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WATER for IDAHO

METHODOLOGY AND CRITERIA FOR SITING ENERGY PLANTS IN IDAHO

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RESEARCH TECHNICAL COMPLETION REPORT

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METHODOLOGY AND CRITERIA FOR SITING ENERGY PLANTS IN IDAHO

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Idaho Water Resources Research Institute
University of Idaho
Moscow, Idaho

John S. Gladwell, Director

FOREWORD

The Idaho Water Resources Research Institute has provided the administrative coordination for this study and organized the team that conducted the investigation. It is the Institute policy to make available the results of significant water and related land resources research conducted in Idaho's universities and colleges. The Institute neither endorses or rejects the findings of the author. In this study a strong effort has been made to make the study as interdisciplinary and interagency as possible within the restraints of time and funding that was available. The Institute does recommend careful consideration of the accumulated ideas and information by those who will be assuredly considering energy plant siting, its administration and planning for the state of Idaho.

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The experience and contacts made by the author serving on an Ad Hoc Committee on Power Plant Siting of the Idaho Society of Professional Engineers was very helpful in carrying out the objectives of the research.

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ABSTRACT

This study contains a review of energy plant siting criteria, methodologies, guidelines and programs that are being considered today in this country. A preliminary screening approach for siting energy plants in Idaho is presented and a detailed heirarchal classification system for siting criteria has been developed. Methodology for using the criteria is suggested. Experience of a workshop trying to identify problems of implementing a ranking and rating for siting energy plants in the general situation for Idaho is reported.

A brief analysis is presented on the needs for regulations and legislation to implement a future program of evaluation that would benefit utilities, the planning agencies, and the regulatory agencies operating within the state of Idaho.

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INTRODUCTION

Origin of Project

This project was initiated during a study the author was conducting on the availability of water for nuclear power production in Idaho. This earlier study (Heitz, 1975) identified as a key problem the need to better define criteria that should be used in allocating resources to the production of energy within the state of Idaho. It was recognized that much of the technology that has been developed in allocating resources in water resources planning could serve as an excellent base for developing methodology for energy plant siting evaluation.

Purpose and Objectives

The overall purpose of the research has been to provide guidelines for future energy development that will meet the needs of people, protect the environment, and ensure adequate safety. It is recognized that all of this must be done under constraints of resource availability such as water resources and the various limiting restraints on the future economy of the region and the nation.

Specific objectives have been:

1. To establish usable and transferrable criteria for siting energy facilities,

2. To recommend information sources and organizational approaches for obtaining needed data,

3. To prescribe methodology for rapid evaluation of siting information.

Primary emphasis has been for application in the state of Idaho; but it is hoped attainment of the objectives will provide information useful to regional application under the nation's goal for energy sufficiency.

History of Project

The project was initiated in January, 1975 through a project sponsored under the allotment program of the Idaho Water Resources Research Institute. This study has paralleled related efforts in energy plant siting. In the fall of 1974 Idaho Power Company applied for a certificate to proceed with construction of a thermal power plant in Ada County. The regulatory agency exercising jurisdiction in Idaho is the Idaho Public Utilities Commission. Several informal and formal hearings have been held in connection with that application and the writer has followed that process to attempt to discern the value this research might have in such proceedings. At times the Public Utility Commission has assisted in this study, but exercised caution that the research should not interfere with the judicial aspects of that case.

In November of 1974, the Idaho Society of Professional Engineers organized a special ad hoc committee to study energy plant siting in Idaho. The writer was asked to serve on that committee and has accepted that assignment throughout the functioning of that committee. The committee made two reports to the body of the society (Wilbur, et al., 1975 and Wilbur, et al., 1976). Naturally some input from this study was made to that effort.

During the fall of 1975 efforts were initiated by different groups to initiate new legislation for siting energy plants in Idaho. This resulted in Idaho House Bill No. 50 which was introduced in the State Affairs Committee of the Idaho House of Representatives. This legislation was patterned to a great extent after legislation recently passed by the state of Montana.

The writer, with assistance from Phillip Rassier, a law student at the time, analyzed this and related legislation and made reports on the subject (Warnick and Rassier, 1975, and Rassier, 1975). The House Bill No. 50 died in committee. A similar unsuccessful attempt was made to pass Senate Bill No. 1401 during the 1976 legislature.

During the second semester of 1974-75, the Idaho Water Resources Research Institute in cooperation with Washington State University offered a joint graduate seminar considering energy plant siting problems of the Pacific Northwest region. This was guided to considerable extent by the author and resulted in proceedings (Gladwell and Warnick, 1975) that recorded opinions, approaches and problems being considered in the region.

Original plans called for a workshop to be conducted through the project in the early summer of 1975, but the Idaho Public Utilities was not in a position to encourage such an effort. A special working document for use in the workshop was prepared in June, 1975. This document was distributed to prospective participants and much of the information of this report was taken from that document. Most significant in that document was extensive analysis of existing literature and programs of energy plant siting. A dictionary of terms was also developed for use by the workshop group.

Work during the summer of 1975 centered on studies of preliminary screening approaches for the state of Idaho and the following of the hearings of the Idaho Power Company application then pending before the Idaho Public Utility Commission.

It was finally possible to schedule and conduct the energy plant siting workshop on January 7-8, 1976 in Moscow. Later sections of the report present results from that workshop. The final phase of the project has been a reappraisal of early approaches and the synthesizing of all information into a comprehensive report of the study.

REVIEW OF EVALUATION STUDIES GUIDELINES AND PROGRAMS

To assess the problem and gain background for developing methodology in this study, an extensive search was made of the literature of studies, guidelines and programs on energy plant siting criteria. It would appear that a summary of this search should be helpful to report and to indicate how the material was used in this research. This is summarized in two ways: 1) studies that appear to concentrate on identifying criteria and methodology for siting energy plants in the evaluation process and 2) reports on programs in practice within various states and nations. These reported studies are only selective and not an inclusive reporting of all the information that is available. That is one of the problems in siting is the great profusion of approaches that are being advocated.

CRITERIA STUDIES

(1)*

An early and significant study is one conducted by Pacific Northwest Laboratories of Battelle Memorial Institute (Harty, et al., 1967). This considered only nuclear power plants and emphasized three important items: 1) siting considerations, 2) representative sites, and 3) economic factors. The stated objectives of the study were as follows:

1. To assist in understanding and applying factors involved in selecting acceptable nuclear power plant sites,
2. As basic information that will be useful to prospective plant owners in preparing studies and analyses related to specific sites,
3. To assist in making economic evaluations,
4. To permit extrapolation.

The approach used was to consider example sites and to make needed assessment sites. Sixteen examples of sites were considered in the Puget Sound area, lower Columbia area, western Oregon area, middle Columbia area, northwest Montana area, and southeast Idaho area.

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* These numbers refer to the identifying column for the particular study that is summarized in Table 1, a matrix for showing information on criteria referred to in various studies that were analyzed.

(2)

Another significant study quite oriented to nuclear energy was a study in a southeastern state (Beer, 1974, and Lewis, et al., 1974). This was a three-stage site selection procedure used to evaluate land-based and off-shore nuclear plant sites. The initial stage was of site selection based on:

1. Land availability -- size and ownership,

2. Exclusion radii -- demographic data and U.S. Atomic Energy Commission,

3. Availability of cooling water -- either once-through cooling or makeup water for cooling towers,

4. Adequacy of transportation facilities -- distance to highways, railways, and navigable waterways.

The second stage narrowed down the number of sites of from 60 to 8. With information obtained by a fly over and, limited walk through and existing data, adequate information were available to make a screening. Next the eight remaining sites were ranked using the following factors with indicated weighting:

Seismology	W.F. = 2
Terrestrial Biology	W.F. = 3
Aquatic Biology	W.F. = 3
Population Density	W.F. = 2

Each site was rated with criterion rating between 0-5 with the higher values indicating increasing site favorability (licensability). Each site criterion value was multiplied by its inter-criteria weighting factor (1-3). The sum of each weighted criterion value for each site was then used to rank sites. Much human judgment was required in assigning values to the criterion rating and the weighting factors. A systems approach was presented of how to evaluate the interaction relationships.

(3)

A regional study by Dames and Moore as consultants for the Public Power Council in the Pacific Northwest was particularly applicable to this research (Dames and Moore, 1973 and West and Dyar, 1974). The study was to serve as a base for development of future generation sites. Siting criteria were developed to reflect the policies and guidelines provided by state and federal regulatory agencies. Site areas and locations were determined by:

1. Elimination from consideration all areas having no apparent potential for power plants,

2. Review remaining potential areas and rejecting all or part of individual study areas not meeting any of the most critical or limiting criteria,

3. Specific site areas were then identified in the remaining areas and detailed site analyses were performed.

The significant criteria used in the study were:

water supply
method of waste heat disposal
meteorology
size of the site area
land acquisition
topography
geology
seismology
other catastrophic phenomenon
access
transmission
water quality
population
land use
public safety and acceptance
economic factors

This study resulted in the selection of a site near Satsop, Washington for the Washington Public Power Supply System.

(4)

A study referred to as the Douglas Point study represents a Maryland power utility's effort to assess the various alternatives to meet their forecasted demand (Scoville, 1974). In this methodological approach the limitations established were the following:

1. A site that could accomodate 2000 Mw capacity of either fossil or nuclear fueled production,

2. The site had to be capable of being developed and production in operation by the year 1980,

3. To minimize environmental as well as capital costs, the site was chosen as close to the load center as possible, considering aesthetic, environmental and regulatory requirements.

A site selection team was composed of the following disciplines: 1) environmental project management, 2) heavy equipment transportation, 3) aquatic biology, 4) meteorology, 5) geology, 6) real estate and local history, and 7) nuclear engineering. In addition to the above, that study was to consider price and availability of fossil fuel and uranium projected to the year 2010. The siting team selected candidate sites through an elimination process. Ultimately three sites were defined and on these sites differential impacts on transportation access and labor availability, site meteorology conditions, representative transmission routes, aquatic ecology, historic and archaeological sites, and geologic, seismic, and hydrologic aspects. Results were presented in matrix form. This produced information on the Douglas Point site for choice as the best site.

(5)

The Tennessee Valley Authority has put forth a set of considerations in connection with siting the Browns Ferry nuclear power plant (Gilleland, 1969). Their system includes hydropower, fossil fuel and nuclear power plants and so the study was restrained by their systems load and economic conditions. Emphasis was on the nuclear mode of production. A treatment was made of economic considerations comparing a coal-fired plant capital and operating costs such as different fuel transportation and transmission costs with the nuclear power plant site costs at Browns Ferry. The specific site selection considerations listed were:

1. load center
2. fuel transportation
3. aesthetic
4. exclusion area
5. meteorology, hydrology, geology, and seismology
6. cooling water supply
7. access

There was rather a minimum presentation on ranking and interesting comment used in expressing social acceptability was "to make generating plant a good neighbor in all respects".

(6)

Recently the state of Ohio conducted a systematic survey to identify and rank a number of candidate areas for nuclear and/or fossil fueled power plant sites (Elkin, DiNunno and Morgan, 1974). The study's basic guidelines were: 1) be within the federal and state regulations governing site selection and 2) must evaluate the engineering, environmental and socio-economic conditions of the state.

The study was conducted in four steps:

1. A preliminary screening of the entire state of Ohio to identify potential areas for power plant siting,

2. The determination of candidate regions and the reduction of their number based on the results of the preliminary screening,

3. A candidate region screening to identify the prime candidate regions for power plant development,

4. Candidate sites within the most promising candidate regions for power development.

Basic factors utilized in the preliminary screening included: 1) hydrology, 2) geology, 3) demography/land use, 4) meteorology, 5) ecological sensitivity, 6) geography/topography and 7) general acceptability.

One hundred and seven candidate regions were identified. These candidate regions were narrowed to 51 regions using a rating matrix with the factors: 1) geology, 2) demography/land use, 3) accessability, 4) ecological sensitivity, and 5) geography/topography. Hydrology and meteorology were not included in the numerical ratings because the regions initially selected do not differ enough to provide a means of discrimination in this phase. The numerical rating system used measures that ranged from 0.0 to 1.0. A factor rating of 0.0 was used when that region was considered unsuitable in light of other alternatives and thus removed from further consideration. Criteria for the 0.0 rating were developed and used only for factors where meaningful. This study recognized some factors are more important than others in the decision matrix, weighting values were assigned to each factor to arrive at a composite rating value for each candidate region.

(7)

The Washington Water Power Company, through personal contact, presented to the writer a basic approach for siting studies the company has made. The following tasks were performed:

1. Review of siting studies and guides,

2. Development of criteria and guidelines to be used in site selection and evaluation,

3. Examine maps and selected areas of interest,

4. Conduct aerial surveys,

5. Select sites for survey on land,

6. Select sites for detailed study.

Information gained and used in rating 13 sites were grouped into the following 10 factors:

1. Highway access
2. Railroad access
3. Transmission
4. Cooling pond
5. Pumping
6. Foundations
7. Land value
8. Population proximity
9. Labor availability
10. Environmental impact

(8)

Another private utility retained a consulting engineering firm to provide full public disclosure (Seiple, 1975). The basic purpose was to determine ranking of five sites in order of suitability. An ad hoc environmental advisory group was formed from representatives of interested groups. Three subcommittees were formed to better use special interests and expertise of the various committee members. Those areas dealt with 1) pollution and safety, 2) land use and aesthetics, and 3) biology and archaeology.

The consultants' specialists evaluated 10 factors for each of the five sites and presented oral and written information to the committee and the utility as work progressed. This included a matrix solution and ranking that was reviewed by the utility and the advisory committee. The final report contained all the committee, subcommittee and minority reports. Weighting factors were used in this evaluation. In this study factors were defined as technological disciplines and criteria are the factor effects and conditions that were considered. The ten factors were as follows:

1. Demography and land use

2. Historic and archaeological sites

3. Aesthetics

4. Noise

5. Biology

6. Meteorology

7. Geology

8. Soils

9. Hydrology

10. Seismology

(9)

Calvert and Heilman suggested a new approach to power plant siting and emphasized that the increased requirement of environmental awareness was changing the process of site selection (Calvert and Heilman, 1972). They approached siting through cyclical and iterative stepped procedure and gave a definition of basic elements of facility siting. They presented as basic steps the following:

1. Establish siting criteria

2. Collect data

3. Define search limits

4. Conduct map search and site discovery

5. Conduct preliminary comparative screening

6. Prepare preliminary engineering, environmental and cost comparisons

7. Prepare inventory

8. Apply preliminary rating system

9. Conduct secondary screening

10. Conduct aerial reconnaissance.

11. Compare comprehensive and environmental and cost comparisons.

12. Prepare refined inventory

13. Apply refined rating system

14. Select sites for detailed study

15. Conduct surface reconnaissance

16. Conduct field studies

17. Conduct detailed engineering, environmental and cost comparisons

18. Apply detailed rating system

19. Make final site selection

The factors they indicated fall into three general categories of 1) engineering feasibility, 2) environmental effects and public acceptance, and 3) economic considerations. Their recommendations broke these main considerations into several subfactors or basic elements. In the study a rating was developed giving a particular site a rating of Excellent = 4, Good = 3, Average = 2, or Poor = 1. Each factor for each site was thus assigned a numerical value. To arrive at the final ranking, a weighting of the factors was used to stress certain factors that were considered more important than others.

(10)

Geitner and Broome in a presentation before the 1974 American Nuclear Society Conference on Nuclear Power Plant Siting presented a systematic formulation for siting (Geitner and Broome, 1974). They indicated a study should represent a "model" of the real world with its key elements including 1) study objective (scope), 2) study assumptions, 3) study criteria (accuracy desired), 4) study hypothesis, 5) study constraints, and 6) study resources (manpower and money). They suggested objectives of the study should define the desired outputs of the study which will be a function of needs at the time and previous work. Two main considerations of power plant type and power system transmission plans must be available as initial assumptions to guide the development of the study. The term consideration in this paper was used to indicate a broad spectrum of information which can be converted in the study to assumptions with which to start the study, hypotheses to be tested by the study, criteria to evaluate the study outputs, and constraints to be used as limits of the study. Resources at hand in such an evaluation include time, money, expertise and existing data.

An initial element of their systematic study is the evaluation of pertinent considerations and their applicability by a multidisciplinary group. A typical grouping of considerations suggested is as follows:

System planning

Engineering

Environmental

Economic factors

Social factors

Institutional factors (including safety)

It was also suggested that siting considerations should be divided into two groups:

a. Those time independent (static)

b. Those time dependent (dynamic)

The static considerations are such that expected changes would not be perceptible over a long time period. Only a few items from environmental group can qualify as static considerations such as: 1) hydrology, 2) topography, 3) geology, and 4) meteorology. Man-made changes can cause variations, but the actual data base when properly assembled will remain as an asset and can be easily reused.

The dynamic considerations are time dependent where ever changing socio-political and regulatory climates change with current political and public interests. Dynamic considerations data must be checked for current relevance and validity before inclusion in a study. Institutional and social variability is the most difficult to project beyond the near term and other important dynamic considerations include safety, system planning, licensing, pollution control, and land use impact. The authors of this study suggest short term (5 years or less) can be predicted by trend analysis and recommend that the effects of time dependent considerations can be separated and reanalyzed later.

