



**US Army Corps  
of Engineers**  
New Orleans District

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## LETTER REPORT

### BAYOU SORREL LOCK REPLACEMENT, LOUISIANA POST AUTHORIZATION CHANGE STUDY



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**LETTER REPORT**

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**POST AUTHORIZATION CHANGE STUDY**



**U.S. Army Corps of  
Engineers  
New Orleans  
District**  
New Orleans,  
Louisiana

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## **EXECUTIVE SUMMARY**

The purpose of the Bayou Sorrel Lock Replacement, Louisiana, Feasibility Study was to determine the feasibility of modifying the Bayou Sorrel Lock to safely pass the project flood in the Atchafalaya Basin Floodway and to reduce delays to barge tows on the Gulf Intracoastal Waterway System. It was conducted at 100 percent Federal cost using funds from the General Investigations appropriation.

The study investigated a flood risk management plan and a combined flood risk management / navigation plan. The feasibility report, dated November 2003, recommended replacing the lock with an adjacent larger lock. The selected plan was the National Economic Development plan. It called for a 75 foot wide by 1200 foot long concrete “U” shaped lock chamber for flood risk management and navigation. The plan was endorsed by the Mississippi River Commission on 27 September 2004 and approved by the Chief of Engineers on 03 January 2005.

Preconstruction, Engineering, and Design began in April 2006. Preliminary cost estimates of the 35 percent design of the selected alternative indicated significant increases in costs since preparation of the feasibility report. Due to anticipated exceedance of the limits of Section 902 of the Water Resources Development Act of 1986, a Post Authorization Change Report was initiated to authorize the higher cost estimate in January 2010.

Economic analyses determined that traffic growth projections used during the feasibility study were no longer valid. The updated prediction of flat oil production in the Gulf of Mexico over the next 50 years has a major influence on Gulf Intracoastal Waterway traffic levels. The consequence of significant cost increases to the replacement lock in concert with reduced traffic benefits is that the recommended plan is no longer economically justified. An Agency Technical Review of the findings was documented in a Potential Cost Savings Letter Report submitted in August 2011. After the review, a transportation benefit analysis was prepared in 2013 to explain how changes in current and expected traffic patterns as well as without project assumptions resulted in lowered benefit cost ratios.

Based upon these results, further analysis of the navigation feature is not recommended. The flood risk management deficiency of the lock will be addressed as a component of the Mississippi River and Tributaries, Atchafalaya Basin, Louisiana Project. This Letter Report recommends terminating the Bayou Sorrel Lock Replacement, Louisiana, PAC Study due to lack of a Federal interest in the project at this time.

## 1. INTRODUCTION

This Letter Report details the U.S. Army Corps of Engineers (USACE) decision for the Bayou Sorrel Lock Replacement, Louisiana, Post Authorization Change (PAC) Study. The report includes an overview of the feasibility study; preconstruction, engineering and design activities; and post authorization change investigations. It describes the study area, authority, alternatives, findings, and the decision reached.

## 2. BACKGROUND

### 2.1 Project and Study Authority

The Bayou Sorrel Lock is a feature of the Mississippi River and Tributaries, (MR&T) Atchafalaya Basin, Louisiana Project (ABLP). The Bayou Sorrel Lock Replacement, Louisiana Feasibility Study was conducted with the following project and study authorizations:

