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REPORT BY THE U.S.

General Accounting Office

Consolidating Federal Stream Forecasting Activities May Reduce Duplication Of Resources And Effort

The National Weather Service and four agencies, including the Corps of Engineers, that operate federal water projects have independent systems to rapidly collect information on stream flow and precipitation and forecast the flow, volume, and height of a stream along its different points

Independent systems may result in duplication of equipment, staff, and forecasting GAO recommends that the agencies study the feasibility of establishing joint stream forecasting centers



GAO/RCED-84-104
JULY 24, 1984

336579

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UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

RESOURCES, COMMUNITY,
AND ECONOMIC DEVELOPMENT
DIVISION

B-215655

The Honorable James O. Marsh, Jr.
The Secretary of the Army

The Honorable Malcolm Baldrige
The Secretary of Commerce

This report discusses the stream forecasting activities of the National Weather Service, the Army Corps of Engineers, and other federal water resources operating agencies. It points out that savings could be realized by consolidating these independent activities into regional river forecast centers.

The report contains recommendations to you on page 24. As you know, 31 U.S.C. 720 requires the head of a federal agency to submit a written statement on actions taken on our recommendations to the Senate Committee on Governmental Affairs and the House Committee on Government Operations not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

Copies are being sent to the Chief of Engineers; the Administrator, National Oceanic and Atmospheric Administration; the Director, Office of Management and Budget; and other interested parties.


J. Dexter Peach
Director

D I G E S T

Rapid, accurate forecasts of water flow in the nation's rivers and streams are important to federal water management and flood warning efforts. To be effective, these forecasts must be available rapidly enough to allow changes in downstream flow by adjusting dam storage and releases and to provide adequate flood warning. Timely stream forecasts can

- save lives and limit property damage by early warning of impending flood danger;
- reduce property damage by lowering flood crests through optimizing use of the storage capacity in flood control reservoirs; and
- increase other benefits from water projects such as hydropower revenues, recreation, and pollution abatement by improving routine water use.

The systems needed to meet these time restraints--called real-time systems--must rapidly collect, communicate, and process large amounts of data to permit the rapid forecasting of stream flows. (See p. 1.)

Four major federal stream forecasters--the National Weather Service, the Army Corps of Engineers, the Bureau of Reclamation, and the Tennessee Valley Authority (TVA)--have independent systems that provide real-time stream forecasts and other information needed to operate water resources projects. (See p. 1.)

GAO reviewed these agencies' stream forecasting systems to determine whether opportunities exist to consolidate activities. GAO found that they have developed independent stream forecasting capability which results in duplication of equipment, staff, and effort. The consolidated stream forecasting system in the Pacific Northwest and GAO's Ohio River Basin case study presented in this report show that duplication can be reduced by consolidating stream forecasting efforts.

**INDEPENDENT STREAM FORECASTING
MAY RESULT IN DUPLICATION**

Several federal agencies have responsibility for forecasting, controlling, and using in-stream water resources. The Weather Service has had the responsibility for providing public flood warnings nationally for over 90 years. In addition, agencies that operate federal water projects such as the Corps, the Bureau, and TVA are increasingly using real-time water data collection and forecasting systems to improve their day-to-day operations. (See p. 2.)

Daily, the Weather Service's 13 River Forecast Centers forecast stream height at population and industrial locations on the nation's rivers and streams. In addition, the Corps and other operating agencies have established independent systems to forecast different points on the same rivers and streams using data similar to that used by the Weather Service. Officials of these agencies recognize that these data needs are similar; however, they said that they must have control over their own information systems to meet their responsibilities for regulation of water projects. (See pp. 7 to 9.)

While different agencies may not forecast the same points on a particular stream and may not use all the information collected by all the agencies in the area, maintaining separate data collection systems, multiple level networks to exchange data with other agencies, separate computer facilities to process and store the same basic information, and separate capability to forecast different points on the same streams may represent a duplication of equipment, staff, and effort.

GAO visited real-time operational systems in two major river basins--the Ohio and Missouri--and found that duplication of equipment, staff, and effort occurs throughout the stream forecasting process. For example, the following agencies operate forecasting systems in the Ohio River Basin:

- The Weather Service River Forecast Center forecasts the entire basin (excluding the TVA area) to prepare site-specific flood warnings for population and industrial centers.
- Each of the three Corps districts has independent systems to predict and control inflows and outflows from Corps structures and predict the down-stream effect of facility regulation. In combination, these systems encompass the same areas of the Ohio basin as the Weather Service River Forecast Center.
- A fourth Corps district has a system that is responsible for the Cumberland River Basin.
- The Corps Ohio River Division has a center that forecasts the Ohio River mainstream and monitors the interaction of its districts.
- TVA has an independent real-time forecasting system for regulating the structures in its area and preparing flood warnings for streams with TVA dams. Forecasts and information are shared with the Corps and a Weather Service River Forecast Center that forecasts the remaining streams in the area.

Because these centers also exchange rainfall and stream flow gauge readings extensively, at least two, and often three, of these centers duplicate receipt, processing, and storage of the same gauge readings and use this information to prepare independent forecasts. (See pp. 10 to 12.)

**DUPLICATION OF REAL-TIME
SYSTEMS CAN BE REDUCED**

GAO also visited a multiagency data collection and joint forecasting system in the Columbia River Basin. The intensive water management requirements in the Pacific Northwest provided the impetus for a joint forecasting system. (See p. 15.)

Using a single data storage and processing system, eight federal agencies¹ have routine access, in whatever format desired, to the real-time water data collected by the other participants. In addition, joint real-time stream forecasting by the Corps and the Weather Service River Forecast Center avoids the duplication of equipment, staff, and forecasting effort while meeting the operational requirements of both agencies. (See pp. 16 to 19.)

GAO believes that the approach used in the Columbia River Basin could be used in other locations. To test the feasibility of such a system in other river basins, GAO devised a consolidated system for the Ohio River Basin to determine the benefits that would result. GAO found that such a system would not only be practical but would also provide the following benefits.

- Centralizing the Corps system would reduce anticipated computer procurement costs by up to \$452,000 and annual computer operations and maintenance costs by up to \$208,000.
- Consolidating Corps and Weather Service River Forecast Center real-time stream forecasting systems would eliminate duplication of equipment, staff, and effort and would free Corps staff to concentrate on other activities.
- Providing routine access to real-time forecasts by other federal and nonfederal agencies in the area. (See pp. 19 to 23.)

Corps Ohio River Division officials agreed that such a system was feasible and would meet their operational needs. However, they said that a more detailed cost analysis would be needed to define specific savings. Weather Service Ohio River Forecast Center officials

¹The federal agencies are the Weather Service, the Corps, the Bureau of Reclamation, Bonneville Power Administration, the U.S. Geological Survey, the Soil Conservation Service, the Forest Service, and the Bureau of Land Management.

said that Forecast Center equipment needs and staff requirements would not change under such a consolidated system. (See pp. 21 and 22.)

CONCLUSIONS

The results of applying consolidation concepts to the Ohio River Basin indicate that benefits would result from establishing a joint regional data center in this basin. Similar benefits may also be possible in other river basins where more than one agency has established a capability to collect and store information and prepare stream forecasts to meet agency specific requirements. Each river basin, however, may present a different set of factors, such as water use and characteristics and differing agency responsibilities, which must be considered in developing a consolidated system to assure that all agency requirements are met. (See p. 24.)

To realize the full benefits of consolidation, all agencies engaged in gathering, storing, or otherwise using water data within the basin should participate in the establishment of joint regional data centers. While the Corps and the Weather Service can provide a framework for regional cooperation, an active effort will be needed to solicit the participation of other agencies in each region.

RECOMMENDATIONS

GAO recommends that the Secretary of the Army direct the Chief of Engineers and the Secretary of Commerce direct the Administrator, National Oceanic and Atmospheric Administration (which includes the National Weather Service) to study the overall feasibility of creating joint Corps/Weather Service stream forecast centers and establish such centers in those regions where the operational requirements of both agencies can be met and duplication eliminated. (See p. 24.)

GAO further recommends that the Secretaries of the Army and Commerce direct the Chief and the Administrator, respectively, to actively solicit the input and participation of other agencies concerned with water data collection and stream forecasting in those regions.

AGENCY COMMENTS AND GAO'S EVALUATION

Both the National Atmospheric and Oceanic Administration and the Army said that they generally agreed that opportunities may exist to consolidate stream forecasting activities and would explore the possibilities for joint operational centers and implement changes that would improve efficiency.

The Army commented, however, that neither the feasibility nor the stated cost savings for the Corps/Weather Service consolidation in the Ohio River Basin have been adequately demonstrated or documented in the report and that the extent of duplication was overstated because the Weather Service does not forecast the same points on a river. In addition, the Army said that opportunities to consolidate stream forecasting are limited, in part, because Corps and Weather Service boundaries and facility locations are different.

GAO believes that the report adequately demonstrates the potential cost savings by consolidating Corps and Weather Service activities in the Ohio River Basin. The system GAO devised for centralizing Corps activities in the Ohio River Division was based on anticipated Corps needs as well as additional capacity to consolidate the Corps/Weather Service stream forecast effort. This system was reviewed and commented on by both Weather Service and Corps officials in the Ohio River Basin. Corps officials said that the system was feasible but that more detailed study would be needed to define specific savings. Weather Service officials said that this consolidation would not increase the agency's staff or equipment needs. (See p. 25.)

GAO agrees with the Army that the Corps and the Weather Service do not forecast the same points on a river. However, all forecasting points could be included in a consolidated system thus eliminating duplicate equipment and effort. GAO also agrees that agency boundaries and facility locations are not identical. Although this may pose some institutional problems, it does not create technical limitations on the ability to use a common information system. (See pp. 13, 14, 25 and 26.)

