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GAO

Report to Congressional Requesters

October 2003

CORPS OF ENGINEERS

Improved Analysis of Costs and Benefits Needed for Sacramento Flood Protection Project

GAO-04-30

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GAO Accountability • Integrity • Reliability

Highlights

Highlights of GAO-04-30, a report to congressional requesters

Why GAO Did This Study

In 1996 and 1999, Congress authorized the U.S. Army Corps of Engineers (the Corps) to strengthen sections of the American River and Natomas Basin levees that provide flood protection for Sacramento, California. In 2002, the Corps reported that the cost of this work, known as the Common Features Project, had increased significantly. GAO was asked to determine why costs increased, the extent to which the Corps analyzed and reported the potential cost increases to Congress in a timely manner, and whether the Corps correctly estimated economic benefits.

What GAO Recommends

To better inform Congress about the costs and benefits of flood protection for Sacramento, GAO recommends, among other things, that the Secretary of the Army

- improve the accuracy of the cost-benefit analysis for the not yet constructed American River levee improvements;
- improve the reporting of costs and benefits and analyze alternative flood protection measures for the Natomas Basin improvements; and
- arrange for a credible, independent review of the completeness and accuracy of the revised analyses.

The Army concurred with GAO's recommendations but took issue with the presentation of some information.

www.gao.gov/cgi-bin/getrpt?GAO-04-30.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Anu Mittal at (202) 512-3841 or mittala@gao.gov.

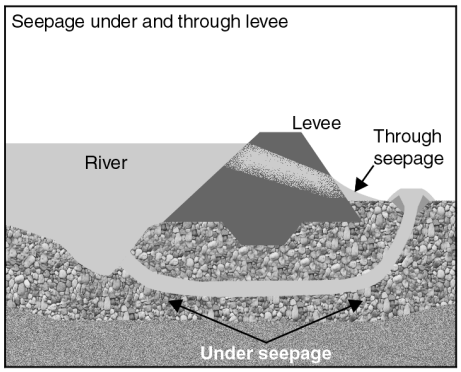
What GAO Found

Estimated costs for the Common Features Project rose from $57 million in 1996 to between $270 million and $370 million in 2002—primarily because of design changes. For the American River, costs more than tripled from $44 million to $158 million in 2002, primarily due to changes such as deepening the walls built in the levees (cut-off walls) to prevent seepage and closing gaps in the walls at bridge crossings. Cost estimates for the Natomas Basin—still in planning—increased from $13 million in 1996 to between $112 million and $212 million in 2002. The Corps has yet to analyze alternative flood protection approaches for the Natomas Basin that might be more cost-effective. Furthermore, it has not analyzed its exposure to potentially significant cost increases for the Natomas Basin work.

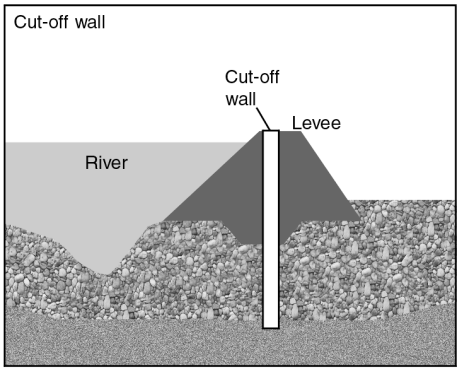
The Corps did not fully analyze, or report to Congress in a timely manner, the potential for significant cost increases for the American River levee improvements authorized in 1996. Specifically, a severe storm in the Sacramento area in January 1997 indicated some cut-off walls would need to be much deeper and therefore would be more costly. Corps guidance generally directs the Corps to seek new spending authority from Congress if it determines, before issuing the first contract, that it cannot complete the project without exceeding its spending limit. However, the Corps began construction in 1998 without analyzing or reporting potential cost increases. By 2003, it had committed most of the funding authorized for the entire Common Features Project to the 1996 American River work, leaving the additional 1999 work and the Natomas Basin improvements without funding.

In 1996, the Corps incorrectly estimated the economic benefits for the American River levee improvements by overcounting the residential properties to be protected. In 2002, it incorrectly estimated benefits for the 1999 improvements by, among other things, miscalculating the size of the area that the improvements would protect. The Corps' quality control process was ineffective in identifying and correcting these mistakes.

Reasons that levees fail



Levee improvement to prevent seepage



Source: U.S. Army Corps of Engineers.

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Accountability * Integrity * Reliability

United States General Accounting Office
Washington, D.C. 20548

October 27, 2003

The Honorable Don Young
Chairman, Committee on Transportation
and Infrastructure
House of Representatives

The Honorable John T. Doolittle
House of Representatives

The Honorable Richard Pombo
House of Representatives

The city of Sacramento, California, located where the American and Sacramento Rivers meet, has faced significant risks of major flooding since its founding in the 1840s. A major flood in the Sacramento area could cause loss of lives; toxic and hazardous waste contamination; disruptions to the city's downtown business and government areas, including the state capitol; and billions of dollars in property damage. To help protect against these risks, in 1991 and again in 1996, the U.S. Army Corps of Engineers (the Corps) identified several alternatives for long-term flood protection. On both occasions, the Corps recommended building a new dam on the American River near Auburn, California. Concerns were raised about the proposed dam's high cost and environmental impacts, and Congress did not authorize its construction.

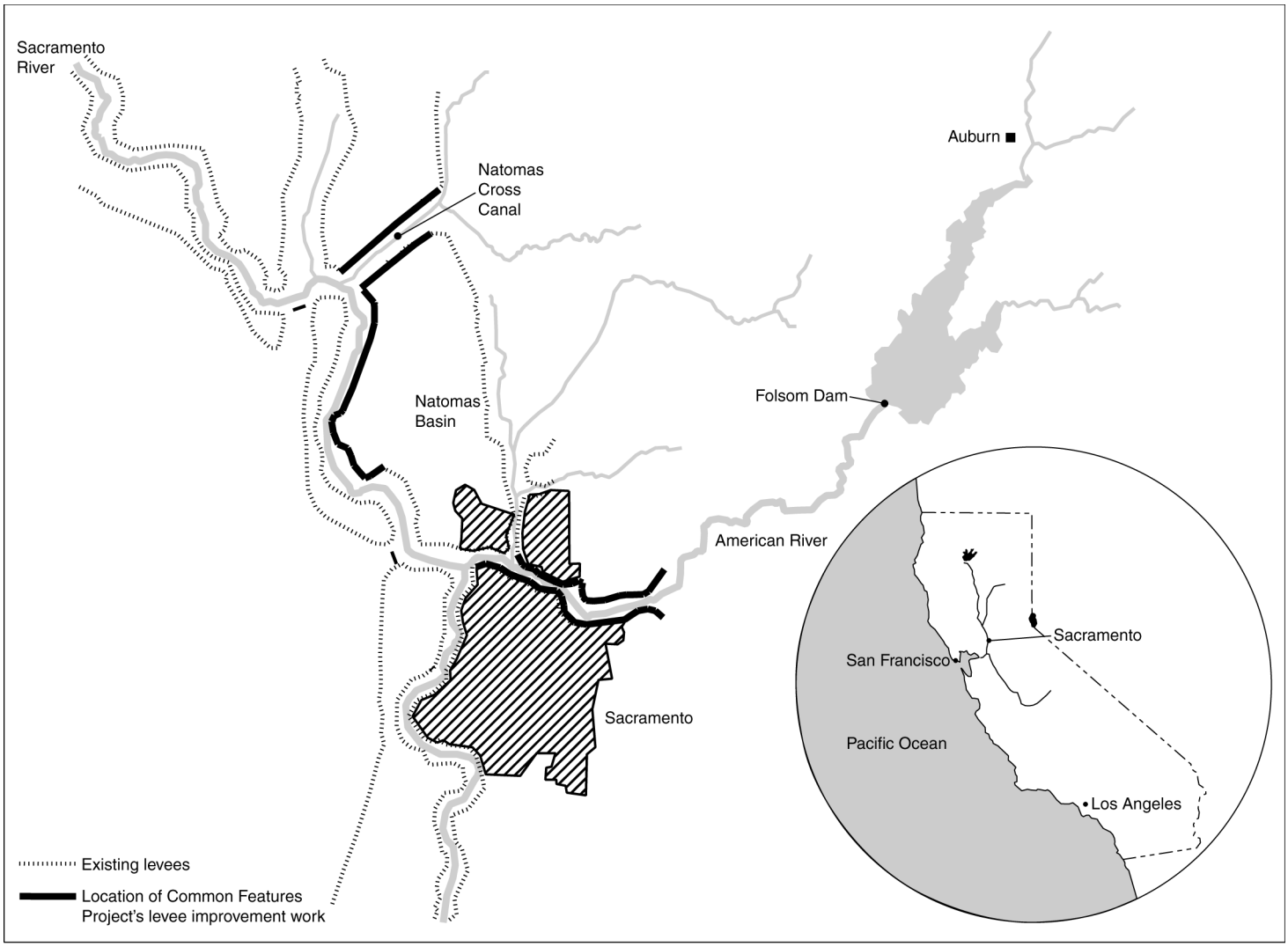
In light of the decision not to proceed with the new dam, the Corps recommended improving the existing levees on the American and Sacramento Rivers to increase the level of flood protection for the greater Sacramento area. Levees provide flood protection by raising the height of river banks, which helps prevent rivers from overflowing during storms. The Corps primarily proposed constructing "cut-off" walls in the center of the existing levees. These walls, composed primarily of soil, cement, and clay, become impermeable when they harden and prevent water from passing through the levees. These levee improvements were common to all of the alternatives that the Corps had considered for Sacramento flood protection in 1996 and became known as the Common Features Project.

The Water Resources Development Act (WRDA) of 1996 authorized $57 million for the project.[1]

The Common Features Project consists of two related but separate components—the American River levee improvements and the Natomas Basin levee improvements. The levees on the American River protect downtown Sacramento, while the levees on the Sacramento River protect the Natomas Basin, a largely agricultural area just north of downtown Sacramento where new development is occurring at a rapid rate. Figure 1 shows the greater Sacramento area and the location of the Common Features Project.

