

June 2002

DELAWARE RIVER
DEEPENING
PROJECT

Comprehensive
Reanalysis Needed



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G A O

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United States General Accounting Office
Washington, DC 20548

June 7, 2002

The Honorable Jon Corzine
The Honorable Robert G. Torricelli
United States Senate

The Honorable Robert E. Andrews
House of Representatives

The U.S. Army Corps of Engineers' February 1992 *Final Interim Feasibility Study and Environmental Impact Statement* reported that deepening the Delaware River ship channel from 40 to 45 feet was economically justified and environmentally feasible. Following this assessment, Congress, in the Water Resources Development Act of 1992, authorized the design and eventual construction of the Delaware River ship channel to accommodate the movement of larger vessels. The total estimated cost of the project is over \$420 million. The federal share of the project cost—approximately \$287 million—would be for constructing the deeper channel and the disposal sites for the dredged material, as well as maintaining the channel for 50 years at a depth of 45 feet. The Delaware River Port Authority (DRPA), the nonfederal sponsor, would be responsible for most of the rest of the cost. The Corps' economic analysis of the project, updated in 1998, concluded it would yield annual benefits of \$40.1 million, largely in the form of transportation cost savings related to importing crude oil (about 80 percent of the benefits) and importing or exporting cargo in containers, as well as bulk commodities including scrap metal, iron ore, and coal. The economic analysis estimated annualized project costs of \$28.8 million. In addition to questions about the project's cost and benefits, a number of concerns have been raised about whether the project would have adverse environmental impacts—for example, whether it would resuspend toxic substances in the water, degrade water quality, permit salt water intrusion into groundwater supplies used for drinking and other purposes, or significantly harm fish and wildlife.

We were asked to review whether (1) the Corps of Engineers' economic analysis accurately and appropriately considered the benefits and costs of the project and (2) the environmental implications of the project have been fully addressed.

Results in Brief

The Corps of Engineers' economic analysis of the Delaware River main ship channel-deepening project contains a number of material errors. As a

result, it does not provide a reliable basis for deciding whether to proceed with the project. In particular, our analysis of the Corps' 1998 benefit estimate identified several miscalculations, invalid assumptions, and the use of significantly outdated information. For example, the Corps misapplied commodity growth rate projections, miscalculated trade route distances, and continued to include benefits for some import and export traffic that has declined dramatically over the last decade. In addition, a number of unresolved issues and uncertainties were not factored into the Corps' economic analysis, the outcome of which could either increase or decrease the benefits and costs of the project. While the Corps has established procedures to ensure that its benefit-cost analyses are fundamentally sound and properly prepared, in this case at least, the process was ineffective in identifying significant errors and analytical problems. Because of the shortcomings we identified in the Corps' analysis, the actual economic merits of the project will not be reliably known unless the Corps comprehensively reanalyzes it.

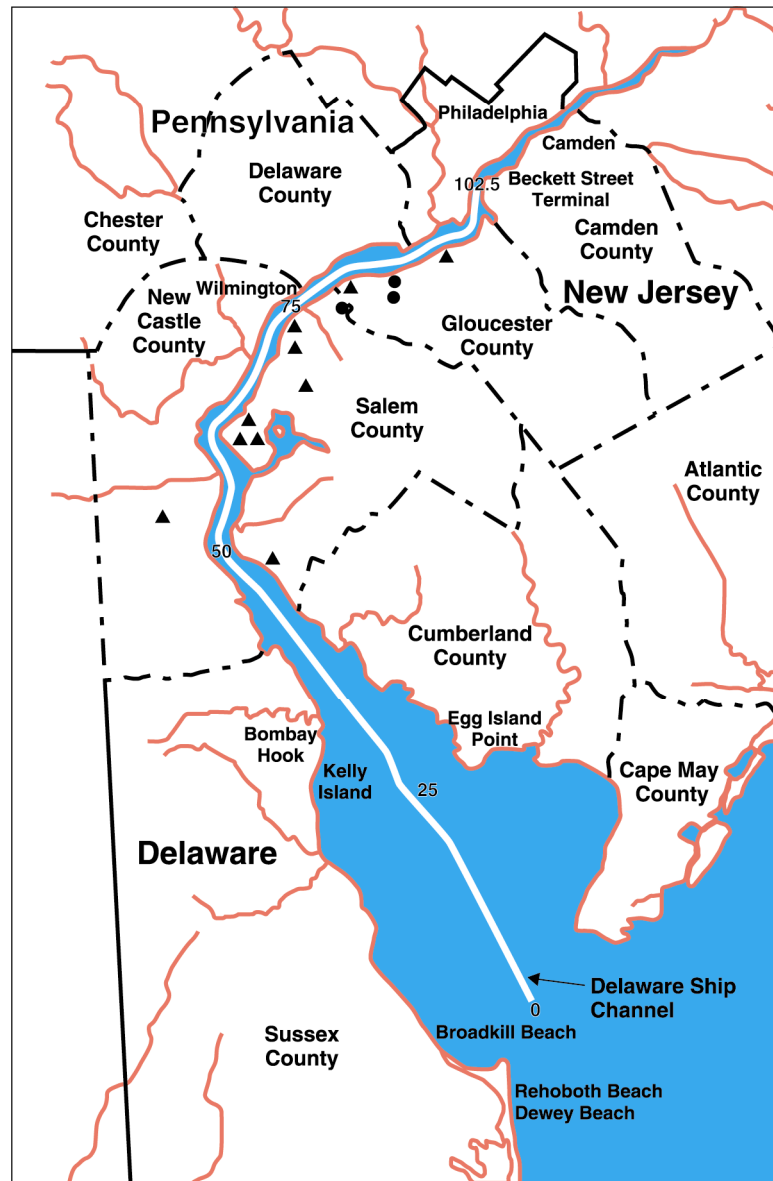
The Corps of Engineers has largely addressed environmental concerns related to the project to the satisfaction of federal and state environmental agencies. On the basis of the results of the Corps' 1992 *Final Interim Feasibility Study and Environmental Impact Statement*, 1997 *Supplemental Environmental Impact Statement*, and subsequent studies, most federal and state environmental agencies have agreed that the project would not significantly affect such areas as water quality and fish and wildlife habitat. Consequently, the Corps has obtained most of the approvals it needs from these agencies. However, a number of unresolved issues remain, including the issuance of a permit from the state of Delaware governing construction projects (such as dredging) that affect state waters.

Given the serious problems we identified with the Corps' economic analysis, we are making recommendations to the Secretary of the Army on the need to comprehensively reanalyze the project. In commenting on a draft of this report, the Under Secretary of the Army generally agreed with our findings and concurred that a new and comprehensive economic analysis of the project's benefits and costs is warranted. The Under Secretary also concurred that once the economic reanalysis is complete, an external independent party would be engaged to ensure that the reanalysis accurately and fairly represents the expected benefits and costs of the proposed project.

Background

Figure 1 is a map of the Delaware River Ship Channel that also shows the locations of various project features discussed throughout the report.

Figure 1: The Delaware River Ship Channel



- Legend**
- ▲ Existing Confined Disposal Facility
 - New Confined Disposal Facility

The Delaware River project plan calls for deepening the main navigation ship channel from the mouth of the Delaware Bay through Philadelphia Harbor, and on to Beckett Street Terminal in Camden, New Jersey—a distance of 102.5 miles. The project includes plans for constructing three new disposal facilities for dredged material, called confined disposal facilities, in Gloucester and Salem counties, New Jersey. Two of these new disposal facilities would be needed to maintain the current channel, even if the project were not built. The new facilities and 10 other existing facilities would accommodate the material dredged during the construction of the deeper channel and during the 50-year maintenance period that would follow. The project also includes plans to restore two wetland areas, one in New Jersey and the other in Delaware, and to replenish a beach site in Delaware.

The Delaware River Port Authority, the nonfederal sponsor, would share in the costs of the project, according to requirements in the Water Resources Development Act of 1986 and a project cooperation agreement that would need to be signed with the Corps before beginning construction. The Port Authority would be responsible for contributing 25 percent of the total costs of the project's general navigation features—largely constructing and dredging—and for providing lands, easements, relocations, and rights-of-way necessary for the project. The Port Authority would pay an additional 10 percent of the general navigation feature costs after receiving credit for providing for such items as lands for dredged material disposal areas. The three states that would be affected by the channel deepening, Delaware, New Jersey, and Pennsylvania, are expected to contribute funds toward the Port Authority's share of the project.

