versus the 19.0 tows per day outside the closure period.

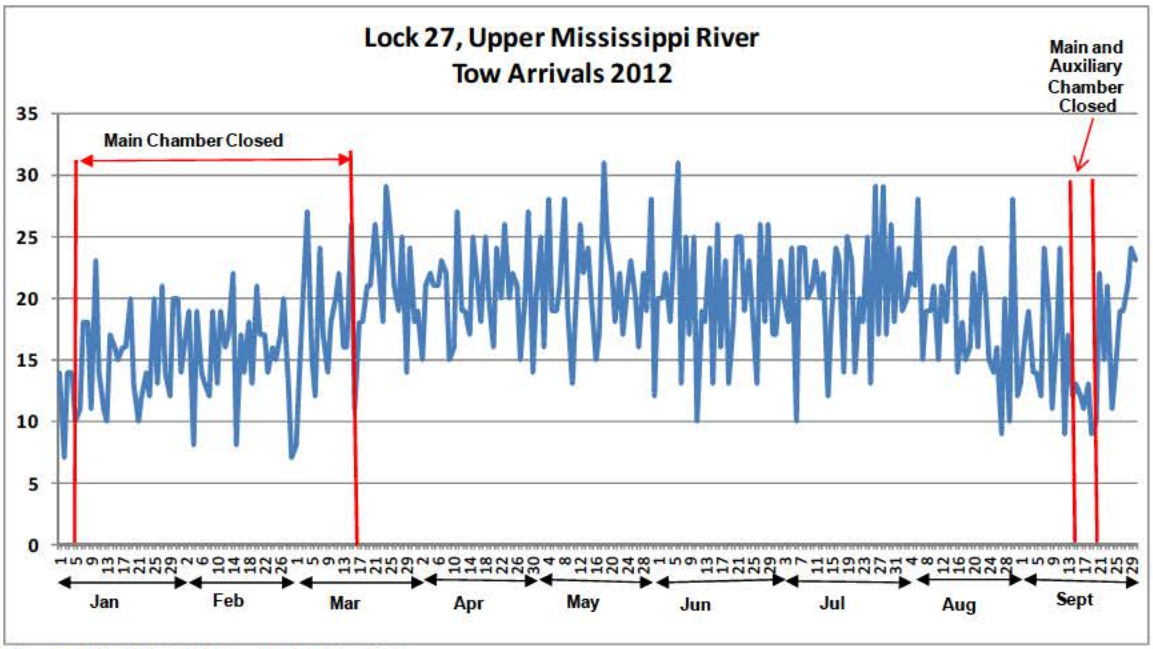


**Figure 14. LD27 Tow Arrivals 2012**

### 4.2.2 Tow Processing Time

During the first closure of the 1200' main chamber that occurred from January through March, 1,089 tows transited LD27's auxiliary chamber. The average processing time increased from 48 minutes, for all tows outside the January through March 2012 closure, to 78 minutes during the closure.

At the beginning of the second main chamber closure from 0020 through 1527 on 15 September 2012, only two tows transited LD27 auxiliary chamber. The average processing time increased from 48 minutes, for all tows outside the September closure, to 209 minutes during the closure.

The 2012 closures increased the processing time 30 minutes per tow. The 1,091 tows that transited the auxiliary chamber during the main chamber closures caused an additional 549 hours of tow transit time.

### 4.2.3 Tow Delays

**FIGURE 15** shows delays at LD27 for the period from January - September 2012. Delays started building soon after the 1200' chamber closed and continued until 17 March 2012 at 0110 hours. This means that the 1700 hour closure impacted traffic for 1,749 hours. The 49 hour difference represents the time required for the reopened chamber to serve the tows in queue and bring the delay back to zero. During the impact period, 16,366 hours of tow delay were experienced by 1,148 tows. This results in an average delay of 14.3 hours/tow for the first closure in year 2012 from January through March. By comparison, 4,054 tows were served at

LD27 outside the January - March and September 2012 closure periods. The average normal delay per tow was 183 minutes or approximately 3.1 hours. Given that the average additional delay per tow was 11.2 hours for the January – March closure, and that 1,148 tows were impacted, the closure caused 12,866 hours of additional delay.

With the September 2012 closure, delays started building soon after the 1200' and 600' chamber closed and continued until 25 September 2012 at 1135 hours. This means that the 123 hour river closure impacted traffic for 251 hours. The 128 hour difference represents the time required for the reopened chambers to serve the tows in queue and bring the delay back to zero. During the impact period, 6,498 hours of tow delay were experienced by 141 tows. This resulted in an average delay of 46 hours/tow. Given that the average normal delay per tow was 3.1 hours, the average additional delay per tow was 43 hours for the September closure, and that 141 tows were impacted, the closure caused 6,068 hours of additional delay.

A total of 1,288 tows were impacted in 2012 which caused an additional delay of 18,934 hours. Therefore, on average, each tow experienced 14.7 hours more delay during the closure than normal. The maximum delay was 127 hours.

