United States General Accounting Office

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Report to Congressional Requesters

July 2000

ARMY CORPS OF ENGINEERS

An Assessment of the Draft Environmental Impact Statement of the Lower Snake River Dams

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GAO/RCED-00-186

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Abbreviations

BPA	Bonneville Power Administration
EPA	Environmental Protection Agency
EIS	Environmental Impact Statement
ESA	Endangered Species Act
GAO	General Accounting Office
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service

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

Resources, Community, and
Economic Development Division

B-284386

July 24, 2000

The Honorable Slade Gorton
Chairman, Subcommittee on Interior
and Related Agencies
Committee on Appropriations
United States Senate

The Honorable Gordon Smith
Chairman, Subcommittee on Water and Power
Committee on Energy and Natural Resources
United States Senate

Hydropower dams on the Columbia River and its main tributary, the Snake River, provide electric power, inland navigation, irrigation, flood control, and recreation to the Pacific Northwest region. The Columbia and Snake rivers and their tributaries are also home to salmon and steelhead that each year migrate from the Pacific Ocean to spawn in fresh water before dying. As juveniles, their young later swim back downstream to the ocean, before eventually repeating the cycle. These salmon were once abundant but have dwindled from up to 16 million a century ago to less than 1 million today. Federal agencies—the Corps of Engineers, Forest Service, Fish and Wildlife Service, Bureau of Reclamation, and Bureau of Land Management—and electricity ratepayers, through the Bonneville Power Administration, are spending about $400 million annually in the region to reverse this decline. The decline has been attributed to many causes, among them overfishing, destruction of habitat, the introduction of hatchery-bred fish, and the presence of hydropower dams. The dams restrict the passage of salmon returning to spawn and may be especially harmful to juvenile salmon as they migrate downstream.

The precipitous decline of salmon has caused the National Marine Fisheries Service (within the Department of Commerce), the agency charged with protecting marine species, to list four different species of salmon and steelhead native to the Snake River as endangered or threatened under the Endangered Species Act (ESA). That act requires federal agencies whose actions affect the survival of endangered or threatened (listed) species to manage their activities to avert the species' extinction. In response, the U.S. Army Corps of Engineers, which operates four hydropower dams on the Lower Snake River, began a feasibility study

in 1995 of how to improve migration conditions for juvenile salmon. The Corps is evaluating four alternatives, one of which involves breaching four dams (removing the earthen portion of the dams and allowing the river to course around the remaining concrete structures). The other alternatives are to (1) maintain current operations, (2) increase the transportation of juvenile salmon around the dams, or (3) make improvements to the dams' systems for collecting juvenile salmon and barging or trucking them past the dams. Because substantial changes in the dams' operations could have significant environmental consequences, the Corps must also adhere to the National Environmental Policy Act (NEPA) and prepare an environmental impact statement—or EIS—as part of the feasibility study.[1] NEPA's guidelines provide a roadmap for decision-making in cases where major federal actions may have environmental consequences, such as significant changes in dam operations. Breaching the dams is the alternative that would have the greatest impact on the region and is highly contentious. It could help salmon, but it would also eliminate a source of hydroelectric power and a waterway for barge transportation to ports 140 miles upstream.

In December 1999, the Corps released its draft EIS assessing the biological, environmental, economic, and social consequences of breaching the four dams, as well as three other alternatives. The draft EIS made no recommendations about which alternative to adopt, as directed by the Assistant Secretary of the Army, who wanted the region to consider the issues addressed in the draft EIS in light of other regional recovery efforts. The Corps is now considering thousands of public comments; the final EIS is not expected until 2001 and will include a recommendation. If breaching were recommended, the Congress would have to authorize and fund the dams' deconstruction. Concerned whether the Corps' EIS adequately considered the economic and environmental effects of breaching the dams, you asked us to determine the following:

- the extent to which the Corps followed applicable procedures and guidelines in preparing the draft EIS and
- the reasonableness of the methodology the Corps used to analyze and present the effects of breaching, specifically with respect to electricity costs, transportation costs, and air quality.

[1] Hereafter, for ease of presentation, the Corps' study and draft report, *Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement*, will be referred to as the EIS.

As agreed with your offices, we reviewed the content, analysis, and conclusions of the Corps' draft EIS for the effects on electricity, transportation, and air quality. We did not review other aspects of the draft EIS, such as the impact of breaching on salmon recovery, water quality, or recreation effects and, therefore, we cannot comment on the adequacy of the entire draft EIS or which alternative the Corps should eventually recommend. To determine the reasonableness of the Corps' analysis and presentation of the effect of breaching on electricity costs, transportation costs, and air quality, we reviewed the draft EIS and appendixes, underlying technical reports and analysis, expert reviews, and public comments. We also met with the principal analysts and other participants in the EIS process, other stakeholders, and outside experts to obtain their views.

Results in Brief

The Corps generally adhered to the procedural requirements of the National Environmental Policy Act, the Endangered Species Act, and other relevant guidelines in preparing the EIS. As required by NEPA, the Corps coordinated with other federal agencies and affected stakeholders, obtained comments from other agencies and the public, and reported on the environmental impacts of proposed alternatives. Similarly, the Corps followed the procedural requirements of ESA, which required the Corps to consult with the National Marine Fisheries Service and the Fish and Wildlife Service. The scope of the Corps' draft EIS is comprehensive, in that it considers a range of effects, including those on the environment, the economy, and wildlife. While the Corps' actions in developing the EIS appear consistent with procedural requirements, the substance of the agency's analyses and conclusions has been challenged. For example, the Environmental Protection Agency has disagreed strongly with the adequacy of the Corps' analyses for both air and water quality.

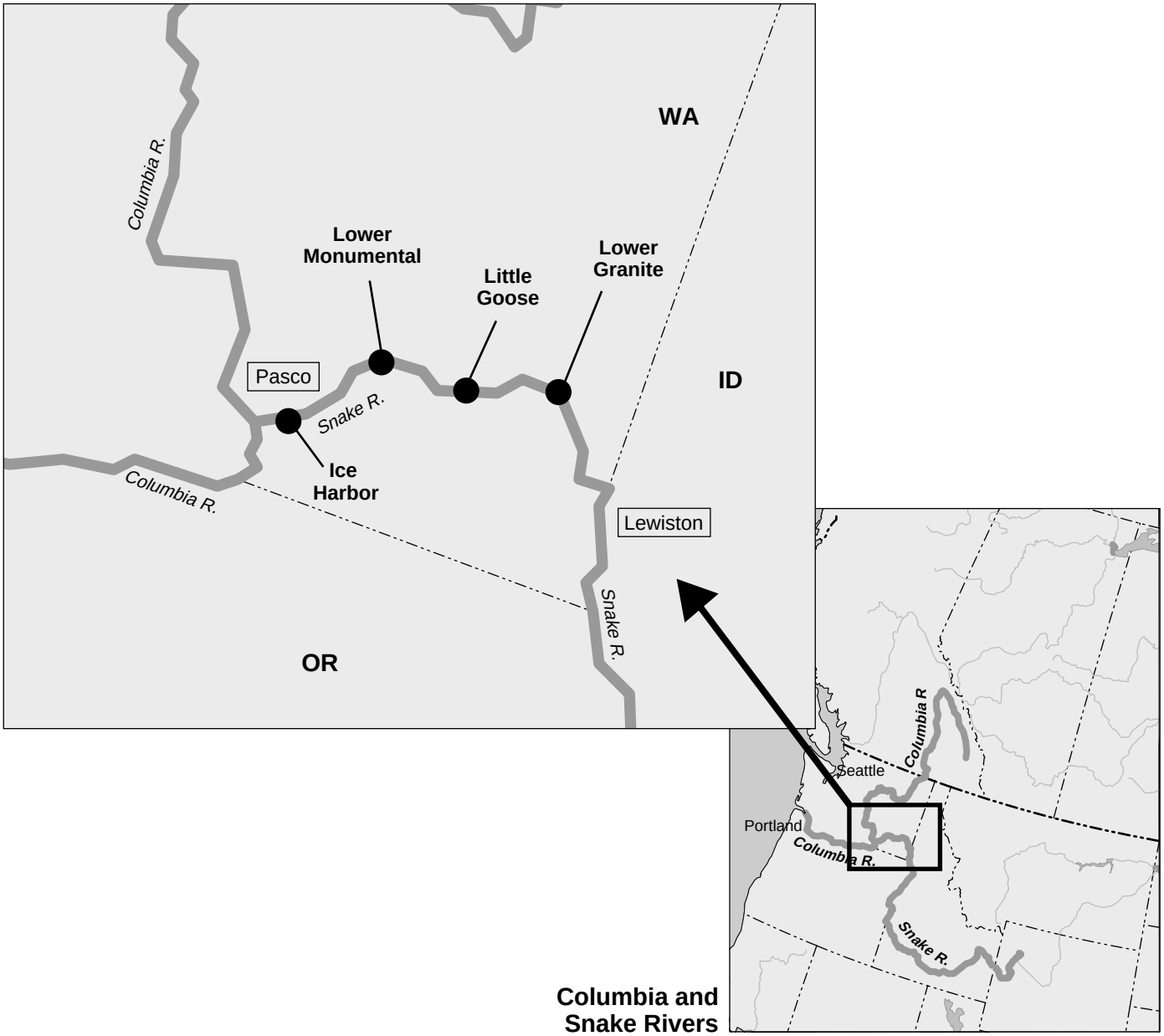
In our view, the Corps' analysis and presentation of the effects of breaching on electricity costs is reasonable; however, we could not determine the reasonableness of the Corps' estimated effects on transportation costs and air quality. The net economic effect on electricity costs, estimated to be $245 million a year, has been reviewed by various stakeholders and subject matter experts, as well as by us, and has been found to be reasonable. In the case of transportation costs, however, some concerns regarding the Corps' assumptions make the reasonableness of the transportation estimate uncertain. For example, the Corps estimated that as much as $532 million in infrastructure would be needed for road, rail, and storage facilities if barge shipments were discontinued on the Snake River. However, the Corps assumed that these infrastructure improvements