The Philadelphia district office of the Corps of Engineers is leading the effort to prepare the various studies and documents required for the project. It completed a *Final Interim Feasibility Study and Environmental Impact Statement* for the project in 1992. This document was used to inform decision-makers and the public of the Corps' recommended plan for the project, potential alternatives to it, its benefits and costs—annualized over a 50-year period—and its likely environmental effects. The Corps then prepared a design memorandum in 1996, which provided details on the final design and engineering plans for the project, and published a *Supplemental Environmental Impact Statement* in 1997. In its *Limited Reevaluation Report* of 1998, the Corps updated the project's benefits and costs. Approval of this report constituted the Corps' decision to budget construction funds for the project. Corps guidance and procedures require that key decision documents such as the *Feasibility*

Study and the Limited Reevaluation Report undergo review by district officials; the Corps' North Atlantic division in Brooklyn, New York; and the Corps' Office of Civil Works in Washington, D.C., before receiving final approval. On April 22, 2002, the Corps' Director of Civil Works suspended work on the project pertaining to the project cooperation agreement, plans and specifications, and advertising for construction, until questions pertaining to the project justification have been resolved.

Corps' Analysis Substantially Overestimated Project Benefits

The Corps' analysis of project benefits contained or was based on miscalculations, invalid assumptions, and outdated information. After taking these problems into consideration, we found that the project benefits for which there is credible support would be about \$13.3 million a year, as compared to the \$40.1 million a year claimed in the Corps' 1998 *Limited Reevaluation Report*. Some of the major problems we identified in the Corps' analysis of project benefits are discussed below.

Corps' Benefit Analysis Contained Miscalculations

Based on a number of miscalculations, the Corps' analysis overstated annual project benefits by about \$8.6 million. In one instance, the Corps misapplied the projections of commodity growth rates for traffic in the Delaware River ship channel when estimating future project benefits. For example, for oil imports from West Africa, the underlying data indicated that the appropriate predicted growth rate for 1992 through 2000 would be 5.8 percent, and 1.4 percent for 2001 through 2005. However, the Corps applied the 5.8 percent growth rate to the entire 1992 through 2005 time period and repeated the mistake by incorrectly applying predicted rates elsewhere in its analysis. In aggregate, this miscalculation led to about a \$4.4 million overestimate of annual project benefits. Corps headquarters officials agreed with our analysis.

After taking the Corps' misapplication of growth rates into consideration, there remained about a \$4.7 million gap between the Corps' estimated annual project benefits and the outcome of our efforts to replicate its results. The Corps' economist for the project told us that this gap was created by a computer error and speculated that it could have occurred when files were transferred from one program to another. Ultimately, however, the Corps was unable to definitively explain the discrepancy between its original estimate and our attempt to replicate its estimate and acknowledged that the error overstated project benefits by about \$4.7 million. Corps headquarters officials agreed with our analysis.

The Corps also inconsistently discounted the project's future benefits to determine their net present value. Specifically, the Corps used different discount rates, realized benefits at different times of the year, and used different 50-year project time periods for the various benefit categories. For example, the Corps estimated project benefits for coal shipments for the period 2005 through 2055 (note that this is 51 years, not 50 years), while it estimated benefits for container ships from 2000 through 2050. Also, the Corps used an 8.75 percent discount rate to discount the coal benefits for present value purposes, but used 7.625 percent for crude oil. The Corps' economist for the project acknowledged the errors and noted that the discounting procedures used for net present value purposes should have been consistently applied. Taking these errors into consideration, as called for by applicable Corps guidelines for water resource projects, we found that annual project benefits would be about \$0.4 million less than the Corps had projected.¹ Corps headquarters officials agreed with our analysis.

Finally, the Corps presented its benefit estimates in dollar values for different years for the various benefit categories. The Corps stated in its 1998 *Limited Reevaluation Report* that the benefit and cost estimates were in 1996 dollars. However, this was not true for any of the benefit categories: coal benefits were calculated in 1991 dollars; crude oil, iron ore, and scrap metal benefits in 1993 dollars; and container benefits in 1995 dollars. A basic principle of benefit-cost analyses is that benefit and cost estimates be given in the same year dollar values. Without such consistency, it is not possible to accurately compare project benefits and costs. Taking this mistake into account, we found that estimated project benefits increased by about \$0.9 million.² Corps headquarters officials agreed with our analysis.

Corps' Benefit Analysis Was Based on Invalid Assumptions

Based on a number of invalid assumptions, the Corps' analysis overstated annual project benefits by about \$9.4 million. The Corps' analysis of the benefits that a 45-foot channel would be expected to produce was based on several components, such as time at sea, time in port, tonnage shipped,

¹ We updated the Corps' estimates so benefits are realized from 2005 through 2054, at the mid-point of each year, using the discount rate applicable at the time of the 1998 *Limited Reevaluation Report*—7.375 percent.

² Using the gross domestic product implicit price deflator, we escalated the input data used in the Corps' analysis to reflect benefits in 1996 dollars.

and average shipping cost per unit of cargo. For certain crude oil vessels, one of these components is time savings in unloading crude oil. Currently, crude oil vessels that are loaded to a hull depth of more than 40 feet must stop at the mouth of the Delaware River to transfer crude oil to smaller vessels (a process called lightering) until the ship's hull is no deeper than 40 feet below the surface. This transfer of cargo takes time and thus increases costs. With a deeper channel, such ships would spend less time lightering, or might not need to lighter at all, thus reducing costs. In calculating the economic benefits that a 45-foot channel would produce, the Corps assumed time savings from reduced lightering at both the port of origin and the port of destination. However, the benefits of reduced lightering are realized only at the destination of the voyage. Thus, the Corps double-counted this benefit, resulting in an overstatement of about \$2.6 million in annual project benefits. Corps headquarters officials agreed that its analysis double-counted lightering time savings and therefore overstated annual project benefits.

The Corps' economic analysis also claimed project benefits for predicted shipments of crude oil on vessels that require a channel depth of only 40 feet. Currently, some of the vessels that deliver crude oil to the Philadelphia area refineries require less than a 40-foot channel depth, but they have the capacity to more fully load, and thus could potentially take advantage of a deeper channel. To estimate the benefits of a 45-foot channel for these vessels, the Corps used a statistical model (two stage least squares) to predict how much oil these vessels would carry if a 45-foot channel were available. The model predicted benefits by analyzing 137 combinations of ship types and trade routes. The model predicted that only 32 of these 137 combinations (or 23 percent) would require a channel depth of greater than 40 feet to make the trip upriver to the oil refineries. Nonetheless, the Corps assumed benefits for all 137 combinations. The Corps' economist was unable to provide a clear rationale for claiming benefits for the 105 ship-type/trade-route combinations that its model predicted would not benefit from a deeper channel. The result was that the Corps claimed about \$3.0 million in annual project benefits that were not supported by its model. Corps headquarters officials told us they believe that a greater number of these vessels could benefit from additional channel depth, but they could not verify their model. We agree that the deeper channel could benefit crude oil vessels with sailing drafts of less than 40 feet, but the amount of such benefits cannot be determined without a comprehensive reanalysis.

We also found that the Corps' container ship benefit analysis was based on several invalid assumptions. First, the Corps incorrectly assumed the same

one-way distance (3,600 nautical miles) for each of several different container ship trade routes (Australia, East Coast of South America, Europe, and the Mediterranean). For example, the one-way distance from Australia to Philadelphia via the Panama Canal is about 10,000 nautical miles. Further, for the Australia-to-Philadelphia route, the Corps assumed that with a 45-foot channel containers would be shipped on larger vessels and would go through the Suez Canal—as opposed to using the Panama Canal, the current trade route for this traffic. But, the Suez Canal trade route is significantly longer than the Panama Canal trade route, raising serious questions about whether shipping via the Suez Canal would be more cost-effective.³ After taking this invalid assumption regarding distances into account, and using the Corps’ methodology, we found that—even with a 45-foot channel depth—the least costly container ship trade route from Australia to Philadelphia remains through the Panama Canal. Furthermore, vessels using the Panama Canal are currently restricted to sailing drafts of 39 feet 6 inches. Thus, the benefits of the deeper channel for this trade route would be minimal. After taking the invalid assumptions in the Corps’ analysis into account, we estimated that annual container ship benefits would be about \$1.7 million less than the Corps estimated. Corps headquarters officials acknowledged our findings and their relative impact, as calculated on the basis of the information presented in the 1998 *Limited Reevaluation Report*. However, they now believe that container ship benefits may be higher than presented in the 1998 report because of changed shipping patterns. While changes have occurred in the container shipping industry, it would be premature to speculate on the effect these changes would have on project benefits without a comprehensive reanalysis.

Moreover, the Corps also incorrectly assumed the same distance for different trade routes when estimating benefits for the category of crude oil vessels with sailing drafts less than 40 feet. Taking this invalid assumption into account reduced annual project benefits by about \$1 million. Finally, we identified about \$1.0 million in additional overestimated annual benefits due to other invalid assumptions related to the analysis for scrap metal, iron ore, and coal commodities.