[1]In this report, costs and benefits are presented in the dollar values for the years in which they were estimated, not in constant dollars, except for the work authorized in 1999, which is presented in 2002 dollars. We did not adjust cost and benefit figures to constant dollars to account for inflation in order to maintain consistency with the figures in published Corps reports on the Common Features Project. However, when discussing changes in project cost, we do report cost increases due to inflation. In addition, appendix II shows 1996 project costs converted to 2002 dollars.

Figure 1: Location of the Common Features Project



Source: U.S. Army Corps of Engineers.

The WRDA of 1999 authorized additional work for the Common Features Project, directing the Corps to raise or strengthen some American River levee sections and raise some levees in the Natomas Basin; it also increased project authorization to $92 million. Several years after this authorization, however, the Corps stated that project costs would go significantly higher.

In the context of these issues, in response to your request, this report addresses (1) why the costs have increased for the Common Features Project, (2) the extent to which the Corps analyzed the likelihood of significant cost increases for the project and reported this information to Congress in a timely manner, and (3) whether the Corps correctly estimated the economic benefits of the American River levee improvements. Our scope and methodology in addressing these questions can be found in appendix I.

Results in Brief

The estimated costs for all components of the Common Features Project have risen from $57 million in 1996 to between $270 million and $370 million in 2002, primarily because of design modifications. With respect to the American River component, estimated costs for the levee improvements authorized in 1996 have more than tripled, from $44 million in 1996 to $143 million in 2002. This increase occurred primarily because the Corps modified the original design of the cut-off walls to close gaps at bridge crossings and other areas and to greatly increase the depth of the walls to prevent water from seeping under the levees. In addition to the cost increases related to the 1996 authorized work, new flood protection measures authorized in 1999 added about $15 million in costs to the American River component of the project. For the Natomas Basin component—which is still in the early planning stage—the Corps' cost estimates increased from $13 million in 1996 to between $112 million and $212 million in 2002. These projected cost increases are largely due to design changes in the planned improvements to the Sacramento River levees and additional work that the Corps has proposed for this part of the project.

The Corps did not fully analyze likely cost increases for the Common Features Project or report them to Congress in a timely manner. Corps guidance generally directs the Corps to seek new spending authority from Congress if it determines, before issuing the first construction contract, that it cannot complete the project without exceeding its spending limit. A severe storm in January 1997 demonstrated vulnerabilities in the American River levees and alerted the Corps of the need to do additional work to close the gaps in the cut-off walls at bridges and other areas and extend the depth of some cut-off walls from about 20 feet to about 60 feet. Although these design changes were likely to increase project costs significantly, the Corps did not use cost risk analysis, or any other analysis, to determine the potential extent of the increases. The Corps then began constructing the redesigned American River levee improvements without communicating to

Congress the project's potential exposure to substantial cost overruns. In 2002, when the Corps finally updated project costs, it had already completed or contracted at a much higher cost for most of the American River levee improvements that were authorized in 1996. Because of the reporting delay, Congress did not have the opportunity to determine whether, at these higher costs, building these levee improvements was an efficient and effective use of public funds. By 2003, the Corps had committed most of the funding authorized for the entire Common Features Project to the 1996 American River work, thereby leaving the 1999 work and the Natomas Basin improvements without funding.

The Corps made several mistakes in estimating the economic benefits for the American River levee improvements. First, in 1996, the Corps incorrectly calculated the economic benefits by overcounting the residential properties that the levees would protect. The actual number of protected residential properties was about 20 percent less than the number that the Corps estimated. Although the Corps updated its benefit estimate in 2002, it again made mistakes in estimating benefits because it incorrectly determined that the levee improvements authorized in 1999 would protect a larger area from flooding than they will and used an inappropriate methodology to determine the amount of flood damages the levee improvements would prevent. However, it is also important to recognize that the levee improvements may reduce the loss of human lives in the event of a flood, which is a benefit that is not included in the Corps' analysis. Second, although the Corps' policy calls for reporting a range of benefits from the levee improvements and the likelihood of realizing them, in 2002 the Corps reported only a single estimate of benefits. The Corps did not provide a range of benefits to Congress because it did not use the most current version available of its computer software, which could have performed the analysis. Finally, although the Corps has a three-tiered quality control process to ensure that it prepares economic analyses accurately and appropriately, this process did not identify the mistakes we found, which raises questions about the effectiveness of the Corps' quality control process.

In light of the concerns we identified with the Common Features Project and to better inform Congress about its costs and benefits, we are making several recommendations to the Secretary of the Army regarding the need for the Corps to (1) improve the accuracy of its cost-benefit analysis of the American River levee improvements that it has not yet constructed and (2) improve its reporting of the costs and benefits of the planned work as well as analyze alternative flood protection measures for the Natomas Basin. In

commenting on a draft of this report, the Department of the Army concurred with our recommendations, but took issue with our presentation of some information. Specifically, the Army believes that this report does not recognize the significant role Congress played in 1999 when it added additional work to the project and authorized funds for construction before the Corps had developed reliable cost estimates. In addition, the Army states that the consistent provision of funds to the Corps by Congress, at or exceeding the Corps' budget request, created the situation of which our report is critical. We have considered the Army's comments; however, we believe that our report is factually accurate and that our findings are presented in their proper context.

Background

Sacramento, California, was established at the confluence of the American and Sacramento Rivers shortly after gold was discovered upstream at Sutter's Mill in 1848. Frequent flooding has been a problem in Sacramento since its founding. To help reduce flooding, over time a complex system of levees, dams, and other related facilities were built. Levees line both sides of the American River from where it meets the Sacramento River upstream for a distance of about 17 miles, and the Natomas Basin is completely surrounded by levees. In addition, the Folsom Dam, completed in 1956 and located upstream from Sacramento on the American River, uses a portion of its storage capacity for flood protection.

The Sacramento area flood protection system was designed on the basis of records of rainfall during the first half of the 20th century. However, since 1950, the American River watershed has experienced five floods that were larger than any recorded in the pre-1950 period, although downtown Sacramento was not flooded during any of these events. Nonetheless, the Sacramento area has less protection than the designers of the original flood protection system realized. In fact, much of urbanized Sacramento is located in areas where a flood has a 1 percent chance of occurring every year—known as the 100-year floodplain. Because of this limited level of protection, the Corps estimates that a very large flood—one with a 0.25 percent chance of occurring every year—would flood the 400-year floodplain, resulting in residential, commercial, industrial, and public property damage of about $15.5 billion as well as loss of lives. According to the Corps, about 305,000 people live in more than 100,000 residential properties located within the American River floodplain. A major flood also would cause toxic and hazardous waste contamination; disrupt the city's downtown business and government areas, including the state

capitol; and interfere with the transportation system, including two interstate highways.

A major flood in 1986, the largest one ever recorded on the American and Sacramento Rivers, severely strained the levee system protecting Sacramento. Although the levees held and downtown Sacramento was not flooded, the event spurred efforts by federal, state, and local entities to identify measures to increase Sacramento's level of flood protection. In 1987, the Corps began work on a comprehensive study of flood protection alternatives for Sacramento. In its 1991 report,[2] the Corps' Sacramento district office considered six flood protection options and recommended building a new dam on the American River at Auburn, California, but Congress did not approve the dam's construction.[3] Subsequently, in response to the Department of Defense Appropriations Act of 1993, the Corps reevaluated three alternatives for increasing flood protection. In its 1996 report,[4] the Corps examined (1) building a new dam near Auburn, California; (2) modifying the existing Folsom Dam; and (3) increasing the amount of water released from Folsom Dam during a flood, coupled with other flood protection measures. The Corps again recommended building a dam at Auburn, but, again, Congress did not approve its construction.

Recognizing the magnitude of the opposition to the proposed Auburn Dam, in June 1996, the Corps recommended the Common Features Project, which included improving sections of the American and Sacramento Rivers' levees, primarily by constructing cut-off walls, to provide small-scale improvements to flood protection for the Sacramento area while the options for more extensive improvements continued to be considered. The WRDA of 1996 authorized $57 million for the Common Features Project, which included 24 miles of levee improvements on the American River and 12 miles on the Sacramento River along the western border of the Natomas

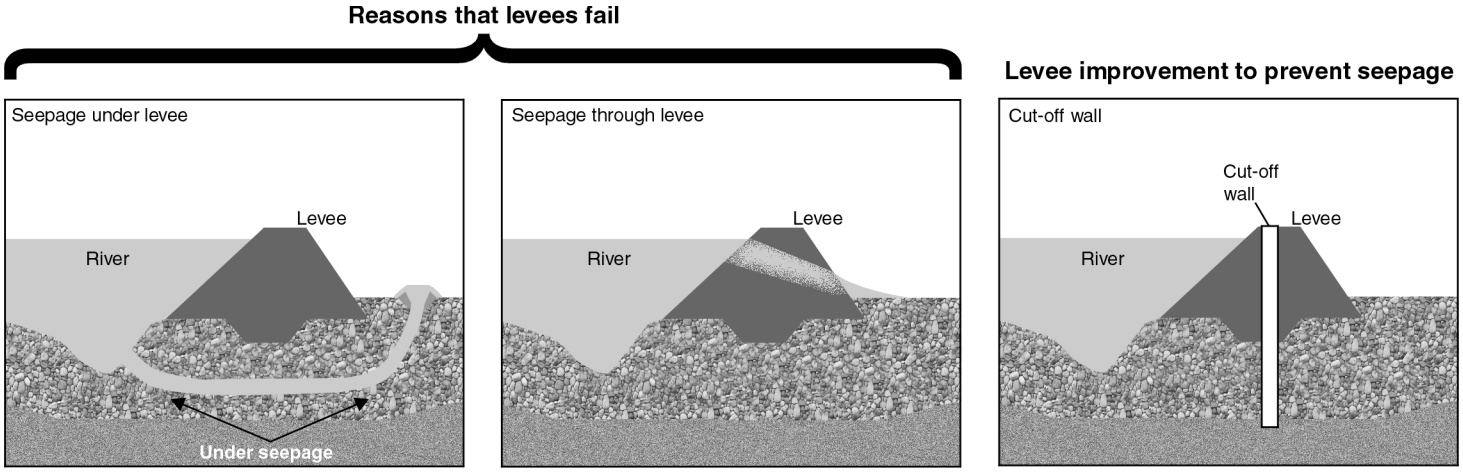
[2]See U.S. Army Corps of Engineers and the State of California Reclamation Board, *Feasibility Report*, *American River Watershed Investigation*, *California* (Sacramento, Calif.: December 1991).

