VOLUME 2 OF 2

APPENDIXES
B THROUGH E

Alaska Power Authority

SUSITNA HYDROELECTRIC PROJECT

PROPOSAL FOR

JUNE 1979

Acres American Incorporated
900 Liberty Bank Building
Buffalo, N.Y. 14202

R&M Consultants Incorporated
5024 Cordova Street
Anchorage, AK 99503

Alaska Power Authority

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ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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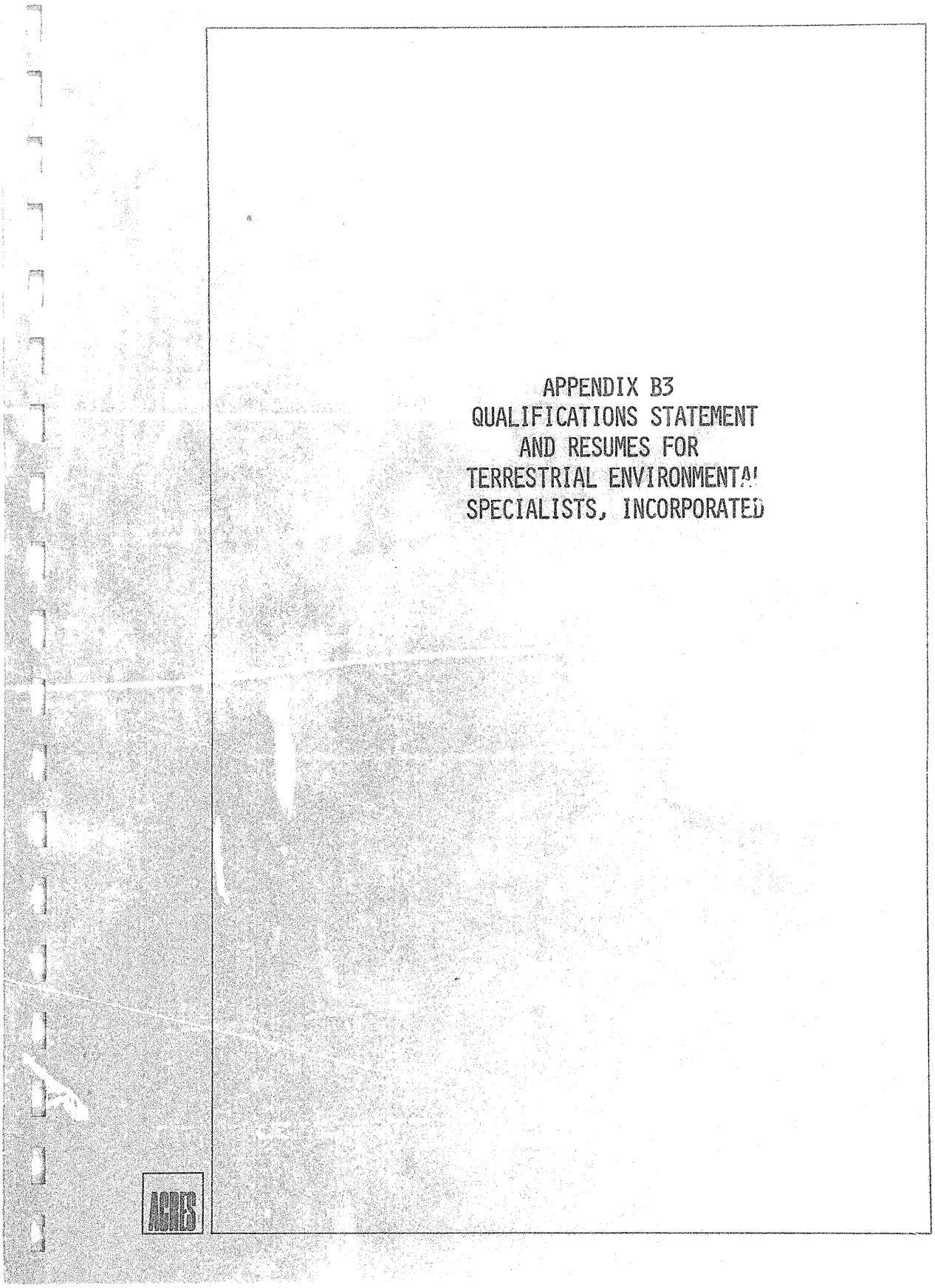

APPENDIX B3
QUALIFICATIONS STATEMENT AND RESUMES FOR TERRESTRIAL ENVIRONMENTAL SPECIALISTS, INCORPORATED

QUALIFICATIONS STATEMENT
CONCERNING ENVIRONMENTAL STUDIES
AS PART OF THE
SUSITNA RIVER HYDROELECTRIC PROJECT

Submitted to:

Alaska Power Authority
333 West 4th Avenue
Suite 31
Anchorage, Alaska 99501

Submitted by:

Terrestrial Environmental Specialists, Inc.
RD 1, Box 388
Phoenix, New York 13135

June 1, 1979

INTRODUCTION

The purpose of this document is to present the qualifications of a team of specialists assembled by Terrestrial Environmental Specialists, Inc. (TES). This team has been carefully chosen in order to make available to the Alaska Power Authority the best organization possible to study the environmental aspects of the Susitna Hydroelectric Project. An attempt was made to obtain scientists whose experience and credentials were best suited for the required study. After reviewing this document, we are certain that there will be little doubt that this goal has been achieved.

It is the proposal of TES to draw upon this assembled expertise, coordinate the capabilities of these specialists, and incorporate the experience of TES staff members in such a fashion that will produce a thorough evaluation of environmental impacts associated with the Susitna Project. To explain how this will be accomplished the remainder of this Qualifications Statement is organized in several sections. Immediately following is a brief description of the Corporate Experiences of TES. This section is very important because the task of organizing all aspects of this team will be the responsibility of TES staff members. Therefore, it is necessary that an organization with extensive experience in conducting environmental studies be selected. The last portion of this Qualifications Statement presents the specific qualifications of both key TES staff members as well as the personnel selected to serve as principal investigators.

TES CORPORATE QUALIFICATIONS

TES staff members have experience in all aspects of environmental studies. This experience includes designing programs, supervising data collection, writing reports, and managing the business aspect of projects. This combination of scientific capability with business experience will enable TES to manage the proposed environmental team on not only a scientific basis but also in a cost-effective business manner.

TES has performed excellent work in all aspects of environmental assessment as it pertains to hydro development. Hydro-related work has included such services as endangered species surveys, socio-economic analyses, archaeological investigations, terrestrial and aquatic ecology studies, land use analyses and preliminary site selection surveys.

As a result of this work TES has developed the ability to interface with the full complement of professionals that are typically involved with hydroelectric generation, including engineers, lawyers, biologists, geologists, hydrologists, and regulatory personnel. Thus TES is familiar with the particular concerns and needs of each group, and can efficiently produce an environmental report satisfactory to all concerned.

TES hydro environmental project experience is extensive. The firm has either prepared or is in the process of preparing environmental assessments for five proposed hydroelectric stations and has prepared an endangered species report for a sixth proposed hydro project. A brief project description is provided in Table 1.

Table 1

Terrestrial Environmental Specialists, Inc.
Hydro Environmental Project Descriptions

Project	Location	Project Description
F. W. E. Stapenhorst	Susquehanna River	Prepared an environmental report under the FERC guidelines for a minor project
Glenn Park	Black River	Provided assistance in evaluating the impact of a proposed hydro project on an endangered species
Hawkinsville/ Forestport	Black River	Prepared a hydro site selection analysis, based upon ecological, archaeological, and socio-economic considerations (Subcontractor to Acres American, Inc.)
Hudson Falls/ Fort Edward	Hudson River	Produced report and graphics concerning land use analysis, socio-economic impacts and an endangered species survey for this major project
Potsdam	Raquette River	Prepared an environmental report under the FERC guidelines for a minor project
Tygart Lake	Tygart Valley River	Evaluated the potential environmental and socio-economic impacts associated with a wide array of alternatives as part of a feasibility study for this major project (Subcontractor to Acres American, Inc.)

As a result of these studies, TES has established a strong working knowledge of the federal regulatory process and is intimately familiar with the hydroelectric licensing procedures of the Federal Energy Regulatory Commission. In addition, TES has been responsible for not only biological assessments but also socio-economic, land use, cultural and recreational resource assessments as well.

This previous hydro environmental study experience has required TES to develop investigational and report production procedures that conform to strict budgetary and schedule requirements. The firm's skillful project management has resulted in meeting deadlines on time and within cost estimates and has allowed clients to meet license application filing requirements.

The staff of TES has prepared terrestrial and aquatic ecology baseline studies and participated in the impact assessment phase of numerous facility siting studies. This experience has provided for the development of efficient and effective study designs and high quality reports that comply with federal and state siting regulations.

Additional experience with facility siting includes the preparation of written testimony and interrogatory responses, the presentation of oral testimony at public hearings, and the critical analyses of existing enviromental reports.

Inventories of the existing flora and fauna are fundamental to the understanding of the ecology of a given area. TES has completed several intensive inventory studies and integrated

this knowledge into reports that provide an understanding of the many aspects of ecosystem organization and dynamics. This inventory information comprises a reliable data base which, along with an understanding of the inter-relationships, is used to predict and mitigate environmental impact.

The recognition of unique habitats or unique populations of flora and fauna are important considerations in mitigating environmental impact. TES has the capabilities to recognize these unique areas or populations and to evaluate their ecological importance.

The personnel of TES have taken an active part in many studies involving threatened or endangered species and related critical habitats as defined by the Endangered Species Act of 1973. The recognition of these species and associated habitats, along with the legal implications of any findings, are important considerations in environmental planning. Rare/endangered plant studies have been conducted by staff botanists in association with the floral investigations of a hydroelectric site on the Hudson River and at a steam electric generating station site on Lake Erie. These searches were conducted based upon information made available to TES by both state and federal agencies, for both state and federally listed species.

An endangered mammal study was conducted as a specific project for a proposed hydroelectric station on the Black River. Other TES staff involvement in rare/endangered studies includes participation in peregrine falcon banding studies involving

banding locations along the east coast. These studies have been initiated in an attempt to gain a more complete understanding of the movements of this rare bird.

TES staff members have extensive experience in identifying both short and long term impacts on terrestrial and aquatic ecosystems. A multidisciplinary approach has been applied to impacts associated with hydroelectric, fossil-fueled, and nuclear generating stations.

The process of impact assessment includes not only identifying potential impacts but also recommending possible alternatives or mitigating actions. In all cases the assessment of environmental impacts incorporates ecological, socio-economic, and aesthetic factors in producing sound recommendations which strive to balance the needs of society with environmental parameters.

In addition to facility siting studies, TES has professional personnel who are experienced in various corridor routing studies. Staff members have developed a corridor selection technique employed in the siting evaluation of electric transmission lines ranging from 115 kV to 765 kV. Key staff personnel also have experience with the impact assessment of high pressure gas transmission line routing and corridor selection for highway projects.

The following pages contain a description of TES projects. In some cases these projects were conducted solely by TES personnel. In other cases, a team effort, similar to the one proposed for the Susitna Hydroelectric Project was developed and

managed by TES. Also included is a list of TES staff publications which demonstrate the ability of staff members to write not only environmental reports but also scientific papers.

CORPORATE EXPERIENCE

NIAGARA MOHAWK POWER CORPORATION (NMPC) · SYRACUSE, NY

TES has provided a wide variety of services to the Environmental Affairs Department and Systems Legal Affairs Department at NMPC. TES designed and conducted a series of studies that formed the terrestrial ecology monitoring program for the baseline studies at the proposed 1700 MW Lake Erie Generating Station complex. In the Article VIII (N.Y.S. Public Service Law) proceedings, TES also provided written and oral testimony before the New York State Public Service Commission with regards to the baseline and monitoring studies.

TES has also designed and conducted studies for NMPC concerning existing land use, socio-economic considerations, and endangered species at proposed facility sites. For a major proposed hydroelectric construction project on the north Hudson River, TES conducted studies on the regional and local land use and socio-economic factors and evaluated the impacts of the proposed project on land use, aesthetics, and socio-economic considerations. This study was designed to comply with Federal Power Commission Guidelines. At the request of NMPC, TES has also prepared reports on prescribed burning as a right-of-way management technique, slash disposal volume estimates for a proposed power plant site, the life history of an endangered vertebrate species, and a survey for endangered plant species. The latter three studies were conducted at proposed fossil-fueled or hydroelectric plant sites.

WEGMANS FOOD MARKETS, INC. ROCHESTER, NY

TES prepared an environmental report under the guidelines of the New York State Environmental Quality Review (SEQR) Act for the proposed Wegmans Mall and Store, Auburn, NY. The nature of this proposed urban development project required that emphasis in the environmental report be given to community factors and socio-economic considerations, such as traffic, parking, and employment. Design considerations, such as the proposed drainage system, were also given special consideration.

DURYEA AND WILHELMI, P. C. SYRACUSE, NY

TES prepared an environmental report on the proposed rehabilitation of Sylvan Beach, NY. The project included both the rehabilitation of the central business district of the village and the construction of a seawall and recreation area along the lakefront. This report emphasized potential disturbances to Oneida Lake and the impacts of disturbances on local flora and fauna, particularly fish.

F. W. E. STAPENHORST, INC. MONTREAL, QUEBEC

TES prepared an environmental report for the proposed renovation of the Colliersville Hydroelectric Facility at Goodyear Lake on the Susquehanna River, Otsego County, NY. This report was designed to comply with the New York State Environmental Quality Review (SEQR) Act and Federal Power Commission Guidelines for impact statements required under the National Environmental Policy Act (NEPA). Considerations included ecological aspects of the proposed action in addition to socio-economic and land-use considerations.

CHASE ARCHITECTURAL ASSOCIATES, P. C. SYRACUSE, NY

Serving as a consultant to CAA, TES prepared the terrestrial ecology, air quality, and hydrology/water quality sections of an environmental report on the construction of a Holiday Inn in Auburn, NY. This report was designed to comply with the requirements of the New York State Environmental Quality Review (SEQR) Act and required emphasis on the urban environment.

DEPARTMENT OF PUBLIC WORKS CHAUTAUQUA COUNTY, NY

TES prepared an environmental impact evaluation in accordance with the New York State Environmental Quality Review (SEQR) Act, for a proposed sanitary landfill in the Town of Ellery, NY. Issues that were addressed included impacts on traffic, noise, hydrology, water quality, terrestrial and aquatic ecosystems, and socio-economic factors. In addition, TES conducted an on-site investigation of the flora and fauna of the Ellery site and made recommendations for restoration and management plans for the landfill site.

NAVAL SURFACE WEAPONS CENTER DAHLGREN, VA

For the Naval Surface Weapons Center/Dahlgren Laboratory, TES designed and conducted surveys of the plants, fish, shellfish, amphibians, reptiles, birds, and mammals on the approximately 4,300 acres that compose this naval facility. This year-long study was designed to provide baseline information for use in the preparation of an environmental impact assessment for facilities operations.

AIR FORCE CIVIL ENGINEERING CENTER EGLIN AFB, FL

TES was selected by the U. S. Air Force to prepare a Handbook of Bird Management and Control and an accompanying slide and tape

presentation to be used as a teaching aid. This manual is to be used by Air Force personnel for the identification, evaluation, and control of pest bird problems at U. S. Air Bases throughout North America.

ROCHESTER GAS AND ELECTRIC CORPORATION ROCHESTER, NY

TES, under contract to Rochester Gas and Electric Corporation and Niagara Mohawk Power Corporation, was selected to prepare an update to an environmental analysis for a proposed 765 kV transmission line. This project included the analysis and comparison of primary and alternate routes for a proposed 66-mile transmission line, the recommendation of new route segments where warranted, and the presentation of testimony under Article VII requirements of New York State Public Service Law.

GENERAL PUBLIC UTILITIES SERVICE CORPORATION PARSIPPANY, NJ

TES was selected to conduct a five-year construction impact monitoring program at the site of the Forked River Nuclear Power Station. This program includes the collection of baseline floral and faunal data for the initial year and a series of monitoring studies during the following four-year period. These studies will be used to assess construction impacts of a salt water cooling tower upon plant communities and important faunal populations.

TES staff members will also gather baseline data concerning local vegetation stress over a three-year period. These data, gathered from color infrared photography and ground reconnaissance, will be coordinated with the collection of air quality data to assess the possible effects of the salt drift field from cooling towers.

NIAGARA MOHAWK POWER CORPORATION (NMPC) SYRACUSE, NY

TES was selected by NMPC to provide a routing analysis and impact assessment for a 115 kV transmission line in Jefferson County, New York. The determination of primary and alternative routes was a result of consideration for various types of constraints, such as: urban development, geology, topography and soils, wetland areas, land use, visual exposure, and cultural resources. The report produced as a result of this study forms an integral part of the New York State Public Service Law Article VII application to the New York State Public Service Commission.

PENNSYLVANIA POWER AND LIGHT COMPANY — ALLENTOWN, PA

TES was selected to conduct an environmental assessment and routing analysis for a 138 kV transmission line in east-central Pennsylvania. This study was designed to comply with the regulations of the Public Utilities Commission of Pennsylvania for siting and construction of electric transmission lines. Among the important considerations for routing the line were coal resources, natural resources, topography, land use, and socio-economic factors.

ONONDAGA COUNTY WATER AUTHORITY — SYRACUSE, NY

TES prepared a critique of a draft environmental impact statement on a stream reclassification proposal for the Onondaga County Water Authority. Important criteria considered in the preparation of the critique were stream water quality, trout populations, recreational fishing potential, and the socio-economic impacts of the reclassification of the stream.

DEPARTMENT OF PUBLIC WORKS — CHAUTAUQUA COUNTY, NY

TES prepared two environmental impact assessments for proposed bridge construction and highway relocation projects. Among the impacts investigated were soil erosion and sedimentation, effects on traffic patterns and volume, and changes in existing noise levels. The alternatives, renovation of the existing bridges or construction of new bridges at sites other than those proposed, were also evaluated.

RIST-FROST ASSOCIATES — GLENS FALLS, NY

TES prepared an environmental report for the proposed renovation of the Village of Potsdam Hydroelectric Facility on the Raquette River, St. Lawrence County, New York. This study was designed in accordance with the Federal Power Commission guidelines for impact statements required under the National Environmental Policy Act (NEPA). Considerations included ecological aspects of the proposed action on plant and animal communities in addition to socio-economic and land use factors.

ACRES AMERICAN, INC. — BUFFALO, NY

As a subcontractor to Acres American, Inc. TES provided environmental and economic assessments as part of a feasibility study for various hydroelectric generation options at the Tygart Dam and Reservoir, Grafton, West Virginia. This study was conducted for the U. S. Army Corps of Engineers - Pittsburgh District. Important considerations during this evaluation included the impacts associated with the recreational use of the reservoir, the effects upon natural aquatic and terrestrial systems, and a variety of land-use and socio-economic considerations.

DONALD R. ANDRES, P. E. SAN JOSE, CALIFORNIA

TES was subcontracted to perform an assessment of a proposed sanitary landfill site in Onondaga County, New York. This qualitative study characterized the vegetation communities and wildlife of the site, and assessed the probability for occurrence of noteworthy species, including threatened or endangered plants and animals.

CONSUMERS POWER COMPANY JACKSON, MICHIGAN

TES was contracted by Consumers Power Company to perform environmental studies at two potential power plant sites in Michigan. These year-long investigations included surveys of soils, vegetation, fauna, historical and archaeological resources, and recreational uses.

ACRES AMERICAN, INC. BUFFALO, NEW YORK

TES was selected to conduct ecological, land use, and socio-economic studies relevant to the selection of a potential hydroelectric generating station site on the Black River, Oneida County, New York. Working closely with the prime contractor, TES tasks included identification of the potential for impacts of the hydroelectric facility upon fish and wildlife, vegetation, unique habitats, land use, local economics, and cultural resources.

TES STAFF PUBLICATIONS

TES personnel, in addition to environmental reports, have published a variety of journal articles and technical reports. The TES staff has produced the following list of publications dealing with: plant community descriptions, plant morphological and anatomical variation, predator-prey interactions, avian and mammalian behavior, capture techniques, avian diversity, urban wildlife, vertebrate population studies, and other subjects.

Lucid, V. J. 1971. The birds of Bissell's Cove. Rhode Island Resources 17 (4): 8-10.

Lucid, V. J. 1971. Utilization of Bissell's Cove salt marsh by birds of the families Anatidae and Laridae. M.S. Thesis, University of Rhode Island, Kingston.

Reed, E. T. 1972. More than game. Pennsylvania Game News.

Roelle, J. E., and R. S. Slack. 1972. The distribution, abundance, and diversity of birds on Edgewood Arsenal's chemical agent test area. EATR 4646: 34 pp.

Slack, R. S., J. E. Roelle, F. P. Ward, and C. F. A. Pinkham. 1972. Reptiles and amphibians on Edgewood Arsenal's chemical agent test area. EATR 4593: 23 pp.

Baumgartner, C. A. 1973. Comparative rates of desiccation and rehydration in two species of salamanders: Desmognathus fuscus fuscus and Desmognathus ochrophaeus ochrophaeus. M.S. Thesis, Pennsylvania State University, University Park.

Conner, R. N., D. C. Chamberlain, and V. J. Lucid. 1973. Some aerial maneuvers of the common raven in Virginia. The Raven (J. Virginia Soc. Ornithology) 44 (4): 99.

Lucid, V. J. 1973. Bird utilization of residential areas of different ages and types of development. Presented at the 39th Annual Meeting of the Virginia Society of Ornithology, Mountain Lake, Virginia. The Raven 44 (2): 52 (abstract).

Slack, R. S. 1973. Sparrow hawk preys on young killdeer. Bull. Okla. Ornith. Soc. 6: 20-21.

Slack, R. S. 1973. The effects of size and coloration of prey on loggerhead shrike predation. M.S. Thesis, University of Oklahoma, Norman.

Abler, W. A., D. E. Buckland, E. T. Reed, R. L. Kirkpatrick, and P. F. Scanlon. 1974. Breeding behavior of captive female white-tailed deer. Va. J. Science 24 (3): 112 (abstract).

Buckland, D. E., W. A. Abler, E. T. Reed, R. L. Kirkpatrick, and P. F. Scanlon. 1974. Breeding behavior of captive male white-tailed deer. Va. J. Science 24 (3): 112 (abstract).

Chamberlain, D. R., R. G. Hooper, V. J. Lucid, and R. N. Conner. 1974. Interspecific associations of common ravens in Virginia. The Raven (J. Virginia Soc. Ornithology) 45 (4). 79-81.

Conner, R. N., V. J. Lucid, and I. D. Prather. 1974. A sora rail on Tinker Mountain. The Raven (J. Virginia Soc. Ornithology) 45 (2): 38.

Lucid, V. J. 1974. Species diversity of breeding birds in residential areas. Va. J. Science 25 (2): 66 (abstract).

Lucid, V. J. 1974. Nocturnal activity and vocalization by a ruffed grouse. Bird-Banding 45 (2): 179.

Lucid, V. J. 1974. Bird utilization of habitat in residential areas. Ph.D. Dissertation. Virginia Polytechnic Institute and State University, Blacksburg.

Lucid, V. J., and R. N. Conner. 1974. A communal common raven roost in Virginia. Wilson Bulletin 86 (1): 82-83.

McMullen, J. M. 1974. Anatomical and morphological variation in Podophyllum peltatum L. due to aspect and elevation. M.S. Thesis, West Virginia University, Morgantown.

McMullen, J. M., and J. F. Clovis. 1974. Anatomical variation in Podophyllum peltatum L. due to aspect and elevation. W. Va. Academy of Science Proceedings. Biology Section 274-280.

Reed, E. T. 1974. Effects of fall orphaning on white-tailed deer fawns. M.S. Thesis, Virginia Polytechnic Institute and State University, Blacksburg.

Reed, E. T., B. S. McGinnes, and B. N. Reed. 1974. Parturition site in relation to subsequent home ranges of white-tailed deer fawns. Va. J. Science 25 (2): 68 (abstract).

Scanlon, P. F., R. E. Mirarchi, and E. T. Reed. 1974. Immobilization of white-tailed deer with succinylcholine chloride. Va. J. Science 25 (2): 68 (abstract).

Baumgartner, C. A., J. McMullen, V. J. Lucid, and R. S. Slack. 1975. Breeding Bird Census: 78. Shrub Community. American Birds 29 (6): 1113.

Groves, D. L., G. H. Cross, V. J. Lucid, and V. B. Cauley, Jr. 1975. A planning model for the utilization of natural resources in high density population areas. Ekistics 239: 287-290.

Lucid, V. J. 1975. Cooperation in nature. Virginia Wildlife 36 (12): 14-15.

McMullen, J., R. S. Slack, V. J. Lucid, and P. G. Kalka. 1975. Breeding Bird Census: 79. Shrub Community II. American Birds 29 (6): 1113-1114.

Reed, E. T. 1975. The future of passerine banding. EBBA News 38 (2): 84-85.

Slack, R. S. 1975. Effects of size of prey on loggerhead shrike predation. Auk 92 (4): 812-814.

Slack, R. S., C. A. Baumgartner, and J. McMullen. 1975. Breeding Bird Census: 143. Open Field. American Birds 29 (6): 1138-1139.

Slack, R. S., C. A. Baumgartner, and V. J. Lucid. 1975. Breeding Bird Census: 144. Vineyard I. American Birds 29 (6): 1139.

Slack, R. S., L. Braband, and H. E. Slack III. 1975. Breeding Bird Census: 145. Vineyard II. American Birds 29 (6): 1139.

Slack, R. S., H. E. Slack III, and P. G. Kalka. 1975. Breeding Bird Census: 60. Scotch Pine Plantation. American Birds 29 (6): 1104-1105.

Slack, R. S., P. G. Kalka, V. J. Lucid, and J. McMullen. 1975. Breeding Bird Census: 3. Red Maple Forest. American Birds 29 (6): 1082-1083.

Conner, R. N., and V. J. Lucid. 1976. Interactions between nesting birds and carpenter ants. Bird-Banding 47 (2) 161-162.

Lucid, V. J. 1976. Songbirds in suburbia. Virginia Wildlife 37: 7-9, 24.

Pinkham, C. F. A., M. R. Braid, J. E. Roelle, and R. S. Slack. 1976. Effects of tests with military chemicals on the mammals of Carroll Island. Edgewood Arsenal Technical Report EO-TR-76071.

Slack, R. S., and J. M. McMullen. 1976. Red-tailed hawk preys on common gallinule. The Kingbird 26: 202.

Reed, E. T. 1977. Is your banding of any value? North American Bird Bander 1: 178-179.

Slack, R. S. and C. A. Baumgartner. 1977. A possible New York State dickcissel breeding colony. The Kingbird 27: 26-27.

Baumgartner, C. A., and R. S. Slack. 1977. Breeding Bird Census: 76. Shrub Community I. American Birds 31 (1): 58.

Baumgartner, C. A., and R. S. Slack. 1977. Breeding Bird Census: 153. Vineyard III. American Birds 31 (1): 87.

Lucid, V. J., P. G. Kalka, and R. S. Slack. 1977. Breeding Bird Census: 77. Shrub Community II. American Birds 31 (1): 58.

McMullen, J. M., and R. S. Slack. 1977. Breeding Bird Census: 4. Mixed Hardwoods Forest. American Birds 31 (1): 30.

McMullen, J. M., R. S. Slack, and V. J. Lucid. 1977. Breeding Bird Census: 3. Mixed Hardwoods. American Birds 31 (1): 29-30.

Slack, R. S. 1977. Breeding Bird Census: 154. Vineyard IV. American Birds 31 (1): 87.

Slack, R. S., and C. A. Baumgartner. 1977. Breeding Bird Census: 152. Open Field. American Birds 31 (1): 86-87.

Slack, R. S., C. A. Baumgartner, and V. J. Lucid. 1977. Breeding Bird Census: 67. Scotch Pine Plantation. American Birds 31 (1): 54.

Slack, R. S. 1978. An unusual Black-capped Chickadee at Phoenix, New York. North American Bird Bander 3: 56-57.

Slack, R. S. 1978. Life expectancy of newer-issue size 1-A bands. North American Bird Bander 3 (3): 99.

Slack, R. S., and H. E. Slack, III. 1979. An unusual Common Grackle in central New York State. North American Bird Bander 4: 14.

PROJECT TEAM AND ORGANIZATION

The key management and scientific personnel that comprise the TES team are presented on Figure 1 and also in the following detailed descriptions. A TES staff member will serve as Discipline Coordinator for each major portion of the study and will be responsible for the work conducted in that area. Staff members assigned as Discipline Coordinators have experience in the respective area of expertise and will serve as a pivot point between the scientific and business aspects of the study.

Discipline coordinators will be responsible for all aspects of work conducted under their supervision. This will include approving the plan of study, inspections of data collection activities, editorial jurisdiction over all reports, and authorization of all funds expended in that particular discipline.

The majority of the scientific expertise required for a study of this scope is represented by the personnel that have agreed to serve as Principal Investigators. Each Principal Investigator is an expert in their field and has experience in either Alaska or in a similar area. The Principal Investigators will be responsible for preparing a plan of study and also seeing that qualified technicians are secured to conduct the data collection phase of the study. The Principal Investigator will also be responsible, in cooperation with the Discipline Coordinator for the writing of all reports. Following are resumes of both the Discipline Coordinators and Principal Investigators.

PROJECT TEAM AND ORGANIZATION-SUSITNA HYDROELECTRIC PROJECT

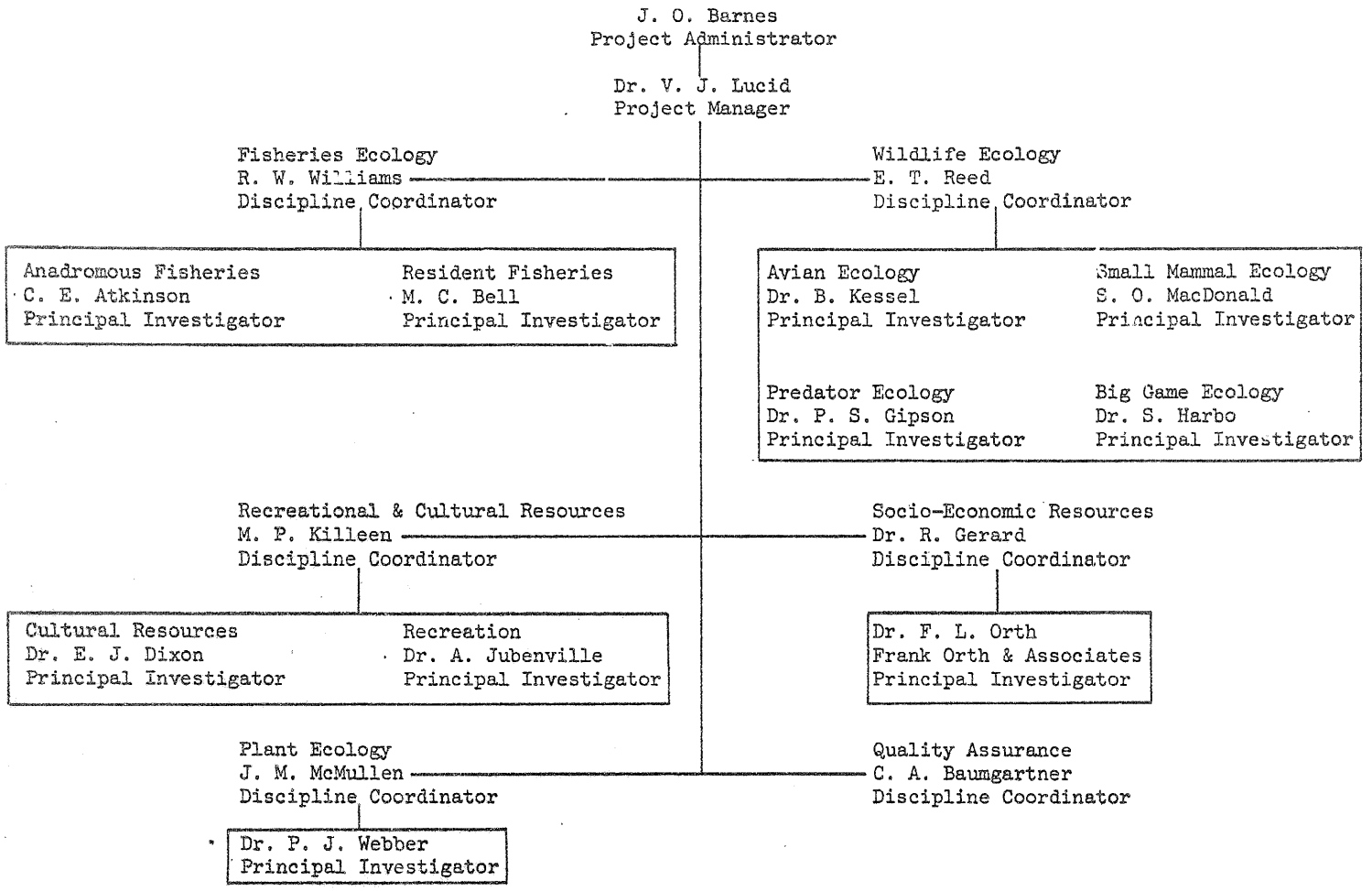

FIGURE 1

PROJECT ADMINISTRATION

PROJECT ADMINISTRATOR: JEFFREY O. BARNES

PROJECT MANAGER: DR. VINCENT J. LUCID

JEFFREY O. BARNES

Terrestrial Environmental Specialists, Inc.