³ The difference in route distances for container ship trade between Australia and Philadelphia via the Suez Canal and via the Panama Canal ranges from 3,500 to 5,000 nautical miles, depending on the port of origin (in Australia) and the number of port calls.

Corps' Benefit Analysis Was Based on Outdated Information

Much of the baseline information that underpins the Corps' project benefit analysis dates from 1985 through 1991. Thus, the data are outdated and do not reflect current shipping practices and trends. For example, the data the Corps used in its economic analysis led to a projection that crude oil imports up the Delaware River would increase by over 20 million short tons from 1992 through 2000.⁴ However, our review of available data indicated that crude oil imports increased by only about 10 million short tons over this period.⁵ We identified a number of instances, discussed below, in which the information used in the Corps' analysis was outdated. Where possible, we updated the information, and found that the Corps' analysis overstated total annual project benefits by about \$8.8 million.

The Corps' 1992 feasibility study included benefits for the time savings related to reduced lightering of crude oil by tankers with a sailing draft of greater than 40 feet. The Corps estimated that crude oil could be unloaded from crude oil tankers to the refineries' storage tanks about twice as fast as it could be transferred to lightering vessels. Since that time, however, the company that provides lightering services in the Delaware River has modified its fleet of vessels that performs this service. Based on information provided by several refineries and the lightering company, lightering rates are almost the exact opposite of those used in the Corps' analysis. According to these sources, crude oil can be transferred from oil tankers to lightering vessels almost twice as fast as it can be unloaded from oil tankers to refineries. The Corps' use of the outdated information resulted in overstating annual project benefits by about \$3.2 million.

As discussed previously, the Corps overestimated the projected growth in crude oil imports. Substituting the predicted growth rates used by the Corps with actual growth rates based on historical import data to the Philadelphia region (at the time of the 1998 *Limited Reevaluation Report*), we found that the Corps' annual benefits were overestimated by about \$3.5 million. In commenting on a draft of this report, the Corps stated that its crude oil projections (1992 through 2000) were in line with actual recorded tonnage. However, this statement is misleading because the crude oil import data that the Corps used to make this claim were inconsistently collected between 1992 and 2000. Nevertheless, the Corps stated in its comments that its project reanalysis would need to verify the

⁴ The term "short ton" is a unit of weight equal to 2,000 pounds.

⁵ We obtained historical data on crude oil imports from the project's nonfederal sponsor (DRPA). Data were drawn from the Journal of Commerce (PIERS) database.

database used to establish current and historic shipments to ensure data reliability. In addition, the Corps' predicted growth rates for container ship imports for some trade routes were also overestimated; substituting the predicted growth rates with actual growth rates, we found that the Corps' annual benefits were overestimated by about \$0.3 million.

Finally, the Corps' analysis included benefits for exporting scrap metal to Turkey and importing coal and iron ore. However, since the time of the Corps' 1992 analysis, trade of these commodities on the Delaware River has greatly declined. Updating for this information, we found that benefits for scrap metal, iron ore, and coal were reduced by about \$1.7 million a year (beyond the \$1.0 million benefit reduction mentioned earlier). Corps headquarters officials concurred that shipments of scrap metal, coal, and iron ore have decreased since the 1998 *Limited Reevaluation Report* but stated that shipments of these commodities increased from 2000 to 2001 and may warrant further analysis.

Table 1 shows the Corps' 1998 benefit estimates and summarizes errors in those estimates based on our evaluation of the Corps' analysis.

Table 1: Analysis of Annual Project Benefits

Dollars in thousands					
Commodity	Corps' estimates ^a	Miscalculations ^b	Invalid assumptions ^b	Outdated information ^b	Remaining benefits ^c
Crude oil	\$32,481	(\$8,883)	(\$6,681)	(\$6,764)	\$10,153
Containers	4,546	3	(1,742)	(294)	2,513
Scrap metal	2,357	406	(938)	(1,465)	360
Iron ore	598	(152)	9	(244)	211
Coal	160	23	(93)	8	98
Total	\$40,142	(\$8,603)	(\$9,445)	(\$8,759)	\$13,335

^a Figures obtained from the Corps' 1998 *Limited Reevaluation Report*.

^b Negative values are given in parentheses and represent reductions to the Corps' estimates.

^c Values are given in 1996 dollars and are calculated as the sum of the previous four columns.

It is important to note that because of the numerous shortcomings in the Corps' analysis, the actual project benefits cannot be reliably known without a comprehensive reanalysis. To be complete, such a reanalysis would need to account for the miscalculations and invalid assumptions we identified. Furthermore, it would need to comprehensively update the data used in the 1998 analysis to account for current shipping trends on the Delaware River, and reexamine the methodology used to estimate benefits.

Corps Has Refined Its Cost Estimate to Reflect Some Changes and Corrections, but Additional Updates Are Needed

The Corps has made several changes to reflect project updates and correct for cost estimating errors since the 1998 *Limited Reevaluation Report*. Some of these changes—reducing the volume of material and locations where dredging would need to be performed—would reduce annual project costs. But this cost reduction would be offset by several other updates and corrections that would increase project costs. Accounting for these increases and decreases, in aggregate, annual project costs would likely be about \$27 million (in 2001 dollars) rather than the \$28.8 million estimated by the Corps in the 1998 *Limited Reevaluation Report*. However, other Corps costs were based on outdated information, contained errors, or did not take into account all pertinent information. While the Corps has not yet addressed these problems, doing so would likely increase project costs. Because of the interrelationship among the cost categories, the effects of the individual updates and corrections cannot be readily isolated from each other.

Reducing Amount of Material and Total Area to Be Dredged Has Lowered Project Costs

The Corps has refined its cost estimate to account for new information. Originally, assuming that the overall depth of the existing channel was 40 feet, the Corps estimated the amount of material to be dredged at 33 million cubic yards. However, new information developed by the Corps indicates that parts of the channel are already deeper than 40 feet. Thus, the Corps has reduced its estimate of the material to be dredged to approximately 26 million cubic yards, thereby lowering the costs of dredging.

Further, new surveys of the main ship channel and the use of new technology have given the Corps more accurate information about areas of the channel that are 45 feet or deeper already and will not need to be dredged. The new technology—side scan sonar—provides more accurate mapping of the contour of the shipping channel, thereby enabling the Corps to determine that less total area needs to be dredged than it previously believed. Thus, costs for construction and equipment have declined.

Other Revisions and Corrections Have Increased Project Costs

In the process of reestimating project costs, the Corps decided to extend the construction period from 4 years to 5 years. This extension resulted from concerns that additional dredging equipment needed to finish the project in 4 years might not be available when necessary. Moreover, a Corps official told us that the Corps was concerned that it might not be able to obtain the funding necessary to construct the project in 4 years.

Additionally, the Corps' 1998 analysis included the cost of purchasing four new confined disposal facilities, but one of these facilities is no longer available. The Corps now plans to take the dredge material excavated during construction that was intended for this facility to another location farther away. The Corps has revised the disposal costs for the construction phase of the project to reflect this change.

Also, during our review of the Corps' cost estimate, we identified a number of omissions. For example, in its 1998 cost estimate, the Corps did not include construction costs for confined disposal facilities in its summary calculations for maintaining the 45-foot channel. A Corps official was unable to explain why this occurred, but the Corps has since corrected for the omission.

Finally, we identified a number of errors in the Corps' cost estimate, one having to do with inconsistent discounting. In estimating costs for maintenance dredging, the Corps used end-year discounting, but for construction costs and benefit calculations, it used different discount periods. As discussed earlier, benefits and costs should be determined using consistent discounting procedures. The Corps agreed that mid-year discounting is appropriate and has updated project costs for this.

Further Corrections for Outdated Information and Additional Errors and Omissions Would Likely Increase Project Costs

The Corps has not updated its cost estimates for maintenance dredging and deepening the side channels that connect the main channel to the benefiting firms' loading docks. Moreover, a number of specific errors and omissions in the cost estimate remain to be addressed; making the necessary corrections would likely increase project costs. For example, the cost estimate for maintaining a 45-foot channel has not been revised to reflect that one of the disposal facilities is no longer available. The alternative location is more distant from the dredging operation. Corps officials agreed that this problem exists in the cost estimate and that the additional distance would increase costs. At the time of our review, the Corps had not calculated how much this correction would increase project costs. Corps headquarters officials believe that updating maintenance and berthing area cost estimates to correct for outdated data and inaccuracies would have a marginal impact on the total project costs. However, the full extent of the impact cannot be accurately estimated until project costs have been completely reanalyzed.