[3]Constructing a dam near Auburn is not a new idea. In 1965, the U.S. Bureau of Reclamation was authorized to construct a dam near Auburn for increasing water supply, providing hydropower, controlling floods, and other purposes. Construction at the site was halted in 1975 because of concerns over the proposed dam's ability to withstand earthquakes, and was never resumed.

[4]See U.S. Army Corps of Engineers, State of California Reclamation Board, and the Sacramento Area Flood Control Agency, *Supplemental Information Report*, *American River Watershed Project*, *California* (Sacramento, Calif.: March 1996).

Basin. Subsequently, the Corps concluded that it could provide the same level of flood protection on the American River by modifying only about 21 miles of levees. Figure 2 shows how a cut-off wall, which is composed primarily of a soil, cement, and clay mixture that forms an impermeable barrier when it hardens, can prevent water from seeping under or through a levee.

Figure 2: Seepage under and through Levees and a Cut-off Wall to Prevent Seepage



Source: U.S. Army Corps of Engineers.

In January 1997, numerous rivers in northern California flooded causing extensive damages, although not in the Natomas Basin or downtown Sacramento. This flood, which was nearly as large as the 1986 flood, highlighted the continuing vulnerabilities of the existing flood protection system. In response, the WRDA of 1999 (1) modified the Common Features Project by adding about 3.8 miles of additional levee modifications along the American River and 10 miles on the Natomas Cross Canal, located on the northern border of the Natomas Basin, and (2) increased the project's authorization from $57 million to $92 million.

When Congress approves a flood protection project, it authorizes a specific amount of money for the project, which provides the basis for the maximum project cost. According to section 902 of the Water Resources Development Act of 1986, as amended, the maximum project cost is the sum of (1) the original authorized amount, with the costs of unconstructed project features adjusted for inflation; (2) the costs of modifications that do

not materially alter the scope of the project, up to 20 percent of the original authorized amount (without adjustment for inflation); and (3) the cost of additional studies, modifications, and actions authorized by the 1986 Act or any later law. As a result of these provisions, the $92 million that Congress authorized for the Common Features Project in 1999 translates to an allowable maximum project cost of about $120 million in 2003.

When Congress authorized the Common Features Project in 1996, federal law required that nonfederal partners pay 25 percent of the cost of flood protection projects.[5] For the Common Features Project, these partners are the State of California Reclamation Board and the Sacramento Area Flood Control Agency. In this report, when we refer to project costs, including the maximum allowable project cost, we are referring to the combined federal and nonfederal expenditures.

Design Modifications Have Greatly Raised Costs for the Common Features Project

Estimated costs for the Common Features Project grew from $57 million in 1996, when the project was first authorized, to between $270 million and $370 million in 2002, primarily because the Corps changed the design of the levee improvements.[6] For the American River levee improvements authorized in 1996, estimated costs more than tripled, due largely to changes in the design of the cut-off walls. New work authorized in 1999 added another $15 million to the cost increase. The Corps has completed much of the American River work authorized in 1996, but it has not begun construction on the work authorized in 1999. Regarding the Natomas Basin component, estimated costs increased from $13 million to between $112 million and $212 million. Costs rose primarily because the Corps changed the design of the levee improvements and proposed adding other improvements to this component. The Natomas Basin work is in the early planning stages, and the Corps has not begun construction. As of July 2003, the Corps had spent or made plans to spend nearly all of the money authorized for the Common Features Project. It therefore will not be able to finish constructing the American River work authorized in 1996, begin constructing the American River work authorized in 1999, or complete

[5]Current law requires the nonfederal partner to pay a minimum of 35 percent of the costs of flood protection projects. This increased cost share requirement only applies to projects authorized after the WRDA of 1996 and therefore does not apply to the Common Features Project.

[6]About 3 percent ($9 million) of this increase is the result of price inflation between 1996 and 2002.

planning for the Natomas Basin work unless Congress increases the project's authorized funding.

Estimated Costs for the American River Levee Improvements Authorized in 1996 Have More Than Tripled Because of Design Changes

The Corps' cost estimate for the American River levee improvements authorized in 1996 has more than tripled, from $44 million in 1996 to about $143 million in July 2002, as shown in table 1.

Table 1: The Corps' Original 1996 Cost Estimate and Estimated Cost Increases for the American River Levee Improvements Authorized in 1996

Dollars in millions

Project element	Original 1996 cost estimate	Estimated cost increase[a]	Total estimated costs as of July 2002
Cut-off walls	$30	$76	$105[b]
Response to construction accidents	N/A	11	11
Planning, design, and other costs	14	6	20
Inflation related to the original 1996 cost estimate	N/A	7	7
Total	**$44**	**$100**	**$143[b]**

Source: GAO analysis of U.S. Army Corps of Engineers data.

[a]In 2002 dollars.

[b]Does not sum to the total due to rounding.

As table 1 shows, costs rose primarily because of the increased costs of the cut-off walls. The Corps' original design called for building cut-off walls to a depth of between 20 and 30 feet to prevent water from seeping through the levees and for allowing gaps in the cut-off walls at bridge and utility crossings. However, after the 1997 flood, the Corps realized it also needed to address the problem of water seeping under levees. It therefore increased the depth of the cut-off walls to between 60 and 80 feet and closed the gaps in the cut-off walls at bridge and utility crossings. For some sections of the levees, the Corps could not close the gaps using its standard approach for cut-off walls because of problems accessing the sites. As a result, the Corps employed a new and more expensive approach—known as jet grouting—to build cut-off walls by drilling and injecting concrete material into areas that were difficult to access. Closing the gaps in the cut-off walls by jet grouting raised estimated costs by $52 million and

increasing their depth raised costs by $24 million, according to the Corps' July 2002 cost estimate. However, in September 2002, the Corps determined that fewer gaps needed to be closed using jet grouting, which should reduce costs to some extent. As of June 2003, however, the Corps had not incorporated these potential cost reductions into an official project cost update.

As table 1 also shows, the Corps' response to accidents that occurred during construction of the 1996 authorized work added $11 million to project costs. On three occasions, liquid material from the cut-off walls accidentally leaked into either the American River or the backyards of homes that are built against the levees. As a result, the Corps incurred costs cleaning up these spills and responding to new work requirements mandated by the Environmental Protection Agency to help prevent future leaks.

Lastly, in addition to the cost increases related to the 1996 authorized work, new flood protection measures authorized in 1999 added about $15 million in costs to the American River component of the project.[7] These measures include raising levee banks at two locations, installing gates and pumps at an existing drain, and installing cut-off walls in two additional levee segments.

Of the American River work authorized in 1996, the Corps has completed about 90 percent and must still close gaps in the cut-off walls at some remaining bridge and utility crossings to complete this work. For the levee improvements authorized in 1999, the Corps has done some planning but has not begun any construction. However, as of July 2003, the Corps had spent or had plans to spend $116 million of the $120 million authorized for the entire Common Features Project. The Corps could not give an exact accounting of how much of the $116 million it had spent on the 1996 American River work. However, on the basis of the information that the Corps provided, we estimate the Corps has spent, or made plans to spend, at least $103 million for planning and constructing the 1996 American River work. Because the Corps has spent or made plans to spend most of the project's authorized funds, it will not be able to complete the 1996 and 1999 work on the American River unless Congress increases the project's authorized funding.

[7]These costs are in 2002 dollars.

Natomas Basin Costs Are Expected to Increase Significantly, and Lack of Funds Has Halted Planning and Cost Estimating Efforts

The Corps' preliminary cost estimates for the Natomas Basin component of the project increased from $13 million in 1996 to between $112 million and $212 million in 2002, as shown in table 2.

Table 2: The Corps' Original 1996 Cost Estimate and Potential Cost Increases for the Natomas Basin Component

Dollars in millions

Project element	Original 1996 cost estimate	Potential cost increase[a]	Total potential costs estimated in 2002
Original levee improvements authorized in 1996	$13	$47 to $88	$60 to $101
New work the Corps proposed in 2002	N/A	37 to 84	37 to 84
Work authorized in the WRDA of 1999	N/A	14 to 26	14 to 26
Inflation related to the 1996 cost estimate	N/A	2	2
Total	**$13**	**$99 to $199[b]**	**$112 to $212[b]**

Source: GAO analysis of U.S. Army Corps of Engineers data.

[a]In 2002 dollars.

[b]Does not sum to the total due to rounding.

As table 2 shows, the Corps estimates that the costs for the original levee improvements will increase by between $47 million and $88 million due to design changes to add cut-off walls or provide other methods of flood protection to control seepage under levees. The Corps proposed new work in 2002 that will increase costs by between $37 million and $84 million. This work is located in an area of the levee where the Corps previously had constructed a cut-off wall to stop water from seeping through the levee. However, the Corps later determined that the cut-off wall was not deep enough to prevent water from seeping under the levee, and the proposed new work will address this problem. Finally, the Corps estimates that the additional work authorized in 1999 to modify levees along the Natomas Cross Canal, which empties into the Sacramento River at the north end of the Natomas Basin, will add between $14 million and $26 million to the cost of this component of the project.