would be made without affecting the transportation cost estimate. The Corps did not sufficiently analyze the validity of this assumption or measure the sensitivity of the transportation estimate to this assumption. Likewise, the reasonableness of the Corps' analysis and presentation is questionable because of an incomplete analysis of air quality effects, including the Corps' failure to consider air quality effects from breaching on certain local populations, and of the effect of exposing potentially contaminated river sediments. Corps officials said they did not believe the level of emissions would pose a significant impact and lacked enough time or money to study the matter in more detail. The Corps is currently considering public and agency comments on the draft EIS before revising it.

Background

The entire Columbia River Basin, including the Snake River Basin, drains over 259,000 square miles of the Pacific Northwest and includes over 150 dams—31 operated by the federal government. The 1,040-mile Snake River is a major tributary of the Columbia River, the fourth longest river in North America. The Snake River runs from Yellowstone Park in Wyoming across southern Idaho to its confluence with the Columbia River in Pasco, Washington; its basin drains 109,000 square miles. The Corps of Engineers operates four dams along a 140-mile stretch of the Snake River in southeastern Washington. The four dams—Ice Harbor, Lower Monumental, Little Goose, and Lower Granite—were placed in service between 1961 and 1975 to provide hydropower, irrigation, recreation, fish and wildlife, and upriver navigation as far as Lewiston, Idaho (see fig. 1).

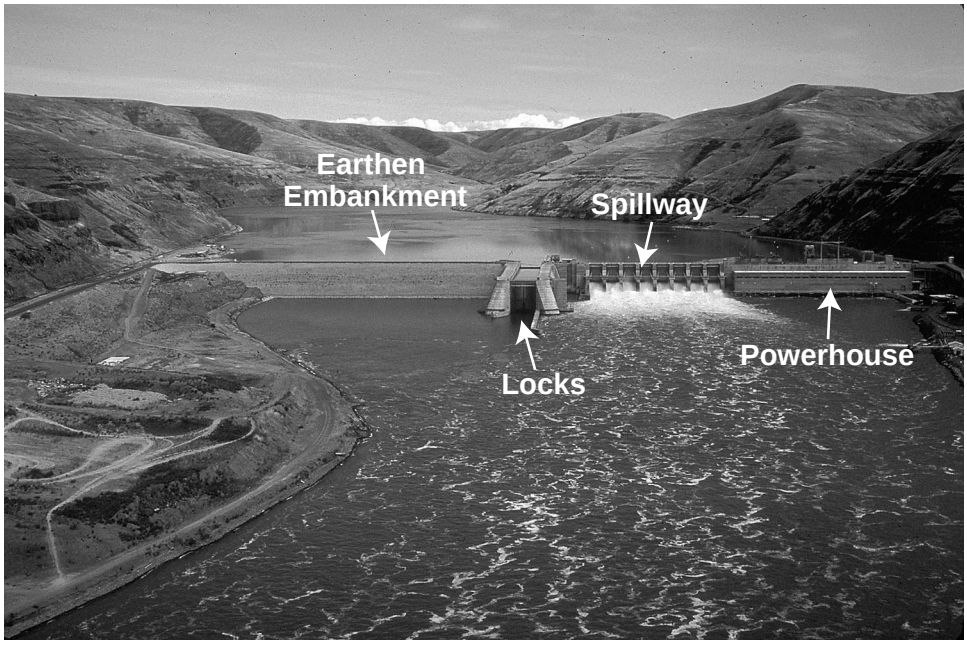
Figure 1: Map of Columbia Basin and Lower Snake River Dams



The four Lower Snake River dams are very similar. In total, they produce about 1,250 average megawatts per year, which is about 5 percent of the

total energy generated in the Pacific Northwest. The dams do not provide flood control and provide only limited irrigation. Each of the four dams is about 100 feet high and between 2,655 and 3,791 feet wide. Each consists of an earthen embankment that would be removed, and a concrete structure consisting of the locks, spillway, and powerhouse that would be mothballed, if the dam is breached (see fig. 2). The Corps has estimated the total construction cost to breach the four dams to be about $900 million. All four have fish ladders for upriver migration for salmon returning to spawn and a bypass system for the downriver migration of juvenile salmon.

Figure 2: Lower Granite Dam, Snake River



Source: Corps of Engineers.

The historic decline of salmon in the Columbia River Basin led to the listing of Snake River sockeye salmon in 1991 by the National Marine Fisheries Service (NMFS) as endangered under the ESA.[2] The following year, NMFS listed Snake River spring/summer Chinook salmon and fall Chinook salmon as threatened.[3] As a result of these listings, NMFS issued rulings (called biological opinions) in 1993 and 1994 that the federal dams in the Columbia River Basin did not jeopardize the salmon species' continued existence. The Idaho Department of Fish and Game challenged the 1993 biological opinion and, in 1994, a federal court found aspects of the opinions to be "arbitrary and capricious".[4] After restudying the matter, NMFS issued a new opinion in 1995 that the dams were likely to jeopardize salmon. As a result, the Corps began a consultation process with NMFS to identify the options, including breaching, that should be considered.

In December 1999, after 4 years and $22 million in study costs, the Corps released the draft EIS, which evaluates alternatives for improving juvenile salmon's passage through the Corps' four Lower Snake River dams. These four alternatives, winnowed from many other alternatives considered and rejected during earlier studies, range from maintaining current operations (base case) to breaching the four dams (see table 1).

[2] The ESA defines endangered as any species that is in danger of extinction throughout all or a significant portion of its range and threatened as any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

[3] In 1994, the NMFS proposed changing the Snake River Chinook salmon's status from threatened to endangered, but in 1998 that proposal was it withdrew that proposal. In 1997, Snake River Steelhead were also listed as threatened. The Steelheads lifecycle is similar to salmon's.

[4] Idaho Department of Fish and Game v. National Marine Fisheries Service, 850 F. Supp. 886 (D. Or. 1994).

