

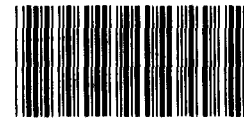
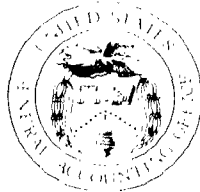
GAO

Report to the Chairman, Subcommittee
on Interior and Related Agencies,
Committee on Appropriations, House of
Representatives

June 1990

GEOGRAPHIC
INFORMATION
SYSTEM

Forest Service Not
Ready to Acquire
Nationwide System



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**Information Management and
Technology Division**

B-230723

June 21, 1990

The Honorable Sidney R. Yates
Chairman, Subcommittee on
Interior and Related Agencies
Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

As previously arranged with your office, we assessed the plans of the Forest Service, Department of Agriculture, to acquire a computer-based geographic information system (GIS) for its field sites nationwide. As agreed, we reviewed the Service's feasibility study, cost/benefit analysis, functional requirements analysis, and other documents related to the planned GIS. Our objectives, scope, and methodology are detailed in appendix I.

On May 2, 1990, we testified before your subcommittee on the matters discussed in this report.¹ We previously reported to you that the Service had an ambitious schedule for completing the feasibility study, cost/benefit analysis, and functional requirements analysis that are prerequisites to a GIS procurement.² We also cautioned that it would be inappropriate to begin a nationwide procurement until these evaluations were properly completed and related issues thoroughly analyzed. In subsequent reports on the 1990 appropriations bill, the House and Senate Appropriations Committees advised the Service to complete all necessary evaluations before proceeding with the GIS procurement.

Results in Brief

While a GIS holds the promise to significantly enhance the ability of the Forest Service to manage and preserve natural resources, the agency is not ready to procure a \$1.2-billion nationwide GIS system. The Service did not analyze a full range of alternatives or adequately analyze alternatives for integrating a nationwide GIS into its operations. The Service made assumptions that limited the alternatives it considered and did not analyze the organizational impact of the alternatives in its feasibility study.

¹Forest Service Not Ready to Acquire a Nationwide Geographic Information System (GAO/T-IMTEC-90-10, May 2, 1990).

²Forest Service: Status of Geographic Information System Acquisition (GAO/IMTEC-89-27, Mar. 6, 1989).

Further, it did not estimate the dollar value of specific benefits it expected to achieve from the planned GIS, but instead used what we believe is an invalid representation of future benefits in its cost/benefit analysis. Finally, the Service did not adequately define its information and system performance needs, thereby failing to comply with Department of Agriculture regulations governing functional requirements analyses.

As a result, an increased and unnecessary risk exists that the proposed GIS will not result in an effective and cost-beneficial system to support the agency's management and protection of the public lands and natural resources entrusted to it.

Background

The Forest Service plans to acquire a computer-based GIS to store, retrieve, analyze, and present spatially referenced information³ about the nearly 200 million acres of national forests and grasslands that it manages. The nationwide GIS will be composed of commercially available GIS software at 880 offices⁴ operating on new computers that will be linked together through an existing telecommunications network. In addition to automating diverse manual monitoring and analytical tasks, the new GIS will replace about 130 individually operated GISs that have been procured in recent years on an ad-hoc basis by various Forest Service offices. These individual GISs were acquired to handle spatially referenced information.

Spatially referenced information has historically been found on maps and other types of data records. The kinds of information that the Service could store in its GIS include land ownership data; vegetation types, such as tree species; soil types; water location; and land elevation. A GIS that can electronically store, analyze, and display geographic data would be a more effective, efficient way to manage this kind of information. For example, a GIS could help to decide which trees to harvest and which areas to protect from logging by visually and analytically combining spatially referenced information, such as the locations and characteristics of rivers and streams, watersheds, wildlife populations, transportation routes, scenic views, soil types, slope angles, vegetative cover, insect infestations, and tree species.

³Information that is associated with a specific place on the earth, such as information about and the geographic location of a lake, road, or stand of trees.

⁴This includes 653 ranger districts; 123 supervisors' offices; 9 regional offices; 8 Washington, D.C., office sites; 9 research stations; 74 research labs; and 4 state or private forestry offices.

The Service decided to acquire an agencywide GIS in January 1988. It established several basic design principles for the system, such as the need to organize GIS data to facilitate its understanding and sharing throughout the Service, the need for technological flexibility, and the need for the system to use nontechnical, user-friendly human interfaces. In September 1988 and July 1989, the Service issued requests for information relating to the planned GIS. The purpose of these requests was to solicit comments from industry and others to help the Service refine its GIS specifications.

As we previously reported, the Service estimated that the cost of developing, implementing, and operating a GIS, including acquiring GIS software and acquiring and maintaining the hardware, would be \$167.6 million for fiscal years 1988 through 1993. Our earlier report emphasized that, while the Forest Service did not have an official estimate, the larger portion of the system cost could potentially be \$1 billion for the collection and conversion of data.

In its July 1989 request for information, the Service published its plans to procure entirely new computers to support not only GIS, but also administrative, technical, and scientific data processing, at a total estimated cost of \$1.6 billion. This includes about \$516 million for the acquisition of GIS, administrative, technical, scientific, and telecommunications software, acquisition of new computers, and maintenance of the software and computer equipment. The Service's estimate also includes about \$1.1 billion over a 12-year period for creating and maintaining GIS data bases and operating the new computers. The Service estimates the GIS component to be \$1.2 billion of the \$1.6-billion total system cost. About \$900 million of the \$1.2 billion GIS estimate is for management and overhead costs.

The Service is currently planning actions to respond to the concerns expressed in this report and reevaluating its schedule to release the request for proposals and award a contract.

Feasibility and Cost/ Benefit Analyses Inadequate

On September 29, 1989, the Service issued a feasibility study and cost/benefit analysis for its planned GIS as required by Agriculture regulations. We found that the feasibility study and cost/benefit analysis did not address how to best harness the capabilities of GIS technology or the organizational changes likely to occur from the implementation of a GIS.

According to the regulations, the purpose of a feasibility study is to identify and evaluate various alternatives for achieving an agency's objectives. The study is to include an analysis of organizational impact, such as reorganization and changes in staffing levels and staff skills that might result. Cost/benefit analyses provide management with information on the quantifiable and nonquantifiable costs and benefits of the alternatives identified in the feasibility study. Together, the study and analysis should provide managers with enough information to determine the most efficient and effective alternative for achieving an agency's objectives.

Alternatives Not Adequately Identified in Feasibility Study

The Forest Service has not adequately identified or analyzed alternative strategies for integrating the capabilities and versatility of a nationwide GIS into its operations. The Service made two critical assumptions that limited the alternatives it considered in its GIS feasibility study: (1) GISS would be placed in all 880 offices, and (2) staffing levels would not change.

Thus, the study did not consider selectively placing GIS technology in offices and sites, but assumed that all offices would need GIS hardware and software. Similarly, the Service did not evaluate alternatives that might involve staffing level changes because it assumed that these levels would not change.

