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Report to Congressional Requesters

January 1989

FEDERAL RESEARCH

Determination of the Best Qualified Sites for DOE's Super Collider

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Resources, Community, and
Economic Development Division

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January 30, 1989

The Honorable Trent Lott
United States Senate

The Honorable Robert A. Roe
Chairman, Committee on Science,
Space and Technology
House of Representatives

The Honorable Robert S. Walker
Ranking Minority Member, Committee
on Science, Space and Technology
House of Representatives

As requested, this report discusses the process for determining the best qualified sites for the superconducting super collider. The report contains a recommendation to the Secretary of Energy to improve future site selection processes.

As arranged with your offices, we will provide copies of the report to the Secretary of Energy, the President of the National Academy of Sciences, and the President of the National Academy of Engineering. We will also make copies available to others upon request.

This report was prepared at the direction of Flora H. Milans, Associate Director. Major contributors are listed in appendix V.

J. Dexter Peach
Assistant Comptroller General

Executive Summary

Purpose

In January 1987 the administration proposed to construct the world's largest high-energy physics accelerator, known as the superconducting super collider, to advance scientific knowledge about the fundamental components of matter and the laws that underlie all physical processes. In selecting the best qualified sites from 35 proposals, the Department of Energy received technical assistance from the National Academy of Sciences and the National Academy of Engineering, which jointly formed a site evaluation committee. The super collider was highly coveted because of its scientific prestige, the economic value of constructing and maintaining the facility, and its potential for stimulating the surrounding region's economic development.

Senator (then-Representative) Trent Lott and the Chairman and Ranking Minority Member, House Committee on Science, Space and Technology, requested that GAO assess the fairness of the process for determining the best qualified sites by reviewing

- the composition of the academies' site evaluation committee,
- the committee's use of Energy's technical evaluation and cost criteria and the impact of Energy's decision not to have the committee make site visits,
- the committee's analysis of the proposed sites' costs, and
- Energy's review of the committee's list of best qualified sites before accepting it.

Background

In April 1987 Energy issued an invitation for site proposals that described the criteria and process for selecting the site for the super collider, whose main feature is an oval tunnel that will be 53 miles in circumference and at least 35 feet underground. The most important criterion was suitable geology and tunneling characteristics, followed by regional resources, which included the proximity and adequacy of housing, schools, and airports. The invitation stated that, while cost considerations were significant, the technical criteria would receive primary emphasis.

The committee evaluated the site proposals by forming subgroups for each of the criteria and then identified eight sites as best qualified. Energy accepted the committee's list of best qualified sites without modification in January 1988. Subsequently, in November 1988, Energy selected Texas (Dallas/Fort Worth) as the preferred site.

Results in Brief

In selecting 21 committee members, the academies sought expertise in many diverse fields related to the site selection criteria, excluded potential members who had participated in preparing a site proposal, and considered the committee's overall geographical representation.

Available documentation and interviews with committee members and staff indicated that the committee used Energy's site selection criteria in their order of importance and that the process was fair. However, Energy could have improved its invitation for site proposals by providing potential site proposers better information about the relative importance of the regional resources criterion. Committee members said that site visits were impractical given the number of proposals and time constraints and that the visits would have had little effect on their evaluation because the proposals generally were well-written and complete.

Sites' costs were a minor factor in the committee's identification of the best qualified sites because of the narrow percentage range of cost estimates. The costs subgroup's economists acknowledged that their analysis was limited because of time constraints; however, they stated that the cost model and its data were adequate for the committee's identification of the best qualified sites.

Energy accepted the committee's best qualified list of sites on the basis of its own site task force's review of each proposed site, the committee's report, and a briefing by the committee's staff.

GAO's Analysis

Members Selected for Their Expertise

The academies' committee chairman and staff stated that 21 members were chosen for the committee to ensure that it had sufficient expertise to evaluate site proposals against each of the site selection criteria and the academies disqualified any person associated with a proposal. Eight members were associated with the Universities Research Association, Inc., the operations contractor for Energy's Fermi National Accelerator Laboratory, which is encompassed by Illinois' proposed site. According to committee members who were not associated with Universities Research Association, the Illinois site was one of the very best sites.

Evaluation Was Based on Criteria

The committee members stated that at their final meeting, they evaluated each proposal against the technical and cost criteria until the committee reached a consensus about whether the proposal was among the best qualified. The subgroups' preliminary ratings indicated that the committee used the technical criteria in their order of importance.

The committee principally used the geology and tunneling and the regional resources criteria to discriminate between proposals. Regional resources played a greater role in the committee's evaluation than some of the site proposers had expected. However, experts, including one current and two former Energy laboratory directors, emphasized to the committee the importance of regional resources for the super collider's scientific productivity.

Committee members said that visits to the 35 sites were impractical, given Energy's site selection schedule, the number of sites, and members' other commitments, and would not have substantially changed the committee's evaluation because most of the proposals were well-written and complete.

Costs Were a Minor Factor in Evaluation

The committee did not use costs to discriminate between the proposed sites (1) because the sites' cost estimates were within 3.3 percent of the $11.2 billion average cost of all sites to construct and operate the super collider and (2) because of uncertainties about future costs over the super collider's 33-year life. Because of time constraints on completing the committee's evaluation, the Energy contractor that developed the life-cycle cost model was not asked to verify the reliability of the model's data, restructure the cost model to allow a discounting of future costs, or reexamine the model's assumptions, such as which resources would be purchased on national as opposed to regional markets.

GAO found no basis to disagree with the committee that the relatively narrow percentage range of cost estimates and the comparable range of the cost data's uncertainty considerably weakened its ability to distinguish between sites' expected costs. GAO did not review Energy's efforts to modify or refine the cost model for the selection of the final site.

Energy Accepted Committee's List

Energy's site task force members stated that they reviewed the committee's best qualified list to determine whether it was supportable and reasonable, making their own assessment of the strengths and weaknesses of each of the 35 sites. Task force members did not attend subgroup or committee meetings in which the proposals were evaluated, and the committee did not give Energy a written assessment of each proposal. Consequently, task force members relied on a day-long briefing by the committee's staff to obtain information about the committee's evaluation of each site.

Site Proposers' Comments

GAO interviewed senior officials from 11 states that proposed sites that were not judged best qualified. (Three of the states also proposed sites that were judged best qualified.) The officials generally were satisfied with Energy's invitation for site proposals. However, if the invitation had provided more information about the relative importance of the regional resources criterion in the site evaluation process, four officials said that their states may have (1) selected alternative sites or (2) decided that they did not have the regional resources base to successfully compete and would not have spent between about $700,000 and $2.4 million for preparing each site proposal. Energy could have better indicated the relative importance of the regional resources criterion by discussing in the invitation its importance for the super collider's scientific productivity as Energy laboratory directors did with the committee in August 1987.

Recommendation

GAO recommends that the Secretary of Energy ensure for any future site selection process similar to the super collider's that potential site proposers be given the maximum information possible in the invitation about the relative importance of the selection criteria.

Agency Comments

The final draft of this report was sent to the Department of Energy, the National Academy of Sciences, and the National Academy of Engineering for comment. Energy concurred with the report's findings and recommendation but noted that its invitation for site proposals had listed the technical evaluation criteria and subcriteria in their descending order of relative importance and that our report found that the academies' committee had used the criteria in their order of importance. While the National Academy of Sciences and the National Academy of Engineering did not provide a formal response, their staff suggested some changes to improve the technical accuracy of the draft report. GAO incorporated appropriate changes.

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Abbreviations

CBO	Congressional Budget Office
DOE	Department of Energy
FY	fiscal year
GAO	General Accounting Office
NAE	National Academy of Engineering
NAS	National Academy of Sciences
R&D	research and development
RTK	joint venture of Raymond Kaiser Engineers, Inc.; Tudor Engineering Company; and Keller & Gannon Knight
SSC	superconducting super collider
URA	Universities Research Association, Inc.

Introduction

In January 1987 President Reagan approved for submission to the Congress a proposal to construct a $4.4 billion (in FY 1988 dollars) superconducting super collider (SSC) as part of the Department of Energy's (DOE) high-energy physics program. Physicists intend to use the SSC to study the fundamental components of matter and the laws that underlie all physical processes in the universe. The SSC will accelerate two beams of protons (positively charged particles found in the nuclei of all atoms) to nearly the speed of light before they collide with an energy of 40 trillion electron volts. Physicists then will analyze the collisions to detect the presence of new subatomic particles and measure their properties. The SSC would be the largest high-energy physics accelerator in the world. The tevatron collider at Fermi National Accelerator Laboratory, which collides subatomic particles with an energy of 1.8 trillion electron volts, currently is the largest accelerator.

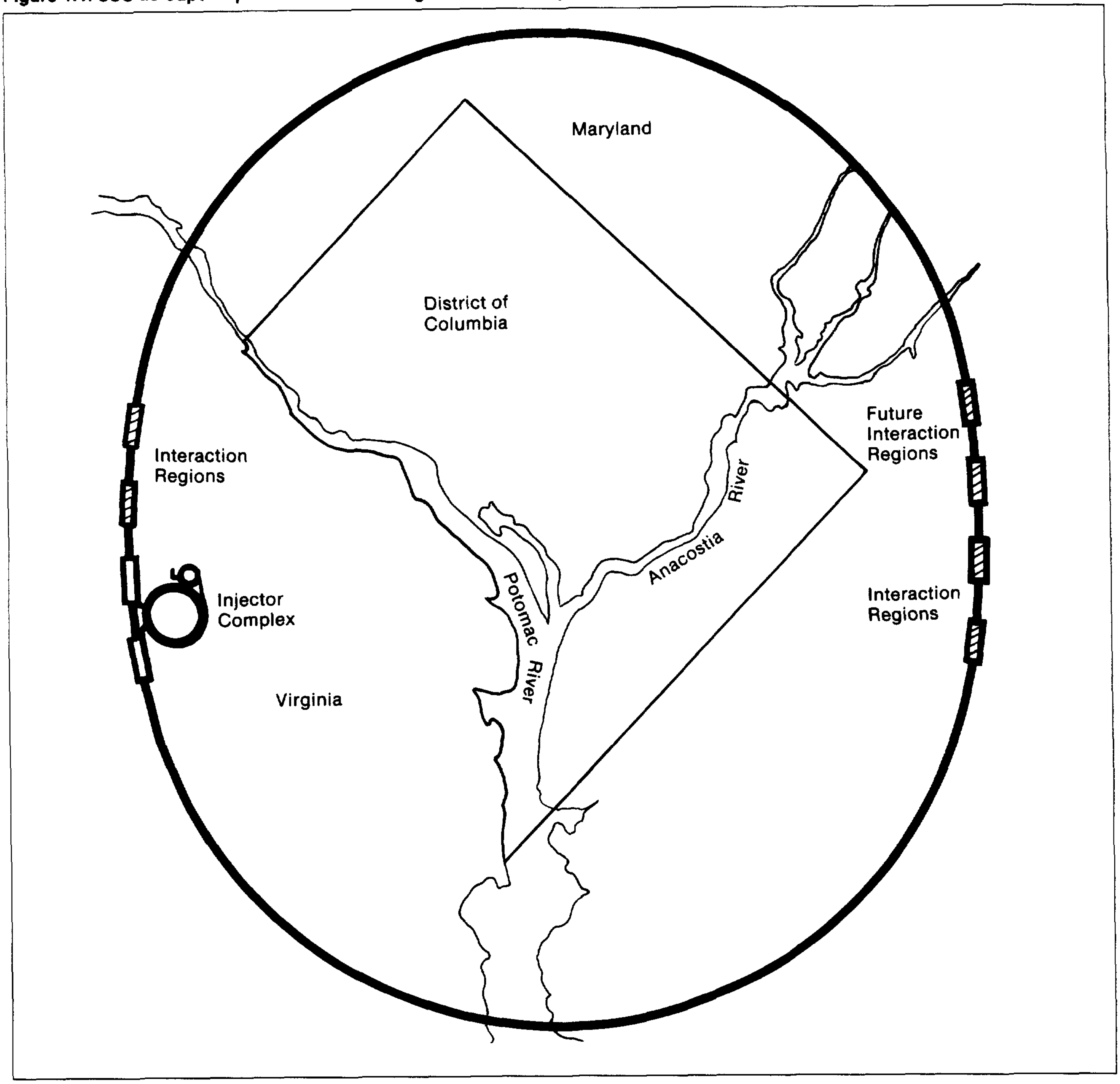
The SSC Facility

The SSC facility will consist of (1) a series of 4 injector accelerators to accelerate the 2 proton beams from rest to 1 trillion electron volts, (2) an oval tunnel 53 miles in circumference (approximately the size of the Washington, D.C., Beltway (I-495)—see fig. 1.1) and at least 35 feet underground to accelerate the proton beams in opposite directions around the oval to nearly the speed of light, (3) 4 large underground interaction halls in which experiments will be conducted by colliding the beams, (4) at least 15 buildings including a central laboratory building, industrial buildings, warehouses, and auxiliary support buildings, and (5) roads and utility infrastructure. The SSC's principal technical components are 9,500 superconducting magnets with associated cryogenic equipment needed to maintain an extremely low temperature.[1] Because the superconducting magnets reduce electrical resistance, the entire SSC facility will need only 100 megawatts of electrical power as compared with at least 4,000 megawatts if conventional copper conductor electromagnets were used.

DOE estimated that construction will take 8 years and that the on-site work force during construction will peak at about 4,500 people. During its 25-year operating life, the SSC will have an annual budget of $270 million (in FY 1988 dollars) and will employ about 2,500 scientists, engineers, technicians, and administrative staff. An additional 500 visiting scientists and graduate students will conduct research at the facility at any given time.

[1]Temperatures will be 4 degrees Kelvin (-452.5 degrees Fahrenheit), the boiling point of liquid helium, to establish superconductivity.