In addition, the Corps' current cost estimate assumes that maintenance dredging for the 45-foot channel would begin after the last year of construction and continue for 50 years. But maintenance dredging for

some sections of the channel could begin before the 5-year construction phase of the project is completed because the sections that are to be deepened to 45 feet in the first years of construction would likely start to fill in as sand and silt resettle in the channel. The Corps' estimate for maintenance costs does not account for the fact that some costs should be inflated and others discounted to reflect that maintenance in certain sections of the channel would need to be done at different times. Taking this oversight into account would increase costs. Although a Corps official acknowledged this inaccuracy, the Corps had not, at the time of our review, calculated how much this correction would increase annualized project costs. Corps headquarters officials have stated that this problem could potentially be corrected by modifying the project construction schedule. However, any modification of the schedule would affect the total project cost.

Finally, the Corps did not include in its estimate all the capital investments that private companies, such as oil refineries, would need to make to take advantage of the deeper channel. For example, officials at two refineries told us that they would need to build additional on-site storage capacity to take advantage of a deeper channel, but these costs were not included in the cost estimate. While taking this omission into account would likely increase annualized project costs, the Corps had not addressed this issue at the time of our review. Corps headquarters officials stated that they assumed no land-side costs attributable to the proposed project at the time of the 1998 *Limited Reevaluation Report*. However, these officials further stated that a reanalysis of the project would reconsider the assumption of no land-side costs, in addition to other potential capital investment costs faced by the benefiting firms.

Several Uncertainties Could Further Affect Project Benefits and Costs

There are a number of uncertainties related to project benefits and costs that could impact the economic analysis. Some of the cases of outdated information and invalid assumptions discussed in this report are examples of the uncertainty in forecasting information such as commodity shipments, technological change, and the economic choices of industry. Reanalysis of the project might consider a more careful treatment of such uncertainty. Our review identified additional uncertainties that the Corps has not addressed in its analysis. If and when these uncertainties are resolved, expected benefits and costs could further increase or decrease, thus affecting the project's economic merits.

Uncertainties Related to Project Benefits

It is uncertain whether the companies expected to benefit from the project, primarily oil refineries, would undertake the capital improvements necessary to take full advantage of a deeper channel and, if so, whether they would do it in the same time frame as assumed by the Corps. In its economic analysis, the Corps assumed that all potential beneficiaries would perform the work necessary to take advantage of a deeper channel, such as dredging side channels and berthing areas, by the end of the last year of planned construction. However, potential beneficiaries have made few firm commitments to make these capital improvements. An official of one company wrote to the Corps supporting the project, and a public relations official from another responded to a local newspaper saying the company would look favorably on the project. In addition, representatives of several other companies told us they believe the project could benefit them, but because substantial work could be necessary to deepen their berthing areas, retrofit docking areas, or expand storage capacity, they would not make a firm commitment to making these improvements. If any of the benefiting companies did not perform the necessary work, or if they delayed these efforts until after the project was completed, anticipated benefits would be reduced. Corps headquarters officials reaffirmed the Corps' support of the draft project cooperation agreement, which calls upon the nonfederal sponsor to enter into agreements with the benefiting firms to complete the necessary work in conjunction with the construction of the project. The draft project cooperation agreement provides that the Corps may elect to stop project construction in the absence of such agreements.

As discussed earlier, one of the benefits of the deeper channel—included in the Corps' analysis—is a reduced need for the lightering of crude oil. In fact, the company that provides lightering services in the bay currently estimates that the demand for its services could decrease by a third, from lightering 90 million barrels of crude oil per year to 60 million. The uncertainty involves how this company would react to a reduction in demand for its services. An official of this company told us that the company might reduce the number of lightering vessels operating in the bay from three to two, which could potentially increase the time that vessels might have to wait for lightering services, increase lightering fees, or both. These scenarios would likely decrease the economic benefits of reduced lightering. Another possibility is that the lightering firm could reduce its fees in an effort to maintain demand for its services. In any event, less lightering could reduce gaseous emissions that occur during the lightering process, thus resulting in some environmental benefits.

In addition, Federal Principles and Guidelines for Water Resource Agencies call for including project benefits that contribute to national economic development. Yet, it is uncertain whether all of the potential benefits of a 45-foot channel would contribute to national economic development because most of the ships coming into Delaware River ports are foreign-owned. The Corps' analysis did not take into account the distribution of the project benefits between U.S. and foreign interests; in essence, the Corps assumed that all transportation savings attributable to the project would accrue to U.S. interests. In commenting on a draft of this report, the Corps stated that we are making an implicit assumption that all benefits should accrue to American interests, and those realized by foreign interests should be netted out in the determination of U.S. national economic development. First, we are not making an implicit assumption. The *Economic and Environmental Principles for Water and Related Land Resources Implementation Studies*—a publication that establishes principles intended to ensure proper and consistent planning by the Corps—and the Corps' own guidance state: "The Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements." Second, it is unclear how the Corps can meet that definition of national economic development without analyzing the distribution of project benefits between U.S. and foreign interests. In summary, our concern is that to the extent that some of the transportation cost savings of this project—as well as those for other similar Corps navigation projects—accrue to foreign interests, the contributions of the project to national economic development are overstated.

Finally, an area of uncertainty that could increase project benefits is the degree to which there are commodities being shipped on the Delaware River that the Corps did not include in its economic analysis. For example, recent shipping data indicate that imports of iron and steel increased from about 550,000 short tons in 1990 to about 4 million short tons in 2000. The importers of these and other goods might benefit from a deeper channel, but the Corps' benefit analysis did not consider these commodities.

Uncertainties Related to Project Costs

There are several uncertainties regarding project costs. One area of uncertainty involves mitigation costs for any unexpected environmental damage that could potentially emerge. While the Corps has included some costs for assessing the likely environmental impacts of the project, should monitoring or construction activities reveal unanticipated problems, the

costs to slow the dredging schedule or rebuild damaged habitat are unclear. In addition, discussed below are several other uncertainties that we identified during our review that may increase or decrease costs by an as yet unquantified amount.

One such uncertainty concerns the recent addition of beach replenishment to the project's plan for disposal of dredged material. The Corps' current disposal plan calls for transporting sand dredged from the lower Delaware Bay to Broadkill Beach in Delaware. However, it is unclear whether the clean sand will ultimately go to Broadkill Beach because, pending an agreement with the state of Delaware, another beach, or beaches, could be selected. Using a beach that is closer to the dredging area would result in a lower cost for beach replenishment than is currently estimated.

Alternatively, if the selected beach were farther from the channel-dredging area, the cost of the operation would be higher than estimated. For example, the current costs of dredging the channel and transporting the sand to Broadkill Beach are estimated at \$10 per cubic yard; the costs for the same activities with Dewey-Rehoboth Beach as the destination would be about \$18 per cubic yard. Given the uncertainty about which beach or beaches will ultimately be chosen, the final cost of this activity is unclear.

It is also uncertain how much purchasing the sites for the three new confined disposal facilities in New Jersey would cost, and whether the project sponsor would be able to acquire all of these sites. Currently, these sites are estimated to cost \$15.4 million.⁶ The Corps does not intend to update its appraisal of these sites, which would involve estimating the amount of land to be purchased, until after the project cooperation agreement between the Corps and the nonfederal sponsor has been signed. In the meantime, the Gloucester County Improvement Authority of New Jersey is seeking to buy portions of these areas for recreational purposes. Given these uncertainties, it is possible that the costs of land needed for new confined disposal facilities could increase.

Another uncertainty concerns how much it would cost the Corps to comply with certain environmental restrictions, called windows. Designed to protect habitat and vulnerable populations such as horseshoe crabs, oysters, and winter flounder in certain sections of the Delaware River, the windows limit where and when dredging, beach replenishment, and

⁶ This figure was cited in the 1998 *Limited Reevaluation Report*; it is presented in 1996 dollar values.

wetland restoration activities can occur. For example, to protect the habitat of winter flounder, dredging cannot occur in the lower portion of the river from January through May without relief from the window. If the Corps could not complete its scheduled dredging from June through December, it would incur additional costs to stop the work and start it up again later. The Corps is currently studying the extent to which fish and surrounding habitat would be harmed by dredging activities. A Corps official told us that these studies may show that the current windows are overly protective, a finding that the official believes would provide some support for federal and state agencies to provide relief from some of the restrictions. In addition, the Corps plans to use two dredges in the areas where restrictions are established to reduce dredging time. In any event, the 1998 estimate and its recent update do not include the potentially increased costs of complying with these windows. According to a Corps official, because the Corps is unsure how much relief it would obtain from the restrictions, it is uncertain how much project costs would increase. Corps headquarters officials now state that a significant portion of the project construction work could be accomplished within the existing environmental windows. Specifically, they have said that the operations at Broadkill Beach and Kelly Island would not require relief. However, to the extent that the Corps cannot obtain the necessary relief in other areas, project costs would increase.