Education

B.S. Zoology (Major), Botany (Minor): State University of New York College of Environmental Science and Forestry, Syracuse, New York, 1971.

Professional Experience

Environmental Scientist, Terrestrial Environmental Specialists, Inc., Phoenix, New York, 1976 - present.

Terrestrial Ecologist, Niagara Mohawk Power Corporation, Syracuse, New York, 1972-1975.

Teacher/Demonstrator, Environmental Matters, Nine Mile Point Nuclear Station Progress Center, Niagara Mohawk Power Corporation, Oswego, New York, 1971-1972.

Awards and Offices

Certificate of Completion, Short Course on Environmental Siting of Transmission Lines, from Bruce Howlett, Inc. Brewster, New York, 1973.

Certificate of Completion, Natural Resource Inventory Workshop, Atmospheric Sciences Research Center, Wilmington New York, 1975.

Secretary - Treasurer (1974-1977); Vice President (1977-1978); The Wildlife Society - New York Chapter.

Memberships

National Audubon Society
National Wildlife Federation
The Smithsonian Institution
The Wildlife Society
The Wildlife Society - New York Chapter

Consulting and Related Experience

- supervised and reviewed impact analyses of six 115 kV to 765 kV electric transmission line sitings.

- devised a Site Sensitive Avoidance Technique for transmission line corridor selection studies and utilized this technique on two 115 kV and one 765 kV study in New York State.

Consulting and Related Experience (Continued)

- prepared and presented oral and written testimony at public hearings regarding electric transmission line siting studies.

- prepared exhibits to fulfill regulations governing the licensing and relicensing of hydroelectric generating facilities.

- supervised feasibility study on technique selection for aquatic biology and water chemistry studies.

- supervised and participated in a study to assess prescribed burning as a vegetation management technique for rights-of-way.

- presented testimony at public hearings regarding proposed electric generating plant siting studies.

- supervised and reviewed impact analyses for siting of high pressure gas transmission lines.

- worked upon the preparation of an environmental update for a proposed 765 kV transmission line and the evaluation of the environmental compatibility of proposed routes.

- supervised the preparation of a critique of a proposed stream reclassification report.

VINCENT J. LUCID

Terrestrial Environmental Specialists, Inc.

Education

B.S. Zoology; University of Rhode Island, Kingston, Rhode Island. 1968.
M.S. Animal Science (Wildlife Management); University of Rhode Island, Kingston, Rhode Island. 1971.
Ph.D. Wildlife Biology; Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 1974.

Professional Experience

Director of Environmental Studies, Terrestrial Environmental Specialists, Inc., Phoenix, New York, 1976 - present.

Environmental Scientist (Senior Terrestrial Ecologist/ Project Manager), Equitable Environmental Health, Inc., Woodbury, New York. 1976.

Associate Environmental Scientist (Terrestrial Ecologist/ Quality Assurance Coordinator), Environmental Analysts, Inc., Garden City, New York. 1975.

Graduate Research and Teaching Assistanships, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 1971 - 1974.

Graduate and Post-graduate Research Assistantships, University of Rhode Island, Kingston, Rhode Island. 1970 - 1971.

Biological Aide, U.S. Bureau of Commercial Fisheries, Biological Laboratory, Boothbay Harbor, Maine. 1966.

Awards

Phi Kappa Phi (National Honor Society). 1973.

Phi Sigma (National Biological Honor Society). 1973.

Sigma Xi (Scientific Research Society). 1974 - Present.

Memberships

American Ornithologists' Union
International Oceanographic Foundation
National Audubon Society
National Wildlife Federation
The Nature Conservancy
The Wildlife Society
Virginia Society of Ornithology
Wilson Ornithological Society

Consulting and Related Experience

- designed and managed a comprehensive study of the effects of fossil fuel effluents on agricultural crops.

- designed and implemented quantitative data analysis of terrestrial ecology studies at two proposed power plant sites.

- coordinated quality assurance programs for aquatic ecology and water quality studies at two proposed power plant sites and five existing stations.

- designed and managed a critical analysis of an environmental assessment for two proposed power plant sites.

- authored terrestrial ecology sections of a report on regional impact issues for electric generation development in the Pacific Northwest.

- authored major sections of a preliminary report on the environmental impact of the XIII Olympic Winter Games.

- compiled and analyzed background information for environmental assessment of a proposed theme park development.

- critically reviewed and conducted computer analysis for a series of terrestrial ecology monitoring studies.

- authored responses to interrogatories concerning testimony on the environmental assessment of a proposed electric generating station.

- authored a report on slash disposal following land-clearing for construction purposes.

- authored sections of a report on the use of private lands for outdoor recreation.

- designed and conducted a comprehensive analysis of bird populations and habitat in residential developments.

Consulting and Related Experience (Continued)

designed and conducted a study of bird utilization of a tidal marsh.

- coordinated and participated in the preparation of an environmental impact statement for the proposed renovation of a hydroelectric generating facility.

- provided technical input in the comparison of environmental impact of two proposed highway routes.

- managed and prepared major portions of an environmental impact statement for a proposed urban redevelopment project, and authored the biological and physical environment sections of a report on another urban project.

- coordinated and participated in floral and faunal surveys at a U. S. Navy installation.

- authored major sections of a bird pest control handbook for the U. S. Air Force.

- conducted major portions of an environmental analysis of proposed routes for a high voltage electric transmission facility.

- coordinated a terrestrial ecology monitoring program at a nuclear power plant construction site.

- coordinated environmental studies at two potential power plant sites in the Midwest.

- performed the faunal portion of a floral/faunal assessment for a proposed sanitary landfill site in central New York.

FISHERIES ECOLOGY

DISCIPLINE COORDINATOR: ROBERT W. WILLIAMS

PRINCIPAL INVESTIGATORS:

ANADROMOUS FISHERIES: CLINTON E. ATKINSON

RESIDENT FISHERIES: MILO C. BELL

ROBERT W. WILLIAMS

Terrestrial Environmental Specialists, Inc.

Research Associate

Education

B.S. Biology; State University of New York, Oswego, New York, 1966.
M.A. Zoology; University of Vermont, 1969.

Professional Experience

President and Owner, Aquatic Equipment Company, Minetto, New York, 1976 - present.

Assistant Adjunct Professor, Syracuse University, Syracuse, New York, 1976 - present.

Director, Oswego Laboratory, Quirk, Lawler and Matusky Laboratories, Inc., Oswego, New York, 1973-1976.

Project Biologist, Quirk, Lawler and Matusky Engineers, Nyack, New York, 1972-1973.

Technical Coordinator of Biological Programs, Quirk, Lawler and Matusky Engineers, Nyack, New York, 1972-1973.

Assistant Director of Laboratory, Quirk, Lawler and Matusky Engineers, Nyack, New York, 1971-1972.

Project Biologist, Quirk, Lawler and Matusky Engineers, Nyack, New York, 1971-1972.

Biologist, Quirk, Lawler and Matusky Engineers, Nyack, New York, 1970-1971.

Memberships

International Association of Great Lakes Research

Consulting and Related Experience

- coordinated general biological, entrainment and impingement studies at the Nine Mile Point Nuclear Station and the Oswego Steam Station.

- coordinated and supervised studies on fish behavior in thermal discharges at three sites for Ontario Hydro.

Consulting and Related Experience (Continued)

- set up and oversaw the execution and quality of field and laboratory studies at the Nine Mile Point Nuclear Station and the Oswego Steam Station.

- coordinated technical biological programs with administrative responsibilities for biological programs on the Hudson River and Lake Ontario.

- coordinated manpower, technical skills and equipment for many projects at the Bowline Generating Station, Lovett Generating Station, Danskammer Point Generating Station, and the Roseton Generating Station.

- participated in power plant siting studies on the Hudson River.

- managed physical, chemical and biological activities associated with intensive projects on lake and river systems in New York.

- managed biological programs for environmental reports on the Hudson River and Lake Ontario.

- participated in physical, chemical and biological investigations on Lake Ontario, Hudson River and Lake Champlain.

B I O G R A P H Y

CLINTON EDWIN ATKINSON

Fisheries Consultant and Advisor

Personal:

Born:	Nov. 5, 1913	Boise, Idaho
Married:	Dec. 15, 1939	New Westminster, B.C. (Canada)
Wife's Maiden Name:		Mary Helen Cormack
Children:		Robert Edwin Atkinson William Clinton Atkinson
Nationality:		U.S. Citizen
Business Address:		8000 Crest Drive N.E. Seattle, Washington 98115
Telephone (Business/Home):		(206) 524 4242

Education:

Primary/Middle School:	1920-1928	Boise, Idaho
High School:	1928-1933	Boise, Idaho
University:	1933-1937	University of Washington (Seattle) Bachelor of Science (Fisheries)
	1937 1943-1945 1962-1964	University of Washington (Seattle) Master of Science (Fisheries)
	1950,1951	Duke University (Marine Station), Beaufort, North Carolina

Experience:

Business:	1932-1936	Boise Glass and Paint Co. (partner) Manufacturer of Aquaria and dealer in fish and aquaria supplies
	1974-	Fisheries Consultant and Advisor
Government:		
U.S. Bureau of Fisheries	1937	Apprentice Fish Culturist Silver Springs Trout Hatchery
International Pacific Halibut Commission	1937	Scientific Assistant
International Pacific Salmon Fisheries Commission	1938-1940 1940-1946 1946-1948	Scientific Assistant Assistant Scientist Senior Scientist

Experience (continued):

Government:

U.S. Fish and Wildlife Service (Bureau of Commercial Fisheries):	1948-1949	Chief, Middle Atlantic Fishery Investigations College Park
	1949-1952	Chief, Middle and South Atlantic Fishery Investigations Beaufort
	1952-1958	Chief, Pacific Salmon Fishery Investigations Seattle
	1958-1966	Director, Biological Laboratory Seattle
	(1965)	Acting Deputy Assistant Director for Research, Washington, D.C.
U.S. Department of State:	1966-1971	Fishery Attache, American Embassy Tokyo
	1971-1973	Regional Fishery Attache for East Asia/Pacific Islands, American Embassy Tokyo

University:

University of Washington:	1952-1964	Lecturer, College of Fisheries
	1974-	Visiting Scholar
University of Alaska	1974-1977	Advisor to the President (Fisheries)
University of Washington	1978	Visiting Lecturer (taught an upper division/graduate course in World Fisheries

Foreign Languages:

High School/University of Washington	1928-1935	French (Fair reading knowledge)
University of Washington	1943-1944	Russian (Fair reading knowledge)
U.S. Department of State (FSI Language School)	1966-1973	Japanese (Fair speaking and reading knowledge)

Awards:

Academic Honor Societies:

Phi Mu Alpha (Music)	1937	University of Washington
Phi Sigma (Biology)	1937	University of Washington
Sigma Xi (Science)	1944	University of Washington

Government:

U.S. Fish and Wildlife Service (Bureau of Commercial Fisheries):	1957	Unit Citation for Meritorious Service (Research on Pacific Salmon)
	1960	Unit Citation for Meritorious Service (Research on Shad)
	1956	Outstanding Performance

Awards (continued):

Government:

U.S. Fish and Wildlife Service (Bureau of Commercial Fisheries):	1960	Outstanding Performance
	1965	Outstanding Performance
Federal Business Association:	1959	Federal Civil Service (Outstanding Contribution)
	1960	Federal Civil Service (Outstanding Contribution)

Foreign:

Governor of Niigata (Japan)	1962	Citation (Assistance in Rainbow Transplants)
Japan Salmon Resources Protection and Preservation Society	1969	Citation (Important Contribution to the Conservation and Propagation of Salmon Resources)
Japan Marine Products Photo Materials Associations	1973	Citation (Technical Assistance in Preparation of Books on the Fisheries of Japan)
Office of Fisheries (Republic of Korea)	1973	Citation (Outstanding Contribution to the Development of Korean Fisheries)

Societies and Associations:

Professional Societies:

Pacific Fishery Biologists	1939-1966	
American Society of Ichthyologists and Herpetologists	1938-1941	
American Fisheries Society	1939-1940	
American Society of Oceanography and Limnology	1947-1948	
Atlantic Estuarine Society	1949-1952	
Atlantic Fishery Biologists	1949-1952	
American Institute of Fishery Research Biologists	1956-	Fellow and Past President
Japan Society of Scientific Fisheries	1974-	

Societies and Associations (continued):

Other:

Junior Board of Trade (New Westminster, B.C.)	1939-1944	Member, Board of Directors
American Foreign Service Service	1966-1973	
Japan-America Society Tokyo	1970-1973	
Japan-America Society Seattle	1974-	

Committees:

North Carolina Resource-Use Education Commission	1951-1952	Commissioner
International North Pacific Fisheries Commission	1954-1967	Expert
U.S. Corps of Army Engineers Technical Advisory Committee	1955-1966	Member
University of British Columbia Hydro and Fisheries Research Committee	1956-1957	Member
Salmon Coordinating Committee	1960-1966	Member and Chairman
International Whaling Commission	1968,1972	Advisor
International North Pacific Fur Seal Commission	1969,1973	Advisor
Inter-American Tropical Tuna Commission	1972	Expert
United Nations (UNESCO (IOC)) Kuroshio Current Study Group	1972	National Coordinator (Acting)
International Commission for the Fisheries of the Northwest Pacific Ocean (USSR-Japan)	1961,1968 1970,1972	U.S. Observer
Alaska Interagency Fisheries Committee	1974-1977	Member and Chairman

Publications:

1939 Notes on the Life History of the Tide Pool Johnny. Copeia.

1944 The Problem of Enumerating Spawning Populations of Sockeye Salmon. 1944 Annual Report. International Pacific Salmon Fisheries Commission.

1944 Notes Concerning a Map to Show the Distribution of Sockeye Salmon (with D.C.G. MacKay). 1944 Annual Report. International Pacific Salmon Fisheries Commission.

1951 Feeding Habits of the Atlantic Shad. Ecology.

1954 A Review of Research on the Salmon Fisheries of Alaska. US Bureau of Commercial Fisheries (Seattle). (mimeo)

1955 A Brief Review of the Salmon Fisheries in the Aleutian Islands. Bulletin, International North Pacific Fisheries Commission.

1956 A Program of Salmon Research for Alaska. Proceedings, Alaska Science Conference.

1960 Fisheries Research (USSR) - Its Organization and Program with Special Reference to the Pacific Fisheries. US Bureau of Commercial Fisheries (Seattle). (mimeo)

1963 An Inventory of Salmon Research on Pacific Salmon along the Pacific Coast of the United States and Canada. Second Governor's Conference.

1964 The Salmon Fisheries of the Soviet Far East. University of Washington Thesis (MSc).

1965 Shellfish Poinsoning on the Pacific Coast. Binnacle.

1966 Salmon of the North Pacific Ocean. IV Spawning Populations of North American Salmon. 4. Pacific Salmon in the United States. (with J.H. Rose and T.O. Duncan). Bulletin, International North Pacific Fisheries Commission.

1967 A Survey of the Salmon and Trout Resources of the Republic of Korea. (with Chun, et al). US Department of State AID and ROK Office of Fisheries.

1967 Production of Fish Blocks in Japan. US Fish and Wildlife Service, Foreign Fisheries Leaflet 110.

1969 Fisheries of Japan. (in The Encyclopedia of Marine Resources, Frank E. Firth, editor.) Van Nostrand-Reinhold. pp. 330-335.

1973 Shrimp and Prawns in the World Today. (in Fisheries in Japan - Prawns. Japan Marine Products Photo Materials Association Dai Nippon Printing Company. pp. ii-iii.

Publications (continued):

1973 A Review of the Salmon Hatcheries of the Republic of Korea. (with Chun, S.K., Chyung, S.C., Combs, B.J., Donaldson, L.R., Kim, J.D., Pressey, R.T., and Chung, D.Y.) U.S. Department of State (Agency for International Development) and the Republic of Korea, Office of Fisheries. 142 pp.

1974 Sea Bream of Japan. (in Fisheries in Japan - Sea Bream. Japan Marine Products Photo Materials Association.) Dai Nippon Printing Company. pp. ii-iii.

1974 The Role of the University of Alaska in the Research and Development of Alaskan Fisheries. Part I - A Program of Training and Education (Revised). University of Alaska, Office of the President. 87 pp.

1974 Notes on the Salmon Propagation Program in Hokkaido, 1974. American Embassy Tokyo. 16 pp.

1975 The Role of the University of Alaska in the Research and Development of Alaskan Fisheries. Part II - Organization of Research. University of Alaska, Office of the President. 119 pp.

1975 Tuna. (in Fisheries in Japan - Tuna. Japan Marine Products Photo Materials Association.) Dai Nippon Printing Company. p. iii.

1976 Salmon Aquaculture in Japan, the Koreas, and the USSR. (in Salmon Aquaculture and the Alaskan Community.) University of Alaska, Sea Grant Report 76-2 (February 1976). pp. 79-154.

1976 Marketing Fish in Japan. Part I - Background of Fisheries and Eating Habits of the Japanese People. University of Alaska, Alaska Seas and Coasts (February 15, 1976), volume 4, number 1. pp. 1-3.

1976 Marketing Fish in Japan. Part II - The Domestic Market. University of Alaska, Alaska Seas and Coasts (April 15, 1976), Volume 4, number 2. pp. 4-7.

1976 Marketing Fish in Japan. Part III - Exports to Japan. University of Alaska, Alaska Seas and Coasts (June 15, 1976), volume 4, number 3. pp. 8-11.

1976 The Importance of Mackerel and Skipjack Fisheries. (in Fisheries in Japan - Skipjack and Mackerel. Japan Marine Products Photo Materials Association.) Dai Nippon Printing Company. pp. iii-iv.

Publications (continued):

1976 Development and Potential Yield of Arctic Fisheries. (Chapter 24 in Assessment of the Marine Environment - Selected Topics, D. W. Hood and D. C. Burrell, editors.) Institute of Marine Science, University of Alaska Fairbanks. pp. 389-400.

1976 United States and the 200-Mile Exclusive Economic Zone. Lecture, National Fisheries University of Busan (Korea), May 26, 1976. 73 pp.

1977 Fisheries and Markets for Tanner Crab in the Northeast Asian Countries. (in The Bering Sea Tanner Crab Resource: U.S. Production Capacity and Marketing). University of Alaska, Sea Grant Report No. 77-5, May 1977. pp. 125-153.

1977 Aquaculture of China. (in World Aquaculture (approximate title), E. Evan Brown, editor). (in press)

1977 Aquaculture of the Eastern USSR. (in World Aquaculture (approximate title), E. Evan Brown, editor). (in press)

1977 The Role of the University of Alaska in the Research and Development of Alaskan Fisheries. Part III - Development of Fisheries. University of Alaska, Office of the President, June 1977. 48 pp. and appendices

1977 Northeast Asian Fisheries. Lecture, University of British Columbia, March 22, 1977. 43 pp.

1978 Statistics of the Crab Fisheries of Japan. University of Alaska Sea Grant Program. (in press)

1978 Statistics of the Tuna, Skipjack and Billfish Fisheries of Japan. Micronsian Maritime Authority. (in manuscript)

1978 The Feasibility of Establishing a Fishing Base at Ponape: An Interim Report. Marine Resources Division, Trust Territory of the Pacific Islands, Ponape, East Caroline Islands. (in manuscript)

CLINTON E. ATKINSON

Fisheries Consultant and Advisor

8000 CREST DRIVE NORTHEAST
SEATTLE, WASHINGTON 98115
TELEPHONE - (206) 524-4242
TELEX - (TWX) 910 444 2108

May 20, 1979

SUPPLEMENTAL STATEMENT

Experience in Alaskan Fisheries and Salmon Research

Alaskan Fisheries -

1. Director of Biological Research for the United States Bureau of Commercial Fisheries (now the National Marine Fisheries Service), including extensive research on salmon in all major fishing/spawning areas in Alaska from Southeast Alaska to Bristol Bay. At that time, research projects were carried out in the Cook Inlet area and the staff was involved in a cooperative study of the proposed development of the upper Susitna river for hydro-electric power. (1952-1956/57).

2. Advisor to the President of the University of Alaska with specific duties to develop a fisheries curricula for the various campuses at the University of Alaska. I have been called in by the University of Alaska to review the program for progress and accomplishment and am engaged in such a review at the present time.

   During this study, I was also directed by the President to study the the organization of the fisheries research program in the University and to make appropriate recommendations. (1974-1977, 1979)

3. Chairman of the Alaska Interagency Fisheries Committee, composed of the President of the University of Alaska, the Regional Director of the National Marine Fisheries Service, the Commissioner of the Alaska State Department of Fish and Game, the Chairman of the Alaska State Senate Committee on Natural Resources and a representative of the Governor's office. (1974-1977)

4. Member of the Board of Directors, Whitney-Fidalgo Seafoods Inc., one of the largest fishing companies operating in Alaska. (1974-1977)

Salmon Fisheries -

1. Staff of the International Pacific Salmon Fisheries Commission, in charge of escapement and other studies on the spawning grounds in the Fraser river, and other related duties. (1938-1948)

2. Director of Biological Research and Chief Pacific Salmon Investigations for the United States Bureau of Commercial Fisheries (see 1 above), but including extensive research on fish passage problems on the dams of the Columbia river (mainly financed by the US Corps of Engineers).

Salmon Fisheries (continued)

The research program also served as the principle agency for the investigation of the distribution of Asian and North American stocks of salmon in the North Pacific and an evaluation of the numbers taken by the Japanese high-seas fisheries. (1952-1965)

3. Member of a number of technical and advisory committees on planning, coordination and negotiation of salmon programs and problems.

4. Two Citations of Recognition from the Governor of Niigata and the Salmon Resource Conservation Preservation Association (Japan) for assistance in developing the salmon propagation programs in Japan.

5. Citation of Recognition from the Republic of Korea for assistance in the survey of the salmon resources of the Republic of Korea and in establishing a salmon propagation program for that country. (1973)

6. Head of delegation of salmon experts to participate in a four-nation salmon symposium at South Sakhalin (USSR) and adjunct professor for the University of Alaska. (1978)

Clinton D. Atkinson

PERSONAL AND PROFESSIONAL RECORD

Milo C. Bell

PERSONAL:

Education - University of Washington, Seattle, Washington
graduated March 1930 (B.S. in M.E.)

Professional Engineer, registered in the States of Washington and Idaho

ACADEMIC:

University of Washington, College of Fisheries:

Special lecturer, 1940 to 1953
Research Associate Professor, 1953 to 1958
Associate Professor, 1958 to 1963
Professor, 1963 to 1975
Professor Emeritus, 1975

Courses given at other universities:

Duke University, North Carolina - summer, 1952
University of Maine - Special lecturer, winter quarter, 1958
University of Alaska - Seminar on Salmon Hatchery Design, July, 1976

HONORS:

Member, National Academy of Engineering, 1968
Association of Conversation Engineers' Eugene Baker Award, 1969

PROFESSIONAL SOCIETIES:

Fellow, American Institute of Fishery Research Biologists, 1973

PUBLICATIONS AND PAPERS:

Engineering section, annual reports, Washington Department of Fisheries, 1935-43

Engineering section, Report of the Preliminary Investigations into the Possible Methods of Preserving the Columbia River Salmon and Steelhead at the Grand Coulee Dam, 1938.

International Pacific Salmon Fisheries Commission:

Engineering section, annual reports, 1943-51

Interim Report on the Chilko River Watershed, 1949

Engineering section, Report on the Fisheries Problems Created by the Development of Power in the Nechako-Kemano-Nanika River Systems, 1951

Engineering section, A Report on the Fish Facilities and Fisheries Problems Related to the Fraser and Thompson River Dam Site Investigations, 1955

Salmon Fisheries versus Power Development (article in World Fishing), 1954

Engineering section (Fisheries), Passamaquody Fisheries Investigations (joint authorship with C. H. Clay), 1959

A Study of the Upstream Passage of Anadromous Fish at Willamette Falls, with Recommendations for Improvements in Fish Passage Facilities (co-author, Harlan B. Holmes), 1960

A Study Report on the Fisheries and Fish Maintenance Proposals Relating to High Mountain Sheep Dam, Snake River, Idaho (co-author J. A. R. Hamilton), 1960

Engineering and Biological Study of Proposed Fish Passage at Four Dams on Susquehanna River, Pennsylvania (co-author, Harlan B. Holmes), 1962

Water Requirements for Fish, Wildlife and Recreation, Section F, Part IV. In A First Estimate of Future Demands for Water in the State of Washington, Volume I of a Four-Volume Report entitled, An Initial Study of Water Resources of the State of Washington, State of Washington Water Research Center, 1967

Compendium on Passage of Small Fish through Turbines (co-authors, Allan C. DeLacy and Gerald J. Paulik), Corps of Engineers, North Pacific Division, Portland, Oregon, 1967

A Compendium on the Survival of Fish Passing through Spillways and Conduits (co-author, Allan C. DeLacy; Special Section on Stilling Basin Hydraulics by Howard D. Copp), Corps of Engineers, North Pacific Division, Portland, Oregon, 1968

Informational Report on Proposed Methods of Treatment of Effluent from Rifle Falls Trout Hatchery, Colorado, 1970

Report on Potential Pollution Problems Associated with the Operation of the Proposed Capilano River Hatchery, British Columbia, 1970

Present Value, Columbia River Water (Fisheries) and Physical and Biological Effects of Major Withdrawals (Temperature). In The Columbia River as a Resource, Report No. 5, State of Washington Water Research Center, 1971

Bonneville Environmental Study: Impacts on Fish and Wildlife, The Dalles to Vancouver, Corps of Engineers, Portland District, Portland, Oregon, 1971

Fisheries Handbook of Engineering Requirements and Biological Criteria, Corps of Engineers, North Pacific Division, Portland, Oregon, 1973

Morgan Lake Fisheries Investigation, Summary Report, 1973

A Report on the Laboratory Examination of a Permeable Dyke as a Fish Barrier (co-authors, Ronald E. Nece and Russell G. Porter), 1974

T. W. Sullivan Power Plant Screening Study (co-authors, Howard S. Strausser and Russell G. Porter), 1974

Environmental Impact Assessment, Kamilche Point Homesite Development, Washington, 1974

Model Development and Systems Analysis of the Yakima River Basin (Fisheries), (co-author, Brian W. Mar), Washington Water Research Center, Pullman, Washington, 1974

Study to Determine Impacts of Power Peaking on the Fish and Wildlife Resources, Columbia River, Washington and Oregon, Corps of Engineers, North Pacific Division, Portland, Oregon, 1974.

Screening of Intakes at Thermal Power Plants (co-author, Russell G. Porter). In manuscript form to be published by Washington Water Research Center.

Research Needs Regarding Reversible Pump-Turbines as Related to Fish Passage, 1974

Follow-up Program Development, Columbia River from Grand Coulee Dam to the Snake River (co-authors, Zell E. Parkhurst, Russell G. Porter, and Marjorie Stevens), University of Washington, Seattle, Washington. Financed by National Marine Fisheries Service, Portland, Oregon, 1975

Effects of Power Peaking on Survival of Juvenile Fish at Lower Columbia and Snake River Dams (co-authors, Zell E. Parkhurst, Russell G. Porter, and Marjorie Stevens), Corps of Engineers, North Pacific Division, Portland, Oregon, 1976

Follow-up Development Program, Columbia River Tributaries Downstream from Grand Coulee Dam, Excluding the Snake and Willamette Rivers (co-authors, Zell E. Parkhurst, Russell G. Porter, and Marjorie Stevens), University of Washington, Seattle, Washington. Financed by National Marine Fisheries Service, Portland, Oregon, 1977

RESEARCH ACTIVITIES:

Development, by use of models, of the slotted baffle fishway (currently in use in the Pacific Northwest and western Canada)

Designed and installed an artificial spawning channel on the Mokelumne River in California

Head losses encountered in use of wire cloth for fish protective screening

Siltation effects in salmon and trout spawning redds (streambed silting)

Major effects on environment in a closed lake system heated by stream generation

Development and installation of equipment for testing the swimming speeds and endurance of salmonoid fish

Development and installation of equipment for testing behavior of fish under light stress conditions

Design of recovery equipment for river testing of juvenile fish

Isolation of physical factors necessary for measuring the success of spawning of salmonoid fish

Effects of stress on fish passing through water use projects

Programming for experiments on passage of fish through turbines and spillways

Development, by use models, of a permeable dyke

Model study for reconstruction of the forebay for downstream migrant passage, T. W. Sullivan Power Plant, Willamette River, Oregon

Model study of a louver screen section for application at the T. W. Sullivan Power Plant, Willamette River, Oregon

Developed plans for the use of heated water in a hatchery proposed by Puget Sound Power and Light Company on the Skagit River, 1976

GENERAL ACTIVITIES:

1930-33; Chief Engineer, Washington Department of Fisheries. Major work included development and installation of the first rotary fish screens in the State of Washington and the development of bypasses.

1933-35: Consultant for the States of Washington and Oregon, assigned to Bonneville Dam project, Columbia River, with the status of a consultant for the Corps of Engineers. Co-holder of basic patents for the fishway systems developed for this project and subsequently used at other major Columbia River dams.

1935-43: Chief Engineer, Washington Department of Fisheries, with responsibility for design, construction and installation of fishways and rotary fish screens in the Yakima, Wenatchee, Entiat, Methow, and White River systems. Activities related to the design and construction of the Grand Coulee salvage facilities at Rock Island Dam, Icicle, Entiat, and Methow Rivers. Designed and constructed numerous hatcheries and the Minter Creek Biological Station. With the United States Geological Survey, established a means of measurement of small streams on an area basis.

1941-43: Consultant to International Pacific Salmon Fisheries Commission. Inaugurated required field work and experimentation for the fish facilities at Hell's Gate Canyon, Fraser River, British Columbia.

1943-51: Chief Engineer and Associate Director, International Pacific Salmon Fisheries Commission. Responsible for construction of the Hell's Gate, Bridge River Rapids, and Farwell Canyon fishways and the Horsefly Lake Biological Field Station. Conducted spawning ground area and lake surveys.

1949 to present: Consultant, Corps of Engineers (North Pacific Division and District offices) on fish facilities design and research programs in the Columbia and Willamette Rivers and the Puget Sound area.

1951-57: Technical Coordinator, Washington Department of Fisheries, heading all biological and hatchery research programs and engineering and stream improvement activities for the department; Acting Director, 1957.

1968-69: Acting Director, Water Research Center, State of Washington.

Consulting activities have included assignments for the States of Pennsylvania, Washington, Oregon, Idaho, and California, Federal agencies of the United States and Canada, and public and private water developers in Washington, Oregon, California, Massachusetts, Michigan, New Mexico, and New York.