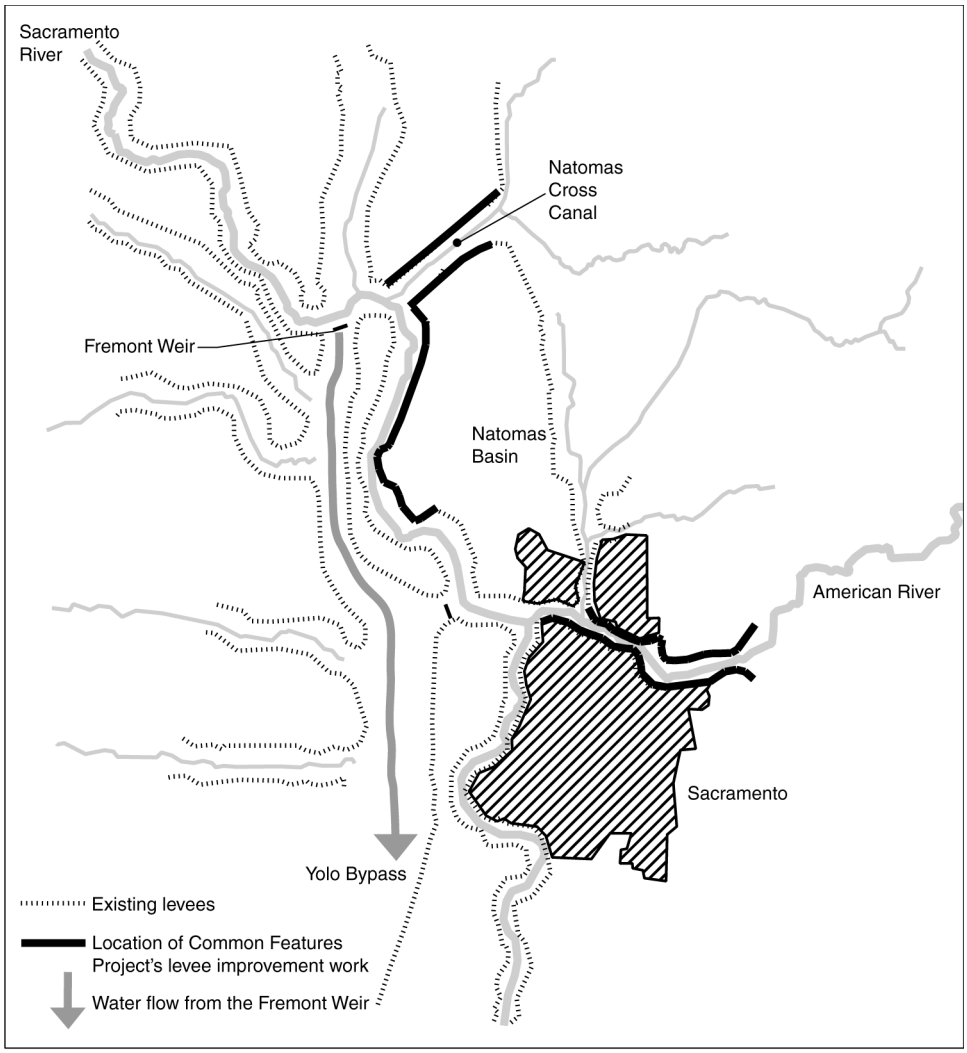
The Natomas Basin work—authorized in 1996 and 1999 and the additional work the Corps identified—is in the planning stages and no construction has yet begun. The Corps has been updating information on the extent of the levee problems and the costs of the improvements identified in the original plan and intends to submit a more precise cost estimate to Congress when it completes its planning. However, the Corps halted its Natomas Basin planning work in June 2003 because it had spent or made plans to spend nearly all of the money authorized for the entire Common Features Project.

Given that the Natomas Basin levee improvements will cost significantly more than originally estimated and no construction has yet begun, identifying and evaluating alternative flood protection measures could result in cost savings. For example, one possible alternative method for flood protection identified by the Sacramento Area Flood Control Agency,[8] as well as the Corps, involves lowering the water level in the Sacramento River during floods by diverting water through the Fremont Weir and into the Yolo Bypass, which is located at a point just before where the Sacramento River flows past the Natomas Basin.[9] The Fremont Weir is a low dam that controls the movement of large volumes of floodwater from the Sacramento River by diverting it into the Yolo Bypass. The Yolo Bypass is a continuous, 40-mile open space corridor that is protected from urban development pressure by flood easements. (See fig. 3.)

[8]The California state legislature established the Sacramento Area Flood Control Agency to coordinate flood protection efforts for the Sacramento area on a regional basis.

[9]See U.S. Army Corps of Engineers and the State of California Reclamation Board, *Sacramento and San Joaquin River Basins, California, Comprehensive Study, Interim Report* (Sacramento, Ca.: Dec. 20, 2002).

Figure 3: Location of the Fremont Weir and the Yolo Bypass



Source: U.S. Army Corps of Engineers.

Lowering the water level in the Sacramento River as it passes the Natomas Basin could, among other things, improve the reliability of the Natomas Basin levees and may provide more cost-effective flood protection than the current Natomas Basin levee improvement plan. However, as of June 2003, the Corps had not yet analyzed the costs and benefits of modifying the weir and the bypass or any other alternative method for Natomas Basin flood protection.

The Corps Did Not Adequately Analyze Likely Cost Increases for the Common Features Project or Communicate Them to Congress in a Timely Manner

After the 1997 storm demonstrated vulnerabilities in the American River levees, the Corps significantly changed the design of the levee improvements but did not analyze the likelihood of cost increases for the Common Features Project. The Corps then began constructing the American River levee improvements without informing Congress that the changes could greatly increase the overall costs of the project. By the time that the Corps reported the significant cost increases in 2002, it had already spent or made plans to spend more than double its original estimate for the American River levee improvements authorized in 1996. Furthermore, as previously discussed, the Corps estimates that it will spend more than three times its original estimate by the time it completes this work. The Corps has been able to pay for these levee improvements by spending funds originally planned for the Natomas Basin and the additional American River improvements authorized in 1999.

The Corps Did Not Adequately Analyze Likely Cost Increases for the American River Levee Improvements

The Corps did not analyze the risk of cost increases after changing the design of the American River levee improvements in 1997 and, therefore, did not provide Congress with information on the project's exposure to significant cost increases. A storm in January 1997 demonstrated that the American River levees were vulnerable to floodwaters seeping under them, which could cause them to fail. On the basis of this information, the Corps significantly changed the design of the levee improvements but did not conduct a cost risk analysis, or any other type of analysis, to determine the extent to which these changes would increase the costs for the Common Features Project.

According to the Corps' policy, project management teams should consider conducting a cost risk analysis when developing cost estimates for projects with considerable uncertainties.[10] A cost risk analysis identifies the areas of a project that are subject to significant uncertainty about costs and provides decision makers with a range of potential costs for a project and the probability that these costs will be exceeded. For example, a cost risk analysis might determine that there is a 50 percent chance that costs for a particular project will exceed $5 million but only a 20 percent chance that costs will exceed $8 million. According to a report from the Corps' Institute for Water Resources, this type of estimate is more accurate than a single point cost estimate and provides decision makers with better and more complete information.[11]

However, the Corps did not analyze the risk of cost increases after changing the design of the American River levee improvements even though it had identified several factors that could lead to significant cost increases. For example, by July 1997 the Corps recognized that it had to close the gaps in the cut-off walls at bridges and other areas and extend the depth of some walls from about 20 to about 60 feet, although the Corps had not developed a final design for these improvements. By identifying a project element with significant cost uncertainty—the design and depth of the cut-off walls—the Corps essentially performed the first step of cost risk analysis. However, the Corps did not follow through by quantifying this uncertainty and determining a range of potential costs for the cut-off walls or the likelihood that the potential costs within that range would be exceeded—the second and third steps of the cost risk analysis. Given that the Corps' original cost estimate for the American River work was nearly equal to its estimates of the benefits, if the Corps had conducted a cost risk analysis, it would have shown whether there was a significant likelihood that project costs would be greater than the economic benefits.

Furthermore, despite experiencing significant cost increases for the 1996 work, the Corps did not conduct a cost risk analysis to determine its exposure to potentially significant cost increases for the 1999 work. In addition, the Corps is not planning to conduct a cost risk analysis for the Natomas Basin improvements. According to Sacramento district officials,

[10]See U.S. Army Corps of Engineers, Engineer Regulation 1110-2-1302.

[11]Charles Yoe, *Risk Analysis Framework for Cost Estimation*, a report prepared for the U.S. Army Corps of Engineers, Institute for Water Resources, December 2000.

the Corps did not conduct a cost risk analysis because it did not believe such an analysis was necessary to account for uncertainties in the project.

The Corps Did Not Provide Congress with Timely Information about Significant Potential Cost Increases for the American River Levee Improvements

The Corps' planning guidance generally directs the Corps to seek new spending authority from Congress if it determines that a project's estimated costs exceed the maximum project cost before it has awarded a project's initial contract.[12] However, after making significant changes to the project's design in 1997, the Corps did not reevaluate its cost estimate to determine if it could still implement the project without exceeding the maximum project cost. For example, the Corps did not estimate the potential for cost increases due to tripling the depth of some cut-off walls, which eventually added $24 million in estimated costs to the project. In addition, the Corps did not estimate the potential for cost increases due to closing the gaps in the cut-off walls at bridges and other areas. This expense was not considered in the Corps' original 1996 cost estimate and potentially involved the use of jet grouting—a technology the Corps had not previously used to construct cut-off walls. Closing the gaps in the cut-off walls eventually added $52 million in estimated costs to the project.

In spite of significantly changing the project's design, the Corps awarded the project's first contract without updating its cost estimate to determine whether it would need additional spending authority to complete the project. In June 1998, the Corps issued the first Common Features Project solicitation for bids to construct about 1.6 miles of the redesigned cut-off wall on the north bank of the American River. These levee improvements represented only about 8 percent of the total miles of planned American River levee improvements, but the bid that the Corps selected amounted to 24 percent of the estimated cost for all of the American River levee work. We believe that this difference should have (1) alerted the Corps to the possibility that costs were likely to be much higher than it had originally estimated and (2) warranted an update of the Corps' cost estimate before it awarded the initial contract.

According to a headquarters official, the Corps issued the first contract without updating its total project cost estimate because it would have been impractical to delay the project while the agency revisited cost estimates. Furthermore, according to the Corps, the first contract was expected to be

[12]See U.S. Army Corps of Engineers, Engineer Regulation 1105-2-100.

more costly than future contracts because, among other reasons, it involved work on only a small stretch of the levee, which limited possible cost efficiencies. However, because the Corps did not analyze the potential for cost increases for the remainder of the American River levee improvements, it did not determine the likelihood that it would need additional spending authority to complete the project before it awarded the first contract.