(11)

A report in Proceedings of the Institute of Electrical and Electronic Engineers (Keeney and Nair, 1975) and reports prepared through Woodward-Clude Consultants of Oakland, California (Nair, et al., 1974) propose a decision analysis approach to siting. This methodology is stated to be a systematic approach for rationally balancing achievement on many conflicting objectives of siting power plants. The study advocates a more formal method of articulating judgments and preferences of a subjective nature along the lines of a more objective consideration for decision making. This analysis indicates essential requirements and criteria for selection were safety and economics, but has been altered due to the enactment of NEPA. The reported trend is toward the following approach:

1. Establishing exclusionary criteria

2. Selecting candidate sites

3. Establishing evaluation criteria

4. Application of criteria

5. Siting decisions

For a decision analysis framework the following steps are proposed:

1. Structuring the decision problem including identification of decision makers, impacted groups, and generation alternatives and an appropriate set of objectives,

2. Describing possible consequences over time of alternatives in terms of measures of effectiveness,

3. Prescribing relative preferences of the decision makers for possible consequences. Tradeoffs are identified,

4. Rationally synthesizing the information from the first three steps and performing sensitivity analysis to determine preferred alternatives.

In this methodology under structuring the decision problem an appropriate set of objectives was specified as follows:

a. Minimize environmental impact

b. Maximize human health and safety

c. Provide quality service for customers

d. Maximize desirable economic impact on the utility.

A mathematical representation was developed for a preference function by breaking the process down into component parts.

(12)

The National Environmental Studies Project (NESP) was a joint effort sponsored by the Atomic Industrial Forum and contributory organizations to provide technical reports on specific environmental topics related to the licensing of nuclear facilities. A series of three references is here mentioned of this project (Commonwealth Associates, 1974; Hittman Associates, 1974; Battelle Pacific Northwest, 1975). The intent of the reports was to present a generalized process of siting used by industry and reported on each stage of the process. The study entailed a survey of utilities, review of applicants' environmental reports, and information. The Appendix A in that report summarizes the results of survey of 26 utilities siting methods.

The general site selection and evaluation process consists of three stages: 1) determination of candidate areas, 2) determination of candidate sites, and 3) selection of proposed sites. The basic considerations involved were grouped into six categories: 1) system planning, 2) safety, 3) engineering, 4) environment, 5) institutional, 6) economic. For each stage of the siting process the siting considerations have areas or prominent attention and the reports presented considerable discussion of these considerations. The generic methods described for each stage are listed below:

1. Determination of candidate areas

    a. power system planning
    b. acceptability/exclusion screening
    c. regional characterization

2. Selection of candidate sites

    a. successive screening
    b. comparative evaluation
    c. classification and rating

3. Final site selection

    a. comparative cost analysis
    b. balancing of cost and environment
    c. formalized numerical rating

The method of approach is based on addressing subjects in checklist form.

(13)

Another systematic approach is reported as Systematic Site Evaluation Method (SSEM) (Fischer and Ahmed, 1974). This is a hierarchal approach of three stages: 1) primary screening, 2) environmental assessment, and 3) decision making stage. The objective of the primary screening is to delineate the siting areas that are obviously not suited for locating power plant sites. A list of siting characteristics that make a site totally undesirable is developed from regulation rules, criteria and guidelines. Some of the characteristics that would make an area undesirable for a nuclear power plant are:

1. Areas having no reasonable source of water

2. High density urban areas

3. Areas subject to frequent flooding

4. Areas that are seismically unacceptable from an engineering point of view

5. Areas with dedicated land use, such as parks and wildlife preservations

6. Areas that are archaeologically important

7. Areas where geological conditions are unacceptable from a construction point of view

8. Areas that are inaccessible

The recommended procedure for primary screening consists of the following steps:

1. Develop a map showing geographical or political boundaries of the areas in which sites can be considered. These areas are based upon power network considerations, need for power, political boundaries, economics, etc.

2. Develop overlay maps for each of the constraints and criteria.

3. Cross out areas in the area map that are unacceptable for power plant siting.

The environmental assessment system proposed by the study consists of four categories as identified in Figure 1. To assess these effects in non-descriptive terms of environmental quality, a relationship is developed having a value from 0 to 1 which is related to characteristic measurements of the environmental consideration. These are not assigned equal values and importance factors are suggested. An impact quotient for each component is determined by evaluating each environmental quality term with and without the plant. The impact quotient (IQ) can be computed by:

$$IQ = (EQ_1 - EQ_2)IF$$

where: EQ_1 = environmental quality with plant

EQ_2 = environmental quality before plant

IF = importance factor

Positive or negative values of impact quotients will reflect beneficial or adverse environmental impact.

The decision analysis process uses a utility function as the indicator of the desirability of a particular site. The utility function can be described by the equation:

$$U = P_1U_1 + P_2U_2 = \ldots P_nU_n$$

where: U_1 = attribute value

P_1 = preference index subject to $0 < P < 1$ and $\Sigma P = 1$

Attribute values for each site are obtained by adding IQ values for each component of the four categories. For each of the categories a preference index is used to assess the preference of the various attributes.

(14)

The Berkshire County Regional Planning Commission of Pittsfield, Massachusetts with the assistance of Curran Associates, has prepared a reviewer's handbook on evaluation of power facilities (Berkshire County Planning Commission, 1974). This covers several types of generating technologies. This presents excellent flow diagrams for processes of evaluation including regulatory steps. The siting evaluation is to be used in selection of the best generation site or transmission line route given that the proposed facility will be built within the region of concern. This study considered four major elements or categories of impact were necessary in the evaluation. These impacts are: 1) aggregate regional income, 2) equity, 3) structural environmental impact,

FIGURE 1

Environmental Assessment System Categories

ECOLOGY	ENVIRONMENT	LAND USE AND AESTHETICS	SOCIAL AND CULTURAL
Terrestrial Population Diversity Value Special considerations	Water Pollution due to addition of artificial materials due to loss of water from the basin due to addition of heat pollution of groundwater	Existing landscape Harmony of man-made objects Sensory Impact odor-air & water visual - water others	Archeological Historical Economic Considerations
Aquatic Population Diversity Value Special considerations	Air Pollution Toxic gasses Particulate matter other Noise Pollution Land Pollution	Interaction with other Communities population property value others Composite Effect Unique Effects Assessment System Categories	Stress on Public and Social Services

and 4) socio-economic impact. The aggregate regional income element includes items such as increased tax revenues. The equity element concerns the impact of alternatives on different segments of population within the region, relative welfare including both tangible and intangible values. The structural environmental impacts element includes the physical, biological and visual impact of a proposed facility. Socio-economic impacts as elements in the evaluation are primarily concerned with the size of the project. The Berkshire County studies and recommendations has a finer breakdown of subelements also and a system of ranking and preference.

(15)

A very recent study in the Pacific Northwest is a siting study prepared for the Washington Public Power Supply System (WPPSS) (Woodward-Clyde Consultants, 1975; and Tillson, 1975). That study was structured in the following elements:

1. A definition of issues and criteria
2. A screening process to identify candidate sites
3. A ranking process to preferentially order the candidate sites

The first step was defining the general objective which was to recommend sites suitable for thermal power plants. A second step was identification of general issues. These were:

1. Health and safety
2. Environmental effects
3. Socio-economic effects
4. System cost and reliability

Under these issues came a hierarchal listing of considerations, measures and criteria for inclusion. For instance, a consideration under the issue of health and safety was flooding. The measure was listed as height above nearest source of water and criteria for inclusion was the area above the primary flood plain. This appeared to be a very orderly and systematic evaluation procedure.

In this study the WPPSS was advised of candidate sites, there was assessment of uncertainties at the sites, a preference function, and a ranking system. This study did identify information on siting in the Panhandle area of Idaho and should be useful to utilities operating in the area, planning entities and the Idaho Public Utilities Commission.

(16)

An interesting type of qualitative analysis has been put forth on ecological implications of power plant siting by a professor at the University of Maryland Center for Environmental and Estuarine Studies (Cronin, 1975). The approach in this study was to respond to five specific questions:

1. Will the processes in the water cycle be altered?

2. Is water quality or water availability altered?

3. Where does the wasted energy go and with what effects?

4. Is the activity affecting other uses of water?

5. Are we improving the ecosystem, if not, can we?

Each of these included several subordinate questions. The interesting aspect of study was the matrix that was developed for all types of energy plants and gave qualitative evaluation of impact on the respective subordinate elements of the above listed questions.

Guidelines and Programs

This section treats those guidelines and programs that have been organized for considering the siting in a rather formal and organizational manner such as state and federal regulatory agencies and legislation dealing with the problem. This includes even a brief mention of programs and approaches to siting in other nations.

(17)

The Atomic Energy Commission (now the Nuclear Regulatory Commission, NRC) grant licenses for nuclear energy plants and under requirements of the National Environmental Policy Act of 1969 (Public Law 91-190) the NRC is responsible for environmental impact statements on nuclear energy plants. (AEC, August 1972 and March 1973) The licensing action has been on a case by case basis and involves a complex, time consuming, and sometimes duplicative activity that contributes to delays. A recent discussion on the problems of this agency are discussed in two papers presented at the American Nuclear Society Conference on Nuclear Power Plant Siting (Davis, 1974 and Norris, 1974). The Norris report identifies four distinct phases as follows:

1. Determination of the region of interest,

2. Determination of the candidate areas within the region of interest,

3. Subsequent determination of candidate sites within candidate areas,

4. Identification of proposed site from the candidate sites.

A detailed listing of considerations applicable to Phase 3 is presented. The broad categories of the detailed guides are divided as follows:

1. System Planning
2. Geology/Seismology
3. Demography
4. Meteorology
5. Hydrology
6. Geography/Topography
7. Land Use
8. Biota/Ecosystems
9. Water Quality
10. Socio-Economic

This effort is intended to help in shortening the licensing process while at the same time maintaining safety and environmental protection.

The general environmental siting guide (AEC, December 1973), provides a comprehensive environmental topics and framework of assessing them. Each topic is discussed and the basis to evaluate them is given along with related references. The following is a list of the environmental topics in the guide (AEC, Dec., 1973):

Geology and Soils

General Seismic and Geological Characteristics
Soil Stability and Topography
Subsidence
Seismically Induced Floods and Water Waves

Atmospheric Factors

Air Pollution Standards
Dispersion Climatology
Atmospheric Dispersion - Valley and Canyon Sites
Atmospheric Dispersion - Shoreline Sites
Vortex Phenomena and Extreme Winds
Fogging and Icing

Hydrology

Water Use Policies
Adequate Water Supply (Quantity)
Groundwater
Inadvertent Loss of Water

Hydrology (cont.)

- Water Quality
- Icing and Sedimentation
- Mixing Zones
- Stratified Waterbodies
- Impoundments

Ecology

- Temperature Sensitive Aquatic Species
- Breeding Habitats
- Species Migration
- Terrestrial Vegetation
- Rare or Endangered Species
- Public Exposure to Radiation

Land Use

- Land-Use Compatibility
- Land-Use Planning
- Coastal Zone Planning
- Watershed Planning
- Transmission Line Corridors

Human Interest Factors

- Unique Natural Resource Areas
- Historical Areas
- Archaeological Sites
- Fossil and Rock Deposits

Esthetics

- View of Transmission Facilities
- View of Power Plant Site

Other Considerations

- Transportation Provisions
- Construction Impact

The regulatory guide "General Site Suitability Criteria for Nuclear Power Stations" (AEC, September, 1974) discusses the major site characteristics the staff considers in determining the suitability of a site. The guidelines should also be used in a screening process to identify suitable candidate sites. The guide discusses the considerations, gives the relevant regulation and regulatory guides and their position on the considerations. The considerations discussed are:

1. Geology and seismology

2. Meteorology (atmospheric dispersion)

3. Population density

4. Hydrology

   a. flooding
   b. water supply
   c. water quality

5. Biota and ecological systems

6. Land use and esthetics

7. Industrial, military, and transportation facilities

8. Socioeconomics

The Appendix B (AEC, September, 1974) summarizes site characteristics related to environmental considerations that should be addressed early in the site selection process. The environmental considerations given are:

1. Preservation of important habitats

2. Migratory routes of important species

3. Entrainment and impingement of aquatic organisms

4. Entrapment of aquatic organisms

5. Water quality

6. Consumptive water use

7. Established public amenity areas

8. Prospective designated amenity areas

9. Public planning

10. Visual amenities

11. Local fogging and icing

12. Economic impact of preemptive land use

Also in this guide is found the following definition of what should be included in the biological and physical environment and on the social and cultural features of any major industrial facility.

Biological and physical environment includes geology (underground and surficial), geomorphology (landform and topography), hydrology (surface and subsurface), climatology, air quality, limnology, water quality, fisheries, wildlife (large mammals, small mammals, birds), and vegetation. Social and cultural features include scenic resources, recreation resources, archeological/historical resources, and community resources (land use patterns, economic base, housing, transportation, sewer, water, police, fire, educational). This is taken from "Development and the Environment: Legal Reforms to Facilitate Industrial Site Selection". Final report by the Committee on Environmental Law, American Bar Association, February 1974.

No doubt with the shift to the new Nuclear Regulatory Commission there is being developed revisions in these guidelines so that summary is apt to be out of date very soon.

(18)

The Arizona program is presented for its organization structure and for identification of the statutory listing of factors to be considered (12 Arizona Revised Statutes Annotated 40-360, 1971 and Westerby, 1973).

In 1971 the state of Arizona passed siting legislation in the form of Power Plant and Transmission Line Siting Act with the claimed purpose of developing a balancing approach to environmental, economic and technical interests or aspects within the state of Arizona. This provided a statutory Siting Committee under the Arizona Corporation Commission. The committee is to consist of the following:

1. State Attorney General
2. State Land Commissioner
3. Chairman of the State Water Quality Control Council
4. Director of Division of Air Pollution Control of the State Board of Health
5. Director of the Game and Fish Commission
6. Executive Director of State Water Commission
7. Executive Director of the Department of Planning and Development

8. Chairman of the Arizona Corporation Commission

9. Chairman of the Archaeological Department of the University of Arizona

10. Director of the State Parks Board

11. Executive Director of the Arizona Atomic Energy Commission

and seven members appointed by the commission to serve for a term of two years of which two members shall represent the public, two members shall represent incorporated cities and towns, two members shall represent counties and one member who shall be a registered landscape architect. The attorney general is designated as the chairman of the committee.

The committee is designated through the act to establish procedures for the expeditious review of proposed power plant siting and provide for timely decisions regarding the issuance of a certificate of environmental compatability. The factors to be considered are identified in Arizona Revised Statutes Annotated in Section 40-360.06.

Factors considered and identified in statute as a basis for action with respect to suitability for siting are:

1. Existing plans of the state, local government and private entities for other developments at or in the vicinity of the proposed site.

2. Fish, wildlife and plant life and associated forms of life upon which they are dependent.

3. Noise emission levels and interference with communication signals.

4. The proposed availability of the site to the public for recreational purposes, consistent with safety considerations and regulations.

5. Existing scenic areas, historic sites and structures or archaeological sites at or in the vicinity of the proposed site.

6. The total environment of the area.

7. The technical practicability of achieving a proposed objective and the previous experience with equipment and methods available for achieving a proposed objective.

8. The estimated cost of the facilities and site as proposed by the applicant and the estimated cost of the facilities and site as recommended by the committee, recognizing that any significant increase in costs represents a potential increase in the cost of electric energy to the customers or the applicant.

9. Any additional factors which require consideration under applicable federal and state laws pertaining to any such site.

It also requires that the committee shall give special consideration to the protection of areas unique because of biological wealth or because they are habitats for rare and endangered species.

(19)

The program and activity in the state of Maryland appears to be unique and appears to involve more state involvement in energy plant siting than most any other state.

There are four operational program elements under Maryland's program (Annotated Code of Maryland - Section 3, 1974 and Perkins, 1974) as given below:

Site Evaluation: the scientific assessment of the site proposed by a utility company, the prediction of impacts that will result from the proposed plant at the proposed site, and recommendations on whether to grant, deny, or grant with conditions the certificate necessary for construction of the plant.

Site Acquisition: the identification, investigation, and acquisition of sites reasonably suitable for the generation of electricity, to be provided as alternate sites in the event that a utility-owned site is determined to be unsuitable.

Monitorings: the assessment of impacts at existing power plants to determine whether the engineering and regulations that have been imposed upon the construction and operation of the plant are producing the desired objectives.

Research: the longer term answer providing element of the program, that overviews the above mentioned elements, identifies problems in capabilities, and sponsors research that will provide solutions, so that the other elements can operate with increasing efficiency and certainty.