C o n t e n t s

		<u>Page</u>
DIGEST		i
CHAPTER		
1	INTRODUCTION	1
	Federal agencies that use real-time stream forecasts	1
	National Weather Service	2
	Corps of Engineers	2
	Other federal agencies	2
	Objectives, scope, and methodology	3
2	DUPLICATION OF EQUIPMENT, STAFFING, AND EFFORT IN FORECASTING SYSTEMS FOR MAJOR RIVER BASINS	6
	Interdependent systems have the same requirements	6
	River Forecast Centers provide forecasts nationally	7
	Operating agencies have independent forecasting systems	7
	Corps of Engineers	8
	Other agencies	9
	Overlapping systems duplicate forecasting effort	9
	Ohio River Basin	10
	Missouri River Basin	12
	Agency comments and our evaluation	13
3	ACTION IS NEEDED TO REDUCE DUPLICATION OF STREAM FORECASTING EFFORTS	15
	Consolidated system in the Columbia River Basin	15
	Consolidated data base	16
	Joint forecasting	17
	Consolidation provides additional benefits	18
	Multiple systems in the Ohio River Basin could be consolidated	19
	Savings would result if Corps systems were centralized	20
	Consolidated forecasting would provide additional benefits	21
	Consolidated system could help meet future Corps needs	23
	Conclusions	24
	Recommendations	24
	Agency comments and our evaluation	24

		<u>Page</u>
APPENDIX		
I	Locations GAO visited	27
II	Letter dated April 26, 1984, from the Assistant Secretary of the Army, (Civil Works)	29
III	Letter dated May 4, 1984, from the Assistant Secretary for Administration, U.S. Department of Commerce	38
IV	Letter dated April 13, 1984, from the Acting Commissioner, Bureau of Reclamation, U.S. Department of the Interior	41
V	Letter dated April 9, 1984, from the Chairman, Tennessee Valley Authority	44

ABBREVIATIONS

CROHMS	Columbia River Operational Hydromet System
GAO	General Accounting Office
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
TVA	Tennessee Valley Authority

CHAPTER 1

INTRODUCTION

Rapid, accurate forecasts of water flow in the nation's rivers and streams are important to federal water management and flood warning efforts. To be effective, these forecasts must be available rapidly enough to allow changes in downstream flow by adjustment of dam storage and releases and to provide adequate flood warning. Timely stream forecasts can

- save lives and limit property damage by early warning of impending flood danger,
- further decrease property damage by reducing flood crests through optimizing use of the storage capacity in flood control reservoirs, and
- increase hydropower revenues and other project benefits such as recreation and pollution control by improving water use during routine operations.

Systems to collect and communicate stream flow and precipitation data and prepare forecasts are becoming increasingly expensive as improved technology becomes available. A variety of data communications methods are available, but use of expensive, automated, real-time¹ data communications networks is increasing in stream forecasting. Similarly, while many forecast centers rely on manual calculations for portions of the forecasting work, use of computers is becoming common in forecast preparation. The ability to handle more information in less time not only increases the advanced warning provided by the forecast but also allows forecasting units to deal with large hydrographic areas as a single unit.

FEDERAL AGENCIES THAT USE REAL-TIME STREAM FORECASTS

The National Weather Service (NWS), the Army Corps of Engineers, and regional water project operators, such as the Bureau of Reclamation and the Tennessee Valley Authority (TVA), require immediate information on precipitation and stream flow to prepare the stream forecasts needed to perform their distinct but interdependent missions.

¹Information systems that collect and communicate data on conditions as they are occurring are generally referred to as real-time systems. Such systems can provide reliable forecasts of downstream events within 1 to 4 hours of a change in upstream conditions.

National Weather Service

The National Weather Service has had statutory responsibility for providing flood warnings to the public for over 90 years. Operating within the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), NWS is the only federal agency authorized to issue public flood warnings. Thirteen regional River Forecast Centers, having no other weather forecast responsibilities, serve as a focal point for hydrologic data and expertise for NWS offices nationwide. In flood situations, River Forecast Centers transmit warnings to the appropriate local NWS office, which is responsible for the decision to issue them to the public.

Corps of Engineers

The Army Corps of Engineers is the nation's largest operator of water projects and has primary responsibility for federal flood control efforts. The Corps is directly responsible for day-to-day operation of over 530 federal water projects. Corps information systems provide the real-time water data needed to regulate these structures and to monitor the day-to-day operation of over 1,300 federal and nonfederal structures. Because of its decentralized management approach, Corps real-time data systems are centered in the 36 Corps district offices to support facility operations. Ten Corps divisions in the continental United States have responsibility for coordinating the operations of the districts in their areas.

Other federal agencies

In addition to the two agencies with nationwide responsibilities, other federal agencies, such as the Department of the Interior's Bureau of Reclamation and TVA, operate federal water projects in certain geographic regions. The Bureau of Reclamation is responsible for developing and conserving the nation's water resources in the 17 western states. The Bureau supervises 330 storage dams and 145 diversion dams, but approximately half of these structures are operated and maintained by other water user organizations. TVA is an independent corporate federal agency that plans, builds, and operates water projects in the greater Tennessee River Valley for a variety of purposes, including flood control, navigation, and hydropower generation. TVA regulates the operation of 47 government and 6 privately owned dams.

OBJECTIVES, SCOPE, AND METHODOLOGY

The objectives of this review were to (1) determine how federal agencies collect real-time water quantity data and forecast stream flows and (2) identify actions that could improve the operations and management of these activities.

The factors that govern stream forecasting requirements vary widely across the country. Principal among these are

- geography, climate, and the amount of rainfall;
- water use, availability, and water-related problems;
- the role of state governments in dealing with water-related problems; and
- the number of federal agencies involved in water management and stream forecasting.

These factors combine to produce major differences between the water management environment in the eastern states, where water is generally plentiful and the federal role is limited, and the western states where water is scarce, competition for use is often intense, and many federal agencies are involved in water management decisions.

Because NWS headquarters officials told us that River Forecast Center operations are relatively uniform nationwide, we based our selection of sites to be visited on Corps and Bureau operations. Corps and Bureau officials told us that because of their decentralized management, there were no division or project office forecasting systems that were representative of the variety of approaches used nationwide. Based on these discussions, we visited river basins that Corps and Bureau officials said represented varied operational approaches and stream forecasting systems. The basins we selected were:

- The Ohio River Basin, because Corps operations in the Ohio River Basin include both a division real-time data collection and forecasting system and four district systems that Corps headquarters officials said were typical of decentralized Corps systems nationwide.
- The Missouri River Basin, because in addition to the Corps and NWS, the Bureau of Reclamation operates a number of projects in the basin. Corps operations in the Missouri River Basin feature a single information system used jointly by the division and the two district offices. Bureau operations, however, are extremely decentralized, with little interaction or real-time information exchange between individual Bureau projects.

During our initial conversations, both Corps and NWS headquarters officials told us that the Columbia River Basin offered a unique example of cooperative efforts between the regional units of these agencies and other federal and non-federal agencies in the area. We also learned from Bureau officials that the Bureau's Northwest Regional Office had the only regional information and stream forecasting system in the Bureau. We therefore visited the operational stream forecasting systems in the Columbia River Basin to review the operations of the multi-agency data collection and stream forecasting system that exists in that basin.

In each basin, we interviewed the hydrologists and reservoir control center officials who manage and operate the real-time water data collection and stream forecasting systems. We observed the systems in operation and discussed the specific system requirements, operational procedures, and agency interfaces at the operational level. We obtained budgetary data, estimates of capital equipment cost, and staffing levels for each operational unit to determine the relative level of effort involved in divergent operational approaches.

To highlight common operations and minimize the impact of hydrologic and water use differences, our analysis concentrated on the operational process of the forecasting systems we reviewed, rather than the final product or specific system requirements. While forecasting system information requirements and process (collection, communication, processing, and forecasting) are the same regardless of the use to be made of the forecast, hydrology, climate, water use, and the role of the federal government vary widely from one hydrographic region to another. These factors affect not only the timing and use of forecasts but also prevent direct comparisons of overall information systems and needs from region to region.

To test the feasibility of consolidating Corps and NWS systems, we applied centralized operational concepts to the planned decentralized system in one Corps division. This alternative approach was not intended to be a specific system recommendation to the Corps but was used to demonstrate the feasibility of an alternative that would provide additional benefits if implemented over the 5-year period envisioned in the existing Corps plan. We obtained specific comments on the practicality of this system and an assessment of its potential advantages from both the Corps division and the corresponding NWS River Forecast Center.

Our analysis was limited to areas where we believed a significant increase or decrease in either cost or system efficiency would result from centralizing current systems. The

areas were computer operations-related personnel costs, hardware acquisition and maintenance costs, and software acquisition and maintenance costs. Other areas such as application software development and maintenance, communications, and other operating expenses were considered but were not included in our cost comparisons because specific performance criteria for these aspects of a centralized system would have to be defined by the Corps. Current Corps plans, however, will require expenditures in these same areas for each of the five components in their planned decentralized system.

This review was performed in accordance with generally accepted government auditing standards. Our work was performed from February through August 1983 at the locations listed in appendix I.

CHAPTER 2

DUPLICATION OF EQUIPMENT, STAFFING, AND EFFORT IN

FORECASTING SYSTEMS FOR MAJOR RIVER BASINS

Although the NWS River Forecast Centers prepare daily forecasts of stream height at various population and industrial sites on the nation's rivers and streams for flood warning purposes, agencies such as the Corps that operate federal water projects have developed independent information systems that use the same basic information and the same process to forecast different points of interest to them on the same rivers and streams. In two major river basins we visited, we found that NWS, Corps, and regional agencies such as the Bureau of Reclamation and TVA maintain real-time data collection networks, computer facilities, and duplicative forecasting capabilities in the same river basins. Our discussions with these agencies' headquarters officials indicate that while the number of agencies and the specific organizational overlap may vary from region to region, duplication occurs nationwide.

INTERDEPENDENT SYSTEMS HAVE THE SAME REQUIREMENTS

Stream forecasts prepared for flood warnings and for facility regulation purposes require not only the same basic information and use the same forecasting process, but also they are heavily interdependent. Regardless of the purpose for which a stream forecast is prepared, the basic process and information requirements are the same. Precipitation information is used to calculate the volume of water that will run off into a given stream basin. Stream gauge readings are used to verify this information and provide flow data in areas where adequate precipitation gauges are not available. Once the volume of flow has been calculated, it can be used to (1) forecast inflow to reservoirs for facility operation decisions and/or (2) predict stream depth for flood forecasts based on channel characteristics at specific points.

In addition to requiring the same information, forecasting systems must also be organized to cover the same geographic areas because stream forecasting must be based on river drainage basins. Although the NWS River Forecast Center and the operating agencies may forecast different points on the same streams, both must consider the entire drainage basin when preparing their forecasts. As a result, the boundaries of Corps divisions and the NWS River Forecast Centers are almost identical.

Because the NWS forecasts could be affected by how much water is released from upstream dams, the River Forecast Centers must know how dams will be operated. Under normal conditions, releases are based on known operating plans and manuals, and only major changes would effect the forecast accuracy. In flood situations, however, releases are based on actual conditions, and meaningful forecasts cannot be made until releases have been determined. As a result, once operational centers complete their forecasts and determine how the structures will be operated, information on planned releases is provided to the River Forecast Center for use in preparing NWS forecasts and public flood warnings.