Table 1: Alternatives Considered Under the Corps' Snake River EIS

Dollars in millions

Alternative	Description	Annual net economic effect[a]
1. Existing conditions	Maintain the existing hydrosystem operations.	None
2. Maximum transport of juvenile salmon	Maintain the existing hydrosystem operations with maximum transportation of juvenile salmon around the dams but without improving systems that collect the juvenile salmon for barging or trucking them past the dams.	$14.1
3. Major system improvements	Improve the existing systems for collecting juvenile salmon for transportation by barge or truck downstream past the dams.	$4.8
4. Dam breaching	Remove the dams' earthen embankments to draw down the four Lower Snake River reservoirs to create a free-flowing 140-mile stretch of river.	($246.5)

[a]These values represent net changes in the value of the national output of goods and services as compared to the base case alternative 1 and are presented in 1998 dollars as average annual amounts over the period 2005 to 2104 discounted at 6.875 percent.

The Corps' final recommendation for the Snake River EIS will be part of a comprehensive response to reverse the decline of salmon throughout the Columbia River Basin. NMFS has also listed eight other salmon and steelhead stocks in the Columbia River Basin, fish that do not have to pass through the Snake River dams. Therefore, the Corps and other agencies with an interest in salmon recovery are seeking to develop a coordinated and comprehensive response for the entire Columbia River Basin. NMFS is expected to release its 2000 biological opinion for the operation of all federal dams in the Columbia River Basin later this year. The Corps' eventual decision regarding the Snake River EIS has also become the focus of media attention, and organized campaigns both for and against dam breaching have generated considerable interest in the issue.

Development of Corps' Draft EIS Followed Procedural Requirements and Guidelines

The Corps of Engineers generally followed procedural requirements and guidelines in developing its draft EIS. Procedural requirements for the development of an EIS are contained in NEPA and accompanying regulations. NEPA provides a framework for decision-making in cases where major federal actions may have environmental consequences. In addition, in accordance with the ESA, the Corps consulted with NMFS and

the Fish and Wildlife Service in developing biological information on the impact of the dams on salmon survival. While the Corps adhered to these broad requirements and guidelines in preparing its draft EIS, the substance of its analyses and conclusions, specifically regarding water and local air quality, has been challenged by the Environmental Protection Agency (EPA) and others.

Corps' Procedures in Line With NEPA's Broad Guidance

Under NEPA regulations, federal agencies are required to compile and develop accurate scientific information on a range of alternatives, obtain expert advice from other agencies, and allow public comment on the alternatives before making decisions with environmental consequences. NEPA lays out a general process for achieving these goals but leaves agencies with considerable latitude in deciding exactly how to develop an EIS.

While NEPA does not dictate the scope of an EIS, the scope of the Corps' draft EIS is substantial. The geographic scope of the draft EIS generally focuses on the 140-mile long stretch of the Lower Snake River between Lewiston, Idaho, and the Tri-Cities area (Pasco, Richland, and Kennewick) in southeastern Washington. Within this area, the draft EIS examines the impact of each of the four alternatives across a comprehensive range of possible effects, including

- migratory and resident fish (biological analysis of salmon and steelhead);
- electric power generation and facilities;
- transportation via navigation, railroads, and highways ;
- air quality;
- water quality and hydrology;
- geology and soils;
- vegetation, wildlife, and protected species;
- cultural resources;
- Native American Indian harvest and land use;
- water uses by agriculture, municipalities, and industry ;
- land ownership and uses;
- recreation and tourism;
- regional demographics, employment, communities, and low-income and minority populations;
- aesthetics, such as landscape characteristics; and
- cumulative effects.

The Corps' procedures for preparing the draft EIS were consistent with NEPA and the agency's implementing guidance. In accordance with NEPA's requirements, the Corps has involved other federal agencies, affected stakeholders, and the general public. The following represents examples of actions taken:

- **Involvement of other federal agencies**. The Corps, as lead agency, formally involved the Bonneville Power Authority (BPA), EPA, and the Bureau of Reclamation as "cooperating agencies," because they have legal jurisdiction over some aspect of the draft EIS. These agencies helped the Corps scope and develop the draft EIS. Other federal agencies—notably NMFS, which prepared the biological analysis of salmon impacts, and the U.S. Fish and Wildlife Service, which assessed the impact on other species—also contributed to sections of the EIS or commented on them.
- **Consultation with affected Indian tribes**. The Corps identified 14 tribes potentially affected by its proposed actions and discussed the EIS process with them. The Corps also contracted with a tribal representative to assess tribal rights and circumstances for inclusion in the draft EIS.
- **Involvement by other stakeholders and the public**. The Corps held numerous workshops and community forums, developed technical workgroups, and held a series of 15 public hearings throughout the Pacific Northwest region. The Corps' workgroups involved outside stakeholders possessing diverse views on the alternatives under consideration. The Corps also made the draft EIS and underlying information available to the public through the Internet. The Corps has received more than 200,000 public and agency comments on the draft EIS, which were the result of the public hearings and organized campaigns both for and against dam breaching.
- **Outside technical review**. The Corps invited outside technical review of the biological, engineering, and economic analyses. The biological analyses were reviewed by the Independent Scientific Advisory Board, a body of scientists under the auspices of the Northwest Power Planning Council (Council). Outside engineers reviewed technical aspects of the Corps' engineering study and found the Corps' analysis, including assumptions, methods, and procedures, to be appropriate. In addition, the draft EIS' economic analysis was reviewed by the Independent Economic Analysis Board, a group of independent regional economists also under the auspices of the Council.

The absence of a recommended alternative in the draft EIS has been a concern expressed in several comments. NEPA does not require agencies to specify a preferred alternative in a draft EIS.[5] According to the Deputy Commander of the Corps' Northwestern Division, the Corps' Walla Walla District Office, which is managing the EIS, initially intended to recommend alternative 3 (major system improvements). When the Northwestern Division forwarded the draft EIS for headquarters' review, however, the Assistant Secretary of the Army for Civil Works ordered the removal of a preferred alternative. The Assistant Secretary's letter to the Corps explained that it was important for all affected parties to consider the issues and information in the draft EIS within the broader context of information being developed for other regional recovery efforts. Among these other recovery efforts is NMFS' preparation of a new biological opinion for the Federal Columbia River Power System, to be issued later this year. It is not unusual that a draft EIS would be issued without a preferred alternative. For example, the draft EIS prepared by the Corps, BPA, and Bureau of Reclamation concerning the operation of the federal power system in the Columbia River Basin was issued in 1995 without a preferred alternative, in part, because the agencies were waiting for NMFS' 1995 Biological Opinion.[6]

[5] Army regulations in effect since 1980 permit a draft EIS to be issued with no preferred alternative specified. 32 C.F.R. Parts 650, 651 Appendix D, paragraph 5.

[6] Columbia River System Operation Review, Final Environmental Impact Statement, U.S. Army Corps of Engineers, Nov. 1995.

Draft EIS Satisfies the Procedural Requirements of the ESA and Other Relevant Guidelines

The Corps' preparation of the draft EIS also complied with the procedures outlined in the ESA and with other relevant guidance for considering the economic effects of the proposed alternatives. The ESA requires federal agencies whose activities are likely to jeopardize the continued existence of listed marine species to consult with NMFS to avert the species' extinction. Agencies do this by preparing a biological assessment of their activities' impact on the listed species. NMFS then responds with a biological opinion that identifies reasonable and prudent alternatives the agency needs to follow to avoid jeopardizing the listed species or to minimize the impact of its actions on the species. In general, if an agency chooses not to implement a reasonable and prudent alternative, it must seek an exemption from the requirement to avoid jeopardy.[7]

For Lower Snake River salmon, NMFS' 1995 Biological Opinion, which found jeopardy from dam operations, reopened the consultation process between NMFS and the Corps. The Corps and the NMFS coordinated the preparation of the draft EIS, and NMFS drafted the EIS' biological study of the four alternatives' effect on marine species. The Corps, in tandem with BPA and the Bureau of Reclamation, also submitted in December 1999 a multispecies biological assessment of the Federal Columbia River Power System, including an assessment of the Lower Snake River dams' effect on salmon.