The program also includes a long range power plant site evaluation of needs, proposed sites and environmental impact. The Public Service Commission assembles and evaluates annually the long range plans of the electric companies regarding needs and means for meeting the needs and forwards a ten-year plan to Department of Natural Resources. The Department of Natural Resources with the advice of the Department of Health and Mental Hygiene prepares a preliminary environmental statement on each possible and proposed site. The preliminary statement is required to include the following considerations:

1. The environmental impact at the proposed site,

2. Any adverse environmental effects which cannot be avoided if the proposed site is accepted,

3. Possible alternatives to the proposed site,

4. Any irreversible and irretrievable commitments of resources which would be involved at the proposed site if it is approved,

5. Where appropriate, a discussion of problems and objections raised by other state and federal agencies and local entities,

6. A plan for monitoring environmental effects of the proposed action and provision for remedial actions if the monitoring reveals unanticipated environmental effects to significant adverse consequences.

Any site which is classified unsuitable in the preliminary statement shall be deleted from the plan. The desirable or acceptable sites are then investigated in detail. If no evidence justifies a revised classification, the Department of Natural Resources shall publish a detailed environmental statement at least two years before construction is estimated to begin.

The program is funded from a surcharge on electricity generated in the state. Any site property obtained by an electric company from the state shall be used and operated without regard to any local zoning provisions. The site acquisition program is evaluating potential sites and has started acquiring sites. The research program has been active including a "Power Plant Site Evaluation Economic Studies Report" with an energy demand study employing a variety of statistical techniques.

(20)

The Montana Utility Siting Act of 1973 was enacted to vest in the Department and Board of Natural Resources and Conservation the authority to require and review long-range planning of certain utilities, to give approval to energy generation and conservation plants and associated facilities, and to require preconstruction certification of such facilities. Plants and facilities include power generating plants, uranium enrichment plants, geothermal developments, gas and liquid hydrocarbon production facilities, transmission facilities for the gas and liquid petroleum, and electric transmission lines and facilities of a specified capacity. This act was reportedly the basis for Idaho's 1975 legislative effort to pass new siting legislation (Culner, 1975).

An item of special interest is the requirement to present annually a long-range plan for construction and operation of utility facilities. This is covered in Section 70.814 and 70.815 of the act (Revised Code of Montana Annotated, 1973). The Montana program is elaborated on in greater detail in the Montana Administrative Code, Sections 36-2.8(1)-S800 to 36-2.8(14)-S8050. The section most pertinent to siting criteria is contained in Section 36-2.8(2)-S820.

The factors to be considered in the Montana evaluation program include seven main headings with numerous subheadings. The main headings are:

1. Energy Needs
2. Land-Use Impacts
3. Water Resource Impacts
4. Air Quality Impacts
5. Solid Waste Impact
6. Radiation Impacts
7. Noise Impacts

(21)

The state of Oregon established a Nuclear and Thermal Energy Council in 1971 (Oregon Revised Statutes 435.305 to 453.575 and 453.994, 1971) and developed rules that were adopted September 5, 1972 (Oregon Administration Rules Compilation, 1973). A task force appointed by the chairman of the Nuclear and Thermal Energy Council prepared a report between June 1972 and December 1974 recommending suitable and unsuitable sites for thermal power plants (Oregon Nuclear and Thermal Energy Council, 1974). Only nuclear-fueled, fossil-fueled, and geothermal-fueled power plants as modes of production were considered.

Planning of the task force proceeded in the following stages:

1. Identified in accordance with guidelines those parameters which should be satisfactorily analyzed on a statewide basis,

2. Identified parameters that must be considered during individual site evaluation,

3. Incorporated advice from affected state agencies and reported results for each parameter in a map form. The task force did not attempt to make its own value judgment on information received from individual state agencies,

4. Compiled maps to form a map of suitable, less suitable and unsuitable areas for power plant siting.

This latter designation in Item 4 was later (December 16, 1974) changed to just two designations of "suitable" and "unsuitable".

This Oregon investigation on a statewide differentiation for suitable areas considered five major parameters: (1) natural resource areas, (2) meteorology, (3) population, (4) water restrictions and (5) geology. The comment was that natural resource areas and water restrictions applied to siting of coal-fired plants, and population and geology applied to siting of nuclear power plants.

Other parameters that the Oregon task force considered as necessary for intensive examination on an individual site basis were as follows:

1. In-depth geologic investigations,

2. Meteorological considerations for wind directional parameters and capabilities of specified air sheds to withstand additions of various particulates of vapors,

3. Physical land requirements for power facility and its adjacent cooling facilities,

4. Storage of fuels and materials,

5. Previous land use and zoning considerations,

6. Electrical facilities required to construct and operate the plant and to provide integration into the main grid transmission system. Construction of above-ground or underground transmission facilities, and the possibility of routing through areas of the least aesthetic and economic sensitivity,

7. Available water and methods of obtaining water, or possibilities of using alternative cooling methods requiring less water,

8. Evaluation of secondary uses of cooling water including agricultural, recreation and industrial uses,

9. Local natural resource, historic, and archeological sensitivity.

On these bases the state of Oregon has tentatively classified broad areas as either suitable or unsuitable for siting of power plants.

The general rules of practice as covered in Oregon Administrative Rules Compilation specify the following information is to be furnished for a specific site certification:

1. Need for power
2. Regional demography
3. Industrial transportation and military facilities
4. Geology and Seismology
5. Meteorology
6. Hydrology
7. Water quality
8. Thermal discharges
9. Air quality
10. Land use compatibility
11. Coal composition, delivery storage and ash disposal
12. Sanitary wastes
13. Radioactive effluents and wastes
14. Biological impact
15. Noise control
16. Aesthetics

17. Possible additional capacity siting in the same area

18. Plant economics

(22)

The program in the state of Washington began with an ad hoc council of representatives from thirteen state agencies acting under executive order from Governor Evans that agreed to siting guidelines. These guidelines were later incorporated in 1970 into a statutory program for the Washington Thermal Power Plant Site Evaluation Council (Revised Code of Washington 80.50, 1970). The statutory council membership was defined under RCW 80.50.030 as follows:

The council shall consist of the directors, administrators, or their designees from the following:

1. Water Pollution Control Commission
2. Department of Water Resources
3. Department of Fisheries
4. Department of Game
5. State Air Pollution Control Board
6. Department of Parks and Recreation
7. Department of Health
8. Interagency Committee for Outdoor Recreation
9. Department of Commerce and Economic Development
10. Utilities and Transportation Commission
11. Office of Program Planning and Fiscal Management
12. Department of Natural Resources
13. Planning and Community Affairs Agency
14. Department of Civil Defense
15. Department of Agriculture

and appointed member from every county wherein an application is being considered.

The considerations are defined as specific guidelines in Washington Administrative Code (WAC 463-12) with the following main headings:

1. Project Description
2. Site Characteristics
3. Transmission Lines
4. Health and Safety
5. Environmental Impact - Land
6. Environmental Impact - Water
7. Environmental Impact - Air
8. Environmental Impact - Vegetation
9. Environmental Impact - Aesthetics
10. Environmental Impact - Recreation and Heritage

Bradley in commenting on the guidelines use, indicates that four utility-selected sites which represent a wide diversity of indigenous environmental considerations and social concerns have been evaluated under the council program (Bradley, 1974). This does appear to be one place where there is an active program of site evaluation. It is being operated on the basis of being responsive to industry or utility district request.

A comment from an Arizona program analysis by Westerby, 1973 is very interesting in this regard. This is quoted below:

> *". . . The statute (Washington) then tells the decision maker what general factors to balance: the increased demands for new or expanded plants against the broad public interest. The statute then continues by detailing what particular elements are critical to the balancing decision: (1) Assuring adequate operational safeguards; (2) preserving environmental quality; (3) increasing the public's enjoyment of natural resources; (4) promoting clean air; (5) pursuing beneficial environmental changes; and (6) providing abundant low cost energy. The guidance is not a precise mathematical formula, of course, but it does describe the essentials of an effective balancing process more fully than does Arizona's present list of general factors"* (Westerby, 1975).

(23)

Idaho's program has been late in developing because up to the present time, energy plants were hydroelectric plants that were licensed under the jurisdiction of the Federal Power Commission. Legislative activity began in the fall of 1974 having started in draft form in the Idaho Attorney General's Office. A draft bill was reviewed in hearing before the legislature met then a revised compromise bill was formally reviewed before the State Affairs Committee of the Idaho House of Representatives (Idaho H.R. Bill No. 50, 1975). Much of the material was influenced by legislation that had been passed by the state of Montana. Section 12 of that proposed act gave a good listing of what are termed issues on which a finding of fact must be made. The main headings are:

1. Energy Needs
2. Land Use Impacts
3. Water Resource Impacts
4. Air Quality Impacts
5. Solid Waste Impacts
6. Radiation Impacts
7. Noise Impacts

This legislation was left in committee and was opposed by the utilities and the Idaho Public Utilities Commission. In the hearings and during the legislative activity, the Idaho Attorney General expressed an opinion that the Idaho Public Utility Commission had authority to act in the siting responsibility.

A new bill was introduced in the 1976 (Idaho Senate Bill No. 1401, 1976) to implement more definitive legislation for energy plant siting in Idaho.

The draft legislation defined energy facilities very broadly specifically identified the Idaho Public Utilities Commission as having authority and power in regard to energy plant siting. Powers of the commission were designated as follows:

1. Adopt, promulgate, amend, or repeal suitable rules and regulations to carry out the provisions of this act, and the policies and practices of the commission in connection therewith;

2. Promulgate rules of practice for the conduct of hearings;

3. Appoint and supervise such independent contractors, employees, or agents as may be necessary to carry out the provisions of this act;

4. Receive and investigate annual reports and applications for certificates;

5. Commission independent studies of proposed energy facilities and associated transmission lines;

6. Conduct public hearings on the proposed location of energy facilities and associated transmission lines;

7. Issue or deny any certificate hereunder;

8. Determine the terms and conditions of any certificate issued hereunder;

9. Monitor the construction and operation of any energy facility granted a certificate hereunder; and

10. Enforce this act and the terms and conditions of any certificate issued hereunder.

A rather important part of the new legislation was provisions for long range planning activities. This effort was to include planned construction for the next 10 years, probable economic and environmental impact of proposed facilities, and proposed efforts for energy conservation.

The specific delineation of power plant siting criteria and procedures was briefer than the 1975 H.B. 50, but it did include specific mention of the following:

1. Safety and reliability

2. Waste handling

3. Geological considerations

4. Aesthetic considerations

5. Ecological considerations

6. Seismic considerations

7. Water supply considerations

8. Transportation considerations

9. Population and load center considerations

An interesting part of the legislation was a brief treatment of the findings in fact that the commission's decision on siting should be based on the following listed issues:

1. Need for the additional generation facilities

2. Ability of applicant to obtain financing

3. Effect of facility on applicant's roles

4. Impact of facility on environment

5. Impact of facility upon the public health, welfare and safety

6. Availability of alternative sites

7. Relative failings of alternative types of facilities

8. Impact upon federal or state energy policies

This legislation passed the Idaho Senate, but failed in the Idaho House of Representatives.

(24)

Two international programs were reviewed to assess practices abroad as to pattern for energy plant siting (Candes, 1974 and Veya, 1974). In France a nuclear installations authorization is submitted for authorization by government act through a report from the Ministry of Industry. The report is based on evaluation by various committees both within and without the Ministry. Stress is placed on description and evaluation of sites safety factors. Presentation of the site study is divided into six sections as follows:

1. Description and Evaluation of Site

2. Meteorology

3. Hydrology

4. Geology and Seismology

5. Radioecology

6. Natural or Preexisting Radioactivity on the Site

Switzerland is similar to Idaho in that it is a country which previously had all hydroelectric generation and is how faced with the problem of siting thermal power plants. The first thermal plant was an oil-fired station which was placed on a steep mountain slope 1200 feet above the valley because of SO_2 dispersion.

The acceptable primary ground rules governing siting are:

1. Nuclear safety

2. Distribution area of the utility

3. Availability of river flow for fresh water cooling

4. Short connection to the high voltage grid

With growing public awareness of the environment with the energy problem the safety aspect is still the prime consideration, but environmental "minimum impact" is very important.

The main considerations of nuclear safety is patterned after the United States and West German standards. The basic factors considered are geology, hydrology and meteorology along with site hazards of catastrophic floods (dam system destruction), seismic effects, airplane crash, pressure wave and sabotage. Population density in highly populated Switzerland and much of Europe must anticipate sites in or near urban communities.

Cooling systems in the future will be atmospheric cooling due to existing regulations and previous experiences. The major concerns of atmospheric cooling include:

Meteorological effects and plume dispersion

Noise level caused by splashing of cooling water

Water pollution aspects

Aesthetics, impact on landscape and land use planning

With the siting outlook today (1974), the following guideline siting considerations are delineated as:

1. Nuclear safety

2. National planning

3. Conservation

4. Defense

5. High voltage grid

6. Hydrology

7. Meteorology

8. Energy concept

Also there are three particular problems in Switzerland. Sites on or near the borders that require harmonization of siting and safety requirements in Europe. Underground plants look attractive, but disclose many new safety problems. The future cooling system and their influence on the environmental aspects of siting.

SUMMARY OF REVIEW OF GUIDELINES AND PROGRAMS

To summarize the review of energy plant studies a matrix table was prepared to identify what criteria were used by each of the studies or programs. Naturally many different words were used to describe the criteria. This matrix is presented in Table 2, a two-page table. The entry columns are labeled with the short names for the study and the numbers at the top of the columns correspond to those listed at the beginning of the descriptive material about the studies and programs. The entry descriptors for the row are criteria that have been used in the classification proposed in this research study. It is very difficult to find consistency in names used for the criteria referred to in all the studies, but if a reasonably synonimous mention was made in the report to this studies criteria, an entry of "x" was made in the matrix.

In the criteria grouping concerned with physical and technological feasibility there is indication that there is much common reference and use of the specific parameters listed. It appears here the identification and acceptance of criteria that need to be considered in energy plant siting is well established.

The matrix shows that the criteria groupings of parameters concerned with social aspects that should be considered in energy plant siting have much less acceptance of what should constitute the criteria to be considered. The criteria grouping concerned with environmental acceptability and the component parameters appear from the entries in the matrix to show reasonably uniform acceptance of the various studies as to what should be considered in siting evaluations.

The criteria group concerned with economic feasibility was frequently mentioned in general, but many of the studies were specifically addressing environmental aspects in the evaluation process and so economic consideration was not the subject of the study. Presumably this does get much consideration in the implementing stages of planning and certification applications. One parameter that this research has considered very important is economic impact on natural resources such as fuels and materials necessary in energy production, appeared to be mentioned very infrequently in the review of literature.

TABLE 1: SURVEY OF ENERGY PLANT CRITERIA, METHODOLOGIES, GUIDELINES, AND PROGRAMS

Considerations, Parameters & Factors	Battelle Study (1)	Beer Study (2)	Dames & Moore Study (3)	Douglas Point Study (4)	Gilleland Study (5)	Ohio Siting Study (6)	N.W. Private Utility Study (7)	Seiple Study (8)	Calvert & Heilman Study (9)	Geitner & Broome Study (10)	Keeney & Nair (11)	NESP Study (12)	Systematic Site Evaluation Method (13)	Berkshire County Method (14)	WPPSS Study (15)	Cronin Study (16)	Nuclear Regulatory Commission Guide. (17)	Arizona Program (18)	Maryland Program (19)	Montana Program (20)	Oregon Program (21)	Washington Program (22)	Idaho Drafts of Program (23)	France & Switzer-land Programs (24)
I. Physical & Technological Feasibility	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
A. Atmospheric Characteristics	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X			X	X	X	X	X
B. Land Characteristics		X	X	X	X	X	X	X	X	X		X		X	X		X	X		X	X	X	X	X
C. Geology & Soils	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X				X		X	X
D. Water Use & Control	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X			X	X		X	X
E. Transportation Facilities	X	X	X	X	X	X	X		X			X	X	X	X		X				X			X
F. Energy Transmission	X	X	X	X	X	X	X	X		X	X	X	X	X	X		X	X			X	X	X	X
G. Reliability & Safety	X	X	X			X		X	X	X	X	X		X	X		X	X		X		X	X	X
H. Power Load Characteristics		X		X	X				X	X		X					X			X	X		X	X
II. Social Aspects	X	X	X			X	X	X	X	X		X	X		X		X			X	X	X	X	
A. Acceptance of Interest Groups	X		X			X			X			X									X			
B. Acceptance of Governmental Units																								
C. Population Characteristics	X					X	X		X				X				X			X			X	X
D. Land Use Characteristics			X			X			X	X			X		X		X			X	X		X	X
E. Other Social Aspects						X							X							X		X	X	

TABLE 1: SURVEY OF ENERGY PLANT CRITERIA, METHODOLOGIES, GUIDELINES, AND PROGRAMS (Cont.)

