This product is part of the RAND Corporation technical report series. Reports may include research findings on a specific topic that is limited in scope; present discussions of the methodology employed in research; provide literature reviews, survey instruments, modeling exercises, guidelines for practitioners and research professionals, and supporting documentation; or deliver preliminary findings. All RAND reports undergo rigorous peer review to ensure that they meet high standards for research quality and objectivity.

TECHNICAL REPORT

Financing the Operation and Maintenance Costs of Hurricane Protection Infrastructure

Options for the State of Louisiana

Trey Miller

RAND Environment, Energy, and Economic Development Program

This project was sponsored by Louisiana's Coastal Protection and Restoration Authority and was conducted under the joint auspices of RAND Environment, Energy, and Economic Development and the RAND Gulf States Policy Institute.

Published 2012 by the RAND Corporation
1776 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138
1200 South Hayes Street, Arlington, VA 22202-5050
4570 Fifth Avenue, Suite 600, Pittsburgh, PA 15213-2665
RAND URL: http://www.rand.org
To order RAND documents or to obtain additional information, contact
Distribution Services: Telephone: (310) 451-7002;
Fax: (310) 451-6915; Email: order@rand.org

Preface

About This Document

Over the next decade, the U.S. Army Corps of Engineers, in partnership with the State of Louisiana, will invest more than $14 billion to help restore the Louisiana coast and improve hurricane and flood protection. The State of Louisiana and local governments are responsible for most or all operation and maintenance costs for these types of federal investments. In Louisiana, levee districts have traditionally been the primary local government entity responsible for providing these services. Because of the extent of the planned improvements over the next decade, these costs will rise and the State of Louisiana and the levee districts will face additional financial demands to cover higher operating budgets.

The purpose of this study is to provide Louisiana's Coastal Protection and Restoration Authority (CPRA) and eight of Louisiana's 20 levee districts in the coastal zone with alternative estimates of additional operating costs and options for potential future sources of revenue.

The study was conducted under the joint auspices of the RAND Gulf States Policy Institute and RAND Environment, Energy, and Economic Development (EEED).

This report was funded by CPRA.

The RAND Gulf States Policy Institute

RAND created the Gulf States Policy Institute in 2005 to support hurricane recovery and long-term economic development in Louisiana, Mississippi, and Alabama. Today, RAND Gulf States provides objective analysis to federal, state, and local leaders in support of policymaking and the well-being of individuals throughout the Gulf Coast region. With offices in New Orleans, Louisiana, and Jackson, Mississippi, RAND Gulf States is dedicated to answering the region's toughest questions related to a wide range of issues that include coastal protection and restoration, health care, and workforce development. More information about RAND Gulf States can be found at http://www.rand.org/gulf-states/ or by contacting the director (rgspi@rand.org).

The RAND Environment, Energy, and Economic Development Program

EEED is part of RAND Justice, Infrastructure, and Environment, a division within RAND dedicated to improving policy and decisionmaking in a wide range of policy domains, including civil and criminal justice; infrastructure protection and homeland security; transportation and energy policy; and environmental and natural resources policy.

Questions or comments about this report should be sent to the project leader, Trey Miller (Trey_Miller@rand.org). For more information on EEED, see http://www.rand.org/energy or contact the director (eeed@rand.org)

Contents

Figures

Tables

Executive Summary

This report analyzes the fiscal capacity of local levee districts in southern Louisiana to shoulder the burden of operating and maintaining the Hurricane and Storm Damage Risk Reduction System (HSDRRS) and other key hurricane protection infrastructure currently under construction by the U.S. Army Corps of Engineers (USACE). It specifically focuses on operation and maintenance (O&M) costs, assuming that costs associated with major repairs and levee lifts will not be borne by levee districts. It also discusses some approaches that other government agencies responsible for operating and maintaining flood and hurricane protection infrastructure are using to generate revenue to cover those costs.

The report discusses the methodology used to project the O&M costs associated with hurricane protection infrastructure. It provides O&M cost estimates for each newly constructed piece of the HSDRRS and estimates the total O&M costs to be borne by eight major levee districts within the HSDRRS. Some of these estimates differ from estimates based on cost-plus engineering estimates because they are based on historical expenditures by levee districts to maintain existing infrastructure. The report then discusses our methodology for projecting levee district budget revenues and budget balances through 2016. The report concludes with a discussion of some options that other states have used to generate revenue for the O&M of levees and hurricane protection infrastructure.

Projections of O&M Costs of Hurricane Protection Infrastructure

We combined two approaches to project the incremental O&M costs of the HSDRRS. The vast majority of incremental O&M costs stems from large, newly constructed projects with no precedent in the pre–Hurricane Katrina system.[1] These include the Gulf Intracoastal Waterway West Closure Complex (WCC) and the Seabrook Control Structure. For these projects, we used cost-plus engineering-based O&M cost estimates developed by the USACE. These estimates derive O&M costs by defining a 50-year O&M schedule; assigning specific monetary costs for each O&M function based on assumptions concerning labor, materials, and overhead costs; and taking the average annual cost over the 50-year project life cycle. To estimate the O&M costs that will be borne by each levee district, we assigned

[1] Hurricane Katrina made its second landfall along the Louisiana coast on August 29, 2005.

each piece of this new infrastructure to a specific levee district and summed the projected O&M costs of all pieces of infrastructure that will ultimately be assigned to that district.

The remaining incremental O&M costs associated with the HSDRRS stem from additions of or major modifications to hurricane protection infrastructure similar to what was in place prior to Hurricane Katrina. Examples of such typical projects include raising existing levees or constructing new gates and pump stations similar to those that existed prior to Hurricane Katrina.[2] To estimate these incremental costs, we employed historical data on O&M expenditures and pre-Katrina hurricane protection infrastructure by levee district to estimate the incremental cost of operating and maintaining typical pieces of hurricane protection infrastructure: levees, floodgates, and pump stations. To estimate maintenance costs for these types of infrastructure, we measured levees in terms of area (acres) and counted the numbers of floodgates and pump stations. We then used an econometric model employing historical cost data to estimate the incremental cost of operating and maintaining an additional acre of levee right-of-way, floodgate, and pump station, respectively. To estimate the additional costs of maintaining and operating the new infrastructure being built within the state of Louisiana, we applied these estimates to data on the numbers of new acres of levee, floodgates, and pump stations being built within the HSDRRS.

To estimate the total O&M costs associated with the HSDRRS, we added the incremental O&M costs obtained from the methods described above to baseline O&M estimates derived by projecting forward actual annual historical O&M expenditures on the pre-Katrina system. Approximately 72 percent of total O&M costs associated with the HSDRRS stems from infrastructure that was in place prior to Hurricane Katrina.

Assignment of O&M responsibilities for HSDRRS infrastructure spanning levee district boundaries or offering protection to multiple jurisdictions is a matter of ongoing discussion in southern Louisiana. In many cases, it is still unclear how the O&M responsibilities for such infrastructure will be shared by jurisdictions. The O&M estimates by levee district presented in this report include only those costs associated with infrastructure that is wholly contained within a levee district's boundaries. As such, they represent a lower bound for a levee district's total expected O&M costs. We identified three major pieces of infrastructure in the West Bank that either span the boundaries of West Jefferson Levee District (WJLD) or provide significant protection to portions of Southeast Louisiana Flood Protection Authority (SLFPA) West: the WCC and the Eastern and Western Tie-Ins. The total cost to operate and

[2] While the number of HSDRRS projects with modifications to or construction of typical projects far exceeds the number of unprecedented projects, the O&M costs associated with each typical project is quite low relative to that of unprecedented projects. Thus, the vast majority of incremental O&M costs stem from unprecedented projects.

maintain this infrastructure is estimated at $3 million to $4 million annually. A key goal for CPRA and other stakeholders will be to determine the allocation of O&M responsibilities for these major pieces of infrastructure.

According to our projections, some districts will bear a larger share of the incremental O&M burden associated with the HSDRRS than others. We project that the O&M costs for Orleans Levee District will increase by $1.9 million to $2.8 million annually once the USACE has transferred responsibility for the new infrastructure associated with the HSDRRS. In contrast, we project that East Jefferson Levee District's O&M costs will increase by just $20,000 annually.

Projected Budget Balances, by Levee District

We use our cost estimates to derive projections of budget balances in 2016 by levee district. Our projections assume the following:

1. The HSDRRS will be complete by 2016, and levee districts will be fully responsible for the O&M costs of the system.
2. O&M costs per acre of levee, per floodgate, and per pump will not rise more rapidly than the rate of inflation, i.e., they will be constant in inflation-adjusted terms.
3. Ad valorem (property) tax revenues will stagnate in inflation-adjusted terms between 2009 and 2016. We also investigate a scenario in which these revenues increase in inflation-adjusted terms by 2 percent annually between 2009 and 2016.

We find considerable variance in projected budget balances across levee districts, with many levee districts enjoying surpluses. Although Lake Borgne is projected to have a $2 million deficit by 2016, Orleans and East Jefferson Levee Districts are projected to have $8 million and $4 million surpluses, respectively, under the scenario that ad valorem revenues remain flat in constant prices. Assuming that none of the O&M functions for the district boundary–spanning pieces of infrastructure in the West Bank will fall on WJLD, the district will roughly break even in 2016. However, if significant portions of O&M responsibilities for the WCC and/or the Eastern and Western Tie-Ins fall on WJLD, then WJLD and SLFPA West could both face budget shortfalls unless additional revenues are raised. Overall, under all scenarios, the total of all projected surpluses exceeds that of projected deficits, even when the district boundary–spanning pieces of infrastructure are included in SLFPA West's budget, suggesting that there may be scope for revenue-sharing across levee districts.

Approaches That Other States Have Tried for Financing Levee and Hurricane Protection Infrastructure

Other states' approaches for financing the O&M costs of levee and hurricane protection infrastructure fall into three categories. First, we discuss options related to states' use of land in the levee right-of-way. Approaches used in other states, not necessarily appropriate in a Louisiana setting, include

1. strategic leasing of prime levee right-of-way to casino and other commercial developers
2. leasing of levee right-of-way for hunting or grazing purposes
3. selling off levee right-of-way and retaining conservation easements
4. leasing levee right-of-way for cell phone towers and billboards
5. developing and charging for the use of recreational facilities with low O&M costs, such as boat ramps and marinas.