RIVER FORECAST CENTERS PROVIDE FORECASTS NATIONALLY

The NWS River Forecast Centers have extensive experience and expertise in stream forecasting and the day-to-day characteristics of the nation's rivers and streams. NWS centers prepare daily forecasts of stream height and crests for all major rivers and streams. Each NWS River Forecast Center collects, processes, and maintains water quantity information within its geographical area of responsibility. River Forecast Center personnel also provide technical assistance to other NWS facilities and local communities in a variety of functions, such as designing flash flood warning systems.

The River Forecast Centers also have extensive expertise in computer applications to real-time data collection and stream forecasting. Since the late 1960's NWS has been developing a standardized data handling software package and a conceptual stream forecasting model that can be adapted to any stream basin. This system, known as the River Forecast System, is in various stages of implementation in 11 of the 13 River Forecast Centers. The other two Centers use similar systems that were developed locally and are tied into unique data systems.

OPERATING AGENCIES HAVE INDEPENDENT FORECASTING SYSTEMS

Because timely stream forecasts can increase the benefits from federal water projects, agencies responsible for regulating the flow through these facilities are making increased use of real-time stream forecasts to improve day-to-day facility operations. Although information requirements are similar and flood forecasting and facility regulation are interdependent, operating agencies have established independent stream forecasting systems that overlap the existing River Forecast Center network.

Corps and Bureau of Reclamation headquarters officials told us that the wide variations in geography, climate, water use,

and the nature of water-related problems across the country require decentralized management of water projects to assure that facility regulation decisions are responsive to local conditions. This decentralized approach means that operational decisions in the Corps are generally made at the district level, while in the Bureau they are usually made at the project offices. For stream forecasting, each of the agencies' operational units has designed and developed its own information systems; purchased equipment to collect, process, and store information; and developed its own stream forecasting capability.

While Corps and Bureau personnel at the field level are willing to use data collected by other agencies, they told us that they must control their own information systems and forecasting capability to insure that they can meet their operational responsibilities. In addition, they expressed a reluctance to consolidate their current operations to better integrate with other agencies' river forecasting activities and said that such a change would reduce the integrity of individual agency functions. In contrast, the Department of the Army in commenting on the draft of this report said that the Corps was not reluctant to integrate activities but that opportunities to do this in all field locations are limited.

Corps of Engineers

The Corps is currently engaged in a large-scale program to increase its water management capabilities that includes upgrading its real-time forecasting capabilities. Corps divisions are responsible for coordinating this expansion by framing and monitoring 5-year improvement plans for each division's program.

Corps headquarters officials did not know to what extent the districts' data collection and forecasting activities for facility operations duplicated work performed by the divisions or by other agencies in each region. The officials said that division forecasting efforts were generally intended to meet the divisions' responsibilities for monitoring district activities, forecasting mainstream rivers that flowed through more than one district, and coordinating activities with other agencies. Because geographic boundaries are based on drainage areas, Corps district data collection efforts usually include individual hydrographic subregions of the overall area covered by the Corps division boundaries and River Forecast Center.

Corps district and division forecast centers are only beginning to develop the sophisticated forecasting capabilities currently used in most NWS River Forecast Centers. Corps headquarters officials told us that while the Corps makes forecasts for selected points on most major rivers and streams in the country on a daily basis, relatively few Corps district and

division forecast centers use proven hydrologic models, and such forecasts are generally prepared by computer-assisted manual calculations. However, these officials expect increased use of advanced hydrologic models and other real-time data collection and forecasting techniques as the Corps continues to upgrade its forecasting capability.

Other agencies

Other federal agencies use real-time stream forecasting systems to optimize their day-to-day operations such as water deliveries for irrigation and hydropower generation. For example, optimizing operations can result in increased hydropower revenue by regulating water releases to increase flow during peak electricity demand periods when the market value of electricity is high. These systems, however, do not provide basinwide forecasts as do those of the Corps and River Forecast Centers. For example,

- Bureau of Reclamation systems collect, store, and use real-time water data at about 40 project offices. Information is entered into a control system which, among other things, predicts flow and water use within a project for irrigation, hydropower scheduling, and other day-to-day operational decisions. Only one Bureau region, the Pacific Northwest, currently prepares basinwide forecasts at a regional center.
- TVA has a real-time stream forecasting capability as part of the overall system it uses to regulate water projects in the Tennessee River Valley. In addition to hydropower generation and transmission, this system is also used to meet TVA's flood control responsibilities in the valley.
- The Bonneville Power Administration is the federal power marketing agency in the Pacific Northwest. It uses its overall information system, which includes forecast capability, to regulate hour-to-hour hydropower generation within daily release schedules provided by the operators of federal water projects (the Corps and the Bureau).

OVERLAPPING SYSTEMS DUPLICATE FORECASTING EFFORT

We visited stream forecasting systems in two major river basins and found that federal agencies operate independent real-time data collection and stream forecasting systems to forecast different points in the same river basin. In both basins we found that agencies maintain systems covering the same

hydrographic area with overlapping gauge networks, multiple communications paths, and duplicative data storage facilities. Although these agencies exchange a large volume of information daily, these common data are processed, stored, and used independently by each of the agencies' operating units.

Ohio River Basin

Three federal agencies operate seven real-time data storage centers and stream forecasting systems in the greater Ohio River Basin. At least two, and often three, of these centers duplicate receipt, processing, and storage of many of the same gauge readings. Because these centers also exchange gauge readings extensively, the same information is used to prepare independent forecasts.

The following self-contained stream forecasting systems operate in the greater Ohio River Basin:

- The NWS River Forecast Center forecasts the entire basin (excluding the TVA area) to prepare site-specific flood warnings for population and industrial centers.
- Each of the three Corps districts has independent systems to predict and control inflows and outflows from Corps structures and predict the down-stream effect of facility regulation. In combination, these systems encompass the same areas of the Ohio basin as the NWS River Forecast Center.
- A fourth Corps district has a system that forecasts for the Cumberland River Basin.
- The Corps Ohio River Division has a center that forecasts the Ohio River mainstream and monitors the interaction of its districts.²
- TVA has an independent real-time forecasting system for regulating the structures in its area and preparing flood warnings for streams with TVA dams. Forecasts and information are shared with the Corps, and the NWS River Forecast Center in Sidell, LA, which forecasts the remaining streams in the area.

²The Corps division operates a ground station to receive data transmitted through a satellite relay from individual gauge locations in the districts.

Each of these operational units also has its own communications network to collect gauge readings and to exchange information with other agencies in its area. Because sharing agreements exist between the River Forecast Center and the Corps division, and between their local offices, information exchange occurs through a complex network of often duplicate paths. For example, a reading obtained by a NWS field office may be telephoned directly to both the NWS River Forecast Center and the Corps district offices. The River Forecast Center will also send this reading and other daily readings to the Corps division, which telephones pertinent NWS information back to the district office.

Unlike the NWS River Forecast Center, which has a regional data storage facility, the Corps has five separate, but limited, real-time data bases in the Ohio River Basin. The Corps division and each district office has a computer and related data handling equipment to store the information it collects. The division stores satellite information, data received from the NWS River Forecast Center, and data from the districts that are needed to forecast the mainstream and monitor the district's water management actions. Each district stores information it collects directly, as well as satellite and NWS data transmitted from the division and information received directly from NWS field offices.

Because of the complexity and informality of the sharing agreements, we were unable to precisely define the extent to which the same information appears in multiple data bases, but indications are it may be substantial. For example,

- readings from over 75 percent of the approximately 1,800 stream stage and precipitation gauges operated in the basin are stored and used by both the River Forecast Center and at least one Corps district office and
- Corps officials told us that approximately 60 to 70 percent of the information in the individual district data bases is also stored at the division. This percentage could increase as the districts use more satellite platforms.

Because all the operating units involved believe their operational responsibilities require them to do their own forecasts, daily forecasts are prepared for the major rivers and streams in the basin by both the River Forecast Center and at least one of the Corps reservoir control centers. Each day, a variety of forecast models, computer time, and staff effort are devoted to preparing these forecasts. While forecast points and the format of the forecasts vary, similar effort and expense are incurred for each of the forecasts on the next page:

- The River Forecast Center currently uses a locally generated model to forecast both the tributaries and the Ohio mainstream and is currently implementing the standard NWS model for its stream forecasting.
- Each Corps district uses several self-generated models to forecast the tributaries feeding the Ohio River mainstream in its area.
- The Corps division office presently uses two models to forecast the Ohio mainstream and is experimenting with a conceptual model.
- TVA uses four self-generated models to provide various types of forecasts.

Missouri River Basin

Duplication occurs in the data collection and forecasting operations in the Missouri River Basin, although it is not as extensive as in the Ohio River Basin. Corps operations in the Missouri River Division are more centralized than in the Ohio River Division, but they still collect and store information and prepare stream forecasts for the same area covered by the NWS Missouri River Forecast Center. Bureau of Reclamation projects throughout the area collect and share data, but real-time storage and use of this data is generally restricted to the local project office.

Both the Corps and the River Forecast Center maintain overlapping gauge networks throughout the Missouri River Basin. The Corps and the River Forecast Center use basically the same communication methods in the Missouri basin as are used in the Ohio basin, with the River Forecast Center the center of a basinwide data collection system, and Corps efforts centered in the districts. Bureau projects collect information within each individual project area with little collection effort outside that area.

As in the Ohio basin, forecasting units exchange gauge readings but store and use them separately. The Corps Kansas City District exchanges information on the lower Missouri River Basin directly with the River Forecast Center, which is located in the same building. The Omaha District, however, exchanges information with NWS principally through the local NWS offices. Bureau information is collected at the project office and is generally telephoned to either the Corps or the River Forecast Center after it has been input to the project office system.

The Corps in the Missouri River Basin maintains a single data base for the entire basin. Corps offices use remote terminals to input and extract data from the central data base. The same data base is used by the division office for regulating hydropower facilities on the Missouri mainstream and by the district offices for regulating facilities in their areas. The Corps uses a timesharing agreement to provide data processing and computer services.

Bureau projects in the Missouri River Basin do not maintain separate storage for water data they collect. Information received in the project offices is generally input to an overall system that monitors and controls the operation of the facilities in the project. This system includes facility operation data, water use requirements for project purposes, such as irrigation or hydropower, and other information needed to operate the project.

Although the Corps and the NWS River Forecast Center systems duplicate equipment and staff in the Missouri basin, there is less duplication of actual forecasting than in the Ohio River Basin. The Missouri River Forecast Center routinely forecasts the basin rivers and streams daily. Corps officials told us that while the division office generally runs mainstream forecasts daily, under routine circumstances Corps districts use the forecasts generated by River Forecast Center for information needed to regulate their facilities. Districts run independent forecasts only during floods, or if there is need for some type of special operation. A Corps-generated forecast model is maintained on the contractor's computer and can be used by the division or district offices as needed.