Figure 1.1: SSC as Superimposed on the Washington, D.C., Metropolitan Region



Site Selection Process

In February 1987 the Secretary of Energy announced DOE's intent to issue an invitation for site proposals, stating that the site selection process was designed to be fair and equitable to all parties—absolutely open and above-board. (See app. I for a chronology of events leading to the selection of the SSC site.) In April 1987 DOE issued the invitation, which described the super collider facility, the site selection criteria, and the process and time frames for evaluating the site proposals. The closing date for submission of site proposals was September 2, 1987.

The invitation identified five qualification criteria that proposals were required to meet in order to be evaluated for selection. (One criterion was the absence of cost to the government for the acquisition of land.) It also listed six technical evaluation criteria in the order of their importance against which the site proposals would be evaluated. (See app. II.) In addition, the invitation stated that cost considerations were important and would be used in conjunction with the technical criteria in selecting the most desirable site, although primary emphasis would be placed on the technical criteria.

The invitation outlined a three-stage process for selecting the preferred site for the SSC. First, DOE's SSC site task force would review all of the site proposals to ensure that they met the five qualification criteria. Second, DOE would then transmit qualified proposals to an SSC site evaluation committee established by the National Academy of Sciences (NAS) and the National Academy of Engineering (NAE) to identify an unranked list of best qualified sites on the basis of the technical criteria and cost considerations.[2] Third, after DOE's acceptance of the list of best qualified sites, the DOE site task force would perform additional detailed evaluation of these sites to identify the preferred site by July 1988 (subsequently changed to November 1988) and select the final site by January 1989. The invitation specifically stated that the NAS/NAE committee would not visit the proposed sites.

DOE asked NAS and NAE for assistance because of (1) the expertise of the academies' members and (2) DOE's concern that the best qualified sites be selected on their technical merits without the appearance of manipulation for political or other reasons. In addition, NAS had assisted DOE's predecessor, the Atomic Energy Commission, in selecting the site for the Fermi National Accelerator Laboratory in 1965.

[2]NAS and NAE are private, nonprofit societies of distinguished scholars engaged in scientific and engineering research.

Selection of the Best Qualified Sites

In February 1987 DOE formed its SSC site task force and asked NAS and NAE to form a site evaluation committee. In the next months DOE developed the invitation for site proposals and a statement of work for the committee, which were reviewed with NAS and NAE. The Presidents of NAS and NAE selected 21 members for the committee, which held its first organizational meeting on June 30-July 1, 1987. During this meeting, the members (1) discussed any potential conflicts of interest, (2) discussed the committee's procedures for evaluating the proposals, and (3) on the basis of their expertise and interests, volunteered to participate in the seven subgroups that were established to evaluate site proposals for each of the technical and cost criteria.

DOE received 43 site proposals by the invitation's closing date. The DOE site task force found that 36 of these proposals met its qualifying criteria and transmitted these proposals to the NAS/NAE committee on September 17, 1987. (Subsequently, in October 1987, New York withdrew its Wallkill Valley site proposal, so the NAS/NAE committee evaluated 35 proposals.) In the next 2 months, each subgroup reviewed the appropriate sections of each proposal and developed preliminary evaluations. The NAS/NAE committee then met on November 13-14, 1987, discussed the extent that each proposal met the technical and cost criteria, and identified the following eight sites as best qualified: Arizona (Maricopa), Colorado (Denver), Illinois (Fermilab), Michigan (Stockbridge), New York (Rochester), North Carolina (Raleigh-Durham), Tennessee (Nashville), and Texas (Dallas-Fort Worth).

The NAS/NAE committee gave its final report, Siting the Superconducting Super Collider, to DOE on December 24, 1987. The committee's staff then briefed DOE site task force members on December 29, regarding the committee's procedures for identifying the best qualified sites and the strengths and weaknesses of each of the 35 proposals. In January 1988 the DOE site task force issued its report, Best Qualified Sites for the Superconducting Super Collider, which recommended that the committee's list of best qualified sites be accepted without modification. On January 19, 1988, the Secretary of Energy announced that DOE accepted the best qualified list unchanged.[3]

After its announcement of the best qualified sites, DOE offered to brief individual site proposers about the site selection process and the strengths and weaknesses of the proposer's site. Since January 1988 the

[3]On January 15, 1988, New York State withdrew its Rochester site from further consideration because of local opposition to the SSC.

DOE site task force has conducted a more detailed analysis of the best qualified sites, which included visits to each of the sites in April-July 1988 and the issuance of a draft environmental impact statement for the SSC in August 1988. DOE selected the Texas (Dallas-Fort Worth) site as the preferred site for the SSC on November 10, 1988, and issued the final environmental impact statement for the SSC in December 1988.

The Fermi Precedent

The last high-energy physics accelerator facility to be constructed was the Fermi National Accelerator Laboratory in Batavia, Illinois. In April 1965 the Atomic Energy Commission issued a press release soliciting site proposals for Fermi, a 200-billion electron volt accelerator. The site selection process for Fermi provided the basis for DOE's process for siting the SSC.[4]

The technical criteria for the SSC were similar to those for Fermi. The Fermi criteria included: (1) at least 3,000 acres of land (DOE required about 16,000 acres for the SSC), (2) adequate electric power supply, (3) reasonable proximity to a commercial and industrial center which includes research and development activities, (4) reasonable proximity to communities with adequate housing, cultural, and educational facilities for a staff of about 2,000, and (5) proximity to adequate surface transportation systems and a major airport with frequent service to major U.S. cities. The Fermi solicitation did not explicitly mention costs as a criterion for evaluating sites; however, it did discuss trade-offs between technical and other factors to obtain overall efficiencies and economies.

Similar to the Atomic Energy Commission in 1965, DOE requested NAS and NAE assistance in identifying the best sites for the SSC. These site evaluation committees are similar to panels of experts that federal agencies have used to assess the scientific merit of proposed research, a process known as "peer review." Peer review is a necessarily inexact and subjective process in which experts judge which proposals are most likely to yield the most fruitful results. It is based on the premise that experts in a given subject, by virtue of their knowledge and experience, are best able to examine a proposal critically and give an informed opinion about its merits and feasibility.

[4]Our report, Federal Research Projects: Concerns About DOE's Super Collider Site Selection Process (GAO/RCED-87-175FS, Aug. 6, 1987), compared several aspects of the site selection processes for Fermi and the SSC.

While the process for selecting the SSC's site is similar to the Fermi selection process, it has varied in several aspects. In addition to requiring the successful proposer to provide land for the accelerator facilities at no cost to the government, the SSC invitation asked proposers to itemize any financial and other incentives offered to defray the cost of constructing and operating the SSC.[5] The Atomic Energy Commission staff's review of the Fermi site proposals in 1965 also included visits to all 148 proposed sites, while DOE's SSC site task force visited only the best qualified sites. In accordance with the National Environmental Policy Act, which was enacted in 1970, DOE issued the final environmental impact statement for the SSC, which assessed each of the best qualified sites.

Objectives, Scope, and Methodology

Senator (then-Representative) Trent Lott and the Chairman and Ranking Minority Member, House Committee on Science, Space and Technology, asked us to assess the fairness of the site selection process for determining the best qualified list of sites for the SSC by examining the following six issues:

- What was the composition of the NAS/NAE committee, including (1) the purpose in selecting 21 members instead of 15 as specified by DOE's statement of work to the committee, (2) the committee's use of consultants in evaluating proposals, (3) committee members' association with Universities Research Association, Inc., DOE's operations contractor for Fermi, and (4) the regional distribution of the committee members?
- Did the NAS/NAE committee use the technical and cost criteria listed in DOE's invitation for site proposals to evaluate the site proposals and identify the best qualified sites? Were committee members predisposed toward sites located near large metropolitan areas as opposed to sites in small metropolitan or rural areas?
- Did the NAS/NAE committee's written documentation and interviews with committee members support the committee's report regarding how the committee evaluated the site proposals and identified the best qualified ones?
- Did DOE's decision that the NAS/NAE committee would not conduct site visits put rural sites at a disadvantage because a rural area would not be as well known to committee members as sites near large metropolitan areas?

[5] The Supplemental Appropriations Act for Fiscal Year 1987 (P.L. 100-71, July 11, 1987), which was enacted after the invitation was issued, prohibited DOE from using any appropriated funds to assess any such offers. DOE amended its invitation in response to the act.

- What was the role of costs in identifying the best qualified sites, and why did the cost estimates for 35 different sites fall within a "remarkably narrow range"?
- How did DOE review the NAS/NAE committee's list of best qualified sites before approving it unchanged?

To assess these questions, we interviewed each of the 21 NAS/NAE committee members, 5 NAS/NAE staff members, and 10 DOE site task force members. We also examined (1) the proposals for the best qualified sites and several other sites, (2) the NAS/NAE committee's documentation, including the preliminary ratings of the proposals by each of its subgroups and the informal notes taken at the November 13-14, 1987, meeting in which the best qualified sites were identified, and (3) DOE's documentation of the site selection process, including the invitation for site proposals, data generated by DOE's life-cycle cost model for each proposed site, and DOE's list of the strengths and weaknesses of each proposed site. In addition, to obtain site proposers' perspectives about the site selection process, we interviewed 11 senior officials responsible for preparing 15 of the 35 site proposals that the NAS/NAE committee evaluated, including 3 sites on the best qualified list.

As agreed with the requesters' offices, we did not independently assess whether any member of the NAS/NAE site evaluation committee had a conflict of interest. Rather, we asked each member to describe any other connection that he or she had with the SSC site selection process besides participating on the committee.

We did not examine the structure of DOE's life-cycle cost model or the reasonableness of its assumptions, such as which SSC cost components would be purchased on national as opposed to local markets. We also did not systematically review the reasonableness of the DOE contractor's cost estimates for each site; however, our report identifies an example of a significant difference between the DOE contractor's and proposers' estimates of tunnel construction at two sites.

We did not assess the need for the SSC or the reliability of current cost estimates for the project. We have issued two reports in recent years that assessed DOE's high-energy and nuclear physics accelerator programs.[6] In addition, in October 1988 the Congressional Budget Office

[6]DOE's Physics Accelerators: Their Costs and Benefits (GAO/RCED-85-96, Apr. 1, 1985) and Nuclear Science: Information on DOE Accelerators Should Be Better Disclosed in the Budget (GAO/RCED-86-79, Apr. 9, 1986).

issued a report that stated that the SSC could cost much more than what DOE has estimated.[7]

We conducted our review between March 1988 and October 1988 in accordance with generally accepted government auditing standards.

[7] Risks and Benefits of Building the Superconducting Super Collider.

The NAS/NAE Site Evaluation Committee

DOE's statement of work for the NAS/NAE site evaluation committee stated, "the committee shall consist of about 15 distinguished scientists, engineers, and other individuals and will be appointed giving due consideration to potential real or apparent conflicts of interest and geographical distribution." The committee's chairman and staff told us that the committee consisted of 21 members, instead of 15, because they were more concerned with having sufficient expertise to evaluate the DOE invitation's technical evaluation and cost criteria than with the total number of members or their geographical representation. The committee supplemented its expertise in some areas by getting assistance from both paid and unpaid consultants; however, none of these consultants voted in the committee's identification of the best qualified proposals.

The Presidents of NAS and NAE and the committee's chairman and staff screened potential committee members for conflicts of interest by excluding any candidate who had assisted in preparing a site proposal for the SSC or had previously agreed to assist a state if that site were selected for the SSC. Eight committee members told us that they were associated with the Universities Research Association, Inc. (URA), which is the operations contractor for DOE's Fermi National Accelerator Laboratory and which managed the development of the SSC's conceptual design. URA is a nonprofit organization comprised of 66 universities in 29 states, many of which submitted site proposals, and Canada. While URA is not directly associated with a site proposal and has publicly stated that it had no site preference for the SSC, Fermi is included in the Illinois site proposal.[1] Committee members who had no connection with URA stated that the Illinois site was one of the best proposed sites in both the geology and tunneling and the regional resources criteria.

We did not find any evidence of favoritism by committee members in evaluating proposals or identifying the best qualified sites based on the members' geographical representation. For example, while 6 of the 21 committee members were from California, the committee decided that neither proposed California site was best qualified. Similarly, only 1 of the 8 best qualified sites was located in the Northeast, even though 10 committee members were from northeastern and mid-Atlantic states. The committee's chairman and staff told us that obtaining geographical distribution was complicated by difficulties in finding experts who (1) were available and willing to devote the necessary time to evaluate the site proposals and (2) did not have a conflict of interest because they were associated with a state's proposal.

[1] Illinois proposed to use Fermi's tevatron collider as the injector complex for the SSC.

Selection of Committee Members

Members of committees formed by NAS and NAE serve on a voluntary basis. They receive no salary, and the committees' responsibilities typically are in addition to those of their regular job. The Presidents of the NAS and NAE chose the 21 members of the SSC site evaluation committee with the assistance of the committee's staff and chairman, who had been selected first. (See app. III for a list of the members.) According to the staff of the committee and the DOE site task force, DOE did not propose any names of potential committee members, and NAS and NAE did not seek DOE's approval of members before naming the committee.

The NAS/NAE project officer told us that NAS and NAE commonly "cast a wide net" for committee members by asking for suggestions from many persons as well as by relying on their own extensive lists of experts in relevant fields. While DOE's statement of work for the committee called for about 15 members, the committee's chairman and project officer told us they wanted to feel comfortable about the expertise available to address each of the technical and cost criteria, rather than limit the committee to a specific number of people. The chairman added that he perceived the $740,132 available for the committee's expenses in the DOE contract as the only constraint on the number of committee members.

As table 2.1 indicates, the members brought to the committee expertise in diverse fields related to the construction, operation, and use of a large scientific facility and in fields that DOE's technical and cost criteria specifically identified. Several members provided expertise in more than one of these fields.