We also discuss an option of the federal government paying a share of the O&M costs of the HSDRRS. When interviewing officials responsible for levee maintenance in other states, we learned that the USACE operates and maintains a large share of the flood control infrastructure along waterways deemed navigable by the federal government, including the Gulf and Atlantic Intracoastal Waterways. Some of the larger pieces of the HSDRRS are situated along the Gulf Intracoastal Waterway and, in theory, could be considered a federal responsibility. Further research by legal experts would be required to assess the viability of the USACE sharing in the O&M costs for that infrastructure.

We also discuss options relating to consolidation of and revenue-sharing among levee districts. A number of state governments, including those of Florida and California, play a larger role than the State of Louisiana in funding O&M costs of levees and other flood control infrastructure. Other states, also including Florida, have a formal mechanism in place for revenue-sharing across local levee districts. Given that projected total surpluses may outweigh total deficits, an appropriately designed revenue-sharing mechanism is one potential means of covering deficits in those districts threatened by substantial increases in costs. This mechanism may hold promise for the State of Louisiana.

Acknowledgments

The author would like to thank the staff at the Coastal Protection and Restoration Authority for their advice and support. Chip Kline, Charles Sutcliffe, Cynthia Duet, Kyle Graham, and James McMenis were particularly helpful. The author would also like to thank the staff of the New Orleans District of the U.S. Army Corps of Engineers for sharing data and discussing projects, especially Michael Park and Joe Hendrix. Many thanks are also given to Sally Sleeper, Keith Crane, and Debra Knopman for their advice and support throughout the course of this project. The author would also like to thank Oliver Wise, Megan Clifford, Jordan Fischbach, and Lauren Andrews for helpful research assistance. Shanthi Nataraj, associate economist at the RAND Corporation, and Douglas Woolley, professor emeritus at Radford University, provided insightful reviews with helpful comments and suggestions. Finally, the author would like to thank the many Louisiana levee district leaders and staff members at flood control agencies in other states whom we interviewed for this study.

Abbreviations

AIWW	Atlantic Intracoastal Waterway
CSSF	Central and Southern Florida Flood Control Project
CPRA	Coastal Protection and Restoration Authority
EEED	Environment, Energy, and Economic Development Program
HSDRRS	Hurricane and Storm Damage Risk Reduction System
IHNC	Inner Harbor Navigation Canal Surge Barrier
OCPR	Office of Coastal Protection and Restoration
OLS	ordinary least squares
O&M	operation and maintenance
PDD	Project Description Document
SLFPA	Southeast Louisiana Flood Protection Authority
USACE	U.S. Army Corps of Engineers
WCC	Gulf Intracoastal Waterway West Closure Complex

1. Introduction

In the wake of Hurricanes Katrina and Rita, Congress authorized the U.S. Army Corps of Engineers (USACE) to take on the task of rebuilding and substantially improving the hurricane protection system in southern Louisiana. The USACE's Hurricane and Storm Damage Risk Reduction System (HSDRRS) has been designed to eventually provide flood protection capable of withstanding a storm with a 1-percent or greater chance of occurrence in any given year to a portion of southern Louisiana, including the Greater New Orleans Metropolitan Area.

The federal government is paying the bulk of the construction cost of the HSDRRS. However, when the system is complete, the responsibilities for conducting and paying for operation and maintenance (O&M) associated with the new infrastructure will fall on local government agencies. According to USACE estimates, the majority of O&M costs associated with the HSDRRS will fall on Louisiana's levee districts, local districts responsible for maintaining and operating flood control systems within their jurisdictions.[3] Levee districts have the authority to levy and collect taxes to fund these activities. Faced with the fiscal uncertainty stemming from the long-term impact that Hurricanes Katrina and Rita will have on the regional economy, as well as the general economic downturn, state and levee district leaders need to have a clear idea of what O&M costs are likely to be in each district and the fiscal capacity of each district to cover the costs of operating and maintaining the new infrastructure.

In order to assist the levee districts and the State of Louisiana to better prepare for these financial obligations, this report provides systematic projections of future O&M costs associated with the HSDRRS that will fall on southern Louisiana's levee districts. It also provides projections of ad valorem tax revenues and expenditures on O&M for affected levee districts through 2016 and discusses some funding approaches that other states and government agencies have used to finance the costs of operating and maintaining hurricane and flood control infrastructure.

[3] The remaining 46 percent of O&M costs will fall on a number of other government agencies, including Plaquemines, St. Charles, and Jefferson Parishes, and the New Orleans Sewage and Water Board.

2. Projecting Operation and Maintenance Costs of Hurricane Protection Infrastructure

In this section, we discuss our methodology for projecting the O&M costs of new hurricane protection infrastructure associated with the HSDRRS and provide estimates of O&M costs by new piece of infrastructure and by levee district. We begin by discussing the data we employ to make projections. Next, we discuss our methodology for projecting O&M costs. We then provide estimates of O&M costs by piece of infrastructure and by levee district.

Data

Our analysis employs data on the hurricane and flood protection infrastructure that was in place before Hurricane Katrina and historical O&M expenditures by levee district. It also employs detailed data on the specific hurricane and flood control projects that are currently being constructed by the USACE as part of the HSDRRS. For each levee district in our analysis, we employ information on acres of levee right-of-way and numbers of floodgates and pump stations that were maintained by that levee district before Hurricane Katrina. We also employ information on the O&M expenditures of those levee districts. Prior to our study, these data had not been aggregated; we assembled these data from a number of sources specifically for this study.

Data on pre-Katrina infrastructure came from the former Office of Coastal Protection and Restoration (OCPR), now part of CPRA. OCPR provided us with detailed information on pre-Katrina infrastructure within Southeast Louisiana Flood Protection Authority (SLFPA) East and West, as well as Grand Isle, Pontchartrain, South Lafourche, Terrebonne, and Atchafalaya Levee Districts. Data included the length and height of all levee reaches[4] and the

[4] We were not given data on acres of levee right-of-way by levee district. We estimated acres of levees using information on the length and height of all levee reaches within each levee district. We assume that each levee has a 10-foot crest, a slope of 3:1, and a berm with a slope of 20:1. Thus, for each reach, we estimate acres of levee right-of-way as:

$$\frac{5{,}280 \times \text{miles} \times \left(10 + 25.4 \times \text{height}\right)}{43{,}560}.$$

This formula is derived under the assumption that 10 percent of the levee's height is devoted to the berm. We divide by 43,560 to covert from square feet to acres. We obtain the

number of pump stations and floodgates operated by each district before Hurricane Katrina. Wherever necessary, we supplemented these data with information from maps supplied by the USACE found in the June 23, 2002, edition of the New Orleans *Times-Picayune*, levee district websites, USACE inspection reports, and information obtained during interviews with levee district leaders. Table A.1 in the appendix shows our data on pre-Katrina hurricane protection infrastructure by levee district.

Data on infrastructure that will be in place once the HSDRRS is complete came from multiple sources. Our primary data source for HSDRRS infrastructure is the USACE O&M cost estimate for the HSDRRS.[5] This data source gives detailed information on the infrastructure associated with the HSDRRS on a project-by-project basis. The USACE also provided RAND with three maps of projects under way within HSDRRS. The maps have information about the pre-Katrina height of specific levee reaches, as well as information about what the final height of those levees will be once construction is complete. The maps also have information about other specific projects that are under way within HSDRRS, including specific information about new floodgates, pump stations, and other flood control and drainage structures. Wherever necessary, we supplemented these data with information from the USACE's publicly available Project Description Documents, the USACE HSDRRS website and interactive project map, and discussions with levee district leaders.

Data on levee district finances came from annual audited financial statements. Audited financial statements for all state and local government entities are publicly available on the Louisiana Legislative Auditor's website (Louisiana Legislative Auditor, various dates). Annual audited financial statements were available on-line back to 1996 for most levee districts. From these financial statements, we recorded annual revenue from ad valorem taxes and annual expenditures on O&M for the years 1996–2009 for all levee districts within SLFPA East and West, as well as Grand Isle, Pontchartrain, South Lafourche, Terrebonne, and Atchafalaya Levee Districts.[6]

---

total acres of levee right of way in a levee district by adding up the imputed acres of levee right of way for each reach within the district.

[5] The USACE cost estimates are not in a public document but are available to the public on request. Questions regarding access should be directed to the New Orleans District of the USACE (askthecorps@USACE.army.mil; Public Affairs, 504-862-2201). In this report, we provide a description of the USACE's methodology in Section 2.

[6] The format of the financial statements varied considerably across levee districts and over time, making it difficult to record financial data in a systematic way. While all levee districts recorded ad valorem revenue separately from other revenue sources, O&M expenditures were defined differently in different financial statements. For the purposes of this report, we defined O&M expenditures as the total expenditures from a levee district's

Methodology

We combined two approaches to project the incremental O&M costs of the HSDRRS. The majority of incremental O&M costs stem from large, newly constructed projects with no historical precedent in the pre-Katrina system. For these pieces, we use cost-plus engineering-based O&M cost estimates provided by the USACE. *Cost-plus engineering-based O&M costs* means that, for each piece of infrastructure, the USACE attempted to specify all O&M tasks over the project's 50-year life cycle, estimated the costs associated with each task, summed the costs over all tasks, and developed an average annual O&M cost for each of these pieces of infrastructure in the HSDRRS. We employ these estimates from the USACE for the following pieces of infrastructure: the Seabrook Control Structure, the IHNC, the WCC, the Bayou Dupree Floodgate, the Western Tie-In, the Caernarvon Sector Gate, the Harvey Canal Sector Gate, and the Bayou Segnette Closure Complex. Note that this list includes all projects with a major sector gate, lock, control, or drainage structure.

The USACE estimates were reviewed by CH2M Hill, an engineering firm employed for this purpose by what was then OCPR. CH2M Hill generally concurred with the USACE's assumptions regarding key O&M tasks. However, through interviews with local levee districts, CH2M Hill found that the USACE's estimates for labor costs were higher than what local levee districts typically pay. CH2M Hill's estimates suggest that, in some instances, the USACE estimates for specific maintenance tasks may be as much as 45 percent higher than what local levee districts will actually pay to cover the O&M costs of the HSDRRS. We thus investigate a scenario in which O&M costs for the eight pieces of infrastructure listed above are correspondingly lower than the USACE estimates. The two sets of estimates are used to establish a range of likely O&M costs for the newly constructed, large and unprecedented projects associated with the HSDRRS.