AGENCY COMMENTS AND OUR EVALUATION

The Department of the Army said that the report overstated the degree of duplication between real-time data collection and stream forecasting systems, because forecast points and data requirements differ from system to system. (See app. II.) TVA said that there was no duplication between TVA forecasts and those of the Corps and the NWS River Forecast Centers. (See app. V.) The Bureau of Reclamation agreed there was duplication of forecasting effort, but said that this resulted from differences in agency functions and specific forecasting requirements. (See app. IV.)

We believe that while different agencies may not forecast the same points on a particular stream and may not use all the information collected by all the agencies in the area, maintaining separate data collection systems, multiple level networks to exchange data with other agencies, separate computer facilities to process and store the same basic information, and separate

capability to forecast different points on the same streams represent a duplication of equipment, staff, and effort.

While systems in the Ohio and Missouri River Basins indicate that duplication of equipment, staff, and effort occurs, we also found an operational system that demonstrates that such duplication is not necessary. This system and its implications for other federal agency systems are discussed in the next chapter.

CHAPTER 3

ACTION IS NEEDED TO REDUCE DUPLICATION

OF STREAM FORECASTING EFFORTS

The intensive water management requirements of the Pacific Northwest provided the impetus for eight federal agencies³ to develop a single, multiagency system that meets the water information needs of each agency. Among other things, this system features a central computer facility used by all agencies and a joint Corps and NWS stream forecasting system. We found that this consolidated approach to meeting common information requirements reduced not only duplication of equipment and forecasting effort but also provided improved information services to the participants.

To test the applicability of a consolidated approach to other hydrographic regions, we used the basic concepts of this system to formulate a consolidated real-time data collection and stream forecasting effort for the Ohio River Basin. We found that a consolidated system would be practical and could reduce the Corps' anticipated computer equipment purchase by up to \$452,000 and annual operation and maintenance cost by up to \$208,000. While the savings at this one site cannot be directly projected to other regions across the country, we believe that similar savings would be possible in many of the major hydrographic regions where consolidated systems do not currently exist.

CONSOLIDATED SYSTEM IN THE COLUMBIA RIVER BASIN

Although federal agencies in the Columbia River Basin operate within the same decentralized management approach used by their agencies in other parts of the country, the intense water management requirements of the basin have prompted development of joint approaches to meeting their real-time water information and stream forecasting needs. In addition to multiple federal water projects in the basin, privately owned hydro-power development, active state participation in water issues, and other factors, such as fish migration needs, have complicated water management. Mechanisms to coordinate these various

³The federal agencies are the National Weather Service, the Corps, the Bureau of Reclamation, Bonneville Power Administration, the U.S. Geological Survey, the Soil Conservation Service, the Forest Service, and the Bureau of Land Management.

factors have developed into close operational coordination that reduces much of the potential duplication between agency efforts.

An important factor in the development of the consolidated system in the Columbia River Valley was the increased hydropower revenue available from precise water management. The need to coordinate flow for hydropower generation without detracting from other project purposes such as flood control, irrigation, and environmental protection has required a high degree of cooperation among the many federal, state, and private agencies in the Pacific Northwest. Coordination of releases from multiple structures in the same stream must be carefully controlled to both maximize peak power generation and equitably distribute flow between the various public and privately owned facilities.

The Corps' North Pacific Division and NWS' Columbia River Forecast Center have been the principle architects of joint approaches to common needs for over 20 years. Among the features of the current Columbia River Operational Hydromet Management System (CROHMS), which became operational in 1978, are:

- A single, regional data base used by all agencies to store and process real-time data collected by each agency.
- A single computer system, owned by the Corps, used to collect and process the data and provide the specific information needed by each agency.
- A joint stream forecasting system, established by NWS and the Corps, to provide real-time forecasts for all points required by both agencies.

Consolidated data base

In the Columbia River Basin, both data collection and exchange are coordinated through a single, centralized computer system. The various agencies collect data from designated areas of the basin and place it in a central data base. Readings from over 1,300 real-time precipitation and stream gauges are processed and used to update the data base. Once the raw data file has been updated with new readings, the computer uses the information to create a series of special reports. Both gauge readings and special reports are available to all participating agencies by access to the central computer.

The central computer report file provides specialized information reports tailored to the requirements of the individual user. Among the approximately 200 reports produced daily by the CROHMS system are:

- Basin condition summary reports of stream flow and precipitation in particular stream basins.
- Information needed for hydropower planning and scheduling.
- Reports that list inflow and outflow from individual water projects.

Direct access to the information in the CROHMS data base can be obtained either automatically or on an as needed basis. Participating agencies in the CROHMS system have computer terminals that can access either reports or gauge readings.

Direct computer links automatically exchange water data with more comprehensive data systems operated by two of the participating agencies. Water quantity data is one of several types of information stored by the Bonneville Power Administration in its complex, computerized system that regulates generation, transmission, and marketing of hydropower. Similarly, the Bureau's Pacific Northwest Regional Office located in Boise, Idaho, maintains its own real-time data base for scheduling hydropower and irrigation releases from Bureau facilities.

Joint forecasting

Joint real-time forecasting by Corps and NWS River Forecast Center personnel is another unique feature of CROHMS. These agencies share the same personnel, equipment, and offices to provide a single forecast that meets both agencies' information needs. The CROHMS data base and a single, jointly developed model are used to forecast all points on the rivers and streams in the Columbia River Basin that are needed by the Corps and the River Forecast Center. The most current forecasts are placed in the CROHMS report file for access by all participants and are used to generate specific special reports for all participating agencies.

The joint forecasting system in the Columbia River Basin does not change the responsibilities or duties of either the Corps or the River Forecast Center. In routine situations, the same forecasts are used by NWS to meet its forecasting responsibilities and by Corps division and district personnel to regulate Corps structures. In flood situations or other nonroutine operations, Corps personnel utilize the system to make the necessary facility operational decisions, which are automatically reflected in the NWS flood warnings.

Joint forecasting represents a major reduction in the Corps real-time forecasting efforts compared to the other locations we visited. As the automated system became operational and the

forecasting model was completed, Corps participation in the day-to-day real-time operations decreased. Currently, one Corps staff member is assigned to the forecasting unit for routine liaison with the division and districts. Corps personnel have complete access to the entire CROHMS system for any additional forecasting for flood control studies or other regulatory purposes.

Consolidation provides additional benefits

The joint system in the Pacific Northwest reduces not only the duplication of equipment and effort between the Corps and the River Forecast Center, but it also provides other benefits. In addition to access to a large volume of information gathered by other agencies, participants benefit from the automated data processing and communications capability of the CROHMS. Finally, the interagency cooperation needed to develop and maintain the system continues to provide indirect benefits in terms of closer contact and communication between each participating agency's personnel.

Both Corps and NWS River Forecast Center officials in the Columbia River Basin said that their joint efforts provide them improved capability at reduced costs. NWS personnel cited the increased amount of information available under CROHMS and the reduced time needed to produce accurate, up-to-date forecasts as the principal benefits of their participation in the consolidated system. Corps personnel identified improved forecasting and reduced staff effort for data collection and real-time forecasting as major benefits. Both Corps and River Forecast Center personnel said that the consolidated system met their operational requirements for real-time water information and stream forecasts without detracting from their other operational responsibilities.

Similarly, other federal and nonfederal agencies in the region benefit from their participation in CROHMS. Representatives of these agencies cited a number of advantages to participation in the consolidated system, including

- access to information from over 1,350 gauges each day although most participants operate less than 125 gauges;
- routine access to specifically tailored, processed, and formatted reports;
- routine access to real-time stream forecasts; and
- elimination of multiple level communication for data exchange.

The consolidated system in the Columbia River Basin has also produced indirect benefits as a result of the cooperation between the agencies involved. For example, different formats for collecting, transmitting, and storing information have always complicated or even prevented timely exchange of information between agencies nationwide. The agencies involved in CROHMS developed and refined a standard format for such information to facilitate data exchange. In 1983 NWS, the Corps, and other agencies collecting real-time water information agreed to adopt this format as a national standard for exchanging water information.

MULTIPLE SYSTEMS IN THE OHIO RIVER BASIN COULD BE CONSOLIDATED

To test the feasibility of using consolidated real-time forecasting systems in other hydrographic regions, we applied the basic concepts used in the CROHMS system to the performance requirements shown in the Corps' Ohio River Division's 5-year master improvement plan to provide a more centralized alternative to real-time data collection and forecasting in the Ohio River Basin. Because Corps systems in the Ohio River Basin are currently decentralized, the first step in consolidating Corps and NWS efforts must be a centralization of Corps systems that preserves the districts access to the information and forecasting capability needed to regulate their structures. The principal features of this system are:

- Centralization of Corps real-time water quantity data in a single regional data base.
- Use of this data base by the NWS Ohio River Forecast Center.
- Modification of current Ohio River Forecast Center procedures and models to forecast all points needed to meet the real-time operational requirements of both agencies.
- Routine access to the data base and forecast capability by the Corps, including remote access by Corps districts, to obtain information needed for facility regulation and operational studies.

Because transition to such a system would have to be gradual to insure that operational requirements are met, we assumed that full implementation would occur over the same 5-year period covered in the original Corps plan.

We believe that transition to a consolidated real-time approach by the Corps and the Ohio River Forecast Center would provide a number of benefits. Our analysis indicates that such

an approach would reduce the computer equipment procurement and maintenance costs of planned Corps systems. We also believe that joint real-time forecasting would free Corps hydrologists for other tasks, while providing the information needed by both agencies to meet their operational responsibilities.

We discussed the consolidated forecasting approach for the Ohio River Basin with officials of the Corps Ohio River Division and the NWS Ohio River Forecast Center. Corps officials said that due to differences in the hydrology and nature of water problems between the Columbia River and the Ohio River, there was no guarantee that the system in the Columbia River Valley would be successful in the Ohio River Basin. While both agencies agreed that benefits could be obtained from consolidation, each expressed concerns that a consolidated system might detract from the performance of their individual responsibilities. They acknowledged, however, that Corps and NWS experience in the Columbia River Basin demonstrated that institutional restraints could be overcome and that a consolidated system could meet the operational requirements of both agencies.

Savings would result if Corps systems were centralized

At some time during consolidation of the Corps and NWS forecasting efforts in the Ohio River Basin, Corps decentralized forecasting would have to be centralized to avoid continuing duplication. We believe that, over the next 5 years, this centralization would reduce the cost of the Corps' currently planned expansion. Our analysis of the potential savings available from centralizing Corps operations in the Ohio River Basin indicated that planned computer procurement costs could be reduced by up to \$452,000 and computer operation and maintenance costs could be reduced by as much as \$208,000 annually.