The Service's feasibility study identified seven alternatives within the limits of these assumptions. These alternatives included an option, for analytical and comparison purposes, of allowing offices to continue acquiring individual GISS on an ad-hoc basis through 1991. A second alternative was to allow offices to continue acquiring individual GISS on an ad-hoc basis for 10 years. The remaining five alternatives provide GISS to all 880 offices, just varying the organizational level with primary responsibility for storing, maintaining, and managing the GIS data. The Service analyzed the variations by shifting some of the cost of data storage devices, workstations, and digitizing devices⁵ among organizational levels.

The Associate Deputy Chief of Administration and other Forest Service officials agreed that these alternatives reflect a basic strategy of maintaining the agency's organization while providing automated capabilities

⁵Devices used for entering certain spatial data—such as the location of roads or stands of trees—from maps, photographs, or other documents, into a GIS.

to handle spatially referenced data at all 880 offices. However, these officials also acknowledged that GIS technology will lead to significant changes in the organization resulting from transformations in how and where data are collected and analyzed, staffing level changes among offices, changes in personnel skill mix, and restructuring of jobs. They agreed that in developing and analyzing alternative approaches, the Service did not address the organizational changes they expect to result from the introduction of a GIS and new computers. They acknowledged that the alternatives in the feasibility study did not consider the benefits of or best approach for dealing with such changes. Thus, even though Service officials expect that significant changes will occur and said they considered the implications of such changes, they did not address them in either the feasibility study or the cost/benefit analysis because they believe some changes will be controversial and are best introduced gradually.

We believe that by not considering alternatives that might alter the organization or reduce, shift, or change the type or distribution of personnel, the Service essentially failed to address how to best harness the full capabilities of GIS technology. The Service did not consider alternatives that consolidated GIS capabilities, data entry, or staffing, preferring instead to provide such capabilities to all 880 offices. For example, instead of locating GIS capabilities at all 653 ranger districts, the Service might consider locating most GIS data processing and analysis at the 123 forest supervisors' offices. Another alternative might be to locate most GIS capabilities at the larger forest supervisors' and ranger district offices. In our opinion, these approaches may not only require fewer GISs than the alternatives evaluated by the Service, but might also result in staff savings and opportunities for increased specialization and productivity through greater concentration of analytical resources.

Benefits Not Adequately Analyzed in Cost/Benefit Analysis

In addition to the narrow range of alternatives analyzed, we believe the Forest Service did not make valid estimates of the economic benefits of the alternatives. As a result, the Service has failed to show that the benefits of its preferred alternative exceed its costs. Moreover, the Service does not have the information needed to assess the relative economic benefits of its alternatives.

Department of Agriculture regulations require the Service to identify and quantify the benefits of alternatives considered, including the dollar

value of cost savings such as staff and budgetary reductions, or economic benefits from improved program delivery, such as improved utilization of resources, improved operational effectiveness, or increased accuracy of information.⁶ The Service's calculation of benefits from the proposed GIS contains two basic components: an estimate of staff productivity increases resulting from the implementation of the GIS and the personnel costs of the way it currently processes spatially referenced information.

On the basis of a work load analysis, the Service estimated that staff productivity related to processing and analyzing spatially referenced information will increase by 400 percent with the full implementation of the GIS. We believe a 400-percent productivity increase strongly implies that the organization could change as a result of the GIS. However, neither the alternatives contained in the feasibility study nor the cost/benefit analysis clearly state how the Service will use the increased productivity or how much it is worth.

The Service then estimated total life cycle benefits of \$4.6 billion for its preferred GIS alternative by multiplying the estimated 400-percent productivity increase by its estimate of the current personnel cost of handling spatially referenced information. We believe this benefit estimate is not valid because the Service failed to identify (1) how staffing reductions or other reductions would save \$4.6 billion or (2) economic benefits of \$4.6 billion from the increased quantity or quality of information products or improved program delivery. In fact, while staffing levels are assumed to remain the same, the GIS is expected to increase costs by \$1.2 billion over the life of the system.

The Service economist in charge of benefits analysis agreed that they did not use customary economic practices in estimating the benefits and acknowledged that federal regulations and guidelines do not sanction using current costs as a substitute for estimating the benefits of a proposed system. According to the economist, the Service considered ways to calculate quantifiable benefits of the proposed GIS. However, he said they (1) found they were not able to estimate cost savings since one of the assumptions of the feasibility study was that implementation of the

⁶According to guidance contained in Office of Management and Budget Circular A-11, agencies should document the projected costs and benefits from major information systems initiatives, with the expectation that initiatives will show a positive net present value.

GIS would not result in staff level changes and (2) decided that estimating the quantifiable benefits of improved program delivery was too difficult.

We believe these reasons do not justify the Service's failure to prepare an acceptable cost/benefit analysis. The fact that the Service was not able to estimate cost savings demonstrates how the Service's assumption of no staff level changes adversely affected its economic analysis. We are concerned that this assumption also limits the Service's ability to address qualitative benefits that may involve staff level changes, such as redistribution of personnel to take advantage of possible productivity improvements from GIS. Also, departmental regulations require preparation of a cost/benefit analysis without regard to difficulty, stating that as the size of the acquisition increases, greater detail and supporting material must be developed.

Information and System Performance Needs Not Adequately Addressed in Functional Requirements Analysis

The Forest Service's functional requirements analysis for the GIS does not adequately address the full range of its information and system performance needs. The purpose of the analysis is to provide support for a full description of the information processing requirements needed to accomplish the agency's mission. These requirements include data and performance specifications to meet user needs. The articulation of mission-based data and performance specifications is important to meeting users' needs.⁷

In planning for the new GIS, the agency outlined the categories of information that it commonly uses or plans to use. However, the functional requirements analysis provides only some of the data and none of the performance specifications required by Department of Agriculture regulations.⁸ In particular, the functional requirements analysis does not provide specific information on the volume and frequency of inputs and outputs; sources, volume, and timeliness of data; data accuracy requirements; data validation requirements; performance requirements, such as response times, update processing times, consequences of system failures, and data transfer and transmission times; and data characteristics, including projected growth in storage requirements. For example, the

⁷Determination of users' data and performance requirements based on mission needs is established in the Federal Information Resources Management Regulation, Part 201-30.

⁸For a description of items to be addressed in the functional requirements analysis, departmental regulations refer to Federal Information Processing Standards Publication 38, Guidelines for Documentation of Computer Programs and Automated Data Systems, National Institute of Standards and Technology, Department of Commerce, Feb. 15, 1976.

maximum time to complete user-initiated operations or transmit data between offices, and the maximum time lost due to malfunctions, should be specified.

The GIS project manager acknowledged that the functional requirements analysis does not comply with requirements to specify the users' data and performance needs. His position, however, is that the level of specificity of data requirements and lack of performance requirements is adequate to conduct the procurement because (1) the regulations apply only to applications software and are not intended for a project that provides software and computer capabilities on a nationwide scale and (2) the Service plans to conduct detailed work load and data analyses at each site before system installation. He said the detailed analyses will provide the data specification information that is needed to select the mix of hardware and software for each of the 880 sites. He also stated that potential vendors will have to make their own estimates of data flow and storage requirements in designing the systems they will offer.