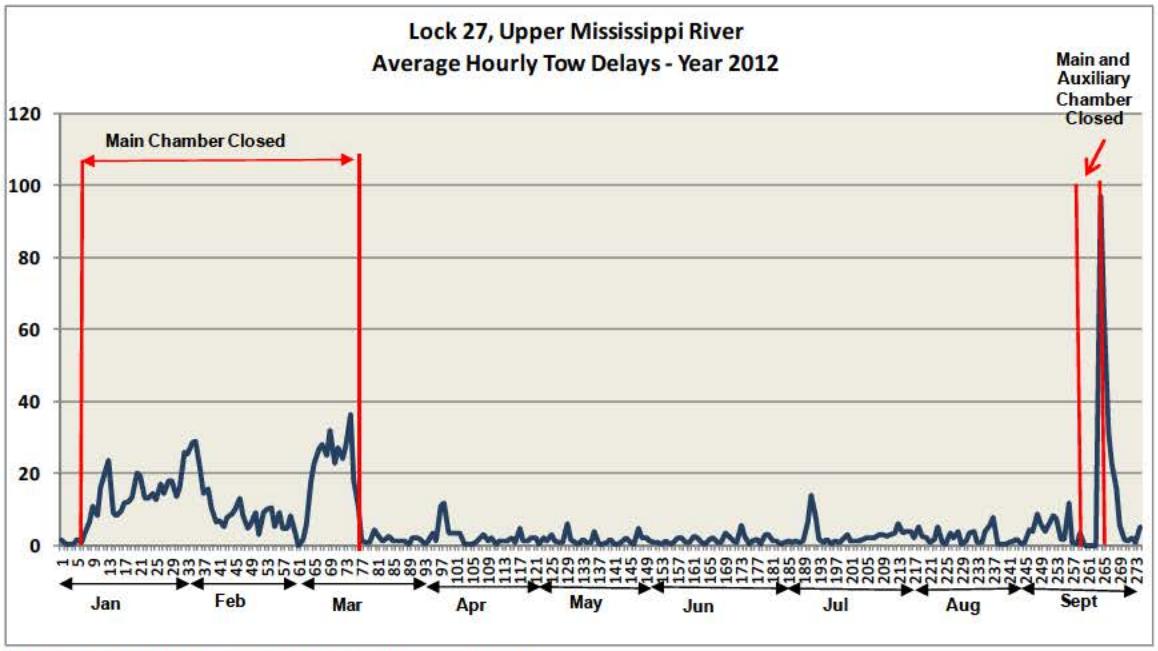


**Figure 15. LD27 Average Hourly Delays, 2012**

### 4.2.4 Cost Impact

The analysis above shows that the January through March 2012 closure caused an additional 543 hours of processing time and 12,866 hours of delay. Given this additional transit time and average hourly operating costs for tows at LD27, the January through March closure cost carriers an additional $8.7 million to process through the lock. The September closure caused an additional 5 hours of processing time and 6,068 hours of delay, for a total closure cost of approximately $3.9 million. While the 70 day closure of the main chamber resulted in additional

costs of $124,000 per day, the much shorter 6 day closure (with 5 days of total river closure) cost industry a much higher $550,000 per day in delay time.

## 4.3 December 2012 through March 2013 Main Chamber Closure

The third and final closure at LD27 occurred between 10 December 2012 and 2 March 2013 when the Corps removed the guide cell damaged in September 2012. Removal of the guide cell necessitated closure of the main chamber (and some brief closures of the auxiliary chamber). The main chamber was closed for 1,968 hours, or approximately 82 days.

### 4.3.1 Tow Arrivals

**FIGURE 16** shows the arrivals per day at LD27 for the months of November 2012 – April 2013. Average tow arrivals per day for the period outside the closures from 1 June 2012 through 31 May 2013 were 18.3 tows per day. Average arrivals per day for the closure period, 10 December 2012 through 2 March 2013, decreased to 12.7 tows per day.