Considerations, Parameters & Factors	Battelle Study	Beer Study	Dames & Moore Study	Douglas Point Study	Gilleland Study	Ohio Siting Study	N.W. Private Utility Study	Seiple Study	Calvert & Heilman Study	Geitner & Broome Study	Keeney & Nair	NESP Study	Systematic Site Evaluation Method	Berkshire County Method	WPPSS Study	Cronin Study	Nuclear Regulatory Commission Guide.	Arizona Program	Maryland Program	Montana Program	Oregon Program	Washington Program	Idaho Drafts of Program	France & Switzer-land Programs
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
III. Environmental Acceptability	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
A. Impact on Open Space and Natural Beauty			X	X	X			X	X	X	X	X	X	X	X		X	X		X	X	X	X	
B. Impact on Animal Life	X	X	X			X		X			X	X	X	X	X		X	X		X	X	X		
C. Impact on Aquatic Systems	X	X	X			X		X			X	X	X	X	X	X	X	X		X	X	X		
D. Impact on Plant Life	X	X	X					X			X	X	X	X	X		X	X		X	X	X		
E. Impact on Protected Areas			X			X		X			X	X	X	X	X		X				X			X
IV. Economic Feasibility	X	X	X		X	X	X		X	X	X	X	X	X	X		X	X		X	X			
A. Benefits	X		X						X						X		X				X			
B. Costs	X		X						X		X	X	X		X		X			X	X			
C. Taxes	X								X								X			X	X			
D. Impact on Local Economy									X		X		X	X	X		X			X	X			
E. Impact on Natural Resources																	X							

EVALUATION METHODOLOGY FOR IDAHO

THE VIEWPOINTS

In any approach to establish or appraise a methodology for evaluation of siting energy plants it should be recognized that the evaluation can be looked at from different viewpoints. Four viewpoints should be considered, that of (1) the utilities, (2) the public agencies, (3) the regulatory agencies, and (4) the general public.

Naturally the utility that is chartered to produce and deliver energy has an interest in energy plant siting, and in particular has a need for a good evaluation methodology for siting energy plants. Historically it appears utilities have developed within their companies a program to study siting of plants. Under a hydroelectric system this has been rather simple because it was limited to stream courses and sites along stream courses where topography and geology favored a hydroelectric plant. This effort has been aided by public resource agency studies such as U.S. Geological Survey studies (Young and Colbert, 1965) of sites and potential power capability planning studies of multipurpose development projects by the U.S. Bureau of Reclamation, the U.S. Corps of Engineers, and the Idaho Department of Reclamation, and finally studies mandated by the Federal Power Commission in its licensing role now.

As the siting turns to other than hydroelectric production there opens up a much broader and different field of location possibilities. The utilities appear to consider that to a certain extent these studies should be conducted in a proprietory operation so as to protect the company from land speculation and perhaps early opposition from interest groups. Obviously if the utility is going to construct and operate the plants, their role ~~should be a major one.~~ A question that remains is how much confidentiality needs to be kept by the utility and how can a standard of uniformity and comparability be maintained to permit decision makers to make efficient and wise decisions in view of the other viewpoints and interests.

In the case of hydroelectric plant siting it was pointed out that public agencies have long exercised a role in planning and development wherein there was multipurpose resource and use considerations. With thermal power plants there is also a planning consideration that involves several public agencies such as water resource planning studies of the Pacific Northwest River Basins Commission, the U.S. Bureau of Reclamation, the U.S. Soil Conservation Service, the U.S. Corps of Engineers, and the Idaho Department of Water Resources. Primary concern here is water supply for cooling of thermal power plants and the impact of that water use on other potential uses of water. These public resource planning efforts likewise include the planning efforts of the Environmental Protection Agency and the Idaho Department of Health and Welfare and their responsibility for water quality management particularly as it applies to the assignment they have under PL 92-500 to prepare Section 208 plans for waste water management programs. These latter two agencies likewise have a certain amount of regulatory responsibility with regard to meeting both water quality standards and air quality standards. Implicit in this latter function is a need for information which will allow for wise decisions.

Another agency that has been designated to be concerned with these is the Idaho Bureau of State Planning and Community Affairs, which involves the land use planning activities in the state. All of these agencies then have a concern in energy plant siting and must include collectively a viewpoint that needs to know where plants might be located and the impact such sitings might have on the resources and the communities for which their responsibility has been defined. A great need from this collective viewpoint is coordination and communication of the various ideas and plans that might be put forth.

Regulatory bodies must make evaluations and render decisions on energy plant siting. Most directly involved in Idaho is the Idaho Public Utilities Commission, the agency that has been designated by statute to issue a certificate for construction for energy plants, and must rule on rates to be charged by utilities. The viewpoint here is apparently that of a quasijudicial role and contention is that the evaluation must be made with an independent approach that considers the public need and convenience as the primary measure. Before present concerns for the environment, that may have been sufficient. Here the expertise for the regulatory agency is not normally available in the staff and hence it is necessary to rely on consultants to help in the evaluation. With the fact that steam power as a mode of production is new to the state, little expertise is available and data on impact analysis is sparse. In this viewpoint there must be an independence of action that protects the public and arrives at an evaluation that is acceptable to all concerned. It would appear the fairness must be extended to the utilities and the general public at the same time in an expeditious authoritative manner. Other regulatory agencies such as the Nuclear Regulatory Commission, the Idaho Department of Health and Welfare must make rulings of specific aspects of siting such as to safety for nuclear power plants and requirement for meeting air and water quality standards. Often these viewpoints from the regulatory agencies are not the same and timing of evaluation is not coordinated.

Still another viewpoint that has become apparent is that of the general public. All too often it is very difficult to ascertain who is the general public and what is their viewpoint in a combined sense. Frequently, special interest groups who are certainly a part of the general public view siting from a single consideration such as concern for the environment. It has been customary to try to obtain the viewpoint or an expression of attitude from a public hearing. Experience though indicates that these hearings often only provide expression from a very vocal minority of the general public. Some authorities say questionnaire surveys can obtain appropriate information on the viewpoint of the general public. Other authorities maintain the general public is not well enough informed that their viewpoint is reliable.

A single methodology that would meet the needs of these four different viewpoints would be idealistic at best, yet this may not be attainable. It appears that at the least a methodology of evaluation that would be commensurate and uniform in information used should be a goal for the benefit of all concerned and particularly for decision makers in company management and government administration.

PRELIMINARY SCREENING

It is obvious that many areas in the state are and will continue for some time to be unsuitable as places for locating energy plants. Nearly all siting studies reviewed had some form of program for preliminary screening of candidate areas to put forth areas that have suitable locations in which energy plants might be constructed in the future. Here at least three steps are needed to make this screening effective. These are (1) determining siting criteria for the screening, (2) selecting the organization or entities to do the screening, and (3) applying the criteria to actually determine the areas in which serious siting evaluation can proceed and preparing the resulting maps for future use in the siting evaluation process.

In this research an attempt has been made to define the siting criteria that could be used in Idaho in the screening process. The writer has made numerous contacts with companies, agencies, and representatives from various professional disciplines to build an example of siting criteria for screening that might be used. A student assistant has helped to build these criteria into an application program. Many other studies have approached this by evaluating cells of space or land areas by applying a restraining or exclusionary process. In this study time did not permit that detail in an approach. Basically the first criteria used was to make evaluations on the basis of three modes of energy production: (1) hydroelectric plants, (2) geothermal plants, and (3) thermal power plants.

Hydroelectric Power Screening Criteria - This involved identifying those locations along streams where power sites have previously been identified as having a development potential. The principal source for this information is a U.S. Geological Survey report entitled, "Waterpower Resources of Idaho" (Young and Colbert, 1965). Only major sites were considered and a major site was defined as a location where the Q_{50} (flow available 50% of the time) and the site reservoir and head differential must provide a capability of producing 20 MW with the gross head available. Sites selected were chosen to develop as much of a river's potential as possible.

For purposes of comparison and as an aid in any future planning, identification was also made of all existing major hydroelectric facilities. All this information was plotted on a map of Idaho for quick and easy reference. This is shown in Figure 2, which is a map inserted in the map pocket at the end of the report. No attempt was made to identify pumped-storage sites where hydroelectric facilities might provide future development potential. It is known that the Portland Office of the U.S. Corps of Engineers has just completed such an evaluation for most of Idaho.

In screening done here, no attempt was made to eliminate locations where restraints such as a designation of the river as a national Wild and Scenic River would prohibit the building of a hydroelectric development. No attempt was made to apply restraints of social acceptability and environmental acceptability; this was left for a siting study where individual sites could be evaluated on the basis of the classification system developed in this research. From suggestions and requests being heard in public forums it appears that re-evaluation of hydroelectric potential should be made for the state in light of the expected increase in cost of power that will come to the state. To make this hydroelectric screening more usable, a plotting has also been made of all major existing hydroelectric facilities in the state.

<u>Geothermal Power Screening Criteria</u> - This screening only involved reviewing the work of the U.S. Geological Survey studies of classifying geothermal potential in Idaho. This is contained in the map on page 3 of a report entitled "Geothermal Investigations in Idaho, Part I, Geochemistry and Geological Siting of Selected Thermal Waters" published by the Idaho Department of Water Administration and the U.S. Geological Survey (Young and Mitchell, 1973). It is recognized that studies of geothermal potential are in progress in the Raft River Valley of Idaho and the technology for harnessing geothermal waters for power production is just beginning to evolve so any screening done now is very likely to change very much in the next few years. Likewise, it is anticipated that a thermal steam process is likely to be the mode of production that will prevail. Hence, the screening criteria in the next section on thermal power plants will apply to a considerable extent.

<u>Thermal Power Plant Screening</u> - This screening for siting thermal power plants is much more complex and can as evidenced in the extensive review of the literature be done in many different ways. In making an initial screening effort for Idaho the emphasis was directed primarily toward

the first classification of considerations the physical and technological feasibility. This was done because it was apparent that if these considerations were not met there was little reason to proceed further with the evaluation. In addition, this classification of considerations was found to be the one which had the most data and information available for making the screening. In making this initial screening it is recognized that other efforts have been going on such as the studies for locating the Pioneer Plant of Idaho Power Comapny, studies of Utah Power and Light Company, studies of Washington Water Power Company, and studies just completed of Washington Public Power Supply. This effort is as completely independent of these other efforts as is possible and hopefully is done for the entire state without any preconceived ideas that might have arisen from a company preference.

Four separate maps were prepared to delineate areas where it is unlikely that thermal power plants would be considered. Figure 3 is a map showing areas limited by the proximity of major population centers and availability of water for cooling. Population centers are defined as communities which are expected to have a population of 10,000 by 1980. Two restraints are shown on the map:

a) for safety and social acceptability, sites should be at least 4 miles from city limits. This limit is shown by the smaller inner circle around a town.

b) for social acceptability, sites should be 25 miles from city limits. This is shown by cross-hatching within the outer circle.

Note, in this case that by including Ontario, Oregon as part of an Ontario-Payette, Idaho as a population center, there could be identified an additional center, but it has not been shown on this map.

Analyses for the areas limited by water availability was limited by a definition of sources that was defined in a report by Leroy Heitz entitled "The Potential for Nuclear and Geothermal Power Plant Cooling in Idaho as Related to Water Resources", (Heitz, 1975). Those sources having sufficient quantity of water available are:

Coeur d'Alene Lake
Pend Oreille Lake
Dworshak Reservoir
Lucky Peak Reservoir
Arrowrock Reservoir
Kootenai River
Pend Oreille River
Spokane River

Coeur d'Alene River, lower
St. Joe River, lower
Clearwater River from Lewiston to Kamiah
Snake River from Palisades River to Hells Canyon Dam
Salmon River in Salmon Valley
Bear River and Bear Lake
Snake Plain Groundwater Aquifer

The extent of Snake River Aquifer was taken from the thesis studies of deSonneville, 1974. In this case Wild and Scenic Rivers were not considered as acceptable water sources. Availability was further limited by defining a restraint of pumping lift above which it was considered that it is unlikely that it would be economical and impractical. Two boundary lines of pumping lift limitation are shown on the map of Figure 3, 500-foot lift restraint and 1,000-foot lift restraint.

a) The solid line indicates the 1000-foot lift restraint above which pumping would be impractical (lightly shaded area)

b) The dashed line indicates the 500-foot lift restraint or a marginal zone of practicality. Darker shaded areas are between 500 and 1000 feet of apparent pump= ing lift.

A further restraint applied was pumping or conveyance distance. Specially labeled lines indicate restraint by distance being either 20 miles from a free water surface or the known aquifer of the listed sources or 10 miles from the groundwater aquifer.

Water in southeastern Idaho is highly appropriated for use, and thus restrained for use in thermal power plant cooling by existing water Rights. However, a 40,000 acre foot per year withdrawal right on the Bear River is possibly available as a result of negotiations between Utah Power and Light and the Idaho Department of Water Resources. This is the reason for including the Bear River, but not the Blackfoot River, Portneuf River, Blackfoot Reservoir and Gray's Lake.

This analysis has been influenced by talks with staff of Idaho Department of Water Resources and preliminary studies of water conservation possibilities suggested by the U.S. Soil Conservation Service. It does not try to delimit only in a very preliminary way the restraints that will be manifest by many complexities of water rights along the river sources mentioned. Likewise, the possibility of combining a pumped-storage operation and thermal power plant operation has not been considered.

Figure 4 represents a delineation of areas that would be considered practical from the availability of transportation facilities. The determining factor here was proximity of existing major transportation facilities and mild enough relief of topography to allow access.

a) The site must be within 30 miles of an existing railroad line or major highway (numbered state or federal system). The 30-mile limit was an arbitrary decision influenced by recognizing the cost of construction and problems of getting necessary right-of-way.

b) It was considered the site should be accessible by a 4% grade (the Mullan Pass grade). However, this restraint was not used to much extent. Relative steepness of terrain was used and most mountainous areas that rise steeply from valleys were considered impractical because of difficulty of finding suitable level land areas for construction.

The shaded area then defines areas considered unsuitable from a transportation availability consideration.

Figure 5 is a preliminary attempt to define the restraint of availability of suitable transmission facilities. Here it is recognized that if cost and limits of right-of-way problems were disregarded transmission facilities could probably be made available throughout the entire state. However, a practical limit does exist which in this case was based on a 50-mile distance to a major transmission line. Less area would be in the restrained area if power lines in Montana were considered. The power lines locations were determined from maps of the Washington Water Power Company, Western System Coordinating Council (1974) and the topographic maps of the U.S. Geological Survey and the U.S. Bureau of Land Management. Some confusion exists on lines in the southern part of the state and more refined field checking was not attempted. Shaded areas on the map indicate areas unsuitable from the standpoint of transmission availability.

Figure 6 deviates somewhat from the consideration of physical and technological feasibility as a criteria and involves the restraint of both social acceptability and environmental aspects. This map shows locations restrained by areas that have special uses that would make it impractical to locate power plants within these areas. The following areas are shown on the map.

TABLE 2

LISTING OF SPECIAL AREAS THAT HAVE BEEN IDENTIFIED FOR IDAHO

NATIONAL

Yellowstone National Park
Craters of the Moon National Monument
Sawtooth National Recreation Area
Hell's Canyon National Recreation Area
Selway-Bitterroot Wilderness
Idaho Primitive Area
Federally designated roadless areas (from: Roadless and Undeveloped Areas (Final Environmental Statement), Selection of Final New Study Areas from Roadless and Undeveloped Areas Within the National Forests, USDA-FS, October 1973)
Upper Priest Lake Scenic Area
Mallard-Larkins Scenic Area
Nez Perce National Historical Park
Wild & Scenic Rivers
- Middle Fork Salmon
- Middle Fork Clearwater-Selway-Lochsa
- Main Salmon (proposed)
- Bruneau (proposed)
- Priest (proposed)
- St. Joe (proposed)
- Moyie (proposed)
- Middle Snake (proposed)

Botanical Areas
- Hobo Cedar Grove
- Settlers Grove of Ancient Cedars

Nuclear Reactor Testing Station (I.N.E.L.)
Research Natural Areas

Shown	Unsure of Location
Bruneau R. Canyon	Bannock Creek
China Cup Butte	Bear Creek
Crater Rings	Canyon Creek
Jarbridge R. Canyon	Dautrich Mem.
Kipuka	Gunbarrel Creek
Salmon Falls Canyon	Idler's Rest
Snake R. Birds of Prey	Lowman
St. Anthony Dunes	Montford Creek
Teepee Creek	Upper Fishhook
Big Southern Butte	Aquarius (proposed)
West Fork Mink Creek	Lower Lochsa (proposed)
	Shoshone Creek (proposed)
	Owyhee River (proposed)

TABLE 2 (cont.)

Other RNA's or Proposed RNA's

City of Rocks (Gooding & Cassia)
Dry Cataracts
(Wapi Lava Field)
(Great Rift Nat'l Landmark)
Malm Gulch

MILITARY RESERVATIONS

Sailor Creek Aerial Gunnery Range
Idaho Army National Guard Artillery Range
(Farragut Naval Research Base)
Mountain Home Air Force Base

INDIAN RESERVATIONS

Fort Hall
Duck Valley
Nez Perce
Coeur d'Alene

STATE

Parks

Black Canyon
Bruneau Dunes
Dickinsheet
Farragut
Hammett
Henry's Lake
Heyburn
Indian Creek
Indian Rocks
Lucky Peak (Recreation Area)
Mann Creek (Recreation Area)
Mary Minerva McCroskey Memorial
Massacre Rocks
North Beach
Packer John's Cabin
Ponderosa
Round Lake
Three Island Crossing
Winchester

Myrtle Creek Game Preserve

CLASSIFICATION SYSTEM FOR DETAILED EVALUATION

Earlier in this section the viewpoints from which evaluations of energy plant siting might be considered were discussed. In this research it is idealistically contended that it would be desirable if a single and uniform system could be utilized to satisfy these different viewpoints of the various entities, the utilities, the planning agencies, the regulatory bodies, and the general public. This would hopefully minimize duplications of effort, would give a better basis for making the decision and minimize the collection of unneeded data. Moreover, it should have a more authoritative impact on all concerned. In considering usefulness, a single system would hopefully serve for evaluating all modes of production including hydropower, geothermal power, fossil fuel steam plants, and nuclear power plants. Naturally the importance of certain considerations and parameters would vary. To accomplish this implies that a very extensive educational program would be necessary to be sure that the entities understood the system of evaluation and treated various considerations in a like manner.