CONFEREE AT INTERNATIONAL FISHERIES CONVENTIONS:

Advisor to United States delegation on Pink Salmon Treaty, Ottawa, Canada, 1956

Member of United States delegation at Conference on Coordination of Fishery Regulations between Canada and the United States, 1957

MISCELLANEOUS ACTIVITIES:

Alternate member and member, Washington State Pollution Control Commission (past)

Chairman, Planning Commission, City of Blaine, Washington (past)

Member, Pacific Marine Fisheries Commission (past)

Citizen member, Water Resources Advisory Committee, Washington State Legislature (past)

Panel member, First Governors' Salmon Conference, Juneau, Alaska, 1961

Panel chairman, Second Governors' Salmon Conference, Seattle, Washington, 1963

Member, Joint Scientific Committee, State of Washington Water Research Center, 1964 to 1966 and 1969 to 1974 (Chairman during 1970)

Moderator and member of Planning Committee, Land and Water Use Seminar, League of Women Voters, Portland, Oregon, 1967

Member, Fish and Wildlife Committee, Pacific Northwest River Basins Commission, April 1969 to present

Fishery advisor to the Quinault Tribal Council, Washington on river problems and fisheries production programs, 1969 to 1974

Member, Water Law Revision Advisory Committee, Washington Department of Ecology (past)

Panel member, Fisheries Seminar of the Lower Mekong River Development Panel, Santa Barbara, California, February, 1972

Member, American Nuclear Society Standards Committee (protection of aquatic organisms at intakes and discharges), January, 1973 to present

Participant and panel member, Entrainment and Intake Screening Workshop, The Johns Hopkins University, Baltimore, Maryland, February, 1973.

Member, Fish Advisory Board, Consolidated Edison Company of New York, 1974 to present

Member, Fish Facility Board of Consultants, California Department of Water Resources, 1974 to present

Chairman of session on Engineering Conceptual Designs and Fish Passage, Engineering Foundation Conference on Environmental Aspects of Hydroelectric and Pumped Storage projects, Rindge, New Hampshire, 1975

Panel member, Technical Session on Hydraulics of Fish Hatcheries, American Society of Civil Engineers (Hydraulics Division) Specialty Conference on Hydraulic Engineering for Optimal Use of Water Resources, Seattle, 1975

Member, American Society of Civil Engineers (Hydraulics Division) Task Committee on Fish Handling Capacity of Intake Structures, 1975 to present

Member Dworshak Hatchery Review Committee, U.S. Fish and Wildlife Service, Portland, Oregon, 1975

Fishery advisor, Lower Elwha Tribal Council, Port Angeles, Washington (fish cultural facilities), 1975 to present

Southern Southeast Regional Aquaculture Association, Inc., Ketchikan, Alaska (fish cultural facilities), 1976 to present

WILDLIFE ECOLOGY

DISCIPLINE COORDINATOR: EDWARD T. REED

PRINCIPAL INVESTIGATORS:

AVIAN ECOLOGY: DR. BRINA KESSEL

BIG GAME ECOLOGY: DR. SAMUEL HARBO

PREDATOR ECOLOGY: DR. PHILIP S. GIPSON

SMALL MAMMAL ECOLOGY: STEPHEN O. MACDONALD

EDWARD T. REED

Terrestrial Environmental Specialists, Inc.

Education

B.S. Science Education; Pennsylvania State University, University Park, Pennsylvania, 1967.
M.S. Wildlife Management, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 1974.

Professional Experience

Environmental Scientist, Terrestrial Environmental Specialists, Inc., Phoenix, New York, 1976 - present.

Associate Environmental Scientist (Director of Mammalian Studies), Equitable Environmental Health, Inc., Woodbury New York, 1974-1975.

Graduate Teaching Assistant (Silviculture), Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 1973.

Biology Instructor, Upper Dublin High School, Fort Washington, Pennsylvania, 1967-1972.

Awards

Gamma Sigma Delta, 1974.

Phi Kappa Phi, 1974.

Memberships

The Wildlif Society
The American Society of Mammalogists
Eastern Bird Banding Association
Editorial Board of Eastern Bird Banding Association
The Ruffed Grouse Society of North America

Consulting and Related Experience

- collected and analyzed data and prepared reports for mammalian studies on six proposed power plant sites.

- critically reviewed an environmental assessment for two proposed power plant sites.

- designed, implemented, and analyzed a technique to assess the habitat suitability of 8,000 acres for selected game species.

Consulting and Related Experience (Continued)

- monitored populations of mammalian species in respect to potential impacts of power plant sitings.
- evaluated the behavioral impact of sport hunting on white-tailed deer.
- designed, implemented and prepared the report of a study to determine species composition of bat populations on proposed power plant sites.
- provided ornithological input to an impact study for a proposed hydroelectric project.
- prepared written testimony concerning mammalian populations and related impacts of power plant construction.
- provided critical review and advice on an impact evaluation of two proposed power plant sitings.
- authored responses to interrogatories concerning baseline ecology studies and related impacts.
- prepared descriptions of the ecology of aquatic fauna and the aquatic impact assessment for a proposed lake shore construction project.
- authored major sections of a comprehensive draft environmental impact statement for a proposed county sanitary landfill.

VITAE

BRINA KESSEL

Birth:

20 November 1925, Ithaca, N.Y.

Education:

B.S. Cornell University, Ithaca, N.Y., 1947
M.S. University of Wisconsin, Madison, 1949
Ph.D. Cornell University, Ithaca, N.Y., 1951

Employment:

Administrative Associate for Academic Programs (including Graduate Studies), Office of the Chancellor, University of Alaska, Fairbanks, 1973-current.
Director of Academic Advising, University of Alaska, Fairbanks, 1973-1979.
Curator of Terrestrial Vertebrate Collections, University Museum, University of Alaska, Fairbanks, 1972-current.
Professor of Zoology, University of Alaska, Fairbanks, 1959-current
Dean, College of Biological Sciences and Renewable Resources, University of Alaska, Fairbanks, 1961-1972.
Head, Department of Biological Sciences, University of Alaska, Fairbanks, 1957-1966.
Associate Professor of Zoology, University of Alaska, Fairbanks, 1954-1959.
Assistant Professor of Zoology, University of Alaska, Fairbanks, 1951-1954.
Instructor in Zoology, University of Alaska, Fairbanks, Summer Session, 1951.
Wisconsin Alumni Research Foundation Assistant, University of Wisconsin, 1948-1949.
Graduate Assistant in Ornithology, Cornell University, 1947-1948, 1949-1951.
G.S. 1 Biologist (Ornithology), U.S. Fish and Wildlife Service, Patuxent Research Refuge, Summer, 1946.
Teaching and Research Assistant, Cornell University, 1945-1947.

Other Experience:

Project Director, University of Alaska Ecological Investigations for AEC Project Chariot, Northwestern Alaska, 1959-1963.
Ornithological Consultant for private industry and government.
Field work undertaken throughout Alaska, but primarily in western, central, and northern Alaska--including Sheenjek River (summer 1956), Chukchi Sea coast (summer 1976), entire Seward Peninsula (summers 1966-1977), Yukon-Kuskokwim Delta (June 1963); also, North Slope (several sites), Cape Thompson, Kivalina, Selawik, Tokotna, Fairwell, Iguigig, Shemya, Cold Bay, Kenai Peninsula, Minto Lakes, entire Alaska Highway system, including Alyeska Haul Road, etc. Funding sources have included U.S. Fish and Wildlife Service, U.S. Forest Service, U.S. National Park Service, U.S. Corps of Engineers, Office of Naval Research, National Science Foundation, Alaska Department of Fish and Game, private foundations, industry, etc.
Editorial Board member for Western Birds and The Murrelet (regional journals).
Referee of journal manuscripts for Auk, Condor, Wilson Bulletin, Syesis, Canadian Journal of Zoology (national journals).

~~Other Experience (continued):~~

Major University Committee Assignments:

Academic Council (17 years; 1960-1977).
Research and Advanced Study Council (15 years; 1960-1974, 1978-).
University Assembly (3 years, 1967-1970).
Self-evaluation Committees for accreditation by Northwest Association of Secondary and Higher Schools (1964, 1969, and 1974).
Academic Development Plan Committee (1973-1975).

Professional Organizations:

American Association for the Advancement of Science, Fellow since 1960 (Life).
American Ornithologists' Union, Fellow since 1973; Vice-President 1976-1977; Governing Council 1969-1972, 1973-1977; (Life).
Arctic Institute of North America. (Fellow)
Cooper Ornithological Society (Life).
Ottawa Field-Naturalists' Club.
Bird-Banding Association.
Pacific Northwest Bird and Mammal Society.
Wilson's Ornithological Society (Life).

Honorary Societies and Who's Who Listings:

Sigma Xi (Cornell University).
Phi Kappa Phi (Cornell University).
Sigma Delta Epsilon (Cornell University).
American Men of Science, since 1954.
Who's Who in America, since 1960 (also in the West, and in American Women).

Selected Publications:

1950. Gillespie, J. H., _____, and J. Fabricant. The isolation of Newcastle disease virus from a starling. Cornell Veterinarian 40:93-94.

1950. Observations on the polygamy and territorial behavior of a male starling (Sturnus vulgaris). Bird-Banding 21:112-114.

1951. Criteria for sexing and aging the European starling (Sturnus vulgaris). Bird-Banding 22:16-23.

1953. Distribution and migration of the European starling in North America. Condor 55:49-67.

1953. Second broods in the European starling in North America. Auk 70:479-483.

1955. Distributional records of waterfowl from the interior of Alaska. Condor 57:372.

Selected Publications (Continued):

1956. Patterns of bird and mammal distribution in Alaska. Science in Alaska 1953:190-197.

1957. A study of the breeding biology of the European starling (Sturnus vulgaris L.) in North America. American Midland Naturalist 58: 257-331.

1958. _____, and T. J. Cade. Birds of the Colville River, Northern Alaska. Biol. Papers University of Alaska, No. 2. 83 p.

1958. _____, and R. W. Kelly. First North American sighting and photographic record of Common Crane, Grus grus. Auk 75:465.

1960. Additional distribution records of some birds in Interior Alaska. Condor 62:481-483.

1960. _____, and G. B. Schaller. Birds of the Upper Valley of the Sheenjek River, Northeastern Alaska. Biol. Papers University of Alaska, No. 4. 58 p.

1963. West-east relationships of the birds of northern Alaska. p. 79-84. In: J. L. Gressitt [ed.], Pacific basin biogeography, a symposium. Bishop Museum Press.

1964. Field Checklist, Birds of Interior Alaska. Revised ed. University of Alaska.

1965. Breeding dates of Rana sylvatica at College, Alaska. Ecology 46: 207-209.

1965. _____, H. K. Springer, and C. M. White. June birds of the Kolomak River, Yukon-Kuskokwim Delta, Alaska. Murrelet 45:37-47.

1966. Saario, D. J., and _____. Human ecological investigations at Kivalina. Chap. 35, p. 969-1039. In: Environment of the Cape Thompson Region, Alaska. U.S. Atomic Energy Commission Div. of Technical Information.

1966. _____, and H. K. Springer. Recent data on status of some Interior Alaska birds. Condor 68:185-195.

1966. The Red-winged Blackbird in Alaska. Auk 83:313-314.

1967. Late autumn and winter bird records from Interior Alaska. Condor 69:313-316.

1967. _____, R. W. Weeden, and G. West. Bird-finding in Interior and Southcentral Alaska, with addendum including Barrow, Nome, Kotzebue, and Juneau. Revised and enlarged edition. Alaska Ornithological Soc. (Processed). 42 p.

Selected Publications (Continued):

1967. Herreid, Clyde F. II., and _____. Thermal conductance in birds and mammals. Comp. Biochem. Physiol. 21:405-414.

1973. Isleib, M.E., and _____. Birds of the North Gulf Coast-Prince William Sound region, Alaska. Biol. Papers University of Alaska, No. 14. 149 p.

1974. Field checklist of the birds of the Seward Peninsula, Alaska. Revised. University of Alaska.

1976. Winter activity patterns of Black-capped Chickadees in Interior Alaska. Wilson Bull. 88:36-61.

1978. _____, and D.D. Gibson. Status and distribution of Alaska birds. Studies in Avian Biology. No. 1. 100 p.

In Press. _____, and D.D. Gibson. Ornithological Investigations, Chukchi-Imuruk Biological Survey, Seward Peninsula. 96 p. (U.S. National Park Service).

Submitted. Avian habitat classification for Alaska.

Submitted. European Starling becomes established at Fairbanks, Alaska in 1978.

Submitted. Spindler, M.A., and _____. Populations and habitat preferences in interior Alaska taiga.

In Prep. Birds of the Seward Peninsula, Alaska.

Contract Completion Reports and Other Documents:

1973. Birds of the Northern Gulf of Alaska, p. 161-173; 685-690. In: Rosenberg, D.H., ed., A review of the oceanography and renewable resources of the northern Gulf of Alaska. Institute of Marine Sciences, Univ. of Alaska, Report R72-23.

1977. Spindler, M.A., and _____. Wetland bird populations in the upper Tanana River Valley, Alaska, 1977. 71 p. (Northwest Alaskan Pipeline Co.).

1978. Raptors and raptor habitat along the Alaska portion of the Northwest Alaskan Gas Pipeline Corridor. 21 p. (Northwest Alaskan Pipelire Co.).

Current Research (Kessel and graduate students):

Birds of Interior Alaska (continuing data collection and compilation)

Migratory movements of Sandhill Cranes in Alaska (data collection; funded by Northwest Alaskan Pipeline Co.)

Waterbirds and wetlands, Chisana-upper Tanana rivers, Alaska (baseline study for Northwest Alaskan Pipeline Co., stressing relationships between habitat and avian productivity)

Birds of Alaska (an active, on-going project of data gathering and compilation for a future book on Alaska birds)

The biology of the puffins... (PhD thesis, Duff H. S. Wehle)

Relationship between feeding ecology and nesting dispersion in Pigeon Guillemots (Cepphus columba) at Naked Island, Prince William Sound, Alaska (MS thesis, Karen L. Oakley)

Plastic pollution in Alaska's seabirds. (MS thesis, Robert H. Day)

Habitat niche relationships of four sparrows in low shrub bog, interior Alaska (MS thesis, Betty A. Anderson)

RESUME TO FOLLOW

DR. SAMUEL HARBO

CURRICULUM VITAE

Philip S. Gipson
Assistant Unit Leader,
Alaska Cooperative Wildlife Research Unit
University of Alaska
Fairbanks, Alaska 99701
Telephone: 907-479-7673 (office)
907-479-4585 (home)

Education: Ph.D., Zoology, University of Arkansas. December, 1971. Dissertation title: "The taxonomy, reproductive biology, food habits and range of wild Canis (Canidae) in Arkansas."

M.S., Zoology, University of Arkansas. December, 1967. Thesis title: "A study of mainland and island populations of small mammals and game animals in northwestern Arkansas."

B.S., Stat College of Arkansas. August, 1964.

Present Position: Assistant Leader of the Alaska Cooperative Wildlife Research Unit. Duties: Develop and supervise research projects in wildlife ecology and related areas. Analyze data, write and edit scientific publications. Serve on graduate student advisory committees and participate in the Wildlife and Fisheries graduate teaching program. Conduct extension education programs and serve on committees as requested by the University and other Cooperators. Assist with administrative activities associated with the Wildlife Research Unit. Research presently supervising: 1) Seasonal movements and diets of wolves in northwestern Alaska, M.S. project, 2) Arctic fox and prey interactions along the Beaufort Sea Coast, two M.S. projects, 3) zoography and systematics of arctic foxes, M.S. project, 4) geographical variation in Alaskan wolves, M.S. project, 5) canid interactions along a transportation and utility corridor, M.S. project, 6) ecology of wolverines in interior Alaska, Ph.D. project. U.S. Fish and Wildlife Service, University of Alaska, Fairbanks. November, 1976 - Present.

Experience: Extension Wildlife Specialist and Assistant Professor, joint research and extension appointment. Research projects: 1) Ecology of known damaging coyotes, 2) coyote social interactions, 3) distribution of coyote x dog hybrids in Nebraska, 4) crop damage caused by deer and pronghorn to alfalfa and corn. Graduate faculty responsibilities: Major advisor to students pursuing M.S. and/or Ph.D. degrees in wildlife ecology. Served as graduate committee member for students

in wildlife ecology and related fields. Extension duties: 1) Worked with County Extension Agents and the public to control wildlife damage to livestock and crops, 2) developed programs to encourage landowners to increase wildlife habitat, and to improve landowner and sportsmen relationships, 3) interacted with professionals in the Extension Service and other agencies to influence their programs for the betterment of wildlife, 4) designed youth programs to develop an appreciation of wildlife and good sportsmanship. Department of Poultry and Wildlife Sciences (now Department of Forestry, Fisheries and Wildlife), Institute of Agriculture and Natural Resources, University of Nebraska, Lincoln, Nebraska 68583. October, 1974 - November, 1976.

Consultant for Marks, Clare, Hopkins, and Rauth, Attorneys at Law, Omaha, Nebraska. Problems associated with managing commensal rodents in food storage facilities. March, 1976 - November, 1976.

Research Associate investigating the ecology of white-tailed deer, and relationships of dogs and deer in regions of Arkansas with high and low density deer populations (home range, activity, heart rate, and body temperature of deer monitored by radio telemetry before, during, and following repeated harrassment with dogs). State-wide survey to determine physical condition of deer caught by dogs. Zoology Department, University of Arkansas. Research sponsored by Arkansas Game and Fish Commission and University of Arkansas. September, 1971 - September, 1974.

Consultant, Arkansas Department of Planning. Endangered species of mammals in Arkansas. July, 1972 - June, 1973.

Research Assistant investigating taxonomy (multivariate analysis of cranial characters), reproductive biology, food habits, and range (radio telemetry) of wild Canis for Ph.D. dissertation. Zoology Department, University of Arkansas. Research sponsored by Arkansas Game and Fish Commission and University of Arkansas. July, 1968 - August, 1971.

Teaching Assistant in General Biology, General Zoology and Comparative Anatomy. Zoology Department, University of Arkansas. September, 1967 - June, 1968.

Seasonal Ranger. Pea Ridge National Military Park, Pea Ridge, Arkansas. July, 1966 - January, 1967.

Research Assistant investigating island vs. mainland small mammal and game animal populations for M.S. thesis. Zoology

Department, University of Arkansas. Research sponsored by Arkansas Game and Fish Commission and University of Arkansas. June, 1966 - August, 1967.

Biologist Aide, herring research. Alaska Department of Fish and Game, Petersburg, Alaska. June, 1965 - August, 1965.

Science teacher, public schools. Juneau, Alaska. January, 1965 - May, 1965 and September, 1965 - May, 1966.

Scientific Publications:

Gipson, P.S. 1974. Food habits of coyotes in Arkansas. The Journal of Wildlife Management. 38(4):848-853.

Gipson, P.S. 1975. Efficiency of trapping in capturing offending coyotes. The Journal of Wildlife Management. 39(1):45-47.

Gipson, P.S. 1976. Melanistic Canis in Arkansas. The Southwestern Naturalist. 21(1):124-126.

Gipson, P.S. 1977. Abortion and consumption of fetuses by coyotes following abnormal stress. The Southwestern Naturalist. 21(4):558-559.

Gipson, P.S. 1978. Coyotes and related Canis in the southeastern United States with a comment on Mexican and Central American coyotes. Pages 191-208. In Beckoff, M. (Editor). Coyotes: Biology and behavior. Academic Press, Inc., New York. 384 p.

Gipson, P.S., and J.A. Sealander. 1972. Home range and activity of the coyote (Canis latrans frustror) in Arkansas. Proceedings of the Twenty-Sixth Annual Conference of the Southeastern Association of Game and Fish Commissioners: 82-95.

Gipson, P.S., and J.A. Sealander. 1975. Changing food habits of wild Canis in Arkansas with emphasis on coyote hybrids and wild dogs. American Midland Naturalist. 93(1):249-253.

Gipson, P.S., and J.A. Sealander. 1977. Ecological relationships of white-tailed deer and dogs in Arkansas. Pages 3-16. In Phillips, R.L., and C. Jonkel (Editors). Proceedings of the Predator Symposium. University of Montana. 268 p.

Gipson, P.S., I.K. Gipson, and J.A. Sealander. 1975. Reproductive biology of wild Canis in Arkansas. Journal of Mammalogy. 56(3):605-612.

Gipson, P.S., J.A. Sealander, and J.E. Dunn. 1974. The taxanomic status of wild Canis in Arkansas. Systematic Zoology. 23(1):1-11.

Andelt, W.F., and P.S. Gipson. 1978. Seasonal movement of coyotes on the Great Plains. Journal of Wildlife Management. In Press.

Buskirk, S.M., and P.S. Gipson. 1978. Characteristics of wolf attacks on moose in Mount McKinley National Park, Alaska. Arctic. In Press.

Dunn, J.E., and P.S. Gipson. 1977. Analysis of radio telemetry data in studies of home range. Biometrics. 33(1):85-101.

Mahan, B.R., and P.S. Gipson. 1978. Osteoarthrosis in a coyote x dog hybrid from Nebraska. Journal of Wildlife Diseases. Journal of Wildlife Diseases. 14:395-398.

Mahan, B.R., P.S. Gipson, and R.M. Case. 1978. Charcter-istics and distribution of coyote x dog hybrids in Nebraska. American Midland Naturalist. 100(1):191-197.

Sealander, J.A., and P.S. Gipson. 1972. Range extension of ring-tailed cat into Arkansas. The Southwestern Naturalist. 16(3&4):458-459.

Sealander, J.A., and P.S. Gipson. 1973. Status of the mountain lion in Arkansas. Arkansas Academy of Science Proceedings. 27:38-41.

Sealander, J.A., and P.S. Gipson. 1974. Threatened native mammals of Arkansas. Pages 123-127. In R. Cullom, B. Shepard, and B. Harbour (Project supervisors), Arkansas Natural Area Plan. Arkansas Department of Planning, Little Rock. 248 p.

Sealander, J.A., P.S. Gipson, and J.M. Hite. 1975. The distribution of the prairie vole (Microtus ochrogaster) and the southern bog lemming (Synaptomys cooperi) in Arkansas. Texas Journal of Science. 26(3&4):421-430.

Scientific Abstracts:

Gipson, P.S. 1975. Coyotes and related Canis in Arkansas. Coyote Research Newsletter. 3(1):4.

Gipson, P.S. 1975. Home range and activity patterns of white-tailed deer. Transactions of the Central Mountains and Plains Section of the Wildlife Society. 20:9.

Gipson, P.S., and J.A. Sealander. 1975. Ecological relationships of white-tailed deer and dogs in Arkansas. American Society of Mammalogists Annual Meeting. 55:101.

Gipson, P.S., and J.H. Quinn. 1977. Fossil Canis of the Ozark Region. American Society of Mammalogists Annual Meeting. 57:13.

Andelt, W.F., and P.S. Gipson. 1977. Seasonal movements of coyotes in Nebraska. American Society of Mammalogists Annual Meeting. 57:18.

Gier, H.T., and P.S. Gipson. 1976. Fluctuations of coyote populations on the Great Plains. American Society of Mammalogists Annual Meeting. 56:23.

Scientific Publications in Preparation:

Gipson, P.S. 1978. Food habits and diets for coyotes. CRC Handbook Series in Nutrition and Food. CRC Press, Inc. In Preparation.

Gipson, P.S., and J. Quinn. 1978. Post-Pleistocene Canis in the Ozark Region. In Preparation.

Andelt, W.F., and P.S. Gipson. 1978. Poultry and livestock depredations by radio-tagged coyotes. Submitted for publication.

Andelt, W.F., and P.S. Gipson. 1978. Coyote movements around den sites with emphasis on a mated pair. Submitted for publication.

Pledger, J.M., J.A. Sealander, P.S. Gipson, M.E. Cartwright. 1978. Habitat utilization by white-tailed deer in southeastern Arkansas. In Preparation.

Sealander, J.A., and P.S. Gipson. 1978. Physiological changes in white-tailed deer during and after controlled pursuit by dogs. In Preparation.

Popular and Extension Publications:

Gipson, P.S. 1972. Wild canids of Arkansas: Past, present and future. Ozark Society Bulletin 6:5-6.

Gipson, P.S. 1973. Coyote research in Arkansas. Proceedings of Great Plains wildlife damage control workshop. Kansas State University, Manhattan: 70-71.

Gipson, P.S. 1974. Coyotes and related canids in Arkansas. Arkansas Game and Fish. 7:8-10.

Gipson, P.S. 1976. Feral mammal damage and control. Proceedings of the second Great Plains wildlife damage control workshop. Kansas State University: 109-115.

Gipson, P.S. 1976. Wildlife damage control workshop summary. Proceedings of the second Great Plains wildlife damage control workshop. Kansas State University: 211-212.

Gipson, P.S. 1978. Prevention and control of damage caused by coyotes, wolves, dogs and foxes. In Henderson, F.R. (Editor), Wildlife damage: Prevention and control handbook. Kansas State University.

Gipson, P.S., and J.A. Sealander. 1974. The dog-deer study: A progress report. Arkansas Game and Fish. 6:10-13.

Gipson, P.S., and G.W. Froning. 1976. Processing small game mammals. Neb Guide. Nebraska Cooperative Extension Service. 4 p.

Gipson, P.S., J. Morris, and D. Fiet. 1976. Farm ponds for Nebraskans. Nebraska Cooperative Extension Service and Nebraska Game and Parks Commission, Lincoln. 14 p.

Case, R., J. Stubbendieck, and P.S. Gipson. 1977. Pocket gophers and their control. Nebraska Cooperative Extension Service. 3 p.

Froning, G.W., and P.S. Gipson. 1976. Processing and preparing big game. Neb Guide. Nebraska Cooperative Extension Service. 3 p.

Froning, G.W., and P.S. Gipson. 1976. Processing game birds. Neb Guide. Nebraska Cooperative Extension Service. 3 p.

Mahan, B.R., P.S. Gipson, and R.M. Case. 1978. Coydogs play role in Nebraska's Wilds. University of Nebraska Farm, ranch, and home quarterly. 24(4):17-18.

Other Professional Activities:

Served as reviewer for scientific articles submitted for publication in Journal of Mammalogy, Journal of Wildlife Management, Science, and Proceedings of Annual Conference of Southeastern Association of Game and Fish Commissioners. Reviewer for research grant proposals submitted to the National Science Foundation. Presented invited seminars at Colorado State University and Kansas State University. Organized a carnivore workshop at University of Alaska. Offered graduate seminars through the Wildlife and Fisheries Program, University of Alaska, during 1977 and 1978. Presented 6 guest lectures in graduate and undergraduate classes during 1977 and 1978.

Formal papers presented at the following scientific meetings:

Annual meeting of the Southwestern Association of Naturalists, 1971. Received Wilks Award for Best Student Paper.

Annual conference of the Southeastern Association of Game and Fish Commissioners. Two papers presented, 1972 and 1974.

Annual Midwest Wildlife Conference. 1973.

Great Plains animal damage control workshop at Kansas State University. 1973.

Coyote Research Workshop sponsored by U.S. Fish and Wildlife Service, Denver. 1974.

Nebraska Wildlife Habitat Conference sponsored by Nebraska Game and Parks Commission, Lincoln. 1975.

Annual meeting of American Society of Mammalogists. 1975.

Annual meeting of Central Mountains and Plains Section of the Wildlife Society. 1975.

Great Plains animal damage control workshop at Kansas State University. Presented two papers and served as session chairman. 1975.

Annual meeting of American Society of Mammalogists. 1977.

Research Goals: Conduct research with mammals, focusing on predator-prey relationships, interactions among predators, and effects of resource development on wildlife.

Professional Organizations: The Wildlife Society, Northwest Section of the Wildlife Society, Alaska Chapter of the Wildlife Society, American Society of Mammalogists, Ecological Society of America, Sigma Xi, American Institute of Biological Sciences.

VITAE

STEPHEN O. MACDONALD

Birth:
27 June 1948, Cloquet, Minnesota

Education:

-- University of Minnesota, Deluth
B.S. University of Alaska, Fairbanks, 1975

Employment and Experience:

Museum Technician I, University of Alaska Museum, Fairbanks, 1977-current. Curatorial, (mammals) and research activities, including principal investigator for small mammal and bird population studies for the baseline studies for the Delta Barley Project, interior Alaska, and mammalogist for a reconnaissance of the mammals of the Skagway-Haines area of Alaska.

Game Technician II, Alaska Department of Fish and Game, Fairbanks, 1976. Logistic planning and field research censusing birds of the coastal habitats of the Chukchi Sea, northern Alaska.

Museum Assistant, University of Alaska Museum, Fairbanks, 1974-75. Curatorial activities and field research conducting a bird species habitat inventory of mainland southeastern Alaska, under a UAF contract with the U. S. Forest Service.

Field Assistant, Institute of Arctic Biology, University of Alaska, Fairbanks, Summers 1970 & 1971. Assisting in various avian field studies at Barrow, Prudhoe Bay, Eagle Summit, and College, Alaska.

Other. Twenty-four years experience in furbearing animal trapping in Minnesota and Alaska.

Professional Organizationa:

American Society of Mammalogists
Ottawa Field-Naturalists' Club (Canadian Field-Naturalist)

Publications:

1978. Checklist - Mammals of Alaska. University of Alaska Museum. 2 p.

Reports:

1975. Bird species and habitat inventory, mainland southeast Alaska, summer 1974. Univ. of Alaska Museum report to U. S. Forest Service. 73 p. (with D. D. Gibson)

1975. The birds of the Chickamin River, Alaska. Unpublished manuscript, Univ. of Alaska Museum, 157 p. (with Nena MacDonald)

Reports (cont'd):

1979. A reconnaissance of the mammals - Skagway/Haines, Alaska, region, June 1978. Univ. of Alaska Museum report to U. S. Forest Service. 16 p.

1979. Breeding birds and small mammals in the Delta Barley Project area, Alaska. Univ. of Alaska Museum report to Alaska Division of Lands. 63 p.

PLANT ECOLOGY

DISCIPLINE COORDINATOR: JOSEPH M. MCMULLEN

PRINCIPAL INVESTIGATOR: PATRICK J. WEBBER

JOSEPH M. MCMULLEN

Terrestrial Environmental Specialists, Inc.

Education

B.S. Biology (Major); Saint Francis College, Loretto Pennsylvania, 1971.
M.S. Biology (Botany, Ecology); West Virginia University Morg[illegible]own, West Virginia, 1974.

Professio[illegible]

Envi[illegible]st, Terrestrial Environmental Spec[illegible] Phoenix, New York, 1976 - present.

Associa[illegible]al Scientist (Director of Plant Ecolo[illegible]e Environmental Health, Inc., Woodbury, New York, [illegible].

Assistant Environmental Scientist (Plant Ecologist), Environmental Analysts, Inc., Garden City, New York, 1975.

Graduate Teaching Assistant (General Biology, Botany), Department of Biology, West Virginia University, Morgantown, West Virginia, 1971-1974.

Awards

Grant-in-aid of research from The Society of Sigma Xi, 1972.

Memberships

American Institute of Biological Scientists
The Wildlife Society (New York Chapter)
Society of American Foresters
Southern Appalachian Botanical Club

Consulting and Related Experience

- designed, implemented, and prepared reports for botanical studies of hardwoods forests, plant succession, and threatened and endangered species.

- prepared vegetation cover type maps for 12,000 acres of mixed communities.

- assisted in the development of two FORTRAN programs for the analysis of vegetation data.

Consulting and Related Experience (Continued)

- collected data and assisted in writing the botanical portion of a study of prescribed burning as a vegetation management technique.

- prepared written testimony and interrogatory responses concerning plant communities and related impact of power plant construction.

- critically reviewed botanical portion of a baseline terrestrial ecology study for two power plant sites.

- supervised technical personnel conducting a botanical survey on a total of 8,000 acres of land.

- collected, analyzed and interpreted data for plant ecology studies on the primary and secondary sites for a proposed major electric generating station.

- provided technical information for slash disposal estimates following land-clearing operations for construction purposes.

- authored vegetation section concerning the environmental impact of a proposed beach and town rehabilitation project.

- prepared sections on soils and vegetation for an environmental report on the renovation of an existing, non-operating hydroelectric generating facility.

- prepared a report on the status of endangered plant species in the vicinity of a proposed hydroelectric facility.

- supervised the preparation and authored various sections of a comprehensive draft environmental impact statement prepared under the guidelines of the New York State Environmental Quality Review Act for a proposed county sanitary landfill.

- designed and supervised the data collection and report preparation for an intensive study of vegetation and designed a five-year monitoring program to assess the impacts of the construction of a nuclear power plant in New Jersey.

- provided input for an environmental assessment and routing analysis for a 138 kV transmission line in Pennsylvania.

- participated in an environmental assessment and routing analysis for a 115 kV transmission line in northern New York.