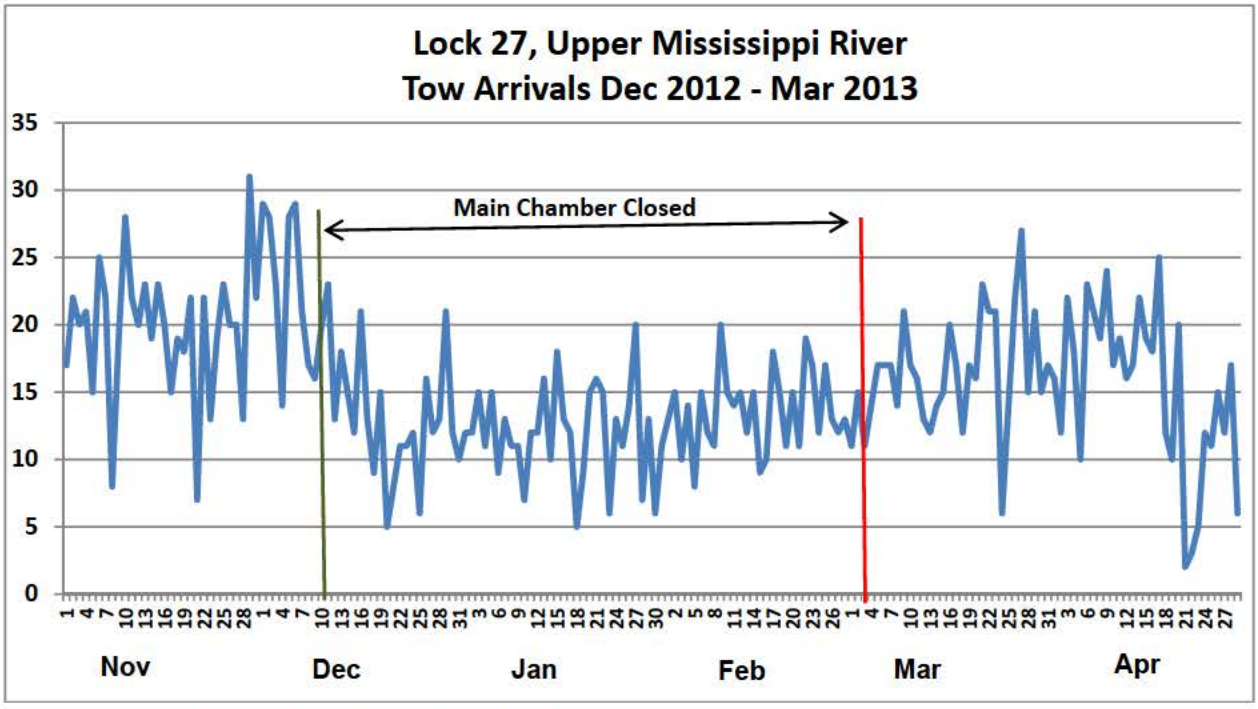


**Figure 16. LD27 Tow Arrivals, December 2012 – March 2013**

### 4.3.2 Tow Processing Time

During the closure of the 1200' chamber, 35% of the tows through LD27 had to double cut – the tow flotilla had to be broken into two parts and each part of the flotilla locked through separately. This increased the average processing time from 51 minutes, for all tows outside the December 2012 through March 2013 closure, to 88 minutes during the closures. During the closures 1,032 tows transited LD27. Given an increase in time of 37 minutes per tow and 1,032 tows, an additional 643 hours of tow processing time was experienced during the closure.

### 4.3.3 Tow Delays

**FIGURE 17** shows delays at LD27 for the December 2012 through March 2013 closure period. Delays started building soon after the 1200' chambers closed on 10 December 2012 at 1530 hours and continued until 4 March 2013 at 0008 hours. This means that the 1,968 hour closure impacted traffic for 2,001 hours. The 33 hour difference represents the time required for the reopened chamber to serve the tows in queue and bring the delay back to zero. During the impact period, 23,058 hours of tow delay were experienced by 1,076 tows (total delay in all of 2011 was 9,349 hours). This 23,058 hours works out to an average delay of 21.4 hours/tow for the closure period. By comparison, 5,246 tows were served at LD27 outside the closure period from 1 June 2012 through 31 May 2013. The average normal delay per tow was 271 minutes or approximately 4.5 hours. Given that the average additional delay per tow was 17 hours for the December 2012 – March 2013 closure and that 1,076 tows were impacted, the closure caused 18,195 hours of additional delay. The maximum delay experienced by a tow during this closure was 80.5 hours.

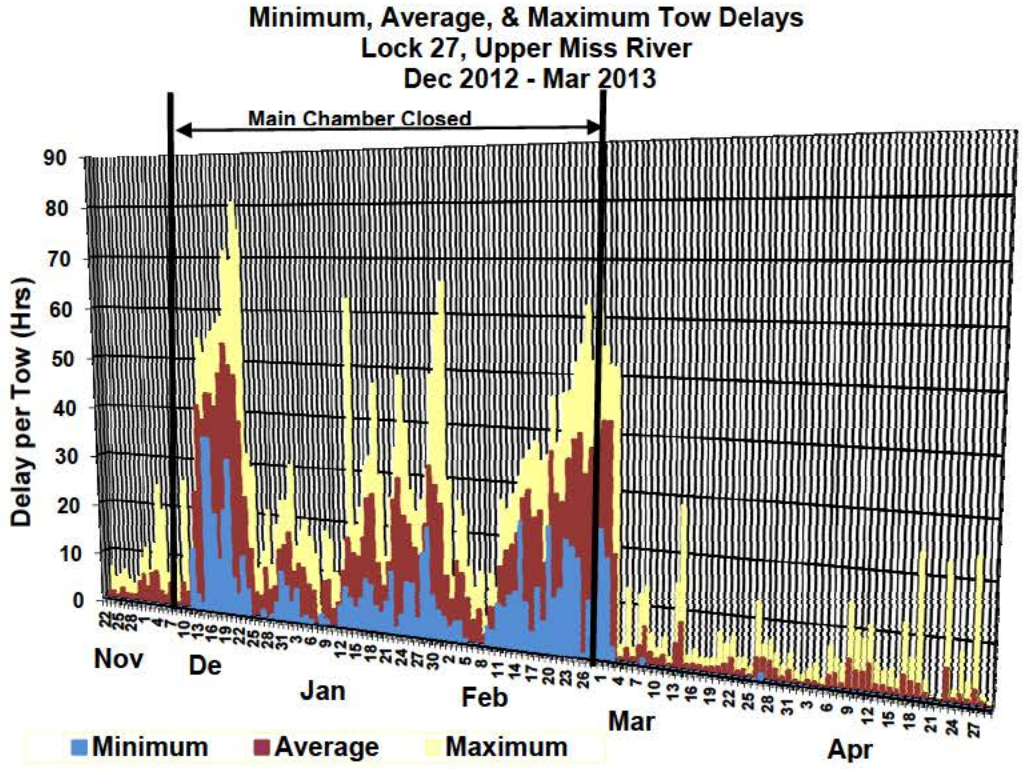


**Figure 17. LD27 Minimum, Maximum and Average Tow Delays, December 2012 – March 2013**

### 4.4.4 Cost Impact

The most recent information available indicates that the average tow transit costs at LD27 are about $648 per hour. Given the analysis above which shows that this scheduled closure caused an additional 643 hours of processing time and 18,195 hour of delay, the estimated additional transit time during the closure cost a total of $12.2 million.

# 5. SHIPPER RESPONSE

## 5.1 Survey Procedures

An OMB-approved Shipper Survey (Control #0710-0001) was used to capture and evaluate shipper reactions to the drought and the emergency closure of LD27 in September (see **Appendix A**). Shippers were defined as companies that receive commodity traffic transiting through multiple reaches on the Mississippi River. The formal shipper survey was conducted between 7 March and 30 May 2013. The purposes of the survey were to find out what measures were taken by industry to mitigate the effects of the drought-related low water and emergency closure at LD27, and to estimate the total costs to industry that resulted from the events.