[7] Corps legal officials expressed the concern that if the biological opinion recommends dam breaching as the reasonable and prudent alternative to conserve listed Snake River salmon, the Corps would not be able to implement that recommendation consistent with its current statutory authority. Because removing an existing dam would require statutory authorization and funding, legislative action would be required before that recommended alternative could be carried out. It is not clear whether an exemption would be required in such a case.

To assess the economic effects of the alternatives, the Corps followed the Water Resources Council's *Economic and Environmental Principles for Water and Related Land Resources Implementation Studies* (1983), which specifies guidelines for evaluating national and regional economic effects. The *Principles* provides a standardized approach for assessing and presenting the costs and benefits of water projects. The Corps generally adhered to the requirements of the *Principles*—for example, presenting economic effects in terms of changes in the national output of goods and services, discounted and on an annual basis. The draft EIS also presents regional economic effects on income, employment, and population, as recommended by the *Principles*.[8]

Compliance With Procedural Requirements Has Not Eliminated Controversy About the Draft EIS' Analysis or Conclusions

Although the draft EIS followed broad procedural requirements, it has been challenged by other agencies and affected parties that disagree with the analysis or conclusions. EPA is the most noteworthy of these critics because of its responsibilities under NEPA and the Clean Air Act.[9] In comments provided to the Corps in April 2000, EPA rated the draft EIS as inadequate because the draft EIS did not adequately assess potentially significant impacts on water and air quality. EPA faulted the Corps' analysis of the dams' effect on water temperature and the amount of dissolved gas the dams produce.[10] EPA also faulted the draft EIS' failure to provide a strategy for complying with water quality standards or to estimate the costs to meet water quality standards under alternatives 1 through 3. In addition, EPA does not consider the draft EIS' assessment of the air quality effects of breaching to be adequate. EPA and the Corps have discussed their differences in hopes of resolving them, but if the discussions are not successful, the EIS will be referred to the President's Council on Environmental Quality for final resolution.

[8] Breaching may also have regional effects on income, employment, and population. The Corps' study includes regional economic impact analysis. The Corps' regional impact analysis uses the estimated national economic effects to determine regional effects on spending, income, and employment. We did not assess these regional impacts in our review.

[9] Section 309 of the Clean Air Act directs the EPA to review and comment in writing on the environmental impacts associated with major federal actions. EPA has the authority to refer an EIS to the Council on Environmental Quality for further review. 40 C.F.R. 1504.1 (1999).

[10] The issue of the Corps' compliance with water quality standards for temperature and dissolved gas is currently in litigation. *National Wildlife Federation v. U.S. Army Corps of Engineers*, No. 99-442 FR (D. Or., Mar. 21, 2000) (cross motions for summary judgement denied).

Corps' Analyses of Electricity, Transportation and Air Quality Vary in Quality

The Corps' analysis and presentation of the effects of breaching on electricity costs is reasonable; but its transportation cost estimate and its air quality analysis are insufficiently developed to determine whether they are reasonable. Breaching the dams would mean losing hydroelectric power generated by these dams as well as shipping on the Lower Snake River. The Corps adhered to guidelines and accepted practices in developing the electricity cost estimates, and independent reviewers and outside stakeholders are generally satisfied with the approaches used. While we identified some concerns with the electricity cost estimates, they would not have a material effect on the Corps' estimates. The Corps' transportation analysis also followed appropriate guidelines but did not fully consider the effect of some of its assumptions and has not corrected some known errors. Finally, breaching would also affect air quality by increasing dust in the air and adding airborne pollutants from substitute sources of power and transportation. The Corps' analysis estimated the total increase in emissions from these sources, but not how they might affect local populations.

Estimated Effects on Electricity Costs Are Reasonable

The Corps' estimates of the costs associated with losing hydropower from the four dams are reasonable and are supported by multiple analyses and outside reviewers. The Corps generally adhered to accepted guidelines, economic principles, industry practices, data sources, and modeling techniques. The process was also open to public participation, and stakeholders representing widely divergent views on the future of the dams generally were satisfied with both the process and quality of the estimates.

The four dams on the Lower Snake River all generate hydroelectric power and currently account for about 5 percent of the total annual power production in the Pacific Northwest.[11] Collectively, their average annual production is enough to power a city of 700,000. The electricity they produce is marketed by BPA, mainly on a wholesale basis to public and investor-owned utilities. These utilities, in turn, resell the electricity to retail customers primarily in western North America.

[11] The four dams collectively account for about 7 percent of the Pacific Northwest's "installed production capacity"—the maximum sustained amount of power that can be produced by a plant measured at a moment in time. However, they account for a somewhat smaller portion of average production.

Breaching Would Increase Electricity Costs by an Estimated $245 Million Annually

Breaching the four dams on the Lower Snake River would raise the net cost of electric power supplies in the western United States by $245 million annually (see table 2). According to the draft EIS, this could increase the average electricity bill for households in the Pacific Northwest by $1.20 to $6.50 per month, while large users, such as aluminum companies, could see monthly increases approaching $1 million. These rate increases assume that BPA is able to recover increased power system costs from its customers. However, the draft EIS also notes that if the electric industry becomes more competitive, BPA may not be able to raise rates to recover higher costs. The largest effect of breaching would be replacing the lost hydropower production, primarily with new gas-fired power plants. The draft EIS reported that breaching the four dams would raise the cost of meeting demand for electricity in the western United States by $217 million to $260 million annually, depending on future conditions and the method of estimation, with $238 million per year as a midpoint estimate.[12] Breaching the dams will also require modifying the electric power transmission system that moves bulk power throughout western North America, adding an average of $25 million per year to the electricity costs. The replacement power sources would also have less operating flexibility, which also has an associated cost. Changing the amount of electricity produced at hydroelectric plants is relatively easy and inexpensive, making them highly valued for their ability to provide “peaking” and “ancillary”services.[13] The draft EIS estimates an $8 million loss in value of ancillary services as a result of breaching the dams. However, these cost increases would be partially offset by reductions in operating and capital expenses if the dams were no longer operating. These “avoided costs” are estimated at $26 million per year. Therefore, the net increase in costs after including these avoided costs is about $245 million annually.

[12] The power impact estimates assume that current dam operations (base case) result in electric power output from the four Lower Snake River dams averaging about 1,250 megawatts per year. However, this assumption does not take into consideration additional constraints on hydropower operations of the dams resulting from NMFS’ 1998 Biological Opinion. According to the Northwest Power Planning Council’s analysis, these additional constraints are likely to reduce power output by about 5 percent. Such a change in power production from the four dams is not likely to have a significant effect on the power cost estimates. In addition, NMFS officials told us that the new biological opinion will further constrain hydropower operations and reduce the power cost estimate.

[13] Peaking refers to the ability to provide power at times of relatively high levels of demand. Ancillary services are defined as those services that are necessary to support the transmission of power from power plants to customers while maintaining the reliable operation of the transmission system in accordance with good utility practice.

Table 2: Annual Electricity System Costs of Breaching the Four Lower Snake River Dams

Dollars in millions

Cost category	Annual costs
Replacement power	$238
Transmission costs	25
Ancillary value losses	8
Total power system costs	**$271**
Avoided operating and capital costs[a]	(26)
Net power costs	**$245**

[a]Total avoided costs are allocated 90 percent to hydropower and 10 percent to transportation, in keeping with the purposes specified in the dams' original authorizing statutes.

Estimates Are Supported by Multiple Analyses

The power system cost estimates are supported by multiple analyses that yielded similar results. Three different organizations—the Corps, BPA, and the Council—conducted parts of the analysis, using different approaches to estimate the impact of breaching the four dams on the cost of electric power supplies (see app. I).[14] The organizations recognized that the estimates are highly dependent on future conditions, such as changes in water flows, growth in the demand for electricity, fuel prices, and changes in the efficiency and costs of power plants. The analyses considered such effects and reported a range of cost estimates. The major difference in the approaches are that the Corps and BPA used an approach based on estimating the costs of meeting electric power demand, while the Council used an approach based on estimating the forecast market prices for electricity. However, both the cost approach employed by the Corps and BPA, and the market value approach employed by the Council are consistent with the Water Resources Council's *Principles*.