We believe that this position is not valid. Mandatory departmental regulations state that the functional requirements analysis should cover any use of software, equipment, communications, and related services, and is not restricted to particular software components of the system. Also, requests for proposals are required by departmental regulation to be consistent with the agency's needs as established by the requirements analysis. Because of this, by failing to adequately describe the required data and performance specifications, the Service is unnecessarily increasing the risk that vendors' offers will not meet the Service's functionality, processing, or performance needs. Likewise, there is an increased risk that the specifications will be insufficient to make appropriate tradeoffs and decisions between systems' price and performance and might hinder the Service's contract administration. Further, it may cause increased costs because the systems capabilities needed to provide adequate performance may be more expensive than anticipated.

In addition to inadequate specification of data requirements for existing sources of data, the Service has not determined a strategy as to how it will collect, store, and process satellite or remotely-sensed image data. For example, the Service's functional requirements analysis describes GIS use in which satellite and aerial photographic products provide fundamental data to Service staff. However, the functional requirements analysis does not specify how the GIS will obtain image products, the accuracy needed, how frequently image data will be collected, the

storage capacities needed, or the processing requirements for image products.

The GIS project manager acknowledged that image data from satellites and aerial remote sensing systems have great potential for cost savings in the collection of resource data, verification of existing maps, and detection of changes in natural resources. The Associate Deputy Chief of Administration and other Service officials anticipate that supplemental procurements and funds will be needed in the future to add the capability to acquire, input, process, and analyze image data. The Service has been working on, but has not yet completed, a plan to provide a framework for integrating image data with the new GIS.

Selection of the GIS prior to the development of these specifications unnecessarily increases the risk of selecting a system that does not provide all of the functionality needed, including image processing, at the lowest cost.

Conclusions

The Forest Service has embarked on an initiative that provides a major opportunity to rethink and improve the way that it performs its mission to serve the public and protect the lands entrusted to it. However, it has not taken full advantage of this opportunity. While the agency made a good start by identifying some basic principles for a nationwide GIS, it did not adequately consider a range of alternatives to take full advantage of the promise of GIS technology and create a comprehensive and thoroughly analyzed design for a \$1.2-billion GIS. In addition, the Service has not demonstrated that the proposed GIS will provide benefits commensurate with its costs.

The agency's feasibility study and cost/benefit analysis were inadequate because of incomplete consideration of alternatives to meet Service needs and invalid estimates of economic benefits. The Service's functional requirements analysis does not include required data specifications for existing and new sources of spatial information or performance requirements for the new system.

As a result, an increased and unnecessary risk exists that the planned system will not effectively and efficiently meet all the agency's information needs, or will not have adequate capacity.

Recommendations

In order to reduce the risk that the GIS may not satisfy mission needs, we recommend that the Secretary of Agriculture direct the Chief, Forest Service, to take the following steps before proceeding with the procurement:

- Evaluate the feasibility, costs, benefits, and organizational impact of alternatives, including selective placement of GIS capabilities and associated analytical resources, to achieve mission-based objectives. The Service should demonstrate that the benefits of the selected alternative exceed projected costs.
- Develop a more comprehensive functional requirements analysis that includes sources, flow, timing, accuracy levels, validation, and performance requirements for processing a complete range of data that include planned as well as existing data sources.

Forest Service Comments and Our Evaluation

In commenting on a draft of this report, the Forest Service disagreed with our concerns, stating that it is well prepared to proceed with the acquisition and implementation of GIS capability. The Service also disagreed with our recommendations to prepare new studies before proceeding with the procurement. (See app. II.)

With regard to our first recommendation, the Service said it will conduct studies to determine the reasonableness of placing GIS technology at particular sites as it implements the GIS. These will be used to determine a break-even point, below which it may not be economically justified to acquire GIS technology. The Service expects this guidance to be especially useful to 54 percent, or 475, of its 880 offices that have 25 or fewer employees. The Service also said it will review cost data, especially management and overhead costs, to determine whether they have been correctly presented, and periodically assess the GIS implementation to minimize costs and maximize benefits.

In our opinion, the Service's intention to conduct further studies during the implementation phase to determine placement of GIS represents partial concurrence with our recommendation to study other alternatives, such as the selective placement of GIS capabilities. However, the planned studies do not fully satisfy our recommendation because the Service does not plan to complete the studies prior to the procurement of the GIS. Selective placement represents a new alternative that could affect the design, organizational impact, operation, costs, and benefits of the GIS. Thus, its feasibility should be studied and compared with other alternatives prior to the procurement, in accordance with departmental and

other government regulations and guidelines. The rationale for these regulations and guidelines is to provide decision makers with sufficient information about plausible alternatives, their costs and benefits, as well as their organizational impact, to make informed decisions prior to major procurements. While the Service recognizes that organizational change will result from the GIS, it argued that this change was controversial and therefore best addressed over time instead of in the pre-procurement studies. However, it is precisely because of the potential controversy surrounding the GIS that we believe that it is important that decision makers be informed of the full range of GIS' potential impact. By not adhering to the prescribed regulatory process and preparing adequate analyses, the Service is thus increasing the risk that the cost and organizational impact of GIS will not receive sufficient consideration by decision makers.

The Service's plans to conduct further studies regarding GIS placement and economic breakeven analysis do not include a reassessment of its estimates of benefits. We remain concerned, therefore, about the adequacy of the cost/benefit analysis because we believe that the Service's method of estimating benefits is neither valid nor traditional and that its estimates are invalid. Since the quantifiable benefits of GIS were not properly estimated, the Service has not yet demonstrated that the benefits from its preferred alternative are commensurate with its costs.

As to our second recommendation, the Service said that it will describe the current and anticipated uses for remotely sensed data and how the GIS is expected to use remotely sensed data in the future. As part of the implementation process, the Service will require each office to analyze its specific data requirements, including work loads and data flows, to identify the type and configuration of equipment that is needed. In addition, the Service will evaluate the performance of offered systems to help it select the offer that will be appropriate for its needs.

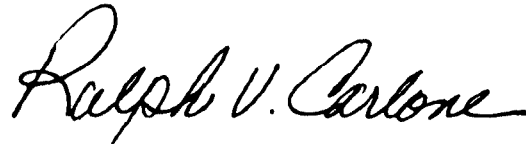
While we believe the Service's plan to describe its expected use of remotely sensed data is an improvement, the action does not address our concern over the lack of data and system performance specifications. Testing the offered systems is a one-time event and does not establish the Service's continuing data and performance requirements to meet the diverse, mission-based needs of hundreds of offices.

We have found that inaccurate cost estimates, and inadequate identification of needs, consideration of alternatives, and definition of requirements are primary causes of problems with computer systems

throughout the government. Therefore, we believe it is not unreasonable but prudent that the Forest Service's GIS procurement proceed on the basis of a better defined strategy as to where the agency is going, alternatives for getting there, and adequately defined requirements for a system to meet the agency's needs.

We will send copies of this report to the Secretary of Agriculture, the Chief of the Forest Service, and other interested parties, and will make copies available to others on request. This report was prepared under the direction of JayEtta Z. Hecker, Director, Resources, Community, and Economic Development Information Systems, who can be reached at (202) 275-9675. Other major contributors are listed in appendix III.