The remaining incremental O&M costs of the HSDRRS stem from newly constructed or significantly altered infrastructure that is similar to the infrastructure that existed prior to Hurricane Katrina. To estimate the costs of these projects, we employed historical data on O&M expenditures from 1996 to 2004 (prior to Katrina) and pre-Katrina hurricane protection infrastructure, by levee district, to estimate the incremental cost of operating and maintaining typical pieces of hurricane protection infrastructure: levees, floodgates, and pump stations.[7] To estimate maintenance costs for these types of infrastructure, we measured levees in terms of area (acres) and counted the numbers of floodgates and pump stations.

---

general fund. Expenditures from other funds, including construction and rainy-day funds, were not coded as O&M expenditures.

[7] See "Data" earlier in this section for data sources.

To estimate future O&M costs for these types of infrastructure, we constructed a linear model of O&M expenditures using the statistical technique of ordinary least squares (OLS) regression. OLS regression is a statistical method of estimating a value—in this case, expenditures on O&M costs—based on adding together other factors that contribute to that value (the cost of O&M expenditures). We used the following regression model:

$$Exp_{it} = a_{1t} + a_2 \times acres_i + a_3 \times floodgates_i + a_4 \times pumps_i + e_i, \quad \text{(Equation 2.1)}$$

where Exp_{it} is expenditures on O&M in 2009 constant dollars by levee district i in year t, $acres_i$ is the number of acres of levee right-of-way maintained by levee district i, $floodgates_i$ is the number of floodgates maintained by levee district i, $pumps_i$ is the number of pump stations in levee district i, e_i is an error term specific to levee district i, and a_{1t} is specific to each observation year (1996–2004).

The estimates we derived for the terms a_2, a_3, and a_4 become our estimates of the incremental cost of operating and maintaining an additional acre of levee right-of-way, floodgate, and pump station, respectively. Note that our model assumes that a levee district's O&M costs are a linear function of the specific pieces of infrastructure that the levee district is responsible for operating and maintaining. Moreover, we do not observe actual O&M costs by each piece of infrastructure; rather, costs are allocated across the types of infrastructure using the analytical approach described above.

To estimate the additional costs of maintaining and operating the new infrastructure being built within the state of Louisiana, we applied these estimates to data on the new infrastructure associated with HSDRRS: the number of new acres of levee, floodgates, and pump stations being built within the HSDRRS, excluding large and unprecedented projects. We added these incremental O&M costs to the USACE's cost-plus engineering-based cost estimates for the large and unprecedented projects in each levee district. Using this information, we estimated the O&M costs that will be borne by each levee district by assigning each piece of new infrastructure to a specific levee district and summing the projected O&M costs of all pieces of infrastructure that will ultimately be assigned to that district.

In our discussions with levee district leaders, we discovered that there is a lack of consensus surrounding the assignment of infrastructure to levee districts. Importantly, many of the large and unprecedented pieces of infrastructure with the highest O&M costs span and/or provide considerable levels of protection to multiple jurisdictions, which significantly complicates the allocation of costs across those jurisdictions. Specifically, we identified four major pieces of infrastructure that span levee district boundaries: Inner Harbor Navigation Canal Surge Barrier (IHNC), the Gulf Intracoastal Waterway West Closure Complex (WCC), and the Eastern and Western Tie-Ins. The IHNC spans the border of Orleans and Lake Borgne Levee Districts, but those districts have established an agreement whereby Orleans will be responsible for 90 percent of the O&M costs associated with the IHNC. The

additional three pieces of infrastructure are in the West Bank, and the eventual O&M responsibility for these pieces of infrastructure is unclear. It appears that the O&M responsibilities for these pieces of infrastructure will fall on West Jefferson Levee District (WJLD) and Plaquemines and St. Charles Parishes. However, for the purposes of this report, we did not include the O&M costs for these pieces of infrastructure in any budget calculations. As such, the O&M projections for WJLD should be viewed as a lower bound. According to USACE estimates, the O&M costs associated with these projects is $3 million to $4 million annually, or roughly one-third of the incremental O&M costs of the entire HSDRRS. As such, CPRA should make it a priority to determine the O&M responsibilities for these pieces of infrastructure in the West Bank.

To estimate the total O&M costs associated with the HSDRRS, we added the incremental O&M costs obtained from the methods described above to baseline O&M estimates derived by projecting forward each levee district's average annual O&M expenditures on the pre-Katrina system over the period 1996–2004.

The primary strength of the approach outlined above is that it is based on historical costs that were actually borne by levee districts. Since historical costs reflect actual costs incurred, they reflect local labor and contractor rates as well as the costs of needed supplies and equipment. We can thus be relatively certain that historical costs will reflect the cost components that will drive what levee districts will have to pay to cover O&M costs of similar infrastructure in the future.

A major assumption embedded in the historical cost approach is that the past expenditure levels by levee districts provided for adequate maintenance. The key concern is that, for financial reasons, during the period of analysis, levee districts might not have spent enough to maintain their infrastructure. USACE inspection reports from 1998 through 2004 indicate that all levee districts in our study were satisfactorily maintaining their hurricane protection infrastructure prior to Hurricane Katrina. The findings from our interviews with levee district officials and USACE staff also confirm that levee districts generally performed their O&M duties at acceptable or higher standards. On this basis, we conclude that past O&M expenditures are a suitable metric for estimating future costs for similar infrastructure.

Estimates

Estimates of Incremental Costs

Table 2.1 presents our estimates of the incremental costs of maintaining hurricane protection and flood control infrastructure associated with land area, floodgates, and pump stations.

Table 2.1 Estimates of the Incremental O&M Costs for Hurricane Protection Infrastructure

Infrastructure	Incremental Cost	Standard Error
Acres	$140	26
Floodgates	$67,252	5,456
Pump stations	$92,936	28,885
R-squared	0.926	
N	69	

Standard error represents one standard deviation on either side of the estimated mean of the incremental cost. R-squared is a measure of how well the linear regression model explains the variability in the data; N is the number of data points used for estimation. The results indicate that it costs approximately $140 per year to maintain a typical pre-Katrina acre of levee right-of-way, $67,252 per year to maintain a floodgate, and $92,936 per year to maintain a pump station, all expressed in 2009 dollars.

Estimates of Total Expected Cost for O&M

We apply the estimates in Table 2.1 to derive estimates of the total expected cost for operating and maintaining each new piece of HSDRRS infrastructure. To do so, we use the total number of additional acres of levee right-of-way, floodgates, and pump stations associated with each new piece of the HSDRRS that are similar in size and scope to typical pieces of the pre-Katrina hurricane protection system. For the large pieces of infrastructure listed in Section 2, we use the USACE cost-plus engineering-based estimates for O&M costs. We refer to these estimates as the *high-cost* scenario. We also investigate a scenario in which O&M costs are 31 percent lower than those determined by the USACE.[8] We refer to these estimates as the *low-cost* scenario.

By adding up these costs for all new pieces of infrastructure in a levee district, we estimate the total expected increase in O&M costs that the levee district will incur as a result of the new HSDRRS infrastructure.[9] Similarly, by adding up those costs for all levee

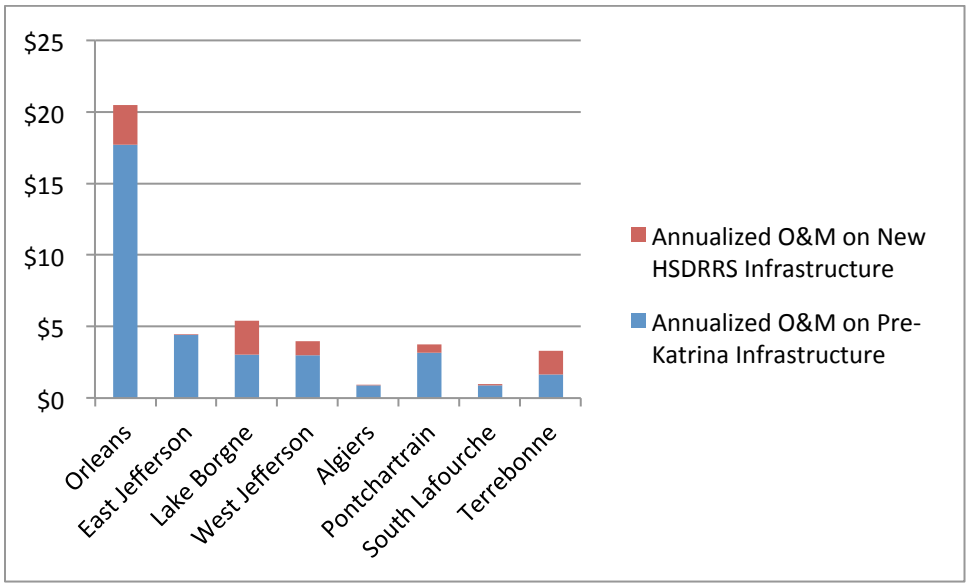
[8] If USACE cost estimates are 45 percent more than those calculated by CH2M Hill, then mathematically, CH2M Hill estimates were 31 percent less than the USACE's estimates. Hence, our use of 31 percent to calculate the lower estimate.

[9] When a major project spans multiple levee districts, we attempted to assign the individual pieces of infrastructure associated with the project to the levee district in which it will be located. So, for example, the IHNC falls in both Orleans and Lake Borgne Levee Districts. Given that two gates are in Lake Borgne and one in Orleans, we assumed that Lake

districts, we estimate the total expected cost to levee districts of maintaining the HSDRRS, over and above the cost of operating and maintaining the pre-Katrina hurricane protection system.

Figures 2.1 and 2.2 show projected O&M costs for pre-Katrina and new HSDRRS infrastructure by levee district under the high- and low-cost scenarios. Again, neither scenario includes the O&M costs associated with the three district boundary–spanning projects in the West Bank.[10] The estimates for specific pieces of new HSDRRS infrastructure are reported in the appendix.