- prepared a vegetation cover map and flora survey for a 4,300 acre naval base in Virginia.

Patrick J. Webber

Biographic and Professional Sketch

Pat Webber is a plant ecologist. He is 41 years old and a native of Bedfordshire, England. He is Professor of Environmental, Population and Organismic Biology at the University of Colorado in Boulder. In September, 1979, he will become Director of the Institute of Arctic and Alpine Research at the University of Colorado. Professor Webber has carried out research in the Arctic for 17 years. He has also done extensive research in the Colorado Rockies and southern California. In addition to research in North America, Webber has done field work in northern Sweden, arctic Siberia, northern India, central Chile, and andean Venezuela. He is a Fellow of the Arctic Institute of North America, a member of the editorial board of the journal *Arctic and Alpine Research*, and a member of several scientific societies. Professor Webber has published over 60 scientific papers and reports. His interests are broad and he describes his research as being directed at promoting the preservation of arctic and alpine environments by means of the study of vegetation dynamics and controls. He has pioneered methods of mapping and describing tundra vegetation and has several current research grants and contracts concerning botanical field research in Alaska. This research is funded by U.S. National Science Foundation, U.S. Army Corps of Engineers, U.S. Geological Survey. It concerns the botanical aspects of oilfield and highway development and management. He has also received funding from the U.S. National Aeronautics and Space Administration, U.S. Department of Energy, U.S. Bureau of Reclamation, and the U.S. Bureau of Land Management.

Curriculum Vitae

PATRICK JOHN WEBBER

Institute of Arctic and Alpine Research
University of Colorado
Boulder, Colorado 80309

May 22, 1979

Name	Patrick John WEBBER
Date of Birth	February 24, 1938
Place of Birth	Luton, Bedfordshire, United Kingdom
Degrees	B.Sc. General Honors in Botany and Zoology, Reading, U.K. 1959
	B.Sc. Special Honors in Botany, Reading, U.K. 1960
	M.Sc. Plant Ecology, Queen's, Canada 1963
	Ph.D. Plant Ecology, Queen's, Canada 1971

Experience

1958-1959	Field Assistant, Nature Conservancy, U.K.
1959-1960	Instructor in Botany, University of Reading
1960-1966	Instructor in Biology, Queen's University
1966-1969	Assistant Professor of Biology, York University
1969-1972	Assistant Professor, Department of Biology and Institute of Arctic and Alpine Research, University of Colorado
1972-1978	Associate Professor with tenure, Department of Environmental, Population and Organismic Biology and Institute of Arctic and Alpine Research, University of Colorado
1978-Present	Full Professor with tenure, Department of Environmental, Population, and Organismic Biology and Institute of Arctic and Alpine Research, University of Colorado
1971-Present	Associate Curator of Botany, University of Colorado Museum

Awards and Fellowships

Bedford County Scholarship, 1956-60
National Research Council of Canada Studentship, 1962-65
Province of Ontario Graduate Fellowship, 1965-66
National Science Foundation Travel Grant to Ireland and Great Britain, April 1973
National Science Foundation Travel Grant to USSR, July 1976
University of Colorado Faculty Fellowship, 1978-1979
Fellow of the Arctic Institute of North America, 1978 to present
Fellow of the New York Academy of Sciences, 1978 to present

Scientific Society Memberships

American Association for the Advancement of Science
American Institute of Biological Sciences
Arctic Institute of North America
Canadian Botanical Association
Ecological Society of North America
International Association for Ecology
Colorado Native Plant Society
National Geographic Society, Washington
Sigma Xi Honor Society
Phi Sigma Honor Society

Published Papers

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Webber, P.J., 1977. Belowground tundra research: a commentary. *Arctic and Alpine Research*, 9(1): 105-111.

Webber, P.J. and D.C. May, 1977. The distribution and adaptive strategy of belowground plant structures in the alpine tundra of Niwot Ridge, Colorado. *Arctic and Alpine Research*, 9(1): 157-174.

Webber, P.J. and D.R. Klein, 1977. Geobotanical and ecological observations at two locations in the west-central Siberian arctic. *Arctic and Alpine Research*, 9(2): 305-315.

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Book Chapters (cont.)

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Komárková, V. and P.J. Webber, 1977. *Annotated List of Vascular Plants from the Meade River Area Near Atkasook, Alaska.* RATE (Research on Arctic Tundra Environments) Data Report, Division of Polar Programs, National Science Foundation, Washington. 18 pp.

Walker, D.A., P.J. Webber, K.R. Everett, and J. Brown, 1977. *The Effects of Low-Pressure Wheeled Vehicles on Plant Communities and Soils at Prudhoe Bay, Alaska.* U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire, Special Report No. 77-17. 49 pp.

Webber, P.J., V. Komárková, D.A. Walker, and E. Werbe, 1978. Vegetation mapping and response to disturbance along the Yukon River-Prudhoe Bay Haul Road. *In* Brown, J. (ed.), *Ecological Baseline Investigations Along the Yukon River-Prudhoe Bay Haul Road, Alaska.* CRREL Special Report 78-13, pp. 25-87.

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Webber, P.J., V. Komárková, D.A. Walker, and E. Werbe, 1978. Vegetation mapping and response to disturbance along the Yukon River-Prudhoe Bay Haul Road. *In* Brown, J. (ed.), *Ecological Baseline Investigations Along the Yukon River-Prudhoe Bay Haul Road, Alaska.* CRREL Special Report 78-13, pp. 25-87.

Lawson, D.E., J. Brown, K.R. Everett, A.W. Johnson, V. Komárková, B.M. Murray, D.F. Murray, and P.J. Webber, 1978. *Tundra Disturbances and Recovery Following the 1949 Exploratory Drilling, Fish Creek, Northern Alaska.* Corps of Engineers, U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire 03755. CRREL Report 78-28. 81 pp.

Komárková, V. and P.J. Webber, 1978. Geobotanical investigations. *In* Lawson, D. *et al.* (eds.), *Tundra Disturbances and Recovery Following the 1949 Exploratory Drilling, Fish Creek, Northern Alaska.* U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire 03755, pp. 63-87.

Reports (cont.)

Webber, P.J., 1979. *A Botanical Inventory of the Rocky Flats AEC Site.* Final Report (COO-2371-6), U.S. Energy Research and Development Administration Contract No. EY-76-S-02-2371.**000.

Webber, P.J., V. Komárková, D.A. Walker, and E. Werbe, 1979. *Geobotanical Studies Along a Latitudinal Gradient Between the Yukon River and Prudhoe Bay, Alaska.* U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. Internal Report 585. 366 pp.

Komárková, V., P.J. Webber, J.J. Ebersole, and D.A. Walker, 1979. *Tundra Recovery and Baseline Investigations in National Petroleum Reserve in Alaska.* U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. Internal Report 586. 266 pp.

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Webber, P.J., J. Terasmae, and J.T. Andrews, 1965. A study of late-Quaternary plant bearing beds in north-central Baffin Island, Canada. *Abstracts Proc. VII Internat. Assoc. Quaternary Research*, pp. 496.

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Abstracts and Book Reviews

Everett, K.R., P.J. Webber, D.A. Walker, R.J. Parkinson, and J. Brown, 1978. *Geoecological Mapping in Alaskan Tundra.* Poster and abstract for the Third International Conference on Permafrost, July 10-13, 1978, Edmonton, Canada.

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Werbe, E., D.A. Walker, and P.J. Webber, 1979. *The Effects of Road Dust on Arctic and Subarctic Vegetation.* Poster and abstract presented to the ARCTIC WORKSHOP, held in the Institute of Arctic and Alpine Research, University of Colorado, Boulder, May 4-5, 1979. 1 pp.

Andrews, J.T., P.J. Webber, and D.A. Walker, 1979. *Palynology of Late and Middle Holocene Peaty Sediments from Northern Alaska.* Poster and abstract presented to the ARCTIC WORKSHOP, held in the Institute of Arctic and Alpine Research, University of Colorado, Boulder, May 4-5, 1979. 1 pp.

Walker, D.A. and P.J. Webber, 1979. *Salix lanata ssp. richardsonii as a Climatic Indicator in Northern Alaska.* Poster and abstract presented to the ARCTIC WORKSHOP, held in the Institute of Arctic and Alpine Research, University of Colorado, Boulder, May 4-5, 1979. 1 pp.

Komárková, V. and P.J. Webber, 1979. *Vegetation Recovery Following the 1949 Exploratory Oil Drilling, Fish Creek, Arctic Alaska.* Poster and abstract presented to the ARCTIC WORKSHOP, held in the Institute of Arctic and Alpine Research, University of Colorado, Boulder, May 4-5, 1979. 1 pp.

Webber, P.J. and K.R. Everett, 1979. *Geoecological Mapping in Tundra Systems.* XIV Pacific Science Conference, Khabarovsk, USSR, August 20-September 5, 1979. 1 pp.

Theses

Webber, P.J., 1963. *Vegetation Gradients in Swamp Forests of Eastern Ontario.* M.Sc. thesis, Queen's University, Kingston, Canada. 223 pp.

Webber, P.J., 1971. *Gradient Analysis of the Vegetation in the Lewis Valley Region, North-Central Baffin Island, N.W.T.* Ph.D. thesis, Queen's University, Kingston, Canada. 366 pp.

RECREATIONAL AND CULTURAL RESOURCES

DISCIPLINE COORDINATOR: MATTHEW P. KILLEEN

PRINCIPAL INVESTIGATORS:

CULTURAL RESOURCES: DR. E. J. DIXON

RECREATION: DR. ALAN JUBENVILLE

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Terrestrial Environmental Specialists, Inc.

Education

B.S. Environmental and Resources Management (Forest Management): State University of New York College of Environmental Science and Forestry, Syracuse, New York, 1974.
M.S. Resource Management and Policy: State University of New York College of Environmental Science and Forestry, Syracuse, New York, 1978.

Professional Experience

Associate Environmental Scientist, Terrestrial Environmental Specialists, Inc., Phoenix, New York, 1979 - present.

Environmental Planner, Essex County, Elizabethtown, New York, 1978 and 1979.

Graduate Research Assistant, Applied Forest Research Institute, College of Environmental Science and Forestry, Syracuse, New York, Spring, 1977.

Graduate Teaching Assistant (Outdoor Recreation Planning and Management), State University of New York College of Environmental Science and Forestry, Syracuse, New York, 1975 - 1977.

Planning Assistant, Essex County Planning Office, Elizabethtown, New York, Summer, 1976.

Memberships

National Wildlife Federation

Consulting and Related Experience

- designed, implemented and prepared a planning report examining the economic, environmental and social impacts related to the development of a countywide system of winter recreational trails.

- prepared a management plan for the winter use of an outdoor education center and served as the director of the center.

- prepared a plan for the development of a countywide system of winter recreational trails, including layout and design of trails, and provided direction and supervision for crews constructing and/or improving more than 100 miles of trails.

Consulting and Related Experience (Continued)

- provided technical information related to the development plans of a municipal recreation area including campsite, beach, and boat-launching site.

- participated in a research project aimed at classifying the users of forest research materials.

- was responsible for the development and implementation of an outdoor educational program at a summer camp for boys.

- performed major portions of an environmental feasibility study for hydroelectric generation at a flood control dam in north central West Virginia.

- participated in a hydroelectric site selection study designed to identify significant ecological, social, economic, and cultural impacts.

VITA

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Personal:
Born: 10 November 1945, East Orange, New Jersey
Married: Mim Phyllis Harris, 1973
Children: One son, James Bryan Dixon

Other: Federal security clearence, 1971, for work on Amchitka Island, Alaska.

Education:
B.A., Anthropology, University of Alaska, 1970
M.A., Anthropology, University of Alaska, 1972
Ph.D., Anthropology, Brown University, 1979

Present Position: Curator of Archeology, University of Alaska Museum since February, 1975.

Duties and Responsibilities: Initiate curatorial program for over one million archeological specimens including comparative collections from Western and Central United States, Europe and Asia. Regional focus of collections: Western North American Arctic. Institute SELGEM for the archeological collections. Provide input into exhibits and educational Museum programs. Develope a program of collections and field research.

Memberships:
Society for American Archeology
American Anthropological Association
Alaskan Anthropological Association
National Geographic Society
Society of Professional Archeologists

Grant/Awards:
1971 Geist Fund Award
1972 George C. Marshall Fellowship, for study in Denmark
1973 Arctic Institute of North America Research Grant
1973 Haffenreffer Museum of Anthropology Collection Grant

E. James Dixon, Jr.

Grants/Awards: (continued)

1973 Society of Sigma xi Equipment Grant
1973 International Research and Exchange Commission Travel Grant to the Soviet Union
1974 Arctic Institute of North America Research Grant
1975 State of Alaska Division of Parks Matching Grant
1976 American Council of Learned Studies International Travel Grant to Nice, France (declined)

Research Contracts:

1971 Archeological Salvage Contract, Holmes and Narver, Inc. (acting on behalf of the Atomic Energy Commission), with J.P. Cook and C.E. Holmes. Archeological salvage of site 49-RAT-32, a large prehistoric Aleut Village Site. ($37,633.00)
1975 Bureau of Land Management Research Contract, probability modeling based on ecological criteria for regions of high archeological site occurrence. ($7,360.00)
1975 Project coordinator and Principal Investigator with R.D. Guthrie, G.D. Sharma and S.W. Stoker, Bureau of Land Management Outer Continental Shelf Office, "Bering Land Bridge Cultural Resource Study". Probability modeling for archeological site occurence on outer continental shelf between Asia and North America. Interdesciplinary study. Conducted a marine archeological survey in an effort to detect submerged aboriginal habitation sites in the Bering Sea. ($225,520.00)
1977 Project Coordinator and Principal Investigator with G.D. Sharma and S.W. Stoker, Bureau of Land Management Outer Continental Shelf Office, "Western Gulf of Alaska, Cultural Resource Study", probability modeling for archeological site occurence on the outer continental shelf in the Western Gulf of Alaska. ($52,000.00)
1977 Project Coordinator and Principal Investigator with G.D. Sharma and S.W. Stoker, Bureau of Land Management Outer Continental Shelf Office, "Beaufort Sea Cultural Resource Study", probability modeling for archeological site occurrence on the outer continental shelf in the Beaufort Sea. ($146,000.00)
1978 Project Coordinator and Principal Investigator

E. James Dixon, Jr.

Research Contracts (cont.)		With G.D. Sharma and S.W. Stoker, Bureau of Land Management Outer Continental Shelf Office, "Lower Cook Inlet Cultural Resource Study", probability modeling for archeological occurrence on the outer continental shelf in Lower Cook Inlet and Northwestern Gulf of Alaska. ($116,532.00)
	1978	With G.D. Sharma and S.W. Stoker, Bureau of Land Management Outer Continental Shelf Office, "Compendium of Alaskan OCS Cultural Resource Studies". ($204,531.00)
	1978	Principal Investigator, U.S. Army Corps of Engineers, Alaska District, "Archeological Survey and Inventory of Cultural Resources Fort Wainwright, Alaska". ($116,185.00)
Relevant Field work and Professional Experience	1967	Field Assistant, Archeological salvage and erosional study, Point Hope, Alaska (August)
	1969	Field Assistant, archeological excavations at Healy Lake, Alaska (summer)
	1969-70	Limited analysis of Healy Lake material (winter)
	1970	Crew Chief, survey and salvage of right of way of proposed haul road and pipeline from Brooks Range to Prudhoe Bay, for Alyeska Pipeline Service Caompany (summer)
	1970-71	Analysis of previous summer's field work
	1971-72	Co-assistant investigator, archeological salvage site 49-PAT-32, Amchitka Island, Alaska (May-January)
	1971	Director of excavations at the Gallagher Flint Station, North Slope, Arctic Alaska (July-August)
	1972	George C. Marshall Memorial Fellow, for study in Denmark (research at the National Museum of Denmark, Copenhagen) (February-May)
	1972	Director of excavations at Old Fish Camp, middle Yukon River region, Alaska (June-July)
	1972	Assisted in geological mapping and survey upper Sagavanirktok River Valley, Alaska, with T. Hamilton (August)
	1972-73	Analysis of Old Fish Camp archeological materials (winter)
	1973	Studied archeological collections housed in Irkutsk and Nova Sibersk, USSR (May)
	1973	Director of excavations at Old Fish Camp, middle Yukon River region, Alaska (summer)
	1973-74	Continued analysis of Old Fish Camp archeological materials (winter)
	1973-74	Teaching assistant, Brown University, Providence, R.I. (winter)

E. James Dixon, Jr.

1974 Alyeska Archeologist, director of excavations at the Gallagher Flint Station and other sites along the Sagavanirktok River. Directed field crew of 30 excavators and foremen (summer)

1975 National Park Service archeologist attached to Anthropology Department, University of Alaska. Helped establish (14th) program for Alaskan Native Historic sites land claim settlement (January)

1975 Reconnaissance of archeological sites reported to the University of Alaska Museum

1975 Archeological site distribution probability modeling in the State of Alaska

1975-76 Research relating to the human occupation of the Bering Land Bridge during Pleistocene and early Holocene times (winter)

1976 Executed first marine archeological survey conducted in the Bering Sea, aboard the University of Alaska's R/V ACONA (June)

1976 Director of archeological survey of St. Matthew Island, Western Bering Sea (July)

1976 Participant (Northwest regional representative in SELGEM Workshop, sponsored by the National Association of Systematics Collections and the University of Knasas, Lawrence, Kansas (1 week in August)

1978 Director of archeological survey of Porcupine River Caves, Eastern Interior Alaska.

Publications: E. James Dixon, Jr.

1972 Remote sensing of Alaskan Archeological Sites: A Preliminary Report, in: Proceedings Twenty-Third Alaska Science Conference, Fairbanks, Alaska, 15-16 August 1972, Science in Alaska, 1972. Published by Alaska Division, American Association for the Advancement of Science.

1973 Arkheologicheskaia ploshchadka Gallagkher-Flint. Stoianka drevengo cheloveka na severnom sklone khrebta Bruksa. Arktichekaia Aliaska (the Gallagher Flint Station. An Early Man site on the north slope of the Brooks Range, Arctic Alaska). Texisy dokladov vsesoiuznogo simpoziuma. Bering-iiaskaia susna i ee znachenie dlia razvitiia golarktichskiin flor i faun v Kainozie, pp. 137-141.

1975a The Gallagher Flint Station, An Early Man Site on the North Slope, Arctic Alaska and its role in Relation to the Bering Land Bridge, Arctic Anthropology XII(1):68-75.

E. James Dixon, Jr.

Publications: (continued)

1975b Analysis of Archeological Potential, in: Heritage Resources along the Upper Susitna River, Alaska Division of Parks Miscellaneous Publications, History and Archeology Series No. 14, edited by Glenn Bacon, pp. 29-43.

1976a Comment on Robert A. Pauls' "Athabaskan Personality Again", American Anthropologist 78(1):115.

1976b The Pleistocene Prehistory of Arctic North America, in: Proceedings of the IX International Congress of Anthropological Sciences, Nice, France, 13-18 September, 1976, Colloque XVII Habitats Humains Anterieurs a l'Holocene en Amerique, J. B. Griffin, ed. pp. 168-198.

1976c Stoyanka Gallakher Flint - arkheologicheskii pamyatink na sebernom sklone khrebta bruksa (arkticheskaia alyaska) i ee otnoshenia k beringiaskoi sushe (The Gallagher Flint Station, an Early Man Site on the North Slope of the Brooks Range, Arctic Alaska and its Relationship to the Bering Land Bridge.). in: Beringia in Cenozoic, Report of All-Union Symposium, Khabarovsk, 10-15 May, 1973, pp. 467-475. Published in Vladivostok, 1976.

Bacon, Glenn H. and E. James Dixon, Jr.

1974 A Reply to Hippler's "The Athabaskans of Interior Alaska: A Culture and Personality Perspective", American Anthropologist 76(3): 569-571.

Research Reports and Papers:

1970 Report of Archeological Survey and Excavations along the Alyeska Pipeline Service Company Haulroad and Pipeline Alignments, printed by the Department of Anthropology, University of Alaska, in conjunction with Alyeska Pipeline Service Company, pp. 87-94, 96-110, 135-146, 149-152, 176, 201-205.

E. James Dixon, Jr.

Research Reports and Papers: (continued)

1971 The Gallagher Flint Station and Other Sites along the Sagavanirktok River, in: Final Report of the Archeological Survey and Excavations along the Alyeska Pipeline Service Company Pipeline Route, printed by the Department of Anthropology, University of Alyeska, in conjunction with Alyeska Pipeline Service Company.

1972a Cook, John P., E. James Dixon, Jr., and Charles E. Holmes, Site Report 49-RAT-32, Amchitka Island, Alaska, printed by the Department of Anthropology, University of Alaska, in conjunction with Holmes & Narver, Inc.

1972b Holmes, Charles E., E. James Dixon, Jr., and John P. Cook, "Site 49-RAT-32, Amchitka Island, Alaska," paper read at the 37th meeting of the Society for American Archeology, Bal Harbour, Florida, May 4-6.

1972c "The Gallagher Flint Station, an Early Man Site on the North Slope, Arctic Alaska," paper read at the 37th Annual meeting of the Society for American Archeology, Bal Harbour, Florida, May 4-6.

1972d The Gallagher Flint Station, an Early Man Site on the North Slope, Arctic Alaska, unpublished M.A. thesis presented to the faculty of the University of Alaska, May 1972.

1974a "Public Relations as an Essential Aspect of Arctic Archeology," paper read at the 39th Annual Meeting of the Society for American Archeology, Washington, D.C., May.

1974b Progress Report on Laboratory Analysis of Old Fish Camp Collection, unpublished report submitted to the Arctic Institute of North America.

1975a Final Report, Archeology Probability Modeling, submitted to Alaska State Division of Parks for Matching Grant PL-89-665, December 15. Unpublished.

E. James Dixon, Jr.

Research Reports and Papers: (continued)

1975b Final Report, Archeological Probability Modeling, submitted to Bureau of Land Management Anchorage District Office under Contract #52500-CT4-114, December 19. Unpublished.

1976a "Current Archeological Concerns of the University of Alaska Museum," paper read in absentia at the Third Alaskan Anthropological Association Conference, Anchorage, Alaska, March 26-27.

1976b Editor and contributor to "The Bering Land Bridge Cultural Resource Study, Final Report", submitted to the Bureau of Land Management Outer Continental Shelf Office, Anchorage, Alaska under Contract #08550-CT5-45. pp. vi-ix, 146-213, 227-237, 247, 248-262. With Sam Stoker, pp. 241-246. Unpublished.

1977 Editor and contributor to "Western Gulf of Alaska Cultural Resource Study, Final Report", submitted to the Bureau of Land Management Outer Continental Shelf Office, Anchorage, Alaska under Contract #AA550-CT-7-7. pp. ix-xii, III-1 to III-18, IV-1. Unpublished.

1978 "Problems Facing Repositories for Archeological Collections Resulting from Federal Agency Archeology in Alaska," paper presented at the Special Symposium on Problems in Alaska Resulting from Federal Agency Archeology at the 43rd Annual Meeting of the Society for American Archeology, 4 May 1978, Tucson, Arizona.

David C. Plaskett and E. James Dixon, Jr.

1978 "Men Out of Southeast Asia: An Alternative Hypothesis for the Early Peopling of the Americas," paper read at the 5th Annual Alaska Anthropological Association Conference, Anchorage, Alaska, 17-18 March, 1978.

UNIVERSITY MUSEUM CAPABILITY STATEMENT FOR ARCHEOLOGY RESEARCH

The University of Alaska Museum has a full-time curator of Archeology, staff, and facilities for archeological field research, data analysis and report preparation. The Archeology staff includes three archeologists with arctic/subarctic specialization, one of whom also has extensive training in Alaskan zooarcheology. The Museum staff is trained in archeological survey and excavation in Alaska with field experience from the North Slope, Arctic Coasts, Interior, Southcentral, Southeast, and Aleutian Islands. Also on staff are a clerk specialist and a curatorial assistant. The curatorial assistant has training and experience in Alaskan archeology, data analysis, bibliographic literature search, and report editing. In addition, a readily available pool of student and field assistants trained by various departments is to be found within the University.

The archeology section has facilities for analysis of data and report preparation. Among these are laboratory space, drafting facilities, an in house hard copy computer terminal for storage, manipulation, and retreival of data; and, a specialized library containing numerous umpublished reports, theses, and manuscripts pertinent to Alaskan archeological collections. The Museum's archeology laboratory is on hand for comparison of artifacts with those from the Museum's extensive collection of archeological materials from all parts of Alaska.

Additional Museum facilities include a herbarium, ethnological collections, as well as large paleontological, marine invertebrate, and mammal and bird collections. These comparative Alaskan materials strengthen and complement the Museum's large archeological collection. The Museum has an experienced full time photographer available for photographing archeological materials and a fully equipped photographic laboratory to assist in documenting data and report preparation.

Archeological analysis benefits from the Museum's proximity to scientific expertise in other sections of the university. These include the Department of Geology and the institutes of Geophysical Sciences, Marine Sciences, Sea Grant and Arctic Biology. The Archeology section's program of field and laboratory analysis is well established and has been functioning for several years. Attached is a list of contract projects successfully completed by Museum archeology research teams.

CONTRACT PROJECTS

Year	Contract Agency	Title of Study	Amount
Fall, 1975	Bureau of Land Management Anchorage District Office #52500-CT4-114	Probability Modeling for Archeological Site Occurrence	$7,630
Winter, 1975-76	Bureau of Land Management Outer Continental Shelf Office #08550-CT5-45	Bering Land Bridge Cultural Resource Study	$225,520
Fall, 1976	Alaska Division of Aviation	Archeological Survey for Pt. Hope & Noorvik Airports	$4,391.98
Fall, 1976	University of Alaska Museum, Fairbanks	Archeological survey of New Museum Site	$2,295
Winter, 1976-77	Bureau of Land Management Outer Continental Shelf Office, Anchorage #AA550-CT7-7	Western Gulf of Alaska Cultural Resource Study	$52,000
Summer, 1977	Bureau of Land Management Outer Continental Shelf Office, Anchorage #AA550-PH7-539 (551)	Beaufort Sea Cultural Resource Study, Phase I	$4,658
Summer, 1977	Alaska Division of Aviation	Archeological Survey for Nelson Lagoon Airport	$3,920.25

Year	Contract Agency	Title of Study	Amount
Summer, 1977	Alaska Department of Highways #203B49952	Dutch Harbor Archeological Salvage Excavation (Amakanak Pridge)	$27,550
Fall, 1977	Alaska Division of Aviation	Archeological Survey for Tatitlek Airport	$3,398.34
Fall, 1977	Alaska Department of Public Works #B91452 & B91455	Archeological Surveys of a Minto & Ruby School Sites	Minto- $2,682.79 Ruby- $3,803.89
Fall & Winter 1977-78	Bureau of Land Management Outer Continental Shelf Office, Anchorage #AA550-CT7-40	Beaufort Sea Cultural Resource Study	$146,000
Winter 1978- Spring 1980	Alaska District Corps of Engineers DACA85-78-C-0047	Ah Archeological Survey of Fort Wainwright and surrounding Army lands	$116,185.
Summer 1978	Stanley Consultants, Inc. #4576-2-28762	Pre-Construction Archeological Resource Survey for a Proposed Golden Valley Electric Assoc. Power Generator Plant at Transmission Line Corridor from Healy to Fairbanks, Alaska	$3,696.06
Summer 1978- Winter 1980	Bureau of Land Management Outer Continental Shelf Office, Anchorage, Alaska #AA550-CT8-38	Compendium of Alaskan OCS Cultural Resources Studies	$204,531.

RESUME

NAME: Alan Jubenville

TITLE: Associate Professor of Resources Management

ADDRESS: Agricultural Experiment Station
School of Agriculture and Land Resources Management
University of Alaska
Fairbanks, Alaska 99701

EDUCATION:

B.S.	Forest Management, North Carolina State University, 1962
M.S.	Forest Ecology, West Virginia University, 1964
Ph.D.	Wildland Recreation, University of Montana, 1970

WORK EXPERIENCE:

1979 to present	Assistant Professor of Resources Management, Agricultural Experiment Station, University of Alaska. FTE = 4.5 months teaching, 7.5 months research.
1971-1979	Assistant Professor, University of Wyoming. Developed outdoor recreation curriculum; FTE = 75% teaching, 20% research, and 5% University activities. Tenured in 1977.
1970-1971	Assistant Professor and State Outdoor Recreation Extension Specialist, University of Illinois. Coordinated extension education programs and participated in major state projects as a planner.
1968-1969	Instructor, University of Montana. Taught a basic biometrics course, including labs.
1967-1968	Natural Resource Planner, State of Indiana. Assisted the private landowner in the development of resource management plans.
1964-1967	Post Maintenance Officer, Ft. Wainwright, Alaska. Coordinated entire post maintenance program on the General Staff. Captain, U.S. Army, Corps of Engineers.
1962-1964	Graduate Teaching Assistant, West Virginia University. Taught silvicultural lab courses.
1961-1962	Forestry Technician. Conducted forest resource inventories, assisted in management prescriptions, headed survey crew.

SUMMARY OF TEACHING ACCOMPLISHMENTS:

1. Coordinated and conducted extension education programs while at University of Illinois. These were programs for the practicing professional and para-professional, and usually done at regional centers throughout the state.

2. Developed the original outdoor recreation resource management curriculum in 1971 and new outdoor recreation planning curriculum. The planning curriculum is aimed at developing a specific, scientific background of the student to prepare him for complex situations he may face in the real world.

3. Developed the following academic courses at the University of Wyoming:

   a. RECR 670D—Outdoor Recreation Management. This course incorporated a systems approach to management, while also presenting in detail each subsystem—visitor management, resource management, and service management.

   b. RECR 680D—Recreation Field Evaluations. This is a summer field course designed to focus the concepts and principles from RECR 670D on specific, contemporary management problems. The 1977 course focused on river recreation management, and was well received by students and those professionals who assisted in the course.

   c. RECR 780D—National Park Policy. This is an advanced undergraduate course designed to develop policies and procedures for park systems. A model approach is used to teach the students policy formulation and evaluation.

   d. RECR 885M—Graduate Seminar. This is a graduate seminar designed to focus on specific contemporary problems of management and/or research. I developed the original course description; it has since been revised to a variable credit course.

4. Developed topographic planning models laboratory as a learning lab. An initial grant was obtained through the College of Arts and Sciences.

5. As former graduate studies coordinator for the department I developed the original departmental graduate catalog at the University of Wyoming. I was appointed a member of the Graduate School in 1974. Personally, I normally handle about five graduate students per year.

6. Plus, I usually have about forty-five undergraduate advisees.

7. In the fall of 1976, I developed and coordinated a special graduate (no credit) seminar on river recreation management. It interfaced the student, the educator, and the practicing professional while identifying, enumerating, and evaluating specific problems associated with river recreation management.

8. I have developed two texts. The *Outdoor Recreation Planning* text has been available since January, 1975; it was revised in 1977. The second one, *Outdoor Recreation Management*, has been available since March, 1978.

9. Assisted Northwest Community College in the development of their recreation majors program in a December, 1977, visit to their campus.

RESEARCH GRANTS:

1. Direct Observation Study, $750.00, Basic Research Division, University of Wyoming, 1973.

2. Evaluation of Wilderness Potential of the Roadless Areas in the Medicine Bow National Forest, $150.00 E.P.A. and $300.00 Wilderness Society, 1972.

3. Snowmobiler Preferences in the Snowy Range, $300.00, Wyoming Recreation Comission, 1972.

4. Park Standards for Wyoming, $11,900.00, Wyoming Recreation Commission, 1973.

5. National Park Service, $13,227.00, Snake River Corridor Study, 1974 and 1977.

6. (with Donald S. Warder) Regional Planning Office, $5,000.00, County-Wide Recreation Plan for Albany County, 1975.

7. "Decision-Making Model: How the Commercial Camper Chooses His Campground." Phase 1, summer 1978. $4,000.00, Basic Research Division, University of Wyoming.