To test whether the centralized processes and concepts of the CROHMS operation in the Columbia River Basin would be feasible and cost effective if implemented in other river basins, we applied these concepts to provide a basic centralized alternative for the Ohio River Basin. This alternative to the Corps Ohio River Division approved decentralized 5-year improvement plan was admittedly a basic plan, but we believe that actual cost reductions from design and procurement of a centralized system would differ little from our analysis.

Ohio River Division officials agreed that this system would provide the same basic capability available in the existing 5-year plan. They said, however, that additional computer capability would be required if NWS River Forecast Center personnel were to use Corps facilities for real-time forecasting. While our review of the CROHMS system indicates that additional

computer capacity would not be needed, we calculated computer equipment savings based on two alternatives: a capability comparable to current plans using two central processing units for the basic computer capability and an increased capability configuration utilizing a cluster of three central processing units.

Our analysis indicates that centralizing Corps real-time data collection activities could be easily accomplished over the next 5 years by redirecting existing procurement plans. In addition, both of our alternative approaches showed considerable potential for cost reductions over the Corps' decentralized plan. Depending on the size of the processing capability, these savings range from about \$186,000 to \$208,000 annually for computer operations and maintenance and about \$208,000 to \$452,000 in computer equipment procurement costs.

Our analysis was limited to areas where we could measure an increase or decrease in either cost or system efficiency from centralizing current systems. The areas were computer operations-related personnel costs, hardware acquisition and maintenance costs, and software acquisition and maintenance costs. Other areas such as application software development and maintenance, communications, and personnel requirements to operate the information collection operations were considered but were not included in our cost comparisons because specific performance criteria for a centralized system would have to be defined by the Corps. Current Corps plans, however, will require expenditures in these same areas for each of the five components in its planned decentralized system. Therefore, we believe that a centralized approach will not increase costs in these areas and could provide additional savings over development of five smaller centers.

Although Corps Ohio River Division officials agreed with the feasibility of centralizing Corps efforts, they said that a more detailed cost analysis would be needed to define specific savings. Corps officials in the Ohio River Division reviewed our concept and said that such a centralized data base could meet their operational needs and reduce the computer costs of their planned expansion. They said that they will review their current 5-year plan to define a specific divisionwide system that will provide a more definite idea of the total cost-saving potential of this approach.

Consolidated forecasting would provide additional benefits

Once Corps data collection systems are centralized, formation of a consolidated Corps and NWS stream forecasting center would provide additional benefits. As demonstrated by the

CROHMS system in the Pacific Northwest, such a joint effort can forecast all the locations needed by both agencies to meet their real-time operating requirements. In the Corps, consolidated real-time forecasting could actually enhance facility operation by releasing hydrologists to perform beneficial studies of facility operation improvements.

Joint forecasting between NWS and the Corps in the Ohio River Basin would require development of a mutually acceptable forecast model to meet the operational needs of both agencies. NWS personnel told us that the reservoir inflow data, additional forecast points, and other information needed by the Corps could be added to the existing River Forecast System model to provide the information the Corps needs for daily facility regulation decisions. Corps personnel would supply reservoir operation plans for input to the forecast. Corps personnel would review the initial forecast, make any changes needed in planned operations, and input the new operations to the forecast model to produce an accurate, up-to-date forecast for NWS purposes. After daily forecasts are completed, the central data base and computer capability of the system would be available for special hydrologic or engineering studies.

Once the joint model was developed, implementing a joint forecasting center would have minimal operational impact on the NWS Ohio River Forecast Center operations. Our discussions with NWS personnel indicate that it is unlikely that River Forecast Center equipment needs would change because most existing equipment interfaces with NWS meteorological services, and the current computer provides needed data links to other NWS meteorological and information systems. Similarly, because there would be no change in responsibility for preparing public forecasts and warnings and other hydrological services, it is unlikely that staff requirements would change.

Joint forecasting with NWS would provide not only the Corps the real-time information needed for facility operations but also would free Corps personnel for other efforts. Currently, Corps personnel in each district and the division office perform the data collection and forecasting functions for facility regulation purposes each day. Once a joint system is in operation, the routine tasks associated with forecast preparation would be handled by NWS personnel as is currently being done in the Corps' North Pacific Division. In the CROHMS system, only one Corps staff member is assigned to the forecasting unit on a full-time basis. Transition to joint real-time forecasting, therefore, would release Corps personnel to perform other hydrologic tasks such as revision of facility operating plans and studies to improve and coordinate basinwide operations.

Consolidated system could help meet future Corps needs

Consolidating data collection and forecasting could also help the Corps meet future operational needs. As Corps water management tasks have become more complex, operational units have become increasingly aware of the need to deal with multiple facility river basins as a single interactive system, rather than operating structures independently. The need for this approach will increase as hydropower generation becomes more widespread on federal structures.

Recent federal initiatives to encourage private development of hydropower at federal facilities could have a major impact on Corps and other federal agencies' water management requirements. Although few federal structures in the Ohio River Basin currently have hydropower capability, almost every federal structure has either a permit or a license application pending with the Federal Energy Regulatory Commission. Experience indicates that about 30 to 40 percent of these applications will eventually result in licenses. Such an increase in hydropower facilities in a single, interdependent river basin would considerably increase the Corps' water management task.

A preliminary Ohio River Division study of hydropower's impact on its real-time water information system was completed in 1983. The study cited a need for more information, equipment, and precise data collection and forecasting in both division and district reservoir control centers. Specifically, the study cited the need for

- regulating facilities as a single, interrelated system rather than individual structures;
- improving modeling capability;
- improving communication capability; and
- collecting more precise data.

While this initial study did not quantify these needs or estimate the cost of the improvements, it did anticipate that more equipment and additional district and/or division personnel would be required to meet forecasting needs. These increases would be in addition to the currently approved 5-year plan we used as the Corps baseline for our comparison.

The type of performance capabilities identified in the study are operational today in the centralized CROHMS system in the hydropower-rich Pacific Northwest. Transition to a jointly operated regional forecast center could meet the needs identified in this study, possibly without personnel increases.

CONCLUSIONS

The results of our application of consolidation concepts to the Ohio River Basin indicate that benefits would result from establishing a joint regional data center in this basin. We believe that similar benefits may be possible in other river basins where more than one agency has established a capability to collect and store hydrometeorological information and prepare stream forecasts to meet agency-specific requirements.

Each river basin, however, may present a different set of factors, such as water use and characteristics and differing agency responsibilities, which must be considered in developing a consolidated system to assure that all agency requirements are met.

To realize the full benefits of consolidation, all agencies engaged in gathering, storing, or otherwise using water data within the basin should participate in the establishment of joint regional data centers. While the Corps and the Weather Service can provide a framework for regional cooperation, an active effort will be needed to solicit the participation of other agencies in each region. We believe that the benefits cited by CROHMS participants will provide the incentive needed to enlist other agencies, particularly if they are given the opportunity to participate in the planning and implementation of the regional system. Such a multiagency effort can also provide an effective vehicle for dealing with other regional water issues.

RECOMMENDATIONS

We recommend that the Secretary of the Army direct the Chief of Engineers and the Secretary of Commerce direct the Administrator, National Oceanic and Atmospheric Administration, to study the overall feasibility of creating joint Corps/Weather Service stream forecast centers and establish such centers in those hydrographic regions where the operational requirements of both agencies can be met and duplication eliminated.

We further recommend that the Secretaries of the Army and Commerce direct the Chief and the Administrator, respectively, to actively solicit the input and participation of other agencies concerned with water data collection and stream forecasting in those regions.

AGENCY COMMENTS AND OUR EVALUATION

The Army and the National Oceanic and Atmospheric Administration agreed that opportunities may exist to consolidate stream forecasting activities. Because there is merit in

bringing data collection, streamflow forecasting, routine reservoir regulation, and water supply forecasting activities closer together, NOAA recommended the formation of a study team by the Corps and the Weather Service. The Army also said that it would explore the possibilities for joint operation centers with NWS; an initial joint meeting, at the technical level, has been scheduled. We are encouraged by the actions the Army and NOAA are taking to explore the possibilities of establishing joint operational centers.

In commenting on this report, however, the Army said that neither the feasibility nor the stated cost savings for the Corps/Weather Service consolidation in the Ohio River Basin have been adequately demonstrated or documented in the report and that the extent of duplication was overstated because the Weather Service does not forecast the same points on a river. In addition, Army said that opportunities to consolidate stream forecasting are limited, in part, because Corps and Weather Service boundaries and facility locations are different. (See app. II.)

We believe that the report adequately demonstrates the potential cost savings by consolidating Corps and Weather Service activities in the Ohio River Basin. The system we devised for centralizing Corps activities in the Ohio River Division was based on anticipated Corps needs as well as additional capacity to consolidate the Corps/Weather Service stream forecast effort. This system was reviewed and commented on by both Weather Service and Corps officials in the Ohio River Basin. Corps officials agreed with the feasibility of this system but said that a more detailed cost analysis would be needed to define specific savings. Weather Service officials said that consolidation was feasible and would not increase staff or equipment needs.

We agree with the Army that the Corps and the Weather Service do not forecast the same points on a river. However, all forecasting points could be included in a consolidated system thus eliminating duplicate equipment and effort.

We also agree that agency boundaries and facility locations are not identical. Although this may pose some institutional problems, it does not create technical limitations on the ability to use a common information system. While a particular sub-basin may be included in one division by the Corps and a different geographic region by NWS, the sub-basin must be treated as a distinct entity by both. Under current arrangements, the Corps exchanges information on these basins with the cognizant River Forecast Center. With modern communications capability, equipment needed to operate a joint system could be physically

located in a Corps district, or even outside the division boundaries. For example, the Corps Missouri River Division and district offices use the North Pacific Division's large computer in Portland, Oregon, for their common data base and forecasting capability.

The partnership established in CROHMS provides both real-time forecasts and other capabilities needed by the Corps and the NWS. The Corps owns the computer which contains the CROHMS data base, forecasting model, and related software and provides more than adequate capability to meet the Corps' other facility regulation requirements. The NWS River Forecast Center computer (which is identical to the computers in other River Forecast Centers) links CROHMS to the extensive NWS hydrometeorological data network and provides the capability to meet other River Forecast Center needs. Both agencies provided the personnel and information needed to develop the joint forecasting model and related software. This system is operated by a normal complement of NWS personnel in routine circumstances, but knowledgeable Corps personnel are available to both supplement NWS staff in nonroutine circumstances and to carry out other Corps regulatory functions. Therefore, the CROHMS system demonstrates not only that even the most complex water data management problems can be handled jointly but also provides a general framework for maintaining the integrity and missions of the agencies involved.