The Corps has paid for the significantly increased costs of the American River levee improvements by using funds planned for the Natomas Basin and for the additional American River work authorized in 1999. Although the Common Features Project has two separate components, and Congress approved parts of the project in 2 different years, the project is subject to a single maximum project cost. The Corps has the flexibility to spend Common Features Project funds as it sees fit and is not required to allocate funds in proportion to its original cost estimates for each component.

Following project authorization in 1996, the Corps began to construct the American River levee improvements before the Natomas Basin improvements. Although the Corps exhausted the funds it had originally estimated that it would need to construct the American River levee improvements, it was able to continue implementing the American River work by spending funds it had originally planned to use for the Natomas Basin work. With the authorization of additional work in 1999, effectively raising the project's maximum cost to about $120 million, the Corps also was able to use funds planned for this work to pay for the increased costs of the American River work authorized in 1996.

After it awarded the first Common Features Project contract, the Corps was not required to inform Congress of project cost increases until it could not contract for additional work without exceeding the maximum project cost. According to the Corps, in March 2001 it briefed a number of Members of Congress on its intention to prepare a report that would evaluate the potential for the cost of the Common Features Project to exceed the project's maximum cost. However, it was not until February 2002, more than 4 years after it significantly modified the design of the American River levee improvements, that the Corps reported to Congress for the first time that due to significant cost increases, it could not complete the project without exceeding the maximum project cost. By this time, the Corps had spent or awarded contracts for more than twice the amount it originally planned to spend on the American River levee improvements authorized in 1996 and had completed about 90 percent of

the work. Furthermore, the Corps estimates that it will spend more than three times its original estimate by the time it completes this work. Because the Corps did not update its cost estimate or report the significant cost increases to Congress until most of the 1996 American River work was complete, Congress did not have the opportunity to determine whether the significantly more expensive levee improvements were still the most appropriate means of providing flood protection for Sacramento.

Corps' Benefit Estimates for the American River Levee Improvements Are Incorrect

The Corps made mistakes in estimating the benefits for the American River levee improvements because it incorrectly counted and valued the properties that the levee improvements would protect and used an inappropriate methodology to determine the amount of flood damages they would prevent. Seven years after Congress authorized the project, the Corps has not yet prepared an accurate assessment of the benefits of the American River levee improvements. In addition, contrary to its guidance, the benefit estimate the Corps prepared in 2002 did not describe the range of possible benefits and the likelihood that the values in this range would be realized. This additional information, describing the uncertainty of the benefit estimate, would have provided decision makers with information on the likelihood that the project's benefits would be greater than its costs. Furthermore, the Corps' three-tiered quality control process did not identify the mistakes that we found during the course of our review.

The Corps Made Mistakes in Counting and Valuing Properties and Determining Flood Damages When Estimating Project Benefits

In its original 1996 analysis of the benefits and costs of the American River levee improvements, the Corps incorrectly counted the residential properties that the proposed levee improvements would protect. As a result, the Corps incorrectly calculated the benefits that these improvements would provide. According to the Corps, the methodology it used to count the number of residential properties in 1996 was "accepted practice and consistent with Corps guidance and technology applicable at the time." In 2002, the Corps used a different methodology that incorporated new technologies and provided a more precise estimate of the number of properties protected. Using this new approach, the Corps determined that the actual number of residential properties protected by the levee improvements is about 20 percent less than its original estimate. The Corps did not calculate the amount that benefits would decrease due to this change. However, given the small difference between the original estimated annual benefits ($5.6 million) and the annual costs ($5.5 million) of the American River levee improvements, if the Corps had incorporated a

more accurate estimate of the property inventory in its 1996 analysis, the benefits of these improvements may have been less than the costs.

For flood protection projects, such as the Common Features Project, the Corps calculates benefits as the dollar value of the physical damages to residential, commercial, industrial, and public properties and infrastructure that the levee improvements prevent. To calculate the reduction in flood damage to properties, the Corps counts the number of properties located in the potential flood area—known as the floodplain—and then assesses the monetary value of the structures and their contents. The Corps uses this information to determine the property damage that would result from floods of various depths and to estimate the impact that the levee improvements would have in preventing this damage.

It is important to remember that, in addition to the economic benefits from preventing property damage, levee improvements may reduce the risk of loss of human lives, which is a benefit that is not included in the Corps' calculations.[13] According to the Corps, about 305,000 people live within the American River floodplain and the number of lives lost because of levee failure would depend on a variety of factors, such as the size of the flood, warning time, time of day, and availability of evacuation routes. Because of the many factors involved and the lack of historical data, the Corps was not able to estimate the number of lives that would be lost as a result of levee failure and flooding in the Sacramento area.

Although the Corps updated its benefit estimate in 2002 to incorporate the benefits from the new levee improvements authorized in 1999, a Sacramento district official acknowledged that the Corps again made mistakes in estimating the number of properties the levee improvements would protect. For the American River levee improvements authorized in 1999, the Corps identified an area that was larger than the area the levee improvements would actually protect. As a result, the Corps overestimated the number of properties protected and the benefits provided by the work authorized in 1999. According to a Sacramento district official, the Corps currently does not have the information it needs to determine the correct

[13]The Corps' guidance (Engineer Regulation 1105-2-100) directs the Corps to address the issue of prevention of loss of life when evaluating alternative plans—which the Corps did. However, the Corps is not required to formally estimate the number of lives saved or lost as a potential effect of a project. In situations where historical data exist, the Corps has the option to estimate the number of persons potentially affected by a project, and include this number as an additional factor for the consideration of decision makers.

area the levee improvements would protect and therefore is unable, at this time, to provide a reliable estimate of the benefits from the 1999 work.

In addition, the Corps made mistakes in its 2002 analysis in estimating the value of the residential properties the American River levee improvements would protect. The Corps' policy calls for calculating a property's value as the cost of replacing the structure less any depreciation, which accounts for a reduction in a structure's value due to deterioration prior to flooding.[14] Because the Corps had more than 100,000 residential properties to assess and a limited amount of time and resources, it determined depreciated replacement values for a small sample of 365 properties and then used the results to estimate the depreciated replacement values for all properties. However, the Corps did not correctly select the sample of properties. According to members of both the Appraisal Institute and The Appraisal Foundation, to accurately appraise a large number of properties by sampling requires a separate sample for each residential property type, such as single-family homes, condominiums, and apartment buildings.[15] Instead of conducting a separate sample for each type of property, the Corps sampled all property types together and calculated an average depreciated replacement value for all property types. As a result, it is unclear whether the Corps accurately calculated depreciation, which in turn raises questions about its estimates of the value of the residential properties the American River levee improvements would protect.

Moreover, the Corps did not use a consistent, objective appraisal methodology to calculate depreciation for the properties in the sample. Instead, the Corps subjectively determined depreciation. For example, if the Corps determined a structure was in "very good" condition it was assigned a zero percent, 5 percent, or 10 percent level of depreciation. However, the Corps could not provide us with its criteria for assigning the level of depreciation. Furthermore, the Corps' economists who made these subjective decisions did not consult with the professional appraisers in the Corps' Sacramento district office to identify alternative appraisal methodologies that may have been more appropriate. According to the

[14]See U.S. Army Corps of Engineers, Engineer Regulation 1105-2-100.

[15]The Appraisal Institute is an international membership association of professional real estate appraisers whose mission is, in part, to uphold professional credentials and standards of professional practice and ethics consistent with the public good. The Appraisal Foundation is a nonprofit education organization that, among other things, develops and promulgates professional appraisal standards and appraiser qualifications.

Corps, the methods it used to determine depreciation are "standard practice at the Corps and are consistent with prior and existing guidance." Nonetheless, we believe that the shortcomings identified above raise questions about the accuracy of the Corps' property value estimates and, in turn, the project benefit estimates that are, in part, based on them. The Corps said it recognizes the need to strengthen its methodologies and is currently developing a new tool to estimate property values.

Finally, the Corps' 2002 analysis did not use the methodology described in Corps guidance to determine the number of properties that are located in the 100-year floodplain and the damages they would sustain in a 100-year flood.[16] The 100-year floodplain is the land area that may be affected during a flood that has a 1 percent chance of occurring every year. Instead of following Corps guidance by directly counting the properties located in the 100-year floodplain and calculating the damages they would sustain in a 100-year flood, the Corps estimated the damages using a methodology that relied on the results from its incorrect 1996 count of properties. The Corps' use of this alternative methodology further calls into question the accuracy of its benefit estimate for the American River levee improvements authorized in both 1996 and 1999, which is based in part on this flood damage assessment. The Corps told us that it could have directly counted the properties in the 100-year floodplain but the necessary information was not available in a "user friendly" format, and that the additional effort needed to collect more accurate information was not expected to change the results. As a result, the Corps did not believe this was an effective use of resources. However, the Corps did not provide us with any evidence to support the validity of calculating the 100-year flood damages as it did or to validate its contention that the results would not change if it had used the methodology prescribed in its guidance.

[16]See U.S. Army Corps of Engineers, Engineer Manual 1110-2-1619.

The Corps Has Not Provided Congress with Information on the Range of Possible Benefits from the Levee Improvement Work or the Likelihood They Will Be Realized

The Corps has not followed its policy to provide Congress with an estimate of the range of possible benefits from the American River and Natomas Basin levee improvements and the likelihood that these benefits will actually be realized. In 1996, the Corps established a policy calling for benefit estimates and benefit-cost comparisons for flood protection projects to be reported with their associated probabilities.[17] For example, rather than reporting that the benefits for a particular project are exactly $1.5 million, the Corps could report that it is 80 percent confident that project benefits will be at least $1 million but it is only 30 percent confident that benefits will reach $2 million. The Corps recognizes that this information can assist Congress in understanding the uncertainty involved in achieving various levels of benefits and in determining whether those risks justify funding the project. According to the Corps, it did not estimate a range of benefits for the Common Features Project in 1996 because the computer software used to assess the project's benefits and costs was developed prior to the 1996 guidance and did not have the capability to calculate a range of values.