Stakeholders and Reviewers Were Generally Satisfied With the Electricity Cost Estimates

The Corps' electricity cost estimate resulted from an open process with active participation by stakeholders representing a spectrum of views on the question of the dams. The results of the analysis generally met with the approval of these stakeholders. The planning and design of the electricity

[14]The Corps' and the Council's analyses spanned the interconnected western power system, which comprises all or part of 14 western states, two Canadian provinces, and northern Mexico, while BPA's analysis was limited to the Pacific Northwest and California. All three made forecasts for 100 years, starting with 2005, and used similar assumptions regarding the future growth in demand for electricity.

cost estimate was part of an open process, with the active participation of widely divergent groups, such as environmentalists, Native Americans, and other advocates of free-flowing rivers, as well as industrial users that are heavily dependent on inexpensive hydropower from dams. Each of these groups participated on the team that developed and reviewed the initial estimates. Representatives of these groups with whom we spoke were generally satisfied with both the process followed and the quality of the cost estimates. The Council's Independent Economic Analysis Board also reviewed the Corps' methodology and analysis. The Board found that the Corps used sophisticated models and accepted methods and that the results can be relied on as a reasonable representation of the economic effects.

Identified Concerns Are Not Material to the Results

There are two concerns with the cost estimation and presentation of the effect of breaching on power costs, but these are not material to the Corps' estimate. The primary shortcoming with the power estimate is that it assumes that the demand for power will not be affected by higher rates charged for electricity.[15] An earlier study developed by the Corps, BPA, and the Bureau of Reclamation reported that a rate increase necessary to cover increased costs for replacement power would reduce the demand for electricity. The resulting drop in demand could reduce the electricity cost estimates associated with breaching by less than 10 percent because less replacement power would be needed. However, Corps, BPA, and Council officials told us that they did not model the relationship between electricity rates and the demand for electricity because it would have required considerable cost and effort without having a significant effect on the results.

The second concern is presentational. The draft EIS does not clearly show the net estimate of the $245 million discussed above. Avoided costs were excluded from the draft EIS' estimate of the increased power system costs that would result from breaching the dams. Avoided costs are the operation and maintenance costs, including the cost to collect and transport juvenile salmon past the dams, and future capital costs associated with the dams and their powerhouses. These costs would be saved if the dams are no longer operational. While the draft EIS' annual estimate of $29 million for

[15] The Corps' draft EIS assumes zero price elasticity of demand. Price elasticity of demand is the relative change in quantity demanded divided by the relative change in price. In this case, zero price elasticity of demand means that a rate increase will not change the quantity demand.

total avoided costs appears reasonable, this estimate is presented in a separate section of the EIS and is not reported in relation to the electricity analysis. According to the Corps' estimate, about 90 percent of the avoided costs at these four dams are attributable to electricity generation. Therefore, if the dams are breached, about $26 million of avoided costs would be saved.[16] By not linking these savings to electricity costs, the draft EIS conveys a greater effect on electricity costs than may actually occur. Corps officials said that the overall net cost for all economic effects is more important than understanding the net power system costs and that is why they presented avoided costs as a single amount.

Transportation Cost Estimate Needs Further Development

The draft EIS' overall approach to computing the costs of breaching the dams on the current river transportation system is generally reasonable. However, the Corps' analysis and presentation did not fully consider the effect of changes in some key but uncertain assumptions. Furthermore, the Corps did not correct for certain errors in its data. We could not determine whether further investigation of the validity of its assumptions and correcting the known errors would materially affect the Corps' final estimate.

Each of the four dams has a lock system, creating a river navigable to barge traffic for 140 miles from near Pasco, Washington, to Lewiston, Idaho.[17] Barge traffic originating on the Snake River largely carries agricultural goods to ports in and around Portland, Oregon, for export overseas (see fig. 3). Generally, barging is the least costly mode of transportation for bulk commodities. From 1987 to 1996, barges transported an average of about 4 million tons annually on the Snake River. About 77 percent of this total was grain; 18 percent, wood chips and logs; and 5 percent, petroleum and other products. About 96 percent of all shipments are moving downriver, with most barges returning empty. If the dams are breached, barge shipments on the Snake River will end because the river will be too shallow. Commodities will then have to be shipped via rail or trucked to ports on the Columbia River.

[16] This $26 million is shown in our earlier presentation of the power system's annual costs and is the amount that reduces the costs from $271 million per year, as shown in the Corps' draft EIS, to the net amount of $245 million per year (see table 4).

[17] From Lewiston downstream to the Pacific Ocean, the waterway is 465 miles.

Figure 3: Lower Snake River Barge

Source: Corps of Engineers.

Annual Net Cost Is Estimated to Be About $21 Million

As computed in the draft EIS, the estimated net increase in shipping costs for all commodities if the dams are breached is $21 million per year over 100 years, less than 10 percent of the net economic effect of breaching estimated by the Corps. Shipping costs of $24 million would be offset by reductions of about $3 million per year, which represents the portion of avoided costs of operating and maintaining the dams allocated to transportation. Of the total increase in shipping costs, about $20 million per year is associated with grain shipments and $4 million per year with nongrain commodities. According to the draft EIS, this equates to an average cost increase by 2007 of about $0.17 per bushel of grain shipped and about $3.78 per ton for other commodities—an increase of 18 and 5 percent, respectively.

Corps' Transportation Analysis Is Generally Valid, but Some Assumptions Are Questionable

To estimate the additional costs of shipping if the dams are breached, the Corps modeled the cost to ship grain both under current conditions and without barge shipments on the Lower Snake River. This required the Corps to estimate the future growth in grain and other shipments, model transportation patterns with or without the dams, and estimate shipping costs under the current approach and under the least-cost alternative if

barging is no longer available. (See app. I for more details on the Corps modeling approach.) Except for its treatment of uncertainty, the Corps' approach generally conforms to the Water Resources Council's *Principles* for estimating economic effects.

Several reviewers and stakeholders question the Corps' assumption that making the infrastructure improvements necessary to replace barge transportation would not add to the transportation cost estimate. The draft EIS estimates that the infrastructure improvements—including such things as new grain elevators farther downstream on the Columbia River, highway improvements, new rail cars, and track improvements—needed to replace barge transportation will cost between $207 million and $532 million. However, the draft EIS assumes that these infrastructure improvements can be absorbed by the transportation sector without affecting their long-run costs. Several stakeholders contend, however, that making these improvements will increase transportation costs, perhaps significantly. In addition, in reviewing the draft EIS, the Washington State Department of Transportation commented that the infrastructure estimates used by the Corps are incomplete because all necessary highway improvements have not been identified. The Independent Economic Analysis Board, a group of independent regional economists that reviewed the Corps' economic analysis, generally supported the Corps' overall methodology but commented that the analysis had not been adequately tested for the impact of increased infrastructure costs. The Board stated that making infrastructure investments could increase the cost of breaching but also suggested that some offsetting cost savings may result from better railroad utilization and technological improvements. The Board concluded that, because of this uncertainty, the Corps should analyze the data to see how sensitive the model results are to the changes in the cost of infrastructure improvements.

Another uncertainty arises from the Corps' assumption that estimated shipping costs provide a better estimate of actual costs than do published shipping rates. The Water Resources Council's *Principles* recommends using published rates to estimate transportation costs unless these rates are not competitively established. Corps officials stated that published rates were not used because barge operators have limited competition and can charge higher than competitive rates. Barge representatives told us that their rates are competitive and have been used in other studies of Columbia and Snake River shipping. The Corps did not test the sensitivity of its transportation cost estimate to using published rates instead of estimated costs.