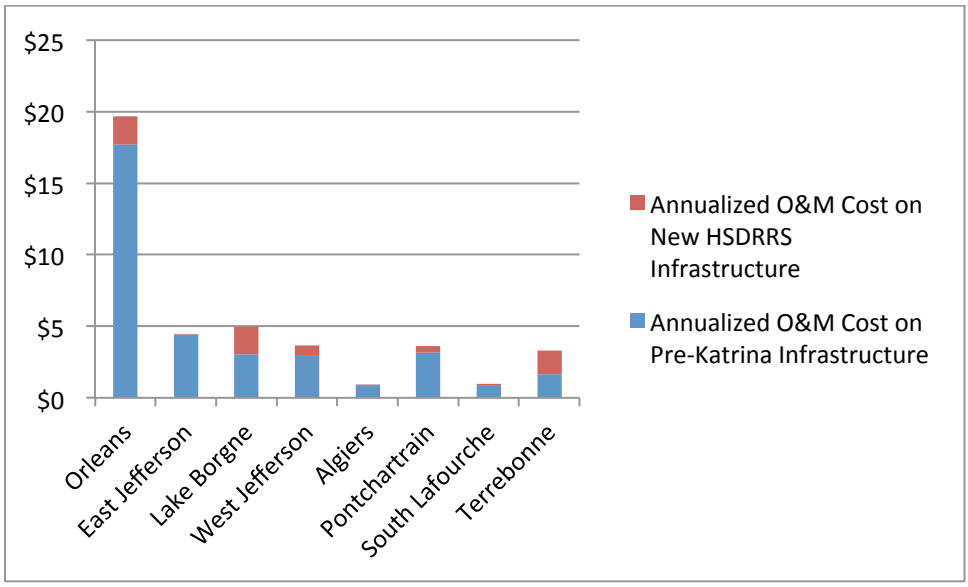
Figure 2.1 Estimates for Annual O&M Costs for Pre-Katrina and HSDRRS Infrastructure, by Levee District, High-Cost Scenario (in millions of dollars)



Borgne would cover two-thirds of the O&M costs for the IHNC with the remainder falling on Orleans Levee District.

[10] The three district boundary–spanning projects are the Eastern and Western Tie-Ins, and the WCC.

Figure 2.2 Estimates for Annual O&M Costs for Pre-Katrina and HSDRRS Infrastructure, by Levee District, Low-Cost Scenario (in millions of dollars)



Findings

Figures 2.1 and 2.2 indicate that the effects on district O&M budgets from the addition of post–Hurricane Katrina infrastructure vary substantially by levee district. According to the information we have received, in East Jefferson Levee District, the USACE is only raising existing levees and adding foreshore protection along the shore of Lake Pontchartrain. These tasks will increase the number of acres of levee right-of-way maintained by East Jefferson Levee District by 172 acres, which will cost roughly an additional $20,000 annually to maintain.

In contrast, the USACE is constructing several large, new hurricane protection projects in Lake Borgne Levee District. These projects include the massive control structure with three floodgates along the Inner Harbor Navigation Canal Surge Barrier (IHNC), ten floodgates between Bayou Bienvenue and Caernavon, and a floodgate at Bayou Dupree. The USACE is also raising existing levees, which will add another 727 acres of levee right-of-way to Lake Borgne Levee District. Our estimates indicate that the cost of operating and maintaining these additional pieces of infrastructure will be an additional $1.8 million to $2.1 million per year, which is a large share of Lake Borgne's current O&M budget.

Our estimates indicate that the levee districts that will incur the largest increases in O&M costs stemming from new infrastructure currently being constructed by the USACE are Orleans, Lake Borgne, Terrebonne, and West Jefferson Levee Districts, whose O&M budgets will increase by roughly $2.8 million, $2.1 million, $1.7 million, and $1.0 million,

respectively, under the high-cost scenario. In contrast, our estimates suggest that the O&M budgets for East Jefferson, Algiers, Pontchartrain, and South Lafourche Levee Districts will increase by less than $125,000 combined.

3. Projections of Budget Balances, by Levee District

In this section, we present our projections of budget balances, by levee district. To project budget balances, we first build on our estimates from Section 2 to provide estimates of future O&M costs. Next, we analyze past trends in ad valorem revenue to make informed projections of future growth in ad valorem revenue. We use these projections of costs and revenues to project budget balances through 2016 under two scenarios for the evolution of property values.

Projecting Future Operation and Maintenance Costs for the HSDRRS

Our cost projection model described in Section 2 provides the backbone for projecting the O&M costs of the HSDRRS. However, to make long-term cost projections, we must make an assumption about the rate of growth of O&M costs of existing hurricane protection infrastructure through 2016. To inform our assumptions about future growth in O&M costs, we examine trends in O&M costs by levee district before Hurricane Katrina. These trends are presented in Figures 3.1 through 3.3.

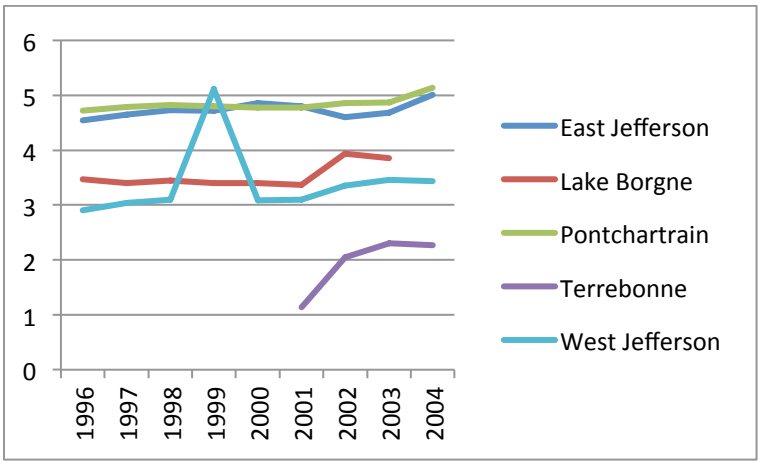
Our data indicate that, from 1996 to 2004, O&M expenditures increased in constant prices for every levee district except WJLD. There are two possible reasons that O&M expenditures increased prior to Katrina. The first possible reason is that the costs of operating and maintaining existing hurricane protection infrastructure may have been rising more rapidly than the average inflation rate. This might have happened because of increases in wages of workers or other costs required to operate and maintain hurricane protection infrastructure above and beyond the rate of inflation. The increases might also have been due to increased needs for maintenance as levees, pumps, and water gates aged.

The second possible reason is that increases in O&M expenditures might have reflected an expansion of the hurricane protection system before Katrina. In this case, increases in O&M expenditures do not reflect growth in O&M costs for the existing hurricane protection system. Rather, they reflect increases in costs to operate and maintain an expanded hurricane protection system.

Our data indicate that the two levee districts with the highest growth rates in O&M expenditures from 1996 to 2004 were Terrebonne and South Lafourche, reporting average annual rates of increase of 22 percent and 8 percent, respectively. During that period, South Lafourche and Terrebonne constructed the Larose to Golden Meadow and Morganza to the Gulf projects, respectively. In contrast, the annual growth rate in O&M expenditures in constant prices was close to zero in other districts where little or no additional hurricane

protection infrastructure was constructed. For example, the average annual rate of growth in expenditures on O&M was approximately 0.6 percent for East and West Jefferson and Orleans. Since those districts were also adding infrastructure, the annual growth rate in O&M expenditures for existing infrastructure was likely even lower. Thus, we conclude that most of the increase in O&M expenditures in our data reflects growth in the pre-Katrina hurricane protection system, as opposed to higher-than-average inflation in the O&M costs. Thus, our projections assume that O&M costs for existing hurricane protection systems are flat over time in constant prices.

Figure 3.1 Operation and Maintenance Expenditures (1996–2004): East Jefferson, Lake Borgne, Pontchartrain, Terrebonne, and West Jefferson Levee Districts (in millions of dollars)



SOURCE: Louisiana Legislative Auditor, various years.

Figure 3.2 Operation and Maintenance Expenditures (1996–2004): Grand Isle and South Lafourche Levee Districts (in millions of dollars)

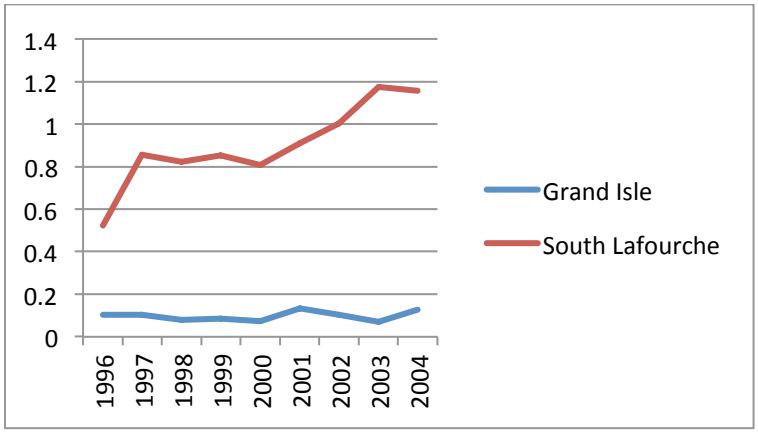
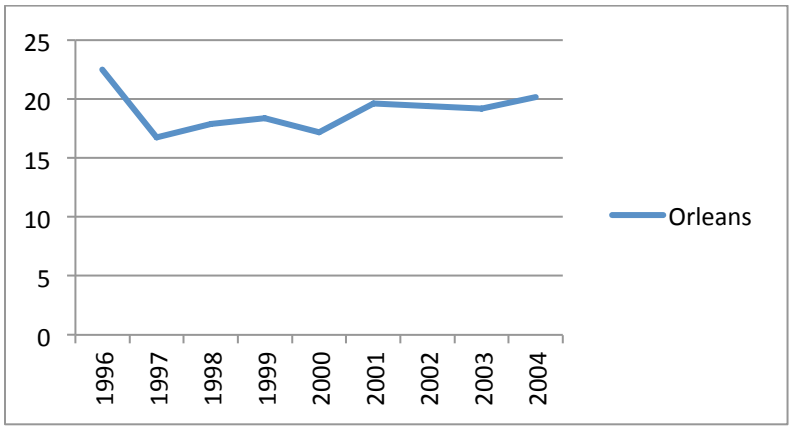