Sincerely yours,



Ralph V. Carlone
Assistant Comptroller General

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Abbreviations

GAO	General Accounting Office
GIS	geographic information system
GSA	General Services Administration
IMTEC	Information Management and Technology Division
RFI	request for information

Objectives, Scope, and Methodology

The Chairman, House Committee on Appropriations, Subcommittee on Interior and Related Agencies, asked that we review the adequacy of Forest Service plans to acquire a geographic information system for its field sites nationwide. In March 1989 we issued a preliminary report in which we cautioned that it would be inappropriate to begin a nationwide procurement until the Service's prerequisite studies had been properly completed and related issues thoroughly analyzed. Our objective in this review was to identify any unresolved issues that could adversely affect the planned acquisition. To do this, we reviewed and analyzed the Service's reports on the GIS field evaluations, feasibility study, cost/benefit analysis, and functional requirements analysis and vendor comments on the agency's two requests for information. We interviewed the project manager for the GIS procurement and the Director of Computer Sciences and Telecommunications for the agency.

We also reviewed comments from potential vendors in response to the Service's two requests for information, and obtained information about the capabilities of current GIS products from interviews with government GIS experts and vendors.

We discussed the contents of our draft report with Forest Service officials and obtained formal agency comments. Forest Service comments and our evaluation are included as appendix II. We did not append enclosures 2 and 3 of the Forest Service letter responding to our draft report because they do not contain comments on our report or the Service's plans to address our recommendations. Information contained in these two enclosures has been incorporated in our evaluation where appropriate.

We performed our work from October 1989 through February 1990 at the headquarters office of the Forest Service in Arlington, Virginia, and at the Department of Agriculture in Washington, D.C. Our work was performed in accordance with generally accepted government auditing standards.

Forest Service's Comments and Our Evaluation

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



United States
Department of
Agriculture

Forest
Service

Washington
Office

12th & Independence SW
P.O. Box 96090
Washington, DC 20090-6090

Reply To: 1420

Date: April 20, 1990

Mr. Ralph V. Carlone
Assistant Comptroller General
Information Management and Technology Division
U.S. General Accounting Office
Washington, DC 20548

Dear Mr. Carlone:

We agree with the General Accounting Office (GAO) that, ". . . GIS holds the promise to significantly enhance the ability of the Forest Service to manage and preserve natural resources . . ." As demonstrated by our studies, the acquisition costs will be more than offset by gains in operational efficiencies. The Geographic Information System (GIS) capability will allow the Forest Service to be more effective and responsive to the public's ever-expanding demands for service. The Forest Service is well prepared to proceed with the acquisition and implementation of GIS capability and should not be further delayed in this effort.

The Forest Service has spent 5 years developing GIS specifications. We sought technical advice from Rand Inc., the GIS and computer industry, and other Government agencies. We acquired many GIS packages, some for a controlled evaluation or pilot test of GIS. These GIS pilots helped the Forest Service evaluate the technology, functional requirements, costs, benefits, and alternatives. We used these pilot test results in the preparation of acquisition plans and all documentation.

In addition, the General Services Administration (GSA) approved a delegation of procurement authority (DPA) for this acquisition. Prior to getting a DPA from GSA, staff from five Departmental offices as well as GSA conducted reviews to analyze the proposed acquisition. These reviews looked at the concepts and strategy of the procurement, the requirements, alternatives, and the cost-benefit analysis. These organizations approved the documentation as having met the requirements of all Departmental and GSA regulations.

The additional studies recommended by GAO will cost the Government more than \$1 million and will only make the economic benefit of this technology appear more advantageous than the very conservative estimate already developed. In addition, the studies will not yield information useful to the vendor community in preparing offers. The General Accounting Office's recommendations do not help the Government realize the benefits the GIS technology has to offer.



Caring for the Land and Serving People

FS-6200-28b(4/88)

See comment 1.

See comment 2.

Appendix II
Forest Service's Comments and
Our Evaluation

Mr. Ralph V. Carlone

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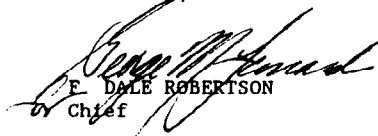
See comment 3.

In our discussions with GAO we agreed additional detail and specific studies would be helpful to clarify parts of the cost-benefit analysis and implementation strategy. Those actions are presented in enclosure 1 along with our specific responses to the report recommendations. The additional detail will be developed as part of the Request For Proposals document and as further implementation guidance. Otherwise, our documentation is in order and we are ready to proceed.

Enclosure 2 is an overview of assumptions and methods used in the GIS cost-benefit analysis. In enclosure 3 we provide examples of the increased efficiency and effectiveness that results from our use of GIS technology.

For additional information, contact Rex Hartgraves, Associate Deputy Chief for Administration, at 447-6709.

Sincerely,



F. DALE ROBERTSON
Chief

Enclosures

ENCLOSURE 1

**FOREST SERVICE RESPONSE TO GAO ASSESSMENTS AND RECOMMENDATIONS IN
DRAFT REPORT "GEOGRAPHIC INFORMATION SYSTEM FOREST SERVICE UNPREPARED
TO ACQUIRE NATIONWIDE SYSTEM" GAO/IMTEC-90-31**

COMMENTS SPECIFIC TO RECOMMENDATIONS

See comment 4.

The Forest Service has been developing and evolving specifications for this acquisition for nearly 5 years. The initial functional requirements were developed as part of a 1985-86 Forest Service sponsored study with a consulting geographer, Tomlinson Associates, Inc. The information needs supporting spatial data requirements, and data and information workload, and flow identified by the geographer led to the formulations of the initial set of functional workload and flow identified by Tomlinson Associates. These functional requirements were used in competitive procurements to acquire GIS in support of our GIS Controlled Evaluation study. As a result of that study, and from comments received from industry in response to two reviews of proposed specifications, amendments were made to GIS specifications. Throughout this refining process well over 90 percent of the more than 1000 comments received were positive, with little objection to the requirements.

See comment 5.

This knowledge and experience greatly reduces the risk in implementing GIS and provides an appropriate level of detail to describe the application at this stage of development. In addition, the GIS Controlled Evaluation study has pointed out probable impacts to the organization. The Forest Service will analyze these impacts and use the results in its plan for nationwide implementation of GIS technology.

In summary, the Forest Service is fully compliant with the Departmental and GSA regulations. In our judgment, there has been enough study, and management technical reviews done on the procurement. All of them support proceeding as soon as possible with the proposed procurement.

We are confident that the Forest Service can effectively execute the acquisition and implement the acquired resources. This is based on the extensive research and trials done by them, and their very successful experience with the existing 7 year old field level automation effort.

We request that GAO reevaluate their audit and work with the agency to ensure the project is carried out in a timely manner.

GAO RECOMMENDATION: Evaluate the feasibility, costs, benefits, and organizational impact of a more complete, innovative, and systematic set of alternative systems.

RESPONSE: Prior to getting a delegation of procurement authority (DPA) from the General Services Administration (GSA), staff from five Departmental Offices plus GSA conducted reviews to analyze the proposed acquisition. These reviews looked at the concepts and strategy of the procurement, the requirements, alternatives, and the benefit/cost analysis. These organizations approved the documentation as having met the requirements of Departmental and GSA regulations.