Other Concerns About the Corps' Estimates

In addition to the uncertainty created by certain assumptions, other concerns affect the Corps' analysis and presentation of transportation costs. The effect of these concerns on the Corps' transportation estimate is not fully known. Table 3 lists three other concerns with the current estimate and the potential impact of those concerns.

Table 3: Examples of Concerns Identified in the Corps' Transportation Analysis

Area of concern	Description	Expected effect on estimate
Shipping forecasts	Projected shipping volume may be overstated. The Corps developed its estimate of shipping volume for grain and other commodities on the basis of the historical average for 1987 to 1996. The Corps is projecting continued shipping growth up through 2017—an overall increase of 26 percent from the historic average. However, the draft EIS acknowledges that 1997 shipping volumes, the most recent year analyzed, are 20 percent less than in 1996.	If projected quantities to be shipped are overstated, then the effect of breaching on shipping costs is overestimated.
Model bias	The Corps adjusted its model results to eliminate instances where the model estimates that shipping without barges is less costly than shipping with barges. The Independent Economic Analysis Board stated that the Corps should not have made these adjustments.	The Corps reports that these model adjustments add $800,000 annually to the transportation cost estimate as a result of breaching.
Uncorrected errors	The Corps' model contains some errors in the costs of handling and shipping grain for some locations. The results have not been recalculated with the errors corrected.	Because these errors are fairly consistent between current conditions and breaching, the difference between the two scenarios is not likely to change significantly if the model results are recalculated. However, they substantially increase the total shipping revenues.

In addition to the concerns discussed above, the Corps' draft EIS does not present a net transportation estimate. Instead, as with the hydropower estimate, the $3 million estimate of savings in the current cost of operation and maintenance of the locks is presented in a separate section of the draft EIS.

Estimated Effects on Air Quality Are Indeterminate

The Corps' air quality analysis is indeterminate because it did not assess how local air quality or human health would be affected if the dams are breached and did not consider the effects of all relevant pollutants. EPA considers the draft EIS to be inadequate, in part, because of its incomplete air quality analysis. EPA is charged under NEPA and the Clean Air Act with reviewing and commenting on all environmental impacts of federal activities. EPA also regulates air quality standards established under the

Clean Air Act.[18] If EPA's concerns are not satisfactorily addressed, it can refer the EIS to the Council on Environmental Quality for further review. The draft EIS' air quality analysis estimated the gross increase in air emissions resulting from replacement power generation, increased truck and rail transportation, and airborne dust for the entire region. The Corps concluded that the combination of these air quality components would not have a significant regional effect. However, the Corps did not examine certain pollutants, such as chemicals in the reservoir sediments. The Corps also assumed the emissions that were studied would be equally distributed across the region, instead of being concentrated in specific locations, possibly impairing local air quality and human health. To identify these more localized effects, EPA has requested that the Corps complete a more thorough analysis.

Corps Estimated Increase in Emissions of Selected Pollutants

The Corps' draft EIS reported that breaching the dams would have some effects on air quality during the breaching process, as well as from changes in the river level and transportation and power generation practices after the dams are breached. For example, as shown in table 4, the draft EIS reports that replacement power generation would increase emissions of carbon monoxide and carbon dioxide, while deconstruction and the exposed river sediment would contribute to an increase in particulate matter.

Table 4: Additional Emissions From Dam Breaching

Tons per year

Source	Carbon monoxide	Carbon dioxide	Nitrogen dioxide	Particulate matter[a]	Sulfur dioxide	Volatile organic compounds[b]
Demolition				304		
Transportation	(15)		(20)	9	(71)	90
Windblown dust				6,292		
Power generation	4,134	4,186,804	174	196	1,813	2
Total change	**4,119**	**4,186,804**	**154**	**6,801**	**1,742**	**92**

[a]Particulate matter refers to solid and liquid particles in the air. Sources include burning and airborne dust. Particulate matter is very small and, if breathed into the lungs, causes health problems.

[18] EPA has established fixed standards for particulate matter, ozone, nitrogen dioxide, sulfur dioxide, carbon monoxide, and lead. In addition, another 188 hazardous air pollutants known or suspected to cause cancer or other serious health effects are controlled.

[b]Volatile organic compounds are chemicals containing hydrogen and carbon that are produced by burning fossil fuels. In the presence of sunlight, volatile organic compounds react to form ground-level ozone, a component of smog.

Source: Corps of Engineers Environmental Impact Statement, Table 5.2-6.

The Corps' air quality assessment estimated emissions from four potential sources. First, the Corps used emission equations from EPA to estimate the amount of dust produced by deconstruction. Second, the Corps computed average emissions for the trucks and trains that would replace barge transportation. Third, the Corps estimated windblown dust from the exposed sediments using wind data and an EPA methodology for predicting the amount of particulate matter resulting from wind erosion. And, fourth, the Corps estimated the emissions from replacement electricity, primarily from new gas-fired power plants. Emissions from each of these sources were then totaled across the region (see app. I).

Air Quality Assessment Is Incomplete

The Corps' air quality assessment was incomplete because it did not consider the impact of breaching on local air quality and human health, and because it omitted from study certain pollutants, such as chemical contaminants in reservoir sediments, that would be exposed as a result of breaching. In some cases, the Corps compared the changes in emissions across a wide geographic area but did not consider concentrated local impacts. For example, the draft EIS estimated that the loss of barge transportation would lead to a decrease in total emissions from carbon monoxide, nitrogen dioxide, and sulfur dioxide. However, this summary view masks increased emissions from grain-hauling trucks likely to occur in certain areas of eastern Washington State. According to the draft EIS, the elimination of barging is expected to result in an additional 223 trucks per day and their accompanying emissions in the Tri-Cities area.

The Corps' air quality analysis did not adequately identify the following effects on local communities from each of the pollution source areas if the dams are breached and did not study certain pollutants that would be released:

- **Deconstruction**. Airborne emissions from deconstruction were not calculated for specific locations that are near the dams and thus most likely to be affected. In addition, the Corps did not consider vehicle engine, tire, and brake emissions from construction equipment. EPA stated that modeling or some alternative techniques are needed to determine the effects of these emissions.
- **Loss of barge transportation**. Emissions from increased use of trucks and trains instead of barges were not adequately assessed for specific

localities. Such an analysis should also look at the potential effect on human health. EPA has also commented that vehicle emission modeling is needed to adequately assess the effect of changes in vehicle movements on specific locations. In addition, EPA and BPA commented that the draft EIS should present a range of potential emissions rather than merely averaging the results of two different studies.

- **Exposed sediments**. Estimates of windblown dust emissions from exposed reservoir sediments did not include estimates of chemical contaminants that have accumulated in sediments and that could become airborne when the sediments are exposed. The Corps' draft EIS reported that reservoir sediments contain heavy metals and DDT, but dispersion modeling would be necessary to determine whether they pose a threat to human health.[19] For example, the effect of these windblown particles on downwind communities, such as Clarkston, Washington, or Lewiston, Idaho, is not known. Both EPA and BPA have recommended that the Corps analyze the potential effect of these airborne sediments.

[19] According to the Corps' 1995 Columbia River System Operation Review EIS, chemical concentrations were found in Lower Snake River reservoir sediments that, if they became airborne, could exceed state standards.

- **Replacement power production**. Estimates of increased air emissions from replacement power did not consider the effect on nearby communities. This type of analysis is typically done by modeling the dispersion of emissions around a power plant. EPA stated that this modeling should have been done to assess compliance with state and local air standards and plans. Corps officials told us that they did not do additional analysis because they were unsure where, and if, additional plants would be constructed. However, the draft EIS lists the most likely number and location of plants to meet power demand and transmission reliability needs, as well as the locations of power plants with submitted or approved permit applications. The Corps could have used this information to estimate the effect on local communities. EPA also commented that the effect of replacement power emissions on global warming was not adequately addressed. In addition, the draft EIS did not examine the potential for alternative energy sources—such as wind and solar—and conservation as a means to avoid increased emissions from replacement power. Conservation groups have concluded that it is possible to replace lost hydropower with conservation and alternative energy, under certain scenarios, without higher power costs.[20]

The Corps Limited Its Air Quality Analysis

Difficulties with the Corps' air quality analysis can be attributed, in part, to getting a late start on the analysis. Initially, the Corps did not include an air quality assessment within the scope of the EIS. Corps officials stated that they did not believe it was a significant issue for this EIS and planned to incorporate an earlier air quality assessment from a 1995 system operating review.[21] This 1995 study identified the potential toxicity of river sediment but did not report significant increases in air pollutants from replacement power emissions if the dams are breached. However, in April 1998, following discussions with BPA and others, the Corps, using input from EPA as a cooperating agency, initiated a new air quality segment as part of the Corps' scope of work.