- a. The Flood Control Act of 1928 (Public Law 70-391), as amended, authorized the Flood Control, Mississippi River and Tributaries Project (MR&T), including the Atchafalaya Basin, Louisiana project feature. Bayou Sorrel Lock is a feature of the Atchafalaya Basin, Louisiana Project (ABLP).
- b. A resolution of the Committee on Public Works of the United States Senate on September 29, 1972:  
*“... (The) Board of Engineers for Rivers and Harbors, be, and is hereby, requested to review the reports on the Gulf Intracoastal Waterway (Louisiana-Texas Section, including the Morgan City-Port Allen Route) submitted in House Document 556, 87th Congress, Second Session, and subsequent reports, with a view to determining the advisability of modifying the existing project in any way at this time, particularly with regard to widening and deepening the existing and/or authorized channel.”*
- c. A resolution of the Committee on Public Works of the United States House of Representatives on October 12, 1972:  
*“... (The) Board of Engineers for Rivers and Harbors, be, and is hereby, requested to review the reports on the Gulf Intracoastal Waterway (Louisiana-Texas Section, including the Morgan City-Port Allen Route) submitted in House Document 556, 87th Congress, Second Session, and subsequent reports, with a view to determining the advisability of modifying the existing project in any way at this time, particularly with regard to widening and deepening the existing and/or authorized channel.”*

### 2.2 Study Area

Bayou Sorrel Lock was completed in 1951 in Iberville Parish in south-central Louisiana, about 20 miles southwest of Baton Rouge (Figure 1). The lock provides navigation via the Gulf Intracoastal Waterway (GIWW) Morgan City to Port Allen route. In addition, the structure is an integral part of the East Atchafalaya Basin Protection Levee and maintains a continuous line of risk reduction against the MR&T project design flood flow (Figure 2).

The ABLP is designed to convey one-half of the MR&T project flood discharge (1.5 million cubic feet per second) safely to the Gulf of Mexico. The Atchafalaya Basin project flood flowline was



**Figure 1**

revised in 1987 (Design Memorandum No. 1, Hydraulic Design, Atchafalaya Basin, LA, Project Flood Flow Line, January 1987) and again in 2010 (Mississippi River and Tributaries Basin, Atchafalaya Basin, Louisiana, 2010 Refined Project Flow Line, Hydraulic Design – Final Report.) Currently, the gate bay elevations are 5 feet below the project flood flowline and 8 feet below the project flood design gate. The lock has the greatest deficiency in the East Atchafalaya Basin Protection Levee in providing risk reduction for the MR&T project design flood. Due to inadequate soil conditions, it cannot be modified by raising the sector-gate monoliths and replacing the sector gates.