The Bureau of Reclamation agreed that in some cases a consolidation of stream forecasting efforts could be effective and reduce overall costs and cited the Colorado River Forecasting Service as an additional example of consolidation. It cautioned, however, that such consolidation be done on a case-by-case basis to ensure that the agencies specific forecasting requirements continue to be fully met. The Bureau said that it will cooperate with the NWS and Corps in any efforts resulting from our recommendations. (See app. IV.)

LOCATIONS GAO VISITEDArmy Corps of Engineers

Office of Chief of Engineers, Hydrology and Hydraulics
Branch, Washington, D.C.

Ohio River Division, Reservoir Control Center,
Cincinnati, OH

Louisville District, Hydrology & Hydraulics Branch,
Louisville, KY

Huntington District, Hydrology & Hydraulics Branch,
Reservoir Control Section, Huntington, WV

Pittsburgh District, Hydrology & Hydraulics Branch,
Reservoir Regulation Section, Pittsburgh, PA

Nashville District, Hydrology & Hydraulics Branch,
Reservoir Regulation Section, Nashville, TN

Missouri River Division, Reservoir Control Center,
Omaha, NE

Omaha District, Hydrologic Engineering Branch,
Reservoir Regulation Section, Omaha, NE

Kansas City District, Hydrologic Engineering Branch,
Hydrology & Hydraulics Section, Kansas City, MO

North Pacific Division, Reservoir Control Center,
Portland, OR

Portland District, Reservoir Regulation Section,
Portland, OR

U.S. Department of Commerce, National Oceanic and
Atmospheric Administration

National Weather Service, Office of Hydrology,
Washington, D.C.

Ohio River Forecast Center, Cincinnati, OH
Louisville Weather Service Forecast Office,
Louisville, KY

Missouri River Forecast Center, Kansas City, MO
Denver Weather Service Forecast Office, Denver, CO
Columbia River Forecast Center, Portland, OR

Department of the Interior

Bureau of Reclamation, Staff Assistant for Operations,
Washington, D.C.

Lower Missouri Regional Office, Water and Land
Operations Branch, Denver, CO

South Platte River Project, Water Scheduling
Division, Loveland, CO
Nebraska-Kansas Projects, Water Control Field
Branch, McCook, NB

Pacific Northwest Regional Office, Reservoir and
River Operations Branch, Portland, OR

Tennessee Valley Authority

Field Operations Branch, Knoxville, TN
Data Services Branch, Knoxville, TN
Reservoir Operations Branch, Knoxville, TN

Bonneville Power Administration

Hydrometeorological Branch, Portland, OR



DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, DC 20310

25 APR 1984

Mr. J. Dexter Peach
Director, Resources, Community, and
Economic Development Division
U. S. General Accounting Office
Washington, D. C. 20548

Dear Mr. Peach:

This is in response to your March 15, 1984 letter to the Secretary of Defense requesting comments on the draft GAO report, "Consolidating Federal Stream Forecasting Efforts Could Save Money," GAO/RCED 84-104 (OSD Case No. 6471).

Specific responses to the relevant findings and recommendations contained in the draft report are enclosed.

Sincerely,

W. R. Gianelli
William R. Gianelli
Assistant Secretary of the Army
(Civil Works)

DEPARTMENT OF DEFENSE RESPONSE
GAO DRAFT GAO/RCED-84-104
"CONSOLIDATING FEDERAL STREAM FORECASTING EFFORTS
COULD SAVE MONEY"
GAO CODE NO. 085653

OSD CASE NO. 6471

* * * * *

FINDINGS

FINDING A: Stream Forecasting Is An Important Part of Federal Water Management. GAO found that rapid, accurate forecasts of water flow in the nation's rivers and streams are an important element of Federal water management and flood control efforts. GAO further found that systems to forecast stream flow and precipitation data are becoming increasingly expensive, as better technology becomes available and as use of expensive, automated, real-time data communications networks grows in stream forecasting. (p. 1, GAO Draft Report).

RESPONSE: DOD concurs

FINDING B: Several Agencies Share Federal Responsibility for Stream Forecasting. GAO reported that several Federal agencies share responsibility for stream forecasting. The National Weather Service (NWS) of the Department of Commerce maintains 13 regional river forecast centers which, having no other weather forecasting responsibilities, serves as the focal point of NWS stream forecasting and expertise nationwide. GAO found that despite having similar data requirements, the Army Corps of Engineers and other operating agencies, such as the Bureau of Reclamation and the Tennessee Valley Authority, have established independent forecasting systems in local or regional offices. GAO further found that these four major Federal stream forecasters have \$41 million invested in stream forecasting systems and spent \$61 million to operate and maintain these systems in FY 1983. GAO also found that the Corps and NWS plan to spend at least \$46 million to modernize their systems over the next 5 years. (See pp. 1-2.)

RESPONSE: DOD partially concurs. Only a portion of the Corps and NWS data requirements overlap. NWS does not forecast at all points required by the operating agencies. Therefore, to meet operational requirements, the operating agencies have developed some capability of their own. The NWS data base includes far more meteorologic data, while operating agencies include considerable amounts of project and system operational data. NWS does not have a need for archiving data. Other software makes up the complete system, thus, funding amounts are questioned. It should be noted that the GAO cost data for the Corps on page 2 are for Corps-wide water control system operation rather than for stream forecasting only.

GAO Note: Page references in this appendix have been changed to correspond with page numbers in the final report.

Relatively small amounts of water control funds (less than 20 percent) are expended for solely forecasting activities. In fact, some districts and divisions are wholly dependent on NWS for forecasting information. Most funding shown in the report is related to facility regulation responsibilities.

[GAO COMMENT: While the National Weather Service does not currently forecast all points required by the operating agencies, a joint system in each hydrographic region could. Similarly, while the Service and the Corps each require information not needed by the other, a joint data base containing all data could meet the needs of both while eliminating duplicate communication and information storage expenses. Changes were made in the report to clarify the nature of Corps and NWS River Forecast Center stream forecasts. While less than 20 percent may be required for actual preparation of forecasts, the vast majority of the Corps' data collection expense results from the requirement for real-time data which is not necessary for nonreal-time regulatory activities. However, because of the lack of information on the actual investment and costs for these systems we have deleted the table on page 2.]

FINDING C: The Corps Of Engineers Decentralized Approach To Stream Forecasting. GAO found that, because of its decentralized approach to management, the real-time hydrologic data system needed to support the Corps' operation of water projects and its responsibility for Federal flood control efforts are centered in the 36 Corps district offices. In addition, the 10 CONUS divisional offices of the Corps have responsibility for coordinating the stream forecasting and other operations of district offices within their respective areas. (See p. 2.)

RESPONSE: DOD concurs. Although the real-time water control data systems in the Corps have been developed based on an overall division Master Plan approved in OCE, the Corps data systems have been developed division-by-division to address varying needs.

FINDING D: Interdependence Of River Forecasting System. GAO found that stream forecasts prepared for flood warning use the same information and forecasting process and are heavily interdependent with those prepared for facility regulation. GAO reported that all forecasting systems must be organized to cover the same geographic areas since they must be based on river drainage basins. (See p. 6.)

RESPONSE: DOD concurs. Stream forecasts do use much of the same information; however, it is important to note that the NWS River Forecast Centers do not forecast at all points required by the operating agencies. Timeliness and extent of detail also are important. Finally, NWS's River Forecast Centers and Corps' division offices are generally not responsible for identical geographic areas nor are they located in the same cities.

[GAO COMMENTS: See our comment under finding B above concerning forecast points. See Agency Comments and Our Evaluation on pages 25 and 26 for discussion of boundary differences and lack of co-location.]

FINDING E: NWS Provides National Forecast Coverage. GAO found the NWS has developed a standardized data software package and a stream forecasting model that can be applied to any stream basin and is being implemented in 11 of 13 NWS Centers. GAO also found that despite having nearly identical information and forecasting requirements, the operating agencies have established independent stream forecasting systems that overlap the existing NWS Centers. GAO concluded that duplication of equipment, staffing and forecasting effort occurs in many phases of Federal stream forecasting, and that the incidence of duplication varied from region to region but exists on a nationwide basis. (See pp. 7-8.)

RESPONSE: DOD partially concurs. The Corps and NWS do not have identical information and forecasting requirements. In fact, NWS forecasts do not provide national coverage. Less than one-third of the locations of interest to the Corps are forecast by the NWS's River Forecast Centers. The Corps and NWS do not collect common data to perform agency functions. Hydrometeorological data collected are shared and exchanged between the two agencies. The existing NWS stream forecasting package is not adaptable for all Corps uses. The Corps is presently working closely with the NWS to adopt the NWS software for inclusion in and application with the Corps real-time regulation models.

[GAO COMMENTS: See our comment under finding B on page 31 concerning forecast points. Current Corps and NWS efforts to adapt NWS software concentrate on automating exchange of raw data. This data, once exchanged, is processed, stored, and used separately by the various Corps and NWS data centers. Under current conditions, more successful data exchange will expand the respective data bases and increase the duplication between the agencies' multiple data bases.]

FINDING F: The Corps and Bureau of Reclamation Believe They Require Independent Forecasting Systems. GAO reported that both the Corps of Engineers and the Bureau of Reclamation believe management of water projects must be decentralized and that they must control their own information systems and forecasting capability in order to meet their operational responsibilities. GAO found that both agencies expressed a strong reluctance to integrate their operations with other agencies' river forecasting activities. (See p. 8.)

RESPONSE: DOD partially concurs. The Department agrees that water control management must be decentralized; however, DOD does not concur that a strong reluctance to integrate activities exists. Integration of activities has been accomplished in the Pacific Northwest as was noted by GAO. The problem is that opportunities to do this elsewhere are limited by the fact that NWS's River Forecast Centers and Corps' division offices are not co-located (Cincinnati and Atlanta are exceptions). Furthermore, areas of geographic responsibility are not compatible, so without realignment, use of common facilities would be very difficult. For example, Southwestern Division would have to coordinate data management with NWS's River Forecast Centers in Ft. Worth, TX, Tulsa, OK and Slidell, MS. Conversely, the Cincinnati River Forecast Center must coordinate with North Central Division and TVA in addition to the Ohio River Division.

[GAO COMMENT: We have added a sentence on page 8 to recognize this position. However, field level personnel who would ultimately implement any agreed upon consolidation did express a reluctance to significantly change their current operations. Accordingly, intensive management attention will be needed to offset this reluctance if the program is to be successful. See Agency Comments and Our Evaluation on pages 25 and 26 on lack of co-location.]