A further uncertainty concerns whether the Corps will employ the technique known as economic loading for its dredging operations in the lower bay area. Using this technique, the water content of dredged material that has been loaded onto a barge, or dredge, is allowed to drain back into the river at that site. Therefore, when the barge is fully loaded, it contains a higher percentage of dredged material, resulting in fewer trips to the disposal sites. Because of concerns that the water drained from the dredge material would contain a large amount of particulate matter that would cause a plume in the water column, the Corps studied the potential environmental effects of economic loading in 1999. The study concluded that economic loading would not cause significant long-term environmental harm. Having reviewed the results of the study, officials from Delaware and New Jersey said they would consider allowing the use of economic loading in the lower bay. However, it should be noted that this option was not included as part of the Corps' permit application to the state of Delaware and that formal approvals from either Delaware or New Jersey have not been requested. Should the Corps formally seek and obtain permission to use economic loading, costs would decrease. In commenting on the draft of this report, Corps officials said that indications from the states of New Jersey and Delaware are that this process may be

viable and practical in the Delaware Bay for dredging sandy material. The Corps estimated that if economic loading were permitted, it could result in a 30 to 40 percent reduction in the unit cost of dredging, which the Corps stated previously would translate into approximately \$2 million in annualized cost savings. However, the Corps recognized that it is uncertain whether economic loading would be used, and that this issue would need to be investigated in any reanalysis of the project.

Finally, a new dredging technology, known as a ladder pump, increases dredge material production rates and has the potential to decrease costs for some of the dredging operations that would occur during the construction and maintenance phases of the project. However, the Corps did not incorporate the use of this new technology into its cost estimate, and it is not known whether the contractors that would conduct the project's dredging operations would use it.

Corps' Quality Control Process Did Not Identify Major Flaws in the Economic Analysis

The Corps has a three-tiered quality control process designed to ensure that its economic analyses of proposed projects are factually accurate and based on sound economic principles. Three organizational levels are involved: the Corps' district offices, division offices, and headquarters. In general, for projects such as the Delaware River deepening project, the following process is used:

- The relevant district office is responsible for conducting a feasibility study that addresses the technical and economic aspects of a proposed project and manages the planning, engineering, and design work that follows. The district office also prepares the *Limited Reevaluation Report* that updates the technical and economic data as needed. Once it has developed these project justification documents, the district office reviews them for technical accuracy and quality, and upon approval, it forwards them to the division for its review.
- The division's responsibility is primarily procedural. It reviews the project justification package to ensure that the district has prepared the required documents such as the *Feasibility Study* and *Limited Reevaluation Report* and has obtained all necessary approvals. It does not review such documents for technical accuracy or to verify the underlying analysis. The division ensures that reports such as the *Limited Reevaluation Report* have undergone a technical review and that the district has issued a quality control certification report with the required district office level approvals. Once the division is satisfied that procedures have been followed, it approves the package and forwards it to headquarters.

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- Headquarters is responsible for ensuring that critical documents such as the *Feasibility Study* and *Limited Reevaluation Report*, the major assumptions on which the justification is based, and the recommendations adhere to Corps policy for conducting benefit-cost analyses and environmental studies. Headquarters also ensures that any concerns that it has raised have been addressed. Once headquarters is satisfied that policy has been followed and that the justification is based on sound economics and environmental studies, it approves the project for construction funding.

Although the district, division, and headquarters offices approved the project according to the procedures in place in 1992 and changes that followed in 1995, these review processes were ineffective in detecting and correcting the significant miscalculations, invalid assumptions, and outdated information in the economic analysis that our review revealed. For example, we found no indication that problems related to benefits, such as misapplying growth rates, double-counting lightering time savings, and miscalculating potential benefits derived from time savings in unloading crude oil at the refineries, were detected during the internal reviews and quality control certification process. This raises serious questions about the adequacy and effectiveness of the Corps' review process. Corps headquarters officials have stated that notwithstanding the changing and existing procedures, there were failures in the execution of the process for the development and review of the feasibility analysis and the *Limited Reevaluation Report*. The economic update in the *Limited Reevaluation Report* was performed in accordance with existing regulations but did not get to the root of the underlying problems, some of which were carried forth from the original report.

Another concern is that since 1995, the primary responsibility for performing the quality reviews of key project documents has been largely delegated to the district office level. The Philadelphia district office prepared the economic analysis and other documents justifying the deepening project and, following the 1995 change in Corps procedures, prepared the 1998 *Limited Reevaluation Report* and then conducted the technical review and quality control certification process on the report. The fact that the same office that prepared the economic analysis was also responsible for conducting the technical and quality reviews raises questions about the independence of the review process. Similar concerns about the Corps' project review procedures were addressed in section 216 of the Water Resources Development Act of 2000, which directed the Corps to contract with the National Academy of Sciences to study and make recommendations with regard to the need for independent reviews

of Corps feasibility studies. The estimated date of completion for the study is 2003.

Looking beyond the Delaware River deepening project, the number and magnitude of problems that were not detected by the Corps' quality control process raises questions about whether, or to what degree, such oversights might exist for other Corps projects. This concern is shared, at least, to some degree by the Corps of Engineers. Specifically, shortly after we briefed the Corps' Director of Civil Works on our findings regarding the Delaware River deepening project, he initiated a pause on projects authorized, but not yet under construction, to resolve any questions about the accuracy and currency of the Corps' economic analyses, the validity of plan formulation decisions, and the rigor of the Corps' review process.

Most Environmental Concerns Have Been Addressed, but Several Related Issues Remain Unresolved

The Corps has largely addressed the likely environmental effects of the project's dredging operations and dredge material disposal to the satisfaction of federal and state environmental agencies; however, several issues are not yet resolved. On the basis of their review of the Corps' environmental impact statements and studies of the potential for the project to disturb toxic dredge material, contaminate water, and harm wildlife and habitat, most federal and state agencies granted the Corps the necessary approvals to proceed with the project. A major exception is the Corps' request for a permit to conduct dredging operations in Delaware waters, which is still pending. In addition, several other issues remain outstanding.

Most Federal and State Environmental Agencies Have Approved the Project

With few exceptions, the Corps has obtained the approvals it needs from federal and state environmental agencies to proceed with project construction plans. As required by the National Environmental Policy Act of 1969, the Corps coordinated with other federal agencies and states; obtained comments from the agencies, the states, and the public; and reported on the potential environmental impacts of the project in the 1992 *Environmental Impact Statement* and the 1997 *Supplemental Environmental Impact Statement*. The Corps also made some changes as a result of agencies' comments. For example, in response to concerns raised by the National Marine Fisheries Service and others, the Corps eliminated its proposal to dispose of some dredged material at an underwater sand stockpiling location. On the basis of their review of these and subsequent documents, as well as consultations performed by the Corps, officials from the U.S. Environmental Protection Agency, the National Marine Fisheries Service, the U.S. Geological Survey, and the

states of New Jersey and Pennsylvania determined that deepening the Delaware River ship channel would not cause significant long-term harm to the environment. Specifically, these officials told us they were satisfied that the project's dredging and disposal operations would not degrade water quality, cause saltwater intrusion, release contaminated sediments, or seriously harm endangered or other species.

The federal and state approvals were also based on a commitment by the Corps to conduct additional studies and monitor the environmental impact of the ongoing channel deepening and construction of confined disposal facilities. Such monitoring would be central to ensuring that project activities would not degrade water quality, damage groundwater through saltwater intrusion, or harm commercially valuable or vulnerable species. Consequently, the Corps has conducted preconstruction monitoring studies on whether the project would adversely affect oysters and water and sediment quality. In addition, the Corps has studied the likely impact of the project on blue crabs in the lower part of the bay and on winter flounder, horseshoe crabs, and shorebirds at Kelly Island. The Corps has provided the results of these studies to the federal and state environmental agencies for their review, and Corps officials told us that they would continue to monitor these and other environmental issues during and after construction. Federal and state officials told us that should monitoring reveal a problem, the Corps would have to undertake some form of mitigation, such as slowing the dredging schedule or rebuilding damaged habitat.

Delaware Permit Is Still Pending

The Corps has not yet obtained a permit from Delaware to conduct dredging operations for the project that affect its waters. The Corps has stated that it will not begin the project until it obtains this permit. Its Philadelphia district office applied for the permit in January 2001 and participated in a public hearing on the application in December 2001. Delaware officials told us that should the state approve the permit application, the permit could include a number of monitoring requirements. For example, Delaware could require the Corps to monitor for possible violations of PCB⁷ standards near the dredging zone. As of May 2002, the State of Delaware was still considering the permit application.