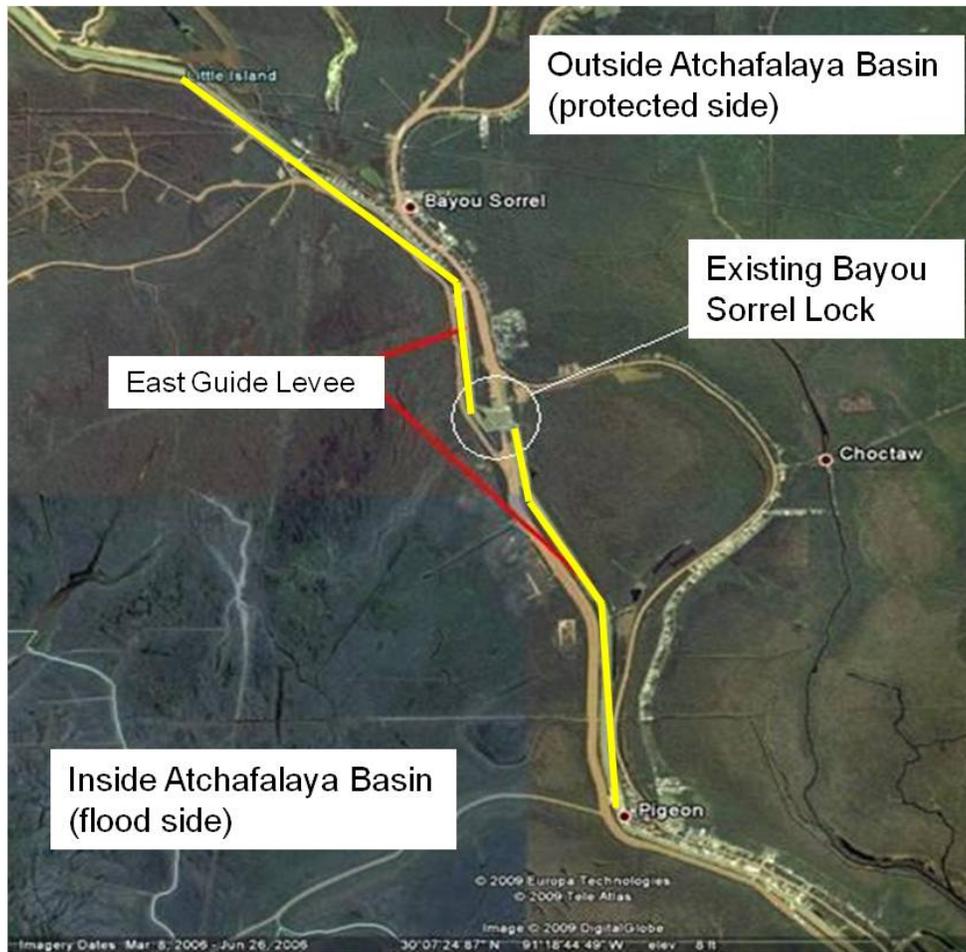
### **3. RECONNAISSANCE STUDY (1992)**

A reconnaissance study, “Intracoastal Waterway Locks, Louisiana,” was completed by the New Orleans District in 1992. It identified a possible Federal interest in providing capacity increases at Bayou Sorrel, Calcasieu, Port Allen and Algiers locks.

### **4. FEASIBILITY STUDY (2003)**

#### **4.1 Introduction**

The purpose of the Bayou Sorrel Replacement Lock, Louisiana Feasibility Study was to develop a plan to modify the Bayou Sorrel Lock to safely pass the project flood in the Atchafalaya Basin Floodway and determine the feasibility of increasing the capacity of the lock to reduce navigation delays to barge tows on the GIWW system. As such, it was a multipurpose study aimed at addressing both flood risk management, and navigation problems and opportunities.



**Figure 2**

## **4.2 Multipurpose Nature and Required Cost Apportionment between Purposes**

**4.2.1 Flood Risk Management.** Measures for addressing flood risk management problems and needs related to Bayou Sorrel Lock were limited in the feasibility study to structural measures to prevent overtopping of the lock during a project flood in the Atchafalaya Basin Floodway. The only non-structural plan considered was flood fighting. Flood risk management problems and needs for Bayou Sorrel Lock were addressed under the authority of the MR&T project, which provides for the confining of the project flood within the Atchafalaya Basin Floodway system.

**4.2.2 Navigation.** Measures addressing navigation problems and needs were limited to structural measures. They were measures to increase the Bayou Sorrel Lock capacity, small-scale improvements at other GIWW locks, and structural improvements on other navigation routes.

**4.2.3 Cost Apportionment.** Any modification of Bayou Sorrel Lock to safely pass the Atchafalaya Basin Floodway project flood is inseparable as a feature of the MR&T project. The MR&T system reduces the risk of floods on the entire Mississippi River below Cairo, Illinois. Because the lock is one of many system components, the benefits of the lock modification cannot be evaluated individually.

To determine the costs of potential navigation improvements at the lock, the cost of the flood risk management improvements had to be separated from the navigation improvement costs. To accomplish this, the first phase was to develop the best plan to pass the project flood. The plan selected for passing the project flood is the base plan, or the without project condition, for the incremental analysis of alternative plans to increase the capacity of Bayou Sorrel Lock. This plan is also referred to as the flood risk management plan. The second phase was to develop the best plan to address lock navigation delays. This plan is the combined flood risk management/navigation plan. The plan selected for navigation improvements is the National Economic Development (NED) Plan, and any costs above the base plan are attributed to the NED Plan.