At the outset of the process, several steps were adopted for including firms in the survey. First, a list was compiled that showed the parent companies that operate at docks in the four affected waterways – the lower Ohio, lower Illinois, Middle Mississippi, and Lower Mississippi Rivers – and that ship through LD27. The parent company/owner of each receiving dock was identified using information available to the Corps and grouped by parent company. This allowed an estimate of tonnage by parent company/owner to be formulated. Parent companies were then ranked in descending order by their total tonnage received. For LD27 and each affected waterway, the top 25 ranked by companies by tons shipped were selected to be surveyed. Duplicate shippers (shippers that had a top 25 ranking in more than one reach) were included as one survey, and the next largest company was added to obtain the top 25 unique companies to survey in the study area. In all, 125 shippers were sent surveys.

Waterborne Commerce Statistics Center (WCSC) data for 2011 was used in assembling basic shipper information. All of the contact information for the top ranking companies was determined by comparing several contact lists. In the absence of any contact information, the Internet was used as a search tool to verify correct contact information for these parent companies. The 125 shippers were sent a mail survey followed by a telephone follow-up if the parent company or carrier sent no response after two weeks. Stakeholders like the American Corn Growers Association, the River Industry Action Council (RIAC), and the Waterways Council, Incorporated (WCI) assisted by encouraging firms to respond by sending emails to all members late in the survey to encourage participation.

According to survey respondents, low water presented the greatest challenge to users of the Lower Mississippi from Cairo, Illinois to Baton Rouge and the Middle Mississippi River between St. Louis and Cairo. Traffic on these two reaches totaled 202.4 million tons in 2011.

## 5.2 Summary of Shipper Responses

Responses to the survey were received from 73 companies, representing a response rate of 59 percent and accounting for 42 percent of total 2011 traffic transiting the affected waterways. Questions 1a and 1b were used to help determine if the shipper had any impacts from either the emergency lock closure event at LD27 or from the low water conditions. Questions 2 and further into the survey were designed to be answered by shippers who had responded that they were impacted by either or both of these events. From question 2 onwards, the subset of respondents is less than the total that returned surveys because some shippers indicated that they were not impacted by either event in question. An overwhelming percentage of respondents to the shipper survey said they were unaffected by the LD27 closure, while half of the respondents indicated they experienced significant effects on operations due to low water. In an effort to meet their needs, shippers sought other sources for product, sought other waterway routes, and used overland transportation routes at a cost to responding shippers of $56 million. The effect of the drought on agricultural production combined with increased transportation costs resulted in temporary plant closures and lost sales that the responding shippers estimated at $79 million.

# 6. CARRIER RESPONSE

## 6.1 Survey Procedures

The Carrier Survey targeted the major towing companies that used the waterways affected by low water in 2012 (the lower Ohio, the lower Illinois, the Middle Mississippi, and the Lower Mississippi Rivers). Appendix B contains the Carrier survey form. The purpose of this survey was to identify carrier responses to the 2012 low water event and the LD27 closure. Like the shipper survey, the formal carrier survey was conducted between 1 March and 30 May 2013. The purpose of the surveys was to determine what measures were taken specifically by the carriers to adapt to the emergency closure at LD27 and drought conditions and what these measures cost.

The firms included in the carrier survey were the 10 largest users of the affected waterways (in tonnage) for the years 2006 through 2010. Responses were received from six companies representing 46 percent of carrier traffic on these waterways. According to survey respondents, low water presented the greatest challenge to users of the Lower Mississippi from Cairo, Illinois to Baton Rouge, Louisiana and the Middle Mississippi River between St. Louis, Missouri and Cairo. Traffic on these two reaches totaled 202.4 million tons in 2011. Survey respondents accounted for 58% of the tonnage in these two reaches.

## 6.2 Summary of Carrier Canvas Responses

Once the initial set of shippers and carriers for canvassing was established, contacts were identified for each company. This information was taken from publicly available sources and in some instances through the assistance of industry associations, such as the American Corn Growers Association, the River Industry Action Council (RIAC), and the Waterways Council, Incorporated (WCI). These organizations were also of assistance in encouraging firms to respond by emailing members late in the survey process to encourage participation.

Responses were received from six carriers (60%) representing 59 percent of total traffic on the affected waterways. All but one of the carriers responding indicated that they were affected by both low water and the LD27 closure, with the low water being the more serious challenge. Moving cargo during this period required carriers to advance or delay shipments, light load vessels (necessitating additional trips), reposition barges throughout the system to accommodate the need for additional barges, restrict tow sizes (also necessitating more trips), and perform additional refleeting. These altered carrier operations cost responding carriers an estimated $80.7 million. Carriers also experienced $16.7 million in additional costs due to the LD27 closure and delays and tug costs of $0.2 million due to tow grounding.

# 7. FEDERAL RESPONSE

Federal stewards of the inland waterways were aided by past experiences, like the 1988 drought and the low-water event on the Lower Mississippi River in 1997, and advancements in the data provided by the National Oceanographic and Atmospheric Administration's (NOAA), as well as hydrologic tools used by the Corps to forecast water levels. These advancements improved the ability of the Corps and the Tennessee Valley Authority in controlling available water in efforts to keep navigation open on the lower Ohio and on the Mississippi Rivers. The U.S. Coast Guard took the lead in creating communication avenues between all stakeholders in managing vessel operation and reaching consensus on channel and vessel operational maintenance during the event. According to representatives of the Coast Guard, no additional expenditures of funds accompanied their extraordinary efforts.