With this in mind, this research has centered on developing a system of criteria for evaluation that could be universally applied in the state of Idaho and may have general application throughout the nation. The approach assumes that the preliminary screening process has been accomplished and that there is a serious effort to try to compare different candidate sites for either new energy plants, transmission facilities, or other energy related facilities that will involve use or impact on land, people, and resources in the area. Naturally this implies that considerable data are available or obtainable, but certainly it should define the kinds of data that need to be obtained that have not been considered previously.

In introducing the system, a classification is made of the various criteria that should be considered in an energy plant site evaluation. The word criteria as used in this research represents a general term for information and data that would be useful in describing and evaluating energy plant siting. The criteria used have been grouped into four main titles. These titles are called considerations and are identified as follows: 1) Physical and Technical Feasibility, 2) Social Aspects, 3) Environmental Acceptability, and 4) Economic Feasibility. This subdivision of criteria is patterned to an extent from the system of accounts suggested by the Water Resources Council's Principles and Standards (U.S. Water Resources Council, 1973) and incorporates ideas gained from the extensive review of literature that has been presented earlier in this report. Thus the term "consideration" as used in this research is a specific term here used to describe the broadest classification of terms used in classifying energy plant siting criteria. In a lower order of hierarchial classification system for siting evaluation, the term "parameter" is used. Parameters are specific criteria terms used to identify sublevel items of the considerations. An example of how this would be referred to is shown below:

I. Physical and Technological Feasibility

A. Atmospheric Characteristics

B. Land Characteristics

C. Geology and Soils

D. Water Use and Control

E. Transportation Facilities

F. Energy Transmission

G. Reliability and Safety

H. Power Load Characteristics

For a further breakdown of the siting criteria a subclassification of the parameter would be factors for siting energy plants. Then the specific term "factor" is used to identify sublevel items under parameters. An example of these factors and their relation in the hierarchal system is shown below:

D. Water Use and Control

1. Water Quantity Availability
2. Water Quality
3. Flood Hazard

If it is desirable to have a finer breakdown than factors, it is suggested that the lowest level of the classification system be referred as a subfactor. The complete hierarchal system is presented in Table 3. This classification system was used in the matrix analyzing the various approaches that have been used in the reviewed studies and programs, and was presented as a part of the matrix of Table 1. This system then is suggested as a working array of energy plant siting criteria that should be used as the basis for siting evaluation.

Once these criteria have been accepted as the basis for evaluation, it becomes imperative to develop a system of measuring or expressing in a quantitative manner these criteria. An approach that is suggested for this is known as the factor profile analysis. The writer used this system in developing a means of classifying the characteristics of reservoirs and lakes (Milligan and Warnick, 1973). This approach is a way of assigning a numerical value between 0 and 10 to each factor used in describing or identifying the important aspects of the process. In this case the process is the arraying of energy plant siting criteria. The numerical value is termed an attribute number.

To illustrate this approach, the Water Use and Control parameter under the Physical and Technical Feasibility consideration has been

Table 3: Classification System for Energy Plant Siting Criteria

I. PHYSICAL & TECHNOLOGICAL FEASIBILITY

A. ATMOSPHERIC CHARACTERISTICS
1. STABILITY OF ATMOSPHERE
2. AIR QUALITY
3. TEMPERATURE & HUMIDITY

B. LAND CHARACTERISTICS
1. SIZE
2. SLOPE - ACCEPTABLE RELIEF
3. ORIENTATION

C. GEOLOGY & SOILS
1. SOILS
2. GEOLOGY
3. SEISMIC CHARACTERISTICS

D. WATER USE & CONTROL
1. WATER QUANTITY AVAILABILITY
2. WATER QUALITY
3. FLOOD HAZARD

E. TRANSPORTATION FACILITIES
1. HIGHWAY
2. RAILROAD
3. AIR TRANSPORTATION
4. WATER TRANSPORTATION

F. ENERGY TRANSMISSION
1. TRANSMISSION CAPABILITY
2. CORRIDORS FOR NEW FACILITIES
3. DISTANCE TO LOAD CENTERS

G. RELIABILITY & SAFETY
1. IMPACT OF POWER FAILURE
2. IMPACT OF CATASTROPHE
3. RADIOACTIVE WASTES
4. ASH & DEBRIS DISPOSAL
5. AIRBORNE POLLUTANTS

H. POWER LOAD CHARACTERISTICS
1. MAJOR LOADS
2. LOCATION & CONCENTRATION
3. PEAK CHARACTERISTICS
4. FUTURE GROWTH

II. SOCIAL ASPECTS

A. ACCEPTANCE BY INTEREST GROUPS
1. ENVIRONMENTAL GROUPS
2. CONSUMER GROUPS
3. DEVELOPMENTAL GROUPS
4. FARM GROUPS
5. INDIAN TRIBES
6. OTHER CONCERNED GROUPS

B. ACCEPTANCE BY GOVERNMENTAL UNITS
1. LOCAL & COUNTY GOVERNMENT
2. STATE GOVERNMENT
3. REGIONAL ENTITIES
4. FEDERAL GOVERNMENT

C. POPULATION CHARACTERISTICS
1. PROXIMITY TO POPULATION CENTERS
2. IMPACT DURING CONSTRUCTION
3. IMPACT FOLLOWING CONSTRUCTION

D. LAND USE CHARACTERISTICS
1. LAND USE PLANS & ZONING
2. PUBLIC LANDS
3. PRIVATE OWNERSHIP
4. INDIAN TREATY RIGHTS

E. OTHER SOCIAL ASPECTS
1. RECREATIONAL IMPACT
2. ARCHAEOLOGICAL, CULTURAL & HISTORICAL SITES

III. ENVIRONMENTAL ACCEPTABILITY

A. IMPACT ON OPEN SPACE AND NATURAL BEAUTY
1. RIVER ENVIRONMENT
2. LAKE ENVIRONMENT
3. GREEN BELTS
4. DESERT SCENES
5. MOUNTAIN VIEWS
6. LOCAL LANDSCAPES

B. IMPACT ON ANIMAL LIFE
1. PROTECTED SPECIES
2. BIG GAME SPECIES
3. SMALL GAME SPECIES
4. NON-GAME SPECIES
5. REPTILES & AMPHIBIANS
6. INSECTS (LAND)
7. DOMESTIC ANIMALS

C. IMPACT ON AQUATIC SYSTEMS
1. WATER FOWL
2. FISH
3. INVERTEBRATES
4. PLANT LIFE
5. INSECTS (AQUATIC)

D. IMPACT ON PLANT LIFE
1. TREES
2. NATIVE PLANTS
3. CULTIVATED PLANTS
4. LOWER FORMS

E. IMPACT ON PROTECTED AREAS
1. STATE PARKS
2. NATIONAL PARKS
3. WILDERNESS AREAS
4. WILDLIFE REFUGES
5. RESEARCH NATURAL AREAS
6. WILD & SCENIC RIVERS

IV. ECONOMIC FEASIBILITY

A. BENEFITS
1. BASE LOAD POWER
2. PEAK LOAD POWER
3. STANDBY RESERVE POWER
4. SECONDARY EFFECTS

B. COSTS
1. DIRECT COSTS
2. SECONDARY COSTS
3. COSTS OF OPPORTUNITIES FOREGONE
4. LEAST COST ALTERNATIVES

C. TAXES
1. TAX REVENUE GENERATED
2. COST OF REQUIRED SERVICES

D. IMPACT ON LOCAL ECONOMY
1. PRECONSTRUCTION
2. CONSTRUCTION
3. POST CONSTRUCTION

E. IMPACT ON NATURAL RESOURCES
1. RENEWABILITY
2. LONGEVITY OF RESOURCE
3. VALUE FOR COMPETING USES

chosen to present the idea as an example. This classification of the criteria as a parameter has been subdivided into three factors: 1) water quantity availability, 2) water quality aspects, and 3) flood hazard aspects. An attribute number is needed for each of the factors of the siting parameters. Assigning this number becomes then a part of the evaluation methodology and process. Guidelines and specifications for assigning attribute numbers that could be used by an experienced water resource expert are presented below.

Water Quantity Availability - The attribute number for this factor should be determined on the basis of: surface water of a quantity sufficient to support cooling needs for the size of plant under consideration, or groundwater of a quantity sufficient for cooling needs, with due regards for water rights constraints, and pumping lifts of reasonable magnitude and the water within reasonable conveyance distances. A suggested scaling specification with numerical ranges for determining an attribute are indicated in Table 4. Water use magnitudes for various sizes of plants that might be located in Idaho have been suggested by Heitz (Heitz, 1975). Technical assistance on this evaluation should be sought through the Idaho Department of Water Resources.

Water Quality Aspects - The attribute number for this factor is to be determined on the basis of the characteristics of the input water for cooling including fowling type of constituents and temperature of the water; and conditions of effluent water including opportunity of utilizing the thermally enriched water and the acceptability of the higher concentrations of dissolved ions in receiving water. A suggested scaling criteria with numerical value ranges for determining an attribute number are indicated in Table 5. Experienced water quality experts should be utilized in assigning a specific attribute number when considering specific sites.

Flood Hazard Aspects - The attribute number for this factor is to be determined on the basis of the characteristics of flood potential for the land area utilized in production or generation of energy, and flood hazard potential in other service areas such as access roads, transmission facilities, substations, and water conveyance systems. This is shown in Table 6. A hydrologist experienced in flood analysis should be utilized in assigning the attribute numbers in a specific evaluation comparing different candidate sites.

This approach can be a semigraphical evaluation representation at this point. Figure 7 is a draft of how the Water Use and Control parameter might be represented on a portion of a factor profile. The lengths of the bars represent a hypothetical evaluation that might have been made. Figure 8 gives a hypothetical representation of how a factor profile might appear covering all the criteria presented in the classification system that is suggested in this research.

TABLE 4

Rating Evaluation Guidelines for Water Quantity Availability Attribute Number for Energy Plant Siting Criteria Concerned with Water Use and Control Parameter as a Physical and Technological Feasibility Consideration.

Description of Guidelines	Numerical Value/s for Attribute Number
1. Site is situated where sufficient surface water is available for __MW plant, there is unappropriated water, conveyance distance is less than 1 mile, pumping lift is less than 20 feet.	8 - 10
2. Site is situated where sufficient groundwater is available for __MW plant, there is unappropriated water in non-critical groundwater area. Conveyance distance is less than 10 total miles, pumping lift is less than 50 feet.	6 - 8
3. Site is situated where surface water and groundwater reallocation in some years of use would provide water for __MW plant, there would need to be water rights adjustments; conveyance distances are less than 15 miles in total, pumping lift is less than 100 feet.	4 - 6
4. Site is situated where in dry years water supply may be limited from surface water and a reallocation of water use would be required each year, water rights problems would be complicated; conveyance distance would be greater than 15 miles, pumping lifts would be in range between 100 to 500 feet.	2 - 4
5. Site is situated unfavorable to obtaining surface water and groundwater, reallocation of use is very unlikely, water rights limitations restrict water availability, conveyance distances are greater than 30 miles, pumping lifts exceed 500 feet.	0 - 2

TABLE 5

Rating Evaluation Guidelines for Water Quality Aspects Attribute Number for Energy Plant Siting Criteria Concerned with Water Use and Control Parameter as a Physical and Technological Feasibility Consideration.

Description of Guidelines	Numerical Value/s for Attribute Number
1. Site is situated where source water has low bacteriological count, low chemical constituents known to fowl cooling systems, ambient temperature of source water rarely exceeds 65°F. No problem exists in disposing of effluent water.	8 - 10
2. Source water as minor water quality problem and will require minor treatment, ambient temperature of source water has upper limit of 72°F that may persist for several months, minor problems exist in disposing of effluent water.	5 - 8
3. Source water will require continuous treatment, ambient temperature of source water fluctuates widely and exceed 70°F considerable time definite problems exist in disposing of effluent water.	2 - 5
4. Source water will be very difficult and expensive to treat, water temperature is very high, serious problems exist in disposing of effluent water.	0 - 2

TABLE 6

Rating Evaluation Guideline for Flood Hazard Aspects of Attribute Number for Energy Plant Siting Criteria Concerned with Water Use and Control Parameter as a Physical and Technological Feasibility Consideration.

Description of Guideline	Numerical Value/s for Attribute Number
1. Plant site is on high ground with no flood danger, transmission lines, substations, access roads and water conveyance all located out of flooding zones.	8 - 10
2. Plant site is on high ground with no flood danger, correctible action can be taken on minor flood hazards of transmission lines, substations, access roads, and water conveyance system.	6 - 8
3. Plant site will require minor flood proofing and flood proofing will be required in locating most of the facilities for transmission, substations, access roads and water conveyance system.	4 - 6
4. Plant site will require flood proofing some drainage and major flood control will be required on all facilities for transmission; substation, access roads and water conveyance system.	2 - 4
5. Plant site and all facilities will require major flood control to correct flood hazard.	0 - 2

FIGURE 7

Sample Factor Profile for the Attribute Numbers of the Water Use and Control Parameter and Factors for an Energy Plant Siting Evaluation.

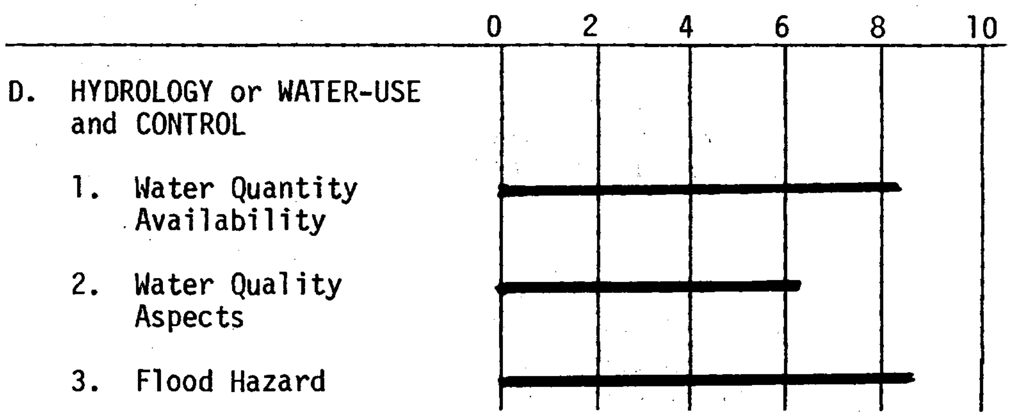
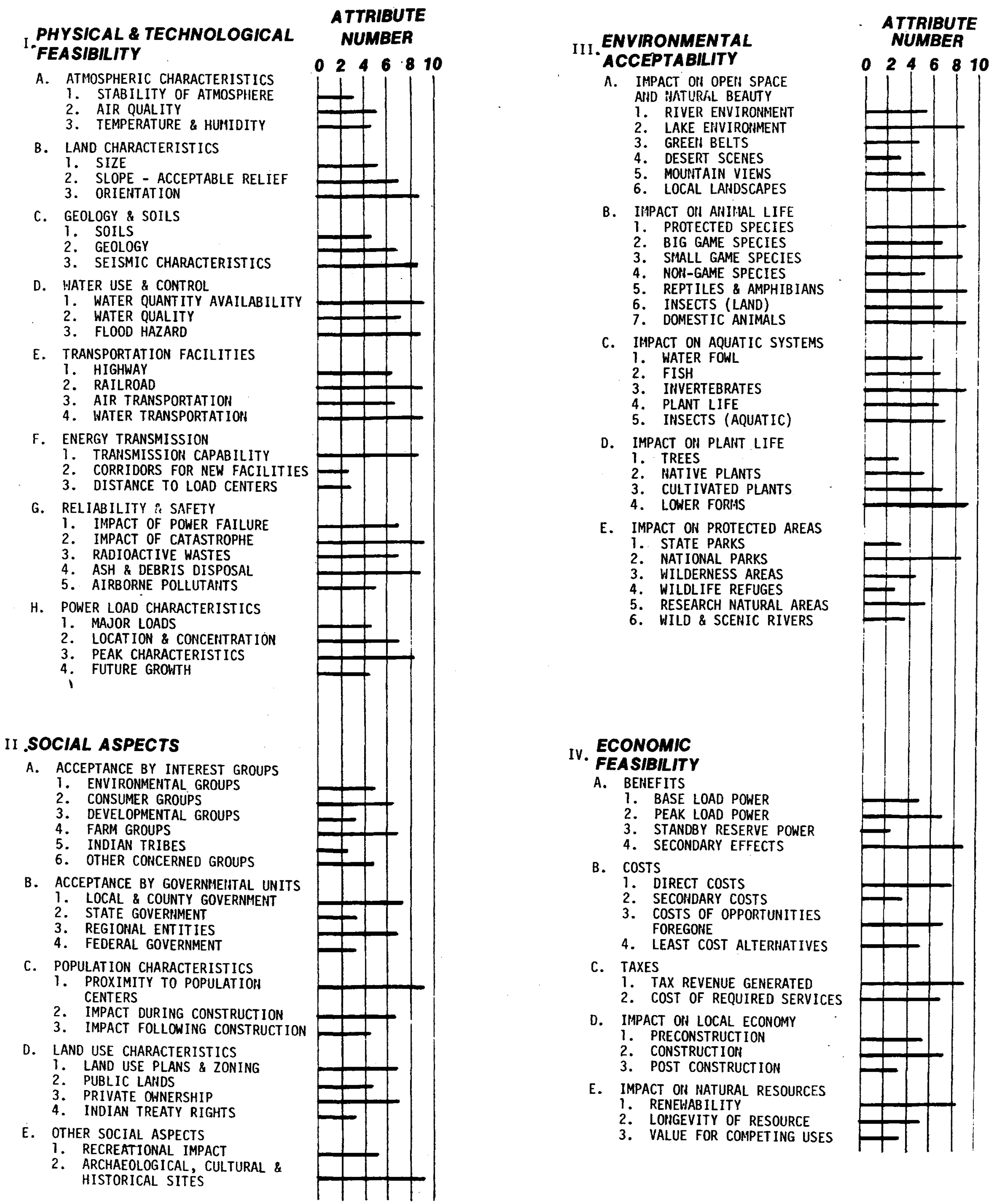


Figure 8: Sample Factor Profile for Energy Plant Siting Criteria



Here it should be pointed out that each factor of the criteria has been treated as an independent term and it may appear that the simple additive total of all these parameters might represent a aggregated number for making an evaluation. It should be recognized that not all the terms are completely independent and certainly the various considerations, parameter and factors have varying importance or weight in the evaluation process. This brings out the need for a ranking procedure for giving different weights to the importance of various criteria used in an siting evaluation process. The next section treats that topic.