**4.3 Study Alternatives**

Two structural flood risk management plans were considered to pass the Atchafalaya Basin project flood in the vicinity of the lock; (1) an independent float-in floodgate located on the flood side of the lock, and (2) a replacement-in-kind lock with the same chamber dimensions as the existing lock. The plans would provide measures to both pass the MR&T project flood at Bayou Sorrel and provide for navigation through the lock with no changes in delays, relative to existing conditions and future conditions projected to occur with the existing Bayou Sorrel Lock.

At October 2000 price levels, the first cost of the independent float-in flood gate (\$29.1 million) was close to 40% of the first cost of the replacement in-kind lock (\$75.3 million). Implementation of the independent float-in flood gate would require closure of the lock for significant periods of time. Because of the impact to navigation traffic, the closure cost was sufficient to result in a higher total average annual cost than for the in-kind lock. Thus, the in-kind lock (56 feet wide by 797 feet long) was selected as the preferred flood risk management plan.

The combined plan evaluated two larger locks in combination with two chamber types (earthen and concrete) to provide flood risk management and more efficient navigation. A lock 75 feet wide by 1200 feet long with a concrete U-chamber emerged as the NED Plan and, as such, was the recommended plan. At that time, the 110-foot-wide by 1200-foot-long lock indicated little difference in terms of economic feasibility, and it narrowly missed being the NED Plan.

**4.4 Recommended Plan**

The final feasibility report, dated November 2003, recommended replacement of the Bayou Sorrel Lock with a larger lock immediately adjacent to the existing lock. The new lock would maintain the authorized level of flood risk management and relieve navigation delays caused by the limited capacity of the existing lock. Table 1 summarizes this selection that was based on the ratio of incremental costs and benefits that would accrue to navigation.

Without Project Condition:	In-Kind Lock (Alt 1)
Recommended Plan:	75' x 1200' Lock (Alt 2)
Year/Discount Rate:	FY2000/5.875%
Inc Annual Costs:	\$976,000
Inc Annual Benefits:	\$16,300,000
BCR	16.7

**Table 1**

The NED Plan was endorsed by the Mississippi River Commission on 27 September 2004, and approved by the Chief of Engineers Report of 3 January 2005. The lock modification for flood risk management purposes had already been authorized by the Chief of Engineers Report, Atchafalaya Basin Floodway System, Louisiana, dated February 28, 1983, at 100 percent Federal cost as a feature within the MR&T system. The incremental cost of the larger replacement lock was charged to the navigation account, to be cost shared 50/50 between the Federal Government and the Inland Waterways Trust Fund.

In September 2006, feasibility costs were updated to October 2006 price levels. Total project costs at this time were \$102.2 million, with approximately \$92.5 million and \$9.7 million being apportioned, respectively, to the flood risk management and navigation components. These costs were included in the transmittal letter from the Assistant Secretary of the Army (Civil Works) to Congress, dated October 4, 2006. The Water Resources Development Act (WRDA) of 2007 (Public Law 110-14) authorized \$9.6 million as the navigation component.

## **5. PRECONSTRUCTION, ENGINEERING, AND DESIGN (2006)**

Preconstruction, Engineering, and Design (PED) was initiated in April 2006 by a regional team comprised of five U.S. Army Corps of Engineers, Mississippi Valley Division (CEMVD) Districts and the U.S. Army Engineer Research and Development Center. Preliminary cost estimates of the 35 percent PED design of the selected alternative indicated significant increases in costs after completion of the feasibility report. The new cost estimate indicated total project costs for the recommended plan had increased to approximately \$297 million. Cost apportionment for the project became \$92 million to MR&T (100 percent Federal), and \$205 million to Inland Navigation (50/50 Construction General and Inland Waterway Trust Fund).

Based on these costs, it appeared the recommended plan could not be executed at the authorized amount of \$9.6 million plus the maximum 20 percent cost increase permitted by Section 902 of WRDA 1986, and that a PAC Report would need to be prepared and submitted to Congress to authorize the higher cost estimate. Some of the factors that contributed to the cost increase were flood flowline adjustments that required the design of the lock to a higher elevation than envisioned in the feasibility study; design changes for "structural superiority;" more austere post-Katrina technical requirements; and higher post-Katrina unit costs. Several features not accounted for in the recommended plan were added to the Design Documentation Report. Among these were a generator, office, and maintenance buildings; a boat ramp and floating boat dock; a berthing dock/needle storage facility; and an emergency bulkhead system with a dedicated crane. Most critically, design efforts indicated significant changes in the access channels, requiring huge increases in the amount of dredging needed to provide safe navigation.