⁷ Polychlorinated biphenyls (PCBs) are highly toxic cancer-causing pollutants used in producing, among other things, plastics.

Other Issues and Permit Approvals Remain Outstanding

One remaining issue concerns the possibility that, under certain conditions, the project might cause increased saltwater intrusion into the Delaware River estuary and the groundwater of the area. While Pennsylvania and New Jersey accepted the results of the Corps' earlier tests for saltwater intrusion, the Delaware River Basin Commission, which sets water quality standards for the Delaware Estuary, requested an additional test. To satisfy the commission's concerns, the Corps agreed to the test, which it has not yet conducted.

In addition, New Jersey officials told us that they would encourage the Delaware River Port Authority to explore alternatives to disposing of dredge material, such as using it for highway construction, before New Jersey would grant water quality certificates for the three confined disposal facilities to be acquired by the Port Authority and built by the Corps in New Jersey. In addition, the Corps and New Jersey's Department of Environmental Protection have developed a groundwater-monitoring program designed to ensure that existing confined disposal facilities in New Jersey do not harm drinking water. A similar program is planned for the three new confined disposal facilities.

Finally, as mentioned earlier, the Corps has not sought formal approval from New Jersey and Delaware for using the economic loading technique. A Corps official told us that the Corps would probably wait until it knows the outcome of its Delaware permit application before deciding whether to seek economic loading approval. Similarly, the Corps has not applied to Delaware or the National Marine Fisheries Service for relief from environmental windows, which restrict when dredging can be performed. However, the Corps is conducting an evaluation of essential fish habitat and is collecting information on the potential effects of the project on horseshoe crabs, shorebirds, and hibernating female blue crabs to determine whether to seek relief from regulatory agencies' restrictions on dredging. Also, the Corps has not yet obtained a special use permit from the U.S. Fish and Wildlife Service for its planned wetlands restoration at Bombay Hook National Wildlife Refuge.

Conclusions

We found significant problems in the Corps' most recent economic analysis for the Delaware River deepening project. These involved several miscalculations, invalid assumptions, and reliance on outdated information. Consequently, we believe that the Corps' current project analysis does not provide a reliable basis for deciding whether to proceed with the project. In addition, there are a number of uncertainties about the project that could increase or decrease both benefits and costs. Because of

the significance of the problems we identified, the uncertainties that surround the project, and the ineffectiveness of the Corps' quality control process, the actual economic merits of the Delaware River deepening project will not be reliably known unless and until it is comprehensively reanalyzed.

Recommendations for Executive Action

Considering the significant problems we identified with the Corps' economic justification for the Delaware River project, we recommend that the Secretary of the Army direct the Corps of Engineers to

- prepare a new and comprehensive economic analysis of the project's benefits and costs, which includes all aspects of the analysis and corrects for the miscalculations, erroneous assumptions, and outdated information contained in the current analysis;
- obtain the information, where possible, that is needed to address the uncertainties—such as changing commodity movements over the last decade and alternative dredging techniques—that could significantly affect project benefits and costs;
- engage an external independent party to review the revised economic analysis to ensure that it accurately and fairly represents the expected benefits and costs of the proposed project; and
- submit the revised analysis, including the external independent review, to the Congress for its use in considering future appropriation requests for the project.

Agency Comments

We provided a draft of this report to the Secretary of the Army for review and comment. In response, the Under Secretary of the Army stated that the report is important to the department because it provides a current, critical look at the proposed Delaware River deepening project and identifies legitimate concerns that warrant comprehensive reanalysis. More specifically, the Under Secretary stated that the Corps concurs that a new and comprehensive economic reanalysis of the project's benefits and costs would be undertaken, and that once the economic reanalysis is complete, an external independent party would be engaged to ensure that it accurately and fairly represents expected benefits and costs of the proposed project. The Under Secretary also provided additional comments on various aspects of the project, which are discussed as appropriate in

the body of the report. The full text of the comments is included as appendix II.

We conducted our review between July 2001 and May 2002 in accordance with generally accepted government auditing standards. A detailed discussion of our scope and methodology is presented in appendix I.

As arranged with your offices, unless you publicly announce this report's contents earlier, we plan no further distribution of the report until 10 days after the date of this letter. At that time, we will send copies to the Secretary of the Army, appropriate congressional committees, and other interested Members of Congress. We will also 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 questions about this report, please contact me at (202) 512-3841. Key contributors to this report are listed in appendix III.



Robert A. Robinson
Managing Director, Natural Resources
and Environment

Appendix I: Scope and Methodology

Overview

Our review had two main objectives: to determine (1) whether the Corps of Engineers' economic analysis accurately and appropriately considered the benefits and costs of the project and (2) whether the environmental implications of the project have been fully addressed.

To determine whether the Corps of Engineers' economic analysis appropriately considered the benefits and costs of the Delaware River deepening project, we assessed the extent to which the Corps met requirements and followed accepted practices in estimating the various elements of the benefits and costs, including whether the major assumptions were reasonable and well supported. To determine whether the environmental implications of the project have been fully addressed, we contacted a number of federal and state environmental agencies such as the Environmental Protection Agency, the Delaware River Basin Commission, and the Delaware Department of Natural Resources and Environmental Control. We also obtained information from environmental groups and other interested parties. For both these objectives, we obtained the Corps' key documents for the project, such as the *Interim Final Feasibility Study* of 1992, the *Design Memorandum* of 1996, the *Limited Reevaluation Report* of 1998, the *Environmental Impact Statement* of 1992, and the *Supplemental Environmental Impact Statement* of 1997. We discussed the content and sources of the data in these reports with Corps officials and staff responsible for their preparation and approval.

To validate the data and assumptions the Corps used in its analyses, we obtained external data and contacted external parties where appropriate. Where we obtained other analyses or studies, we considered the points raised in these external studies but conducted our own independent review. Where we identified problems with or changes to benefits, costs, or environmental issues, we discussed them with the responsible Corps staff and considered any new data or revisions that they provided. If the problems involved miscalculations, invalid assumptions, errors, omissions, or outdated information that would affect the project's benefits, costs, or the environment, we attempted to identify how or why these problems occurred. In addition, we identified uncertainties related to the benefits, costs, and the environmental implications of the project and considered whether resolving these uncertainties would increase or decrease the benefits and costs. We also reviewed the Corps' quality control processes. In the following sections, we provide more detail on our first objective consisting of benefits, costs, uncertainties, and the Corps' quality control process; and our second objective about the potential environmental implications of the project.

Project Benefit Estimate

To evaluate the Corps' project benefit analysis, we had three primary objectives. First we used the Corps' data and methodology—obtained from the 1992 *Interim Final Feasibility Report*, and the 1996 *Design Memorandum*, and through interviews with the Corps' economist—to attempt to replicate the estimated annual project benefits for each commodity as published in the Corps' 1998 *Limited Reevaluation Report*. These commodities included coal, containers, crude oil shipped on vessels with sailing drafts greater than 40 feet, crude oil shipped on vessels with sailing drafts less than or equal to 40 feet, iron ore, and scrap metal. Where we were unable to replicate the Corps' estimates, we met with the Corps' economist to discuss and resolve the discrepancies. Second, to identify questionable assumptions in the analysis, we examined the data used and calculations applied in the Corps' benefits programs. To determine whether the Corps' assumptions were supportable, we requested documentation or guidelines from the Corps' economist that validated the questioned approach. In addition, we met and talked with industry representatives to obtain their response. Third, to identify whether the analysis was based on up-to-date information, we reviewed the origin of any changes to the benefits estimates in the 1998 *Limited Reevaluation Report* from the 1992 *Interim Final Feasibility Study* and the 1996 *Design Memorandum*. Where no changes in benefits estimates occurred, we searched for data sources available at the time of the Corps' latest report. Where possible, we updated the information on the basis of historical or industry trends at the time of the 1998 *Limited Reevaluation Report*.

We met with officials from the four companies that own the six oil refineries representing 80 percent of the benefits in the Corps' analysis, as well as Maritrans Corporation, which conducts the lightering operations for the oil refineries on the Delaware River. We obtained information on commodity shipments up the Delaware River to the Philadelphia region from the Delaware River Port Authority. We also spoke with the Maritime Exchange, which gathers data on ship tracking and reporting on the Delaware River and represents a cross section of interests and companies that depend upon or conduct business on the river. In addition, we met with the firm Rice, Unruh, and Reynolds—shipping agents—to gather information on shipping practices, and with the National Ports and Waterways Institute to gather information about the container shipping industry.