We disagree with the recommendation. The new study would cost the Government between \$1 and \$2 million, and would result in the same recommendation to Forest Service management as the current study: GIS is a cost-effective technology for the Forest Service.

GAO RECOMMENDATION: Develop a more comprehensive functional requirements analysis that includes sources, flow, timing, accuracy, levels, validations, and performance requirements for processing a complete range of data that include planned as well as existing data sources.

RESPONSE: We disagree with the recommendation. The Functional Requirements Analysis performed by the Forest Service was completely consistent with guidelines, and was approved by an Acquisition Review Team comprised of representatives from GSA, USDA, and the Forest Service.

**SPECIFIC COMMENTS ON THE DRAFT REPORT AND PROPOSED ACTIONS
ON THE BENEFIT/COST ANALYSIS AND IMPLEMENTATION STRATEGY**

1. FEASIBILITY STUDY

GAO Concerns

GAO believes that the feasibility study did not address all possible alternatives, and the alternatives addressed were constrained by the assumptions used.

Forest Service Comments

The Forest Service objective in conducting the feasibility study was to find the best possible method to manage spatial resource information. The alternatives laid out various management approaches for accomplishing this. The purpose of the acquisition of the proposed technology is to support the information management methodology which best meets that objective.

The analysis of the feasibility of implementing Geographic Information Systems documents why it is necessary to meet the mission of the Forest Service. By stating that "a GIS holds the promise to significantly enhance the ability of the Forest Service to manage and preserve natural resources ..." GAO apparently agrees with our assessment.

Alternatives Considered, and Dropped from Detailed Analysis

Alternatives were developed which focused on the need of getting work done on the ground. They were not developed simply to implement a new technology. During the feasibility stage of the analysis, several alternatives were discussed but dropped from further consideration because they would not serve the objective of giving the right people adequate tools to better serve the public and protect resources. Interaction with the public and the intensity of management of the resources increases as one gets closer to the resource (Ranger District, Forest Science Lab, etc). It is counterproductive to keep the necessary tools away from field offices where public interaction and resource management needs are greatest.

For example, the possibility of having one central processing unit for the entire Service was explored and debated during the analysis. After looking at the size of system required, telecommunication needs, and relying on past experience of such central processing in resource management and planning work, we determined that this approach is not a viable alternative to be studied further. Instead, an alternative which stored all data centrally but still allowed local geographic information system analysis and display capability was studied.

See comment 6.

**Appendix II
Forest Service's Comments and
Our Evaluation**

Assumptions Are Reasonable And Are Based On Experience

See comment 7.

The capabilities provided by a geographic information system are necessary at all levels of the Agency. A geographic information system provides enhanced capability for the Agency to communicate with the public. The primary location where this communication occurs is at the Ranger District where actual land management occurs, the resources are most familiar to managers, and users and clients are in contact with managers. Removing these communication tools any distance from the District will have a direct and detrimental impact on the capability of the Agency to meet the responsibility to protect and manage resources and serve the public. The feasibility study examined these options and found them to be unacceptable and thus, not considered as a viable alternative for consideration in the benefit/cost analysis.

An alternative which would place geographic information system processing at the Supervisor's Office but not at the District was also explored. This is analogous to placing telephones at the Supervisor's Office and having the districts travel in to get their calls or having the Supervisor's Office mail letters to the District interpreting their phone calls. While this is technically feasible, it is not responsive in a practical sense.

See comment 8.

In the analysis, the total Forest Service staff ceiling is not reduced. Instead the productivity increases result in better public service using the present staff level. This is accomplished by having machines do the calculations, overlays, drawing maps, and producing detailed reports. This allows employees who currently do those tasks to invest time in performing more comprehensive analyses, developing better inventories, and being more responsive to public concerns. (For examples of this better public service see Enclosure 3.)

Virtually every responsible study undertaken since the early 1980's has shown that computerization of information work does not result in overall staff reductions. This includes research supported by the National Research Council. The typical pattern is that some positions—typically lower level positions associated with manual information handling tasks—are eliminated, usually by attrition (since it takes some time before the technology is sufficiently internalized in day-to-day operations). Other positions, however—usually those requiring some kinds of technical expertise—are added. While there may be a small net reduction in number of staff, there is usually *not* a reduction in labor costs.

Further, there may be some adjustments in the staffing of units relative to one another. For example, electronic time and attendance forms implemented on the Agency-wide network allow smaller units to pool resources and share one time and attendance clerk (whereas before, each had its own). Again, such shifts are relatively localized, evolve over time as the technology is internalized, and are not likely to alter overall staffing levels or patterns. In sum, wherever large staff reductions have been observed, it has been in response to economic reverses and/or to federal mandates. New technology has not driven these changes, but it has helped agencies live up to their mandates in spite of them.

Forest Service Actions Planned

See comment 9.

To assist offices in determining whether it is reasonable to place GIS technology at a site, we will conduct two studies. One which quantifies the organizational costs, has three implementation options: (1) provide full on-site capability, consistent with the preferred alternative; (2) provide minimal capability, sufficient for electronic access to submit data, read data, produce displays, and do remote computing; and (3) provide no on-site capability nor electronic access for small offices. The costs could be categorized by capital investment, systems support and maintenance, and employee productivity.

The second study will determine which combination of conditions, such as office size, workload, and level of public pressure should be considered by Forest Service managers to determine whether GIS is appropriate for installation at a site. The results of these analyses would be used to develop recommendations and direction for implementation and determine a "break even" point, below which may not be economically justified to acquire GIS technology. We expect this guidance will be especially valuable for the 54 percent of Forest Service offices that have 25 or fewer employees.

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These studies will become supplements to the benefit/cost analysis as well as internal policy documents giving guidelines for the implementation decisions of all units.

2. BENEFIT/COST ANALYSIS

GAO Concerns

GAO believes that the benefit/cost study does not provide Forest Service managers with sufficient information to determine whether to proceed with the acquisition of GIS.

Forest Service Comments

The benefit/cost analysis clearly demonstrates that implementation of GIS would provide a positive benefit to both the public and to the Government. This conservative analysis provides clear support for the decision to proceed with the acquisition of this technology.

The benefit/cost analysis follows traditional methods of analyzing the costs and benefits associated with implementation of computer technology. Thierauf and Reynolds (1982) have outlined the steps appropriate to study the acquisition of new technologies. The steps are essentially the same as outlined by USDA directives which were followed in performing the analysis and preparing the documentation. The cost and benefit categories outlined by Thierauf and Reynolds (1982) are directly in line with those applied in the geographic information system studies. Costs and benefits include one-time and recurring (operational) costs, tangible (quantifiable) and intangible (nonquantifiable) benefits, and the application of standard discounting procedures.

Quantifiable benefits were valued as increases in productivity and effectiveness. They were calculated under the assumption that geographic information system technology would increase the agency's efficiency and effectiveness. This assumption is backed by the experience of current geographic information system users, both private and public (page 70, Benefit/Cost Analysis). These productivity increases were phased in over time as training and experience with GIS increased. They varied according to alternative, as productivity is a function of the degree of access to a technology, its management, and control of data.