Table 2.1: Relevant Expertise of Committee Members

Accelerator design:
Dr. Courant, Mr. Reardon, Dr. Wojcicki

Economics:
Dr. Baumol, Dr. Leonard

Engineering geology:
Mr. Cliff, Dr. Deere, Gen. Heiberg

Environment:
Dr. Cantlon, Ms. Tschinkel

Experimental physicists:
Dr. Schwitters, Dr. Townes, Dr. Wojcicki

Large construction management:
Mr. Gould, Gen. Heiberg, Dr. Jefferson, Mr. Reardon

Large science facility management:
Dr. Adams, Dr. Everhart, Dr. Frieman, Dr. Goldberger, Dr. Massey, Dr. Samios

Procurement:
Dr. Frieman, Mr. Gould, Gen. Heiberg, Dr. Jefferson

Theoretical physicists:
Dr. Goldberger, Dr. Townes, Dr. Weinberg

Utilities:
Mr. Gould

Source: NAS/NAE.

Table 2.2 shows the members who participated in each of the committee's subgroups, which corresponded to the DOE invitation's technical and cost criteria. Committee members told us that the chairman asked them to participate in more than one subgroup and that they volunteered for subgroups to which they were best able to contribute. A comparison of table 2.1 with table 2.2 shows that (1) engineering geologists and environmental experts generally participated in both the geology and tunneling and the environment subgroups, although they devoted most of their time on the subgroup directly related to their primary expertise, (2) experimental and theoretical physicists and managers of large scientific facilities and large construction projects generally participated in the regional resources subgroup, (3) economists participated in the costs subgroup, and (4) the utility manager participated in the utilities subgroup.

Table 2.2: Site Evaluation Committee's Subgroup Members[a]

Geology and Tunneling:
Dr. Deere, Dr. Cantlon, Mr. Cluff, Gen. Heiberg

Regional Resources:
Dr. Adams, Dr. Everhart, Dr. Goldberger, Dr. Jefferson, Dr. Massey, Mr. Reardon, Dr. Samios, Dr. Schwitters, Dr. Weinberg, Dr. Wojcicki

Environment:
Dr. Cantlon, Mr. Cluff, Dr. Deere, Ms. Tschinkel

Setting:
Dr. Courant, Dr. Deere, Dr. Jefferson, Mr. Reardon

Regional Conditions:
Mr. Reardon, Dr. Deere, Dr. Everhart, Dr. Jefferson, Dr. Samios, Dr. Townes

Utilities:
Mr. Gould

Costs:
Dr. Baumol, Dr. Leonard, Dr. Schwitters

[a]The first member listed for each of the technical criteria subgroups served as the chairman.
Source: NAS/NAE.

Consultants to the Committee

In addition to the members' contributions, the committee received assistance from several outside consultants in evaluating the proposals. Geology and tunneling subgroup members told us that they initially were concerned that the committee included only two geologists and a civil engineer, particularly given the short, 3-month time frame for evaluating a large number of site proposals. They therefore asked NAS and NAE for permission to hire consultants in engineering geology. NAS and NAE approved this request and hired Don W. Deere and James C. Gamble. Mr. Deere, who has a masters degree in engineering geology and has been active in the field since 1975, was the chief of the geotechnical division of Rocky Mountain Consultants, Inc. He is the son of committee member Dr. Don U. Deere. Dr. Gamble, who has a Ph.D. in geotechnical engineering and began his career in 1965, worked in the geosciences department of Pacific Gas and Electric Company for committee member Lloyd Cluff. Both consultants participated in geology and tunneling subgroup meetings, but neither attended the final committee meeting.

In August 1987 the regional resources subgroup met with five senior managers and scientists from large research facilities to discuss the regional resources that are important for the SSC's scientific productivity. (This meeting is discussed in more detail in chap. 3.) The U.S. Army

Corps of Engineers assisted the setting subgroup by analyzing land acquisition requirements for each proposed site.

Two committee members received assistance from members of their organization's staff. Edward Jefferson received assistance from Jerry Okeson of Du Pont Company, and Lt. General Elvin Heiberg received assistance from Richard Armstrong of the Army Corps of Engineers. Committee staff told us that, although this is not a common practice, very busy members who had agreed to participate on other NAS and NAE committees have drawn on their organization's staff for assistance. Dr. Okeson and Mr. Armstrong attended several subgroup and committee meetings. While they contributed to the discussion of the proposed sites, they did not vote during the committee's deliberations.

Universities Research Association

The committee's chairman and staff, who assisted the Presidents of NAS and NAE in identifying potential committee members, told us that they disqualified any prospective member who directly, or whose employer, had (1) assisted a state or locality in preparing a proposal or (2) previously agreed to participate in that state's or locality's efforts if it were selected for siting the SSC. They stated that screening for conflicts of interest, while essential for ensuring the integrity of the committee, made their task of identifying members with expertise in the invitation's technical criteria more difficult because many of the leading geology and tunneling experts and architect and engineering firms had participated in developing states' proposals. In addition to the initial screening, each committee member filled out a standard NAS/NAE conflict-of-interest form and discussed possible conflicts at the committee's June 30-July 1, 1987, organizational meeting. We did not independently assess whether committee members had a conflict of interest.

Eight committee members told us that as part of their regular responsibilities, they have been associated with URA, which is DOE's (1) operations contractor for Fermi, which is included in Illinois' proposed SSC site, and (2) manager of the central design group, which developed the SSC's conceptual design. URA is a nonprofit organization, consisting of 66 research universities located in 29 states and Canada.[2] All of the member universities have graduate programs in science and are active in particle physics. Member universities pay dues to URA and receive no

[2]URA conducts its affairs through a Council of Presidents of the member universities. The Council appoints a board of trustees, which in turn appoints boards of overseers for Fermi and the central design group. Each board has a representative from each of URA's seven regions, as well as several representatives-at-large.

financial return. They can participate in making policy for the management of Fermi and the central design group, propose members for the governing boards of URA, and determine how URA spends the members' dues. Because access to the Fermi accelerator is determined through peer review of research proposals, they do not necessarily receive greater access to the research facilities.

The eight committee members had the following associations with URA:

- Four members were either the president or the vice president for research of URA member universities and thus were members or alternates of URA's Council of Presidents.
- One member was an experimental high-energy physicist who conducted research at Fermi, headed Fermi's operations group for the collider detector, and was a member of the board of overseers for the SSC central design group.
- One member was an experimental high-energy physicist and an accelerator design expert who conducted research at Fermi and was the deputy director of the SSC central design group.
- Two members, who were experts in accelerator design, worked for the central design group in developing design parameters for the SSC.

In addition, one committee member was on the board of trustees of a university that belongs to URA. Another member told us that, although he had no connection with URA while he participated on the NAS/NAE committee, he subsequently was asked and agreed to serve on URA's board of trustees. Several other members of the committee were on the faculty of universities that were URA members, but they stated that they had no direct connection with URA.

The committee's chairman and staff stated that they wanted to include both high-energy physicists, as representatives of the SSC's user community, and experts in accelerator design on the committee. They noted that because Fermi currently has the world's largest accelerator, experimental high-energy physicist candidates were likely to have conducted research at Fermi. Similarly, accelerator design experts were very likely to have worked on the SSC's design.

Committee members stated that individual members mentioned their associations with URA during the discussion of potential conflicts of interest at the committee's organizational meeting. Members who were not associated with URA told us that (1) they did not perceive that these members' association with URA biased the committee's evaluation of proposals or identification of the best qualified sites and (2) the Illinois proposal was one of the best for both the geology and tunneling and regional resources criteria.

In addition, members told us that high-energy physicists and accelerator designers have a stake in whether, but not necessarily in where, the SSC is built. One member questioned what impact the siting of the SSC would have on URA because, similar to Fermi, the SSC would be a government-owned facility and URA or a similar organization probably would operate it. Another member pointed out that locating the SSC at the Fermi site may have drawbacks for high-energy physicists if Fermi's tevatron collider becomes the injector complex for the SSC because experimentalists may no longer be able to use it once construction begins.

Geographical Distribution

Appendix III shows that the committee consisted of six members from California, one from Delaware, two from Florida, one from Illinois, two from Massachusetts, one from Michigan, two from New Jersey, three from New York, one from Texas, and two from Washington, D.C. In addition, all of the members had lived and/or worked in other geographical regions of the United States. For example, the chairman of the geology and tunneling subgroup stated that he had been in more than 300 different tunnels around the world in the past 10 years. Another member of the geology and tunneling subgroup told us that the subgroup's members and consultants generally were familiar with the geology of all 35 proposed sites because at least one of them had worked on a nearby project.

The committee's chairman and project director stated that their efforts to get members from different parts of the country were made more difficult by conflict-of-interest concerns that disqualified some potential members as well as by the actual location of experts who were available and willing to devote the necessary time to evaluate the site proposals. In addition, they noted that they added a 21st member to the committee from the Midwest to improve its geographical balance because one member moved from a Midwest to a California university after he had agreed to serve on the committee.

We did not find any evidence of favoritism by committee members in evaluating proposals and identifying the best qualified sites on the basis of the members' geographical representation. Three members pointed out that the committee decided that neither proposed California site was best qualified even though 6 of the 21 committee members were from California. However, we note that if the committee had identified a California site as best qualified, the high percentage of committee members from California could have raised major questions about the appearance of favoritism.

The NAS/NAE Committee's Evaluation of the Technical Merit of the SSC Site Proposals

Available documentation and interviews with NAS/NAE site evaluation committee members and staff indicated that the committee used DOE's site selection criteria in their order of importance for identifying the best qualified sites and that the process was fair. We found no evidence either during our interviews or in our examination of the committee's supporting documentation that would indicate that the committee used criteria other than those in the DOE invitation or that the process was not fair.

The committee's documentation showed that it established review procedures in advance of receiving the proposals and evaluated the proposed sites using DOE's published criteria. Committee members told us that in the final November 13-14, 1987, meeting, they discussed each proposal in turn across the technical and cost criteria until the members reached a consensus about whether or not the proposal was among the best qualified. They stated that they used DOE's technical evaluation and cost criteria in DOE's stated order of importance and that geology and tunneling and regional resources were the most significant criteria for discriminating between proposals. Neither the invitation nor the committee assigned specific weights to the criteria.

The preliminary ratings of the committee's subgroups indicated that the committee used the technical criteria in their order of importance in identifying the best qualified sites; however, they did not conclusively show whether geology and tunneling or regional resources were more important. Review of the subgroups' preliminary ratings showed that 6 of the 8 best qualified sites were among 13 sites that the geology and tunneling subgroup rated as good and 7 of the best qualified sites were among 12 sites that the regional resources subgroup rated as satisfactory or better in all four of its subcriteria.

Committee members told us that the best qualified sites generally were located near large metropolitan areas because metropolitan areas tended to have existing community, transportation, and industrial infrastructure that met DOE's regional resources criterion. The members told us that DOE's decision that the committee would not conduct site visits did not put rural sites at a disadvantage in the committee's evaluation process because (1) several committee members generally were familiar with the region around the proposed sites and (2) almost all of the proposals were well-written and complete in presenting relevant information.

NAS/NAE Committee's Procedures for Evaluating Proposals

DOE's invitation for site proposals outlined the framework for selecting the SSC's site. The invitation stated that DOE's goal was to select a site that would permit the highest level of research productivity and overall effectiveness of the SSC facility at a reasonable cost of construction and operation and with minimal adverse impact on the environment. Appendix II shows the DOE invitation's six technical evaluation criteria with their component subcriteria that were the basis for selecting the SSC site. The invitation further stated that the criteria and each criterion's subcriteria were listed in descending order of relative importance so that geology and tunneling was most important, followed in order by regional resources, environment, setting, regional conditions, and utilities. The invitation noted, however, that a serious deficiency in any one subcriterion might prevent a proposal from being considered best qualified.

The statement of work in DOE's contract with NAS and NAE directed that before receiving the proposals, the committee would establish its evaluation techniques, processes, and special analyses using the announced criteria, subcriteria, and their relative importance. DOE also directed the committee to prepare a final report within 3 months of receiving the proposals that would provide an unranked list of best qualified sites, describe the committee's process in evaluating the proposed sites against the technical and cost criteria, and assess the best qualified sites.

Prior to receiving proposals from DOE, the NAS/NAE committee formulated its evaluation procedures. The procedures stated that, instead of adopting a rigid set of weights for each criterion and subcriterion, the committee would form subgroups for each of the criteria that would evaluate proposals against the subcriteria using a scale of "good," "satisfactory," or "questionable." These initial evaluations then would be discussed by the full committee. The procedures also stipulated that the committee's staff would aggregate the subgroups' preliminary ratings across the technical criteria to test whether varying the criteria's weights would affect the relative performance of the proposals. Committee members then would review all proposals and determine whether each proposal would be placed on the best qualified list on technical grounds. Finally, after determining the technically qualified list, the costs would be considered and a best qualified list incorporating both technical evaluation and cost criteria would be prepared. The procedures stated that costs would be left until the end to meet the specification in the invitation that technical performance would be the dominant criterion.

Subgroups' Evaluation of the Proposals

As described in chapter 2, the Presidents of NAS and NAE chose committee members who represented a broad range of expertise and experience. At the committee's organizational meeting, members then volunteered to participate in the technical and cost criteria subgroups on the basis of their expertise. The committee members told us that they read, at a minimum, each proposal's summary volume and the volume that addressed the criterion for each of the subgroups in which they participated. In addition, the members divided the proposals among themselves so that each proposal was read in its entirety by at least one member. Each of the technical criteria subgroups met in early October 1987 to evaluate the proposals against the subcriteria.

Geology and Tunneling

The geology and tunneling subgroup evaluated each proposal using the 4 subcriteria that were further broken into 20 factors. (See table 3.1.) The subgroup report showed that the subgroup further considered various favorable and unfavorable conditions associated with the 20 factors.

Table 3.1: Geology and Tunneling Factors

Subcriterion	Factors
Suitability of the topography, geology, and associated geohydrology for efficient and timely construction of the proposed SSC underground structures.	Topography Percentage of rock types Groundwater depths Support needed Excavation method Estimated advance rates
Stability against settlement and seismicity, and other features that could adversely affect SSC operations.	Settlement risk Seismic zone Liquefaction potential Subsidence Other
Installation and operational efficiency resulting from minimal depths for the accelerator complex and experimental halls.	Average depth to cover Excavation method
Risk of encountering major problems during construction.	Faults Mixed face Flowing ground Complexity of geology Groundwater control Cavities Gas

Source: NAS/NAE.