To determine the new cost apportionment between MR&T and navigation, an updated cost estimate was developed for the in-kind lock, which was the preferred flood risk management plan. The revised cost of the replacement in-kind lock at 2007 price levels was \$220 million. Because of the significant cost increases of both the replacement in-kind lock and recommended plan, the cost estimate of the independent float-in flood gate was also updated. The purpose of revisiting the independent float-in flood gate was to determine if the feasibility report conclusion regarding the preferred flood risk management plan would remain intact if the project were being currently formulated. The revised cost estimate of the independent float-in flood gate at 2007 price levels

was \$92 million. As a result, the independent float-in flood gate became the preferred flood risk management plan, which was also the without project condition for the study.

A preliminary economic analysis compared the revised costs to feasibility report benefits after adjustments were made to both price levels, the without project condition, and the federal discount rate. As displayed in Table 2, the recommended plan continued to be economically justified; however, the benefit cost ratio (BCR) fell from 16.7 to 2.7.

Without Project Condition:	Flood Gate (Alt 4)
Recommended Plan:	75' x 1200' Lock (Alt 2)
Year/Discount Rate:	FY2007/4.875%
Inc Annual Costs:	\$7,615,000
Inc Annual Benefits:	\$20,379,000
BCR	2.7

**Table 2**

## 6. POST AUTHORIZATION CHANGE STUDY EFFORTS (2010)

Based on the cost increases discovered during the PED phase, it appeared a Post Authorization Change (PAC) Report might be required. It was clear that PED design decisions needed to be challenged to confirm that only required features were incorporated. Also, the designs and costs for the flood risk management plans needed to be revised (particularly for the independent float-in floodgate) to accurately determine the cost of the project navigation increment. Once design and cost information was brought to similar standards (35% design), the costs of the navigation and flood risk management components could be compared to determine the need for a PAC.

An In-Progress Review (IPR) was held 26 June 2009 to discuss the potential need for a PAC with representatives from the Mississippi Valley Division, New Orleans District, and Vicksburg District in attendance. As a result of this meeting, the Vicksburg District assumed responsibility to determine the need for a PAC report and develop it, if required. A guidance memorandum dated 26 July 2009 from the Commander of the Mississippi Valley Division approved transfer of PAC responsibilities from the New Orleans District to the Vicksburg District.

Engineering for the PAC Study was conducted by a regional team, many of which served on the regional PED effort. A kickoff meeting was held in the Memphis District on 28 January 2010 with all six CEMVD Districts in attendance with an emphasis on the need to reduce construction costs if feasible. During and subsequent to this meeting, Project Delivery Team (PDT) work assignments were made, with engineering investigations commencing soon thereafter. Engineering tasks included challenging design decisions of the selected alternative and updating the design accordingly; updating the design of the flood risk management options to allow for appropriate comparison (floodgate and in-kind lock); developing new cost estimates for the floodgate and lock alternatives included in the feasibility study; apportioning costs between the navigation and flood risk management components; and confirming the need for a PAC.

The New Orleans District maintained responsibility for the economic evaluation and preparation of the supporting economic documentation. The economic tasks included modifying the Ohio River

Navigation Investment Model (ORNIM) to incorporate the GIWW system (GULFNIM) and updating traffic and demand projections in order to develop a new transportation savings benefit analysis.

The need for a PAC was confirmed on 29 December 2010, based on a 35% design cost comparison of alternatives. The recommended plan could not be executed at the amount authorized in WRDA 2007 plus the 20 percent cost increase permitted by Section 902 of WRDA 1986 for the navigation component. Costs for the recommended plan increased from \$297 million to \$362.5 million, while the navigation component increased from \$9.7 million to \$181.5 million.