These benefits are realized in two ways; the improved efficiency of employees, and the value added from increases in effectiveness. The improved efficiency allows better analysis in support of the Agency's mission. Value added is the improvement in service to the public and better decisions.

The study conservatively estimates the total benefit as the combination of both improved efficiency and value added potential by using an opportunity cost approach. This approach has been cited in literature as a way to estimate nonmarket values in economic analyses.

The benefit values are estimated to be the personnel costs associated with providing the increased level of production using the old technology (opportunity cost). Thus, under the old technology it would require additional personnel to duplicate the level of production possible from the new technology. It should be recognized that this approach does not attempt to value the products that will be provided from the new technology that are not feasible under the old technology. This approach, therefore, assumes a very conservative estimate of the benefit values.

The benefits are valued as increases in productivity and effectiveness. These increases are used to improve spatial analyses, provide better service to the public, and make sharper decisions. This increase is worth at least the personnel cost (soft savings) of providing the same product using the old technology (opportunity costs). This is conservative since it would require more than personnel to produce that increased service. Supplies, overhead, etc. would also be required.

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Value of 400 Percent Productivity Increase

The total life cycle benefits were not estimated by multiplying the estimated 400 percent productivity increase by the estimate of current cost of handling spatially referenced information, as stated by GAO. Instead, the cost of producing the increase in service was calculated based only on the personnel costs required to produce those products under the old technology. In addition, those benefits were phased in over a 5-year period for each unit as the technology was acquired.

Forest Service Actions Planned

The Forest Service will review the cost data, especially the management and overhead costs which presently account for over 70 percent of the system life cost. We will also meet with the developers of the Department of Agriculture benefit/cost procedures used in the analysis to make sure we properly interpreted and applied the cost guidelines. This review will determine what the correct presentation of cost is, and ensure that commensurate changes are made in benefits, where appropriate, so the relationship of benefits to costs is accurately portrayed. We anticipate that this analysis will make the implementation of GIS appear more favorable than is presently displayed by the analysis.

Rand Corporation, under contract to the Forest Service, is developing a methodology to determine what benefits are actually realized by GIS. This study has three objectives:

1. Evaluate the contribution of current and future geographic information technologies to the performance of recurring resource management tasks in key mission areas;
2. Assess the effectiveness of these technologies for the sharing and use of resource information strategically across functional and organizational boundaries;
3. Assess the usability and functionality of these technologies as tools to support professional work.

Collectively, these three study objectives constitute the basis for a flexible and responsive evaluation strategy that will enable the Forest Service to understand the contributions of GIS to its mission and to plan and control those contributions effectively.

During implementation of GIS, Rand will make periodic assessments of progress made, and will provide management reports and recommendations which the Forest Service will use to make adjustments in the implementation strategy. This independent, unbiased evaluation will help the Forest Service minimize costs and maximize benefits from GIS.

3. INFORMATION NEEDS

GAO Concerns

GAO believes that the Forest Service has not adequately addressed information needs, and as a result, increased the risk that vendors will not be able to meet functionality, processing or performance needs.

Forest Service Comments

The Forest Service has been developing and refining data, information, and functional requirements for 5 years. This includes formal staff work and studies which were initiated by the Forest Service beginning in 1984 to better understand GIS technology and prepare the organization to effectively and efficiently take this technology on. The development of the required documentation to support the GIS acquisition relies heavily on this staff work and practical field studies.

The initial functional requirements were developed as part of a 1985-86 Forest Service sponsored workload analysis study with a consulting geographer, Tomlinson Associates, Inc. The information needs, supporting spatial data requirements, and data and information workload and flow identified by the geographer led to

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the formulation of the initial set of functional requirements. These functional requirements were used in a competitive procurement to acquire GIS in support of our GIS Controlled Evaluation Study. This Study was referenced in the GAO's first report. As a result of that Study, amendments were made to the initial set of GIS functional requirements.

These revised requirements were provided to industry for review and comment via the Request for Information (RFI) process in preparation for the present proposed Servicewide GIS acquisition. As a result of comments received, a few additional minor amendments were made to the GIS specifications. These revised requirements were again provided to industry in a second RFI. Well over 90 percent of the approximately 1000 comments received between the two RFIs from industry on these specifications were positive, with little objection to the requirements.

The close interaction the Forest Service has had with the vendor community over the past 2 years in developing and refining the specifications for this procurement has greatly minimized the risk to the Government, and promoted full and open competition for this acquisition. By developing an environment where industry fully understands the Forest Service's needs, and the Forest Service recognizes what industry's capabilities are, the likelihood of acquiring appropriate solutions is greatly increased. The free exchange of information with industry is the most effective way to ensure that the Forest Service will be able to acquire cost effective, efficient technology solutions.

Forest Service Actions Planned

The Forest Service is developing an attachment to the RFP which describes the current use of remotely sensed data, anticipated uses for this class of data, and how the GIS hardware and software are expected to use remotely sensed data in the future. This will augment information already provided to industry and will allow the vendor community to fully understand both the current use of remote sensing as a tool to collect resource data, and the relationship of remote sensed data to future Forest Service data needs.

See comment 11.

4. SYSTEM PERFORMANCE NEEDS

GAO Concerns

GAO believes that the Forest Service has provided some of the data and none of the performance specifications required by the Department of Agriculture regulations. As a result, the Draft Report states that there will be insufficient information to make tradeoffs and decisions between systems' price and performance.

Forest Service Comments

GAO bases this position on the belief that the "Departmental regulations incorporate [emphasis added] Federal Information Processing Standards Publication 38 (FIPS PUB 38). . .", and upon misquotes of Forest Service employees. Both the Forest Service and the Department of Agriculture disagree with this position. Department Regulation 3130-1, Technical Approval for IRM Products and Services, references FIPS PUB 38 as a guideline, and does not incorporate that publication, in whole or in part, as a part of the regulation. The Forest Service has followed the direction in the Department Regulation, has used FIPS PUB 38 as a guideline as appropriate, and has considered the factors referenced in Part 201-30 of the Federal Information Processing Regulations (FIRMR) in developing the functional requirements and the specifications of the RFP.

The workload information that will be used in performance tests to evaluate proposed systems is derived from the workload study performed by Tomlinson Associates, Inc., and from actual experience in the use of GIS systems. All data used in these tests are from a Forest Service office which currently uses GIS. All GIS tests represent actual use of data and real types of problems our employees face today.

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System performance will be evaluated by executing the performance tests on the proposed configurations with a representative set of real data scaled to a small-sized field unit and a large-sized field unit. Small and large scale generic types of project applications and analyses using these data will be run on the proposed systems to simulate actual field unit applications and analyses. To provide a realistic simulation, project applications will be run both in parallel and sequentially, and in batch and interactive processing operations over a fixed time interval.

The mix of project applications is based on current known and anticipated business operations for the various types of field units.

This approach ensures that technology configurations offered will be realistically tested, and the selected offer will be appropriate for Forest Service needs.