The subgroup met in early October to discuss the strengths and weaknesses of each proposal for each factor until they reached a consensus about the geology and tunneling characteristics of each site. The subgroup members told us that the SSC could be built at any of the 35 sites. Consequently, they evaluated proposals' weaknesses in terms of

(1) expected increased construction costs and delays and (2) greater risks and uncertainties that would likely lead to increased costs.[1] The members were concerned about the costs associated with controlling or mitigating the presence of water, complex geologic conditions with many changing rock types and wide variations in their properties, or the presence of active faults. They also were concerned about any risks, such as the presence of explosive or toxic gas, and uncertainties, such as the presence of flowing ground or underground cavities, associated with each site.

Subgroup members told us that they reached a consensus that, particularly given that other criteria had to be factored into identifying the best qualified sites, differences in geology and tunneling among the top half of the sites were not critical. Sites in the bottom half were not serious contenders for the best qualified list because they had geological characteristics that would lead to increased construction costs or delays and/or greater risks and uncertainties. Subgroup members also mentioned that they knew that a site with good geology and tunneling, but without the appropriate regional resources, would not be considered best qualified.

The geology and tunneling subgroup, which developed an overall rating for each proposal, rated 13 sites as good, 9 as satisfactory, 9 as satisfactory minus, and 4 as questionable. The subgroup rated six of the best qualified sites as good and two as satisfactory. The subgroup's chairman added that they considered 6 of the 13 good sites, including 3 on the best qualified list, to have great geology and tunneling characteristics.

Regional Resources

To better understand the issues and concerns in managing large scientific facilities similar to the SSC, the regional resources subgroup met on August 31, 1987, with five senior managers and scientists:

- Leon Lederman, Director of the Fermi National Accelerator Laboratory;
- Wolfgang Panofsky, former Director of the Stanford Linear Accelerator Center;
- Louis Rosen, former Director of the Los Alamos Meson Physics Facility;

[1] The recently completed 17-mile tunnel for the large electron-positron collider at Cern, Switzerland, illustrates some of the subgroup's concerns. Even though prior geological studies revealed potential difficulties due to geological faults and/or underground water and Cern managers subsequently repositioned the tunnel, the tunneling team ran into an aquifer that flooded the tunnel at a rate of about 26 gallons per second. Tunneling was stopped for several months to reinforce the tunnel lining and the surrounding rock. In addition, three fatal construction accidents occurred despite safety efforts. However, even with these problems, Cern officials stated that completion of the collider has remained on schedule.

- Samuel Ting, Nobel Laureate and Professor of Physics, Massachusetts Institute of Technology; and
- Paul van den Bout, Director of the National Radio Astronomy Observatory, which has observatories at Greenbank, West Virginia; Socorro, New Mexico; and Kitts Peak, Arizona.

Subgroup members told us that these experts emphasized the importance for the SSC's scientific productivity of (1) recruiting and retaining senior scientific and engineering staff and (2) having local machine shops and other businesses for repairing and manufacturing equipment and parts. In addition, Dr. van den Bout, who manages radiotelescope facilities that need to be located in remote areas, discussed the disadvantages of operating a scientific facility in a remote area.

Several subgroup members told us that the managers and scientists confirmed their perceptions about the SSC's regional resources needs, rather than adding new or conflicting information, and that these concerns matched well with the DOE invitation's four regional resources subcriteria. On the basis of the subcriteria and the discussions at the August meeting, the subgroup identified eight critical variables that would be significant in determining the success of the final SSC site. (See table 3.2.) The critical variables generally related to recruiting a first-class staff, the facility's accessibility and openness to U.S. and foreign high-energy physicists who generally are affiliated with other institutions, and the site's regional industrial base.

Table 3.2: Critical Variables for Regional Resources

1. Community proximity
2. Medical services and local schools
3. Employment opportunities for spouses in professional or quasi-professional setting
4. Cultural resources
5. Driving time/distance to a well-serviced airport
6. Variety and openness to variable life-styles
7. Skilled labor pool and local industrial base
8. Local and regional cooperation

Source: NAS/NAE.

Subgroup members considered recruiting a first-class staff the most important objective, stating that the SSC's success will depend on its 2,500-member permanent staff, about one-third of whom are highly skilled engineers, physicists, and technicians who are much in demand. Accordingly, the subgroup evaluated information in each proposal about the proximity and adequacy of housing, schools, and medical facilities, as well as cultural resources and professional or quasi-professional employment opportunities for spouses.

Two critical variables addressed concerns about the approximately 500 high-energy physicists and graduate students who will conduct research at the SSC at any given time. Subgroup members told us that they considered airport accessibility important because many (1) U.S. researchers will make quick visits to supervise their graduate students while teaching at universities and (2) foreign researchers will come to conduct experiments at the SSC. Some members considered openness to variable life-styles, which addressed the availability of community resources on a nondiscriminatory basis, important because high-energy physics is an international field. However, other members stated that it was less important than other variables because the high-energy physicists are likely to form their own communities.

Several subgroup members concurred with the experts regarding the need for local machine shops and other businesses that could quickly respond to requests for repairing equipment or making specialized parts. One committee member stated that the presence of this infrastructure nearby would be important to keep the SSC facility operating because downtime is very expensive and added that it would be costly for DOE to build. However, the subgroup chairman stated that the information in the proposals for evaluating this variable was inconsistent, so the subgroup ended up putting less emphasis on this variable than it otherwise might have.

Subgroup members stated that the local and regional cooperation critical variable was of little utility because of the inadequacy and uncertainty of the available information in the proposals. Without conducting site visits, members were unable to assess the representativeness or validity of press reports, letters, signed petitions, and other materials that they received about local opposition or support for several sites. The committee's final report stated that members strongly believed that DOE must consider community acceptability, support, and cooperation carefully in its examination of the best qualified sites.

While individual subgroup members may have given more or less importance to certain critical variables, the chairman said that the subgroup generally gave the eight variables equal weight in its evaluation of the site proposals. One member noted that the variables were strongly coupled, so that a site strong in one tended to be strong in several and vice-versa. He cited as an example that a large airport tended to be associated with housing and other infrastructure that the regional resources criterion was looking for. Similarly, the chairman told us that the subgroup's evaluation involved an understanding of the suitability of each site on the basis of the combination of all of the critical variables, rather than a narrow evaluation of each site on each variable.

The regional resources subgroup, which rated sites on each of the four subcriteria, considered:

- Twelve sites as satisfactory or better for all 4 subcriteria. Of these, two sites were good in all four subcriteria, and four were good in three subcriteria.
- Six sites as satisfactory-questionable or less in only one subcriterion. Of these, three sites were good in at least two other subcriteria.
- The remaining 17 sites as satisfactory-questionable or less in at least 2 subcriteria.

The subgroup rated seven of the eight best qualified sites as satisfactory or better in all four subcriteria. The other best qualified site was rated good in two subcriteria, satisfactory in one, and satisfactory-questionable in one.

Environment

As shown in table 3.3, the environment subgroup used 15 factors to evaluate site proposals, giving greatest weight to the first 10 factors related to environmental impacts. Subgroup members stated that they were especially concerned about ecological resources, which included whether any federally or state-designated endangered, threatened, or special interest species would be significantly disturbed, because of the potential for lawsuits that could delay the project. The subgroup's chairman stated that (1) some sites had problems, but most of the problems could be mitigated and (2) in many cases the proposers were aware of the problems and had suggested mitigation techniques. Mitigation primarily meant moving the placement of the tunnel or shafts to protect, for example, endangered species or unique wetlands. Alternatively, new wetlands might be created elsewhere, or unique and rare plants could be moved during tunneling and returned after construction.

Table 3.3: Environment Factors

1. Earth resources
2. Water resources
3. Air resources
4. Noise/vibration matters
5. Ecological resources
6. Health and safety matters
7. Land use
8. Socioeconomics
9. Scenic/visual resources
10. Cultural (historical, archaeological, and paleontological) resources
11. Compliance with federal laws and regulations
12. Compliance with state laws and regulations
13. Compliance with local laws and regulations
14. Alternative mitigative measures available
15. Cost effectiveness of mitigative measures

Source: NAS/NAE.

According to subgroup members, while no site was kept off the best qualified list because of the environmental criterion alone, several sites that they considered less suitable also had weaknesses with at least one other major criterion, typically geology and tunneling. As a result, the committee did not identify any of these sites as best qualified.

The environment subgroup, which rated sites on each of the 15 factors listed in table 3.3, rated 18 sites as good in at least 10 of the 15 factors, 8 sites as good in 8 or 9 factors, and 9 sites as good in less than 8 factors. The subgroup rated only 6 sites as questionable in one or more of the 15 factors. All of the best qualified sites were rated as good in at least 10 factors.

Setting

The setting subgroup evaluated the land acquisition process for each site and the flexibility of adjusting the position of the SSC, if necessary. The subgroup received assistance from the Army Corps of Engineers, which provided a detailed description for each site of the land acquisition still to be done, the legal impediments to acquisition, and the types of rights involved, for example, surface, mineral, or tunneling rights. On the basis of data from the proposals and the Corps of Engineers, the subgroup found that no site had serious problems. Consequently, while the subgroup rated down proposals that had a large number of properties that could delay land acquisition for the SSC facility, the setting criterion was not a significant factor for discriminating between the sites.

The setting subgroup, which developed an overall rating for each proposal, rated 12 sites as good, 10 sites as good-satisfactory, 11 sites as satisfactory, and 2 sites as satisfactory-questionable. The subgroup rated three of the best qualified sites as good, three as good-satisfactory, and two as satisfactory.

Regional Conditions

The regional conditions subgroup evaluated each proposal for problems in vibration, noise, and climate. According to the subgroup's chairman, the subgroup did not penalize any proposal significantly, and proposers tended to be aware of any related problems and had proposed solutions for them. One subgroup member told us that the biggest variation between proposals was in temperature and the number of days with snow on the ground. He added that temperatures would had to have been very extreme to make a difference and that the regional conditions criterion probably was included for completeness and to rule out any extreme cases.

The regional conditions subgroup, which developed an overall rating for each proposal, rated 8 sites as good, 17 sites as good-satisfactory, 9 sites as satisfactory, and 1 site as satisfactory-questionable. The subgroup rated one best qualified site as good, three as good-satisfactory, and four as satisfactory.

Utilities

The utilities subgroup assessed the proposals for availability and reliability of electric power, water, fuel, waste disposal, and sewage disposal. The subgroup's chairman told us that, except for one proposal that also did not satisfy other criteria, the sites met the utilities subcriteria and the subgroup could not discriminate between proposals. Because all but one of the sites met the subcriteria for utilities, the subgroup determined that it had no basis on which to discriminate between the proposals.

The Committee's Evaluation of the Proposals

On November 13-14, 1987, the committee evaluated the proposals across all of the technical evaluation and cost criteria and identified the best qualified sites. The 17 members who attended the final committee meeting told us that the committee used the technical evaluation criteria in the order of importance established by DOE's invitation to evaluate the proposals.[2] The members also stated that the committee considered no other criteria to evaluate the proposals. The committee's list of sites reflected the combined subjective judgment of its 21 members; the committee did not assign quantitative weights to the criteria and subcriteria. All 21 members endorsed the process and the list of best qualified sites, stating that they identified sites that would give the SSC the greatest chance for success.

Subgroups' Combined Preliminary Ratings

While not conclusive, the subgroups' preliminary ratings of the proposals indicated that the committee used the criteria and subcriteria in the DOE invitation's order of importance in determining the best qualified sites. These ratings, which were made by individual subgroups and given to the committee's staff before the November meeting, did not necessarily reflect full committee discussion and evaluation of proposals. However, they generally supported statements by the committee members about the evaluation process and the identification of the best qualified sites. While the preliminary ratings showed that geology and tunneling and regional resources both played significant roles in identifying the best qualified list, they did not conclusively show whether geology and tunneling or regional resources was more important.

Tables 3.4 and 3.5 compare the subgroups' preliminary ratings of the best qualified sites with all of the other sites that either the geology and tunneling or the regional resources subgroup rated as good. The tables show that the best qualified list included 6 of the 13 sites that the geology and tunneling subgroup rated as good and 7 of the 12 sites that the regional resources subgroup rated as satisfactory or better in all 4 subcriteria. The tables also show that the environment subgroup rated all of the best qualified proposals as good overall, while giving lower ratings to several of the nonbest qualified sites.

[2] Dr. Baumol, Mr. Gould, Dr. Massey, and Dr. Townes could not attend the final committee meeting. The chairman and members of the committee discussed the final evaluation with each of them in a telephone conference call during the committee meeting.

Table 3.4: Preliminary Ratings of the Best Qualified Sites for Each Technical Evaluation Criterion[a]

Site[b]	Geology and tunneling	Regional resources	Environment	Setting	Regional conditions	Utilities
1	G	G G G G	12-G,3-S	G	G/S	ND
2	G	G G G G	11-G, 4-S	G/S	S	ND
3	G	G S G G	11-G, 4-S	G/S	G	ND
4	G	S G S S	10-G, 5-S	S	G/S	ND
5	G	S S G S	14-G, 1-S	S	S	ND
6	G	S/Q G S G	13-G, 2-S	G	G/S	ND
7	S	S G G S	11-G, 4-S	G	S	ND
8	S	S S G G	12-G, 3-S	G/S	S	ND

[a]The geology and tunneling, setting, regional conditions, and utilities subgroups provided overall ratings. The regional resources subgroup rated each of the 4 subcriteria, and the environment subgroup rated the 15 component factors of the 4 environment subcriteria.

[b]DOE officials requested that we not identify the proposed sites because they considered the proposals to be the proprietary data of the proposers and therefore the ratings to be sensitive information. An NAS/NAE official also stated that the proposed sites should not be identified, noting that the ratings were preliminary and did not necessarily reflect the committee's final evaluation.

G=Good.
S=Satisfactory.
Q=Questionable.
ND=No basis to discriminate between sites.

Source: NAS/NAE.