FINDING G: Decentralization of Corps of Engineers Stream Forecasting Nationwide. GAO found that the Corps is pursuing a program to increase real-time stream forecasting capabilities, but that decentralized management leaves control of system design, procurement and operational decisions in the hands of the 36 district offices. The result is wide variation in system capabilities at both the division and district levels. GAO also found that Corps Headquarters officials did not know to what extent the data collection and forecasting activities of the district offices duplicated work performed by either the Corps division offices or by other agencies in a given region. (See pp. 8-9.)

RESPONSE: DOD partially concurs. The Corps is not pursuing a program to increase real-time forecasting capabilities. Rather, the Corps is pursuing a program to increase water management capabilities, i.e., facilities regulation. It is the Corps belief that decentralized management is desirable for timely and reliable regulation of Corps projects. Control of system design and procurement, however, rests with the 10 CONUS division offices through the OCE approved Water Control Data Systems Master Plans. (Also see response to Finding F).

[GAO COMMENT: Changes were made to page 8 to clarify that upgraded stream forecasting capability is part of this program, not necessarily the objective, and to recognize that the divisions are the responsible offices.]

FINDING H: Duplication of Forecasting Efforts In The Ohio And Missouri River Basins. GAO studied stream forecasting systems in two major river basins said to be representative of nationwide efforts (the Ohio and Missouri River Basins) and found independent systems covering the same hydrographic areas. The overlapping Corps and NWS systems were found generally to forecast the same rivers and streams on a daily basis. For the Ohio River, GAO was unable to determine the extent to which the same information appears in different data bases but found indications that it may be substantial. GAO found less duplication in the Missouri than the Ohio River Basin, but concluded there was duplication of equipment and staff through all phases of the real-time stream forecasting effort in both regions. (See pp. 9-13.)

RESPONSE: DOD partially concurs. Missouri River and Ohio River Divisions are not "representative." Rather, along with the North Pacific Division, they indicate the degree of division involvement in real-time water control management. These divisions are not typical of Lower Mississippi Valley, North Atlantic, North Central, South Atlantic or the South Pacific Divisions where division involvement is minimal and facility regulation considerations are quite different. The degree of duplication is overstated; however, some savings may be possible. Corps forecasting activities are the result of either a need not met by the NWS (e.g., many reservoir inflow points) or evaluation of facility regulation effects.

[GAO COMMENT: Corps headquarters officials told us that because of the wide difference in approaches to real-time data collection and stream forecasting in the Corps Divisions, there were no divisions that could be considered representative of Corps efforts nationwide. Our selection was therefore based on reviewing basins that represented varied operational approaches and stream forecasting systems. Changes were made to page 3 of the report to clarify the basis of our selection. We also revised the conclusions on page 24 to state that our findings relative to duplication refer only to the Ohio River Basin, and we have modified our recommendation (see our comment on page 36 on Recommendation 1) to study the feasibility of centralizing operations elsewhere. See also our comments under finding B on page 31 concerning forecast points.]

FINDING I: Consolidated Forecasting System Works In the Columbia River Basin. GAO found a multi-agency operational system in one region, the Pacific Northwest, which demonstrates that an integrated system can meet common information and forecasting needs without the duplication existing in other regions. GAO found that the intense water management requirements of the Columbia River Basin have stimulated development of close operational coordination of hydrographic data collection and forecasting, which eliminates most of the potential duplication of agency efforts. GAO concluded that the increased hydropower revenue available from precise water management is an important factor in the consolidated approach. (See pp. 15-16.)

RESPONSE. DOD concurs.

FINDING J: Consolidated System Reduces Duplication In Columbia River Basin. GAO found that the Columbia River Operational Hydromet Management System (CROHMS), designed primarily by the Corps and NWS, provides coordination of data collection and an integrated report file operated through a central computer, plus joint real-time forecasting by Corps and NWS personnel. GAO also found that the Corps and NWS share the same personnel, equipment and offices to provide through CROHMS a single forecast which meets the information needs of both agencies. GAO concluded that the joint system not only reduces duplication of effort but also provides improved forecasting capability with reduced staff effort and cost. (See pp. 16-19.)

RESPONSE: DOD concurs. It should be noted that the CHROMS system is much broader than just the forecast mission in that it includes real-time facilities regulation. It also should be emphasized that forecasting and regulation cannot be separated.

FINDING K: CHROHMS Leads To Interagency Agreement. GAO found that Corps and NWS participation in CROHMS led to an effort to have such a system adopted nationwide, and the result was an agreement among NSW, the Corps and other agencies collecting real-time water information to adopt the CROHMS format as a national standard for exchange of water information. (See p. 19.)

RESPONSE: DOD partially concurs. No effort has been made to adopt a CHROMS type system nationwide. The interagency agreement was limited simply to a data format for real-time data exchange. This data format agreement now may be in some jeopardy since there are indications that the U.S.G.S. may not participate.

[GAO COMMENT: Page 19 has been revised to clearly state that the effort referred to in the report addresses only the adoption of a common format for exchange of information.]

FINDING L: Centralization of Corps System In The Ohio River Basin Would Produce Savings. GAO found that a necessary first step in multi-agency consolidation of forecasting in the Ohio River Basin is a centralization of Corps systems in the region. GAO concluded that centralizing Corps Ohio River operations could reduce planned computer procurement costs by up to \$452,000 over five years and computer O&M costs by as much as \$208,000 per year. (See pp. 20-21.)

RESPONSE: DOD partially concurs. DOD concurs that some potential savings may result from centralization or consolidation of the Corps real-time facility regulation system with NWS forecasting efforts in the Ohio River Basin from computer equipment procurement and the associated O&M costs. However, neither the feasibility nor the stated cost savings for the Corps/NWS consolidation in the Ohio River Basin has been adequately demonstrated or documented in the GAO report. Because of the significant potential savings that have been noted, DOD believes that additional studies to determine the feasibility and cost effectiveness of Corps/NWS consolidation in the Ohio River Basin are warranted (see response to Recommendation 1).

[GAO COMMENT: See Agency Comments and Our Evaluation on page 25.]

FINDING M: Ohio River Basin Systems Could Be Consolidated. GAO applied the multi-agency CROHMS approach to the Ohio River Basin as a test of whether it would be cost-effective in other river basins. GAO concluded that consolidation of the Corps Ohio Division forecasting system and the NWS Ohio River Center would benefit both agencies. GAO further concluded this approach would not only reduce computer procurement and maintenance costs but also provide other benefits. GAO reported that while both agencies acknowledge such a consolidated system could meet their operational needs, it would require development of a mutually acceptable forecast model to do so. (See pp. 19-22.)

RESPONSE: DOD partially concurs. See response to Finding L.

FINDING N: Consolidated Forecasting In The Ohio River Basin Would Provide Additional Benefits. GAO found that moving to a joint forecasting system with the NWS would release Corps personnel from current data collection and forecasting functions and enable them to focus on other hydrologic tasks. GAO concluded that consolidating the data collection and forecasting function in the Ohio River Basin could assist the Corps in meeting operational needs in the future, when it is likely to face a much increased water management load in the hydropower area. (See pp. 21-33.)

RESPONSE: DOD partially concurs. See response to Finding L.

FINDING 0: CROHMS Concept Can Be Extended Nationwide. GAO reported that the Columbia River experience, and its test of CROHMS on the Ohio River Basin, indicate that substantial benefits can be realized by establishing joint regional data centers nationwide. GAO concluded that experience with CROHMS shows that consolidated operations can be consistent with the need of operating agencies to be responsive to local conditions. GAO also concluded that agreement to establish joint regional centers by the two national agencies involved in stream forecasting, the Corps and NWS, would provide a national organizational framework that could be used in each region by other operating agencies as well. (See p. 24.)

RESPONSE: DOD partially concurs. The application of the CROHMS concept on a nationwide basis has yet to be proven feasible or cost effective. However, it may be practicable in certain regions. DOD concurs that the concept deserves further study by both the Corps and NWS (see response to Recommendation 1).

[GAO COMMENT: See Finding L.]

RECOMMENDATIONS

RECOMMENDATION 1: Directive To Create Joint Corps/NWS Operational Centers. GAO recommended that the Secretary of the Army and the Secretary of Commerce direct the execution of a Memorandum of Understanding creating joint Corps of Engineers/National Weather Service operational centers for real-time data collection and stream forecasting to meet the operational requirements of both agencies. (See p. 24.)

RESPONSE: DOD partially concurs. The Corps and NWS will explore the possibilities for joint operational centers and implement changes that would improve efficiency. Initial contact for a joint Corps/NWS meeting, at the technical level, has been made. The meeting will be held in early May 1984.

[GAO COMMENT: We have modified the report and now recommend that the Corps and the Weather Service study the overall feasibility of creating joint stream forecasting centers and implement changes, where appropriate. See also Agency Comments and Our Evaluation on page 25.]

RECOMMENDATION 2: Corps and NWS Should Seek The Participation of Other Agencies In Consolidated Systems. GAO recommended that the Secretaries of the Army and Commerce also direct the Corps and NWS to actively solicit the input and participation in the joint regional systems of the other agencies concerned with water data collection and stream forecasting in each region. (See p. 24.)

RESPONSE: DOD concurs.



UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Administration
Washington, D.C. 20230

MAY 04 1984

Mr. J. Dexter Peach
Director, Resources, Community, and
Economic Development Division
United States General
Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

This is in reply to GAO's letter of March 15, 1984, requesting comments on the draft report entitled Consolidating Federal Stream Forecasting Could Save Money (GAO code 085653).

We have reviewed the enclosed comments of the Deputy Administrator for National Oceanic and Atmospheric Administration and believe they are responsive to the matters discussed in the report.

Sincerely,

A handwritten signature in cursive script that reads "Kay Bulow".

Kay Bulow
Deputy Assistant Secretary
for Administration

Enclosure



APR 6 1984

Mr. J. Dexter Peach
 Director, Resources, Community, and Economic
 Development Division
 General Accounting Office
 Washington, D. C. 20548

Dear Mr. Peach:

This is in reply to your letter of March 15, 1984,
 requesting comments on the GAO draft report entitled
Consolidating Federal Stream Forecasting Efforts Could Save
 Money.

We have reviewed the report, and we are pleased that GAO, in
 its overall findings, stresses the vital national role and
 capability of the National Oceanic and Atmospheric
 Administration's National Weather Service (NWS) in meeting the
 real-time flood hazard and water resource forecasting needs of
 the country. Also, we support the concept of GAO's
 recommendations for the Corps of Engineers and National Weather
 Service to create joint operational forecast centers. We
 disagree, however, that all this can be accomplished with
 existing staff and computer resources.