UNIVERSITY ACTIVITIES:

University of Wyoming:

Faculty Senate, 1977-1979
University Ad Hoc Committee, Campus Sports Club, 1978
University Ad Hoc Committee, new Master's in Planning Program, 1977-1979
Governor's Land Use Planning Committee, 1976-1977
Former departmental graduate studies coordinator, 1974-1977
Former advisor to the Recreation Club (for Recreation and Park majors), 1971-1973
Departmental chairman for library acquisitions, 1976-1978
Member of the Yellowstone Environmental Research Committee, 1975-1977
Research Associate and Advisory Board Member, Center for Behavioral Studies, Institute for Policy Research, Univeristy of Wyoming, 1976-1978
Member of the Association of American Geographers (Recreation Research Division), 1977
Participated in a Humanities project entitled "A Wyoming Design Ethic." The $14,900 grant from the Wyoming Council for the Humanities was to sponsor a workshop for top level state decision-makers, 1977-1978.

RECENT RELATED PROFESSIONAL ACTIVITIES

Chairman, Albany County Park and Historic Preservation Board, 1976-1978.
Participated in a 15-hour Short Course on Citizen Participation Techniques, March 4-5, 1977, at Laramie, Wyoming.
Participated in a National Conference on River Recreation Management and Research, January 24-27, 1977, at Minneapolis, Minnesota.
Asked by the Bureau of Outdoor Recreation to participate in the evaluation of the Nation-wide Plan at the National Congress in Boston, Massachusetts.
Consulting editor for recreation books, W. B. Saunders Co., Philadelphia, Pa.—have reviewed three book manuscripts for publication recommendation since 1975.
Resource person for a workshop on *Recreation and Tourism*, Wyoming Planning Association, October 17, 1977.

MEMBERSHIP IN HONOR SOCIETIES:

Gamma Sigma Delta (Agriculture)
Tau Alpha Sigma (Wildlife)
Xi Sigma Pi (Forestry)

CONSULTING:

Site Feasibility for Four Campgrounds in Illinois, 1970.

Review of Management Plan for BWCA, 1971.

(with Donald S. Warder) "Analysis of the Relocation of the Ryan Park Winter Sports Site," 1975.

(with Donald S. Warder) "County Recreation Plan," Albany County, Wyoming, 1975.

(team member) *Master Plan for South Pass Historic Mining District*, 1976.

Conducted two public hearings for the U.S. Forest Service on a proposed site development, February 8 and 9, 1977, in Douglas and Casper, Wyoming.

Composite Plan for the Continental Divide Area of the Medicine Bow National Forest, Wyoming, November, 1977.

PUBLICATIONS:

Refereed Articles:

1. "A Test of Differences Between Wilderness Recreation Party Leaders and Party Members," *Journal of Leisure Research*, 1972 (Vol. 3, No. 2, pp. 116-119).

2. "Development of Career Programs in Parks and Recreation: The Illinois Junior College System," *COMPACT*, 1973 (Spring).

3. (with Terry L. Wood) "Quasi-Wilderness: The Intermediate Types of Hiking Experiences," *Parks and Recreation*, 1973 (July, p. 38, 43 and 48).

4. "The Conservation Organizations and Wilderness—A Time for Policy Appraisal," *Environmental Conservation*, 1974 (Vol. I, No. 2, pp. 93-99).

5. (with Donald S. Warder) "A Different Kind of Fire Hazard—Fabrics," *Camping Magazine*, 1974 (Summer, pp. 29-31).

6. (with Donald S. Warder) "Urban Leisure Life-styles," *Parks and Recreation*, 1974 (April, pp. 22-25).

7. "The Image of Wilderness—A Synthesis of Cause-Effect Relationships and Management Implications," *Western Wildlands*, (in review process), 12 pp.

PUBLICATIONS–Continued:

Other Publications:

1. "Site Management Plan for Hope Forest, North Carolina," 1962, School of Forest Resources.

2. "The Need for Popularizing Research Results–The Environmental Era," Montana Academy of Science, 1969.

3. Preliminary Proposal for an Inservice Training Program and Employees Orientation for the Illinois Department of Conservation, 1970, University of Illinois (co-authored with Thomas McGuire).

4. "A Model for Federal Grant Application," *Illinois Parks and Recreation*, May-June, 1971.

5. *A Self-Evaluation Checklist for Outdoor Recreation Planning and Development*, O.R.P.R.-23, University of Illinois, 1971, 23 pp.

6. *Planning and Design of Outdoor Recreation Sites and Facilities*, O.R.P.R.-24, Univeristy of Illinois, 1971, 49 pp.

7. *Research Topics*, Department of Recreation and Park Administration, University of Illinois (in-house), 1971.

8. *A Study of Parks and Recreation–Highland Park, Illinois*, O.R.P.R. Research Report, 1971, (project member).

9. "Site Plans for Eastbrook Areas and River Park," University of Illinois, 1971.

10. (with G. R. Peel, Jr.) *A Pilot Study of Modeling the Snake River Float Trip*, Grand Teton National Park, final project report dated January, 1974, 24 pp. (supported by the National Park Service).

11. (with D. S. Warder) *Perceptions and Management Preferences of Users as a Result of the Commercial Floating Experience on the Snake River Within A Grand Teton National Park*, final project report dated March, 1976, 49 pp. (supported by the National Park Service).

12. (with D. S. Warder and I. Bruce Maxon) *The Perception of the Floating Experience by the Private Floater Compared with the Commercial Floater on the Snake River in Grand Teton National Park*, final project report dated April, 1977, 76 pp. (supported by the National Park Service).

13. *Outdoor Recreation Planning*, Philadelphia: W. B. Saunders Co., 1975–a 399-page textbook; revised Spring, 1977; second printing, Fall, 1977.

14. Book reviews on *Issues in Outdoor Recration* and *Outdoor Recreation in America* by Clayne R. Jensen (as requested by the *Journal of Leisure Research*), 1977.

15. "Participation Analysis for South Pass Historic Mining District, Wyoming," (part of a larger BLM study), 1977.

16. Contributing editor, *Wyoming Issues*, Vol. 1, No. 3, Summer, 1978. Entitled "RARE II."

PUBLICATIONS—Continued:

Other Publications—Continued:

17. *Outdoor Recreation Management*. Philadelphia: W. B. Saunders Co., 1978—a 290-page textbook.

18. *Continental Divide Composite Plan*. November, 1977 (34-page project report to the U.S. Forest Service).

19. With I. Bruce Maxon. 1978. "User Perception, Management Preferences, and Personal Characteristics: A Comparison of the Commercial and Private Floater Within Grand Teton National Park," Research Paper No. 246, Institute for Policy Research, University of Wyoming.

20. "A recent History of the American Wilderness," *Wyoming Issues*, 1978, (Vol. 1, No. 3 pp. 6-11).

21. "Mystique, Myths, and Management: Three Dimensions of Wilderness," *Wyoming Issues*, 1978, (Vol. 1, No. 3, pp. 14-16).

SOCIO-ECONOMIC RESOURCES

DISCIPLINE COORDINATOR: DR. ROY GERARD

PRINCIPAL INVESTIGATOR: DR. FRANK L. ORTH

ROY GERARD

Socio-Economic Consultant

Terrestrial Environmental Specialists, Inc.

EXPERIENCE

Current:

President, Economic Consultants Organization, Inc.
Buffalo and Syracuse, New York

Prospect, obtain, prepare, design, supervise collection of data and analysis, help write report, present and defend findings to client.

As President of E.C.O., Inc., prepared or assisted in preparation of studies of: housing, economic base - industrial development, population, finances, capital budget, growth management, governmental unification, economic impact of bridges, roads, colleges, management analysis of social agency. These studies covered more than 250 separate areas in New York State, Vermont, Massachusetts, Connecticut, New Jersey, Ohio and West Virginia. Clients are public agencies, private concerns, banks, other professionals (engineers, architects, planners), quasi-public agencies.

Lecturer, Niagara University

Teach sequence of Society and Economic Behavior in the Fall Term and Population Change, Society and the Economy in the Spring Term.

Lecturer, State University College at Buffalo

Teach Housing and the Community in the Fall Term; Management and Operations and Housing Management in the Spring Term.

Past:

Lecturer, Associate Professor, Chairman, Department of Economics, and Director, Bureau of Economic Research
Le Moyne College, Syracuse, New York

Taught Principles of Economics, International Trade Theory, Urban Economics, Macro-Economics, Economic Research, Government and Business. Directed economic studies of communities and areas.

EXPERIENCE - Past (Cont'd.)

Lecturer, College of Art, Architecture and Planning, Cornell University

Assisted in developing concepts and analysis for field work courses in planning. Projects covered in courses were plans for: Onondaga County, City of Auburn and Cortland County, New York.

Director of Research, Syracuse Department of City Planning, Syracuse, New York

Responsible for demographic and economic analysis of master plan; supervised parking and site selection studies.

Lecturer, Syracuse University

Part-time teaching: Principles of Economics, Financial Management, Personnel Management, Labor Market Analysis, Consumer Economics.

Labor Market Analyst, Division of Employment, New York State Department of Labor, Syracuse, New York

Responsible for monthly (public) letters and bi-monthly detailed analysis of labor market conditions (current and projected) for a seven-county area. Developed basic employment and unemployment series. Assisted in operations of Division.

Business Editor, Research Institute of America, Inc. New York City

Prepared analyses on management problems; interpreted government price control regulations for business subscribers.

Market Research Analyst, Dun & Bradstreet, Inc. New York City

Carried out studies for individual clients on: potential for entering the truck-trailer industry; prospects for house trailers; outlook for textile products and for binderies, etc.

EDUCATION

Ph.D., Economics, New School for Social Research, New York City
(minor: Sociology)

M.A., Economics, American University, Washington, D. C.
(minor: Marketing)

B.A. cum laude, Economics, Brooklyn College, Brooklyn, New York
(minor: Statistics)

PUBLICATIONS

Cost Aspects of Industrial Location, Pacific N.W. Business Review.

Commuting and the Labor Market Area, Journal of Regional Science.

Commuting in the Syracuse Labor Market Area from the Standpoint of Employment and Unemployment, College of Business Administration, Syracuse University.

Analysis of Syracuse Area, Industrial Bulletin, New York State Department of Labor.

Managing Growth: Costs, Capacities and Attitudes, Erie County Division of Planning.

Housing Subsidies and Municipal Finances, Rochester, New York, Rochester City Planning Commission, Bureau of Planning.

An Overview of Capital Budgeting in the Corning-Elmira Area - 1975-1980, Southern Tier Central Regional Planning and Development Board.

Opportunities for Improving Government Services in the Corning Area: A Study of Municipal Management in Non-Metropolitan New York, Southern Tier Central Regional Planning and Development Board.

Salary Study for the Town of Lockport, Lockport, New York.

Recreation in the Southern Tier West Region, Southern Tier West Regional Planning and Development Board.

A Comprehensive Study of Proposed Bridge Crossings of Long Island Sound, New York State Department of Transportation.

Highway Interchange Impact Study, Genessee County, New York, Genesee County Department of Planning.

Department of Human Resources Operational Analysis, City of Buffalo, Department of Human Resources.

Information Flow and Model Cities, Model Cities Agency, Buffalo, New York.

Information Flow and Model Cities Committees, Model Cities Agency, Buffalo, New York.

Residents' Attitudes Toward Problems and Services, City of Buffalo, Division for Demonstration Projects, Department of Human Resources.

Resident Attitudes and Perceptions in Model Neighborhood Area, Model Cities Agency, City of Buffalo.

Niagara County Goals Study, Niagara County Economic Development and Planning Department.

Regional Population Projections, Erie and Niagara Counties Regional Planning Board.

Economic Development in the Erie-Niagara Region, Erie and Niagara Counties Regional Planning Board.

Economic Development in the Southern Tier Central Region, Southern Tier Central Regional Planning and Development Board.

Economic Development Report, Buffalo and Erie County Economic Development Committee.

Industrial Attitudes and Opportunities for Development, Southern Tier West Regional Planning and Development Board.

Forest Industries Feasibility Study - Allegany, Cattaraugus, and Chautauqua Counties, Volume II - Financial Analysis of Proposed Processing Facilities, Southern Tier West Regional Planning and Development Board.

Attitudes of Industry Toward the Physical, Social and Economic Environment, Niagara County, 1973, Niagara County Industrial Development Agency.

Industrial Fact Book: Niagara County, Niagara County Industrial Development Agency.

Technical Report on Housing in the Erie-Niagara Region - Three Year Study, Erie and Niagara Counties Regional Planning Board.

Regional Housing Requirements and Recommendations, Southern Tier West Regional Planning and Development Board.

Residential Analysis for Westchester County, New York, Westchester County Department of Planning:

Interim Report 1 - Code Enforcement in Westchester County
Interim Report 2 - Cost Factors Affecting the Supply of Housing
Interim Report 3 - Growth of Demand and Supply, 1970-1990
Interim Report 4 - Housing, Households and Health
Interim Report 5 - Housing Requirements: Sub-Market Household Groups
Interim Report 6 - Zoning Ordinances and Administration
Interim Report 7 - Welfare: Households and Housing

Housing: Requirements, Obstacles, and Opportunities in the Southern Tier Central Region. An Analysis of Housing in a Post-Disaster Environment, Southern Tier Central Regional Planning and Development Board.

Housing Allocation: Criteria and Strategies, Southern Tier Central Regional Planning and Development Board.

Housing: Problems of Public Assistance Recipients, Genesee County Planning Board, Genesee County Department of Planning.

An Interpretive Report: Housing, Genesee County Planning Board, Genesee County Department of Planning.

An Interpretive Report: Highway Interchange Impact Study, Genesee County Planning Board, Genesee County Department of Planning.

SPEECHES

Society of Real Estate Appraisers - Marketability and Feasibility Measures, March, 1975.

Association of Industrial Development Agencies - Economic Impact Statement, June, 1975

Federal Government Personnel, HUD, DOT, and NYC Planning Commission - Effect of Economic and Financial Factors on Land Use Planning, February, 1976.

Association of Erie County Governments - Fiscal Management and Costs of Development, October, 1976.

Technical Advisory Committee, Erie-Niagara Counties - Economic Development Problems and Processes in the Region, May, 1975.

Southern Tier West Regional Planning and Development Board - Economic Development Needs in the Region; Recreational Potentials, December, 1975.

Southern Tier Central Regional Planning and Development Board - Economic Development Requirements as Result of Flood Disaster, June, 1973.

Conference of Federal Agencies, Planning Personnel, HUD - Implications of Housing Decisions on Land Use and Capital Budgeting, March, 1972.

New York State Department of Transportation and local transportation officials - Cost-Revenue Procedures and Transportation Planning, March, 1968.

FRANK ORTH & ASSOCIATES
ECONOMIC AND BUSINESS CONSULTANTS
135 Lake Street South, Suite 232
Kirkland, Washington 98033

The following is a partial listing and description of Frank Orth & Associates' current clients and projects in Alaska:

Alaska Sea Grant Program (Bureau of Land Management): Analyzing potential impacts of Outer Continental Shelf oil development on Northern and Western Gulf of Alaska fisheries.

Alaska Commercial Fishing and Agriculture Bank (in organization): Providing general and specific management consulting services to Board of Directors. Tasks performed to date include organizational planning and plan implementation, financial planning, and operations planning.

David Choquette and Associates: Performing a feasibility study and developing financing, business, and marketing plans for an evolving bottomfishing enterprise in Alaska.

BACKGROUND

Frank Orth and Associates was organized in 1979 to provide consulting services in the fields of economics and business. The function of the firm is to serve the needs of its clients by providing practical solutions to problems. Results are provided on a timely basis in a form consistent with client expectations.

The firm offers services in the areas of natural resource development and financing economic development. The project experience of Frank Orth and Associates' professional staff has recently been concentrated in fisheries development - planning, project evaluation, financing, and market analysis - due to the high demand for services in these topic areas.

The professional employees of the company have maintained residence and conducted research activities in Alaska and the Pacific Northwest over the past decade. This geographic presence has fostered development of a mature understanding of the economic, political, social, and business environments of the region. The location of the firm in this region, augmented by extensive travel, enhances the ability of its staff to maintain and develop those contacts with resource-management, banking, and other institutions in the private and public sectors which play key roles in natural resource and economic development.

Frank Orth and Associates has the capability to supply a broad range of services by virtue of the complementary training and experience of its professional staff. The permanent staff are experienced professionals; each has conducted challenging research and analysis tasks independently

BACKGROUND
(Continued)

and each has had project management experience involving staff direction and coordination, and integration of complex topics. In addition, each has a reputation for outstanding analytical ability and is motivated by the compatible requirement for practical applicability and broad communicability of study results.

- Existing capabilities of the firm are readily expanded by:

  - ability to recruit nationally for temporary and permanent staff
  - direct contacts with functionally complementary academic, governmental, and industrial institutions and organizations.
  - ability to arrange sub-contracts with other organizations with expertise in areas such as architectural-engineering, investment banking, development banking and law.

The latter asset is further enhanced by Frank Orth and Associates' willingness to perform work on a sub-contract basis for other organizations.

AREAS OF EXPERTISE

- Natural Resource Development

Fuller utilization of natural resources has been a trend for many decades and is likely to continue at an increasingly rapid pace in the future. Should this trend intensify, existing pressures will mount to develop natural resources and to allocate them in an efficient manner. Efficient resource allocation is in the interest of all entities involved with resource development since a high level of well being is implied.

AREAS OF EXPERTISE
(Continued)

Natural resources may be developed to serve the goals or needs of private organizations or the general populace. These entities must in some manner determine if resources should be developed, which resources should be developed, how they should be developed, etc. Few have the knowledge to make and implement all decisions of this nature; frequently, outside assistance is needed to analyse specific problems, answer complex questions and provide a course of action that uses resources efficiently and serves the entity's objectives. Frank Orth and Associates was organized to provide this type of service.

The professional staff of Frank Orth and Associates has extensive training and experience in identifying, analysing, and solving multi-dimensional problems in natural resource development. The staff has developed new approaches and has successfully implemented methods to solve these problems. Examples of approaches are presented in the INVESTIGATIVE APPROACHES section and staff training and experience are shown in the resumes.

Financing Economic Development

Frequently, individuals or organizations recognize a development opportunity but lack a strategy and means to finance its exploitation. As a result, some economically feasible developments are not undertaken.

To remedy this situation Frank Orth and Associates offers services to facilitate the financing of economic development, including resource development. The purpose of these services is to identify viable development opportunities and to enable clients to

AREAS OF EXPERTISE (Continued)

pursue preferred sources and methods of finance. Approaches utilized to investigate means for financing economic development are presented below.

INVESTIGATIVE APPROACHES

Feasibility Studies

Persons or organizations facing a development opportunity must generate or obtain information concerning the economic viability of the opportunity. Frequently, it is difficult to be objective or complete when attempting to determine the economic feasibility of a development project because overly optimistic outlooks, inadequate information, or other factors may bias the analysis.

Frank Orth and Associates, as an outside party, is able to provide objective and comprehensive analysis. The firm has considerable experience in studies of financial and economic feasibility. Broad knowledge of current conditions in natural resource based industries, and financial institutions and markets, coupled with close client contact and coordination, enables the firm to produce accurate, reliable information. Methods employed include-benefit cost analysis and cash-flow analysis, among others.

Market Analysis

Markets are important elements in resource and economic development. A crucial step in the development process is to exploit apparent market opportunities. To do so it is highly desirable to first ascertain the size and nature of relevant markets and to determine the relation of these market characteristics to development objectives and plans. Analysis of this nature facilitates implementation of plans and signifi-

cantly increases the probability of being consistent with and realizing objectives.

Frank Orth and Associates analyses markets to support development planning activities of organizations. Extensive experiences in determining 1) the structure of markets and its relation to industry conduct and performance, and 2) market potential for goods and services enables the firm to provide a wide range of information essential to comprehensive planning operations.

In addition to providing market analyses as a discreet element of the planning process, the firm specializes in integrating market analyses with other investigative approaches to provide for a more complete understanding of resource and economic development problems and issues. This synergistic process, often lacking in analyses, can signigicantly affect the success of a development plan.

Planning

Success of almost any endeavor in today's complex world requires the use of a plan. People and organizations plan informally and implicitly in their everyday activities. One or more of four forces may cause business and other organizations to adopt formal planning procedures:

- rapid growth in size
- change in function and/or scope of activities
- required interaction with adversaries or regulators
- significant change in competitive environment

INVESTIGATIVE APPROACHES (Continued)

Planning is an internal function of senior management. Outside assistance may be desired with organization of the planning process, informational and analytical support, and independent review. Frank Orth and Associates can contribute to all parts of the planning process or to any part individually. The firm's professional staff has experience in strategic planning, project planning, financial planning, and market planning.

Economic Impact Analysis

Private or public entities, when planning an activity which will have a significant impact on the economic environment, are usually required to submit a statement of environmental impact. Preparation of this document can be a tedious, complex, and costly endeavor even for large, diversified organizations. In many instances purchase of these services from an outside organization which specializes in this service is desirable.

Frank Orth and Associates have substantial experience in economic impact analysis. Familiarity with the economic environment in Alaska and the Pacific Northwest together with training in fields of economics and business which bear on impact analysis enable the firm to perform economic impact studies efficiently and at relatively low cost. Methods employed include economic-base analysis, input-output analysis, and benefit-cost analysis, among others.

Policy Analysis and Planning

A policy problem exists when a principal within an entity, or an entity among a number of entities, perceives the necessity to obtain specified objectives by utilizing courses of action which are different from those es-

poused by other principals or entities. Occasionally entities perceive different objectives as well as different courses of action. Resolution of these kinds of problems requires that a set of principles, guidelines, or criteria be established or sanctioned to serve as a general basis for decision, action, or performance by the entity or group of entities.

Frank Orth and Associates specializes in the analysis of policy problems and their resolution. By virtue of the staff's training in interdisciplinary approaches to policy problem solving, and their subsequent practical experience in this area, the firm is well qualified to perform policy analysis of natural resource development issues.

The firm also has the capability to perform policy planning studies. As in policy analysis, a set of principles, guidelines, or criteria are determined. However, in the case of policy planning, problems are anticipated, not pre-existing; plans are formulated to avoid the emergence of anticipated policy problems.

Summary

A variety of approaches are utilized by Frank Orth and Associates to solve problems of resource and economic development. The resumes of the professional staff which follow provide further insight into the areas of expertise and investigative approaches of the staff.

RESUMES OF PROFESSIONAL STAFF

RESUME

Franklin L. Orth

EDUCATION

University of Tennessee, Ph.D. in Economics. Dissertation: "An Empirical Analysis of the Relationship Between Diversification and Profitability in the 1,000 Largest U.S. Corporations."

University of Richmond, B.A. in Economics.

Dr. Orth studied in the areas of industrial organization, finance and economic theory. He has lectured on each of these subjects as well as environmental economics, fisheries management, and aquaculture economics. His research and publications include topics in industry organization, banking, marketing, and the financing of resource development.

EMPLOYMENT HISTORY

- President
  Frank Orth & Associates, Kirkland, WA.
  1979 - present.
- Senior Economist and Vice President
  Private Consulting Firm, Seattle, WA.
  1978 - 1979.
- Associate Professor
  Department of Economics and Alaska Sea Grant Program, University of Alaska.
  1971 - 1978.
- Assistant Professor
  Department of Economics, Colorado State University.
  1970 - 1971.

EXPERIENCE

While working in both academic institutions and in a private consulting business, Dr. Orth applied his expertise in industrial organization, natural resource economics, market and financial planning, and banking to a wide range of problems. He has provided numerous private and public organizations with research, planning, and policy analysis services. In the private sector, organizations assisted include:

EXPERIENCE
(continued)

- Commercial Banks
- Financial Investors
- Seafood Companies
- Architectural-Engineering Firms

Public sector organizations include:

- National Marine Fisheries Service
- Alaska Department of Commerce and Economic Development
  - Division of Banking and Securities
  - Division of Business Loans
  - Division of Economic Enterprise
- Alaska Fisheries Council
- Alaska Legislature
  - House Judiciary Committee
  - Senate Interim Committee on the Permanment Fund
  - House Resource Committee
  - Senate Interim Committee on Bottomfish Development
  - Senate Commerce Committee
- Alaska Power Administration

Dr. Orth has extensive experience in project management. Management functions include the direction and coordination of large research staffs and subcontractors, the integration of complex study elements into unified and purposeful documents, project budgeting, and professional and support-staff recruitment. In addition, he has successfully managed company operations and marketing functions. In both project and company management efforts, Dr. Orth has been highly successful in the motivation of independent-minded professionals with diverse areas of expertise toward common goals.

PROJECT EXPERIENCE

- Project manager and analyst on study to estimate benefits and costs of U.S. fisheries development. Developed methodology for analysis, directed and coordinated staff research and project integration. For National Marine Fisheries Service and United States Department of Commerce Task Force on Fisheries Development. 1979.

PROJECT EXPERIENCE
(continued)

- Analysed market and entry conditions for locating a new bank. Projected demand for bank services and analysed the impact of entry. For the Eagle River State Bank, 1978. Similar study conducted for Alaska Pacific Bank, 1974-75.

- Developed and implemented a methodology to determine the domestic and export market potential for currently underutilized U.S. fish and shellfish species. For National Marine Fisheries Service, U.S. Department of Commerce. 1978.

- Developed and implemented a methodology for analysis of financial impediments to fisheries development in the U.S. For National Marine Fisheries Service, U.S. Department of Commerce. 1978.

- Conducted economic and financial feasibility and planning studies in support of the Comprehensive Regional Salmon Enhancement Plan for Prince William Sound, Alaska. For the Prince William Sound Aquaculture Corporation, 1978-79.

- Managed study of the market structure of the Alaska Seafood processing sector. Study included extensive primary data collection from Alaska Department of Fish and Game and from private industry. Study results have applications in private and public sector policy formulation. For the University of Alaska Sea Grant Program, 1977-79.

- Estimated current and future levels of credit demand from the commercial fisheries industry of Alaska. Estimates considered replacement and upgrading capital requirements for current fishing and processing operations as well as new capital requirements. For the Federal Intermediate Credit Bank of Spokane, Washington, 1978-79.

- Determined the economic impact of Outer Continental Shelf Oil Development on the razor clam fishery of the Northern and Western Gulf of Alaska. For the University of Alaska Sea Grant Program and the U.S. Bureau of Land Management, 1978-79.

PROJECT EXPERIENCE
(continued)

- Developed and implemented methodology to estimate capital requirements of the Alaska Commercial Fisheries and Agriculture Bank. For Alaska Department of Commerce and Economic Development, 1978-79.

- Conducted analysis of Japanese marketing channels for tanner crab. Intended for use by the North Pacific Fisheries Management Council. For Alaska Sea Grant Program. 1978.

- Performed descriptive study of Japanese ownership in Alaska seafood processing industry. Intended for use by fisheries management agencies. For Alaska Sea Grant Program. 1978.

- Managed study of U.S. production capacity and marketing for Alaska tanner crab. For National Marine Fisheries Service. 1977.

- Developed regulations for implementing financing provisions of Alaska Salmon Enhancement Act. For State of Alaska, Department of Commerce and Economic Development, Division of Business Loans. 1977.

- Developed issue paper on implications of foreign investment in Alaska seafood processing industry. For Senate Interim Committee on the Permanent Fund, Alaska Legislative Affairs Agency. 1977.

* Conducted detailed analysis of problems and alternative solutions for financing Alaska fishing businesses. This study laid the foundation for the creation of the Commercial Fisheries and Agriculture Bank by the Alaska Legislature. For Senate Interim Committee on the Permanent Fund, Alaska Legislative Affairs Agency. 1977.

- Performed market evaluations in support of bank acquisition. For private clients (confidential). 1976.

PROJECT EXPERIENCE (continued)

- Performed financial analysis of proposed bank acquisition. For Doyon, Inc. 1976.
- Conducted detailed economic and legal evaluation of the commercial potential of Alaska clam fishery. For Alaska Sea Grant Program. 1975.
- An analysis of economic impact of proposed civic, recreation, and convention center on economy of Cordova, Alaska. For Linck-Thompson Engineers and Planners. 1973.

PUBLICATIONS

Orth, F.L., J.A. Richardson and S. Pidde. 1979. Market Structure of Alaska Seafood Processing Industries: Shellfish. Volume I. Alaska Sea Grant Program (in press).

Orth, F.L., J.A. Richardson and J.R. Wilson. 1979. Market Structure of Alaska Seafood Processing Industries: Finfish. Volume 2. Alaska Sea Grant Program (in preparation).

Orth, F.L. 1978. Processing Capacity Estimation for Fishery Management. Proceedings: Journal of American Agriculture Economics Association.

Gorham, A.H. and F.L. Orth. 1978. Market Demand and Channels for Alaska Tanner Crab. Alaska Sea Grant Program.

Ball, J., C. Kerns, C. Wiese, and F. Orth. 1978. A Uniform Reporting System for Production and Financial Information for Salmon Enhancement Facilities in the State of Alaska. Alaska Sea Grant Program.

Orth, F.L. 1977. Economic Feasibility of Private Non-profit Salmon Hatcheries. Alaska Sea Grant Program.

Orth, F.L. 1976. The Economic Implications of Alternative Forms of Business Organization for Alaska Salmon Ranching Ventures. Proceedings: Conference on Salmon Aquaculture. Alaska Sea Grant Program.

PUBLICATIONS (continued)

Orth, F.L. 1976. Alaska's Evolving Salmon Aquaculture Policy: An Economic Perspective. Paper delivered at the 27th Alaska Science Conference.

Orth, F.L. 1975. The Alaska Clam Fishery: A Survey and Analysis of Economic Potential. Alaska Sea Grant Program.

Orth, F.L. 1975. "Economic Feasibility of Private Nonprofit Salmon Hatcheries: An Introduction." Aquaculture Notes. No. 1 Alaska Sea Grant Program.

Orth, F.L. January, 1974. The Fairbanks Economy in the 1970's. Alaska Construction and Oil.

* Orth, F.L. (contributor). 1974. Economic Analysis and Load Projections. Alaska Power Survey. Federal Power Commission.

ACTIVITIES

- Member, Alaska Fisheries Council, 1977-1978.
- Member, Steering Committee for Bering Sea Clam Development, 1977.
- Member, Executive Advisory Committee Alaska Power Survey, 1974.
- Faculty Fellow, Pacific Coast Banking School, University of Washington, 1973.
- Participant, Standard Oil of California, Faculty Forum, 1972.

ORGANIZATIONS

- American Economic Association
- American Agriculture Economic Association
- Western Association for the Advancement of Ecosystems
- Seattle Economists Club

RESUME

Peter W. Rogers

EDUCATION

University of Washington, M.A. in Economics

University of Washington, Master of Marine Affairs

Research Paper (authorized jointly with Christine L. Dawson) - "The Use of Allowable Biological Catch as the Biological Basis for Fishery Management: Analysis and Policy Implications", supervised by Professors James Crutchfield, Edward Miles, Robert Stokes, and Warren Wooster.

University of Washington, B.S. in Biological Oceanography and Botany

Mr. Rogers' background includes study in the fields of economics, marine affairs, and biological oceanography. The integration of his economic concentrations, natural resource economics and public finance, and his marine affairs concentrations, marine resource management and policy analysis, provide him a unique and effective means for analyzing problems of resource utilization. Additional formal training in marketing and other business subjects has broadened his capabilities significantly.

RECENT EMPLOYMENT

- Economic Analyst
  Frank Orth & Associates, Kirkland, WA.
  1979 - present.

- Economic Analyst
  Private Consulting Firm, Seattle, WA.
  1978 - 1979.

- Trainee, Institute for Marine Studies,
  University of Washington.
  1976 - 1977.

- Research Assistant, Institute for Marine Studies, University of Washington
  1975 - 1976.

EXPERIENCE

Mr. Rogers has over four years of experience in the application of economic and business principles to both structured and unstructured problems in natural resource-based and other industries. This experience includes, among other things, development and implemenation of research strategies for market and financial analysis and planning, forecasting industry activity levels and benefit-cost analyses. He has also formulated and successfully utilized interdisciplinary approaches for the analysis and resolution of policy issues.

PROJECT EXPERIENCE

- Analysed and assessed the domestic market potential of currently underutilized fish and shellfish species under U.S. jurisdiction. Analysis based upon trend analysis of import, export, and domestic production data. Assessed relative importance of consumer characteristics, resource availability, institutional structure, and state of technology as impediments to market development. Also reviewed and synthesized literature on U.S. seafood consumers. For the National Marine Fisheries Service, U.S. Department of Commerce, 1978-79.