Forest Service Actions Planned

As part of its implementation preparation, each office will be required to analyze data requirements to size their system to meet their specific needs. This analysis will determine the unique data requirements for each office, and will identify the type and configuration of equipment appropriate for that workload. We anticipate that this focused data analysis will result in lower overall systems costs, and in the acquisition of systems optimally configured to meet the unique needs of each office.

GAO Comments

1. The Forest Service stated that GIS holds much promise and that gains in operational efficiencies will more than offset acquisition costs. It said the planned system will allow it to be more effective and responsive to expanding demands for services and it believes it is well prepared to proceed with the acquisition and implementation of a nationwide GIS system.

We agree that GIS is a promising technology, but disagree that the Service is prepared to procure a \$1.2-billion nationwide GIS system. As we discuss in our report, the Service made assumptions that limited the alternatives it considered and did not analyze the organizational impact of the alternatives in its feasibility study. It did not estimate the dollar value of specific benefits from its planned GIS, but instead used what we believe is an invalid representation of future benefits in its cost/benefit analysis, as discussed in comment 10. Finally, the Service did not adequately define its information and system performance needs. As a result, there is an increased and unnecessary risk that the proposed GIS will not result in an effective and efficient system to support the agency's mission.

We have found repeatedly that the lack of clear identification of needs, inadequate consideration of alternatives, inaccurate cost estimates, and inadequate definition of requirements are primary causes of problems with the government's civilian and military computer systems. We have no reason to believe that the GIS procurement would be immune from such problems.

2. The Service said it spent 5 years developing GIS specifications, sought outside technical advice, and evaluated GIS technology in a variety of settings. It added that the GIS project has been approved by the Department of Agriculture, a delegation of procurement authority was issued by the General Services Administration (GSA), and these organizations approved the project documentation as having met all departmental requirements and GSA regulations. The Service added that the studies recommended by GAO will cost more than \$1 million, make the benefits of GIS appear more advantageous, and not yield useful information for potential vendors.

We agree that evaluating and testing GIS technology and consulting with GIS experts should help provide information that would be useful in planning for the acquisition of a nationwide GIS. However, the Service's efforts have not resulted in adequate analyses of the alternatives and

associated costs and benefits or specification of functional requirements for the planned system.

We disagree that the Service's documentation meets all departmental regulations. As discussed in our report, the cost/benefit analysis does not include the required dollar value estimates of specific benefits and, in our opinion, the quantified estimates are not valid. Also, the functional requirements analysis includes only some of the data and none of the performance specifications required by departmental regulations, which refer to Federal Information Processing Standards Publication 38 for a description of what to address in the functional requirements analysis. With regard to approvals, GSA officials who reviewed the Service's request for procurement authority told us that they did not evaluate the technical content of the functional requirements analysis.

While we have not seen the basis for the Service's estimate, a cost of \$1 to \$2 million represents less than 0.2 percent of the estimated incremental system life cycle costs of \$1.2 billion. We also note that all this additional cost might not have been necessary if the Service had adequately analyzed its alternatives, costs, and benefits and specified its functional requirements.

3. The Service stated that additional detail and studies would help clarify parts of its cost/benefit analysis and implementation strategy. The additional detail would be included as part of the request for proposals and as further guidance for systems implementation.

Comments 5, 9, 10, and 11 cover the Forest Service's specific response to these matters.

4. The Service stated that it has been developing and evolving specifications for the GIS acquisition for 5 years, including using a consulting geographer, conducting a controlled evaluation study, and amending specifications in response to comments on two requests for information (RFI). It said there has been little adverse comment from potential vendors on the specifications contained in the RFIs. The Service believes its knowledge and experience greatly reduce the risk involved in implementing a GIS.

We disagree that the Service's efforts have resulted in adequate specification of functional requirements for the planned system. As we discuss in our report, the functional requirements analysis addresses only some of the data and none of the system performance specifications required

to meet the needs of the users. Therefore we believe that the Service is unnecessarily increasing the risk that vendors' offers will not meet its functionality, processing, or performance needs. Also, there is increased risk that the specifications will be insufficient to make appropriate tradeoffs and decisions between systems' price and performance, might hinder the Service's contract administration, and may cause increased costs because the systems capabilities needed to provide adequate performance may be more expensive than anticipated.

We also note that in regard to the second RFI, comments that we reviewed from 11 potential vendors contained reservations about the adequacy of the Service's data and performance specifications.

5. The Service said its controlled evaluation study identified some of the organizational impact from GIS technology and it plans to analyze this impact and incorporate the results of the analysis in its implementation plan for the nationwide GIS acquisition. The Service summarized by saying it is fully compliant with departmental and GSA regulations, has adequately studied and reviewed the procurement, and should proceed as soon as possible with the procurement. It disagreed with our recommendations and requested that we reevaluate our audit and work with the agency to ensure the project is carried out in a timely manner.

We agree that organizational changes and impact should be analyzed. As discussed in our report, these analyses should be made as part of the pre-procurement feasibility study to provide management with enough information to select the best alternative for achieving the agency's objectives. Therefore we believe that the Service's plan to incorporate the results of these analyses into its implementation plan is not sufficient to address our concern. Also, as discussed in comments 1 and 2, we do not agree that the Service is fully compliant with regulations or should proceed with the procurement as soon as possible.

With regard to reevaluating our audit work, we have reviewed our evaluation of the facts and have met with Forest Service officials a number of times to discuss the concerns raised in our report. The Service has not provided any additional facts that would lead us to different conclusions.

6. The Service stated that its objective for the feasibility study was to find the best possible method to manage spatial resource information, that the alternatives it studied laid out various management approaches

to accomplish this objective, and that the planned acquisition will support the methodology that best meets the objective. It said its analysis of the feasibility of implementing the system explains why GIS is required to meet its mission. The Forest Service said it considered alternatives that focused on the need to manage information and get work done on site at forest locations, and analyzed several alternatives.

We agree that the feasibility study should help management find the best alternative to manage spatial resource information to meet the organization's needs. We disagree that the level of analysis performed by the Service is sufficient to determine an alternative that will best meet the objective of managing spatial resource information. As we discuss in our report, the alternatives considered in the feasibility study were limited by two assumptions and therefore the study did not consider selectively placing GIS technology at offices or evaluate alternatives that might involve staffing level changes. In addition, none of the alternatives addressed the organizational impact that Service officials expect to result from GIS implementation. Therefore, we disagree that the Service has adequately supported its assumptions or the extent to which it needs GIS technology, or defined how to best use the technology to meet its mission.

7. The Service stated that GIS capabilities are necessary at all levels of the agency, to provide enhanced ability to communicate with the public and that contact with the public occurs at all levels, and is highest at the ranger districts. It said it explored and rejected an alternative that would have placed GIS capabilities at the supervisors' offices but not at the ranger districts on the grounds that it would be analogous to placing telephones only at supervisors' offices while expecting ranger district employees to travel to supervisors' offices to place calls.

While GIS may provide for enhanced communications with the public, we disagree that the feasibility study adequately demonstrates the extent to which GIS would provide enhanced communications, or the need for enhancements at all agency sites. As discussed in our report, the Service should consider a range of alternatives that includes selective placement of GIS technology and the alternatives should be evaluated in terms of the relative costs and benefits. Also as described in comment 9, the Service is now planning to determine whether it is reasonable to place GIS technology at all 880 sites.