Figure 3.3 Operation and Maintenance Expenditures (1996–2004): Orleans Levee District (in millions of dollars)

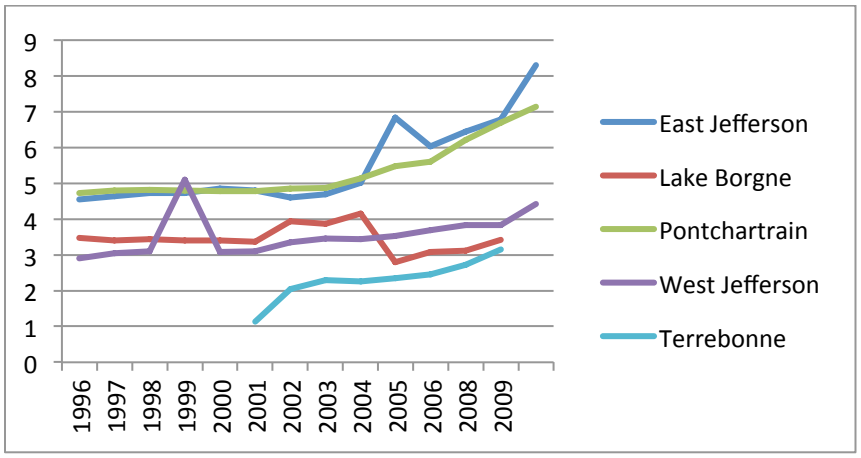


SOURCE: Louisiana Legislative Auditor, various years.

Trends in Ad Valorem Revenue, by Levee District

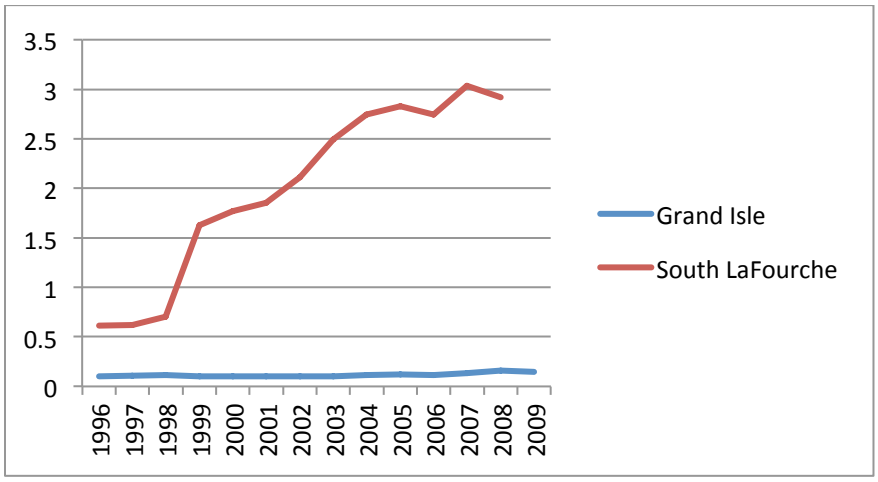
To make projections of budget deficits, we must make assumptions about the levels and future growth rates in ad valorem revenues. Unfortunately, events such as Hurricane Katrina, the *Deepwater Horizon* oil spill, and national increases in housing prices until 2008 make it difficult to accurately forecast future ad valorem revenues. To help inform our assumptions about future growth in ad valorem revenues, we begin by examining past trends. In doing so, we pay close attention to the extent to which ad valorem revenues declined after Hurricane Katrina and the extent to which revenues have rebounded since. Figures 3.4 to 3.6 present trends in ad valorem revenue by levee district from 1996 to 2009. Note that the vertical scales of the figures vary depending on the size of the levee district.

Figure 3.4 Ad Valorem Revenue (1996–2009): East Jefferson, Lake Borgne, Pontchartrain, Terrebonne, and West Jefferson Levee Districts (in millions of dollars)



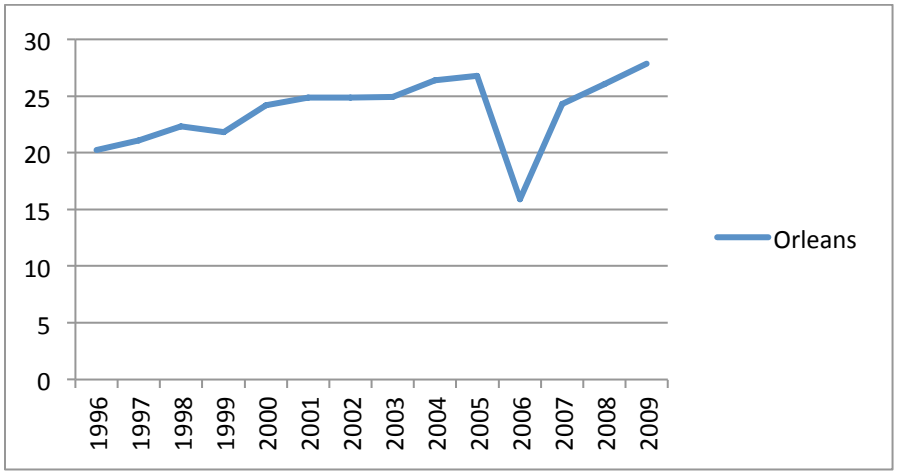
SOURCE: Louisiana Legislative Auditor, various years.

Figure 3.5 Ad Valorem Revenue (1996–2009): Grand Isle and South Lafourche Levee Districts (in millions of dollars)



SOURCE: Louisiana Legislative Auditor, various years.

Figure 3.6 Ad Valorem Revenue (1996–2009): Orleans Levee District (in millions of dollars)



SOURCE: Louisiana Legislative Auditor, various years.

There are several points to take away from Figures 3.4 to 3.6. First, Hurricane Katrina affected levee districts in different ways. While some districts experienced significant declines in ad valorem revenue immediately following Hurricane Katrina, others experienced above-average growth. The districts with the greatest percentage declines in ad valorem revenues were Orleans and Lake Borgne, where real ad valorem revenue collections declined by 40 percent and 34 percent, respectively, from 2005 to 2006. In contrast, real ad valorem revenue in Pontchartrain Levee District increased by 11 percent from 2005 to 2006, well above the pre-Katrina growth rate of 0.7 percent.

Second, ad valorem revenues in those levee districts with declines following Hurricane Katrina have generally surpassed pre-Katrina levels. For example, ad valorem revenue in Orleans Levee District declined from $27 million to $15 million from 2005 to 2006 but returned to $28 million in 2009. The one exception is Lake Borgne, where ad valorem revenue was still 18 percent below its pre-Katrina level of $4.2 million in 2009.

In many cases, growth rates in ad valorem revenues are well above pre-Katrina rates. For example, East Jefferson's ad valorem revenue grew at a 0.6-percent annual rate from 1996 to 2004 but experienced a 12.7-percent annual growth rate from 2007 to 2009. The key exceptions are South Lafourche, where construction was slowing on the Larose to Golden Meadow Project, and WJLD, where ad valorem revenue growth has remained relatively flat.

Outlook for Growth in Ad Valorem Revenue through 2016

To project revenue from ad valorem taxes, we must make assumptions about the future rate of growth of property values across levee districts. While our data suggest a general upward trend in ad valorem revenues and above-average growth in ad valorem revenues

since Hurricane Katrina through 2009, we do not believe that these trends will persist in the near term. First, the above-average growth rates in recent years occurred during years of significant rebuilding and population growth as residents returned to southern Louisiana. As this process wanes, property values will begin to stabilize. Indeed, the most rapid growth in ad valorem revenues occurred in 2006; growth rates have fallen since that year.

Second, the economic recession, which was precipitated by significant declines in housing prices nationally, has affected property values in southern Louisiana as well. Our current data are based on audited financial statements of ad valorem revenue collected in 2008, which largely reflect property values assessed prior to the recent drop in housing prices. While property values have continued to appreciate in the city of New Orleans, most of southern Louisiana has experienced declining housing prices since 2008. As these properties are reassessed, ad valorem revenues will fall.

In light of these considerations, we base our projections of ad valorem revenues on two different scenarios for growth rates through 2016: 0-percent growth and 2-percent growth. The 2-percent growth scenario represents a case in which ad valorem revenue growth stabilizes at pre-Katrina levels. The median pre-Katrina growth rate for ad valorem revenue across the levee districts in our study was roughly 2 percent. The 0-percent growth scenario represents a case in which declining housing values stemming from the current economic downturn hold property values down in the medium term. The projections based on the 0-percent growth scenario are also useful for understanding the effect of the HSDRRS on budget deficits when ad valorem revenues are held constant.

Projected Budget Balances, by Levee District

Figure 3.7 presents our projections for budget balances in 2016 by levee district under four scenarios:

- high O&M costs and 0-percent real growth in ad valorem revenue
- high O&M costs and 2-percent real growth in ad valorem revenue
- low O&M costs and 0-percent real growth in ad valorem revenue
- low O&M costs and 2-percent real growth in ad valorem revenue.

More-detailed information showing how these figures were derived are presented in the appendix. Note that our budget projections for Orleans Levee District assume that the Special Levee Improvement Tax will be renewed in 2015.