However, in its 2002 reanalysis of project benefits, when a new version of the software capable of calculating benefit ranges and probabilities was available and costs for the American River work had significantly increased, the Corps chose not to calculate a range of benefits and instead continued to report a single estimate. Because the Corps' 2002 estimates of benefits and costs for the American River work were so close in value (1.1 to 1), an analysis of the potential range of benefits would have revealed whether there was a significant probability that project benefits could be lower than the single estimate the Corps reported and perhaps lower than project costs.[18] According to a Sacramento district official, the Corps did not use the new version of its software that could have calculated the range of benefits to maintain consistency with information on flood protection it had previously released to the public. For example, the Corps has reported to the public that the American River levees have about a 1 percent chance of being breached by floodwaters in any given year. This estimate of flood protection could be different if calculated using the newer version of the software. The Corps was concerned that using the newer software would require it to report a different, and perhaps slightly lower, level of flood

[17]See U.S. Army Corps of Engineers, Engineer Regulation 1105-2-101.

[18]The Corps' 2002 estimate includes the benefits of both the expanded 1996 work and the additional 1999 levee improvement work.

protection, which would confuse the public. However, by taking this approach, the Corps did not provide Congress with important information about the uncertainty surrounding the amount of benefits the project would provide.

The Corps' Quality Control Process Did Not Identify Flaws in Its Benefit Analyses

Three organizational levels within the Corps—district, division, and headquarters—reviewed and approved the 1996 and 2002 benefit analyses for the American River component of the Common Features Project, but these reviews did not identify the mistakes that we found. This issue raises questions about the adequacy and effectiveness of the Corps' review process. We raised similar concerns about the Corps' review process in our report on the Delaware River Deepening Project, which found significant miscalculations and invalid assumptions in the project's economic analysis that the Corps did not find during its reviews.[19]

For the Common Features Project, the Corps' Sacramento district office conducted the 1996 study that analyzed the technical and economic aspects of the proposed project and the 2002 report updating that information. The Corps' Los Angeles district office reviewed the 2002 economic analysis for technical accuracy. Next, the Corps' South Pacific division reviewed the analysis; although, following the Corps' policy, it did not review the district's work for technical accuracy or verify the underlying analysis. Rather, the division checked that the district's reports had undergone a technical review, and that the district had issued a quality control certification report with the necessary district office-level approvals. The division then forwarded the project to headquarters. Corps headquarters also did not conduct a technical review of the analysis. Rather, headquarters checked that the district's report adhered to Corps policies for conducting a benefit-cost analysis and addressed any concerns headquarters had raised.

These review processes, however, were ineffective in detecting and correcting the mistakes in the benefit analyses we identified. For example, for the 2002 study, we found no indication that the mistakes made in calculating the number and the value of residential properties or the mistake made in calculating flood damages were detected during the Corps' review process. For the 2002 analysis of the American River levee

[19]See U.S. General Accounting Office, *Delaware River Deepening Project: Comprehensive Reanalysis Needed*, GAO-02-604 (Washington, D.C.: June 7, 2002).

improvements, a Corps economist from another district independently reviewed the benefits analysis. However, the review was not comprehensive enough to sufficiently identify methodological problems. The review primarily focused on process-oriented issues, such as assessing whether the Sacramento district conducted certain analyses, rather than examining the technical aspects of how the analyses should have been and were conducted.

Conclusions

It is critical that decision making and priority setting be informed by accurate information and credible analysis. Reliable information from the Corps about the costs and benefits for the American River component of the Common Features Project has not been present to this point. The analysis on which Congress has relied contained significant mistakes. And of most relevance today, the analyses for the remaining work do not provide a reliable economic basis upon which to make decisions concerning the American River levee improvements authorized in the WRDA of 1999. To provide a reliable economic basis for determining whether these improvements are a sound investment, the Corps' analysis needs to adequately account for the risk that project costs could increase substantially, correctly count and value the properties the project would protect, and include information on the range of potential project costs and benefits.

Moreover, because the Corps has not made some critical decisions regarding the Natomas Basin work, it is not yet known whether the Corps will be able to identify cost-effective flood protection options for this area. Specifically, the Corps has not determined whether it will (1) conduct a cost risk analysis of its current plan to identify its exposure to potentially significant cost increases or (2) evaluate the costs and benefits of alternatives to the current levee improvement plan to identify the most cost-effective flood protection option. In addition, identifying cost-effective flood protection involves reporting the range of potential project benefits and the probability of achieving them, which the Corps has not done for the Natomas Basin work. If the Corps begins implementing the authorized Natomas Basin work before it completes a comprehensive, accurate cost-benefit analysis, significant unanticipated cost increases could materialize, as they did with the American River work. Finally, for Congress to have confidence that the Corps' economic analyses have been prepared accurately, the Corps' quality control process would need to be sufficiently independent and detailed to identify the types of mistakes that our review revealed.

Recommendations for Executive Action

For the American River levee improvements authorized in 1999 and for the planned Natomas Basin work, we recommend that the Secretary of the Army direct the Corps of Engineers to

- determine whether it is appropriate to conduct risk analyses of project costs and document the basis for that decision in its project files;
- report information to Congress on the range of potential project benefits and the probability of achieving those benefits, as called for in the Corps' guidance, in future benefit-cost analyses; and
- arrange for a credible, independent review of the completeness and accuracy of the revised benefit-cost analyses.

For the American River project component, we also recommend that the Secretary of the Army direct the Corps of Engineers to reanalyze the benefits of the improvements authorized in the WRDA of 1999, correcting for the mistakes made in counting and valuing properties and the inappropriate methodology used to calculate flood damages.

Additionally, for the Natomas Basin project component, we recommend that the Secretary of the Army direct the Corps of Engineers to

- analyze the costs and benefits of alternatives to the current levee improvement plan and identify the flood protection plan that provides the greatest net benefits and
- submit a report to Congress that includes a cost estimate for all of the planned Natomas Basin work, and wait until Congress authorizes funding that is based on the report before beginning construction of any Natomas Basin levee improvements.

Agency Comments and Our Evaluation

We provided a draft of this report to the Secretary of the Army for review and comment. In commenting on the draft report, the Army concurred with all of our recommendations. Perhaps most significantly, the Army acknowledged that on the basis of the Corps' experience in constructing the American River levee improvements, there is a potential for substantial cost increases for the Natomas Basin levee improvements, and therefore the Corps needs to investigate a wider array of alternatives for providing flood protection for the Natomas Basin. In addition, although the Army

concurred with our recommendation to reanalyze the benefits of the improvements added to the American River component of the project in 1999, it contended that the Corps has already completed the reanalysis. We disagree. In 2002, the Corps prepared an analysis of the economic benefits for the work added to the project in 1999. However, our review found several mistakes in this analysis, including mistakes in counting and valuing properties and using an inappropriate methodology to calculate flood damages. We continue to believe that before the Corps begins construction of the work added to the American River project component in 1999, it should reanalyze this work to ensure it is cost beneficial.

The Army stated that the report does not recognize the significant role Congress played in 1999 by adding additional work to the project and providing funds for construction before the Corps had developed reliable cost estimates, which created the situation of which our report is critical. By focusing its comment on the relatively small amount of work added in 1999, the Army avoided the main issues regarding the American River levee improvements discussed in our report. Specifically, that (1) the costs for the American River component of the project approved in 1996 are more than triple the original estimate; (2) the Corps had information, before construction began, that should have alerted it that costs would likely increase greatly; and (3) the Corps should have communicated this information to Congress at that time, but it did not. Furthermore, the additional funding provided by Congress for the work authorized in 1999 has not been used for that purpose, but rather has been used to fund the cost overruns for the work authorized in 1996. The full text of the Army's comments, and our responses to them, are presented in appendix III.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the date of this letter. At that time, we will send copies of this report to the appropriate congressional committees, other interested Members of Congress, and the Secretary of the Army. We also will make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you, or your staff, have any questions about this report, please contact me at (202) 512-3841. Key contributors to this report are listed in appendix IV.

Anu Mittal
Director, Natural Resources
and Environment

Scope and Methodology

To determine the reasons for the cost increases for the Common Features Project, we obtained the key cost estimation documents prepared by the U.S. Army Corps of Engineers' (the Corps) Sacramento district office. Specifically, we obtained the Corps' 1996 *Supplemental Information Report, American River Watershed Project*; the 1997 *Addendum to the Supplemental Information Report*; the 2002 *Second Addendum to the Supplemental Information Report*; and other related documents. We reviewed the *Supplemental Information Report*, which examined a number of different flood protection alternatives, because it provided the foundation, including cost estimates, for the project elements that the Corps later grouped together as the Common Features Project. The *Addendum* to this report documented the Corps' first cost estimate that specifically and exclusively addressed the Common Features Project and included separate costs for both the American River component and the Natomas Basin component of the project. We reviewed the *Second Addendum*, the Corps' most current official cost estimate, to establish the amount of and the reasons for the increased costs. We also analyzed construction contracts to determine the cost of responding to accidents constructing the levee improvements authorized in 1996. We calculated the extent of inflation for both components of the project, using the Corps' Civil Works Construction Cost Index System and a cost index from the Office of Management and Budget. Finally, we discussed the reasons for the cost increases with economists, cost estimators, project managers, engineers, and other staff from the engineering, constructions operations, and planning divisions of the Corps' Sacramento district office.

To determine whether the Corps analyzed the likelihood of significant cost increases for the project and reported them to Congress in a timely manner, we reviewed the Corps' (1) policy regarding the use of cost risk analysis in estimating costs for civil works projects (Engineer Regulation 1110-2-1302) and (2) requirements for updating project cost estimates and informing Congress of cost increases (Engineer Regulation 1105-2-100). We also reviewed a document from the Corps' Institute for Water Resources on incorporating risk and uncertainty into cost estimation. We examined the American River levee improvement construction contracts to determine when the Corps became aware of cost increases for this component of the project. In addition, we reviewed the Corps' annual budget documents related to the Common Features Project, which contained information on the project's status and any changes or cost increases. We examined the Corps' cost estimates from 1996, 1997, and 2002 for compliance with relevant Corps cost estimating guidance and to determine if the Corps provided Congress with accurate information about significant expected

cost increases. Finally, we discussed the Corps' cost estimating procedures and awareness of likely cost increases with cost estimators, project managers, and other staff from Corps headquarters and the Sacramento district office.