On the Ohio River, the Corps of Engineers essentially borrowed resources from other locations to be repaid at some future date. No emergency funding was made available. Channel surveys were conducted more frequently on known trouble spots, sometimes twice weekly. The Louisville District estimated that dredging costs were approximately $2.1 million higher than in a typical year (see **TABLE 9**). The funds were drawn away from other projects, in effect with the promise of repayment in a future year to accomplish work that could not be done as a result of moving funds to the lower Ohio.

**Table 9. Costs Incurred by the Corps**

($millions)

| District | Added Cost | |
|---|---|---|
| Vicksburg | | $ 7.29 |
| St.Louis | | |
| dredging | $ 11.90 | |
| blasting | $ 9.70 | |
| LD27 1/ | $ 0.97 | |
| subtotal | | $ 22.57 |
| Louisville | | $ 2.07 |
| TOTAL | | $ 31.93 |

1/ Costs to bring LD27 into immediate service. Includes cost of spud barge, temporary helperboat assists and gravel cleanup.

Source: U.S. Army Corps of Engineers, Vicksburg, St. Louis, and Louisville Districts.

On the Mississippi River, emergency funds were made available by Congress in 2011 in response to the flooding that year and any possible future emergencies. The rock pinnacles at Thebes and Grand Tower, Illinois were blasted and debris removed at an estimated cost of $9.7 million. At LD27 the spilled gravel from the damaged cell and the cell itself were removed and

temporary safe passage accommodated at an estimated cost of $1.0 million.[11] St. Louis District dredging was concentrated on the Middle Mississippi as the Lower Illinois was not severely affected. Dredging completed by the Vicksburg District on the main stem Mississippi cost $7.3 million more than average dredging costs over the last several years.

[11] The Corps estimates it will cost another $3.5 million to replace the damaged cell. This was not included in the federal cost.

# 8. FINDINGS

Traffic patterns were examined on the four high volume waterway segments affected by low water in 2012. With the exception of the Lower Mississippi from Cairo, Illinois to Baton Rouge, Louisiana, each segment experienced lower traffic in 2012 than in 2011. Sharp declines in corn traffic, related to a greatly diminished harvest, explain most of the traffic decline, though carriers continued to maintain volumes of all other commodities otherwise.

When looking at monthly traffic levels reported in the LPMS data for the gateway locks to the Ohio, Illinois, and Upper Mississippi (LD53, Peoria LD and LD 27), typical cyclical patterns of shipment are apparent in 2012, but at lower levels. Vessel operators ran significantly fewer tows in the summer and fall, moved fewer barges at LD27 and Peoria, but more barges at OH53 – this increase is explained by the increased movement of empty barges. Tows pushed fewer loaded barges that were more lightly loaded (100 tons per barge less than average at LD27). The end result was lower traffic at each of these three projects.

Unfortunately there is no data equivalent to LPMS available at the constriction points on the Mississippi River at Thebes, Illinois and Grand Tower, Illinois that will describe how vessel operators configured tows by number of barges per tow. We do know that there were vessel draft restrictions that affected both loadings and the size of towboats, as well as tow size restrictions. We also know from surveys and discussions with vessel operators (discussed in previous sections) that fleeting operations were initiated above and below these points in order to optimize the use of a limited number of smaller towboats required through this reach, while still utilizing the larger towboats that typically move through this area.

The Corps surveyed 125 shippers and ten carriers. The 73 shippers that responded represent 42 percent of all shipper traffic transiting the affected waterways. Half of the respondents to the shipper survey indicated that they did not experience any significant effects on operations due to low water and an overwhelming percentage said they were unaffected by the LD27 closure. Ten carriers were surveyed. The six carriers responding represented 46 percent of all carrier traffic transiting the affected waterways. All but one of the carriers responding indicated that they were affected by both low water and the LD27 closure, with the low water being the more serious challenge. The difference in shipper and carrier responses suggests that the shippers were somewhat insulated from these events by the strategic and tactical actions taken by the carriers that minimized impacts on the shippers.

Despite lower corn production and a 51% decline in corn exports, waterway traffic through the Middle Mississippi's rock pinnacles at Thebes, Illinois constriction was largely unchanged between 2011 and 2012 (though it is important to remember that the worst low water conditions were experienced from December 2012 through February 2013). Moving cargo during this period required carriers to advance or delay shipments, light load vessels (necessitating additional trips), reposition barges throughout the system to accommodate the need for additional barges, restrict tow sizes (also necessitating more trips), and perform additional refleeting. It cost responding carriers an estimated $80.7 million to alter operations in this fashion (see TABLE

10). The carriers also faced $16.7 million in additional costs as a result of the LD27 closures and delays and tug costs of $0.2 million due to tow groundings. Despite these actions, shippers did not escape the effects of the low water. In an effort to meet their needs, shippers sought other sources for product, sought other waterway routes, and used overland transportation routes at a cost to responding shippers of $55.9 million. The effect of the drought on agricultural production combined with increased transportation costs resulted in temporary plant closures and lost sales that the responding shippers estimated at $79.0 million.

**Table 10. Survey Results - Low Water Cost Impacts**

| Cost Category | Cost ($000) |
|---|---|
| **Transportation cost impacts** | |
| Carrier cost impacts | |
| Delays due to LD27 closure | $ 16,100 |
| Other costs due to LD27 closure | $ 573 |
| Groundings | $ 164 |
| Altered operations | $ 80,723 |
| Shipper cost impacts | $ 55,860 |
| **SUBTOTAL** | **$ 153,419** |
| **Production cost impacts** | **$ 79,000** |
| **TOTAL** | **$ 232,419** |

# 9. CONCLUSIONS

Several observations can be made from an examination of the traffic data obtained from LPMS and WCSC sources and responses generated from the surveys of the navigation industry. The obvious message is that a system that is not operating at a level of reliability expected by users will have economic consequences. Resulting increases in transportation costs and/or delays to the transportation of commodities will have an effect on the marketplace. Either the producer will pay more, thus reducing expected profit associated with their products, or the end user will experience higher commodity prices at the market once prices are adjusted.