Figure 3.7 Projected Budget Balances, by Levee District, Under Four Scenarios (in millions of dollars)

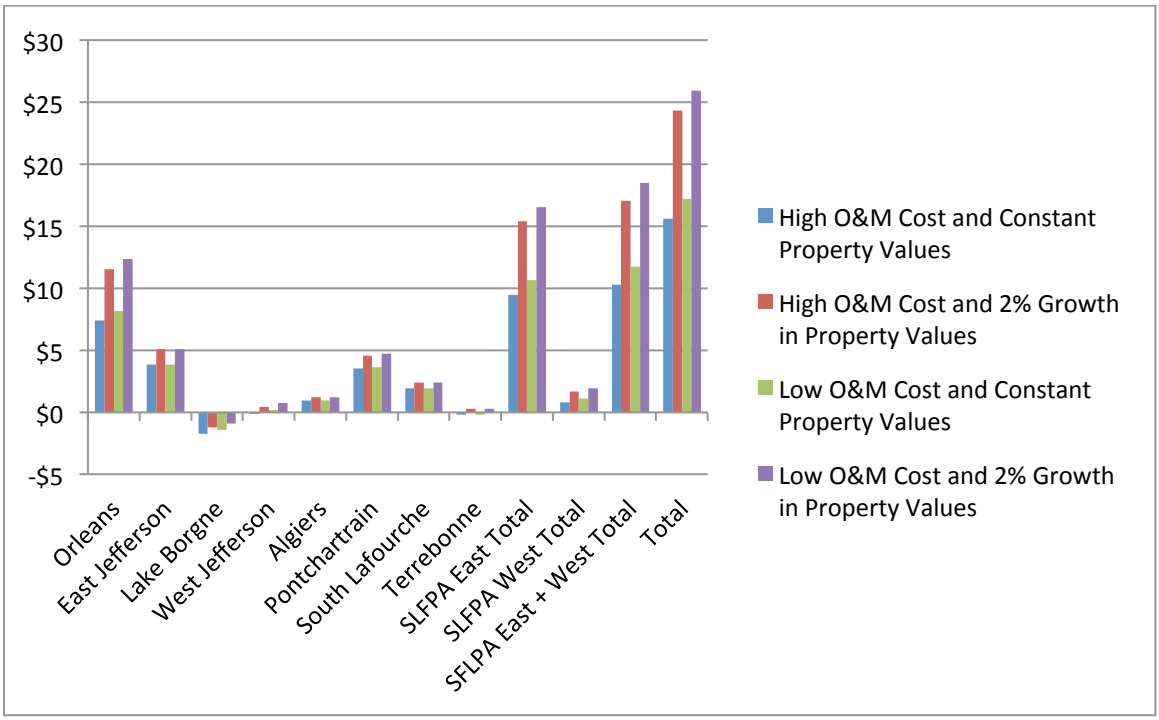


Figure 3.7 suggests that there is considerable variance in projected budget balances across levee districts. Lake Borgne Levee District is expected to run a deficit of up to $2 million per year in constant dollars, or up to 57 percent of projected ad valorem revenue, depending on the scenario. Assuming that none of the O&M responsibilities associated with the WCC and the Eastern and Western Tie-Ins will fall on WJLD, WJLD will likely break even or experience a modest surplus in 2016. However, if a significant share of the O&M costs associated with the district boundary–spanning projects in the West Bank falls on WJLD, WJLD may experience significant deficits. In contrast, East Jefferson and Orleans Levee Districts are projected to run surpluses of between $3.8 million and $7.6 million under the high-cost and 0-percent growth scenario. We project Pontchartrain and South Lafourche both to have small surpluses under all scenarios. We project that Terrebonne will roughly break even under all scenarios.

Under all of the scenarios, we find that, in the aggregate, the levee districts in our study will break even or have a modest combined surplus, depending on the scenario. In all but one scenario, both SLFPA East and West are projected to break even or have aggregate surpluses on their own. However, we find that some levee districts are projected to have large budget deficits in coming years.

Limitations on the Projections of Operation and Maintenance Costs and Budget Deficits

There are several limitations of our analysis. First, our analysis assumes that the USACE estimates for O&M costs for large and unprecedented HSDRRS infrastructure are accurate. We have not conducted an independent review of these estimates, but, as a consequence of a review conducted by CH2M Hill suggesting that the USACE estimates may be as much as 45 percent too high because of their assumptions regarding labor costs, we investigated a low-cost scenario in which O&M costs for large and unprecedented infrastructure pieces are assumed to be 31 percent less than corresponding USACE estimates.[11]

Second, our data on the new hurricane protection infrastructure may be incomplete. While we have taken great care to gather information on the major pieces of infrastructure included in the HSDRRS, there may be smaller projects that are not mentioned in our primary data sources and were not discussed in our conversations with USACE and levee district officials. We expect such projects to be small in size and scope and that they will therefore contribute little to future O&M costs.

Third, our analysis does not distinguish between floodwalls and earthen levees: We treat a mile of earthen levee the same as a mile of floodwall of equal height. For example, we assume that the cost of maintaining a mile of 10-foot floodwall is the same as that of maintaining the acreage of levee right-of-way that a mile of 10-foot earthen levee would encompass. We need to make this assumption because levee districts with extensive floodwalls also tend to have extensive earthen levees, so it is impossible to distinguish statistically between the cost of operating and maintaining earthen levees and floodwalls. We do not believe this to be a major concern for projecting O&M costs because floodwalls and earthen levees are highly correlated. Thus, our methodology implicitly controls for the typical mix of earthen levees and floodwalls. As long as the mix before Katrina is roughly equivalent to what it will be after Katrina, our methodology should yield accurate cost projections.[12]

---

[11] If USACE cost estimates are 45 percent more than those calculated by CH2M Hill, then mathematically, CH2M Hill estimates were 31 percent less than the USACE's estimates. Hence, our use of 31 percent to calculate the lower estimate.

[12] Note that, in some cases, HSDRRS projects involved building a concrete floodwall on top of an existing or expanded earthen levee. In these cases, we assumed that a levee with a floodwall on top would cost the same to maintain as a levee of the combined height of the floodwall and levee. Using our conversion of levee height to footprint, this leads to a corresponding higher figure for levee acreage and hence cost.

Fourth, our analysis does not distinguish between floodgates and navigation gates. This is appropriate so long as the distribution of types of gates in the pre-Katrina system is similar to that after Katrina. To account for differences in costs with large sector gates, we used USACE cost accounting–based estimates for features that include sector gates. Any other differences in the distribution of gate types that alter average O&M costs per gate in the pre-Katrina and current systems are not reflected in our estimates.

Fifth, there is considerable uncertainty surrounding the completion dates of USACE projects as well as dates for specific O&M tasks, and we do not have accurate data on expected project completion or task dates. Thus, we do not attempt to model the completion of HSDRRS projects or dates for specific maintenance functions and instead project the average annual O&M costs of a complete and static HSDRRS. While the USACE or levee districts may need to build additional projects beyond the current system at a later date, such projects are beyond the scope of our analysis.

Sixth, the O&M costs of periodic O&M functions, such as levee lifts, armoring, and scouring, are included in our analysis to the extent that levee districts performed those tasks prior to Hurricane Katrina. Any changes in the extent of or costs associated with these tasks that lead to real O&M cost differences will not be reflected in our estimates.

Seventh, our projections of deficits in ad valorem revenue are based on the assumption that the growth rate of O&M costs of a static hurricane protection system in constant prices is zero. This assumption appears appropriate based on examination of growth rates in O&M expenditures pre-Katrina in constant prices. If, however, there is real inflation in O&M costs over time, then our projections of budget balances in ad valorem revenue are biased upward.

Eighth, our projections of budget balances in ad valorem revenue are based on the assumption that, in constant prices, ad valorem revenue will grow by 0 percent or 2 percent annually over the medium term. The 2-percent scenario represents a return to the median pre-Katrina growth rate of ad valorem revenue in levee districts that were not experiencing rapid growth in hurricane protection infrastructure from 1996 to 2004. The 0-percent growth scenario represents a case in which economic uncertainty stemming from the current housing-induced recession holds property values constant in the medium term. If the true growth rate of ad valorem revenue is higher than 2 percent, then our projections of budget balances in ad valorem revenue are biased downward and therefore would be lower than actual; if the true growth rate is lower than 0 percent annually (meaning a decline in revenue growth), then our projections are biased upward and therefore would be higher than actual.

Finally, our estimates for budget balances do not include the O&M costs associated with the WCC and the Eastern and Western Tie-Ins, which are partly contained within or provide significant protection to WJLD. Our conclusion that WJLD will break even or experience a modest surplus in 2016 relies crucially on the assumption that the O&M costs for these pieces will fall on other jurisdictions, including Plaquemines and St. Charles Parishes.

Should a significant share of the O&M costs associated with these projects fall on WJLD, WJLD and SLFPA West will experience budget deficits without additional revenue.

4. Approaches That Other States Have Tried for Financing O&M Costs of Levee and Hurricane Protection Infrastructure

In this section, we discuss approaches that other states and local government agencies have used to finance the O&M costs of levees and hurricane protection infrastructure. We used several sources of information to collect data on these other states' approaches. In our interviews with levee district leaders from Louisiana, we discussed revenue sources and probed for revenue sources currently used by levee districts other than ad valorem taxes. We examined the websites of a number of state and local sponsors of federal flood control projects, as well as general state flood control and water management agencies. We also interviewed individuals in charge of operating and maintaining flood control projects in the states of Mississippi, Florida, Texas, and California. We chose to concentrate on these states because, like Louisiana, they are prone to flooding and other disasters and have significant flood control infrastructure in coastal areas and along navigable waterways.

We found that flood control agencies generate most of their revenue for day-to-day O&M from ad valorem or other forms of property taxation. Excluding federal and state grants and interest on financial assets, very few of the agencies with which we communicated receive more than 10 percent of their revenue from local sources other than ad valorem or other forms of property taxation. Nevertheless, we did identify some approaches that government agencies have used to finance the O&M costs for levee and other hurricane protection infrastructure. These approaches fall into three general categories:

1. other states' uses of levee rights-of-way
2. request for additional funds from the federal government
3. cost-sharing between or consolidation of levee districts.