- Developed and implemented a methodology to forecast credit demand for Alaska's agriculture industry. Examined conditions of access to capital markets, determined the availability of capital for agricultural purposes, and assessed market shares of institutional lenders. For the Federal Intermediate Credit Bank of Spokane, 1978-1979.

- Developed and utilized a methodology to forecast biological and economic variables of the Alaska razor clam industry. Variables forecast included employment of capital and labor, values and volumes of harvested and processed products, resource availability, availability of support sector facilities, and income. For the University of Alaska Sea Grant Program and the U.S. Bureau of Land Management, 1978-79.

PROJECT EXPERIENCE (continued)

* Aided in the development and implementation of a methodology utilized to determine the net social present value of developing certain U.S. fisheries. For the National Marine Fisheries Service, U.S. Department of Commerce, 1979.

- Determined capital requirements for the Alaska agriculture industry to the year 1990. Participated in the valuation of Alaska's fishing fleet utilizing regression techniques; conducted vessel value survey as a prerequisite to the valuation exercise. For the Department of Commerce and Economic Development, State of Alaska, 1978-79.

- Identified and examined sources of capital suited for the finance of Pacific whiting (hake) harvesting and processing operations; determined the relative ease of harvester and processor access to these markets. For Coos-Curry-Douglas Economic Improvement Association, Oregon, 1979.

- Reviewed and integrated recent studies concerning market structure of the U.S. seafood processing industry. Presented industrial organization theory in a manner understandable to a varied audience. For the University of Alaska Sea Grant Program, Alaska, 1978.

* Analysed the economic impact of limiting vessel entry into the Washington State salmon fishing industry. Developed and implemented methodology, and coordinated the project in its early and middle stages. For University of Washington Sea Grant Program, Washington, 1976-77.

RECENT ACTIVITIES

- Keynote speaker for finance segment of Pacific Northwest Indian conference; participated on Finance Panel. At Bellingham, Washington, September, 1978.

- Attended National Limited Entry Conference. At Denver, Colorado, July, 1978.

- Attended National Limited Entry Workshop. At Lake Wilderness, Washington, May, 1978.

RESUME

Joseph M. Terry

EDUCATION

University of California, Santa Barbara, Ph.D. candidate in Economics. Dissertation: "A Comparative Analysis of the Responsiveness of California Sales and Income Tax Revenues to Economic Growth."

University of Washington, M.A. in Economics.

Stanford University, A.B. in Economics.

Mr. Terry studied in the areas of public finance, international economics, economic development, and economic theory. He has lectured in each of these subjects. His research and publications include topics in public finance, resource development, and community impact analysis.

EMPLOYMENT HISTORY

Associate Economist
Frank Orth & Associates, Kirkland, WA.
1979 - present.

Instructor
Department of Economics & Alaska Sea Grant Program, University of Alaska.
1976 - present.

Visiting Lecturer
Algoma University College.
1974 - 1975.

Research Associate
University of California, Santa Barbara.
1973 - 1974.

Economic Analyst
California Department of Finance.
1969 - 1970.

EXPERIENCE

Mr. Terry has conducted applied economic research for both federal and state governments. This research includes the analysis of proposed tax legislation, the development and application of community impact analysis, and forecasting industry activity levels and tax revenues. Mr. Terry's experience encompasses the management of large research projects as well as direct participation in applied economic research.

PROJECT EXPERIENCE

- Project manager and principal investigator for a group of studies to document the development of various commercial fisheries in Alaska, project the development of these fisheries, and to analyze the potential impacts of Outer Continental Shelf petroleum development. For the Alaska Sea Grant Program and the U.S. Bureau of Land Management, 1978 - present.

- Developed methodology and directed research effort to estimate the local economic impact of the University of California, Santa Barbara. 1974.

- Forecasted state tax revenues and analyzed the revenue effects of proposed legislation for the California Department of Finance. 1969 - 1970.

PUBLICATIONS

Terry, J. M., A. H. Gorham, and R. S. Scoles. 1979. The Development of the Northern and Western Gulf of Alaska Commercial Fishing Industries. Alaska Sea Grant Program (in preparation).

Terry, J. M. 1974. The University of California and the Santa Barbara Economy. University of California.

ORGANIZATIONS

- American Economic Association
- Western Economic Association

RESUME

William G. Workman

EDUCATION

Utah State University, Ph.D. in Economics. Dissertation: "Nonresident Enrollment Demand at Utah State University."

Utah State University, M.A. in Economics

University of Wyoming, B.S. in Agricultural Economics

Dr. Workman studied in the areas of agricultural and natural resource economics, quantitative methods, and economic theory. He has taught courses in each of these areas as well as in managerial economics. His research and publications cover topics in human resource development, agricultural marketing, outdoor recreation management, forestry economics, and land use economics and planning.

EMPLOYMENT HISTORY

- Associate Economist
  Frank Orth & Associates, Kirkland, WA.
  1979 - present.

- Associate Professor
  Department of Economics and Agricultural Experiment Station, University of Alaska.
  1973 - present.

EXPERIENCE

Dr. Workman's research efforts have been directed toward providing both private and public entities with information to aid in decision making processes and to improve resource allocation. In the private sector these organizations include:

- General Electric Corporation
- Agricultural firms
- Alaska Native Corporations

Public sector organizations include:

- Utah State University
- U. S. Forest Service
- Bureau of Land Management
- Alaska Department of Natural Resources
- University of Alaska

EXPERIENCE
(continued)

* Dr. Workman's involvement in research has included the roles of both project manager and research team member. Much of his activity has involved participation in interdisciplinary groups consisting of representatives from the biological, physical and social sciences as well as engineering.

PROJECT EXPERIENCE

- Project manager and analyst on study to assess the supply of and demand for resources on the Chugach National Forest, Alaska Developed framework for analysis, directed and coordinated staff and analyzed results. For U.S. Forest Service, 1978-79.

- Analyzed economic forces influencing enrollment outlook for the various instructional units of the University of Alaska, Fairbanks. For University of Alaska, 1979.

- Project manager and analyst on study to assess the feasibility of a program whereby the State of Alaska would purchase the development options from farmland owners in Alaska as a means of preserving agricultural land. For Alaska Department of Natural Resources, 1978.

- Conducted study of property tax exemption provisions of Alaska Native Claims Settlement Act and examined implications for land resource allocation decisions. For University of Alaska, 1978.

* Conducted study examining economic implications of alternative marketing strategies for Interior Alaska forest products. Employed input-output analysis to estimate regional impacts associated with these various strategies. For University of Alaska, 1977.

* Participated in study of the economic aspects of outdoor recreation facility management on Forest Service lands in Alaska. Developed research design for surveying recreationists regarding preferences and participation rates in outdoor recreation activities and evaluation of Forest Service recreation facilities and programs. Analyzed and reported results from these surveys. For U.S. Forest Service, 1974-1977.

PROJECT EXPERIENCE
(continued)

* Participated in study of the use of off-road recreational vehicles on public lands in Interior Alaska. Developed research design for surveying results. For Bureau of Land Management, 1975-76.

· Participated in study of the economic feasibility of producing salad vegetables under controlled environment facilities in Alaska. Responsibilities consisted of assessing size of market for salad vegetables in Alaska, evaluating consumer acceptance on vegetables grown under controlled environment conditions, and aiding in the development of the experimental design in the controlled environment faciliites. For General Electric Corporation and Kenai Natives Association, 1973-75.

· Conducted study of the demand for enrollment at Utah State University by non-residents. Developed and empirically tested an education demand model. For Utah State University, 1973-75.

· Developed conceptual framework for assessing the economic contribution of out-of-state students to the Utah economy. For Utah State University, 1972.

· Assisted in the development of an experimental design for a project directed toward determining the economic optimum applications of fertilizer on range sites. For the U.S. Forest Service and ranches in northern Utah, 1969.

PUBLICATIONS
PAPERS
REPORTS

Workman, W.G., E.L. Arobio and A.F. Gasbarro (forthcoming, July 1979). "Will Alaska Farmers Sell the Development Rights to Their Lands?" Agroborealis.

Gasbarro, A.F., E.L. Arobio, and W.G. Workman 1979. Supply and Demand Assessment of the Resources of the Chugach National Forest. Draft Report to the U.S. Forest Service.

Workman, W.G. 1979. "Subsistence and Taxation of Native Lands." IN: The Subsistence Lifestyle in Alaska - Now and in the Future (Proceedings). School of Agriculture and Land Resources Management, University of Alaska, Fairbanks.

PUBLICATIONS
PAPERS
REPORTS (continued)

Workman, W.G., E.L. Arobio, and A.F. Gasbarro 1979. An Examination of a Development Rights Purchase Program for Alaska Agricultural Lands. Final report to Alaska Department of Natural Resources.

* Arobio, E.L., W.G. Workman, and C.R. Griffey. Resources of the Copper River Delta Planning Unit: Some Economic Considerations. Final report to the U.S. Forest Service.

Workman, W.G., A.F. Gasbarro and E.L. Arobio. 1978. A Development Rights Purchase Program for Alaska Agricultural Lands: Phase I Report. Report to Alaska Department of Natural Resources.

Workman, W.G. 1978. Nonresident Enrollment Demand At Utah State University. Unpublished Ph.D. dissertation, Utah State University.

Workman, W.G. and W.C. Thomas. 1977. "Some Economic Implications of Alternative Marketing Strategies for Interior Alaska Forest Products." IN: North American Forest Lands at Latitudes North of 60 Degrees (Proceedings). School of Agriculture and Land Resources Management, University of Alaska, Fairbanks.

Workman, W.G. 1977. "Institutional Arrangements Affecting Agricultural Land Use in Alaska." IN: Expanding Agriculture and the Management of Interior Alaska Resources (Proceedings). School of Agriculture and Land Resource Management, University of Alaska, Fairbanks.

Workman, W.G., W.C. Thomas, L.K. Johnson, and S. Helgath. 1977. Recreation on National Forest Lands in Alaska. Final Report to the U.S. Forest Service.

Workman, W.G., C.E. Lewis, and C.F. Marsh. "Consumer Reaction to CEA Vegetables". Agroborealis, Vol. 9, No. 1, January, 1977.

* Workman, W.G. "Outdoor Recreation in Alaska: Some Economic Aspects". Presented at 27th Alaska Science Conference, Fairbanks, Alaska; Alaska Division of the American Association for the Advancement of Science, August, 1976. (Also abstracted in Conference Proceedings)

PUBLICATIONS
PAPERS
REPORTS (continued)

Workman, W.G. and C.F. Marsh. "Examination of the Salad Vegetable Market of Anchorage and the Kenai Peninsula, Alaska". Agroborealis, Vol. 6, No. 1 May, 1974.

Thomas, W.C., W.G. Workman, C.E. Zunker, and L. Doak. 1974. "Interim Economics Report on the Controlled Environment Agriculture Project". Unpublished report.

Workman, W.G. and W.C. Thomas. 1974. "The Time Variable Again". Unpublished document regarding controlled environment agriculture (CEA).

Workman, W.G. and W.C. Thomas. 1974. "Consideration of Time in Agricultural Response Function Analysis". Unpublished document regarding controlled environment agriculture (CEA).

Workman, W.G. and W.C. Thomas. 1974. "Economic Feasibility Analysis". Unpublished document regarding controlled environment agriculture (CEA).

Workman, W.G. and B.D. Gardner. 1973. "Response of Nonresidents to Tuition Changes at Utah State University: Some Preliminary Results". Paper written for the Utah State University Administration.

Workman, W.G. and B.D. Gardner.1972. "Impact of Nonresident Student Spending on the Utah Economy: A Conceptual Framework". Paper written for the Utah Legislature.

ACTIVITIES

- Alaska representative on Western Agricultural Economics Association Council, 1977-79
- University of Alaska representative on Technical Committee of Western Regional Project, "Determinants of Choice in Outdoor Recreation", 1975 - present; vice-chairman, 1978.
- Participant, Exxon Corporation, Faculty Forum, 1977.

ORGANIZATIONS

- American Economic Association
- Western Economic Association
- Western Agricultural Economic Association
- Soil Conservation Society of America

BIOGRAPHICAL LISTINGS

- Outstanding Young Men of America, 1973
- Community Leaders and Outstanding Americans, 1975
- Men and Women in Science, 1977.

COMPANY REFERENCES

PRIVATE

Belden H. Daniels, Lecturer, City and Regional Planning, Harvard University, and President, Counsel for Community Development, Inc., Cambridge, Massachusetts. (617) 495-4972.

Armin Koernig, President, Prince William Sound Aquaculture Corporation, Cordova, Alaska. (907) 424-7511.

Marc Langland, President, First National Bank of Fairbanks, Alaska. (907) 452-2146.

Bill McNeil, General Manager, Oregon Aquafoods, Inc., Springfield, Oregon. (503) 746-4484.

GOVERNMENT

Lee G. Anderson, Associate Professor of Economics and Marine Studies, University of Delaware, Newark, Delaware. (302) 738-1215.

Donald H. Rosenberg, Director, Alaska Sea Grant Program, University of Alaska, Fairbanks, Alaska. (907) 479-7086.

Brian J. Rothschild, Senior Scientist, Office of Policy and Planning, NOAA, U.S. Department of Commerce, Washington, D.C. (202) 377-4497.

Frederick J. Smith, Professor, Department of Agriculture and Resource Economics and Extension Service (Marine Advisory Program), Oregon State University, Corvallis, Oregon. (503) 754-4821.

Keith W. Specking, Legislative Assistant to the Governor, Alaska Governor's Office, Juneau, Alaska. (907) 465-3500.

QUALITY ASSURANCE

DISCIPLINE COORDINATOR: CATHIE A. BAUMGARTNER

CATHIE A. BAUMGARTNER

Terrestrial Environmental Specialists, Inc.

Education

B.A. Biology (Major); Douglass College, Rutgers University, New Brunswick, New Jersey, 1969.
M.S. Zoology; Pennsylvania State University, University Park, Pennsylvania, 1973.

Professional Experience

Environmental Scientist, Terrestrial Environmental Specialists, Inc., Phoenix, New York, 1976 - present.

Associate Environmental Scientist (Director of Herpetological Studies), Equitable Environmental Health, Inc., Woodbury, New York, 1975.

Assistant Environmental Scientist (Herpetologist), Environmental Analysts, Inc., Garden City, New York, 1973-1975.

Instructor, Pennsylvania State University, Altoona, Pennsylvania, 1973.

Assistant Curator of Herpetology, Pennsylvania State University Museum, University Park, Pennsylvania, 1973.

Graduate Teaching Assistant (Zoology, Ecology, Ornithology), Pennsylvania State University, University Park, Pennsylvania, 1967-1973.

Undergraduate Laboratory Technician, Department of Biological Sciences, Rutgers University, New Brunswick, New Jersey, 1969.

Awards

National Science Foundation Grant - Summer Science Program - Paterson State College, Wayne, New Jersey, 1964.

National Science Foundation Grant - Summer Science Program - Fairleigh Dickenson University, Rutherford, New Jersey, 1963.

Phi Sigma (National Biological Honor Society), 1971-1973.

Sigma Delta Epsilon (Graduate Women in Science), 1972-1973.

Memberships

American Association for the Advancement of Science
American Birding Association, Inc.
American Ornithologists' Union
American Society of Ichthyologists and Herpetologists
Eastern Bird Banding Association
Ecological Society of America
Federation of New York State Bird Clubs, Inc.
Raptor Research Foundation
Society for the Study of Amphibians and Reptiles
Wilson Ornithological Society

Consulting and Related Experience

- designed and implemented herpetofaunal surveys at four proposed nuclear power plant sites.

- designed and supervised herpetofaunal surveys at two proposed fossil fuel power plant sites.

- authored herpetofaunal sections of environmental impact statements for 6 proposed power plant sites.

- authored testimony and responses to interrogatives on the environmental assessment of a proposed electric generating facility.

- supervised and coordinated production of a report on a major baseline terrestrial ecology study conducted for a proposed electric generating facility.

- designed, implemented, and authored report on study of vegetation mapping of a small impoundment.

- critically analyzed sections of an environmental assessment for two proposed power plant sites.

- participated in data collection on peregrine falcons as part of a nation-wide effort.

- conducted literature search on ecological parameters of selected marine fauna in conjunction with generation facility feasibility study.

- conducted literature searches on habitat requirements, distribution, and predator-prey interactions of selected vertebrates of the northeast.

- conducted study on habitat ecology of several species of stream vertebrates.

- collected ornithological data at 6 proposed power plant sites.

Consulting and Related Experience (Continued)

- designed and supervised studies of amphibian, reptilian, and fish resources of a 4,300 acre naval facility.

- assisted in the collection of baseline breeding bird data to be used to monitor the impacts of power plant construction activities.

- participated in the preparation of a report assessing impacts of an urban redevelopment project.

- supervised the preparation of a report assessing a lake shoreline development project in central New York.

- participated in the preparation of a report assessing the impacts of the renovation of a small hydroelectric facility.

- supervised and coordinated a route selection study for a 115 kV transmission line.

- participated in data collection and report preparation for an environmental assessment of a proposed sanitary landfill.

- designed and implemented data collection for a baseline and herpetofaunal monitoring program assessing the impacts of construction of a nuclear power plant.

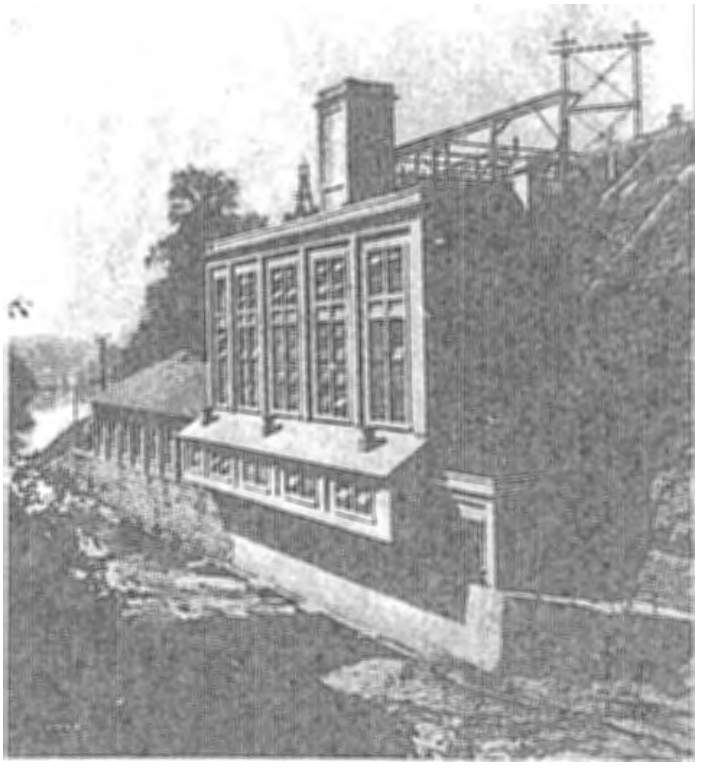
APPENDIX C1

PROJECT DESCRIPTION SHEETS
NORTH AMERICAN
HYDROELECTRIC DEVELOPMENTS

TRENTON FALLS HYDRO DEVELOPMENT P4984.00

Location	West Canada Creek, New York
Client	Niagara Mohawk Power Corporation
Year	1978–1980
Value	$8,000,000 (Approximate capital cost)

Feasibility study and detailed design for increasing the capacity of the existing Trenton Falls hydro development from 23,600 kw to 28,600 kw. The project involves replacement of four original units by a single 9,000 kw unit, reconstruction or rehabilitation of the associated powerhouse structure, replacement of two 3,500-foot long pipelines from the Trenton Dam to the power facilities, and rehabilitation of the existing power intake and surge tank. The program also includes rehabilitation of the equipment and structures for the existing powerhouse.

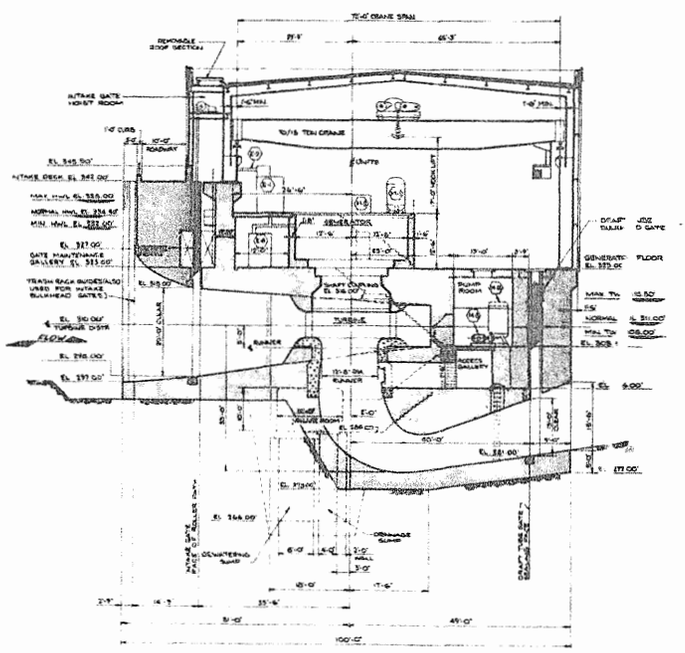


Location **Fulton, New York**

Client **Niagara Mohawk Power Corporation**

Engineering for preliminary and detailed design of a 10 MW hydroelectric redevelopment of the existing Granby Plant on the Oswego River near Fulton, New York. The generating facilities will consist of an integral intake-powerhouse structure containing two 5 MW turbine-generator units operating under 23.5 feet of head. The station will be equipped for fully automatic operation at a remote source.

The scope of work for the project includes selection of turbine/generator equipment, final project arrangement, engineering design for controlled demolition of the existing plant, intake and powerhouse structures, cofferdams and dewatering, powerhouse mechanical and electrical equipment and station equipment for automatic and manual operation.



CROSS SECTION AT UNIT 2 CENTER LINE

ACRES

ST. MARY'S RIVER GENERATING STATION

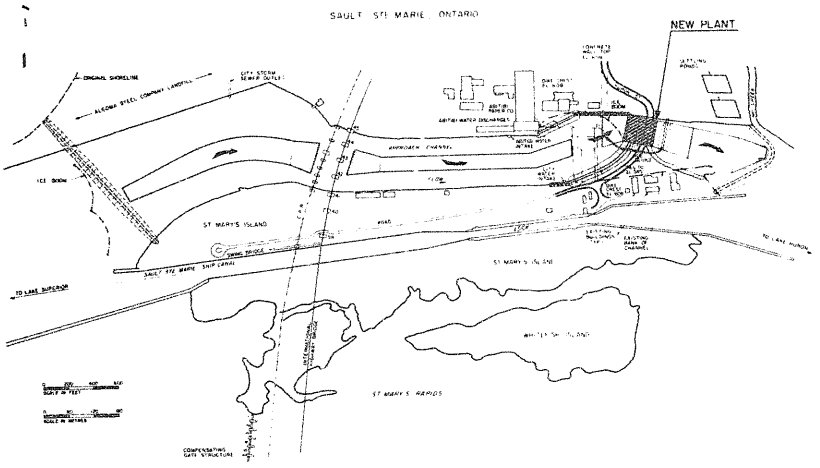
P4617

Client — Great Lakes Power Corporation Limited
Utilities Division

Location — Sault Ste. Marie, Ontario

1979

Engineering and construction management for the redevelopment of a hydroelectric generating station in the St. Mary's River. The new plant will have three 17.3-MW bulb type turbine generating units under a head of 5.7 m. The plant is designed to utilize Canada's full quota of water from the St. Mary's River.



General Arrangement

Owner Manitoba Hydro

Consortium Crippen Acres Limited

Commercial Power Scheduled for 1984

Location Nelson River, Manitoba

Value $1,200,000,000 (Approximate capital cost)

Engineering for a ten-unit run-of-river type hydroelectric power development with a total capacity of 1,070 MW. The first commercial power is scheduled for 1984 with the final unit expected to go on line in 1986.

The main dam of the development is approximately 1,300 m long. The two earth-fill sections of the main dam, which have a combined length of 800 m and a maximum height of 33 m, are founded on rock. The main dam and the upstream cofferdam comprise a total volume of 3.2 million m^3 of compacted gravel, crushed rock and impervious core.

The concrete overflow spillway has 7 vertical-lift gates, each 13.0 m wide by 15.8 m high, with a design discharge capacity of 9,500 m^3/s. During the final diversion stage, the river flow will pass through 7 low-level openings regulated temporarily with the permanent spillway gates.

The intake structure contains 30 gates, each 8.5 m wide by 14.3 m high. The powerhouse contains 10 vertical-shaft, fixed-blade, propeller type turbines rated at 107 MW under a net head of 26.2 m. The generators are of the umbrella type, each rated at 125 MVA at 0.8 power factor. The main transformers are rated at 90/120/150 MVA, 13.8/230 kV, 3-phase, 60 Hz ONS/ONP. The powerhouse contains two overhead cranes, each having a capacity of 250 tonnes.

The spillway, intake, powerhouse and auxiliary concrete structures contain approximately 540,000 m^3 of concrete and will require 121,000 tonnes of cement and 27,000 tonnes of reinforcing steel.

River management during construction is complicated by major ice jamming during long winters and by daily peaking operation of upstream power plants. Heights of the 4-million m^3 cofferdams are governed by ice conditions rather than flood flows.

ARNPRIOR GENERATING STATION

P3197,3176

Location — Madawaska River
Arnprior, Ontario

Client — Ontario Hydro

1972 – 1976

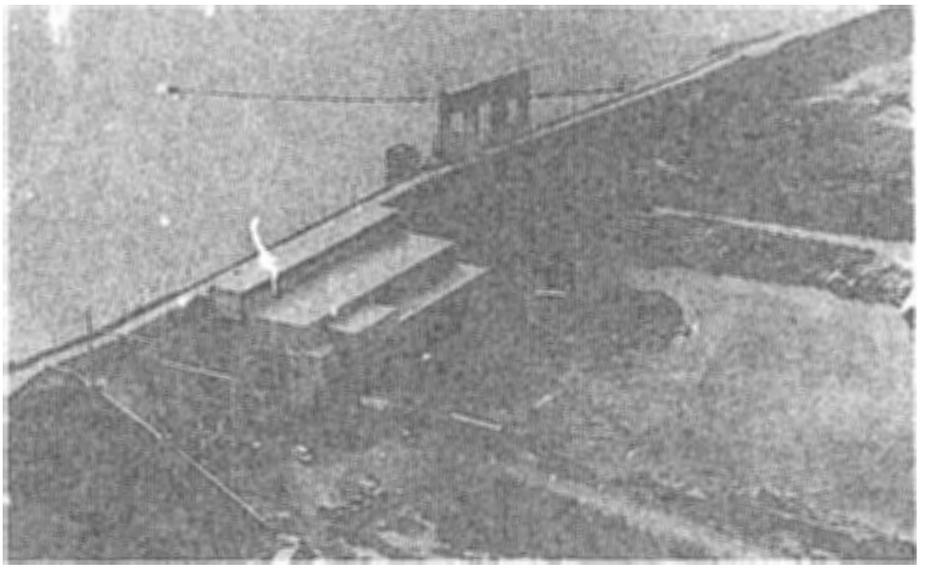
Value — $80,000,000 (Approximate capital cost)

Engineering, construction supervision and project management for a peaking type hydroelectric power development having two 54,000-hp turbine units under a head of 68 feet.

The main dam and powerhouse are located within the Town of Arnprior. The main dam (crest length 2,500 feet) consists of a headworks structure, gravity bulkhead sections, a sluiceway, an emergency sluiceway and earth rock-fill dike sections. A close-coupled powerhouse is located immediately downstream of the headworks structure.

The 42,000-cfs capacity sluiceway incorporates three fixed-roller type sluicegates, each 24 feet wide by 32 feet 7 inches high with wire rope hoists.

The four-fixed roller type head gates, 24 feet 6 inches wide by 37 feet 3 inches high, are operated by hydraulic hoists.

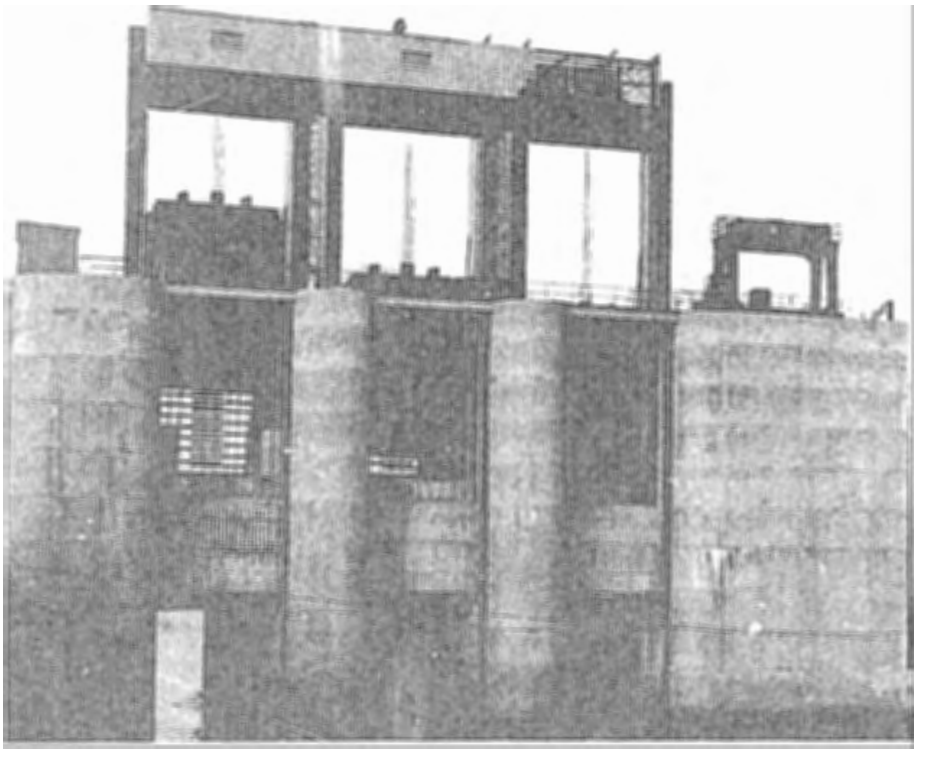


In addition to the main dam and powerhouse the following ancillary works were included in the development:

- channel improvements to tailrace between the powerhouse and the Ottawa River (190,000 cubic yards of rock)
- a 1,050-foot long semicircular tailrace control weir in the Town of Arnprior
- a two-lane, 1,150-foot long bridge over the head pond
- a 3,700-foot long zoned earth-fill saddle dam 56 feet high on a sensitive marine clay foundation
- relocation of 3.2 miles of CPR mainline track
- a four-lane, 704-foot long highway bridge over the Madawaska River in the Town of Arnprior.

Because of the proximity of the project to the Town of Arnprior, numerous utilities had to be relocated including 115-kv transmission lines, long distance telephone circuits, watermains, storm and sanitary sewers, a natural gas main and many overhead telephone and power distribution lines.

Acres, as Project Manager, arranged all contract packages, called tenders, let contracts and certified progress payments. Acres also maintained responsibility for project scheduling, budget, project safety, security and community relations.



LONG SPRUCE GENERATING STATION P2999

Location Nelson River, Manitoba

Owner Manitoba Hydro

Consortium Crippen-Acres Limited

Commercial Power Scheduled for 1977

Value $445,000,000 (Approximate capital cost)

Engineering for a ten-unit run of river type hydro-electric power development with a total capacity of 1,000 Mw. The first commerical power is scheduled for 1977 with the tenth and final unit expected to go on line in 1980.

The main dam of the development is approximately 4,000 feet long. The two earth-fill sections of the main dam, which have a combined length of 2,475 feet and a maximum height of 130 feet, are founded on rock and consist of a central impervious core, with 3 million cubic yards of compacted gravel and crushed rock supporting fills.

The concrete overflow spillway has 6 vertical-lift gates, each 42.7 feet wide by 57.5 feet high, with a design discharge capacity of 336,000 cfs. During the final diversion stage, the river flow will pass through 12 low-level openings located below the rollway crest.

The intake structure contains 30 gates, each 18 feet wide by 46 feet high. The powerhouse contains 10 vertical-shaft, fixed-blade, propeller type turbines, rated at 135,000 hp under a net head of 80 feet. The generators are of the umbrella type, each rated at 115-Mva at 0.85 power factor. The main transformers are rated at 100/133 Mva, 13.8/230kv, three phase, 60 hertz ONS/ONP. The powerhouse contains two overhead cranes, each having a capacity of 225 tons.