The low water, the 5-day closure of LD27 in September 2012, and the subsequent 82 day closure of the main chamber between December 2012 and March 2013 imposed additional transportation costs of $153.4 million just on the companies that responded to the Corps' surveys. Drought and/or low water accounted for another $79.0 million in production losses, bringing the total reported impact to $232.4 million. Shipper survey respondents averaged $0.98 per ton in production losses and $0.80 per ton in increased transportation costs as they shifted to other modes and routes. These values were applied to tonnage not accounted for through the sample or for which no response was given. Carrier survey respondents provided a range of cost impacts: $0.09 per ton for production loss, $0.005 per ton for non-delay related operations during the LD27 closure, $0.001 per ton related to grounding logistics, and $0.69 in added transit costs. Using these values, a simple extrapolation of the sample to the population of movements using the most affected waterways (the Middle Mississippi and Lower Mississippi River) either not sampled or not responding suggests that additional transportation costs totaled $277.0 million and production impacts amounted to $165.2 million, for a total impact of $442.2 million.[12]

**Table 11. Low Water Cost Impacts from 2012 Event**
**(Costs in $000)**

| Cost Category | Survey Responses | Estimate for Firms Not Responding, Not Surveyed | TOTAL |
|---|---|---|---|
| **Transportation cost impacts** | | | |
| Carrier cost impacts | | | |
| Delays due to LD27 closure 1/ | $ 16,100 | $ - | $ 16,100 |
| Other costs due to LD27 closure | $ 573 | $ 417 | $ 990 |
| Groundings | $ 164 | $ 119 | $ 283 |
| Altered operations | $ 80,723 | $ 58,719 | $ 139,442 |
| Shipper cost impacts | $ 55,860 | $ 64,277 | $ 120,137 |
| **SUBTOTAL** | **$ 153,419** | **$ 123,532** | **$ 276,951** |
| **Production cost impacts 2/** | **$ 79,000** | **$ 86,248** | **$ 165,248** |
| **TOTAL** | **$ 232,419** | **$ 209,780** | **$ 442,199** |

1/ Includes delay cost experienced due to LD27 main chamber closure Dec 2012 - Mar 2013 to remove damaged cell.

2/ Includes economic impact of reduced corn production and higher transportation costs due to low-water.

[12] It is important to remember that not all waterways affected by the drought were covered by this survey

Using available transportation rate studies conducted for navigation improvement studies on the Upper Mississippi, Illinois, and Ohio River, it is estimated that this tonnage moves at an average transportation rate savings of $25.58 a ton. Therefore, at 2011 traffic levels, total savings on these rivers would likely have been an estimated at $5.8 billion dollars. The three most affected Corps of Engineers districts expended $31.9 million to keep the lower Ohio, lower Illinois, Middle Mississippi, and Lower Mississippi river channels open to navigation in extreme drought conditions, enabling shippers to continue navigation. While industry faced losses of an estimated $277.0 million due to increased transportation costs, through the cooperative and coordinated efforts of the Corps, the Coast Guard, and industry partners, shippers and the Nation were able to realize a savings in transportation costs of an estimated $5.5 billion despite this extreme low water event.

# APPENDIX A – SHIPPER QUESTIONNAIRE

OMB Control # 0710-0001
Expiration date 02/28/2015

## 2012 DROUGHT/LOCK 27 CLOSURE – SHIPPER SURVEY

Date: _____

Firm: _____

Address: _____

Phone: _____

FAX: _____

Point of Contact: _____

E-Mail _____

Title: _____

General Description of Firm and Products Produced: _____

**NOTE: ALL RESPONSES WILL BE TREATED AS CONFIDENTIAL**

1. Was your company impacted by the closure event at Lock 27 in 2012? Yes No .
Was your company impacted by low water associated with the Drought Low water conditions in 2012? Yes No (If no interview is complete).

2. Does your company have a response plan for these types of impacts? If so, did it result in additional work, organization to implement or was it detailed enough to cover all the impacts?

## 2012 DROUGHT/LOCK 27 CLOSURE – SHIPPER SURVEY

| LD27 closure only | Low water | Description of Response |
|---|---|---|
| | | a. No change in procedures |
| | | b. Stockpiled product and: waited for traffic to clear if closure or; changed loading depth in barges for low water |
| | | c. Switched to all-overland mode for product delivery from existing sources |
| | | d. Switched to different waterway routing for product delivery from existing sources |
| | | e. Switched product source to an entirely new source |
| | | f. Ceased operations during the period |
| | | g. Altered production during the period |
| | | h. Switched production to another facility |
| | | i. Purchased intermediate or final product, rather than produced |
| | | j. Other or combinations of the above. (Please explain)_____ |

3. During the 2012 event (either Low water or Lock 27 closure), what was your company's response? Please indicate with an "x" in the appropriate box.