**6.1 Updated Traffic Forecast (2011)**

Although GIWW traffic was expected to grow over the 50-year period of analysis in the feasibility study, updated traffic forecasts showed that current traffic levels would remain essentially the same over the foreseeable future. This was based on a prediction of flat oil production in the Gulf of Mexico over 50 years, and the associated influence on GIWW traffic levels. Applying this no growth traffic assumption to the benefits in the feasibility report produced a significant (~75%) decrease in average annual transportation saving benefits. Once the analysis incorporated the updated construction costs, the recommended plan was no longer economically justified with a BCR of 0.6.

Without Project Condition:	Flood Gate (Alt 4)
Recommended Plan:	75' x 1200' Lock (Alt 2)
Year/Discount Rate:	FY2010 /4.125%
Inc Annual Costs:	\$6,900,000
Inc Annual Benefits:	\$4,100,000
BCR	0.6

**Table 3**

**6.2 Agency Technical Review and Cost Savings Analysis (2011)**

Due to the major impact of cost increases on economic justification, an external review of the designs and cost estimates was critical. The Pittsburg District was recommended by the New Orleans District Engineering Division based on their recent and comparable experience with other lock design and construction projects. The Agency Technical Review (ATR) was coordinated through the Planning Center of Expertise for Inland Navigation. An ATR kickoff meeting and site visit were held in July 2011. The ATR team was requested to perform a standard ATR process to ensure technical compliance and to determine the potential for any cost savings.

Potential cost savings were documented in a Letter Report dated August 2011. Major concepts for reducing costs included (1) consider an earthen chamber as it may be more cost effective than a concrete chamber, (2) locate the new lock immediately adjacent to the existing lock to reduce excavation and dredging costs, and (3) change the location of the floodgate, moving it downstream to increase the lock chamber length. ATR was completed by the Pittsburg and Huntington Districts, Great Lakes and Ohio River Division (LRD) in early September 2011. No major errors or omissions were found in the engineering designs or cost estimates.

During the ATR some small scale and operational improvements were developed to improve the efficiency of the lock. These were (1) realigning the access channel to reduce cross-current and

enhance tow alignment on approach, (2) extending guidewalls to enhance tow alignment during approach, (3) providing tow assists or winches to help reduce approach time, (4) replacing the ring levee with a solid vertical wall to reduce the size of the free water surface and thus time required to fill/empty the chamber, and (5) constructing mooring facilities to improve traffic flow.

### **6.3 Potential for General Reevaluation Report (2011)**

Based on the LRD Letter Report and suggestions provided by the PDT for small scale and operational improvements at the existing Bayou Sorrel Lock, it appeared possible that an economically feasible plan could exist that met current navigation needs of the GIWW. However, the study would have to be expanded beyond a Limited Reevaluation Study to address the potential for other more cost effective alternatives. Consideration of a range of alternatives would need to be made in the context of a General Reevaluation Report (GRR) to allow for appropriate study of all potential lock improvements while balancing the changed navigation benefits.

### **6.4 Expert Workshop (2012)**

An IPR was held with the vertical team in December 2011 to discuss and develop a way forward based on the ATR and potential cost savings that had been identified. The vertical team concurred with the New Orleans District recommendation to convene a team of experts to investigate additional alternatives and the potential for a successful GRR.

A teleconference workshop was held 20-22 March 2012. Participants included representatives from the New Orleans, Vicksburg, St. Louis, Rock Island, St. Paul, and Pittsburg Districts. The intent was to identify cost saving measures and alternatives. The team found some cost saving measures for the recommended plan (reducing the cost to \$349 million) and developed six new alternatives. The least cost combined alternative was a 75 feet wide by 800 feet long lock with a riprap chamber and steel pipe pile walls. The cost for this alternative is approximately \$260 million. (This was compared to the updated recommended plan cost of \$362 million in the 2005 Chief of Engineers Report). This indicated that less costly lock alternatives could be identified in further studies; however, investigations would be needed to determine economic feasibility, particularly due to the fact that (1) a least cost combined plan had not been developed for cost apportionment purposes and (2) the benefits associated with the smaller size of the least cost lock alternative were unknown.