To determine whether the Corps correctly estimated the economic benefits of the American River levee improvements, we reviewed the extent to which the Corps followed accepted economics practices and whether the major assumptions used in the analysis were reasonable and well supported. We obtained the Corps' 1996, 1997, and 2002 economic analyses for the Common Features Project and discussed the sources of these data and conduct of the analyses with the Corps economists responsible for preparing them. We also discussed the basis for the hydrologic and engineering assumptions used in the economic analysis with the Corps specialists who provided this information. In addition, we obtained the Corps' guidance (Engineer Regulations 1105-2-100 and 1105-2-101 and Engineer Manual 1110-2-1619) on the accepted economic and engineering methodologies for incorporating risk and uncertainty into benefit estimation. To verify and supplement the information we received from officials in the Corps' Sacramento district office, we spoke with, among others, Corps officials at the Hydrologic Engineering Center and the Institute for Water Resources and experts in real estate appraisal from the Appraisal Foundation and the The Appraisal Institute. Where we identified problems that affected the accuracy of the benefit analysis, we discussed them with the responsible Corps staff and considered any new data or revisions that they provided. Finally, we identified the roles and responsibilities of the Sacramento district office, South Pacific division, and headquarters in the Corps' internal quality control process for the Common Features Project. We also obtained copies of the quality control reviews and the reviewers' comments on the economic analysis and discussed the comments and their resolution with Corps officials.

We conducted our review from September 2002 through September 2003 in accordance with generally accepted government auditing standards.

Conversion of Costs to Constant Dollars

In this report, unless otherwise noted, we present costs in the dollar values for the years in which they were estimated, not in constant dollars. For example, the Corps estimated the original cost of the project as $57 million in 1996, and that is how we present it in this report. We did not adjust the costs to constant dollars to account for inflation to maintain consistency with the figures in published Corps reports on the Common Features Project. However, table 3 shows the Corps' 1996 cost estimates for key components of the Common Features Project and also shows the same estimates adjusted to 2002 constant dollars to account for inflation.

Table 3: Common Features Project's Cost Estimates in Original 1996 Dollars and in Adjusted 2002 Dollars

Dollars in millions

Common Features Project	Amount authorized in 1996 (1996 dollars)	Amount authorized in 1996 plus inflation (2002 dollars)
American River component		
Levee improvements	$30	$33
Planning, design, and other costs	14	18
Subtotal	**$44**	**$51**
Natomas Basin component	13	15
Total	**$57**	**$66**

Source: GAO analysis of U.S. Army Corps of Engineers data.

Comments from the Department of the Army

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

22 SEP 2003

REPLY TO
ATTENTION OF

Ms. Anu Mittal
Acting Director
Natural Resources and Environment
U.S. General Accounting Office
441 G Street, NW
Washington, D.C. 20548

Dear Ms. Mittal:

This is the Department of Defense (DOD) response to the General Accounting Office (GAO) draft report, "'CORPS OF ENGINEERS: Improved Analysis of Costs and Benefits Needed for Sacramento Flood Protection Project,' dated August 19, 2003 (GAO Code 360273/GAO-03-1055)."

Now GAO-04-30.

We appreciate the opportunity to comment on GAO's draft report and its recommendations. The report provides a current look at the American River Common Features project, which is currently under construction.

Enclosed are our comments on the report.

Sincerely,

John Paul Woodley, Jr.
Assistant Secretary of the Army
(Civil Works)

Enclosure

Printed on Recycled Paper

Now GAO-04-30.

GAO DRAFT REPORT - DATED AUGUST 19, 2003
GAO CODE 360273/GAO-03-1055

"CORPS OF ENGINEERS: IMPROVED ANALYSIS OF COSTS AND BENEFITS NEEDED FOR SACRAMENTO FLOOD PROTECTION PROJECT

DEPARTMENT OF DEFENSE COMMENTS TO THE RECOMMENDATIONS

See comment 1.

Overall Corps of Engineers Evaluation of the Report: The Corps of Engineers has reviewed the General Accounting Office's (GAO) draft report entitled "CORPS OF ENGINEERS, Improved Analysis of Costs and Benefits Needed for Sacramento Flood Protection Project." The report is focused on improving the analysis of cost and benefits for the American River Common Elements Projects, and communication with Congress on cost increases associated with the project. Based on the findings of its review, the GAO makes six recommendations on the American River levee and/or Natomas basin portions of the project. The Corps response to those recommendations is contained in a separate section. Even though the Corps believes that the GAO has made some factual errors, and has taken some data out of context, it concurs with the recommendations of the report. The Corps' concerns are outlined, as appropriate, in the responses to the specific GAO recommendation in the section.

See comment 2.

An overarching concern is the failure of the GAO report to recognize the significant role Congress has played in the authorization and construction funding of the American River levee portion of the project. In the Water Resources Development Act (WRDA) of 1999, the Congress added features without a Corps report. Even while the Corps was still in the process of completing studies and developing reliable cost estimates, the Congress was directing that the project be implemented by providing funds for construction. The GAO report should acknowledge that this has taken place and is not the standard business practice of the Corps. The Corps seeks authorization of projects, based on completed, reviewed and approved decision documents. These decision documents describe the project features, benefits and costs in detail, and are intended to serve as the basis for Administration decisions and for Congressional authorizations and funding. In 1999, Congress exercised its discretion and authorized the additional project features without the usual decision document and Administration endorsement. Further, the consistent provision of funds by Congress at or exceeding budget request created the situation of which the GAO report is so critical.

See comment 3.

See comment 4.

The GAO report also does not acknowledge Corps standard practice for continually communicating project specific information both formally and informally to Congress. Once a project is authorized, as was the American River Common Features Project in WRDA 1996, the Corps, through the yearly appropriations process, informs Congress of potential cost and schedule changes, and on any related need to prepare supplemental

decision documents. The Corps identified the need to prepare a new decision document to incorporate changes authorized by the WRDA of 1999 into the overall project in the FY 02 budget submission, and identified the need for reauthorization to increase the total authorized project costs in the FY 03 budget submission. In addition, in March 2001, briefings were held in which Members of Congress were informed of the need to prepare a decision document to include an evaluation of the potential for the total project costs to exceed the cost limits allowed by Section 902 of the WRDA 1986. A number of Congressmen and Senators were briefed at this time, including Robert Matsui, John Doolittle, Harry Reid, and Richard Pombo.

It is also important to note that in order to formally inform Congress of the project cost increases, recommend reauthorization if cost exceed the Section 902 limit required by Congress, and for increased funding that reflects cost increases to be included in the President's budget, the decision document (which includes a detailed project cost estimate), must be approved by the Secretary of the Army, delegated to the Assistant Secretary of the Army (Civil Works) (ASA(CW)). Currently, ASA(CW) is reviewing the Corps decision document for the American River Common Features.

The GAO report does not recognize the dynamic environment in which water resources projects are developed. Data availability, methodologies and technologies change as projects are developed. The Corps continually assesses the need to obtain new data and employ new techniques in analyses of ongoing projects. As an example, it was the flood of January 1997 that showed that the existing levees were not adequately designed to withstand the destructive effect of seepage. It was not an error, but an unknown condition for which the Corps had to revise its design and this resulted in the cost increases noted in the GAO report. This shows that the Corps employs new data, methodologies and techniques in decision documents to accurately inform decision makers of changes and of cost increases.

See comment 5.

Finally, GAO seems to consider separable elements of the Common Features as separate projects. The American River Common Features project includes multiple elements, such as the Natomas basin work, but in fact is considered one project.

See comment 6.

Corps Response to GAO Recommendations: The GAO report has a total of six recommendations. However, the recommendations are grouped into three classifications dealing with recommdations for (1) American River levee and Natomas basin components, (2) American River levee component only, and (3) Natomas basin component only. The responses are presented in a similar fashion.

RECOMMENDATION 1: For the American River levee improvements authorized in 1999 and for the planned Natomas basin work, we recommend that the Secretary of the Army direct the Corps of Engineers to:

- determine whether it is appropriate to conduct risk analyses of project costs and document the basis for that decision in its project files;
- report information to Congress on the range of potential project benefits and the probability of achieving those benefits, as called for in the Corps' guidance, in future benefit-cost analyses; and
- arrange for a credible, independent review of the completeness and accuracy of the revised benefit-cost analyses.

DOD RESPONSE: CONCUR. Regarding the risk analysis of project costs, as outlined in an Engineering Regulation on Civil Works Cost Engineering (ER 1110-2-1302) dated 31 March 1994, the intent of cost risk analysis is to identify and measure the impact of design level uncertainties or unknowns in certain features on the estimated total project cost. Cost risk analysis is intended to aid in the identification of the amount of contingency that should be added to a cost estimate to account for uncertainties although it is acknowledged that such analyses "will not reduce the uncertainties associated with the project costs estimate or solve problems of cost variance due to insufficient information." [1]

With regard to the American River levee improvement features, the Corps did review the need for project cost risk analysis in support of the 1996 project report and determined that more detailed analyses were not required, although this decision was not explicitly documented in the project files. Project cost estimates developed for this initial 1996 feasibility report, were based upon relevant actual design and construction experience, and the most recent project specific data that was available, and followed Corps policy in accordance with ER 1110-2-1302, by incorporating a reasonable contingency to account for potential unknowns. At that time, no one was aware of any areas of significant uncertainty necessitating more detailed examinations. It was only the flood in January 1997 that showed the design should be changed to account for significantly greater under seepage than what was already included in the Corps' design.

See comment 7.

Project specific design and construction information was used to form the basis of cost estimates developed for the March 2002 American River Watershed Project (Common Features) Second Addendum to the Supplemental Information Report. The Corps agrees with the GAO that the use of the cost risk analysis should be considered. An evaluation of the need to perform more detailed cost risk analysis was made and it was determined that potential uncertainties were appropriately accounted for in the project cost estimate contingencies. However, as pointed out in the GAO report, this decision was not explicitly documented in the project files. The Corps will document the basis for past cost risk decisions in the project files.

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[1] ER 1110-2-1302, Department of Army, U.S. Army Corps of Engineers, Engineering and Design, CIVIL WORKS COST ENGINEERING, 31 March 1994.