Table 3.5: Preliminary Ratings of Several Sites That Were Not on the Best Qualified List[a]

Site[b]	Geology and tunneling	Regional resources	Environment	Setting	Regional conditions	Utilities
(Sites rated good in geology and tunneling)						
1	G	S/Q S/Q S G	9-G, 6-S	G/S	G/S	ND
2	G	S/Q S/Q S/Q S	9-G, 5-S, 1-Q	G	G	ND
3	G	Q S/Q S/Q G	8-G, 7-S	S	S	ND
4	G	Q S/Q S/Q S	7-G, 5-S, 3-Q	G	G	ND
5	G	Q Q Q S	12-G, 3-S	G/S	S	ND
6	G	Q Q Q S	10-G, 5-S	G	G/S	ND
7	G	Q Q Q S/Q	6-G, 9-S	G	G/S	ND
(Sites rated good in two regional resources subcriteria)						
8	S	G G G S	11-G, 4-S	G	G/S	ND
9	S-	G S G G	12-G, 3-S	G/S	G/S	ND
10	Q	G G G S/Q	7-G, 6-S, 2-Q	S/Q	G/S	ND
11	Q	G S/Q S G	9-G, 6-S	G	G	ND
(Sites rated satisfactory or better in regional resources)						
12	S	S S G S	12-G, 3-S	S	G	ND
13	S	S S S G	10-G, 5-S	S	S	ND
14	S	S S G S	6-G, 8-S, 1-Q	S	G/S	ND

[a]The geology and tunneling, setting, regional conditions, and utilities subgroups provided overall ratings. The regional resources subgroup rated each of the 4 subcriteria, and the environment subgroup rated 15 component factors of the 4 environment subcriteria.

[b]DOE officials requested that we not identify the proposed sites because they considered the proposals to be the proprietary data of the proposers and therefore the ratings to be sensitive information. An NAS/NAE official also stated that the proposed sites should not be identified, noting that the ratings were preliminary and did not necessarily reflect the committee's final evaluation.

G=Good.
S=Satisfactory.
S-=Satisfactory minus.
Q=Questionable.
ND=No basis to discriminate between sites.

Source: NAS/NAE.

Table 3.5 shows that of the seven nonbest qualified sites that the geology and tunneling subgroup rated as good, the regional resources subgroup rated (1) six as less than satisfactory in at least three subcriteria and (2) one as less than satisfactory in two subcriteria. In comparison, the regional resources subgroup rated one best qualified site as less than satisfactory in one subcriterion.

Table 3.5 also shows four nonbest qualified sites that the regional resources subgroup rated as good in at least two subcriteria. While the geology and tunneling subgroup rated three of these sites as less than satisfactory, it rated one site as satisfactory. The committee did not identify this site as best qualified mainly because the geology and tunneling subgroup identified several problems and did not consider it comparable to the two best qualified sites with satisfactory geology and tunneling ratings. In addition, the table shows three nonbest qualified sites that both the geology and tunneling and regional resources subgroups rated as satisfactory. Members told us that the committee did not consider these sites best qualified because they were not sufficiently strong in either criterion.

Use of the DOE Criteria

The committee's staff used the preliminary ratings to perform sensitivity analyses by giving the technical evaluation and cost criteria and subcriteria different weights consistent with the rank ordering in the invitation. According to the staff, the tests indicated that, as long as the rank order in the invitation was maintained, varying the weights of the criteria and subcriteria had little effect on the results of the evaluation—that is, the proposals that ranked highest with one set of weights on the criteria tended to rank high with any set of weights. The staff also used the subgroups' preliminary ratings to develop an approximate ranking of the site proposals on the basis of the subgroups' preliminary ratings. According to committee members and staff, this ranking served as a starting point for the overall evaluation, but did not reflect the committee's final judgment for several proposals.

The committee considered each proposal in turn, with each subgroup chairman presenting the subgroup's evaluation of the proposed site. Committee members stated they did not establish numerical values for each of the technical evaluation and cost criteria. Rather, the committee subjectively evaluated each of the 35 proposals against the criteria and subcriteria. The committee discussed the merits of each proposal until the members (1) reached a consensus that it was or was not among the best qualified sites or (2) decided to defer consideration of the proposal because a consensus could not be readily reached. The sites that were deferred generally had good geology and tunneling characteristics and satisfactory regional resources or vice-versa. After further discussion, the committee reached a consensus on whether each of these sites should or should not be included on the best qualified list.

Committee members told us that geology and tunneling and regional resources were the two principal criteria that the committee used to discriminate between the 35 proposals. While environment was not the primary criterion for keeping any site off the best qualified list, it also was important in the committee's evaluation of several sites. One environment subgroup member noted that no site that the subgroup considered to be less suitable was identified as best qualified. Committee members stated that the setting, regional conditions, utilities, and cost criteria did not significantly discriminate between sites.

Geology and tunneling subgroup members told us that the committee gave geology and tunneling characteristics appropriate weight in evaluating proposals and determining the best qualified sites. The subgroup's chairman stated that the geological strengths and weaknesses of each site were discussed fully. The chairman said that subgroup members knew that a site with great geology and tunneling characteristics but without the appropriate regional resources would not get on the best qualified list. He added that, compared with their strengths, the geological weaknesses of the best qualified sites were not so great or so extensive as to penalize them appreciably.

Application of the Regional Resources Criterion

In response to our questions of whether committee members were predisposed to favor siting the SSC near a metropolitan area, 13 committee members told us that any such predisposition was inherent in the DOE invitation's criteria. This is because the community, transportation, and industrial infrastructure necessary to fulfill the regional resources subcriteria were more likely to exist near a large metropolitan area. One subgroup member noted that (1) building housing, roads, schools, and machine shops that do not already exist would be costly and inefficient and (2) the SSC's director will have enough to do in getting the SSC facility built on time and within budget without having to worry about whether the necessary regional resources are in place to attract the staff. Another subgroup member pointed out that the absence of infrastructure slows a project's completion, staff recruitment, and getting repairs done. While the subgroup considered proposals' plans to improve the regional resources infrastructure in its evaluation of the sites, two members told us that they gave more weight to proposals that had the regional resources infrastructure in place.

Regional resources subgroup members also told us that neither the subgroup nor the committee specified the minimum population of a nearby metropolitan area for a site to be considered best qualified. While they noted that a site generally had to be within an hour's drive of a metropolitan area to fulfill the regional resources subcriterion for proximity, they pointed out that the Colorado site was considered best qualified despite being 1-1/2 hours from Denver.

Regional resources subgroup members also stated that, although airport size and accessibility were much discussed, they never specified a minimum airport size (measured by the number of takeoffs and landings) or a minimum distance from the SSC's campus to the airport. Three members stated that no proposed site was kept off the best qualified list because airports were considered inaccessible; rather, the subgroup gave higher ratings to site proposals with airports that were hubs for major airlines and/or were within an hour's driving time of the SSC campus.

Number of Sites on the Best Qualified List

Committee members stated that after evaluating all of the site proposals, the members reached a consensus that the eight sites on the best qualified list were the best sites proposed for the SSC, and that a clear gap existed in the quality of these sites and the next group of sites. According to DOE and NAS/NAE staffs, neither DOE nor NAS/NAE established, in advance, the number of sites to be on the best qualified list. Committee members told us that they did not decide how many sites would be on the best qualified list until the end of their evaluation process.

Although the committee did not rank sites, members told us that proposals clustered into several groups. The proposals within each group, based on overall evaluations, were similar enough in meeting the criteria that the committee could not easily discriminate between them. Committee members told us that a first gap was after a group of about 5 proposals, the next gap was after the 8 proposals on the best qualified list, and the next gap was after about 13 proposals. Several members told us that they would not have been doing a conscientious job if they had sent a list of either 5 or 13 sites to DOE as the first was too few and the second too many.

Site Visits

The DOE invitation stated that the NAS/NAE committee would not conduct site visits during its evaluation of the proposals. This is because DOE's site selection schedule, which planned for the final site designation in January 1989, provided 3 months for the committee to complete its evaluation to identify the best qualified sites. The DOE task force made 4-day visits in April-July 1988 to each of the best qualified sites as part of its evaluation for identifying the preferred site for the SSC.

Committee members did not believe that rural sites were at a disadvantage by not having a visit as part of the committee's site evaluation process or that site visits would have had a significant impact on the committee's evaluation of proposals for the following reasons:

- In general, several committee members were familiar with the region around the 35 proposed sites.
- Several members told us that they were very impressed by the quality and completeness of the information in the proposals and that site visits would not have added substantially to this information. Two members stated that they would have liked to conduct site visits primarily as an opportunity to give this feedback directly to the states and the people responsible for developing the proposals.
- The benefits of a short site visit are limited because much of the time would have been filled with official events that would not add substantially to the information in each proposal. In addition, one geology and tunneling subgroup member noted that, while site visits may have assisted the regional resources subgroup, they would not have contributed substantially in the geology and tunneling subgroup's evaluation because the SSC's tunnels will be constructed at least 35 feet underground.

Some members also stated that site visits are more important for taking sites off a list than for adding them to a list because the purpose of site visits primarily is to confirm information in a proposal. For example, several members mentioned that they received letters opposing some of the proposed sites from local residents. Because they did not make site visits, the committee members were unable to determine the extent of local support and opposition for each site and, consequently, they did not consider the residents' letters in their evaluations of the sites. After the committee identified New York (Rochester) as best qualified, New York State withdrew it from further consideration because of local opposition to the site.

Committee members discussed whether they should conduct site visits at the committee's organizational meeting. Several members stated that site visits were logistically impractical because of DOE's 3-month reporting constraint and the other responsibilities of the committee members, who contributed their time voluntarily to the committee. Members also noted that the DOE invitation specifically stated that the committee would not make site visits. Many members also said that if the committee had visited one site, it would have had to visit all sites, and at least a significant proportion of the committee's members would have had to participate on each site visit.

Alternatively, some committee members favored options of (1) teams of 2-3 members making site visits or (2) using a 2-step process that would have narrowed the list of 35 sites to the most viable sites, which the committee would visit to eliminate some sites while identifying the others as best qualified. In response, some members pointed out that the first option could have led to a perceived or actual bias in the evaluation process because the committee would rely on the perceptions of the two/three-member teams. The DOE task force implemented the second approach by visiting each of the best qualified sites as part of its evaluation for determining the preferred site.

SSC Life-Cycle Costs

In defining the relative importance of the site selection criteria, DOE's invitation for site proposals stated that, although cost considerations are significant, the technical evaluation criteria would receive primary emphasis. Although they would have preferred to perform some additional analyses, the NAS/NAE costs subgroup's economists told us that the cost model's data were adequate for the committee's identification of the best qualified sites. Their analysis showed that (1) the sites generally were within 3.3 percent of the average estimated cost of $11.2 billion to construct and operate the SSC and (2) the difference between the highest and lowest cost sites in this range was $725 million, or 6.5 percent of the average cost for all sites. We found no basis to disagree with the committee's assessment that the relatively narrow percentage range of the cost estimates and the comparable range of the cost data's uncertainty considerably weakened its ability to distinguish between the sites' expected costs.

DOE contracted with RTK to develop an SSC life-cycle cost model using the SSC's conceptual design.[1] After site proposals were submitted, RTK used the model to estimate each site's costs in inflation-adjusted fiscal year 1988 dollars. In addition, the costs subgroup asked RTK to "attenuate," or reduce, differentials between sites' costs and the average cost of all sites over time. The subgroup's economists stated that their intent in using attenuation was to reduce the weight of future costs that they considered less certain. Attenuation reduced the range of difference between the highest and lowest cost sites from $1.61 billion using unattenuated data to $725 million using attenuated data. While uncertainties about future costs limited the committee's ability to discriminate between site proposals, we are not convinced that attenuation was appropriate because this method of addressing uncertainty about future cost differentials between sites had the effect of pushing all site costs toward the average cost of all sites. We note that, instead, these cost differentials may persist or widen.

The costs subgroup's economists stated that their analysis of the sites' costs was limited because the SSC life-cycle cost model was developed prior to their involvement and the committee was given 3 months to report on its evaluation of the proposed sites. The economists established broad parameters for comparing the sites' costs, reviewed the results, and performed some sensitivity analyses. However, because of the committee's time constraints, RTK was not asked to verify its cost

[1] RTK, which is based in Oakland, California, is a joint venture of three engineering firms—Raymond Kaiser Engineers, Inc.; Tudor Engineering Company; and Keller & Gannon-Knight.

data for each site, compare its data with the proposals' estimated costs, or incorporate the geology and tunneling subgroup's analysis of each site's geological characteristics into its cost estimate. In addition, the economists stated that they would have preferred to (1) discount each site's costs to account for the time value of money, (2) examine the model's assumptions about the percentage of the SSC's cost components that would be purchased on national as opposed to regional markets, and (3) consider social and environmental costs associated with each site.

SSC Life-Cycle Cost Model

RTK designed the SSC life-cycle cost model to estimate each proposed site's costs over 8 years of construction and 25 years of operation as a basis for comparing the cost of the proposed sites. (The model did not include land acquisition costs because DOE's invitation required that the successful proposer donate the land for the site at no cost to the federal government.) To estimate the sites' costs, RTK first developed a base case that (1) used DOE's conceptual design for the SSC and (2) put all costs in inflation-adjusted fiscal year 1988 dollars. Table 4.1 shows the total life-cycle cost for the base case is $11.1 billion, which includes $4.4 billion (40 percent) for the construction phase and $6.7 billion (60 percent) for the operations phase.

Table 4.1: SSC Life-Cycle Cost Model's Base Case

Millions of FY 1988 dollars

Cost category	Cost	Percentage of total cost
Construction phase:		
Construction activities	$3,210	29
Accelerator R&D	274	2
Detectors	719	7
Preoperating	172	2
Subtotal	**4,375**	**40**
Operations phase:		
Operations activities	4,729	43
Accelerator equipment	708	6
Experimental equipment	789	7
Accelerator improvement projects	266	2
General plant equipment	197	2
Subtotal	**6,689**	**60**
Total	**$11,064**	**100**

After RTK received the site proposals in early September 1987, it modified the base case to develop cost estimates for each site. For example, RTK made adaptations and adjustments to the base case for geotechnical conditions, such as the type of rock or soil for tunneling, the topography, and climatic conditions of each site. RTK also used regional cost data from the Department of Labor's Bureau of Labor Statistics, the Means Building Construction Cost Survey, and the Dodge Heavy Construction Cost Survey to develop regional cost indexes for modifying the SSC's variable costs. RTK used cost data of each site's nearest relatively large city under the assumption that much of the locally purchased labor would be drawn from that city.