[20] An April 2000 study by the Northwest Energy Coalition, *Going With the Flow: Replacing Energy From the Four Snake River Dams*, concluded that power lost from breaching the dams could be replaced through conservation and nonpolluting power generation, such as solar and wind power. The study recognizes that this strategy would require government intervention and higher nonpower costs. BPA is working to estimate the cost of such a strategy, but this estimate will not be available until later this year.

[21] The Corps' 1995 System Operating Review EIS assessed the various impacts, including air quality, from various changes in the way federal dams are operated in the Columbia River Basin.

The Corps did not complete significant portions of its original air quality scope of work, which included an assessment of the direct and cumulative effects on air quality of the four alternatives studied. The Corps' original scope of work also detailed plans to evaluate how each of the four alternatives would affect state plans for limiting air pollutants. In 1998, the Corps contracted for a work plan for the air quality assessment based on the scope of work prepared by EPA. Corps officials advised us that, during negotiations with the contractor on the proposed work plan, it became apparent that the existing budget and study time frames would not allow the original scope of work to be carried out. Several of the tasks included in the scope of work could not be done for the cost or time allotted. In order to meet budget and time constraints, the Corps reduced the work plan. Modeling the effect of replacement power on air quality, including health effects, was deleted, as was modeling of dust emissions from the exposed riverbed. While the work plan did include modeling of the increase in vehicle emissions from the loss of barge transportation, the contractor never completed any vehicle emission modeling. The contractor stated that the amount of money provided by the Corps was not sufficient to support any type of modeling of the effects on air quality. The Corps is considering EPA and others' comments and has not determined whether additional analysis is needed.

Agency Comments

We provided the U.S. Army Corps of Engineers with a draft of this report for review and comment. While the Corps did not indicate whether it agreed or disagreed with the overall message of our report, it did comment that the scope of our review was limited and that we should have assessed the importance of our concerns in relation to the Corps' decision process and the "value-added" of having the Corps correct its analysis. However, precisely because the scope of our review was limited, we could not estimate the value of resolving problems with the Corps' estimates. For this reason, our report does not make any recommendations regarding whether the Corps should address the concerns discussed in this report. Instead, the Corps must determine whether improving the reasonableness of its estimates in these and other areas warrants the additional time and expense required. In addition to this general comment, the Corps provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to appropriate House and Senate Committees and Subcommittees; the Honorable William S. Cohen, Secretary of Defense; Lt. Gen. Joe N. Ballard, Chief of Engineers and

Commander, U.S. Army Corps of Engineers; and other interested parties. We will also make copies available to others upon request.

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

Jim Wells
Director, Energy, Resources,
and Science Issues

Description of the Corps' Analysis for Electricity Costs, Transportation Costs, and Air Quality

The U.S. Army Corps of Engineers used different methodologies and analyses for each of the three impact areas—electricity, transportation, and air quality—that we assessed. The following are short descriptions of these different approaches and the participants who contributed to them.

Corps of Engineers' Electricity Analysis

The Corps' estimate of the net economic development costs from the loss of hydropower produced by the four Lower Snake River dams includes three components—replacement power, improvements to transmission systems, and ancillary services.

- **Estimation of replacement power costs**. The Corps, Bonneville Power Administration (BPA), and the Northwest Power Planning Council (Council) each used its own procedures to estimate the cost of meeting electric power demand with and without the four dams. BPA and the Corps each used its own hydrology and hydropower models, which simulate on a month-by-month basis the entire Columbia River Basin with respect to river flows, dam operations, and hydroelectric production. The models use mathematical programming techniques that take into account not only the hydrologic conditions of the basin, but also the various goals of flood control, navigation, hydropower production, fish protection, and recreation. The two models are conceptually very similar. Next, the Corps and BPA used power supply models to translate the difference in hydropower production with and without the four dams into power system costs. The resulting cost and market valuation estimates were similar: The Corp's estimate was $252 million per year, while BPA's medium-case scenario was $255 million per year. The Council's analysis was based on the Corps' and BPA's estimates of how much hydropower would be lost by breaching the four dams. However, instead of calculating the cost of replacing the power, Council's analysis placed an economic value on the estimated hydropower losses, using forecast wholesale market prices for power. Using this analysis, the Council estimated the value of the lost hydropower from the four dams at about $225 million annually.[1]
- **Estimation of transmission system costs**. To determine the potential effects of breaching on the reliability of the electric power transmission

[1] The forecast market prices were obtained from a 1998 analysis done by the Power Planning Council using an electric power pricing model called Aurora. This analysis was a major modeling effort that received the approval of various groups with diverse views on hydropower in the Pacific Northwest.

system in the Pacific Northwest, BPA used electric transmission models and extensive information about generation, transmission, and load (demand) throughout western North America. Using 1998-99 conditions as a baseline, BPA's analysts developed modeling simulations that identified the locations and types of adverse transmission impacts stemming from the loss of the four dams. Using a discount rate of 6.875 percent, BPA estimated the annual costs on the transmission system to be between $22 million and $28 million. These costs included various mitigation measures that might be taken to deal with the transmission problems, such as upgrading the intertie between transmission systems in the Northwest and Southwest, building a new transmission line, and constructing new generating capacity.

- **Estimation of ancillary services costs**. To determine the impact of breaching on ancillary services, BPA used actual transaction prices and made certain assumptions regarding the frequency and level of utilizing the Lower Snake River dams for the provision of such services. Deregulation in the power industry has made it possible to create a separate market for ancillary services that previously were part of the "bundled" service that power suppliers provided at no charge.[2] Starting in 1998, BPA began to unbundle ancillary services and sell them separately. Breaching would affect two types of ancillary services. First, it would decrease reserves required for the federal power system, which would cost $7,183,000 annually to replace.[3] Second, breaching would diminish automatic generation control, which allows for small but very frequent changes in electric power generation to balance supply and demand. BPA estimated lost generation control services at an average annual value of $465,000. The total of decreased reserves and automatic generation control is $7,648,000 annually.

Corps of Engineers' Transportation Cost Analysis

To estimate the net economic development costs from breaching the four Snake River dams and the attendant loss of barge shipping, the Corps used a three-stage analytical approach. First, the Corps forecast future shipments. Second, using these forecasts, the Corps modeled the movement of these shipments, first assuming river transportation is

[2] "Bundled" service refers to the grouping of separate services into one product "bundle" that a supplier provides uniformly to a class of customers.

[3] To ensure reliable service to customers, electric power suppliers maintain emergency power production capacity. Reserve capacity is needed to replace unexpected power generation losses or to meet unexpectedly high demand.

available, and second under a least-cost alternative assuming river transportation is not available. Finally, the Corps estimated shipping costs under both scenarios and computed the difference.