Although regionalized joint centers are feasible and may be
 desirable based upon our experience in Portland, Oregon, there
 are other major considerations that must be taken into account
 before going ahead with a comprehensive consolidation effort.
 For brevity, I will list our more vital concerns:

1) The NWS presently provides inflow forecasts for
 approximately one-third of the 1340 reservoirs owned or operated
 by the Corps. Assuming forecast responsibility for the remaining
 900 reservoirs without a commensurate increase in staff will
 seriously overburden the River Forecast Centers, particularly at
 a time when forecasts for the public are competing timewise with
 forecasts for the Corps.

2) Interactive computer capability will be essential to
 meeting multiple user needs from a joint center. Present NWS
 computer capability is not adequate for this type of operation.

3) Current staffing in the River Forecast Centers is
 adequate to provide one full 8-hour shift a day with limited
 coverage on weekends and holidays. Extended hours of operation
 up to 10 p.m. Monday through Friday are covered at a few
 centers. The increased workload generated by creation of the
 joint centers and 900 additional forecast points can only be
 achieved with additional staff.



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4) Expanding the proposed Corps/National Weather Service joint center would by necessity have to involve the Soil Conservation Service, U.S. Geological Survey, Bureau of Reclamation, power bureaus such as the Bonneville Power Administration, and Tennessee Valley Authority, if it is to be truly an interagency center.

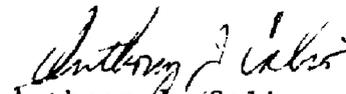
5) Requirements for meteorological input were not addressed, but a joint center would not be complete, from a hydrometeorological viewpoint, without the products from one or more Weather Service Forecast Office(s). This requires major considerations by the Corps and National Weather Service on collocations.

6) Two major issues will be to procure additional computer resources and the integration of forecast procedures. Given the inherent delays in the procurement process and the complexity of forecast procedures and software of the agencies, it is doubtful the 5-year implementation time frame is realistic.

Because there is merit in bringing data collection, streamflow forecasting, routine reservoir regulations, and water supply forecasting activities closer together, I recommend the formation of a study team by the Corps and the National Weather Service to prepare a report on the overall feasibility of accomplishing part or all of the recommendations to create joint forecast centers. Following this it would be necessary to expand the effort to include other agencies.

[GAO COMMENT: Because of the uncertainty associated with the amount of staff and computer resources needed to implement joint forecast centers in all locations, we have modified the report and now recommend that the Corps and the Weather Service study the overall feasibility of creating joint stream forecasting centers and implement changes, where appropriate. The specific time frame for implementing these changes should be determined as part of this study effort.]

Sincerely,


Anthony J. Calio
Deputy Administrator



United States Department of the Interior

BUREAU OF RECLAMATION
WASHINGTON, D.C. 20240IN REPLY
REFER TO:

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APR 13 1984

Mr. J. Dexter Peach
Director
General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

As you requested, we have reviewed the GAO Draft Report to Congress - Consolidating Federal Stream Forecasting Efforts Could Save Money (job code 85653). While the report contains no specific recommendations for the Department of the Interior, we do have some concerns over the conclusions made in the report.

The report fails to fully explain the different functions of the various Federal agencies, and we believe that those differences are largely responsible for any duplication of forecasting effort that may exist. The National Weather Service (NWS) has, as stated in the report, the statutory responsibility for providing flood warnings. Those warnings must be issued for all waterways, whether small streams with no water control structures, or large regulated rivers such as the Ohio, Missouri, or Columbia River. NWS therefore needs extensive forecasting capability in order to adequately provide flood warnings for all rivers and streams. The Corps of Engineers (Corps) has the primary responsibility for directing flood control operations at Corps as well as other Federal dams, along with operating major rivers for navigation purposes. The Corps thus needs forecasts or forecasting capability only for those streams or rivers on which flood control projects or navigation projects are located. The Bureau of Reclamation (Bureau) has the primary function of providing adequate water supplies for irrigation and municipal and industrial uses in the arid Western States. The Bureau is therefore more concerned with monthly, seasonal or annual runoff conditions than with daily flow forecasts, and the forecasting needs and capabilities of the Bureau focus on predicting runoff from existing snowpack in the western mountains.

[GAO COMMENT: We believe that the report provides sufficient information to enable the reader to understand the different functions of the various agencies. (See pp. 2 and 7 to 9.)]

The report is correct in stating that forecasting system information requirements and processes are the same regardless of the use to be made of the forecast, but that factors such as hydrology, climate,

See GAO note on page 42.

Mr. J. Dexter Peach

2

water use, and the role of the Federal Government may vary widely from one river basin to another. The report should go one step further and recognize that the unique functions of the various Federal agencies require different forecasting efforts in terms of forecast location, forecast frequency, and type of forecast. While we agree that in some cases a consolidation of forecasting efforts could be effective and reduce overall costs, we would caution that any such consolidation be done on a case by case basis to ensure that the agencies' specific forecasting requirements continue to be fully met after the consolidation.

[GAO COMMENT: See Agency Comments and Our Evaluation on page 26.]

We believe that a great deal of cooperation in forecasting efforts currently exists among the Federal agencies, and that consolidation of those efforts has already occurred in areas of greatest feasibility for such consolidation. In addition to the Columbia River example cited in the report, we would point out the Colorado River Forecasting Service (CRFS) as a primary example of consolidation. The CRFS involves the NWS, Corps, Bureau, Soil Conservation Service (SCS), Geological Survey (GS), and Western Area Power Administration. The CRFS was formed in 1979. Prior to that time the various agencies had made independent forecasts of Colorado River runoff and streamflow to suit their agency needs. Now the CRFS uses the data from SCS and NWS snow surveys along with GS stream gaging data and Bureau reservoir data to make the needed forecasts to meet all agency requirements.

In other western river basins, the Bureau relies primarily on joint NWS and SCS snowpack data and runoff forecasts in operating projects for water supply functions. In some areas, however, the Bureau does perform its own stream forecasting for smaller tributary streams that directly affect project operations and for which detailed forecasts are not generally issued by the NWS. Even in those instances, the Bureau relies as much as possible on data obtained and developed by other agencies to avoid duplication of effort.

We have the following specific comments on the report:

1. On page ii, the report cites the high cost of Federal stream forecasting systems. We believe that the costs are small in comparison to the benefits provided, and some indication of that fact should be included in the report.
2. On page 9, the first sentence under "Other Agencies" is misleading in that it implies the principal function of real-time stream forecasting systems is to increase hydropower revenue. The Bureau uses real-time forecasts to optimize project operations, which includes water deliveries for irrigation and other uses as well as hydropower generation. On Bureau projects hydropower

[GAO COMMENT: The reference to high cost on page ii has been deleted.]

Mr. J. Dexter Peach

3

generation is generally incidental to water supply deliveries and thus is not the principal function. We suggest that the sentence be revised accordingly.

[GAO COMMENT: Changes were made on page 9 to reflect the Bureau's concern regarding the use of real-time forecasting.]

We appreciate the opportunity to comment on the report, and will cooperate with the NWS and Corps in any efforts resulting from the recommendations made in the report that would involve Bureau projects.

[GAO COMMENT: See Agency Comments and Our Evaluation on page 26.]

Sincerely yours,

Acting 
Commissioner

GAO Note: Page references in this appendix have been changed to correspond with page numbers in the final report.

TENNESSEE VALLEY AUTHORITY

KNOXVILLE TENNESSEE 37902

OFFICE OF THE BOARD OF DIRECTORS

APR 9 1984

United States General
Accounting Office
Regional Office
8112 Federal Office Building
Fifth and Main Street
Cincinnati, Ohio 45202

Gentlemen:

Thank you for the opportunity to review the draft of the proposed report, "Consolidating Federal Stream Forecasting Efforts Could Save Money."

In the Tennessee Valley, TVA has established a gaging network (rainfall and streamflow) to help us operate the reservoir system as efficiently as possible, consistent with recognized priorities by which we must operate the system. We have a very good working relationship with both the United States Army Corps of Engineers (USACE) and the National Weather Service (NWS) for exchange of data useful to all three agencies in carrying out their designated responsibilities. TVA gathers almost all the rainfall and streamflow data in the Tennessee Valley on a real-time basis.

In the Tennessee Valley, there is no duplication between USACE and TVA. Streamflow and rainfall data are collected by TVA and shared with USACE. NWS maintains some data collection stations at TVA streamgauge locations to record historical data to aid in developing future forecasting models. The TVA gages report rainfall and streamflow data on a real-time basis.

The NWS River Forecast Center responsible for issuing flood warnings in the Tennessee Valley is located in Slidell, Louisiana. Information obtained by TVA is provided to them daily by computer and on an as-needed basis. Because of their national responsibility, they issue flood warnings on uncontrolled streams (those having no dams). For storms during which operation of the TVA reservoir system affects river stages in the Tennessee Valley, TVA prepares stage forecasts at strategic points in the Valley and furnishes them to the NWS for dissemination to the general public through their established means. Although TVA prepares storm volume forecasts for streams in order to operate the reservoir system efficiently, we do not issue crest stage forecasts to the general public. This policy avoids duplication and the possibility of conflicting or different crest forecasts for the same location.

See GAO note on page 44.

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APR 9 1984

We also have some specific comments about references in the report to USACE and TVA forecasting activities. The third paragraphs of page IV and page 10 state that a fourth USACE district (Nashville) is responsible for the Cumberland River Basin and part of the Tennessee River Valley. The Nashville District forecasts flows for its operations in the Cumberland River basin, but it does not forecast flows in the Tennessee Valley. TVA forecasts flows for operation of all reservoirs in the Tennessee River Valley. The Nashville District's activities in the Tennessee Valley are limited to other regulatory functions.

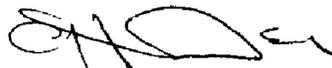
[GAO COMMENT: Changes were made to pages iii and 10 of the report to clarify TVA's interface with other agencies operating in its area.]

Fiscal year 1983 operation and maintenance costs for TVA are shown on the table on page 2 as \$2.1 million. The estimated cost of real-time stream forecasting (gages, communications, and data processing equipment) should be about \$1.2 million. We cannot determine where the \$2.1 million figure might have come from unless it is a typographical transposition or includes the cost of other functions in addition to stream forecasting.

[GAO COMMENT: Costs were provided by TVA reservoir operations personnel to reflect the cost of real-time data collection and stream forecasting. However, because of the lack of information on the actual investment and costs for these systems we have deleted the table on page 2.]

If we can be of further assistance, please let us know.

Sincerely,



C. H. Dean, Jr.
Chairman

GAO Note: Page references in this appendix have been changed to correspond with page numbers in the final report.

(085653)

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