### **6.5 Updated Traffic Forecast (2012)**

The US Energy Information Administration published the "Annual Energy Outlook 2012 with Projections to 2035." This report projected continued growth for energy demand as well as increased domestic crude oil and natural gas production. A brief review indicated significant growth in the chemical sector over previous projections. It was thought that significant chemical sector growth would translate to higher lock traffic volumes. However, when new projections were translated into updated traffic forecasts for the GIWW, including Bayou Sorrel Lock, it was discovered that this growth was not projected for the petrochemical sector, which is the single biggest commodity group for Bayou Sorrel Lock. The updated forecasts for petrochemicals were similar to previous forecasts (little to no growth over time) and the outcome of this analysis was that lock traffic under the updated forecasts did not significantly increase.

The PDT reduced the estimated cost of the recommended plan through value and methods analysis. The total first costs for the 75' x 1200' lock were lowered from \$349 million to \$328 million. However, as shown in Table 4, the BCR remained unjustified at 0.95.

Without Project Condition:	Flood Gate (Alt 4)
Recommended Plan:	75' x 1200' Lock (Alt 2)
Year/Discount Rate:	FY2013/3.75%
Inc Annual Costs:	\$14,700,000
Inc Annual Benefits:	\$13,900,000
BCR	0.95

**Table 4**

**6.6 Least Cost Flood Risk Management Plan (2012)**

To accurately apportion costs between the flood risk management and navigation components of the least cost combined plan and determine its BCR, the team developed a least cost flood risk management alternative for the without project conditions as shown below in Table 5.

Without Project Condition:	Flood Gate (Alt 6)
Recommended Plan:	75' x 800' Lock (Alt 5)
Year/Discount Rate:	FY2013/3.75%
Inc Annual Costs:	\$11,500,000
Inc Annual Benefits:	\$7,800,000
BCR	0.68

**Table 5**

This alternative was a cast-in-place floodgate with an estimated cost of \$75 million. The decrease in the cost of the without project condition resulted in an increase in the navigation component of the project, dramatically lowering the BCR.

**7. CONCLUSIONS**

Based upon the Bayou Sorrel Lock Replacement PAC Study, further analysis is not warranted at this time. ATR of the designs and cost estimates by LRD indicate that these items were in technical compliance with engineering regulations and criteria regarding lock construction. No major errors were identified in the process. Confidence in the alternative cost estimates is high.

In general, lock replacement costs have continued to escalate while transportation savings benefits have steadily declined. Until transportation savings benefits are projected to begin increasing similar to project costs it is unlikely that a new lock will be economically justified.

To address the possibility that other more cost effective alternatives could exist to satisfy the flood risk management and navigation project purposes, additional work was performed to identify a least cost combined plan. A smaller lock alternative was identified that suggested less expensive options exist that could meet long term transportation needs. However, an economic analysis on the new lock dimensions has not been developed and it can reasonably be assumed that a smaller lock would result in fewer economic benefits. It should be noted that initiating a GRR to

develop least cost combined alternatives would require development of least cost flood risk management alternatives. Based on the PDT's preliminary assessment, the potential for a significantly more cost effective flood risk management alternative (without project condition) would make economic justification difficult, if not impossible, under a GRR.

## **8. RECOMMENDATION**

The USACE has determined that there is currently no potential for a Federally implementable plan for the Bayou Sorrel Lock Replacement, Louisiana PAC Study. The study will be terminated in accordance with the USACE policy and all analysis will cease. Records will be maintained for future reference in the event that conditions change warranting further investigation or reanalysis.