4. If you have checked "c" or "d" in question 3, please complete the following table:

| Movement | Commodity | Affected tonnage | Origin (City, State) | Destination (City, State) | Deliverd $\ton prior to drought | Delivered $\ton during drought |
|---|---|---|---|---|---|---|
| Examples: | | | | | | |
| 1 | Corn | 12,000 | Minneapolis, MN | New Orleans, LA | $30 | $35 |
| 2 | Lube oils | 4,000 | Houston, TX | Huntington, WV | $40 | $50 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

## 2012 DROUGHT/LOCK 27 CLOSURE – SHIPPER SURVEY

5. If you checked "e" in question 2, please complete the following table:

| Movement | Commodity | Affected tonnage | Pre-drought Origin (City, State) | Changed Origin (City, State) | Destination (City, State) | Deliverd $\ton prior to drought | Delivered $\ton during drought |
|---|---|---|---|---|---|---|---|
| Examples: | | | | | | | |
| 1 | Corn | 12,000 | Minneapolis, MN | Cincinnati, OH | New Orleans, LA | $30 | $35 |
| 2 | Lube oils | 4,000 | Houston, TX | Ashland, KY | Pittsburgh, PA | $40 | $50 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

6. If you checked response a, or b under question 3, how were your total production costs affected during the period of closure at Lock 27 or Drought-related low water (total increase in cost, if applicable)? Please explain.

7. If you checked response "f" under question 3, what was the total estimated loss to your firm as a result of ceasing production? (during the closure period at Lock 27 or Drought)

## 2012 DROUGHT/LOCK 27 CLOSURE – SHIPPER SURVEY

8. If you checked response "g" under question 3, what was the total estimated loss to your firm as a result of altering production processes? (during the closure period at Lock 27 or Drought)

9. If you checked response "h" under question 3, what was the total increase in costs to your firm as a result of changing production locations? (during the closure period at Lock 27 or Drought)

10. If you checked "i" under question 3, to what extent did purchasing intermediate or final product increase your company's total costs? (during the closure period at Lock 27 or Drought)

11. If you checked response "j" under question 3, to what extent did the other measures or combination of measures undertaken as a result of the closure increase your company's total production costs? (during the closure period at Lock 27 or Drought)

## 2012 DROUGHT/LOCK 27 CLOSURE – SHIPPER SURVEY

12. Have these events (drought-related low water or Lock 27 closure) caused your company to alter its long-term transportation strategy (e.g. switch to all-overland modes, increase stockpiles, etc.)? How will this impact your total commodity transportation or other costs (per year)? Please explain.

13. Has the (drought-related low water or Lock 27 closure) caused your company to take any other long-term permanent measures? Please explain. How will this affect your company's long-term operating costs (per year)?

14. Has your company been impacted by other navigation system disruptions this shipping season? (these would be other than the Low water from the drought or the Lock 27 closure)

## 2012 DROUGHT/LOCK 27 CLOSURE – SHIPPER SURVEY

15. If your company has experienced significant navigation disruptions[1/] prior to this shipping season, please complete the following table:

| Event | Date | Short-term response[2/] | Long-term response[3/] |
|---|---|---|---|
| Example: | | | |
| McAlpine closure | Jan – Feb 2006 | Diverted to overland modes | none |

[1/] Significant navigation system disruptions are defined as disruptions that result in delays to your shipment of more than 48 hours (include scheduled and unscheduled lock outages, accidents, and low and high water events).

[2/] Short term response refers to the response actions detailed in question 2.
a. No change in procedures.
b. Stockpiled product and waited for traffic to clear or light loaded for low water.
c. Switched to all-overland mode for product delivery from existing sources.
d. Switched to different waterway routing for product delivery from existing sources
e. Switched product source to an entirely new source.
f. Ceased operations during the period of closure/low water.
g. Altered production during the period of closure/low water.
h. Switched production to another facility.
i. Purchased intermediate or final product, rather than produced.
j. Other or combinations of the above. (Please explain.)

[3/] Long term response refers to a modification of your long term business plan to include altering your long-term transportation strategy (e.g. switch to all-overland modes, increase stockpiles, etc.). Other long term responses might include sourcing commodities at alternate sites or moving production activities to a different location.

# APPENDIX B – CARRIER QUESTIONNAIRE

# Waterway Carrier Interview Questions
# Effects of the 2012 Drought and LD27 Closure

Name of towing company _____
Location _____
Name and title of Point of Contact _____
Phone number (  )_____ email _____

## PART 1. LOW WATER DUE TO DROUGHT CONDITIONS

1. Did your firm experience a reduction in tonnage carried on the Mississippi, Illinois or Ohio waterways in 2012? Please verify data for 2010 and 2011, indicating your estimates for 2012 in table below.

**Operator Traffic Destined for Lower Mississippi Ports (2010 and 2011 from WCSC):**

| Origin | 2010 | 2011 | 2012 |
|---|---|---|---|
| Mississippi above St. Louis | | | |
| Mississippi St. Louis to Cairo | | | |
| Mississippi south of St. Louis | | | |
| Illinois River | | | |
| Ohio River | | | |

2. What factors led to changes in traffic between 2011 and 2012? For example, drought conditions that affected agricultural production, low water that affected your ability to operate efficiently, loss or gain of a contract(s), increased competition from rail, or other factors – please specify and indicate relative weight of each.

3. Have you had to change the way you operate your vessel fleet due to the drought? If so, what changes did you make and when did these occur?

4. The two tables below are intended to describe how your operations are affected by water depth and flows on the Cairo – St. Louis reach of the Mississippi River.

**a.** Do the operational changes suggested in the tables below for the Cairo – St. Louis reach (Upper Reach) describe the way you would operate given the gage readings and flow shown for these two reaches in the tables? If yes, please indicate in the appropriate box in the table below with a "Y"; if no, please indicate what restrictions you impose on your operations given the gage and flow readings provided.