We determined the net effect of the miscalculations, invalid assumptions, and outdated information on the Corps' \$40.1 million annual project benefit estimate by applying an eight-step iterative approach. In the first

four steps, we corrected for an error in the Corps' computer program, the misapplication of growth rates, inconsistent discounting, and different year dollar values. For the fifth step, we corrected for the Corps' invalid assumptions regarding trade route distances and its calculation of average shipping costs. With the sixth and seventh steps, we updated the information used in the Corps' analysis—specifically, the relative difference between the unloading and lightering rates, and the commodity growth rate information through 1997. In the eighth step, we corrected for the Corps' incorrect assumption that its statistical model predicted benefits for the 45-foot channel deepening project—when it did not. The net effect of the eight steps was a reduction in the estimated annual project benefits to about \$13.3 million (in 1996 dollars).

Project Cost Estimate

To establish a baseline against which future revisions could be compared for completeness and accuracy, and to get detailed information on planning, engineering, and design study costs, we used the 1996 *Design Memorandum*. We then compared the 1996 estimate with that in the *Limited Reevaluation Report* of 1998. Our subsequent efforts focused on changes to the project, various updates to costs by the Corps, corrections we identified, and additional issues that could further affect costs. Where changes in the project had occurred, and where we identified errors or omissions that the Corps agreed to correct, we determined whether the changes or corrections would increase or decrease the annualized project costs.

Our review included the two main parts of the Corps' cost estimate: the construction costs for the main navigation ship channel and the private berthing areas, and the operations and maintenance costs for operating and maintaining a 45-foot channel rather than a 40-foot channel. We also reviewed the Corps' estimates of costs to construct or modify both new confined disposal facilities and existing confined disposal facilities. Because the Corps makes extensive use of internally developed cost-estimating computer programs, we obtained these programs so that we could replicate construction costs and operations and maintenance costs using the Corps' programs and methodology. We gained an understanding of the Corps' Cost Engineering Dredge Estimating Program, which estimates costs for each of the three types of dredging operations used in the project, and the Corps' Micro Computer-Aided Cost Estimating System, which estimates the costs of constructing elements of the project that require land equipment, such as the confined disposal facilities. We discussed these programs, and the major assumptions and information

used in them, with Corps staff in other offices responsible for developing the cost-estimating programs and providing updates for them.

To identify a more accurate and updated cost estimate, we took into account changes to the project that had occurred since the 1998 *Limited Reevaluation Report* and corrections for errors and omissions that we identified during our work. We obtained documentation on the project changes, verified the information, and determined whether any updated cost estimates undertaken by the Corps accurately reflected the changes. For example, where new information existed on the volume of the material to be dredged from the channel, we asked for documentation from the Corps, not only on the volume of material that had been reduced but also on where those reductions had occurred in the channel. When we learned that less of the channel needed to be dredged because side-scan sonar technology provided better information on the areas of the river that were already 45 feet deep, we obtained survey maps from the Corps and verified that the estimated reductions in surface areas that the Corps was using in its revised costs were reasonable. We also identified any costs that were in error, or that were omitted, such as costs to reflect the loss of a disposal site and to transport material to other locations.

Since the Corps was updating various cost factors and revising its estimates for changes in the project design and scope at the same time that we were identifying the extent to which costs were accurate, we reestimated the overall project costs using the Corps' programs and most recent data. We compared our estimate with that of the Corps and obtained agreement with the Corps on a revised annualized project cost estimate that accounted for project changes and corrections that had been made as of the time of our review.

Uncertainties of Project Benefits and Costs

During our review, we identified a number of uncertainties related to project benefits and costs that the Corps had not addressed in its economic analysis. In some cases, the uncertainties are linked to decisions that are outside the control of the Corps, while others concern information that may not be currently available. Some of these uncertainties are the result of environmental issues that could affect future project benefits and costs. When we identified an uncertainty, we sought information from Corps officials and others that would allow us to say whether the uncertainty would increase or decrease benefits and costs.

Corps' Quality Control Process

We obtained the Corps' quality control procedures to gain an understanding of its processes and discussed them with Corps officials. We identified the roles and responsibilities of the district, division, and headquarters offices as they related to the Delaware River channel deepening project at the time of the feasibility study in 1992 and any changes in the review processes after that time. In doing so, we obtained copies of technical reviews and the quality control certification for the project, identified the offices responsible for the reviews, and obtained comments that the reviewers had on the economic analysis and the environmental impact statement. We also reviewed the responses of the Philadelphia district staff to determine whether comments by headquarters and the division were taken into consideration in any updated analysis.

Environmental Implications of the Project

To determine whether the Corps had considered and analyzed all areas of environmental concern, we reviewed the Corps' *Environmental Impact Statement* of 1992, the *Supplemental Environmental Impact Statement* of 1997, and other Corps studies. We contacted the Environmental Protection Agency, the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the Delaware River Basin Commission, the U.S. Geological Survey, and environmental agencies in the states of Delaware, New Jersey, and Pennsylvania to discuss the project and obtain studies and documents from them. We also reviewed information provided to us by environmental groups and other interested parties. Where the Corps had tested for contaminated sediments and hazardous materials, and had conducted studies to determine the potential impact of the project on water quality, groundwater, fish and wildlife and their habitat, we reviewed the test data and studies and discussed them with responsible federal and state agencies. Further, we reviewed the Corps' studies and monitoring plans for identifying any adverse impacts of the project on water quality, groundwater, fish and wildlife, and aquatic habitat with these agencies.

For example, to address concerns about contaminated sediments from the dredging operations in the main navigation ship channel, in the private berthing areas of the oil refineries, and at confined disposal facilities, we reviewed sampling data in the Corps' *Supplemental Environmental Impact Statement*. We reviewed the type of tests the Corps had conducted and the number of samples and sites selected, and we discussed the tests and results with Corps staff. We contacted officials from the Environmental Protection Agency, the Delaware River Basin Commission, and state environmental agencies in Delaware, New Jersey, and Pennsylvania to determine whether they were satisfied with the test

results and the Corps' monitoring plans for identifying potential problems during and after construction.

Additionally, we identified unresolved environmental issues and any outstanding approvals that remain open. For instance, to determine whether and to what extent saltwater intrusion into aquifers from dredging operations was addressed and what the Corps intended to do to resolve any outstanding concerns, we discussed this issue with Corps staff, and officials from the Environmental Protection Agency in Philadelphia and New York City, as well as with officials from the departments of environmental protection in Delaware, New Jersey, and Pennsylvania. We determined how satisfied these officials were with the Corps' studies and tests. We also met with officials from the Delaware River Basin Commission to discuss their outstanding request for an additional test for saltwater intrusion under certain drought conditions. We followed up with Corps officials to identify what they planned to do to resolve the Delaware River Basin Commission's concern.

Appendix II: Comments from the Under Secretary of the Army



UNDER SECRETARY OF THE ARMY
WASHINGTON

29 May 2002



Mr. Robert A. Robinson
Managing Director, Natural Resources and Environment
U.S. General Accounting Office
Washington, DC 20548

Dear Mr. Robinson:

This is in response to your May 22, 2002, letter to Secretary White requesting Department of the Army review of the draft GAO report entitled "Delaware River Deepening Project: Comprehensive Reanalysis Needed".

We appreciate the opportunity to comment on GAO's draft report as well as GAO's cooperation with the Corps of Engineers in providing clarification of issues and conclusions. The report is important to the Department because it provides a current, critical look at the proposed Delaware Deepening project and identifies legitimate concerns that warrant comprehensive reanalysis.

Enclosed are our comments on the report.

Sincerely,

A handwritten signature in black ink that reads "R. L. Brownlee".

R. L. Brownlee

Enclosure

Overall Corps of Engineers Evaluation of the Report

The Corps of Engineers has reviewed GAO's draft final report entitled "Delaware River Deepening Project: Comprehensive Reanalysis Needed." The report raises serious concerns on the benefits analysis accompanying the original 1992 authorization and 1998 limited reevaluation report (LRR) and how well the ten-year period since authorization is actually reflective of current conditions and commodity projections. The following discusses GAO's report on the benefits, costs, other uncertainties, the Corps review process, environmental concerns, and the Corps plan to remedy those concerns. Because of the complexities and uncertainties since the 1998 timeframe, the Corps concurs with GAO that a re-analysis is warranted.

Project Benefits

GAO's investigation was based upon an attempt to replicate and verify the Philadelphia District economic models results from the 1996-98 timeframe and bring those economic forecasts up to date based on today's actual port conditions. The models were the basis for the original 1992 feasibility report. GAO found, and the Corps concurs, that the Corps analysis of project benefits contained miscalculations, invalid assumptions, and outdated information. Concerning model errors, the Corps crude oil transportation savings models were revised to correct for the growth rate and trade route tabulation errors as part of the district coordination efforts with GAO during its benefit review.