This research has not proceeded to the stage of developing the guidelines for assigning attribute numbers or scalings for all the factors used in the system proposed. It should be obvious that this will require an interdisciplinary team to develop these guidelines and must be done with the particular region or area for which evaluation is to be applied. Likewise it may require modification for different modes of production being proposed for development in the state or region.

The classification system as put forth in Table 3 and the further elaboration of it in a factor profile display as depicted in Figure 8 do represent a unifying approach to energy plant siting that could be used to at least prepare a check list and to attempt to measure each item of that list in an evaluation of a site or sites.

PROBLEMS OF RANKING ENERGY PLANT SITES

It is not obvious that selection of energy plant sites is a decision process of ranking the various alternatives. However, from the very beginning of siting evaluations there appears to be a ranking and rating process in progress. Most of the time it is probably quite subjective. Important questions are who should do it and when should it be done? If we reflect back to the previous section on evaluation methodology it is apparent that utilities, the public planning agencies, the regulatory bodies, and the general public all probably express a ranking of relative preference for alternate energy plant sites. This research would indicate that it would be wise to try to get some kind of standardization in articulating that ranking.

It is contended that if the evaluation methodology has identified the criteria appropriately and then that there has been a careful and objective attempt to measure the characteristics of the various considerations, parameters and factors, hopefully, then a more logical ranking of energy plant sites alternatives can be made. Many times in making the ranking it is articulated only in a session where oral expression is made. For records and for analyses purposes it would appear wise to develop a more formal process of ranking and rating. In answer to the first part of the question of who should rank the siting preferences, it is contended all the viewpoints should be articulated. The timing of when ranking should be done is not so easy to answer because the ranking gets intermeshed with the screening process. However, it does appear wise to carry the evaluation process along on several alternate sites to provide enough information to be assured that all reasonable opportunities have been considered.

In this research a workshop was conducted in which a portion of the time was devoted to an attempt to develop better methods for making rankings. The system of classification proposed in this research was used as a basis for the ranking process and that classification system was discussed and revised to respond to the group's recommendations. First a copy of the classification system was presented to selected experts who had what were considered to be a reasonable acquaintance with the problem and good qualifications for rendering a decision. One group of faculty members from Idaho State University made a ranking of preference of the importance of the four major considerations without benefit of discussion and merely made a selection of preference ranking with a minimum of training or attempting to come to a concensus on what was reasonable.

The participants in the workshop that was held on the campus of the University of Idaho January 7-8, 1976 are indicated in Table 7.

TABLE 7

Participants in Energy Plant Siting Workshop with
Affiliation, Professional Background, and Home Address

Name	Affiliation	Professional Field	Residence
Robert Anderson	Wash. Water Power Co.	Elec. Engr.	Spokane, Wa
Robert Blank	Univ. of Idaho	Polit. Sci.	Moscow, Id
George Belt	Univ. of Idaho	Forest Sci.	Moscow, Id
Gomer Conditt	Idaho Power Co.	Elec. Engr.	Boise, Id
David Fortier	Canyon Devel. Council	Civil Engr.	Caldwell, Id
Maynard Fosberg	Univ. of Idaho	Soil Sci.	Moscow, Id
John Gladwell	Univ. of Idaho	Civil Engr.	Moscow, Id
Harry Haycock	Utah Power & Light	Elec. Engr.	Salt Lake City, Utah
Verl King	Idaho Dept. of Water Resources	Agr. Engr.	Boise, Id
James Kuska	Univ. of Idaho	Landsc. Arch.	Moscow, Id
Paul Mann	Univ. of Idaho	Elec. Engr.	Moscow, Id
Peter Meserve	Univ. of Idaho	Biologist	Moscow, Id
Fred Rose	Idaho St. Univ.	Biologist	Pocatello, Id
Nancy Savage	Univ. of Idaho	Biologist	Moscow, Id
Carl Savage	Id. Bureau of Mines	Geologist	Moscow, Id
David Tillson	Wash. Public Power Supply System	Engr. Geol.	Richland, Wa
Calvin Warnick	Univ. of Idaho	Civil Engr.	Moscow, Id
Kathleen Warnick	Idaho League of Women Voters	Home Econ.	Moscow, Id
Russell Withers	Univ. of Idaho	Ag. Econ.	Moscow, Id
James VanLeuven	Univ. of Idaho	Journalist	Moscow, Id
Ian VanLindern	Idaho Dept. of Health & Welfare	Biologist	Coeur d'Alene, Id

This was a mixture of academic people, utility representatives, agency representatives and participants from the public sector. The table gives information on the participants affiliation, professional field, and residence. It is contended that it is a group that should be able to make a good judgment and hopefully could be said to be representative of a spectrum of people that would articulate a fair ranking.

Information on energy plant siting criteria and a draft of the classification system for energy plant siting was sent out to prospective participants of the workshop and they were asked to make a ranking or weighting of the relative value they would place on the four different considerations proposed for evaluation classification in this research. The only instruction given was the summary information sent out and a brief statement on the sample ranking form. The sample ranking form is shown in Table 8. Only ten of these prospective participants completed forms, because several of the participants said they could not do it or were not ready to commit themselves. After some discussion at the workshop of the evaluation criteria, and presentations on the screening process, the participants were asked to complete the forms. Following this the group was divided into four groups and they were asked to either by vote or by concensus come up with a group rating. Table 9 shows the results of the workshop efforts to arrive at a weighting or ranking of principal considerations that might be used in a siting evaluation that would involve alternate sites. This assumes that there is need for the energy plant and that there are several suitable sites that can and should be compared. It does not assume that the physical and technological feasibility has been ranked, but information is available on the various parameters and factors that compose the physical and technological feasibility considerations. Note, in the workshop slightly different titling of the principal considerations was used than appears in Table 3.

In analyzing the results it is quite obvious that the range of weights was much greater when the respondents had not discussed the problem of energy plant siting evaluation. It is apparent that the group of professors from Idaho State University expressed a marked preference for the environmental consideration being higher than the engineering (physical and technological) feasibility and the economic feasibility. This was expected because they would normally be considered to have more idealistic views. In noting changes in magnitude of mean values and range of values of preference points allocated to the principal considerations it appears that as evaluators become more familiar with all the considerations, the tendency is to lower the weightings on the environmental considerations and probably tend to approach an equality between the four considerations.

The writer noted that those representatives from utilities before the workshop indicated the rating system was not realistic, but after working with the group it seemed apparent the utility representatives were willing to concede some value in the ranking exercise.

TABLE 8

Sample of Form Used to Obtain Rankings of Preference for Principal Considerations in Energy Plant Siting Evaluation.

Considerations	Your Rating	Sample Rating
I. Engineering and Physical Feasibility		50
II. Social Acceptability		800
III. Environmental Acceptability		20
IV. Economic Feasibility		130
TOTAL	1000	1000

If given 1000 points to divide among the major plant-siting considerations on the basis of relative importance, how would you distribute the 1000 points? Shown is one way it could be done. See Working Draft Document for explanation and more detail on methodology and the system of classification of criteria for siting energy plants in Idaho.

TABLE 9

Results of Weighting Evaluations for Principal Energy Plant Siting Considerations as Produced by WR-Siting Methodology Workshop.

	Pre-Workshop Response						Workshop Participant Response					
	Id. State U. Profs.			Prospective Workshop Participants			Individuals Without Discussion			Group Concensus with Discussion		
	11 respondents			10 respondents			19 participants			4 groups		
CONSIDERATION	Median	Mean	Range	Median	Mean	Range	Median	Mean	Range	Median	Mean	Range
Engineering	175	157	300 / 50	250	225	400 / 0	300	297	500 / 0	300	285	300 / 240
Social	200	236	400 / 100	225	275	400 / 100	200	205	400 / 50	273	215	250 / 165
Environmental	400	416	750 / 250	325	332	750 / 100	200	209	400 / 100	213	231	350 / 150
Economic	200	191	300 / 100	150	168	350 / 50	300	288	500 / 100	302	269	370 / 100

The numbers represent the number of points out of 1000 that would be assigned to a weighting for particular siting considerations.

It is recognized that in no classification will we get complete independence of considerations. It is admitted that the physical and technological feasibility is often greatly influenced by the economic feasibility consideration.

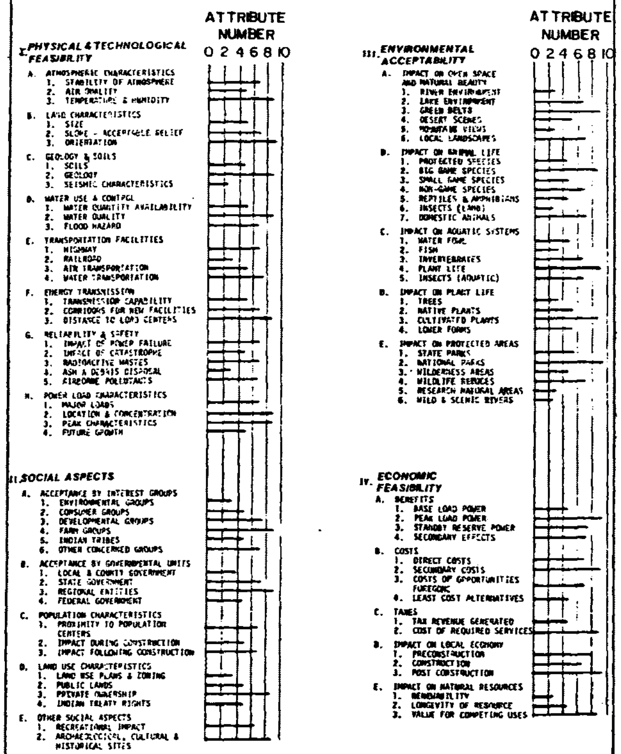
The workshop proved valuable as a training experience and gave an opportunity to get interdisciplinary input into the evaluation process. It would appear that a similar ranking could be done within a utility company utilizing various staff members and executives to arrive at a energy plant site selection or ranking of sites. Likewise, the procedure could be used by a regulatory agency that is required to make a selection. The experience in this research indicates there are shifts of ranking weights when discussion of the considerations, parameter, and factors are presented in an objective appraisal. Additional valuable research might be done to characterize preferences of ranking with regard to professional background, affiliation, educational level, income level, and other population characteristics. Needed also is how these evaluation rankings might change with time. What is needed is a system in which it is understood how the ranking varies with individual characteristics of the evaluator and hopefully a rating that does not change very much with time.

A suggestion is here made for how the factor profile evaluation technique and a ranking weighting could be used to develop a final numerical evaluation which would sum the characteristic values of all the factors, parameters and considerations and give one numerical siting number. This is shown in flow diagram as Figure 9.

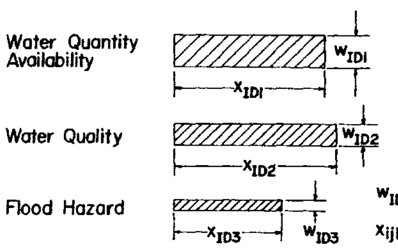
This implies that there has first been an evaluation made of each factor in the classification system and an attribute number has been assigned to each factor. Note that then a weighting coefficient (the width of the bar) must be assigned to each factor that composed a given siting parameter, then a weighting coefficient must be assigned each parameter that is part of a given siting consideration, and finally a weighting coefficient must be assigned to each of the four principal considerations that make up a complete evaluation system. The workshop gave an example of how weighting coefficients might be obtained. Assigning these weighting coefficients should give flexibility in the evaluation procedure and methodology and at the same time provide opportunity for a political process to become operative. Further interesting research might be to do a post-selection study of a site selection that has been made trying to determine in a systematic and quantitative way how was the selection made, and could there be weighting coefficients developed that would reflect the same results that were arrived at in the real selection process. Or a sensitivity analysis might be made to see what effect varying weighting coefficients might have on the composite siting number.

Figure 9. Flow Diagram of Procedure for Ranking and Weighting Energy Plant Siting Criteria

FACTOR PROFILE FOR ENERGY SITING CRITERIA



EXAMPLE OF WEIGHTING PARAMETER FACTORS I_D WATER USE AND WATER CONTROL



$W_{ID1} + W_{ID2} + W_{ID3} = 1$

x_{ijk} [0→10]

The width of the bar represents the weighting coefficient or preference function indicating the relative importance of each of the factors that compose a particular parameter, in this case the Water Use and Water Control parameter. The length of the bar x_{ijk} is the attribute number as measured from the scale of guidelines provided for in the factor profile. These values for each factor are between 0 and 10 in magnitude. A value of 10 would imply perfect suitability for siting an energy plant. See Figure 8 for attribute number tabulation.

A numerical evaluation for a particular parameter is obtained by summing up the area of the bars.

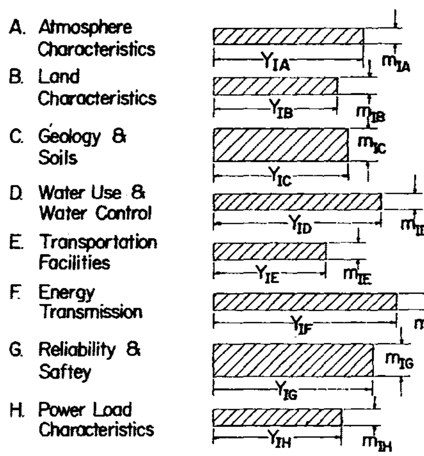
$$Y_{ij} = \Sigma x_{ijk} w_{ijk} \text{ or for the above example}$$

$$Y_{ID} = x_{ID1} w_{ID1} + x_{ID2} w_{ID2} + x_{ID3} w_{ID3}$$

This weighting must be done for each factor under each parameter and again done for each parameter under each consideration.