**Upper Reach – Navigation Restriction**

| St. Louis Gage Reading | Flow (CFS.000) | Navigation Restriction | Carrier's Nav Restriction Followed |
|---|---|---|---|
| Above 2.0 | Above 90 | No restriction | |
| 0.0 to 2.0 | 74 to 90 | 25 barges | |
| -2.5 to 0.0 | 55 to 74 | 20 barges | |
| -3.5 to -2.5 | 48.5 to 55 | 16 barges | |
| -4.0 to -3.5 | 46 to 48.5 | 8.5 ft draft | |
| -4.5 to -4.0 | 44 to 47 | 8.0 ft draft | |
| Below -4.5 | Below 44 | Navigation halts | |

**b.** What is the number of tows - by size of tow, horsepower and draft – that you operate through the St. Louis to Cairo reach of the Mississippi? For each foot of draft that is lost, what is your added cost per trip? Please use the table below in making your response.

**Upper Reach – Tows moved thru the St. Louis - Cairo reach in 2011 (or year not affected by low water)**

| Tow size | | Towboat Horse-power | Barge Draft | Cost/ton of loading below desired barge draft | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Barges/ tow | No. of tows | | | 0.5' | 1.0' | 1.5' | 2.0' | 2.5' | 3.0' | 3.5' | 4.0' |
| 1 - 8 | | | | | | | | | | | |
| 9 - 15 | | | | | | | | | | | |
| 16 - 19 | | | | | | | | | | | |
| 17 - 20 | | | | | | | | | | | |
| 21 - 25 | | | | | | | | | | | |
| >25 | | | | | | | | | | | |

5. The two tables below are intended to describe how your operations are affected by water depth and flows on the Mississippi River south of Cairo.

**a.** Do the operational changes suggested in the tables below for the Lower Reach of the Mississippi River south of Cairo describe the way you would operate given the gage readings and flow shown for these two reaches in the tables? If yes, please indicate in the appropriate box in the table below with a "Y"; if no, please indicate what restrictions you impose on your operations given the gage and flow readings provided.

**Lower Reach – Navigation Restriction**

| Cairo Gage Reading | Flow (CFS in 000s) | Navigation Restrictions | Carrier's Nav Restriction Followed |
|---|---|---|---|
| Above 11.8 | Above 189 | No restriction | |
| 6.0 to 11.8 | 111 to 189 | 25 barges per tow | |
| 5.0 to 6.0 | 95 to 111 | 8.5 ft draft and 20 barges | |
| 3.5 TO 5.0 | 80.5 to 95 | 8 ft draft and 12 barges | |
| Below 3.5 | Below 80.5 | Navigation halts | |

**b.** What is the number of tows - by size of tow, horsepower and draft – that you operate on the Lower Reach of the Mississippi south of Cairo? For each foot of draft that is lost, what is your added cost per trip? Please use the table below in making your response.

**Lower Reach – Tows moved through the reach south of St. Louis in 2011 (or a year not affected by low water)**

| Tow size | | Towboat Horse-power | Barge Draft | Cost/ton of loading below desired barge draft | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Barges/ tow | No. of tows | | | 0.5' | 1.0' | 1.5' | 2.0' | 2.5' | 3.0' | 3.5' | 4.0' |
| 1 - 12 | | | | | | | | | | | |
| 13 - 16 | | | | | | | | | | | |
| 17 - 20 | | | | | | | | | | | |
| 21 - 25 | | | | | | | | | | | |
| >25 | | | | | | | | | | | |

6. If you light load due to low water, would you proceed entire trip as originally light loaded or top off below Cairo, or maybe add additional barges to where the normal tons per horsepower ratio is achieved? If latter, how would this be done and at what cost?

7. Did any of your tows experience a grounding? If yes, how many total occurrences did you experience and what was the impact on your firm? Please indicate your response below.

___ total groundings

___ events with tows delayed more than 8 hours; _____ cost of delays

___ events involving lightering cargo; _____ cost of lightering

___ events involving towboat assists; _____ cost of towboat assists

8. What was major impact of low water due to the drought in terms of effect on your operations - increased operating cost? Lost business? Equipment damage? Safety concerns? Groundings? Efficient dispatch of fleet? Others?

9. Please indicate the economic impact of low water levels on your company in the table below (please include figures from your response to #5 above):

| **Indicate with an "X" if this applies to your firm** | **Description of impact** | **Cost** | | |
|---|---|---|---|---|
| | | **Cost/ton** | **Tons Affected** | **Total cost** |
| | Increased transit time (including delays) | | | |
| | Increased cost due to restricted tow sizes | | | |
| | Increased costs due to light loading | | | |
| | Idle vessels/lost revenue | | | |
| | Damaged equipment | | | |
| | Increased management/logistics costs | | | |
| | Other (please specify) | | | |

## PART 2. CLOSURE OF LD27

10. If you have tows already at the lock do you generally wait until it reopens?

11. What is typical amount of time you will wait at a lock for it to reopen before you decide to do something else? What do you do if you decide not to wait any longer? What factors affect this decision? If you re-dispatch the tow, what does this cost?

12. If you have tows underway in the system and a closure occurs at a lock to be transited, do you continue to the closure point, wait elsewhere, or re-dispatch the tow? What factors affect this decision?

13. Please indicate the economic impact of the **closure of LD27** on your company in the table below:

| Indicate with an "X" if this applies to your firm | Description of impact | Cost | | |
|---|---|---|---|---|
| | | Cost/ton | Tons Affected | Total cost |
| | Delay costs at the lock | | | |
| | Delays in place (dock or port) | | | |
| | Idle vessels/lost revenue | | | |
| | Increased management/logistics costs costs (including re-dispatching) | | | |
| | Other (please specify) | | | |

## PART 3. FINAL COMMENTS

14. Do you have any other information that would help us describe and quantify the economic impact on waterway carriers associated with low water due to the drought of 2012 and/or the closure of LD27?