- **Forecasting growth in shipments**. The Corps relied on its Institute for Water Resources to assist in developing commodity growth estimates. This Institute was used for earlier Columbia River studies and has forecast shipping on other waterways. These forecasts were based on forecasts originally developed for another study, The Columbia River Channel Deepening Feasibility Study. To forecast commodity growth, the Institute separated the shipments into five distinct groupings—grain, wood products, petroleum, paper and pulp, and other commodities. For grains, the Institute estimated that about 23 percent of the Lower Columbia River area export grains are shipped on the Snake River and assumed that this proportion would stay constant in the future. Using the average of Columbia River grain shipments for 1987 through 1996, the Institute projected Snake River grain shipments through 2017 and assumed level shipments thereafter. For the nongrain commodities, the Corps used information from the earlier study to reflect projected changes in the quantities of commodities shipped. For example, wood chips and logs are assumed to remain constant while petroleum products are tied to projected population increases. Overall, the Corps estimated a total increase in shipments of 26 percent, to 5 million tons by 2017.
- **Modeling transportation patterns**. One of the key elements in determining transportation costs is identifying origins and destinations of product movements. For grain (primarily wheat and barley), the Corps used an established model to determine the current path by which grain is trucked to the river and barged to the export port in the Portland, Oregon, area. The Corps then modeled the least-cost alternative routing. For some grain, the alternative involved a longer drive to ports on the Columbia River for barge transport to Portland. For other grain, the alternative involved transfer to railroad hopper cars and shipment by rail to the export port. For nongrain commodities, the Corps used the same approach, but only modeled the path from the origin to the destination port under current conditions and under the least-cost alternative.
- **Estimating cost effects**. Using the modeled shipping pattern information, the Corps estimated the cost of shipping under current conditions and if the dams are breached. For each shipment, the Corps estimated the shipping cost on the basis of the estimated cost to the carrier (barge, railroad, or truck). For example, for a shipment of grain

via truck and barge, the Corps estimated the per-ton costs of the trucker and barge operator to move that grain. In its approach, the Corps assumed that the (1) unit costs for rail and truck operators would not change if competition from barge operators ceases and (2) necessary infrastructure investments in rail lines and highways will be made. The Corps then compared the total costs of shipping under current conditions and the least-cost alternative without river navigation. The incremental cost of breaching, before considering avoided costs, totaled $24 million annually.

Corps of Engineers' Air Quality Analysis

The Corps' air quality assessment estimated emissions from four sources if the Lower Snake River dams are breached.

- **Airborne emissions from deconstruction**. The estimated 2-year deconstruction of the four Lower Snake River dams would produce airborne dust. The primary source would be material-handling activities, such as bulldozing, hauling, dumping, and grading. The deconstruction dust emission estimates were based on construction-related dust emission factors from EPA. These factors were then used to estimate particulate emissions from each dam on the basis of the volume of material to be moved, road lengths, hours of operation, and average weight of the haul trucks. The effects of dust emissions were not quantified.
- **Air emissions from the loss of barge transportation**. If the four Lower Snake River dams are breached, grain and goods that are currently transported by barge would have to be trucked to rail cars or to river ports downstream. The Corps estimated emissions by averaging the results of two different approaches that converted transportation data for grain into vehicle emissions using EPA emission factors and extrapolated that data for other commodities.
- **Windblown dust emissions from exposed reservoir sediments**. Eastern Washington is relatively arid and subject to considerable windblown dust. The study concluded that until vegetation cover becomes established, the dust emissions from the dry reservoirs would be between 0.4 and 13 percent of the total emissions from eastern Washington agricultural areas during individual windstorms. Emissions were estimated using an EPA methodology for predicting the amount of particulate matter because of wind erosion. The analysis used 1984 through 1991 wind data for selected cities in the region.
- **Increased air emissions from replacement power generation**. Breaching the four Lower Snake River dams would require 1,550

megawatts of replacement power generation. The Corps assumed that the replacement power would come primarily from new thermal power plants, most likely gas-fired. These plants would produce such pollutants as carbon dioxide, nitrogen dioxide, and sulfur dioxide. Amounts for these substances were estimated on the basis of the BPA model used to estimate electricity costs and then extrapolated to other pollutants, such as carbon monoxide, using EPA emission factors.

Scope and Methodology

To assess the extent to which the Corps followed requirements and accepted practices in preparing the draft environmental impact statement (EIS), we reviewed the draft EIS in comparison to individual requirements of the National Environmental Policy Act, the Endangered Species Act, the Water Resources Council's *Economic and Environmental Principles for Water and Related Land Resources Implementation Studies* (1983), and Corps and Department of Army implementing guidance for the preparation of an EIS. To the extent we found variances, we discussed these with Corps officials, other agencies, and outside experts. We also reviewed the scope and content of the Corps' draft EIS, including the Corps' assessment of compliance with applicable federal environmental statutes and regulations. We also spoke with interested stakeholders, both pro-dam and conservation groups; other agencies; and outside experts. Finally, we attended public hearings, reviewed hearing transcripts, and reviewed public and agency comments submitted to the Corps.

To determine the reasonableness of the Corps' analysis and presentation of the effect of breaching on electricity costs, we reviewed and assessed the Corps' draft EIS and technical background reports and spoke with outside experts and interested stakeholders. In addition to current and earlier drafts of the EIS and relevant appendixes, we reviewed and analyzed numerous technical reports and studies that underlay the Corps' analysis. We examined the depth and quality of the reports' analyses and the consistency of the reported results across the studies. These reports include the Hydro Impact Team's *Technical Report on Hydropower Costs and Benefits*, the Northwest Power Planning Council's *Analysis of the Bonneville Power Administration's Potential Future Costs and Revenues*, and BPA's *Transmission Impacts of Breaching the Lower Snake and John Day Dams*. We conducted interviews with the principal analysts responsible for the cost estimation from three public agencies, the Corps, BPA and the Council. We also interviewed stakeholders representing diverse views on the Lower Snake River dams, and various independent reviewers and hydropower experts. We also reviewed the detailed comments of the Independent Economic Analysis Board regarding the EIS and discussed them with several members of the Board. Through these efforts, we developed an understanding of the various modeling exercises that the Corps, BPA, and the Council used for estimating increases in power system costs in the western United States because of the breaching of the four Lower Snake River dams or changes in their current operations. Finally, we assessed the extent to which the data and estimation models employed had been reviewed by internal or external reviewers or used for other operational or planning purposes.

To determine the reasonableness of the Corps' analysis and presentation of the effect of breaching on transportation costs, we reviewed and assessed the Corps' draft EIS and technical background reports and spoke with outside experts and interested stakeholders. In addition to current and earlier drafts of the EIS and relevant appendixes, we reviewed and analyzed studies that underlay the Corps' analysis, including studies by Corps consultants. To understand the Corps' analysis and conclusions, we assessed underlying studies prepared for a Washington State Legislature Transportation Committee, the Eastern Washington Intermodal Transportation Study, a study by the Port of Portland, and documents prepared by various stakeholders, such as American Rivers and the Pacific Northwest Waterways Association. We also reviewed the Corps' transportation model for its completeness and accuracy, especially as compared to the Water Resources Council's Principles. We interviewed officials from the Corps in Portland, and Walla Walla, Washington, and in Northern Virginia who had contributed to the analysis and the consultant with primary responsibility for the transportation section of the draft EIS. To understand the limitations of the Corps' analysis, we looked at the assumptions, inconsistencies, and uncertainties identified by the Corps and others. We assessed the extent to which the data and estimation models employed had been reviewed by internal or external reviewers or were consistent with other transportation modeling efforts. Finally, we reviewed the comments of various stakeholders submitted to the Corps and discussed the implication of their comments with the appropriate Corps officials.

To determine the reasonableness of the Corps' analysis and presentation of the effect of breaching on air quality, we reviewed and assessed the draft EIS and its underlying documents. We compared the Corps' early work plans with the scope of work later negotiated with the Corps' contractors and with the draft EIS. We also reviewed existing air quality standards and requirements and assessed the extent to which the Corps analyzed and reported the impact of breaching on these standards and requirements. We also met with, and obtained documentation from BPA, the Corps, EPA and the Corps' prime and subcontractors for the air quality work. Finally, we reviewed and evaluated agency and public comments received by the Corps.

We performed our work in accordance with generally accepted government auditing standards from December 1999 through June 2000.

GAO Contacts and Staff Acknowledgments

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Acknowledgments

In addition to those named above, Chris Abraham, Paul Aussendorf, Margaret Armen, Philip Farah, William Hanson, Mehrzad Nadji, Tim Schindler, and Stan Stenersen made key contributions to this report.

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