Other States' Uses of Levee Right-of-Way

A number of levee districts in Louisiana and flood control agencies in other states generate revenue through those states' uses of levee rights-of-way and other land holdings owned by the district. Approaches that have shown promise in Louisiana and other states include the following:[13]

[13] It is important to note that increasing development within levee rights-of-way may lead to more damage in future storm events, and may negatively impact the ability of levee districts to respond to flood control needs. This tradeoff must be balanced against the benefit

1. **Strategic leasing of prime levee rights-of-way to casino and other commercial developers.** The strategy has generated significant revenues in the state of Mississippi, where the Mississippi Yazoo Levee District generates all revenue necessary to cover its O&M responsibilities from strategic leases of levee rights-of-way in desirable urban areas to casino developers. While Mississippi has concentrated on development by casino interests, development by other commercial interests such as hotel chains and high-density residential developers is also a possibility. The potential revenue from such relationships is considerable in high-traffic tourist destinations such as New Orleans, but districts must be careful to retain sufficient undeveloped right-of-way to accommodate future flood- and hurricane-protection projects.
2. **Leasing of levee right-of-way for passive or agricultural use.** This strategy has shown promise in Mississippi, where the Mississippi Levee Board generates $10 to $15 per acre per year for hunting leases, $5 to $10 per acre for grazing and pasture leases, and $50,000 per year from timber sales. These relationships generally place little strain on the day-to-day operations of levee maintenance crews. Indeed, our interviewees suggest that leases often contributed to maintenance because the lessee often cleared brush for hunting and grazing. While the potential revenue from such relationships is modest, it could help alleviate budget deficits in hard-hit districts with prime hunting or grazing land, such as Terrebonne, South Lafourche, Plaquemines, and St. Bernard Levee Districts. However, some levee district leaders were concerned that this approach could limit their ability to effectively operate and maintain levee district right-of-way.
3. **Selling off levee rights-of-way and retaining conservation easements.** This idea was mentioned in discussions with levee district leaders in Mississippi, and could have the potential to generate considerable revenue. Levee districts could sell all levee rights-of-way to interested parties but maintain the development rights to that property in the form of a conservation easement, which places development and other restrictions as agreed that last into perpetuity.
4. **Leasing levee rights-of-way for cell phone towers and billboards.** This strategy has been debated in the state of Florida and has the potential to generate modest revenue in urban districts that, like St. Bernard and WJLD, have levees in close proximity to dense populations.

---

of additional revenue. Only in cases where potential revenues are high relative to the potential for future damage and disruption should levee districts consider these options.

5. **Developing and charging for the use of recreational facilities with low O&M costs.** This strategy has been successful in Orleans Levee District, where revenue from two district-owned marinas on Lake Pontchartrain and a regional airport have generated revenue for years. Similarly, the state of Florida operates a number of boat ramps in strategic areas that have the potential to generate modest revenues at low operating costs. The Mississippi Levee Board generates revenue by charging barges for the right to park against the riverbank in high-traffic areas. Note, however, that, if levee districts or the state of Louisiana elect to pursue this route, sites and activities must be chosen so that the revenue generated from the sites is greater than the construction and operating costs. There is evidence that, as a general rule, parks and other public facilities tend to cost more to operate than they generate in revenue, so the net revenue-generating capacity of this option may be limited (Bowker, Cordell, and Johnson, 1999).

Based on our interviews with state flood control and water management agencies in other states, we conclude that the revenue-generating capacity of strategies related to other states' use of levee right-of-way is limited. Most agencies generate less than 10 percent of revenues from those states' uses of levee rights-of-ways. However, as shown by the success of such transactions in Mississippi, districts with levees near prime commercial real estate, such as Orleans, could generate significant revenue from strategic development of excess rights-of-way. Similarly, as shown by the success of marinas and the Lakefront Airport in Orleans Levee District, considerable revenue may be generated by developing strategically placed recreational facilities with low construction and operating costs.

The revenue-generating capacity of such options is also limited by the extent of levee right-of-way that is owned outright by levee districts versus that held through easements. For example, there are two levee districts in Mississippi. The Mississippi Yazoo Levee District owns most of its levee rights-of-way, while the Mississippi Levee Board maintains most of its levee rights-of-way through easements. Mississippi Yazoo leases rights-of-way to casino operators for substantial sums of money, and has no ad valorem taxes. The Mississippi Levee Board does not have this possibility because it does not own the rights-of-way. It generates 90 percent of its revenues from ad valorem taxes. In most cases in Southern Louisiana, levee right-of-way is retained by levee districts only in the form of easements, so the revenue-generating potential of these options may be limited.

Requesting Assistance from the Federal Government for Maintaining Infrastructure Along Navigable Waterways

In our interviews, we discovered that, in many states, the USACE takes full responsibility for operating and maintaining flood control infrastructure along navigable waterways,

including the Gulf and Atlantic Intracoastal Waterways. This is true in Florida, where the USACE operates all locks and floodgates along the Gulf Intracoastal Waterway that are associated with the USACE's Central and Southern Florida Flood Control Project (CSSF). As is true for the HSDRRS, the USACE built the CSSF but local authorities are responsible for operating and maintaining the infrastructure. However, unlike the situation with HSDRRS, the USACE maintains O&M responsibilities for the infrastructure along the Gulf Intracoastal Waterway.

Navigation is one of the core responsibilities of the USACE. According to its mission statement, "The responsibility of the U.S. Army Corps of Engineers is to facilitate the safe, reliable and economically efficient movements of vessels, and it does so by constructing and *maintaining* navigation channels and harbors, and *regulating water levels* on inland waterways." Some in Louisiana have argued that the USACE should be responsible for maintaining the flood control infrastructure along Louisiana's portion of the Gulf Intracoastal Waterway. This would include several of the large new pieces of infrastructure that will be assigned to Lake Borgne and West Jefferson Levee Districts, including the IHNC and WCC, and possibly the Seabrook Control Structure along the Inner Harbor Navigation Canal. Further research by legal experts would be required to assess the viability of this option.

Cost-Sharing Between or Consolidation of Levee Districts

Our projections indicate that most levee districts will be able to cover increased O&M costs stemming from the new infrastructure being constructed with existing revenues. However, Lake Borgne is projected to incur substantial budget deficits in the coming years. One possible solution to these shortfalls would be to consolidate districts in surplus with districts where O&M costs are projected to increase sharply.[14]

Our interviews with flood control agencies in other states suggest that Louisiana has many more levee districts than other states. Florida has six regional water management districts. Water management districts are made up of basin boards, which are similar to Louisiana levee districts but are responsible for maintaining flood control infrastructure within an entire drainage basin. Water management districts and basin boards both levy an ad valorem tax, but the water management district allocates its collections across the basin boards under its jurisdiction in accordance with need. Mississippi has just two large levee districts. In general, no state that we examined delegates the O&M responsibilities of flood

[14] It is important to note that consolidating levee districts would most likely lead to redistribution of resources from resource-rich to resource-poor districts. Although this would help resource-poor districts meet their O&M needs, it could handicap resource-rich districts.

control infrastructure to local taxing districts with jurisdictions as small as Louisiana's local levee districts. Economic theory suggests that, in cases in which there are spillovers and externalities between local jurisdictions, such as in the case with flood control, government oversight is optimally handled at a higher level (Oates, 1973).

Our discussions with levee districts and state leaders in Louisiana suggest that there is little support for outright consolidation of levee districts, particularly beyond basin boundaries. Levee districts are concerned about giving away so much local control that they are unable to deal effectively with local problems in a timely fashion. They are also concerned that such a change would simply redirect funds from property-rich districts to property-poor districts; this is seen as unfair, even within property-poor districts. Among levee district leaders who were amenable to the idea of consolidation, there was strong support for the idea that any consolidation should not expand beyond basin boundaries. So, for example, SLFPA West may incorporate portions of Plaquemines Parish and St. Charles Parish that are within the West Bank Basin and contain major pieces of HSDRRS infrastructure, including the WCC and the Eastern and Western Tie-Ins, so long as the incorporated territory would contribute to the SLFPA West's tax base.[15]

One final option would be to build upon the SLFPA model and give SLFPA East and West the authority to transfer funds between constituent levee districts. Since the projected surpluses in Orleans and East Jefferson surpass the projected deficits in Lake Borgne, this model could effectively solve Lake Borgne's problems. Similarly, we project Algiers to have revenue surpluses through 2016, which would help make up for the potential deficits in WJLD. Another option would be to consolidate SLFPA East and West and grant the authority to channel funds between all constituent districts. Because the surpluses in East Jefferson and Orleans are expected to be larger than the deficits in Lake Borgne, such an arrangement could alleviate near-term revenue shortfalls in that district. Our interviews with levee district officials suggested general support for building upon the SLFPA model, particularly for giving SLFPA East and West the authority to reallocate funds among levee districts within their respective jurisdictions. However, there was less support for consolidating SLFPA East and West because they protect separate basins.

[15] The logic is that the flood control infrastructure within a basin is interconnected so that, if one piece of infrastructure within a basin fails, it can cause flooding and other damage in other parts of the basin. Thus, levee districts within a single basin depend on each other to maintain their respective infrastructure. Thus, some stakeholders argued that planning for hurricane and flood protection is most effectively managed at the basin level.

5. Findings

In the wake of Hurricanes Katrina and Rita, the USACE is in the process of rebuilding and improving the hurricane protection system in southern Louisiana. The HSDRRS has been designed such that, when it is complete, it will provide protection capable of withstanding a storm with a 1-percent or greater chance of occurrence in any given year.

This report provides data-driven estimates of O&M costs associated with the new HSDRRS that will be borne by Louisiana's levee districts:

- For the large and unprecedented pieces of infrastructure being built by the USACE, we used cost-plus engineering estimates of O&M costs provided by the USACE and CH2M Hill.
- For new or significantly altered infrastructure that is similar in size and scope to that included in the pre-Katrina system, we used pre-Katrina data on hurricane protection infrastructure and expenditures on O&M to statistically estimate the incremental cost of operating and maintaining an acre of levee right-of-way, a floodgate, and a pump station.
- We assigned the incremental costs for all HSDRRS infrastructure wholly contained within a single levee district to the appropriate levee district and incorporated those estimates into projections of annual O&M costs through 2016.
- We also projected ad valorem revenue through 2016 and analyzed the projected surpluses in ad valorem revenue by levee district.
- Finally, we discussed approaches that state and local government agencies in Louisiana and other states are using to generate revenue to finance the O&M costs of levee and hurricane protection infrastructure.

This analysis yields the following findings:

1. There is considerable variance in incremental O&M costs stemming from new HSDRRS infrastructure across levee districts. For example, Orleans Levee District's O&M costs are expected to increase by $2.0 million to 2.8 million, while East Jefferson's are expected to increase by just $20,000.
2. The maximum increase in O&M costs as a consequence of new HSDRRS infrastructure will be 78 percent or less of pre-Katrina O&M expenditures in all districts. In Lake Borgne, incremental O&M costs of new infrastructure associated with HSDRRS under the high-cost, low-growth scenario are expected to run roughly $2.1 million, 78 percent more than pre-Katrina O&M expenditures.