The Corps will continue to evaluate the need for cost risk analysis for any future work associated with the American River levee improvements. For the planned Natomas basin work, the Corps will, as recommended, determine whether it is appropriate to conduct risk analyses of project costs and document the basis for that decision in its project files.

Regarding the GAO recommendation to inform Congress on the range of potential project benefits and the probability of achieving those benefits, the economic model and related benefit estimates used for the 1996 feasibility report were prepared using the most advanced evaluation techniques and data available at the time the studies were conducted. The economic model was developed specifically to support the evaluation of American River project impacts. The Corps recognizes the need to use new technologies as they become available, and the Corps will, as recommended by GAO, provide Congress information on the range of potential project benefits and the probability of achieving those benefits in future benefit-cost analyses for the American River levee improvements, if warranted, and for the planned investigations for the Natomas basin features.

See comment 8.

See comment 9.

Regarding the GAO recommendation that any revised benefit-cost analysis that might result from the recommendations noted above, be subject to a credible, independent review, the Corps conducts both a technical and policy review as part of the decision documents approval process. The Corps believes that its review process results in decision documents that form the basis of sound recommendations. Additional independent reviews of the completeness and accuracy of benefit-cost analyses for the American River levee improvement work would likely be of little value, given that construction of the features authorized in both WRDA 1996 are nearly complete and over $110 million in Congressional appropriations have been obligated to date. For the planned Natomas basin investigations, the Corps will arrange for a credible, independent review of the completeness and accuracy of benefit-cost analysis.

RECOMMENDATION 2: For the American River project component, we also recommend that the Secretary of the Army direct the Corps of Engineers to

- reanalyze the benefits of improvements authorized in the 1999 WRDA, correcting for the mistakes made in counting and valuing properties and the inappropriate methodology used to calculate flood damages.

DOD RESPONSE: CONCUR. The GAO report raised questions with the methodology used in the 1996 feasibility study to estimate the number of residential development effected by flooding and benefiting by levee improvements. This methodology was accepted practice and consistent with Corps policy at the time the work was done. New technologies (i.e., Geographic Information System analysis which included tax record database integration) and information which allowed for a more accurate estimate of effected properties was available for the March 2002 American

River Watershed Project (Common Features) Second Addendum to the Supplemental Information Report and allowed the Corps to refine the original estimate of residential structures.

See comment 10.

The Corps already has completed the reanalysis recommended by the GAO. The overestimation of residential structures that appeared in the 1996 feasibility report was accounted for in the benefit estimates included in the March 2002 American River Watershed Project (Common Features) Second Addendum to the Supplemental Information Report. The reported 1.1 to 1.0 benefit-cost ratio for the American River levee improvements is based on the lower estimate of structures. In keeping with Corps practice to provide the most recent and reliable data, other changes also were accounted for in the March 2002 American River Watershed Project (Common Features) Second Addendum to the Supplemental Information Report analysis, including the value of residential structures and hydrological changes.

See comment 11.

See comment 12.

In terms of valuing properties, the GAO report did not acknowledge or explain the difference between economic and real estate evaluations. The Corps, during the feasibility study phase, does not develop real estate appraisals of the value for individual property acquisition. Such an analysis requires a separate individual appraisal for each property. There are approximately 169,000 structures, including roughly 163,000 residential structures, in the 400-year floodplain. During the study phase, the Corps develops estimates of structure values for determining aggregate economic damages. The cost of preparing detailed real estate appraisals during the study phase, when the engineering feasibility, economic justification, and environmentally acceptability of project have not been determined, is not warranted and would be prohibitively costly. The methods used in this economic evaluation continue to be standard practice today.

RECOMMENDATION 3: Additionally, for the Natomas basin project component, we recommend that the Secretary of the Army direct the Corps of Engineers to:

- analyze the costs and benefits of alternatives to the current levee improvement plan and identify the flood protection plan that provides the greatest net benefits; and
- submit a report to Congress that includes a cost estimate for all the planned Natomas basin work and wait until Congress authorizes funding based on the report before beginning construction of any Natomas basin levee improvements.

DOD RESPONSE: CONCUR. The Corps acknowledges that in light of the potential for substantial increases in project costs, based on construction experience with the American River levee improvements, there is a need to investigate a wider array of alternatives for providing flood protection for the Natomas basin. Corps policy requires a reformulation of the authorized project. The ability of the authorized engineering features to provide outputs intended by Congress will be evaluated, as will all other reasonable alternatives.

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GAO Comments

The following are GAO's comments on the Department of the Army's letter dated September 22, 2003.

1. Although the Army asserted that we made some factual errors, its subsequent comments failed to identify any specific factual errors.

2. The Army believes that the report does not recognize the significant role Congress played in 1999 when it added additional work to the project and authorized funds for construction before the Corps had developed reliable cost estimates. While the Congress did add work to the Common Features Project in the Water Resources Development Act (WRDA) of 1999 without a Corps report, the cost of this work is relatively small in comparison to the work authorized in 1996. We believe the Army's comment is not relevant to the main focus of our report, which is the significant cost increases for the work the Corps recommended and the Congress authorized in 1996. For example, the costs for the work the Corps recommended on the American River more than tripled from $44 million in 1996 to $143 million in 2002. In contrast, the estimated cost for the work on the American River levees the Congress added in 1999 is about $15 million. We believe our report accurately reflects the limited impact the addition of work in 1999 had on the American River component of the project's overall cost. Furthermore, the additional funding provided by Congress for the work authorized in 1999 has not been used for that purpose, but rather has been used to fund the cost overruns for the work authorized in 1996.

3. The Army stated that the consistent provision of funds to the Corps by Congress, at or exceeding the Corps' budget request, created the situation of which our report is critical. We do not agree. Two of the main issues in our report are that the costs of the American River component of the project nearly tripled due to design changes, and that the Corps began construction of the American River levee improvements without analyzing the likelihood of these cost increases or reporting the potential cost increases to Congress. The fact that Congress provided funding for the project does not absolve the Corps of its responsibility to communicate project cost increases in a timely manner.

4. The Army implied that Congress was informed of potential cost increases for the Common Features Project during the yearly appropriations process. This is not the case on the basis of our review

of all of the Corps' submissions for the annual appropriations process from 1997 through 2001. As our report states, it was not until February 2002, more than 4 years after it had significantly modified the design of the American River levee improvements, that the Corps informed Congress for the first time of the significant cost increases for the American River component of the project.

5. The Army stated that the levee improvements were not originally designed to withstand the destructive effect of seepage and that this design was not an error. Rather, an unknown condition (i.e., the potential for destructive seepage under the levees) resulted in design changes and increased costs. Our report does not criticize the Corps for not anticipating the need for a levee improvement design that would stop seepage under the levees. We acknowledge that the flood of January 1997 caused the Corps to change the design of its levee improvements. However, as our report notes, the Corps did not develop new cost estimates after making these design changes and did not communicate the resulting significant cost increases to Congress in a timely manner.

6. We do not consider the separable elements of the Common Features Project as separate projects. This report makes clear that there is one Common Features Project comprised of an American River component and a Natomas Basin component.

7. We agree with the Army that, in 1996, the Corps was not aware of any significant areas of cost uncertainty for the proposed American River levee improvements. However, as the Army recognizes, the flood of January 1997 showed that the Corps' design for the levee improvements should be significantly modified. After making these design changes, though, the Corps did not estimate the potential for cost increases due to tripling the depth of some cut-off walls or closing the gaps in cut-off walls at bridges and other areas. These design changes eventually added $76 million to the cost of the project.

8. The Army stated that the Corps believes that its review process results in decision documents that form the basis for sound recommendations. However, in two recent cases, we found that the process did not serve its intended purpose. As this report documents, the Corps' review process was ineffective in detecting and correcting the mistakes in the benefit analyses we identified. We raised similar concerns about the

review process in our June 2002 report on the Delaware River Deepening Project.

9. We did not recommend that the Corps reanalyze the costs and benefits of the work authorized in 1996. We agree that a reanalysis of this work, which is nearly complete, would be of little value. However, we continue to believe that a reanalysis of the economic benefits from the work authorized in 1999 is necessary because the Corps' initial analysis contained significant mistakes and construction of the work has not yet begun. Before beginning construction of this work, the Corps should verify that the work is in fact cost beneficial. In addition, the Corps should arrange for a credible, independent review of the completeness and accuracy of its reanalysis.

10. The Army contends that the Corps has already completed the reanalysis we recommended of the work added to the American River component of the project in 1999. We disagree. The Corps analyzed the economic benefits for the 1999 work added to the project for the first and only time in 2002. Our review found several problems with the Corps' 2002 analysis of the benefits from this work. For example, we found that the Corps had made mistakes in how it counted and valued properties and had used an inappropriate methodology to calculate flood damages. As a result, the Corps has not yet prepared an accurate assessment of the benefits resulting from the 1999 work. The Corps has not begun any construction for the work authorized in 1999, and it is not currently known if the benefits provided by this work are greater than the costs. Consequently, we recommend a reanalysis of these benefits in order to correct the mistakes that we identified.

11. The Army stated that the Corps does not conduct individual real estate appraisals to determine the value of each property that could be damaged in a flood. Our report does not suggest that the Corps should conduct such appraisals. Rather, we identified weaknesses in the sample the Corps used to estimate property values and its methodology for calculating depreciation for the properties in the sample. For example, to accurately appraise a large number of properties by sampling requires a separate sample for each residential property type, such as single-family homes and apartment buildings. However, the Corps sampled all property types together. In addition, the Corps did not use a consistent objective appraisal methodology to calculate depreciation for the properties in the sample. These weaknesses raise

questions about the accuracy of the Corps' property value estimates and the project benefit estimates that are, in part, based on them.

12. The Army claims that there are approximately 163,000 residential structures in the 400-year floodplain. This is not correct on the basis of the Corps' most current analysis. The estimate of 163,000 residential structures comes from the Corps' 1996 economic analysis. However, in 2002, the Corps updated its analysis and found that it had overestimated the number of residential structures in 1996. The Corps' 2002 analysis estimated that there were 115,347 residential structures in the 400-year floodplain.

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