EXAMPLE OF WEIGHTING CONSIDERATION PARAMETERS

I Physical and Technological Feasibility



A numerical evaluation for a particular consideration is obtained by summing in the equation below:

$m_{IA}+m_{IB}+m_{IC}+m_{ID}+m_{IE}+m_{IF}+m_{IG}+m_{IH} = 1$

Y_{ij} [0→10]

The width of bar m_{ij} represents the weighting coefficient or preference function indicating the relative importance of each of the parameters that compose a particular consideration, in this case Physical and Technological consideration. The length of the bar Y_{ij} is the weighted average of the attribute numbers from factors that compose a particular parameter.

$$Z_Z = \frac{1}{N}[Y_{IA}m_{IA} + Y_{IB}m_{IB} + Y_{IC}m_{IC} + Y_{ID}m_{ID} + Y_{IE}m_{IE} + Y_{IF}m_{IF} + Y_{IG}m_{IG} + Y_{IH}m_{IH}]$$

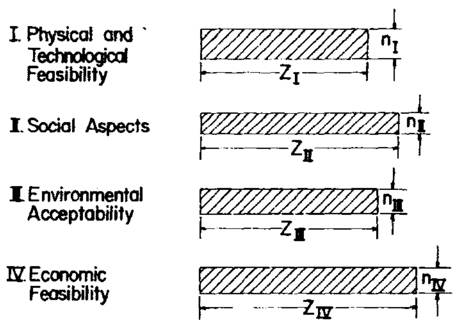
where N is the number of parameters under a given consideration

EXAMPLE OF WEIGHTING SITING CONSIDERATIONS

A numerical evaluation of a composite number here termed a siting number S is obtain by the following equation:

The width of the bar n_i represents the weighting coefficient or preference function indicating the relative importance of each of the major considerations that forms the basis for the siting decision. In the Energy Siting Workshop $n_I = 0.285$, $n_{II} = 0.215$, $n_{III} = 0.231$ and $n_{IV} = 0.269$. The length of the bar Z is the weighted average of the numerical evaluation made for all the parameters that compose a particular consideration.

$$S = Z_I n_I + Z_{II} n_{II} + Z_{III} n_{III} + Z_{IV} n_{IV}$$



$n_I + n_{II} + n_{III} + n_{IV} = 1$

Z_i [0→10]

ANALYSIS OF NEEDS FOR POLICY REGULATIONS AND LEGISLATION ON ENERGY PLANT SITING IN IDAHO

Recent attempts in the Idaho Legislature have been made to enact or revise statutes concerned with energy plant construction certification. This is evidenced in House Bill No. 50, First Regular Session, Forty-Third Legislature of 1975 and Senate Bill No. 1401, Second Regular Session, Forty-Third Legislature of 1976. Present authorization for regulation of energy plant siting is embodied primarily in Section 61-526 Idaho Code which states in part the following.

> *"No street railroad corporation, gas corporation, electrical corporation, telephone corporation or water corporation, shall henceforth begin the construction of a street railroad, or of a line, plant, or system or of any extension of such street railroad, or line, plant, or system, without having first obtained from the commission a certificate that the present or future public convenience and necessity require or will require such construction: provided, that this section shall not be construed to require such corporation to secure such certificate for an extension within any city or county, or city or town, within which it shall have theretofore lawfully commenced operation, or for an extension into territory whether within or without a city or county, or city or town, contiguous to its street railroad, or line, plant or system, and not theretofore served by a public utility of like character, or for an extension within or to territory already served by it necessary in the ordinary course of its business: and provided further, that if any public utility in constructing or extending its lines, plant or system, shall interfere or be about to interfere with the operation of the line, plant or system of any other public utility already constructed, the commission on complaint of the public utility claiming to be injuriously affected may, after hearing, make such order and prescribe such terms and conditions for the locating of the line, plant or system affected as to it may seem just and reasonable . . ."*

This section of the code does not appear to be specific enough and certainly does not make mandatory times for action or extent of evaluation procedures with respect to environmental aspects of siting. The writer through this project research with P.J. Rassier made an analysis of House Bill No. 50 and earlier drafts of Idaho legislation in a report made earlier (Warnick and Rassier, 1975, and Rassier, 1975). The report by Warnick and Rassier contains a good summary of important legislation from surrounding states.

Both of these bills mentioned above were not enacted, being left in committee. This leaves the utilities and existing government entities with a somewhat undefined responsibility in Idaho.

Study of the policy and legislative problems leads to a strong belief that there is need for the following:

1. A sustained system of financing the regulatory and planning aspects of energy plant siting, with support for financing based on those who use the energy.

2. An assurance that energy utilities of the state can proceed with their planning and construction of facilities in an orderly and timely manner without being disrupted by extended lawsuits and excessive public objection.

3. A means of getting diversity of viewpoint into both the planning process and the decision making process and at the same time provide for harmonious interplay of the functioning of all agencies of government which have assigned responsibilities. This would require that there be a single entity, such as the Public Utility Commission, assigned to have overall responsibility.

4. Provisions are needed for keeping the public informed and for giving opportunity to the public to give input into the planning and decision making processes.

5. Provisions are needed in the evaluation process for the siting of energy plants to take due regard to environmental impact and social impact of the particular siting situations. This implies that qualified people must be employed in the planning, the review and the regulatory phases of the siting process.

In addition to the above, the recent legislative attempts have also indicated there is need to define what is being done to conserve on energy use and define the possible future impact of that conservation on energy plant siting needs.

Hopefully, new legislation and agency regulations will be developed soon to meet these needs.

CONCLUSIONS AND RECOMMENDATIONS

Study of energy plant siting for Idaho has permitted review and analysis of an extensive group of studies, guidelines and programs being carried out in neighboring states and throughout the nation. This has led to the conclusion that there is needed a more systematic and uniformly applied system of evaluation on which to base siting of energy plants to be located in Idaho. Such a system has been prepared and tested at a workshop. This system is initially introduced in a classification system in Table 3.

The methodology for energy plant siting was further studied to try to arrive at a procedure for evaluation that might serve the needs of utilities, public planning agencies, regulatory bodies, and the general public.

A suggested procedure includes the following:

1. A preliminary screening or exclusion process to locate areas that might be suitable for siting energy plants from a broad basis of criteria for selection,

2. Use of a factor profile system to measure each criteria used in the evaluation of particular sites,

3. A ranking or rating of the criteria in a systematic manner following a consistent procedure utilizing decision makers at various levels and having various viewpoints.

This study has developed a preliminary screening of areas suitable for locating energy plants. This information is contained in a series of maps and should be useful as basis for future planning. This should not be taken as the final word, but will need updating as conditions change within the state.

The factor profile approach is highly recommended as a means of objectively pursuing the siting evaluation process. This needs further development and research by professionals in various areas of expertise to develop the guidelines for assigning attribute numbers to each of the factors that make up the list of criteria proposed in the classification system. An example system of how the factor profile technique can be used has been worked out for the water use and water control parameter.

A graphical and mathematical procedure has been developed for making rankings of groups of factors, groups of parameters and four main siting considerations that can be used in ranking energy plant siting criteria. This procedure is shown in Figure 9, and uses the basic classification system of Table 3. The weighting coefficients can be assigned by the decision makers. The energy plant siting workshop held on the campus used different techniques of making these rankings that could be used in arriving at weighting coefficients and ranking approaches. Utilizing a group of people will strengthen the ranking to be sure that a particular bias is not overweighted or underweighted.

A brief study of legislation being introduced within Idaho and statutes that have already been passed in surrounding states would indicate there is need for better definition of the role of government in energy plant siting for Idaho. In the realm of legislation and policy regulation it is concluded there is need for a sustained system of financing of planning and regulatory aspects of energy plant siting, statutory or regulatory procedures that will assure orderly and timely planning and construction of needed facilities, a means of getting diversity of viewpoint into the decision process and yet harmonious interplay of all agencies and entities having responsibility of energy plant siting, and more specific language as to the evaluation with respect to environmental impact and social impact of particular energy plant siting situations. Following the ideas presented in the classification system proposed in this study should do much toward providing a basis for better legislation and more definitive regulations.

Related to the siting problem is the need to define an explicit energy conservation program by government and the private sector. This can influence very much the timing and need for new energy facilities and at present the impact of energy conservation is very much unknown.

One important conclusion is the need to have more uniformity in approaches to evaluation and to have appropriate public involvement. This implies the need for more education of the various groups involved. It is highly recommended that effort in the form of workshops and conferences be developed to bring the results of this research to various groups in the state.

Another recommendation is made that ideas presented in this research be tested in studies where actual siting studies might be reviewed applying the techniques proposed for evaluation and ranking.

As a minimum it is recommended that the classification system proposed in this research be used as a check list by utilities, public agency planners, regulatory agencies, and the general public in considering what criteria should be used in future energy plants within the state of Idaho.

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Figure 2

STATE OF IDAHO

POTENTIAL AREAS FOR ENERGY PLANT SITING

DEVELOPED AND POTENTIAL HYDROELECTRIC SITES

1975

Idaho Water Resources Research Institute

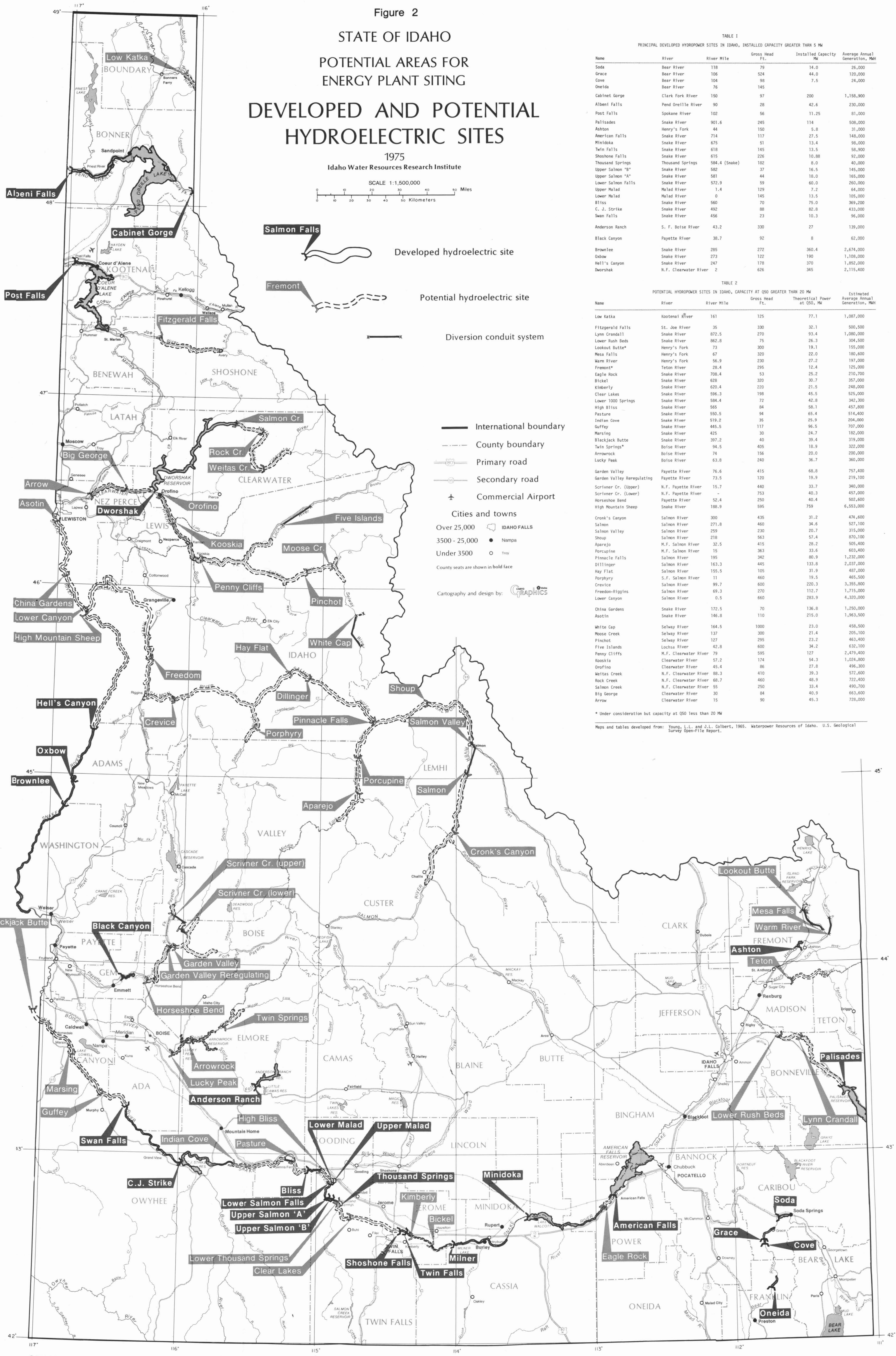

TABLE I

PRINCIPAL DEVELOPED HYDROPOWER SITES IN IDAHO, INSTALLED CAPACITY GREATER THAN 5 MW

Name	River	River Mile	Gross Head Ft.	Installed Capacity MW	Average Annual Generation, MWH
Soda	Bear River	118	79	14.0	26,000
Grace	Bear River	106	524	44.0	120,000
Cove	Bear River	104	98	7.5	24,000
Oneida	Bear River	76	145		
Cabinet Gorge	Clark Fork River	150	97	200	1,158,900
Albeni Falls	Pend Oreille River	90	28	42.6	230,000
Post Falls	Spokane River	102	56	11.25	81,000
Palisades	Snake River	901.6	245	114	508,000
Ashton	Henry's Fork	44	150	5.8	31,000
American Falls	Snake River	714	117	27.5	148,000
Minidoka	Snake River	675	51	13.4	98,000
Twin Falls	Snake River	618	145	13.5	58,900
Shoshone Falls	Snake River	615	226	10.88	92,000
Thousand Springs	Thousand Springs	584.4 (Snake)	182	8.0	40,000
Upper Salmon "B"	Snake River	582	37	16.5	145,000
Upper Salmon "A"	Snake River	581	44	18.0	165,000
Lower Salmon Falls	Snake River	572.9	59	60.0	260,000
Upper Malad	Malad River	1.4	129	7.2	64,000
Lower Malad	Malad River	0	145	13.5	105,000
Bliss	Snake River	560	70	75.0	369,200
C. J. Strike	Snake River	492	88	82.8	433,000
Swan Falls	Snake River	456	23	10.3	96,000
Anderson Ranch	S. F. Boise River	43.2	330	27	139,000
Black Canyon	Payette River	38.7	92	8	62,000
Brownlee	Snake River	285	272	360.4	2,674,000
Oxbow	Snake River	273	122	190	1,108,000
Hell's Canyon	Snake River	247	178	370	1,852,000
Dworshak	N.F. Clearwater River	2	626	345	2,115,400

TABLE 2

POTENTIAL HYDROPOWER SITES IN IDAHO, CAPACITY AT Q50 GREATER THAN 20 MW

Name	River	River Mile	Gross Head Ft.	Theoretical Power at Q50, MW	Estimated Average Annual Generation, MWH
Low Katka	Kootenai River	161	125	77.1	1,087,000
Fitzgerald Falls	St. Joe River	35	330	32.1	500,500
Lynn Crandall	Snake River	872.5	270	93.4	1,080,000
Lower Rush Beds	Snake River	862.8	75	26.3	304,500
Lookout Butte*	Henry's Fork	73	300	19.1	155,000
Mesa Falls	Henry's Fork	67	320	22.0	180,600
Warm River	Henry's Fork	56.9	230	27.2	197,000
Fremont*	Teton River	28.4	295	12.4	125,000
Eagle Rock	Snake River	708.4	53	25.2	210,700
Bickel	Snake River	628	320	30.7	357,000
Kimberly	Snake River	620.4	220	21.5	248,000
Clear Lakes	Snake River	596.3	198	45.5	525,000
Lower 1000 Springs	Snake River	584.4	72	42.8	342,300
High Bliss	Snake River	565	84	58.1	457,800
Pasture	Snake River	550.5	94	65.4	514,400
Indian Cove	Snake River	519.2	35	25.9	204,000
Guffey	Snake River	445.5	117	96.5	707,000
Marsing	Snake River	425	30	24.7	182,000
Blackjack Butte	Snake River	397.2	40	39.4	319,000
Twin Springs*	Boise River	94.5	405	18.9	322,000
Arrowrock	Boise River	74	156	20.0	200,000
Lucky Peak	Boise River	63.8	240	36.7	360,000
Garden Valley	Payette River	76.6	415	68.8	757,400
Garden Valley Reregulating	Payette River	73.5	120	19.9	219,100
Scrivner Cr. (Upper)	N.F. Payette River	15.7	440	33.7	340,000
Scrivner Cr. (Lower)	N.F. Payette River	-	753	40.3	457,000
Horseshoe Bend	Payette River	52.4	250	40.4	502,600
High Mountain Sheep	Snake River	188.9	595	759	6,553,000
Cronk's Canyon	Salmon River	300	435	31.2	474,600
Salmon	Salmon River	271.8	460	34.6	527,100
Salmon Valley	Salmon River	259	230	20.7	315,000
Shoup	Salmon River	218	563	57.4	870,100
Aparejo	M.F. Salmon River	32.5	415	28.2	505,400
Porcupine	M.F. Salmon River	15	363	33.6	603,400
Pinnacle Falls	Salmon River	195	342	80.9	1,232,000
Dillinger	Salmon River	163.3	445	133.8	2,037,000
Hay Flat	Salmon River	155.5	105	31.9	487,000
Porphyry	S.F. Salmon River	11	460	19.5	465,500
Crevice	Salmon River	99.7	600	220.3	3,355,800
Freedom-Riggins	Salmon River	69.3	270	112.7	1,715,000
Lower Canyon	Salmon River	0.5	660	283.9	4,320,000
China Gardens	Snake River	172.5	70	136.8	1,250,000
Asotin	Snake River	146.8	110	215.0	1,963,500
White Cap	Selway River	164.5	1000	23.0	458,500
Moose Creek	Selway River	137	300	21.4	205,100
Pinchot	Selway River	127	295	23.2	463,400
Five Islands	Lochsa River	42.8	600	34.2	632,100
Penny Cliffs	M.F. Clearwater River	79	595	127	2,479,400
Kooskia	Clearwater River	57.2	174	54.3	1,024,800
Orofino	Clearwater River	45.4	86	27.8	496,300
Weitas Creek	N.F. Clearwater River	88.3	410	39.3	572,600
Rock Creek	N.F. Clearwater River	68.7	460	48.9	722,400
Salmon Creek	N.F. Clearwater River	55	250	33.4	490,700
Big George	Clearwater River	30	84	40.9	663,600
Arrow	Clearwater River	15	90	45.3	728,000

* Under consideration but capacity at Q50 less than 20 MW

Maps and tables developed from: Young, L.L. and J.L. Colbert, 1965. Waterpower Resources of Idaho. U.S. Geological Survey Open-File Report.