The spillway, intake, powerhouse and auxiliary concrete structures contain approximately 600,000 cubic yards of concrete and will require 110,000 tons of cement and 22,000 tons of reinforcing steel.

The principal structures are flanked by sand fill dikes on each side of the river. The dikes are constructed on permafrost and have a combined length of 45,000 feet, a maximum height of 32, feet and contain approximately 3,600,000 cubic yards of fill.

LOWER NOTCH GENERATING STATION

P1661

Location Montreal River, Cobalt, Ontario

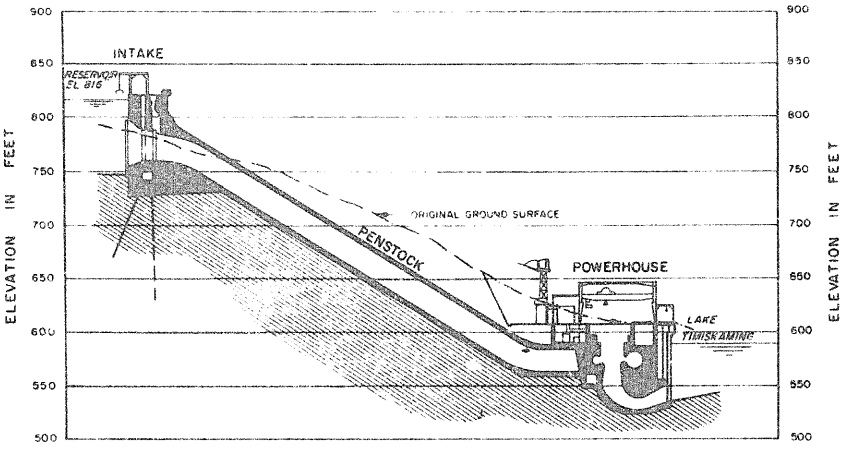
Client The Hydro-Electric Power Commission of Ontario

1967 – 1971

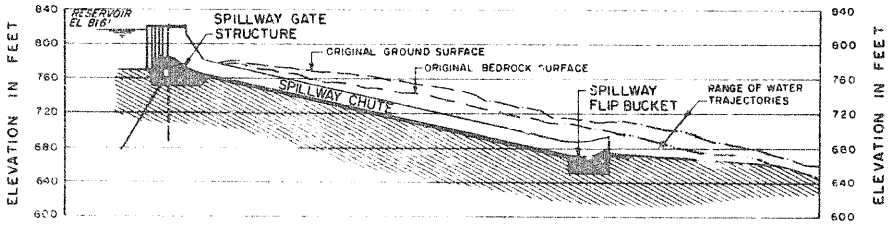
Value $60,000,000 (Approximate capital cost)

Engineering, construction supervision and project management for a peaking-type hydro-electric power development having two turbine generator units, each rated at 170,000 horsepower under a head of 230 feet (340,000 horsepower total capacity).

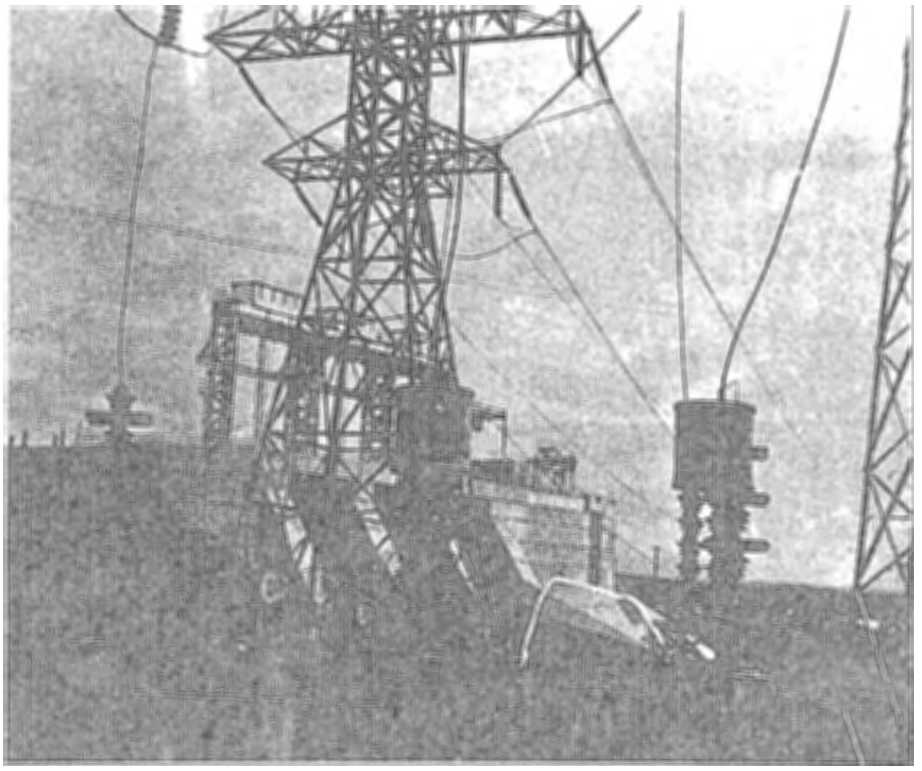
The development includes a D-shaped diversion tunnel (35 feet high, 34 feet wide, 2,000 feet long), and earth-and rock-fill dam and reservoir dike (crest 400 feet above foundations, 2,600-foot crest length, 2,200,000 cubic yards), earth-and rock-fill canal dikes (2,500-foot total length, 600,000 cubic yards),a flip bucket-type chute spillway with three vertical cable lift gates (each 32.5 feet high, 29 feet wide), an intake structure, two penstocks (23-foot diameter, each approximately 460 feet long) and a powerhouse.



INTAKE, PENSTOCK AND POWERHOUSE



SPILLWAY



CHURCHILL FALLS 230–735-KV SWITCHYARD

P1522

Location	Churchill River, Labrador, Newfoundland
Project Managers	Acres Canadian Bechtel of Churchill Falls
Owner	Churchill Falls (Labrador) Corporation Limited
Value	$25,000,000 (Approximate capital cost)

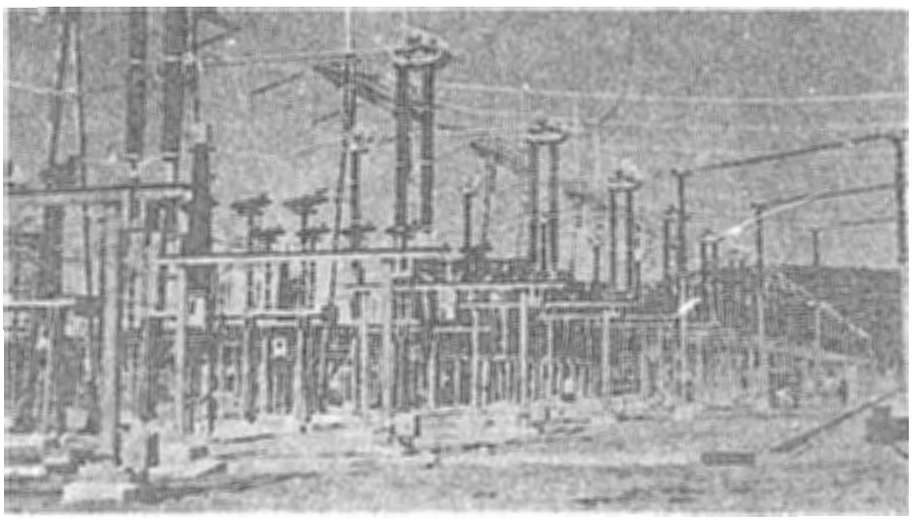
The planning, engineering, and detailed design for this switchyard was provided by Acres Canadian Bechtel of Churchill Falls, a joint venture between Acres Consulting Services Limited and Canadian Bechtel Limited, as an integral part of the Churchill Falls project.

Power from the eleven generations in the underground powerhouse is delivered to the switchyard by means of 230-kv self-contained oil-filled cables. Each cable is connected to a 230-kv, 15,000-Mva air blast circuit breaker.

Power is stepped up to the main 735-kv transmission voltage by six banks of 230–735-kv autotransformer, each rated at 1,000 Mva. Each bank comprises three single-phase units having a rating of 333 Mva.

The 735-kv switchyard is laid out on a breaker-and-one-third basis, with twelve 735-kv, 25,000-Mva air blast circuit breakers and three outgoing lines. Shunt reactors with a 3-phase rating of 165 Mva are connected to each of the 735-kv lines. The 735-kv bus work is laid out on two levels. The lower level is fabricated from rigid 154-mm diameter aluminum tubing, while the high-level strain bus comprises a 2-conductor bundle of 2,050-sq mm stranded aluminum conductors.

Adjacent to the switchyard is a central control building with facilities for remote control of all major functions in both the powerhouse and the switchyard.



ACRES

CHURCHILL FALLS DEVELOPMENT

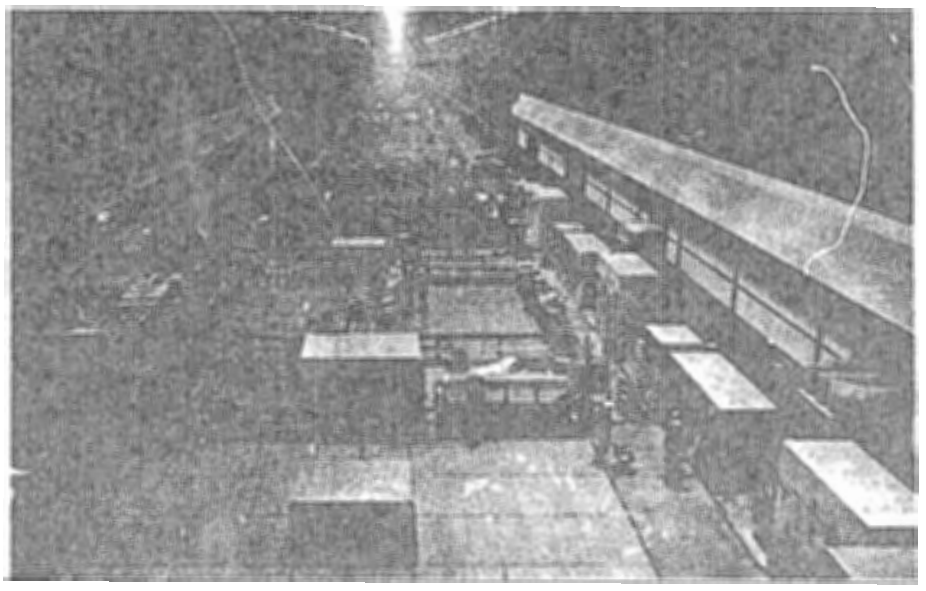
P1520

Location	Churchill River, Labrador, Newfoundland
Project Managers	Acres Canadian Bechtel of Churchill Falls
Owner	Churchill Falls (Labrador) Corporation Limited
Value	$665,000,000 (Approximate capital cost)

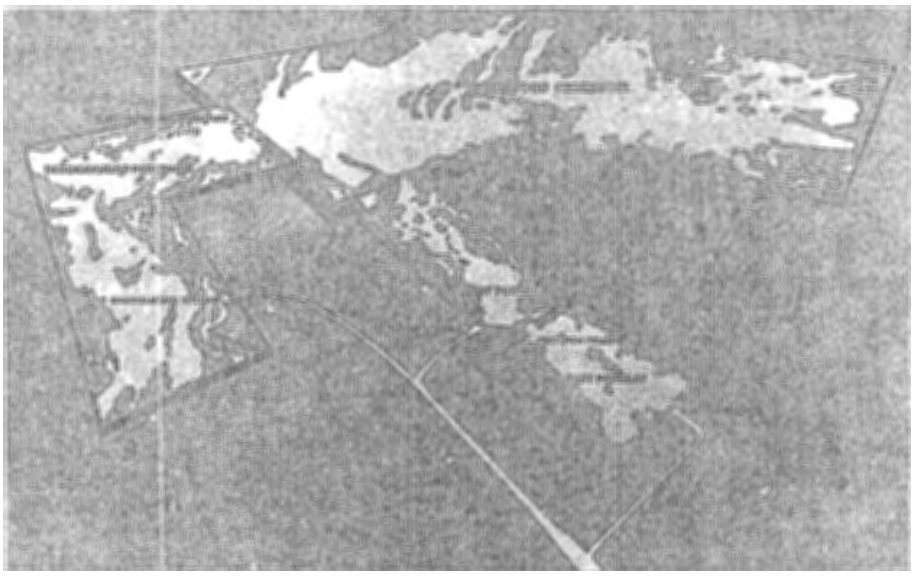
Planning, engineering, detail design and construction management services for the entire development were provided by Acres Canadian Bechtel of Churchill Falls, a joint venture between Acres Consulting Services and Canadian Bechtel Limited. Through this joint venture Acres provided Engineering Management and the detailed engineering design of the entire underground power plant facilities and numerous ancillary works, including water control structures, their gates and equipment.

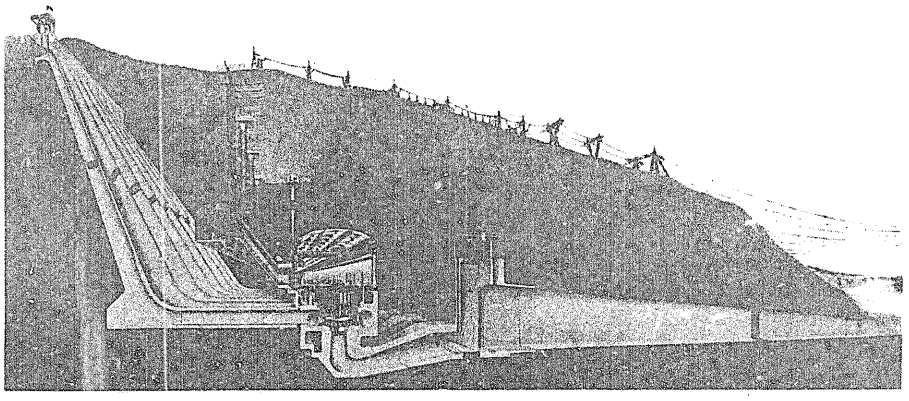
The power plant is located about 1,000 feet underground and comprises eleven Francis turbine units of 475-Mw output at a 1,025-foot net head. Each unit has a concrete- and steel-lined inclined penstock shaft extending to an intake structure at the surface, and the flow from the turbines is returned to the Churchill River by two unlined tailrace tunnels,45 feet wide by 60 feet high, which are 5,500 feet long.

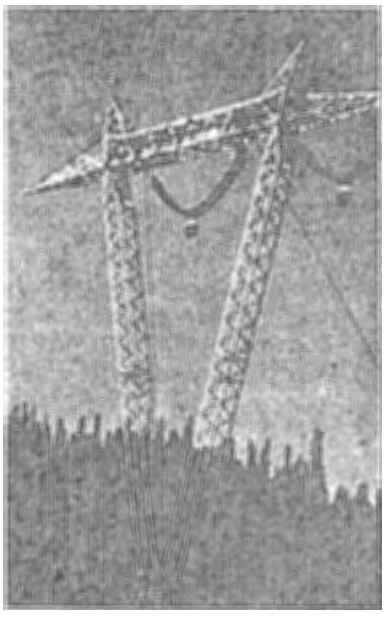
Water control and spillway structures for the project reservoirs have a total capacity of 670,000 cfs and have 17 gates ranging up to 45 feet wide by 57 feet high, designed for service in severe winter conditions.



ACRES







KETTLE GENERATING STATION

M101.1
P1432

Location Nelson River, Manitoba

Client Manitoba Hydro

1966 – 1974

Value $300,000,000

Engineering and liaison for construction of a 12-unit run-of-river type hydroelectric power development with a total capacity of 1,224 MW.

The two main earth-fill dams of the development total approximately 3,500 ft and have a maximum height of 150 ft. The reservoir dikes constructed on discontinuous permafrost have a total length of approximately 35,000 ft and average height of 15 ft. In addition to the dikes, a 4,000-ft long, 70-ft high dam was required across a local valley. Due to permafrost-affected weak materials in the valley, approximately 1,300,000 cu yd of materials had to be excavated to a depth of 50 ft, with subsequent dam fill of 2,300,000 cu yd.

The concrete overflow spillway has eight 38-ft wide by 48-ft high vertical-lift gates, with a design discharge capacity of 336,000 cfs. The intake structure contains thirty-six 19-ft 9-in. wide high gates, operated by hydraulic hoists. Intakes eight to twelve were utilized for river diversion, prior to the downstream powerhouse construction, and were stabilized by the addition of temporary concrete ballast blocks (total weight 86,000 tons) on the upstream side. The powerhouse contains twelve vertical-shaft, fixed-blade propeller type turbines rated at 140,000 hp at 98.5-ft head, each coupled to an umbrella type generator rated at 120 MVA at 0.85 power factor.

Construction quantities included 430,000 cu yd of excavation, 8,000,000 cu yd of earth-fill materials and 98,000 cu yd of concrete.

The work included extensive studies of the probable effects of ice jams on the heights of cofferdams required for the various stages of river diversion during construction. The studies focused primarily on the scheme for Stage II diversion through the partially constructed powerhouse intake. This scheme involved raising the water level and maintaining a stable ice cover immediately upstream from the site,in order to prevent ice from jamming in the narrow flow passages. The ice studies included field surveys to establish the natural ice regime of the Nelson River and simulation of ice jams in a 6-mi reach of the river using an 85-ft long hydraulic model, to determine the minimum height of the upstream cofferdam.

Actual operation in the field during diversion was in accordance with the results of the ice model studies in all major respects. A stable ice cover was successfully formed at the recommended level, and was maintained until late spring when the weakened ice cover was safely sluiced through the control structure.

GRAND RAPIDS DEVELOPMENT

P1282, 826

Location . he mouth of the Saskatchewan River, on the west shore of Lake Winnipeg, Manitoba

Client Manitoba Hydro

1965, 1968

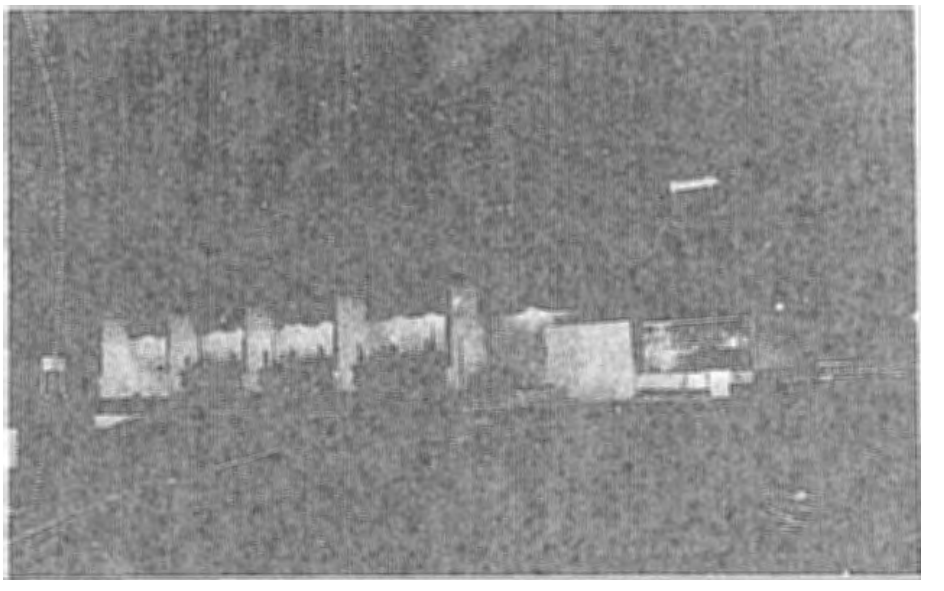
Value $140,000,000 (Approximate capital cost)

Engineering for a complete 450-Mw hydro-electric development and the subsequent installation of an additional unit.

The reservoir has an area of about 2,040 square miles and is formed by earth-fill dikes and cement grout curtains on its east boundary. The dikes have a maximum height of 110 feet and a total length of approximately 16 miles, and the grout curtains have a maximum depth of 200 feet and a total length of approximately 18 miles. The reservoir spillway has a capacity of 140,000 cfs, regulated by four 42.5-foot high by 40-foot wide gates with cable hoist mechanisms.

An intake structure of the mass concrete gravity type with eight hydraulically operated, vertical 36-foot high by 16-foot wide lift gates feeds the four penstocks of the development. The penstocks are of concrete-encased, steel construction and they are 29 feet in diameter and 200 feet long.

The powerhouse contains four units, each rated at 150,000 horsepower under a head of 120 feet. Power is generated at 13.8 kv and transformed by 30,000/40,000 kva, single-phase transformers to 230 kv for transmission.



MACTAQUAC DEVELOPMENT

P1140

Location Saint John River, New Brunswick

Client The New Brunswick Electric Power Commission

1968

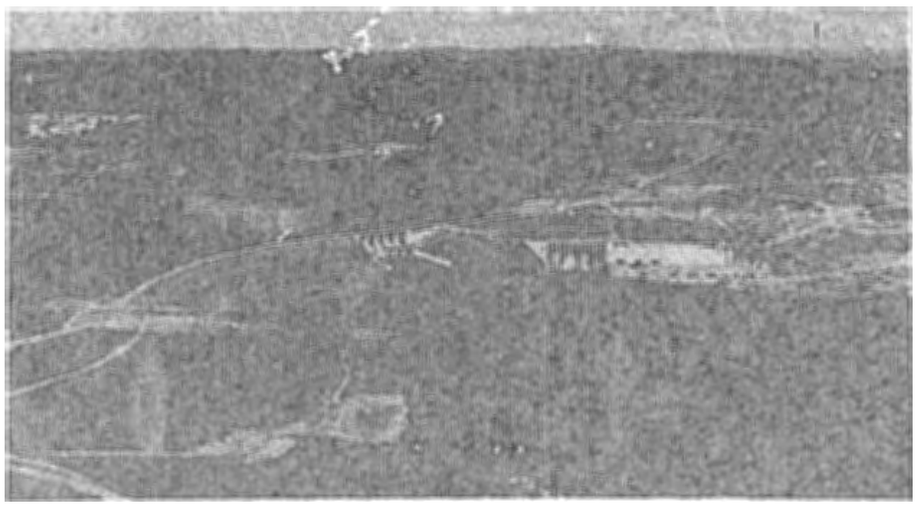
Value $110,000,000 (Approximate capital cost)

Engineering and supervision of construction for a run-of-river type hydro-electric power development having an ultimate total rated capacity of 625-Mw.

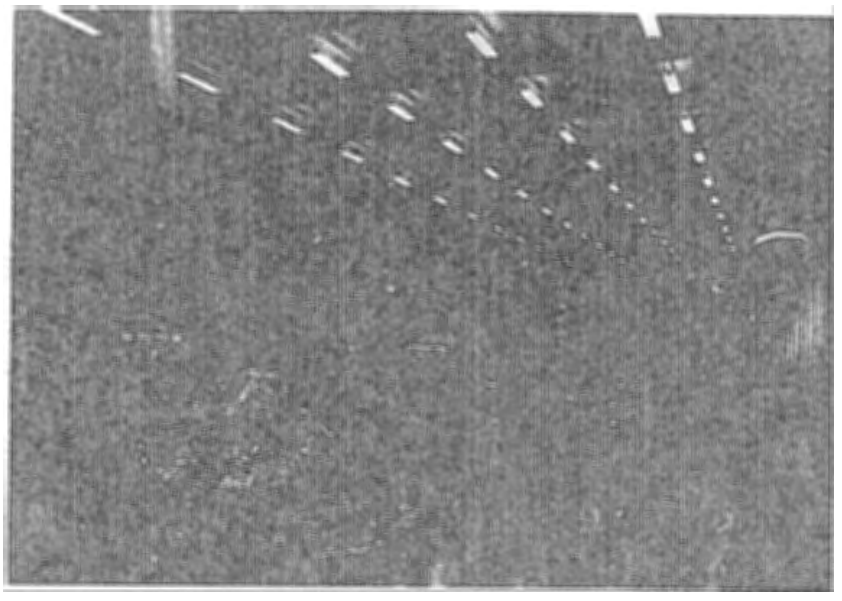
The dam of the development is constructed of compacted rock fill (3,741,000 cubic yards) with a near vertical core of impervious glacial till (745,000 cubic yards), and it is approximately 1,700 feet long with a maximum height of 184 feet. The foundation preparations for the dam included the dredging, by 30-inch cutter suction dredge, of approximately 2,000,000 cubic yards of material from the riverbed.

The development has two concrete spillway structures, each having five vertical lift crest gates (53 feet high by 45 feet wide) for a total design flood discharge capacity of 575,000 cubic feet per second. One spillway structure is located in the diversion channel and the other is joined to the powerhouse structure.

The conventional indoor surface-type powerhouse contains two vertical, 112.5-rpm, Kaplan-type units, each rated at 140,000 horsepower under a net head of 112 feet, and ultimately will contain six units for a total rated capacity of 840,000 horsepower. Each unit is supplied by one steel penstock, 29 feet in diameter and 178 feet in length with two vertical lift intake gates (34.5 feet high by 16 feet wide). One intake approach channel supplies both the powerhouse and the main spillway structure, and it is approximately 1,300 feet long, 500 feet wide and 55 feet deep.



Each of the unit step-up transformers is rated at 85.5/114 Mva, 13.8/138 kv, 3-phase, 60 hertz, ONS/ONP.



MANICOUAGAN 1 DEVELOPMENT P1096

Location Baie Comeau, Quebec

Client Quebec Hydro-Electric Commission

1967

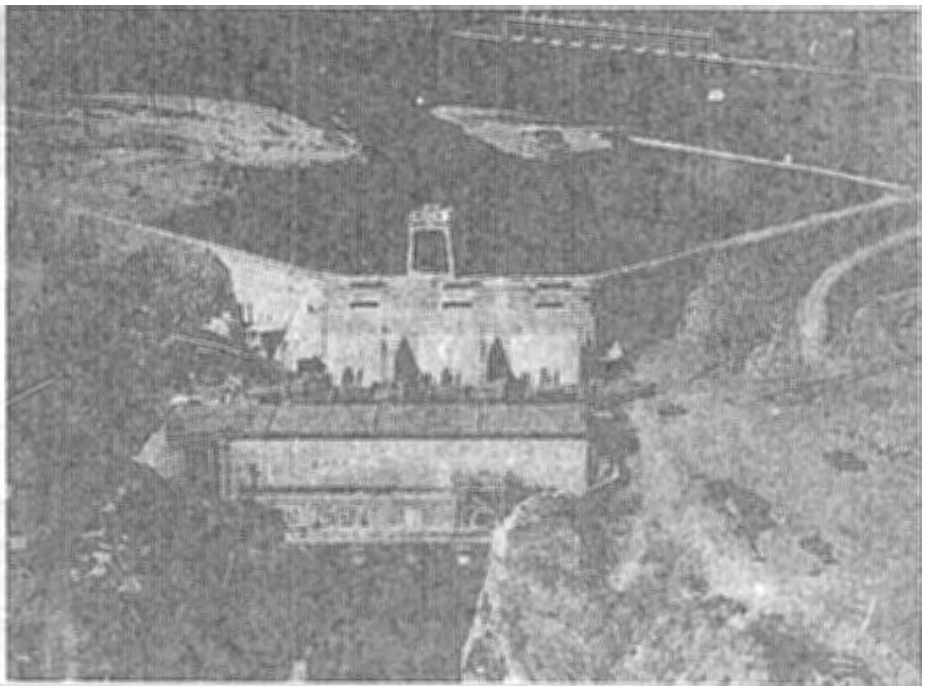
Value $20,000,000 (Approximate capital cost)

Engineering for a complete hydro-electric power development having three units each rated at 80,000 horsepower (61,500 kw) under a net head of 120 feet.

The development utilizes the forebay of the McCormick Development to which it is connected by means of an intake channel 120 feet wide and 600 feet long with a hydraulic depth of 50 feet.

The intake works contain three gates each 27 feet by 20.5 feet which supply three steel-lined, concrete penstock tunnels each 22 feet in diameter and 120 feet long.

The tailrace channel is 72 feet wide and 1,800 feet long with a hydraulic depth of 40 feet.



AGRES

Owner **British Columbia Hydro and Power Authority**

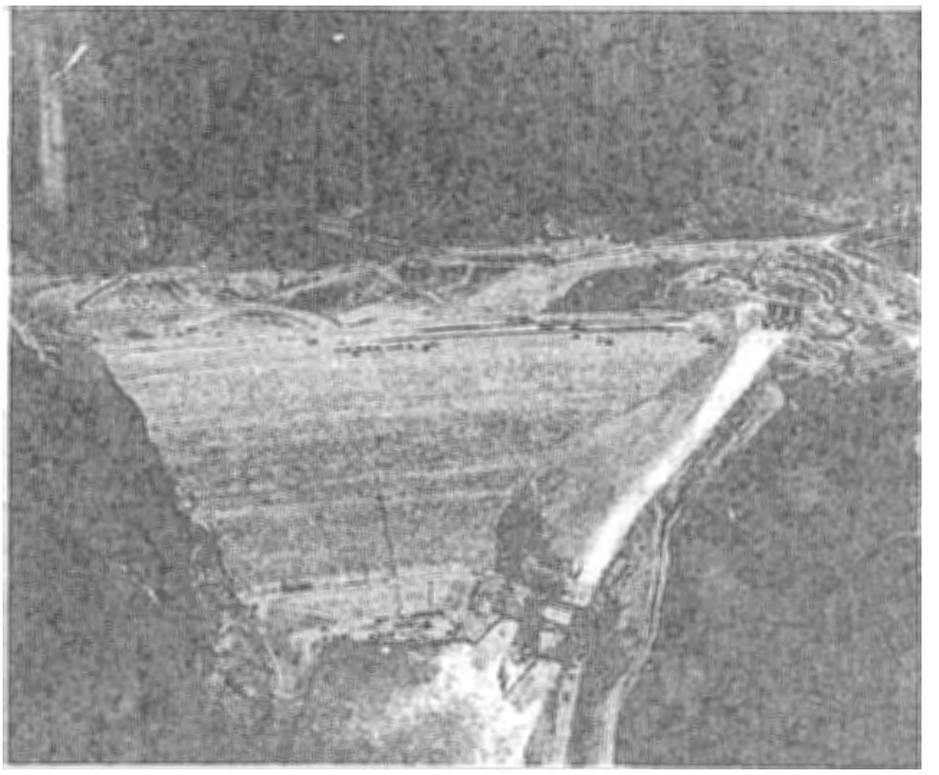
Consortium **CASECO Consultants Limited**

Location **Columbia River, British Columbia**

Value **$200,000,000** (Approximate capital cost)

CASECO Consultants Limited, a joint venture with equal participation by the three companies, H. G. Acres & Company Limited, Shawinigan Engineering Company Limited and G. E. Crippen & Associates Limited, was formed in 1961 to provide complete planning, engineering, detail design and construction supervision for the Mica Dam project. The project, which was completed in 1973, consisted of the diversion works, cofferdams, main dam, low-level outlets, outlet works, spillway, power intakes, and associated electrical and mechanical control equipment.

The main dam is a compacted earth-fill structure with a near-vertical impervious core of glacial till. Maximum height of the dam is 243 m above the lowest bedrock level in the riverbed core trench. The inner and outer shell zones consist of sand and gravel, and rock fill, respectively. The total volume of fill material is approximately 32,000,000 m^3. The crest length of the dam is 792 m. The reservoir created by the Mica project measures about 425 km^2 in area with a total storage volume of 25 by 10^9 m^3.



The diversion works consist of two concrete-lined tunnels, 14 m in diameter, each having a length of about 1,000 m. Designed as free-flow structures, the tunnels have a combined capacity of 4 250 m^3/s.

Cofferdams required for dewatering the main dam foundation area in the river were largely incorporated into the dam embankment. Deep tube wells were installed through the river alluvium for control of water in the core trench excavation.

A low-level outlet structure was constructed in one of the diversion tunnels to pass required releases during reservoir impounding in the dead storage area. This hydraulic structure featured an expansion chamber between two concrete control plugs within the tunnel to dissipate energy.