8. The Service stated that it did not reduce the staff ceiling in the feasibility study, but instead assumed that the potential productivity

increases from GIS technology would be used to improve services such as performing more comprehensive analyses, developing better inventories, and being more responsive to public concerns. It said computerization of information work usually does not result in overall staff reductions. It acknowledged that the GIS may result in some staffing changes, but does not expect GIS to significantly affect overall staffing levels or patterns.

We agree that GIS may offer improvements in staff productivity. However, we believe that the Service's assumption that the entire productivity improvement should be allocated to improving service is not reasonable. The Service's estimate of a 400-percent productivity increase with full implementation of GIS would eventually be equivalent to saving about 4,900 staff years per year, or applying 4,900 staff years per year to improving service, assuming information production was held constant. We believe that decisions about staff year allocations should not be based on this assumption but, instead, should be based on assessments of the relative benefits of potential cost savings, value of personnel in alternative activities, and value of improved quantity and quality of information products.

Similarly, while computerization may not have resulted in widespread reductions in clerical and office workers, we believe that these general, historical patterns do not justify the Service's assumption that GIS will not result in staffing level changes. The Service has recognized the potential for organizational change but has not assessed the potential organizational impact in its feasibility study. We believe that it is incumbent on the Service to address the potential organizational impact of implementing a nationwide GIS.

9. The Forest Service stated that it will conduct two additional studies as it implements the planned GIS to determine whether it is reasonable to place GIS technology at all sites. The Service will study employee productivity and the costs to implement full GIS capability, minimal GIS capability, or no GIS capability at various sites. It said it will also study combinations of conditions, such as office size, work load, and level of public pressure, to determine a break-even point below which GIS technology may not be economically justified.

The Service expects the results of these two studies to be especially useful in deciding whether the GIS is economically justified for the 475 (54 percent) offices having 25 or fewer employees. The Service added that these studies will become supplements to the cost/benefit analysis,

as well as policy documents to guide the implementation decisions of all offices.

We believe that the Forest Service is not ready to proceed with the procurement on the basis of its feasibility study. The Service's intention to conduct further studies during the implementation phase to determine the reasonableness of placing GIS capability at small offices indicates that its earlier assumption that all 880 offices need GIS hardware and software needs to be reassessed. Although this addresses one of our concerns about the feasibility study, these studies would amount to a reevaluation of the Service's preferred alternative after the agency issues a request for proposals and perhaps after awarding a contract on the basis of its preferred alternative. We believe that selectively placing GISs at the agency's 880 offices is a new alternative and should be analyzed as such before moving the project into the procurement stage.

We also remain concerned that the Service did not adequately address the organizational impact of GIS in its feasibility study and cost/benefit analysis. As discussed in our report, Service officials acknowledged that GIS technology will lead to significant changes in the organization resulting from transformations in how and where data are collected and analyzed, staffing level changes among offices, changes in personnel skill mix, and restructuring of jobs. They agreed that the feasibility study did not address the organizational changes they expect to result from the introduction of GIS and new computers.

10. The Service disagreed that its benefits estimates are invalid, stating that it followed traditional methods of analyzing benefits associated with computer technology, which resulted in a clear demonstration that GIS would provide a positive benefit to the public and to the government. It said its estimates of total quantifiable benefits from GIS are based on an estimated 400-percent productivity increase, which equates to providing a fourfold improvement in information with the current level of staff. The Service reiterated that it did not attempt to estimate the value of improved information products from the GIS. It also said it will review cost data, especially management and overhead costs, to determine whether they have been correctly presented. Finally, the Service said it will use a contractor to develop a methodology and periodically assess the benefits realized from the GIS implementation. This information will be used to adjust the Service's implementation strategy.

After further review of the Service's methodology and consideration of its comments, we continue to believe that the Service did not use valid or

traditional economic methods to estimate the quantifiable benefits of the GIS and that its estimates are invalid. Since the quantifiable benefits of GIS were not properly estimated, the cost/benefit basis for selecting the agency's preferred alternative was not sound. The Service's request for delegation of procurement authority was also based in part on this analysis.

The Service did not produce valid estimates of the value of increased productivity or how it would use the increased productivity, the value of increased quality or quantity of information products, or the value of improved program delivery. Instead, it assumed that the current value of handling spatial data and producing information is equal to the personnel costs it now incurs for such work.

The Service estimated the total quantifiable benefits of the GIS by increasing the relevant estimated personnel costs fourfold. It increased costs fourfold because it expects the GIS to increase productivity 400 percent. We disagree with this methodology because it assumes that the value of a product is equal to the cost of producing it, regardless of actual benefits received. In addition, the Service acknowledged in an enclosure to its letter that the Service has not validated its basic assumption that the current value of handling spatially referenced data is equal to the current personnel costs associated with these activities.

We agree that it would be worthwhile to monitor and assess the benefits achieved from the implementation of GIS technology, but we believe that post-implementation evaluation is not a substitute for valid pre-procurement estimates of benefits.

11. The Service stated that its information requirements have been adequately specified, stating that it has been developing and refining data, information, and functional requirements for 5 years. It said its functional requirements have been distributed in two requests for information with little adverse comment from potential vendors and, on the basis of numerous interactions, it believes that the potential vendors fully understand its needs.

The Service said it followed the direction of departmental regulations, used Federal Information Processing Standards Publication 38 as a guideline, and considered the factors referenced in the Federal Information Resources Management Regulation. It stated that the planned performance evaluation of offered systems will be based on the actual data of a Forest Service office that will be realistically scaled to a small- and

large-sized field unit. The Service will also require each office to analyze its specific data requirements, as part of the implementation process, to identify the type and configuration of equipment that is needed to meet its specific needs.

The Service added that it is developing an attachment to the request for proposals that describes the Service's current and anticipated uses of remotely sensed data, and how the GIS is expected to use remotely sensed data in the future.

While we believe the Service's plan to describe its expected use of remotely sensed data is an improvement, the functional requirements analysis provides only some of the data and none of the performance specifications required by Agriculture regulations, which refer to Federal Information Processing Standards Publication 38 for a description of what to address in the functional requirements analysis. As discussed in our report, the Service's functional requirements analysis does not provide specific information such as the sources, accuracy, volume, or frequency of inputs and outputs or users' response-time requirements.

We also believe that the Service's plan to test the performance of offered systems is not a valid substitute for defining its data and performance specifications as part of its functional requirements analysis. The performance test is a one-time event and does not establish the continuing data and performance requirements that must be met as the system is implemented and used by hundreds of offices.

We believe that its plan to further study its data and performance requirements during the implementation phase is inadequate, in the absence of compliance with the requirement to provide data and performance specifications in its functional requirements analysis. Notwithstanding any understanding the Service may have with the vendor community, the functional requirements document is the fundamental document of record to support the requirements contained in its solicitation and, as such, should provide a description and specification of its mission-based requirements.

In sum, we believe that by failing to adequately describe the required data and performance specifications, the Service is unnecessarily increasing its risk of acquiring a system that will not meet its functionality, processing, and performance needs.

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