3. There is a lack of consensus surrounding the allocation of O&M responsibilities for three major pieces of infrastructure in the West Bank with a combined O&M cost of $3 million to $4 million annually. Levee districts, CPRA, and other stakeholders should work to determine the ultimate responsibility for these O&M costs. Should significant portions of the O&M responsibility for this infrastructure fall on WJLD, WJLD will need to raise additional revenues to avoid significant budget deficits.
4. Levee district ad valorem revenues have generally rebounded since Hurricane Katrina. In some cases, growth in ad valorem revenues in the years since Hurricane Katrina has been well above pre-Katrina rates. For example, East Jefferson's ad valorem revenue grew at a 0.6-percent annual rate from 1996 to 2004 but experienced a 12.7-percent annual growth rate from 2007 to 2009. The one exception to this general trend is Lake Borgne, where ad valorem revenue still has not returned to pre-Katrina levels in constant prices and growth in revenue has been just 5.3 percent annually since 2007.
5. Levee districts vary considerably in terms of projected surpluses in ad valorem revenue in the medium term, but the overall fiscal condition of levee districts is likely to be solid. Although Lake Borgne is projected to have deficits in 2016 of up to $2 million depending on the scenario, projected surpluses in other levee districts surpass these deficits. In aggregate, we project that the levee districts studied in our report will either break even or show a modest combined surplus in 2016, depending on our assumptions about the growth of ad valorem revenue and O&M costs for large and unprecedented pieces of infrastructure.
6. Most levee districts in Louisiana and flood control agencies in other states rely on ad valorem or other forms of property taxation for most of their income. Other forms of income account for 10 percent or less of revenues. However, many state and local governments generate significant revenues through their uses of levee rights-of-way. Options include leasing levee rights-of-way in high-rent areas to commercial interests, leasing levee rights-of-way for passive and agricultural purposes or billboards and cell phone towers, outright sale of levee rights-of-way while retaining appropriate conservation easements, and developing and charging for use of recreational property with relatively low construction and operating costs.
7. Given that the overall fiscal health of levee districts appears strong through 2016, the state might consider actions surrounding the consolidation of levee districts. One option that might be acceptable to levee districts would be to grant SLFPA East and West the authority to shift funds between constituent districts. Given that the projected surpluses in Orleans and East Jefferson would more than cover the projected deficits in Lake Borgne, and the modest surplus in Algiers would just offset modest potential deficits in WJLD, such an option could solve funding concerns

through 2016. Leaders at both SLFPA East and West voiced concerns over their inability to shift funds between their constituent districts.

8. Given that there is a precedent for the USACE retaining maintenance responsibilities for flood control infrastructure along navigable waterways as part of its responsibility for navigation, there may be an opportunity for the state and the USACE to consider changes in the current allocation of O&M costs of infrastructure along the Gulf Intracoastal Waterway, Inner Harbor Navigation Canal, and other navigable waterways.

Appendix

Table A.1 Pre-Katrina Hurricane Protection Infrastructure, by Levee District

Levee District	Floodgates	Pump Stations	Acres of Levee
East Jefferson	12	16	1,707
Grand Isle	0	0	429
Lake Borgne	15	8	2,733
Orleans	200	37	6,072
Pontchartrain	3	3	9,267
South Lafourche	8	6	1,361
WJLD	23	22	2,393
Atchafalaya	0	0	29,436
Terrebonne	2	0	517

Table A.2 Estimates of Annual Incremental O&M Costs for HSDRRS Infrastructure, by Levee District

Levee District	Task	Additional Acres of Levee	Additional Pump Stations	Additional Other Floodgates	Share	Unprecedented	Projects	Total USACE Cost ($)	O&M Cost (High) ($)	O&M Cost (Low) ($)
Orleans	Foreshore protection	100	0	0	100				13,765	13,765
	Raise levee	986	0	0	100				135,723	135,723
	Seabrooke	0	0	3	100	X	IHNC-01	1,245,207	1,245,207	858,763
	IHNC	71	0	1	90	X	IHNC-02	1,509,129	1,358,216	936,701
	Total	1,157	0	3					2,752,911	1,944,952
Lake Borgne	Caernavon to Bayou Bienvenue	0	0	13	100				959,128	959,128
	Raise levee	727	0	0	100				100,072	100,072
	Caernavon sector gate	0	0	1	100	X	LPV-049 (sector gate Only)	433,135	433,135	298,714
	IHNC	71	0	2	10	X	IHNC-02	1,509,129	150,913	104,078
	Bayou Dupree floodgate	0	0	1	100	X	LPV-144	499,569	499,569	344,530
	Total	798	0	14					2,142,817	1,806,522
East Jefferson	Foreshore protection	100	0	0	100				13,765	13,765
	Raise levee	72	0	0	100				9,911	9,911
	Total	172	0	0					23,676	23,676
SLFPA East	Total	2,127	0	17					4,919,404	3,775,150
WJLD	Raise levee	284	0	0	100					0
	Harvey Canal	0	0	1	100	X	LPV 47.1	471,581	471,581	325,228

Levee District	Task	Additional Acres of Levee	Additional Pump Stations	Additional Other Floodgates	Share		Unprecedented	Projects	Total USACE Cost ($)	O&M Cost (High) ($)	O&M Cost (Low) ($)
	Bayou Segnette	7	1	1	100	X		WBV 16.2	477,463	477,463	329,285
	Total	659	4	9						949,044	654,513
Algiers	Raise levee	37	0	0	100					5,093	5,093
	Total	37	0	0						5,093	5,093
SLFPA West	Total	696	4	9						954,137	659,606
	North of Airline Hwy	134	0	0	100					18,445	18,445
	Additional pump stations	0	2	0	100					121,411	121,411
Pontchartrain	Cross Bayou drainage structure	4	0	6	100	X		LPV-07b.2	207,408	207,408	143,040
	St. Rose drainage structure	24	0	2	100	X		LPV-07c.2	119,962	119,962	82,732
	Alameda/Walker drainage structures	5	0	2	100	X		LPV-07d.2	121,907	121,907	84,074
	Total	134	0	0						589,134	449,703
Terrebonne	Morganza to Gulf	2,526	7	12	100					1,657,993	1,657,993
	Total	2,526	7	12						1,657,993	1,657,993
South Lafourche	Larose to Golden Meadow	477.86	0	0	100					65,777	65,777
	Total	477.86	0	0						65,777	65,777
Total HSDRRS	Total									8,186,445	6,608,229

SOURCES: Primary data provided by OCPR and supplemented with maps provided by the USACE and found in the New Orleans *Times-Picayune*.

Table A.3 Major HSDRRS Infrastructure with Multiple Potential Operators

Task	Additional Acres of Levee	Additional Pump Stations	Additional Other Floodgates	Potential Operators	Unprecedented	Projects	O&M Cost (High) ($)	O&M Cost (Low) ($)
Eastern Tie-In	48	4	2	Plaquemines Parish, WJLD	X	WBV 12, 09A-C	633,911	437,180
Gulf Intracoastal Waterway	0	1	3	Plaquemines Parish, WJLD	X	WBV 90	2,445,474	1,686,534
Western Tie-In	320	0	4	Plaquemines Parish, St. Charles Parish	X	WBV 71-76, 17.b2	1,083,593	747,306
Total	368	5	9				4,162,978	2,871,019

SOURCE: USACE cost estimate for the HSDRRS (USACE methodology described in Section 2).

Table A.4 Projected Budget Balances, by Levee District

District	O&M Costs ($ millions)			Ad Valorem Revenue ($ millions)		Surplus ($ millions)			
	Pre-Katrina Infrastructure	New HSDRRS Infrastructure (High)	New HSDRRS Infrastructure (Low)	Constant Property Values	2% Growth Rate of Property Values	High O&M Cost and Constant Property Values	High O&M Costs and 2% Property Value Growth Rate	Low O&M Costs and Constant Property Values	Low O&M Costs and 2% Property Value Growth Rate
Orleans	17.73	2.75	1.94	27.88	32.03	7.40	11.55	8.21	12.36
East Jefferson	4.44	0.02	0.02	8.30	9.53	3.84	5.07	3.84	5.07
Lake Borgne	3.02	2.37	1.96	3.42	3.93	(1.97)	(1.46)	(1.56)	(1.05)
SLFPA East Total	25.19	5.14	3.92	39.60	45.49	9.27	15.16	10.49	16.38
WJLD	2.98	0.99	0.69	3.84	4.41	(0.13)	0.44	0.17	0.74
Algiers	0.87	0.01	0.01	1.83	2.11	0.95	1.23	0.95	1.23
SLFPA West Total	3.85	1.00	0.70	5.67	6.51	0.82	1.66	1.12	1.96
SLFPA East + West Total	29.04	6.14	4.62	45.27	52.00	10.09	16.82	11.61	18.34
Pontchartrain	3.16	0.59	0.45	7.15	8.21	3.40	4.46	3.54	4.60
South Lafourche	0.90	0.07	0.07	2.92	3.36	1.95	2.39	1.95	2.39
Terrebonne	1.65	1.66	1.66	3.15	3.62	(0.16)	0.31	(0.16)	0.31
Total	34.75	8.46	6.80	58.49	67.19	15.28	23.98	16.94	25.64

SOURCES: USACE cost estimate for the HSDRRS (USACE methodology described in Section 2; author's calculations.

References

Bowker, J. Michael, H. Ken Cordell, and Cassandra Y. Johnson, "User Fees for Recreation Services on Public Lands: A National Assessment," *Journal of Park and Recreation Administration*, Vol. 17, No. 3, 1999, pp. 1–14. As of November 26, 2012: http://www.srs.fs.usda.gov/pubs/1372

Louisiana Legislative Auditor, Louisiana levee district audited financial statements, various dates. As of November 26, 2012: http://app1.lla.state.la.us/PublicReports.nsf/vwPRByServiceFinancial

Oates, Wallace E., *Fiscal Federalism*, New York: Harcourt Brace Jovanovich, 1973.