As shown in table 4.2, RTK divided the base case costs into items that would be purchased on the national market, which were considered "fixed" costs because they would not vary across the proposed SSC sites, and items that would be purchased on a regional or local market, which were considered "variable" costs. Overall, $5.8 billion (52 percent) of the SSC base case costs were considered fixed and would not vary between sites, while $5.3 billion (48 percent) of the base case costs were considered variable. Only 33 percent of the construction phase activities were variable costs. This included $459 million for constructing the SSC's tunnels, buildings, roadways, and other conventional facilities. However, it did not include, for example, $1.1 billion for the superconducting magnets, which were considered fixed costs because DOE plans to procure them on the national market through a separate contract. In contrast to the construction phase, 57 percent of the operations phase activities were variable costs. This included $1.8 billion for labor and $1.1 billion for electric power.

Table 4.2: Fixed and Locally Variable Components of the SSC's Life-Cycle Costs

(Millions of FY 1988 dollars)

Activity	Fixed component	Percentage fixed	Locally variable component	Percentage variable	Total
Construction activities:					
Technical components[a]	$1,374	90	$145	10	$1,519
Conventional facilities[b]	155	25	459	75	614
Systems engineering & design	98	32	209	68	307
Management & support	117	57	88	43	205
Contingency	356	63	209	37	565
Subtotal	**2,100**	**65**	**1,110**	**35**	**3,210**
Other construction phase activities[c]	836	72	329	28	1,165
Operations activities:					
Labor	645	27	1,759	73	2,404
Materials & supplies	661	55	541	45	1,202
Power	0	0	1,123	100	1,123
Subtotal	**1,306**	**28**	**3,423**	**72**	**4,729**
Other operations phase activities[d]	1,541	79	419	21	1,960
Total	**$5,783**	**52**	**$5,281**	**48**	**$11,064**

[a]Includes superconducting magnets ($1,068 million), cryogenics system ($129 million), and other technical components ($322 million).

[b]Includes 4 injector accelerators ($42 million), collider tunnel ($370 million), 4 interaction halls ($66 million), at least 15 campus buildings ($45 million), and roads and utility infrastructure ($91 million).

[c]Includes accelerator research and development, detectors, and preoperating activities.

[d]Includes accelerator operations equipment, experimental operations, accelerator improvement projects, and general plant equipment.

NAS/NAE Costs Subgroup's Analysis

The committee's two economists participated in the costs subgroup and, with the assistance of an economist from the committee's staff, were responsible for the costs analysis. On July 28, 1987, they met with personnel from the DOE site task force and RTK to discuss the SSC life-cycle cost model and the costs subgroup's needs for its analysis of the proposed sites' costs. Because RTK already had developed the cost model before the costs subgroup was formed and DOE had requested the committee to submit its final report 3 months after it received the site proposals, the attendees agreed that the subgroup would not redesign RTK's model or verify the sites' data. Instead, the subgroup established broad parameters for comparing the sites' costs, reviewed the results, and asked RTK to perform some sensitivity analyses.

Basis for Attenuation

The costs subgroup economists and staff stressed that a great deal of uncertainty necessarily surrounded the proposed sites' cost data and the life-cycle cost model's assumptions, thus making the sites' cost estimates highly uncertain, particularly in the SSC project's later years. To reduce the weight of future costs that they considered less certain, the costs subgroup asked DOE and RTK to modify each site's cost data by a process called "attenuation." Attenuation reduced the weight of long-term cost differentials between sites by moving the sites' costs in each of the SSC's cost categories over time toward the average cost of all sites for the category.

The costs subgroup attenuated labor costs by 10 percent per year, power costs by 5 percent per year, and tax costs by 2 percent per year.[2] These rates reduced cost differentials from 100 percent in the first year so that by the ninth year, which would be the first year of the SSC's operations phase, labor cost differentials were valued at 43 percent, power cost differentials were valued at 66 percent, and tax cost differentials were valued at 85 percent. The economists did not provide documentation about the basis for these rates.

None of the subgroup's economists or staff identified other cost analyses that had used a similar attenuation process. However, they generally agreed that attenuation was appropriate for analyzing the proposed sites' costs because it would, as one of the economists described it, give less weight to cost data about which there was greater uncertainty.

In addition, one economist considered attenuation as a "rough proxy" for discounting because it reduced dollar cost differentials between sites, which would be expected in discounting projects with similar time streams of expenditures.[3] A proper discounting of future costs would have been possible only with a more thorough investigation of site-specific time streams of expenditures.

The other economist told us that presently observed cost differentials between sites should not be assumed to persist because siting a large public works project affects costs in a region and is likely to drive up

[2]Attenuation valued labor cost differentials at full cost in the first year, at 90 percent in the second year (100 percent multiplied by 90 percent), and 81 percent in the third year (90 percent multiplied by 90 percent).

[3]Unlike discounting of projects that have similar time streams of expenditures, however, attenuation significantly reduced the percentage differences in costs between sites and changed the sites' rank order for costs. This reflected in this case the use of different attenuation rates for the three major cost categories.

costs more in lower cost areas than in higher cost areas. He noted that this might happen because a lower cost rural area may not be able to supply the quantity of labor needed for the project, and thus wages may have to rise to attract labor from elsewhere. On the other hand, a higher cost urban area is more likely to have the necessary labor so wages need rise only a small amount to attract labor from elsewhere in the local economy.

We are concerned about the use of attenuation to address future cost uncertainties associated with the SSC's 33-year life. It is not a standard financial analysis technique and was developed essentially for this particular cost analysis. We are not convinced that attenuation was appropriate because its effect was to push cost differentials toward the average cost of all sites while these differentials may actually persist or widen in the future.

Results of the Cost Analysis

Table 4.3 shows the results of the costs subgroup's analysis using attenuation for 33 of the 35 sites. All of these sites were within 3.3 percent of the average cost of all sites. The costs subgroup excluded the highest cost site from its analysis because the site was substantially more costly than the next most expensive site and both the geology and tunneling and regional resources subgroups had rated it low. In addition, RTK did not develop a cost estimate for another site because the proposal did not provide sufficient data to estimate its cost. We similarly have excluded these sites from our discussion.

Table 4.3: Costs Subgroup's Analysis of the Proposed Sites' Costs

Costs in millions of FY 1988 dollars

Site[a]	Attenuated variable costs[b]	Fixed costs[c]	Total costs	Percentage difference from the average cost	Rank among 33 sites
Best qualified sites:					
1	$5,272	$5,783	$11,055	(1.2)	10
2	5,180	5,783	10,963	(2.0)	4
3	5,528	5,783	11,311	1.1	25
4	5,290	5,783	11,073	(1.0)	14
5	5,514	5,783	11,297	1.0	23
6	5,418	5,783	11,201	.1	18
7	5,527	5,783	11,310	1.1	24
8	5,310	5,783	11,093	(.8)	16
Lowest cost site	5,053	5,783	10,836	(3.2)	1
Highest cost site[d]	5,778	5,783	11,561	3.3	33
Average cost of the 33 sites[e]			**11,188**		

[a]DOE officials requested that we not identify the proposed sites because they considered the proposals to be the proprietary data of the proposers and the ratings to be sensitive information. An NAS/NAE official also stated that the proposed sites should not be identified, noting that subgroups' ratings of sites were preliminary and did not necessarily reflect the committee's final evaluation.

[b]The attenuated variable costs for the Illinois site include DOE's estimated savings of $351 million for construction activities by using sections of the existing Fermi accelerator as the injector complex for the SSC.

[c]Fixed costs were not attenuated because they were considered to be the same for all sites.

[d]These data are actually for the second highest cost site because the highest cost site was substantially more expensive than the other sites and it had been rated low by both the geology and tunneling and regional resources subgroups.

[e]The average cost does not include data for the highest cost site and for a site that did not provide sufficient data for RTK to estimate its cost.

In interviews with the subgroup's economists, we pointed out that the difference between the highest and lowest cost sites was $725 million. The economists acknowledged that this was a large amount of money; however, they believed that because of the high level of "noise" created by uncertainty, the model's results could be used to discriminate between sites only if the sites' costs differed substantially. They stated that the 6.5-percent difference in cost was well within this range of uncertainty and added that they would have preferred a formal treatment of uncertainty and the specification of its ranges in their analysis if more time had been available.

Other members of the NAS/NAE committee who were not involved in the costs subgroup's analysis similarly expressed concern about the uncertainty of future costs, such as the effect of a utility's decision in the year 2000 to build a new power plant on a locality's power rates. In addition, members questioned the reliability of the sites' cost data because the data (1) did not reflect geological characteristics at several sites that were likely to add to construction costs and (2) were too preliminary and not sufficiently based on actual costs to be considered reliable. As a result, the committee's report stated that

"Cost calculations did play a role in the final evaluation process, but that role was more minor than might have been anticipated. The reason was not lack of concern by members of the committee over the costs. The reason was, rather, the remarkably narrow range within which cost estimates for the different sites fell. The cost of the most expensive sites was only a few percent above the average for the group, and that of the most economical site was only a few percent below the average. Since the range of uncertainty was no doubt at least comparable in magnitude, this obviously weakened considerably the committee's ability to distinguish among the site proposals in terms of the costs each could be expected to entail."

Sensitivity Analyses

RTK performed some sensitivity analyses using alternative attenuation rates for different cost categories. The subgroup's economists stated that the model's results were not sensitive to alternative attenuation rates even though (1) most of the variable costs were associated with labor and power during the operations phase and (2) attenuation affected operations costs more than construction costs because the operations costs occurred in later years. This is primarily because 52 percent of the SSC's total base case costs were considered fixed and thus would not vary with attenuation.

In addition to assessing alternative attenuation rates, the costs subgroup requested and received cost data in fiscal year 1988 dollars that were not attenuated and thus did not distinguish whether the money would be spent earlier or later in the SSC facility's life cycle. (See table 4.4.) The purpose of considering the unattenuated cost data was to provide an upper bound for cost differences between sites.

Table 4.4: Costs Subgroup's Analysis Using Attenuated and Unattenuated Costs

Millions of FY 1988 dollars

Site[a]	Total attenuated costs[b]	Percentage difference from average attenuated costs	Sensitivity analysis: Total unattenuated costs[b]	Sensitivity analysis: Percentage difference from average unattenuated costs
Best qualified sites:				
1	$11,055	(1.2)	$10,892	(2.2)
2	10,963	(2.0)	11,107	(.3)
3	11,311	1.1	11,147	.1
4	11,073	(1.0)	10,900	(2.1)
5	11,297	1.0	11,512	3.4
6	11,201	.1	11,286	1.3
7	11,310	1.1	11,504	3.3
8	11,093	(.8)	10,873	(2.4)
Lowest cost site	10,836	(3.2)	10,353	(7.0)
Highest cost site[c]	11,561	3.3	11,961	7.4
Average cost of the 33 sites[d]	**11,188**		**11,138**	

[a]DOE officials requested that we not identify the proposed sites because they considered the proposals to be the proprietary data of the proposers and the ratings to be sensitive information. An NAS/NAE official also stated that the proposed sites should not be identified, noting that subgroups' ratings of sites were preliminary and did not necessarily reflect the committee's final evaluation.

[b]The total attenuated and unattenuated costs for the Illinois site include DOE's estimate of $351 million in savings for construction activities by using sections of the existing Fermi accelerator as the injector complex for the SSC.

[c]These data are actually for the second highest cost site because the highest cost site was substantially more expensive than the others and it had been rated low by both the geology and tunneling and regional resources subgroups.

[d]The average cost does not include data for the highest cost site and for a site that did not provide sufficient data for RTK to estimate its cost.

Attenuation generally increased the cost of lower cost sites and decreased the cost of higher cost sites, moving most sites toward the average cost for all sites, and it changed the relative ranking of the sites for costs.[4] For example, the unattenuated cost of the lowest cost site was $10.353 billion, or $482 million less than its attenuated cost, while the unattenuated cost of the highest cost site was $11.961 billion, or $400 million more than its attenuated cost. As a result, attenuation reduced the range of difference between the highest and lowest cost sites from $1.608 billion using unattenuated data (14.4 percent of the average cost

[4]Attenuation moved the costs of two sites away from the average total cost for all sites because the SSC's cost categories were attenuated at different rates.

for all sites) to $725 million (6.5 percent of the average cost for all sites). The subgroup's economists stated that even the unattenuated data's cost differentials were within the range of uncertainty of the sites' cost estimates and thus did not change their analysis using the attenuated data.

Limitations of the Cost Analysis

The costs subgroup's economists stated that their analysis was limited because RTK developed the life-cycle cost model prior to their involvement and the committee was given 3 months to report on its evaluation of the proposed sites. However, the economists told us that the SSC life-cycle cost model was adequate for their analysis to determine whether any site was significantly less or more costly than the others. The economists stated that they did not verify RTK's costs data for each site, compare RTK's data with the proposals' estimated costs, or incorporate into each site's cost estimate the geology and tunneling subgroup's analysis of its geological characteristics. In addition, they said that they would have preferred to improve their analysis by (1) discounting cost estimates to determine the net present value of each site's costs, (2) reviewing the model's assumptions about the fixed and variable components of the SSC's costs, and (3) considering social and environmental costs in their analysis.

Cost Data Reliability

RTK provided cost estimates for each of the 35 sites to the costs subgroup 2 months after the closing date for the submission of site proposals. To develop cost estimates for each site, RTK used broad indexes to modify its base case. Because of the time constraints, RTK did not have the opportunity to modify cost estimates to reflect the NAS/NAE geology and tunneling subgroup's concerns about geological characteristics at several sites that would likely add substantially to the cost of tunnel construction.