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Figure 3

STATE OF IDAHO

POTENTIAL AREAS FOR ENERGY PLANT SITING

COMBINED WATER AVAILABILITY AND POPULATION PROXIMITY RESTRAINTS

Thermal Power Plants

1975

Idaho Water Resources Research Institute

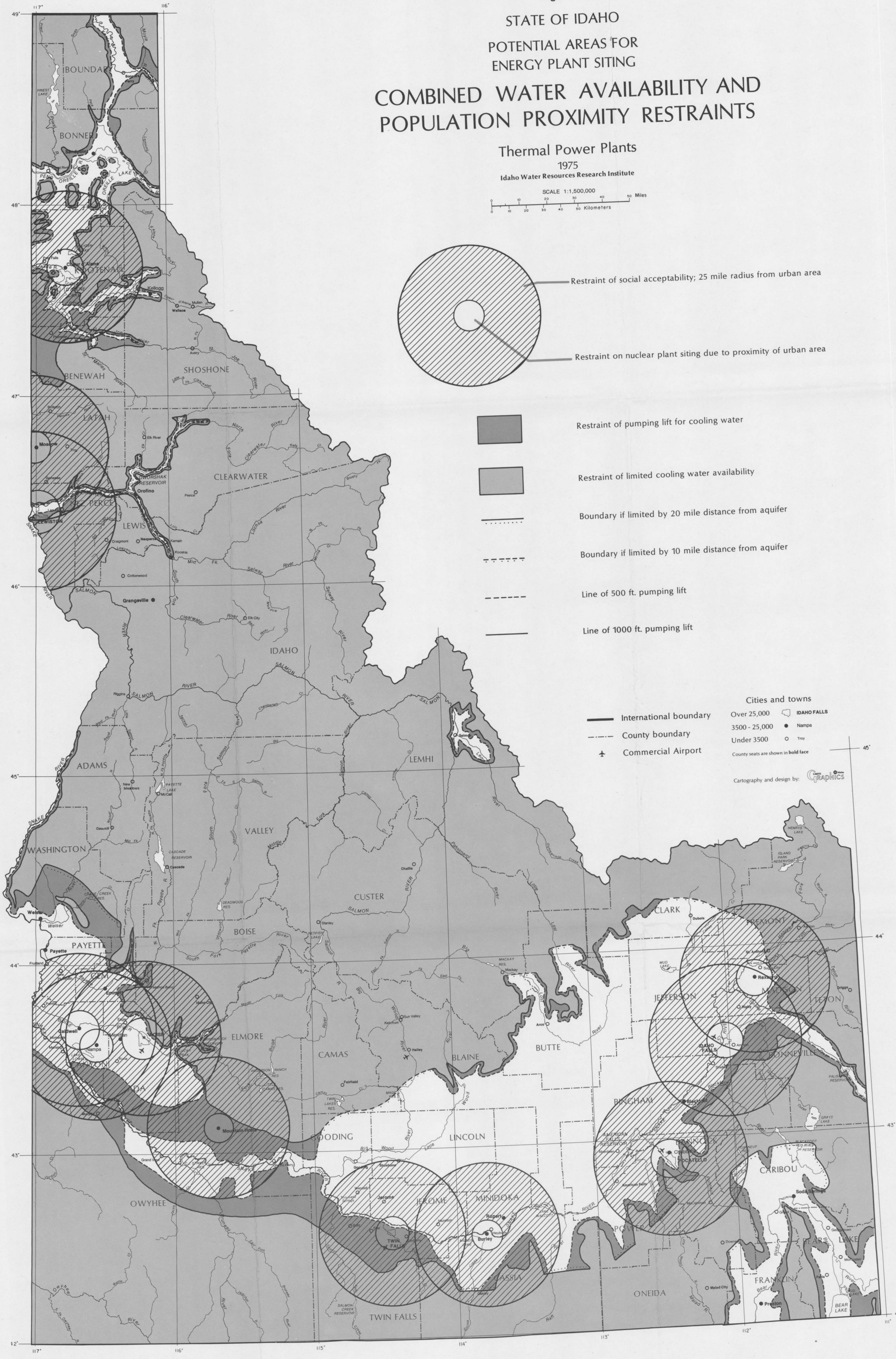

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Figure 4

STATE OF IDAHO

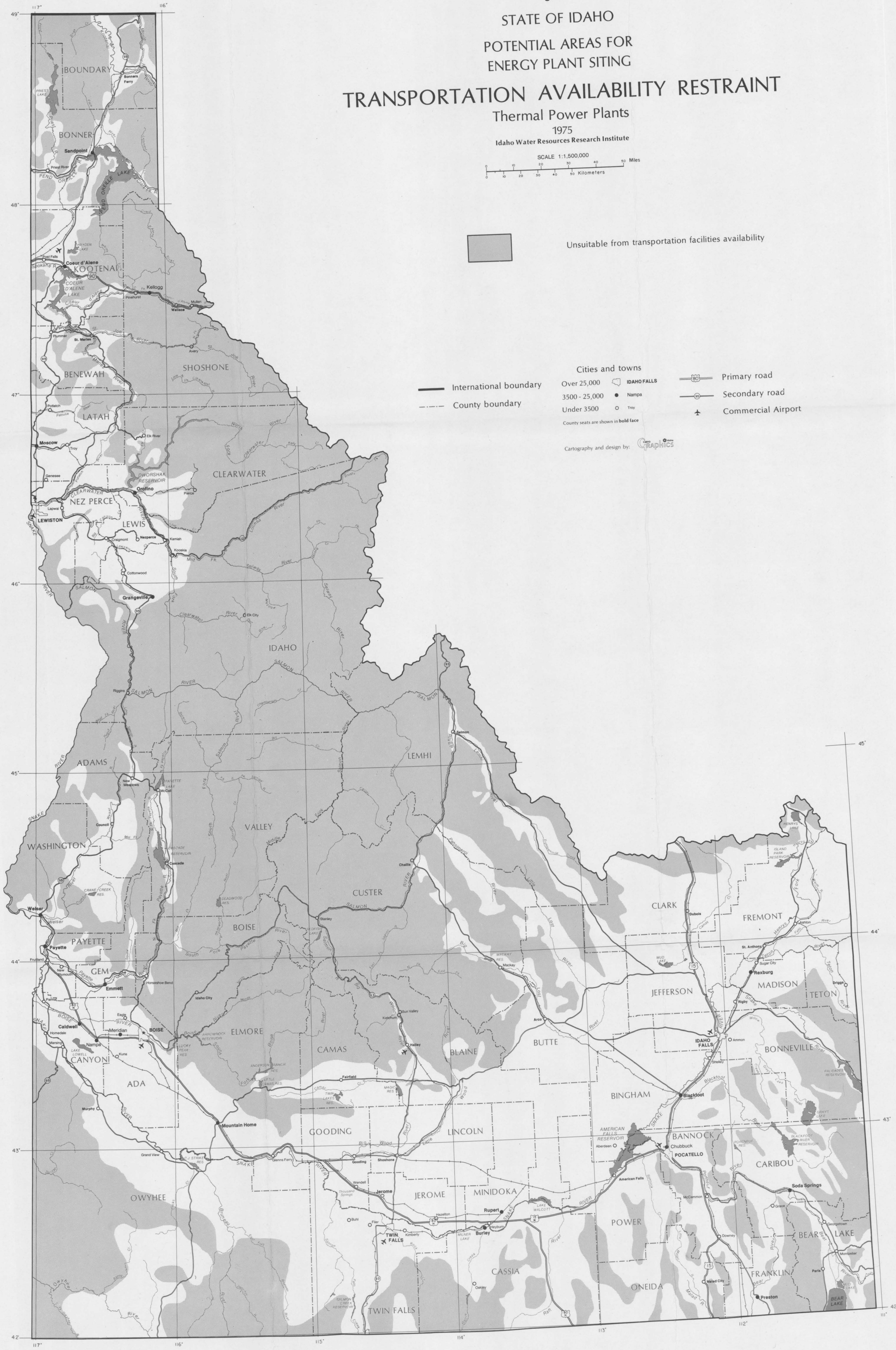
POTENTIAL AREAS FOR ENERGY PLANT SITING

TRANSPORTATION AVAILABILITY RESTRAINT

Thermal Power Plants

1975

Idaho Water Resources Research Institute



OWRT PROJECT A-048-IDA

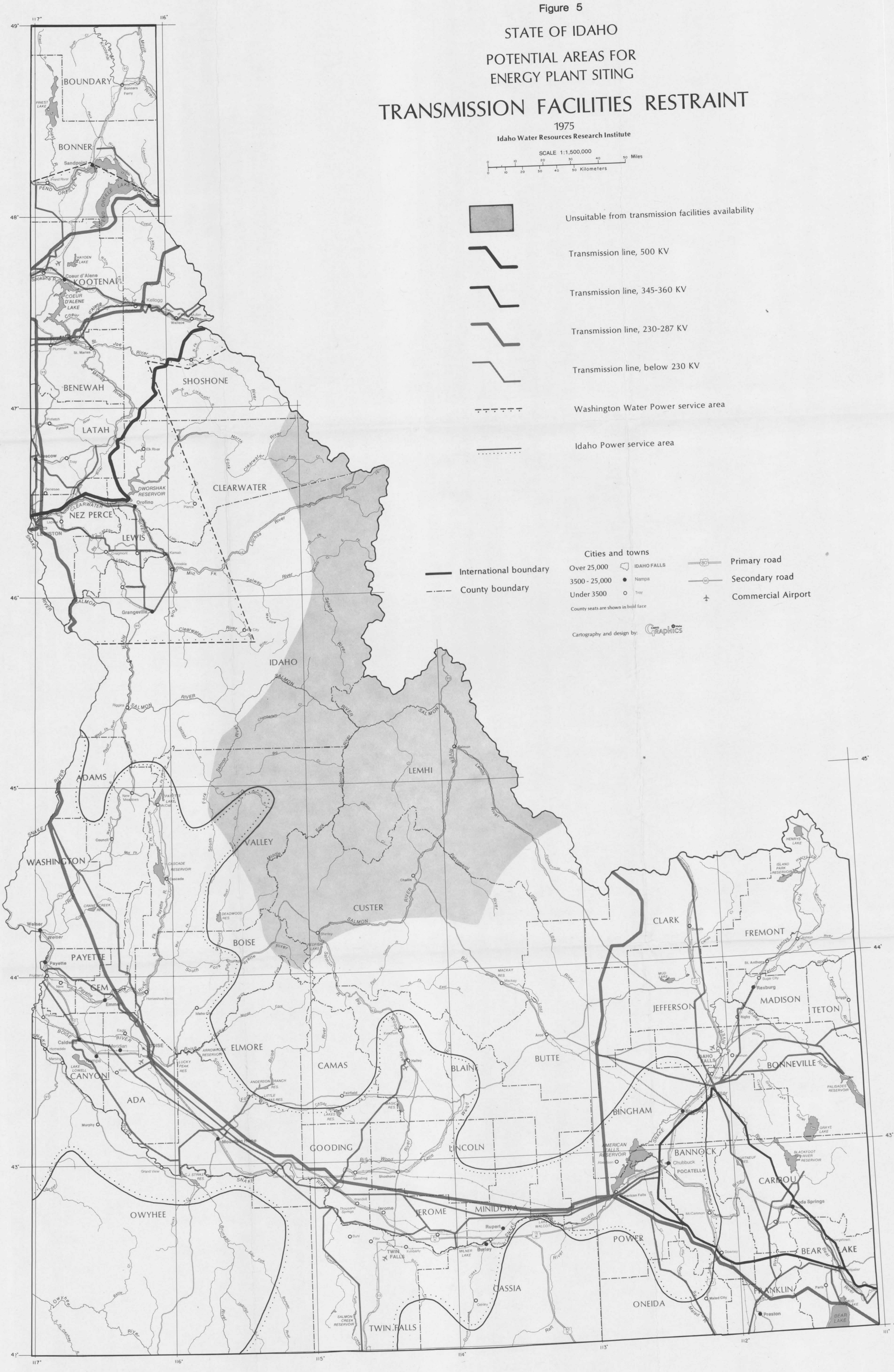


Figure 5

STATE OF IDAHO

POTENTIAL AREAS FOR ENERGY PLANT SITING

TRANSMISSION FACILITIES RESTRAINT

1975

Idaho Water Resources Research Institute

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Figure 6

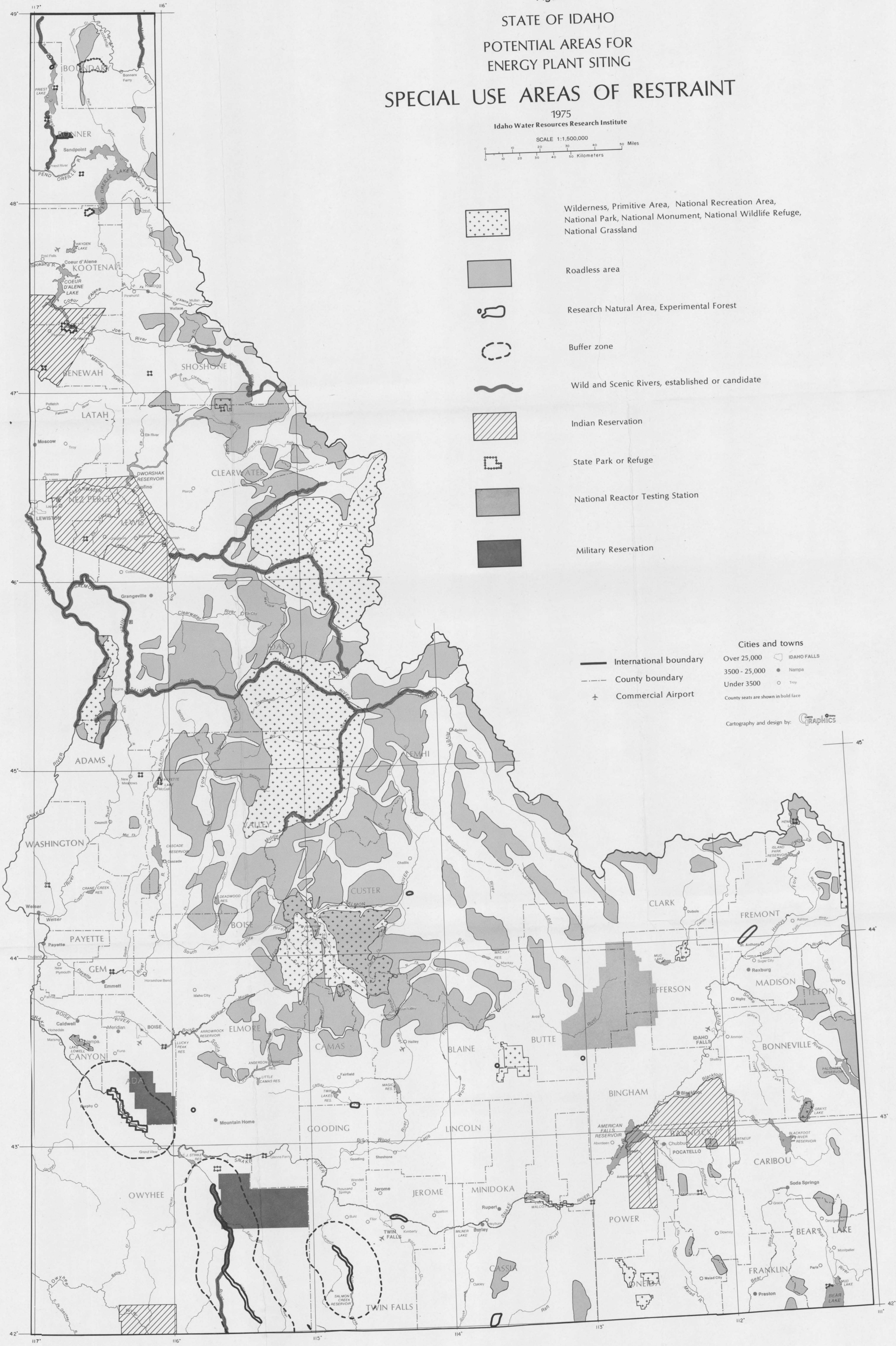
STATE OF IDAHO

POTENTIAL AREAS FOR ENERGY PLANT SITING

SPECIAL USE AREAS OF RESTRAINT

1975

Idaho Water Resources Research Institute



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