Assumptions in Crude Oil Benefit Evaluations. GAO also stated the Corps used invalid assumptions in its benefit evaluations. Because of channel depth restrictions, crude oil vessels calling at port refineries currently lighter at the mouth of the river, thus enabling safe passage at reduced draft to the refineries. GAO cited a number of problems in the Corps analysis from 1998 relating to the lightering process. First, the timesavings on the lightering process that could be expected from a deeper channel would be reflected only at the point of destination. Second, the vessel loading patterns predicted by the statistical model that the district used to calculate expected crude oil vessel behavior with a 45-foot channel could not be replicated. Other factors affecting benefits include the comparative shore side and lightering vessel rate of cargo transfer for crude oil imports. GAO sources indicated that the lightering cargo transfer rate was twice as fast as the shore side cargo transfer rate. The overseas source of crude oil imports has changed significantly since the 1998 LRR. The reanalysis will verify this new information as well as other current conditions. For example, recent information from the oil company accounting for one-half the benefiting crude oil imports indicates that some of its tankers could unload at the dock at a rate six times as great as the dockside rate applied in the 1998 LRR analysis. Accordingly, the crude oil benefits could be greater and should be reaffirmed in the re-analysis. Corps crude oil projections were in line with actual recorded tonnage. The actual tonnage through the six benefiting facilities exceeded projected tonnage by 15 percent for the year 2000. GAO recommended that the Corps reexamine all the options and variables inherent in the process. Because of the complexities and uncertainties since the 1998 timeframe, the Corps concurs with GAO that a re-analysis is warranted. To ensure data reliability, the re-analysis would need to verify the database used to establish current and historic shipments and industry input on future trends.

Containership and Other Commodity Groups. For containership traffic, port dynamics have been even more pronounced over the last 10 years. The original feasibility report and LRR were predicated on traffic utilizing the Suez Canal route. As further evidence of the dynamic situation, since the LRR was completed, the trade routing of the shipper has changed to include New Zealand, other East Coast ports, and Europe for around the world service. GAO notes, and the Corps concurs, that these changed conditions warrant re-analysis. What was observed in the 1998 timeframe has changed today. Furthermore, since the 1998 LRR, the export of scrap metal to Turkey has ceased but new commodity traffic--coal, iron ore, and steel--provides substantial new tonnage and economic benefits which support the need for a critical re-analysis of both the containership benefit methodology and the verification of inputs of the economic model.

Project Costs

The GAO report also examined costs and concluded there were a number of variables that could potentially affect project costs. As part of its normal process, the Corps continually updates project costs to reflect current conditions and provides their current estimate of costs to its project cost sharing sponsors as a basis for sponsors to use as an estimate of costs they could be expected to incur and finance. The Corps is presently estimating an average annual cost of \$26.42 million, which is based on a 5-year construction period, exclusion of an unavailable disposal area, and discounting for maintenance dredging costs. The GAO and Corps both acknowledge that cost reductions could occur based on more current sediment surveys, recalculation of dredging loads, and economic loading, if permitted.

Capital Investments. GAO stated that the Corps had not included in its estimate all capital investments that private companies would need to undertake to realize the benefits of a deepened channel. The Corps benefit analysis in the LRR assumed that tonnages would be the same in both the with- and without-project conditions. Thus, any landside capital improvements to handle increased crude oil shipments would not be required as a result of the project but would occur gradually over time, regardless of the proposed deepening project. The essential factor is that the Corps receives a commitment from the port that non-Federal berthing areas be deepened to realize the benefits of any proposed Federal channel deepening. The LRR decision document was based upon the assumption that there are no associated landside costs attributable to the proposed project required to be included in the economic analysis. The GAO industry sources indicated a need to invest in additional shore side facilities for unloading and inventory in the with-deepening condition. The re-analysis needs to utilize industry sources in determining the applicability of any shore side associated costs needed to achieve the benefits from a deeper channel.

Uncertainties that Could Affect Project Benefits and Costs

Principles & Guidelines. GAO takes issue with the fundamental procedures under which potential navigation improvement projects are analyzed. Under the Federal Principles and Guidelines for Water Resources Agencies, navigation projects are formulated based upon transportation cost savings that can potentially be realized in the proposed with-project condition. The Principles and Guidelines (P&G) provide that this is based upon transportation savings to U.S. and foreign-based vessels involved in the import and

export of commodities. GAO is concerned that there is an implicit assumption that all benefits should accrue to American interests, and those realized by foreign interests should be netted out in the determination of U.S. NED benefits. The P&G does not call for netting out these benefits. The principle embodied in Corps regulations is that benefits would be passed on to the U.S. consumer and the national economy as a whole from the flow of funds generated to producers and consumers participating in import-export trade.

Local Service Facility Commitments. GAO expressed concern that the Corps must secure more definitive commitments from the potentially benefiting parties before any proposed project could be allowed to proceed. The project cooperation agreement (PCA) provides that before any construction could proceed, the sponsor must assure that improvements are made at the local service facilities necessary to realize project benefits and provide copies of third party agreements as evidence of their commitment.

Lightering Practices. GAO notes that crude oil lightering needs to be thoroughly revisited to determine the impact of potential reduced lightering services, increased lightering fees, and time to wait for lightering in the with-project condition. The Corps notes that the lightering service implications need to be fully investigated to determine the impact on ultimate project benefits. The P&G economic analysis assumptions are that the improvements are undertaken under a full employment economy and any resources like lightering ships can be successfully reemployed elsewhere in the economy. The resource savings from improvements occur over the 50-year economic analysis period. Any uneconomic displacement of resources can be expected to be short run and probably less than one year in duration.

Recent Commodity Changes. GAO notes that an area of uncertainty that could potentially increase project benefits may result from the increase in other commodity traffic that has occurred during recent years. The Corps concurs with GAO that the importers of iron and steel could potentially benefit from a deeper channel, and should be thoroughly addressed in a comprehensive re-analysis.

Potential Reduction in Dredging Costs. Economic loading could substantially reduce project costs. Indications from the states of New Jersey and Delaware are that this process may be viable and practical in Delaware Bay for dredging sandy material. If economic loading were permitted, it could result in a 30-40 percent reduction in unit cost of dredging. This is another uncertainty that would need to be investigated in any re-analysis of the project.

Corps Quality Control Procedures

This project has highlighted the difficulties in thoroughly analyzing a navigation project experiencing dynamic changes that extends over a 10-year planning horizon. Complicating the changes in port dynamics over the last 10 years were the changes occurring to the Corps review process. The review process, in the initial stages when the feasibility report was prepared was sequential; districts were responsible for the quality of the feasibility report they prepared and its underlying analysis, with both division and headquarters offices providing additional technical and policy review.

Between 1992 and when the LRR was prepared, further changes occurred, which principally moved technical review out of Washington and the division offices and placed it totally at the district level. This was in response to numerous sponsor and congressional concerns over the cost of studies and the length of time from project authorization to construction. This aspect was driven principally by the additional costs due to inflation that lengthy delays generally cause, as well as these costs being absorbed by sponsors, and the Federal Government, in their respective increased cost shares. During the timeframe of the LRR through the present, division offices were responsible for quality assurance of technical review and the headquarters was responsible for policy compliance. Notwithstanding the changing and existing procedures, there were basic failures in the execution of the process for the development and review of the feasibility analysis and the LRR. The economic update in the LRR was performed in accordance with existing regulations, but did not get to the root of the underlying problems some of which were carried forth from the original feasibility report. Although the established project review process was followed, GAO notes, and the Corps acknowledges, the failure in the process was to adequately verify the model and data input. The Corps agrees that it must re-examine the basis, development, and verification of economic modeling for commercial navigation projects and its internal checks and controls to prevent similar problems occurring in the future.

Environmental Concerns

In general, GAO notes that with few exceptions, the Corps has obtained the approvals it needs from Federal and State environmental agencies. GAO did not find any material weaknesses in the NEPA process. The State of Delaware permit is still pending and the Corps could not, and would not, proceed to construction without the State's Subaqueous Lands/Wetlands Permit. The PCA specifically recognizes this fact. We concur with GAO that the Corps would have to receive approval from the affected states before any potential use of economic loading of dredged material could proceed.

GAO's Recommendations for Executive Action

GAO recommends, and the Corps concurs, that a new and comprehensive economic analysis of the project benefits and costs be undertaken. Furthermore, GAO recommends, and the Corps concurs, that once the economic re-analysis is complete, an external independent party be engaged to ensure that it accurately and fairly represents expected benefits and costs of the proposed project.

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

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