RTK used a Norwegian study of 16 broad rock-type categories to estimate the tunneling costs for each site. The 16 rock types did not cover all of the rock types identified for the 35 proposed sites. RTK engineers then used their judgment to determine which of the 16 rock types were the most appropriate for the site and used the corresponding cost. An example of the difficulty involved in adapting the Norwegian study is shown by the construction costs for two site proposals that proposed to tunnel in a rock type that the study did not list. These site proposals estimated tunneling costs in this rock to be about $650 per linear foot. RTK, using the rock type in the Norwegian study that its geologists considered most appropriate, estimated the cost to be about $1,050 per linear-foot, or about 60 percent more than the proposers. Contract bid data for another construction project in the same rock type as the two site proposals support the proposers' tunneling cost estimate. RTK's higher linear foot estimate added about $100 million to the site proposals' total tunnel construction cost for this type of rock. An RTK official told us that RTK did not have enough time to verify the proposals' cost estimates. The official added that RTK considered data in the best qualified sites' proposals in refining cost estimates for DOE's selection of the preferred site.

At the November 13-14, 1987, committee meeting, members of the geology and tunneling and costs subgroups discussed the reliability of the cost model's tunneling costs for several sites. The geologists stated that the cost model did not account for geological characteristics, such as ground water problems, sandy soil, or numerous interfaces between different rock types, that (1) would increase construction costs and result in schedule delays or (2) had greater risks and uncertainties. One economist stated that the addition of, for example, $50 million to a site's costs to account for these problems would not change the costs subgroup's analysis. The geology and tunneling subgroup's chairman told us that he did not perceive this limitation in the cost analysis to be a problem because (1) his subgroup gave less than satisfactory ratings to sites with the most serious geology and tunneling problems, effectively considering the added costs of their geology in its evaluation, and (2) the committee did not identify any of these sites as best qualified.

Discounting

Discounting is a standard financial analysis method that government and industry use to compare the costs and benefits of alternative projects. It is based on the premise that the present value of a dollar spent today is higher than a dollar spent later because, for example, the unspent money available today could be deposited in a bank to grow at the current rate of interest. RTK did not design the cost model to permit discounting because it used the base case's time stream of cost expenditures to estimate each site's aggregate costs, instead of developing site-specific time streams of cost outlays over the SSC's 33-year life. As a result, the costs subgroup could not derive a net present value for each site by discounting future dollar costs at an appropriate rate.[5]

[5]The Office of Management and Budget generally considers a discount rate of 10 percent to be appropriate for analyses using inflation-adjusted dollars to reflect the before-tax rate of return on private sector capital. In contrast, we use a discount rate based on the average nominal yield of marketable Treasury debt for costs incurred after the project's first year, which currently would imply a discount rate of about 4 percent for this analysis.

One of the subgroup's economists considered attenuation as a rough proxy for discounting, while the other economist said that it was not a substitute. Both economists stated, however, that had they considered a proper discounting of future costs to be crucial for their analysis, they would have insisted that RTK redevelop the sites' cost data to allow such discounting. The economists did not insist on this additional work because they believed that discounting was unlikely to change the sites' relative costs appreciably. One of the economists stated that the inability to discount was not a serious problem because:

- The purpose of the subgroup's analysis was to uncover any significant cost differentials in constructing and operating the SSC at the 35 proposed sites. The subgroup was not concerned about estimating the SSC's total present value cost. In addition, RTK officials told the costs subgroup that the time streams of expenditures across sites were very similar. Therefore, while discounting would reduce the size of the cost differentials between sites, it was unlikely to appreciably change the relative ranking or the percentage of cost differences between the sites.
- All cost estimates were in inflation-adjusted fiscal year 1988 dollars. Because the economist believed that an appropriate real discount rate for a project of this type would have been fairly low—about 2 or 3 percent—the lack of discounting introduced only a small error in comparative site cost estimates.

Because of the structure of the life-cycle cost model, we could not analyze the effect that discounting might have had. RTK provided us scheduling data, which indicated that the inability to discount may not have had a significant effect on the cost analysis. Time streams of expenditures were dependent on parallel activities of constructing the tunnels and fabricating the superconducting magnets. According to an RTK official, a faster tunnel construction rate would not significantly alter the construction schedule unless DOE decided to change the schedule for magnet fabrication by adding more production lines, which would add to fabrication costs. In contrast, as discussed previously, the geology and tunneling subgroup gave less than satisfactory ratings to several sites that had geological characteristics that would increase construction costs and/or cause schedule delays.

Fixed and Variable Costs

RTK determined that goods and services that represented 52 percent of the total SSC construction and operating costs would be purchased on the national markets, and thus their costs were considered fixed, while goods and services that represented 48 percent would be purchased on regional or local markets, and thus their costs were considered variable. The high percentage of fixed costs was an important factor in the costs subgroup's analysis because, as shown in table 4.3, the $725 million difference between the highest and lowest cost sites using attenuated costs represented only differences in the variable costs. None of the fixed costs changed between sites. While $725 million was 6.5 percent of the total average cost for all sites, it was 13.4 percent of the variable costs.

We asked the subgroup's economists why such a high percentage of the SSC's costs was considered fixed. While the economists did not review RTK's basis for determining whether SSC component costs were fixed or variable, they stated that some of the fixed costs may have had some regional cost components that were not included in their cost analysis.

Related to the mix of fixed and variable costs, another element of the uncertainty about the SSC's future life-cycle costs is the reliability of DOE's total cost estimate. The Congressional Budget Office (CBO) in its report, Risks and Benefits of Building the Superconducting Super Collider, assessed the SSC's construction costs. In comparison with DOE's estimate of $4.4 billion in fiscal year 1988 dollars, which DOE said was accurate within 10 percent, CBO's technical analysis estimated that construction would cost between $4.5 billion and $5.1 billion in fiscal year 1988 dollars. CBO's historical analysis estimated that construction could escalate to $6.4 billion in fiscal year 1988 dollars. CBO indicated that most of the higher cost associated with its technical analysis involved the SSC's technical components, such as the superconducting magnets and the detectors, which the life-cycle cost model considered fixed. However, CBO noted that the construction of conventional facilities could be higher than estimated, depending on DOE's selection of the final site.

Social and Environmental Costs

One of the subgroup's economists stated that he would have preferred that the cost model also address the SSC's social and environmental costs and benefits, if time had allowed. These included, for example, the benefit of siting the SSC in an economically depressed area or the cost of taking valuable farm land out of production. The economist stated that, while he was prepared in principle to discuss social costs or benefits in the committee's evaluation of the sites, he did not consider any site to have unusually significant social costs or benefits. In addition, the economist said that the environment subgroup included land use issues as a factor in its evaluation of the sites and noted that the concern about removing valuable farm land from production was an important factor in the committee's evaluation of at least one site.

DOE's Acceptance of the NAS/NAE Committee's Report and Proposers' Comments About the Selection Process

DOE's acceptance of the NAS/NAE committee's report and list of best qualified sites was based on its site task force's review of the (1) strengths and weaknesses of each proposal for each of the technical evaluation and cost criteria and (2) committee's procedures for evaluating the proposals. In performing this review, the task force made its own assessment of the proposals' strengths and weaknesses for each of the technical evaluation criteria; assessed the committee's report, which discussed the best qualified sites and its procedures for evaluating the site proposals; and received a 10-hour briefing from the committee's staff.

Senior officials who were responsible for preparing 15 of the 35 site proposals told us that the invitation for site proposals was well-conceived. However, they added that the site selection process could have been improved if DOE had provided better information about the relative importance of regional resources in its invitation for site proposals and more detailed feedback about their proposals in the debriefings after the best qualified sites were announced.

DOE's Review and Acceptance of the NAS/NAE Committee's Report

The DOE site task force was created in February 1987 to oversee the SSC site selection process. Its 10 members included 5 from DOE's office of energy research and 1 each from DOE's office of procurement operations, office of National Environmental Policy Act project assistance, office of real property, office of the assistant general counsel for procurement and finance, and San Francisco operations office. (An attorney, serving as a legal advisor, and the member from the San Francisco operations office, who came from a state that submitted two proposals, were non-voting members of the task force.)

Task force members were selected because of their experience in high-energy physics, accelerator design, managing the construction and operation of DOE scientific facilities, procurement, real estate acquisition, civil engineering, and environment. The task force also obtained assistance in its review from contractors and other DOE staff. For example, the civil engineer who was responsible for assessing the geology and tunneling criterion was assisted by Earth Technology Corporation, a subcontractor of RTK, and the member who reviewed the utilities criterion was assisted by a staff member from DOE's office of public utilities.

Task force members stated that after the September 2, 1987, closing date for site proposal submissions, they reviewed the proposals to determine whether each was qualified in accordance with the DOE invitation. Once the qualified proposals were transmitted to the NAS/NAE committee, the task force members spent the next months familiarizing themselves with the proposals by reviewing and then jointly discussing four or five proposals per week. Similar to the committee's subgroups, task force members reviewed the site proposals against the technical evaluation or cost criterion that corresponded with their expertise.

Task force members told us that they assessed the strengths and weaknesses of each proposal for each of the criteria so they would be able to assess whether the committee's list of best qualified sites was supportable and reasonable. Members stated that the task force purposely did not develop overall evaluations of the proposals or make overall comparisons between proposals because they did not want to duplicate the committee's evaluation. The task force's chairman stated that this approach would allow the task force to (1) modify the committee's list if members believed that the committee had made a major mistake or (2) accept the committee's list even if individual task force members believed that the list should include other proposals.

The NAS/NAE committee gave its report, Siting the Superconducting Super Collider, to DOE on December 24, 1987. Task force members reviewed the report and then met with the committee's staff in an all-day session on December 29, 1987, to discuss the committee's evaluation process and the strengths and weaknesses of each of the 35 site proposals. Committee and task force staff members stated that the committee and the task force generally agreed about the sites' strengths and weaknesses. They discussed in more detail information, such as sites' geological characteristics or distances to communities and airports, that they perceived differently. This briefing was important for the task force because (1) in accordance with DOE's statement of work for the committee, the report assessed only the best qualified sites and (2) DOE management, to prevent any appearance of tainting the NAS/NAE committee's independent evaluation, had directed DOE personnel not to attend committee and subgroup meetings. As a consequence, the task force was dependent on the committee staff's briefing to obtain information about the members' evaluation of each of the 27 sites that were not judged best qualified. DOE could have improved its accountability for the site selection process by obtaining a written or oral assessment of each of the 35 proposals from the committee's members, rather than its staff.

On the basis of the report, the committee staff's briefing, and its own review of the 35 proposals, the DOE site task force's report, Best Qualified Sites for the Superconducting Super Collider, concluded that the (1) committee represented a highly qualified, credible, and broad range of experience and expertise, (2) committee's methodology was consistent with the terms of DOE's invitation for site proposals and its statement of work for the committee, (3) best qualified list recommended by consensus of the committee was developed impartially and without bias, (4) eight best qualified sites were supportable on the basis of the technical evaluation and cost criteria, and (5) committee made an appropriate determination that important differences between the sites, principally in the geology and tunneling and regional resources criteria, supported its decision on the eight best qualified sites. The task force recommended that DOE accept the committee's list of best qualified sites without modification. On January 19, 1988, after further review by the Energy System Acquisition Advisory Board, the Secretary of Energy announced that DOE accepted the committee's recommended list of best qualified sites.[1]

Task force members told us that in determining that the list of best qualified sites was supportable and reasonable, individual members did not necessarily believe that the committee's list was the best list of sites. However, they stated that (1) none of the top sites had been excluded and any differences were at the margin of the best qualified list and (2) such differences were likely to occur when different groups made subjective judgments. On the basis of the task force's visits to each of the best qualified sites in April-July 1988, the chairman of the task force stated that a first-class SSC facility could be built and operated at any of these sites. Three task force members added that the sites were even better than they had expected.

The task force's chairman also noted that the number of sites on the best qualified list was appropriate, adding that a larger list of, for example, 15 sites would have stretched the task force's resources because of the time needed for site visits and the environmental impact statement. The executive director for the task force told us that, while neither DOE nor the NAS/NAE committee had specified the number of sites that would be identified as best qualified in advance of the committee's evaluation of the proposed sites, DOE's schedule for selecting the final site by January 1989 was based on the assumption of six best qualified sites.

Once the best qualified sites were announced, DOE offered to debrief the proposers about the selection process and the strengths and weaknesses

[1]The Energy System Acquisition Advisory Board is a board of senior DOE managers that advises the Secretary of Energy on site selection decisions.

of the proposer's site for each of the technical evaluation and cost criteria. These debriefings, which the executive director for DOE's office of energy research and task force members conducted, were based on the combined information from the NAS/NAE committee's evaluation and the task force's review of the site proposals. DOE staff did not compare the proposer's site with the best qualified sites. In addition to the DOE debriefing, some proposers requested and received a debriefing from the NAS/NAE committee's staff.

Site Proposers' Comments About the Selection Process

We talked with 11 senior officials who were responsible for preparing 15 of the 35 site proposals, including 3 considered best qualified, to get their perceptions about the site selection process and debriefings. (See table 5.1.) These officials estimated that their states spent from about $600,000 to about $2.4 million to prepare each proposal that they submitted.

Table 5.1: States That We Interviewed About the Site Selection Process

State	Site
California	Davis Stockton
Idaho	Idaho National Engineering Laboratory
Louisiana	Louisiana site
Michigan	Dundee Stockbridge
Mississippi	Mississippi site
Nevada	Nevada site
New Mexico	Estancia Basin
New York	Rochester St. Regis Valley
Oklahoma	Oklahoma site
South Dakota	Northern Great Plains
Texas	Amarillo Dallas-Fort Worth

Ten of the officials told us that the invitation for site proposals was well-conceived, clear, and complete regarding the information that DOE asked proposers to submit. However, five officials stated that DOE could have improved the invitation by giving approximate weightings for the importance of the technical evaluation and cost criteria. They said that the NAS/NAE committee gave more weight to regional resources and the importance of locating a site near a large metropolitan area than they anticipated from the invitation's discussion and its ranking of geology and tunneling as most important. One official stated that if DOE had better indicated the actual weight given regional resources, his state would have proposed an alternative site whose geology and tunneling characteristics were not as good but which was close to a large metropolitan area. Two officials told us that their states would have devoted more effort addressing the regional resources criterion. Alternatively, one of these officials and two other officials said that their states, which are predominantly rural, may have decided not to submit a proposal and use the money that was spent preparing the proposal for other purposes.

We believe that DOE could have better indicated the comparative importance of regional resources in selecting the best qualified sites and the final site. While five officials who prepared proposals expressed surprise at the importance of regional resources, this emphasis was known within certain levels of DOE and could have been made available to proposers. The views of one current and two former directors of DOE high-energy physics facilities were made known when they discussed the importance of regional resources infrastructure for the SSC's scientific productivity with the NAS/NAE committee's regional resources subgroup in an August 1987 meeting that was convened to get their expert opinions. If this information had been made available to the states in April 1987 invitation for site proposals, it may have influenced how some proposers responded to the invitation.

Six of the 11 officials also stated that the DOE debriefings were inadequate because they did not get sufficiently detailed information about their sites' weaknesses or relative ranking for each of the technical evaluation criteria. In addition, one official stated that DOE was not responsive to questions in the debriefing and another said that his state received conflicting information from DOE and the NAS/NAE committee's staffs about the strengths and weaknesses of the state's proposed site.

Conclusions

DOE's decision to accept the NAS/NAE committee's list of best qualified sites was based on a review of the technical merits of each site proposal and the committee's procedures for evaluating the site proposals. We believe that the site selection process could have been improved if DOE had better indicated the relative importance of the regional resources criterion and its subcriteria by (1) qualitatively discussing the importance of the regional resources for the SSC's scientific productivity and/or (2) giving approximate weights to the technical evaluation criteria. The site proposers we interviewed spent from about $600,000 to about $2.4 million to prepare their proposals. If the proposers had better understood the importance of locating the SSC facility near a metropolitan area, they may have (1) selected a better overall site for the SSC, (2) prepared a better proposal, or (3) decided that their state did not have an appropriate regional resources base and used the money that was spent preparing the proposal for other purposes.

Recommendation

We recommend that the Secretary of Energy ensure for any future site selection process similar to the SSC that

- potential site proposers be given the maximum information possible in the invitation about the relative importance of the selection criteria.

Agency Comments and Our Response

DOE concurred with our recommendation, stating that it is critically important for potential proposers to fully understand the selection criteria and their relative significance to the selection decision. (See app. IV.) DOE also pointed out that its invitation for site proposals (1) listed the site selection technical evaluation criteria and subcriteria in descending order of relative importance, (2) explained important siting considerations for each of the criteria, and (3) specified in detail the information necessary from the proposer to evaluate each criterion.

Ten of 11 senior officials responsible for preparing site proposals told us that the invitation was well-conceived, clear, and complete. However, five of the officials stated that the NAS/NAE committee gave more weight to regional resources and the importance of locating a site near a large metropolitan area than they had anticipated from the invitation's discussion and its ranking of geology and tunneling as most important. DOE could have better indicated the relative importance of the regional resources criterion by discussing in the invitation its importance for the SSC's scientific productivity as DOE laboratory directors did with the NAS/NAE committee in August 1987.

Chronology of Events Leading to the Selection of the SSC Site

July 1983	DOE's High Energy Physics Advisory Panel recommended research and development (R&D) on the SSC as highest priority.
Mar. 1984	DOE selected Universities Research Association, the management contractor for Fermi National Accelerator Laboratory, to manage R&D and design studies for the SSC.
June 1984	Central design group formed to coordinate national R&D and design effort for the SSC.
Nov. 30, 1984	The Director of DOE's Office of Energy Research asked the Presidents of NAS and NAE whether they would be willing to assist DOE in evaluating proposals to select the best qualified sites for the SSC.
Dec. 7, 1984	The Presidents of NAS and NAE replied that they would be willing to assist DOE.
Mar. 1986	Central design group submitted SSC conceptual design report to DOE.
Jan. 1987	President Reagan requested congressional approval for the SSC.
Feb. 10, 1987	The Secretary of Energy announced the site selection process. DOE established its SSC site task force and asked NAS and NAE to form their site evaluation committee.
Apr. 1, 1987	DOE issued the invitation for site proposals for the SSC.
Apr. 29, 1987	DOE held a preproposal conference to answer questions by potential proposers.
June 30-July 1, 1987	NAS/NAE site evaluation committee held its first meeting in Washington, D.C.
July 28, 1987	NAS/NAE committee's costs subgroup met in New York City.
Aug. 31, 1987	NAS/NAE committee's regional resources subgroup met with Dr. Leon Lederman of the Fermi National Accelerator Laboratory, Dr. Wolfgang Panofsky of the Stanford Linear Accelerator Center, Dr. Louis Rosen of the Los Alamos Meson Physics Facility, Dr. Samuel Ting of the Massachusetts Institute of Technology, and Dr. Paul van den Bout of the National Radio Astronomy Observatory.
Sept. 2, 1987	DOE received 43 site proposals by its deadline.
Sept. 17, 1987	DOE transmitted 36 qualified site proposals to the NAS/NAE site evaluation committee.
Sept. 21-Oct. 9, 1987	All of the NAS/NAE committee's six technical evaluation subgroups met to develop preliminary evaluations of the 36 proposals.
Oct. 8-10, 1987	NAS/NAE site evaluation committee met to discuss the subgroups' preliminary ratings of the 36 proposals.

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Oct. 15, 1987	New York State withdrew its Wallkill Valley proposal from further consideration.
Nov. 13-14, 1987	NAS/NAE site evaluation committee evaluated each of the 35 proposals and identified 8 for the list of best qualified sites.
Dec. 24, 1987	NAS/NAE site evaluation committee submitted its final report, Siting the Superconducting Super Collider, to DOE.
Dec. 29, 1987	NAS/NAE staff briefed the DOE site task force on the committee's procedures and its evaluations of each of the 35 proposals.
Jan. 15, 1988	The Energy System Acquisition Advisory Board accepted the NAS/NAE committee's best qualified list without modification.
Jan. 15, 1988	New York State withdrew its Rochester proposal from further consideration.
Jan. 19, 1988	The Secretary of Energy announced that DOE accepted the NAS/NAE site evaluation committee's recommended list of best qualified sites without modification.
Apr.-July 1988	DOE site task force conducted site visits to each of the best qualified sites.
Aug. 1988	DOE issued the draft environmental impact statement for the SSC, which assessed each of the best qualified sites.
Nov. 10, 1988	DOE identified Texas (Dallas-Fort Worth) as the preferred site for the SSC.
Dec. 1988	DOE issued the final environmental impact statement for the SSC.
Jan. 1989	The Secretary of Energy plans to announce the SSC site.

SSC Technical Evaluation Criteria in Descending Order of Relative Importance

Geology and Tunneling:	a. Suitability of the topography, geology, and associated geohydrology for efficient and timely construction of the proposed SSC underground structures. b. Stability of the proposed geology against settlement and seismicity and other features that could adversely affect SSC operations. c. Installation and operational efficiency resulting from minimal depths for the accelerator complex and experimental halls. d. Risk of encountering major problems during construction.
Regional Resources:	a. Proximity of communities within commuting distance of the proposed SSC facilities capable of supporting the SSC staff, their families, and visitors. Adequacy of community resources—e.g., housing, medical services, community services, educational and research activities, employment opportunities for family members, recreation, and cultural resources—all available on a nondiscriminatory basis. b. Accessibility to the site, e.g., major airport(s), railroad(s), and highway system(s) serving the vicinity and site. c. Availability of a regional industrial base and skilled labor pool to support construction and operation of the facility. d. Extent and type of state, regional, and local administrative and institutional support that will be provided, e.g., assistance in obtaining permits and unifying codes and standards.
Environment:	a. Significance of environmental impacts from siting, constructing, operating, and decommissioning the SSC. b. Projected ability to comply with all applicable; relevant; and appropriate federal, state, and local environmental/safety requirements within reasonable bounds of time, cost, and litigation risk. c. Ability of the proposer, DOE, or both to reasonably mitigate adverse environmental impacts to minimal levels.

Setting:

a. Ability of the proposer to deliver defendable title, in accordance with the schedule for land and estates in land that will adequately protect the government's interest and the integrity of the SSC during construction and operation.

b. Flexibility to adjust the position of the SSC in the nearby vicinity of the proposed location.

c. Presence of natural and man-made features of the region that could adversely affect the siting, construction, and operation of the SSC.

Regional Conditions:

a. Presence of man-made disturbances, such as vibration and noise, that could adversely affect the operation of the SSC.

b. Presence of climatic conditions that could adversely affect construction and operation of the SSC.

Utilities:

a. Reliability and stability of the electric-power-generating and transmission grid systems. Flexibility for future expansion.

b. Reliability, quality, and quantity of water to meet the needs of the facility.

c. Availability of fuel, waste disposal, and sewage disposal.

Source: DOE Invitation for Site Proposals.

Site Evaluation Committee Members

Member	Position and location
Edward A. Frieman[a] (Chairman)	Director Scripps Institute of Oceanography La Jolla, Calif. Vice Chancellor of Marine Science University of California-San Diego San Diego, Calif.
Robert McCormick Adams	Secretary Smithsonian Institution Washington, D.C.
William J. Baumol	Professor of Economics Princeton University Princeton, N.J. Professor of Economics New York University New York, N.Y.
John E. Cantlon	Vice President for Research Michigan State University East Lansing, Mich.
Lloyd S. Cluff	Manager, Geosciences Department Pacific Gas and Electric Company San Francisco, Calif.
Ernest D. Courant	Senior Physicist Brookhaven National Laboratory Upton, N.Y.
Don U. Deere	International consultant in engineering geology and rock mechanics Gainesville, Fla.
Thomas E. Everhart	President California Institute of Technology Pasadena, Calif.
Marvin L. Goldberger	Director Institute for Advanced Study Princeton, N.J.
William R. Gould	Chairman Emeritus Southern California Edison Company Rosemead, Calif.
Elvin R. Heiberg III	Chief of Engineers[b] U.S. Army Corps of Engineers Washington, D.C.
Edward G. Jefferson	Chairman and Chief Executive Officer (ret.); Member, Board of Directors; and Chairman, Finance Committee E.I. Du Pont de Nemours & Company Wilmington, Del.
Herman B. Leonard	Professor of Public Sector Financial Management Harvard University Cambridge, Mass.

(continued)

Member	Position and location
Walter E. Massey	Vice President for Research and for Argonne National Laboratory University of Chicago Chicago, Ill.
Paul J. Reardon	Vice President Science Application International Corp. Princeton, N.J.
Nicholas P. Samios	Director Brookhaven National Laboratory Upton, N.Y.
Roy F. Schwitters	Professor of Physics Harvard University Cambridge, Mass.
Charles H. Townes	Professor of Physics University of California-Berkeley Berkeley, Calif.
Victoria J. Tschinkel	Consultant in environmental regulation Tallahassee, Fla.
Steven Weinberg	Professor of Physics University of Texas Austin, Tex.
Stanley G. Wojcicki	Professor of Physics Stanford University Palo Alto, Calif. Deputy Director SSC Central Design Group Berkeley, Calif.

[a]Former Director, DOE's Office of Energy Research.

[b]Retired from this position since the completion of the evaluation by the site evaluation committee.

Comments From the Department of Energy

Department of Energy
Washington, DC 20585

DEC 2 1988

Mr. Keith O. Fultz
Senior Associate Director
Resources, Community, and
Economic Development Division
U.S. General Accounting Office
Washington, DC 20548

Dear Mr. Fultz:

The Department of Energy (DOE) appreciates the opportunity to review and comment on the General Accounting Office (GAO) draft report entitled, "Federal Research: Determination of the Best Qualified Sites for DOE'S Super Collider (GAO/RCED-89-18)."

From the beginning of the Superconducting Super Collider (SSC) site selection process in February 1987, the DOE has conducted its review of candidate SSC sites in a fair and equitable manner. All sites have been consistently evaluated against the technical evaluation criteria and cost considerations stated in the *Invitation for Site Proposals for the SSC (Invitation)* issued in April 1987.

The National Academy of Sciences/National Academy of Engineering (NAS/NAE) has been an invaluable part of this process, and we again acknowledge our appreciation for their efforts. We are particularly pleased that the General Accounting Office's (GAO) draft report notes that the NAS/NAE used the DOE's site selection criteria in their order of importance and that the process was fair.

As you are aware, on November 10, 1988, Secretary Herrington announced that Texas is the preferred site for the SSC. He made this decision stating that Texas received the highest overall technical evaluation ratings of any proposal and exhibited no overall weaknesses. The ratings of the sites were made by the SSC Site Task Force consistent with the terms of the *Invitation*. The final site selection is scheduled to be made in January 1989 after completion of the Final Environmental Impact Statement.

The draft report recommends that the Secretary of Energy ensure for any future site selection process similar to the SSC that potential site proposers be given the maximum information possible in the solicitation about the relative importance of the selection criteria. We concur that it is critically important for potential proposers to fully understand the selection criteria and their relative significance to the selection decision, and we will comply with this recommendation.

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However, we wish to point out that the *Invitation* specifies that the SSC site selection technical evaluation criteria and subcriteria are listed in their descending order of relative importance. Cost considerations are described as important to the selection, but secondary in importance to the technical evaluation criteria. Further, the important siting considerations for each of the technical evaluation criteria are explained in the appendix of the *Invitation*, and Section 2 of the *Invitation* specifies in detail the information necessary from the proposer to evaluate each criterion.

We would like to thank the GAO staff for their courteous and professional approach in conducting this study. The DOE hopes that these comments will be helpful to GAO in their preparation of the final report.

Sincerely,

Lawrence F. Davenport
Assistant Secretary
Management and Administration

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