Releases from the reservoir in the live storage range are accomplished by an inclined tunnel leading into the second diversion tunnel. The capacity of the outlet works is 1,060 m^3/s at full pool level.

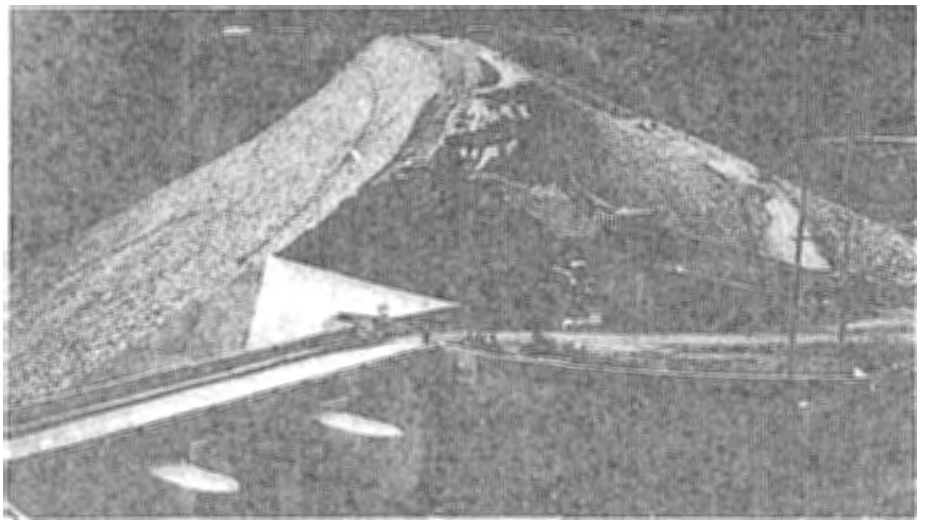
The spillway structure consists of a control structure with three radial gates, a 531-m long concrete chute, and mass concrete flip bucket. The maximum capacity of the spillway is 4,250 m^3/s.

The project included a power intake structure, comprising a 76-m high opencut excavation in rock for an approach channel and six intakes.

Each intake consists of a bell-mouth entrance, gate chamber and short concrete-lined stub tunnel leading to the penstocks. Inflow control is accomplished by vertical fixed-wheel gates operated from 8.7-m diameter, 76-m deep gate shafts.

CASECO's responsibilities in the Mica Dam project also included reservoir slope stability studies, engineering for the permanent townsite, preliminary studies for the power installation and other project-associated studies and designs.

Engineering of the underground generating station at Mica was carried out subsequently by the British Columbia Hydro and Power Authority.



Location On the Nelson River, approximately 425 air miles north of Winnipeg, Manitoba

Client The Manitoba Hydro-Electric Board

1961

Value $44,000,000 (Approximate capital cost)

Engineering and supervision of construction for a run-of-river hydro-electric power development. The development is designed on the unit basis and it has five turbine/generator/transformer units with provisions for the future installation of one additional unit.

The turbines are of the fixed-blade propeller type, rated at 42,000 horsepower under a head of 55 feet, and the generators are rated at 37,500 kva, 13.8 kv, 3-phase, 60 hertz. The step-up transformers are rated at 37,500 kva, 13.8/138 kv, 3-phase, 60 hertz, and they are located together with the switchyard equipment on the roof of the power-house. The development is arranged for local operation, or for remote control from Thompson by means of power line carrier.

The main dam is of the rock-fill type with an upstream impervious sloping core, and it has a maximum height of 120 feet, a crest length of 955 feet and a volume of 288,300 cubic yards. Adjoining the dam is a concrete sluiceway structure 66 feet high and 480 feet long with nine fixed-roller, crest-type gates (each 43.5 feet high by 40 feet wide). The sluiceway has a discharge capacity of 250,000 cfs. The development has 6,250 feet of clay dikes having a maximum height of 38 feet, and 3,900 feet of sand dikes (founded on permafrost) having a maximum height of 20 feet.

MANICOUAGAN 2 DEVELOPMENT

P703

Location — On the Manicouagan River approximately 12 miles north of Baie Comeau, Quebec

Client — Quebec Hydro-Electric Commission

1967

Value — $120,000,000 (Approximate capital cost)

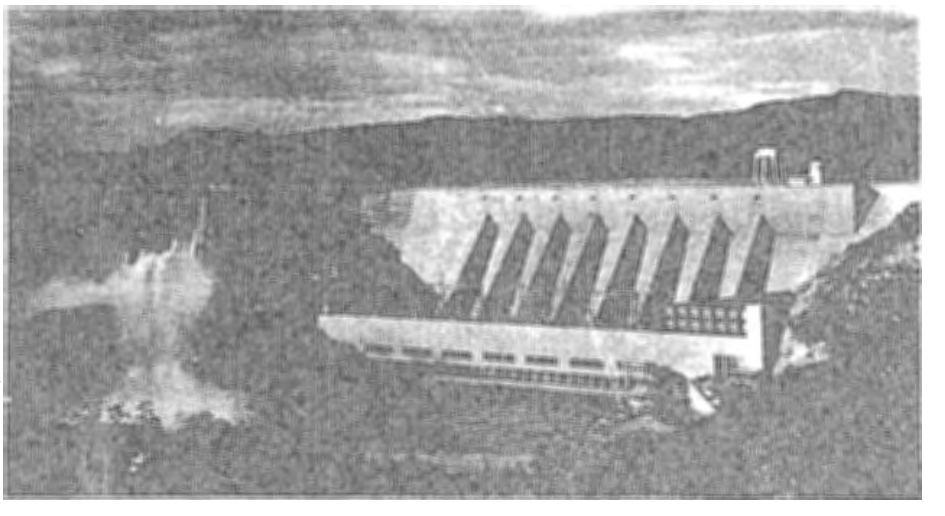
Engineering for a complete hydro-electric power development.

The development consists of a concrete gravity dam incorporating a spillway, a log sluice and an intake structure with the powerhouse located immediately downstream and parallel to the dam.

The intakes are located at the top of the dam and water is led from the intakes in steel penstocks, 23 feet 6 inches in diameter, down the downstream face from the dam to the generating units. The powerhouse contains eight 120-rpm, vertical, Francis-type turbine generator units each rated at 170,000 horsepower under a head of 230 feet.

The spillway has five gates (each 40 feet by 40 feet) with sufficient capacity to discharge a flood flow of 200,000 cfs with no water passing through the powerhouse units. The log sluice is designed to take care of all future requirements for log driving on the river.

The type of dam chosen for this development is a section known as "Hollow Joint" Concrete Gravity Dam. This type of construction reduces concrete quantities by approximately 10 per cent, compared with normal gravity sections. In addition, the system of hollows and galleries provides a means of observing seepage and uplift pressures in the foundation of the dam, and remedial work, if required, can be carried out within the dam at minimum cost.



BERSIMIS NO. 2 DEVELOPMENT

P608A

Location — On the Bersimis River approximately 170 miles north of Quebec City, Quebec

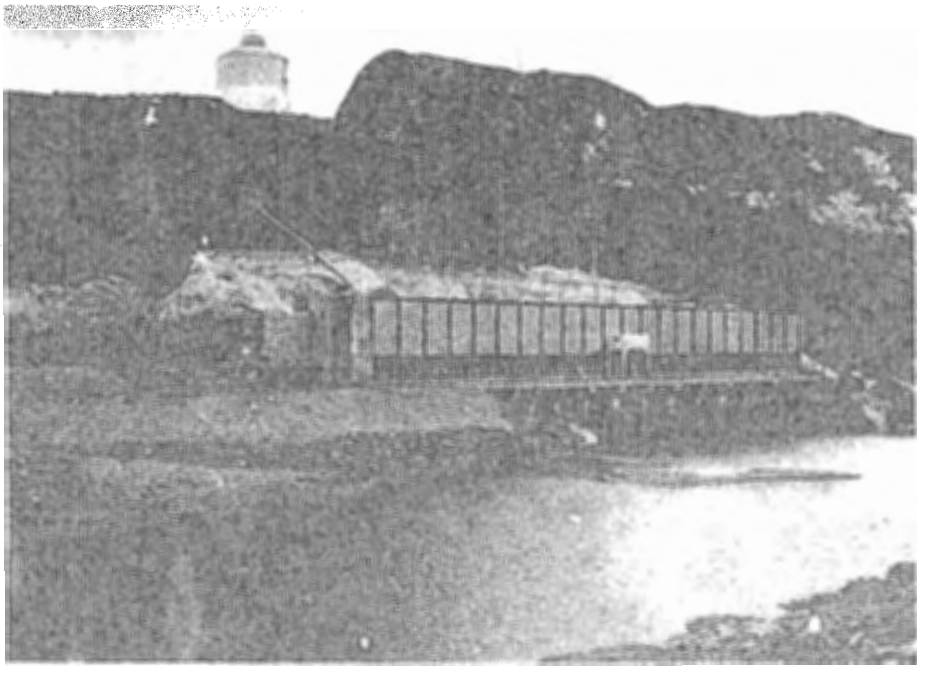
Client — Quebec Hydro-Electric Commission

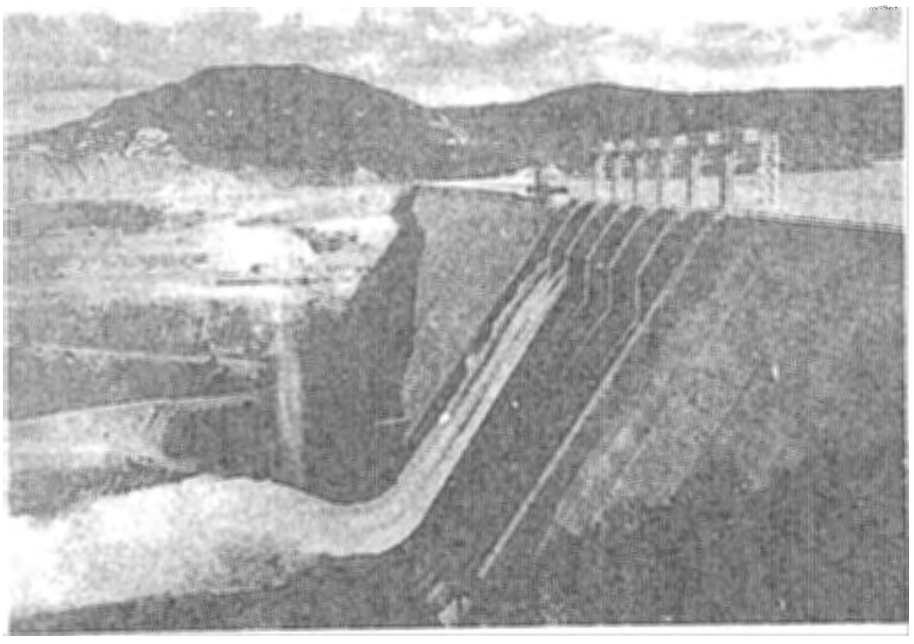
1960

Value — **$120,000,000** (Approximate capital cost)

Engineering and field liaison for a complete hydro-electric power development having five 163.6-rpm units each rated at 171,000 horsepower under a head of 367 feet.

The development has a main dam and two auxiliary dams. The main dam is of the mass concrete gravity type 275 feet high and 2,110 feet long and it has an integral spillway section with six cable hoist-type gates each 31 feet high by 40 feet wide. The auxiliary dams are of the earthfill vertical clay core type. The first is 97 feet high and 3,310 feet long, and the second is 64 feet high and 3,920 feet long. The concrete-lined supply tunnel is 38 feet in diameter and 2,700 feet long, and it is protected by a steel surge tank of the orifice type, 100 feet in diameter.





APPENDIX C2

PROJECT DESCRIPTION SHEETS
INTERNATIONAL
HYDROELECTRIC DEVELOPMENTS

LA BORUCA HYDROELECTRIC POWER PROJECT

P5301

Client Instituto Costarricense de Electricidad

Location Rio Grande de Terraba, Costa Rica

Studies and engineering design of a 760 MW hydroelectric development which will include the highest rock-fill dam in the western hemisphere.

Objective of the study is to carry out geological and engineering investigations necessary to define the main components and a cost and economic evaluation. Acres will also conduct an environmental study of the area downstream of the project.

Acres responsibilities in the engineering design will include the power complex and switchyard consisting of

- underground powerhouse of four 190-MW units. Separate penstocks connect each unit to the power intake
- chute spillway controlled by 5 radial gates 15.2 m wide by 17.2 m high
- sloping core rock-fill dam, 260 m high having a total fill volume of approximately 43,000,000 m^3
- diversion of upstream and downstream cofferdams 50 and 20 m high respectively which will form part of the main dam and 4 diversion tunnels, 8 m in diameter and horseshoe shaped. The tunnels pass directly under the powerhouse and after diversion will serve as draft tube discharge tunnels
- 220-kV transformers and switchyard located on the surface directly above the powerhouse
- two double-circuit 220-kV transmission lines, 53 km long to transmit power to Uvita and a proposed aluminum smelter.

The project is located in an area having an average annual rainfall of approximately 4,000 mm. The foundation geology at the site consists of permeable limestone and a formation of sandstone and shale. The general region is seismically active and a major geological fault traverses the damsite.

KARUN II AND III DEVELOPMENT PROJECTS P5001

PROJECT DEFINITION, PRELIMINARY AND FEASIBILITY STUDIES

Client The Imperial Government of Iran
Ministry of Energy
Khuzestan Water and Power Authority

Location Iran

1978

A joint venture of Land and Water Resource Development Engineering Company of Tehran and Acres International Limited, is the consulting engineer for the Karun II and III Development Projects in Iran. These multibillion dollar hydroelectric and irrigation projects are situated in Khuzestan in southwestern Iran.

The Karun River rises in the rugged Zagros Mountains and, after flowing through the mountain chain, enters the semidesert coastal plain at Gotvand. From there it meanders seaward to its mouth in the Shatt-al-Arab at Khorramshahr near Abadan. It is the largest remaining source of hydroelectric power in Iran. Regulation will also permit a major increase in irrigated land area.

The proposed development will utilize the 300-m drop of the Karun River over a distance of about 100 km between the confluence with the Khersan River and the reservoir for the existing Reza Shah Kabir Dam. One or two dams will be built to harness this hydroelectric potential and to provide storage and river regulation which will permit the development of irrigation for more than 100,000 ha of land on the plains.

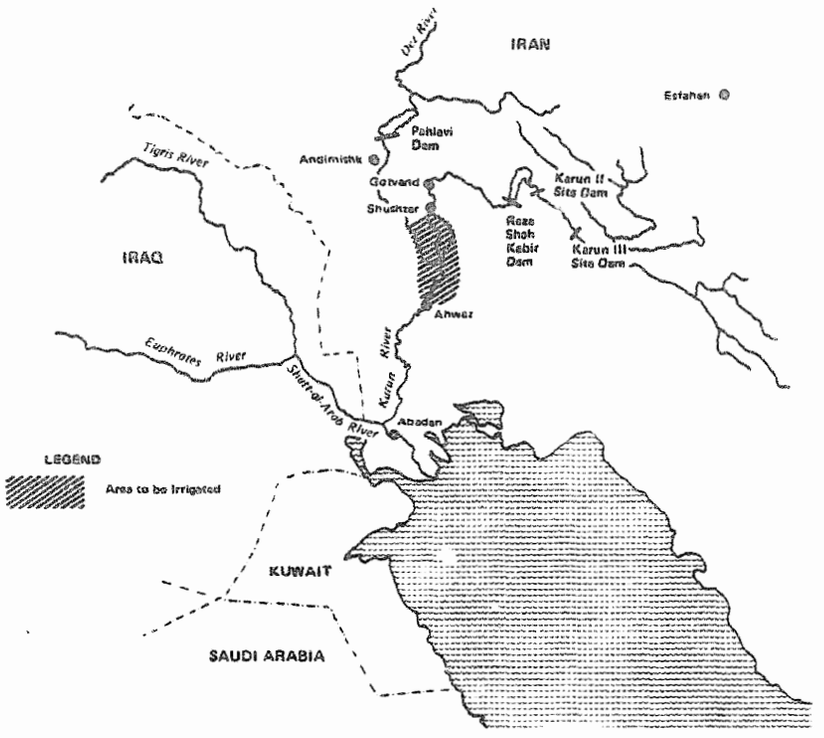
The first phase of the work consists of project definition, preliminary and feasibility studies. The studies will examine the various power and irrigation options, select the preferred development scheme for optimal benefits, and make a comprehensive feasibility study of the selected scheme. The studies are scheduled to take about 3 years.

A prime objective of the first-phase work will be to determine whether a single 300-m high dam, either rock-fill or concrete arch, is technically and economically feasible. The alternative scheme using two lower head dams, each about 155 m high, will also be investigated. Hydrological and reservoir operation studies, geological investigations, power demand forecasts, transmission line routing studies, and dam and power facility layouts are all included in the work.

To carry out physical investigation work at the damsites, including exploratory drilling and adits and topographic and geologic mapping, access roads and camps will have to be built.

Soil surveys, land classification, agricultural and argonomic studies will be carried out to determine the crops to be grown, and to optimize land utilization in the irrigated area, and to assess marketing conditions. Layouts and preliminary design of major diversion structures, distribution system and drainage works are included in the studies.

Later phases will involve detail design, construction supervision and commissioning of the dam(s), power plants(s), transmission lines and irrigation system. Target date for completion of construction is 1987.



KPONG HYDROELECTRIC PROJECT

P4123

Location Volta River, Ghana

Client Volta River Authority

1976 – 1981

Value $240,000,000 (Approximate capital cost)

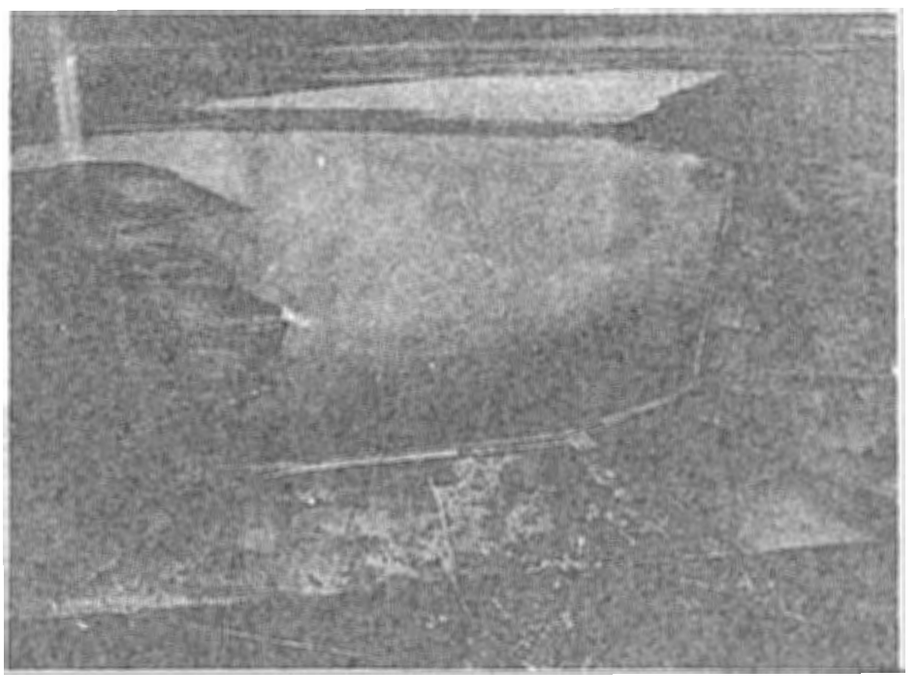
Engineering, construction supervision and general planning for low-head hydroelectric power development having four generating units rated at 40 Mw each, under a head of 11.75 metres.

The principal components of the project comprise a close-coupled intake/powerhouse structure, some 51 metres high above foundations, a spillway with 15 radial gates having a discharge capacity of 20,700 cu m/sec, an earth-fill dam section and a total of 4.5 km of dikes, a 4-story control building, switchyard and 52 km of double-circuit transmission lines. Provision will be made for future irrigating works.

The head pond of the project forms the tailrace for the existing Akosombo plant, and the Kpong plant will operate generally in tandem with the Akosombo plant.

Because of the very low head, the fixed-propeller turbines are extremely large with a runner diameter of 8.13 metres, currently the largest in the world.

The first unit is scheduled to go on line early in 1981.



ACRES

02/77

TARBELA HYDROPOWER EXTENSION PROJECT P4069

Location Tarbela Dam, Indus River, Pakistan

Client Water and Power Development Authority, Pakistan

Value $119 million (approximate capital cost)

Design and supervision of construction for extension to the existing powerhouse, to contain Units 5 to 8, and the installation of Units 5 and 6 with all electrical and mechanical auxiliaries.

The extension comprises

- a concrete powerhouse structure designed to accommodate four water-turbine generators
- a steel-lined concrete-encased penstock supplying water to the four units of the extension from one of the existing tunnels, used as a diversion tunnel during construction of the dam
- two vertical-shaft waterwheel generators of 175-Mw capacity, connected through 500-kv single-phase transformers to the switchyard
- four turbine inlet butterfly type valves.

Construction work will commence 1977. Units 5 and 6 are scheduled to be commissioned in 1980.

WARSAK DEVELOPMENT

P602
P3963

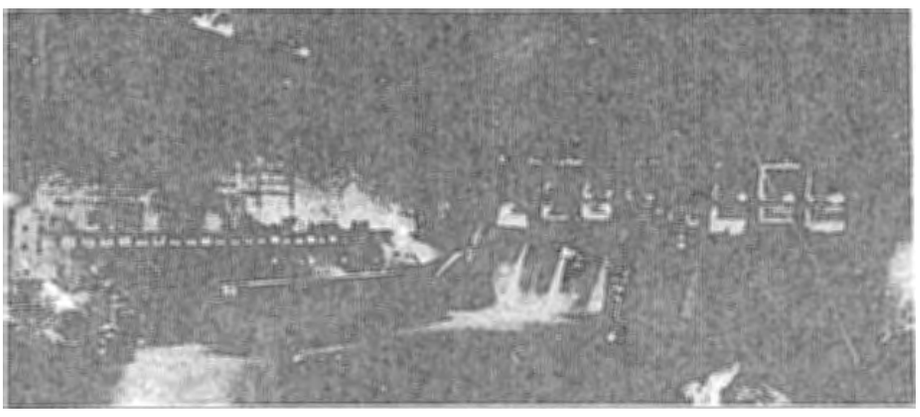
Location	On the Kabul River approximately 19 miles northwest of the City of Peshawar, Pakistan
Client	Government of Canada Department of Trade and Commerce Colombo Plan Administration in Canada Canadian International Development Agency – Units 5 and 6
Owner	Water and Power Development Authority, Pakistan
	1961 – 1978
Value	$55,000,000 – Initial Installation $15,000,000 – Units 5 and 6

Engineering and supervision of construction for a complete hydroelectric power development.

The initial development commissioned in 1961 had four units, each rated at 40 Mw under a head of 144 feet. Two additional units, each rated at 41.5 Mw are scheduled for commissioning in 1978.

The dam of the development is of the concrete gravity type, 250 feet high and 650 feet long, with the river section being a spillway (540,000 cfs) equipped with nine 40-foot by 40-foot taintor type gates. The reservoir created by the dam has a useful live storage volume of 25,000 acre-feet.

The intake of the supply tunnel is a fan-shaped concrete structure 138 feet long, with nine converging piers supporting trashracks and two steel headgates each 39 feet high and 17 feet wide. The concrete-lined supply tunnel is 689 feet long, has a circular cross section 39 feet in diameter, and terminates in six steel-lined penstocks, each 120 feet long and 18 feet in diameter. The diversion tunnel for the project was 1,650 feet in length and had a concrete-lined, horseshoe-shaped cross section 35 feet in diameter. The development includes a concrete-lined irrigation tunnel 17,100 feet long with a circular section 10 feet in diameter.



ASLANTAS DAM AND POWER PROJECT P2012

Location Ceyhan River, Adana, Southern Turkey

Associates Sofina – Traction, Brussels, Belgium
Su-Yapi, Ankara, Turkey

Client Directorate General of the State Hydraulic Works,
(Devlet Su Isleri)

1972

Value $80,000,000 (Approximate capital cost)

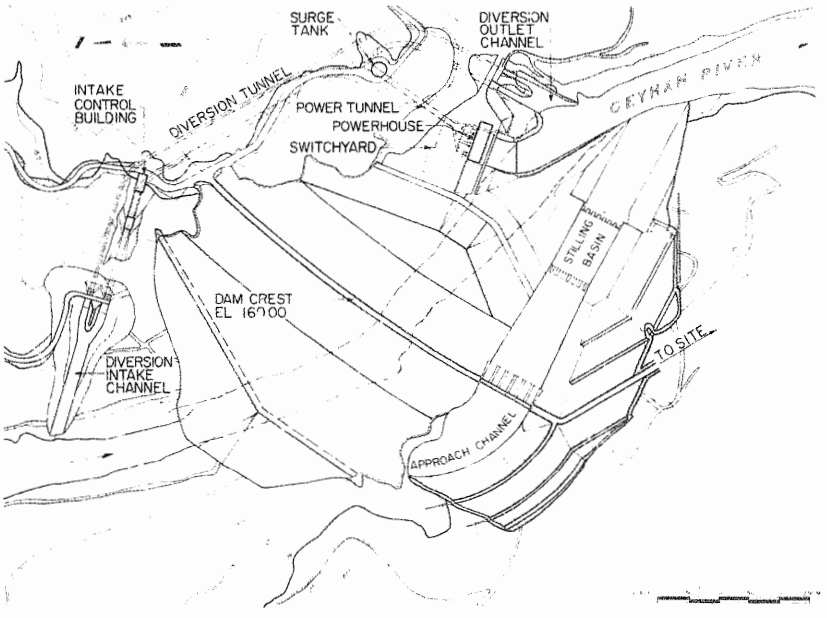
Engineering services for the design and specification of a dam and powerhouse on the Ceyhan River.

The project is the primary electric power generation, irrigation and flood control development in the Ceyhan Basin, and the principal features of the project are:

a 110-metre high earth-fill dam to create a reservoir having a capacity of 2,250 million cubic metres. Of the total capacity, 2,000 million cubic metres are for electric power generation and irrigation, and the remaining 250 million cubic metres of the capacity are for flood control purposes;

a three-unit 125-Mw powerhouse with 350-Gwh estimated average annual output;

a 60-km transmission line to Ceyhan.

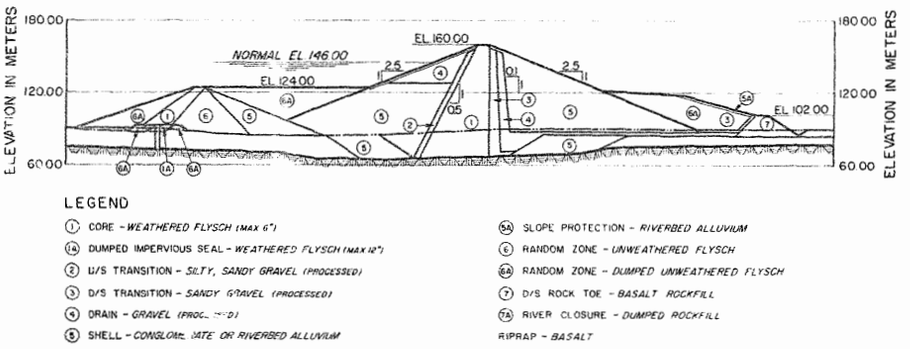


ASLANTAŞ PROJECT LAYOUT

The dam is founded on a layered sequence consisting predominantly of clay-shale, with minor amounts (15 per cent) of interbedded sandstone. This geological unit is referred to as Flysch. The clay-shale is composed of approximately 50 per cent calcite and 50 per cent montmorillonite with minor clay-mineral fractions, as established by X-ray diffraction. The dam is an earth-fill structure with an impervious core consisting of compacted clay-shale derived primarily from the excavations for the spillway and other structures. The section also includes upstream and downstream weighting berms to buttress the dam against sliding on the relatively weak foundation.

The excavations for the spillway and other structures involved the removal of several million cubic yards of clay-shale. Careful design of the excavation slopes was required to preclude stability problems associated with planes of weakkess parallel to the bedding of the clay shales and to other geological features which constitute weaknesses within these deposits.

The twin diversion/power tunnels (each 9 metres in diameter) of the project had to have continuous temporary support consisting of a combination of shotcrete with Perfo bolts or steel ribs. The permanent support for both tunnels consists of concrete linings.



LEGEND

① CORE - *WEATHERED FLYSCH (MAX 6")*
⑭ DUMPED IMPERVIOUS SEAL - *WEATHERED FLYSCH (MAX 12")*
② D/S TRANSITION - *SILTY, SANDY GRAVEL (PROCESSED)*
③ D/S TRANSITION - *SANDY GRAVEL (PROCESSED)*
④ DRAIN - *GRAVEL (PROCESSED)*
⑤ SHELL - *CONGLOMERATE OR RIVERBED ALLUVIUM*
⑤A SLOPE PROTECTION - *RIVERBED ALLUVIUM*
⑥ RANDOM ZONE - *UNWEATHERED FLYSCH*
⑥A RANDOM ZONE - *DUMPED UNWEATHERED FLYSCH*
⑦ D/S ROCK TOE - *BASALT ROCKFILL*
⑦A RIVER CLOSURE - *DUMPED ROCKFILL*
RIPRAP - *BASALT*

ASLANTAS DAM – CROSS SECTION

ALTO ANCHICAYA PROJECT P1630

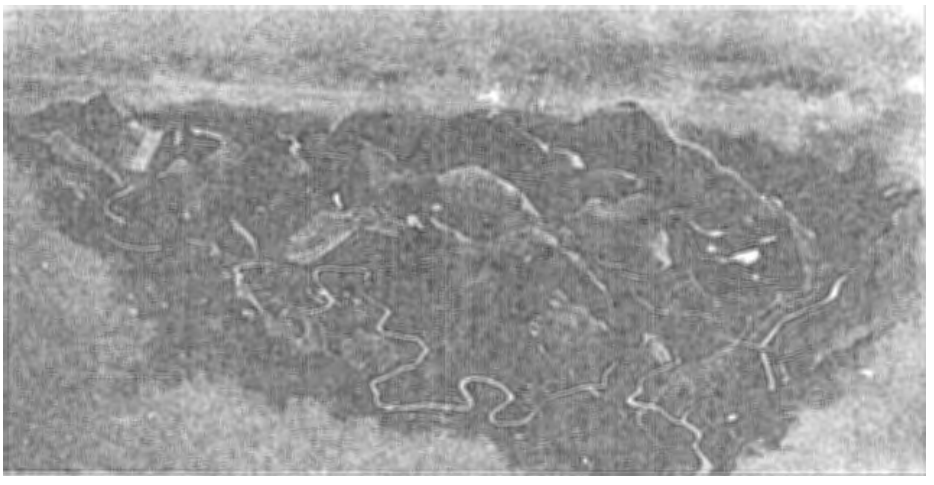
Location Anchicaya River, Colombia

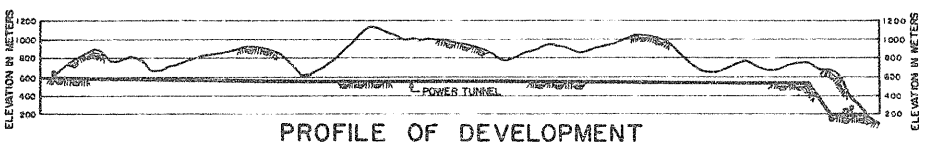
Client Corporacion Autonoma Regional del Cauca (CVC)

1967 – current

Technical and economic feasibility studies of the Alto Anchicaya Project for international financing agencies; preparation of engineering designs, specifications and contract documents; and participation in a mixed client/consultant project management team for the project. The project management team is headed by a member of the Acres staff.

The Alto Anchicaya Project is a hydro-electric power development in Western Colombia on the Alto Anchicaya River, downstream from the Rio Verde confluence. The project consists principally of a reservoir impounded by a concrete-faced rock-fill dam, a power tunnel, an underground powerhouse, and a tailrace tunnel which discharges into the existing Chidral reservoir.





PROFILE OF DEVELOPMENT

STATISTICS

Reservoir		
Drainage Area	520	km^2
Storage	30,000,000	m^3
Dam		
Rock fill with concrete upstream diaphragm		
Height	140	m
Volume	2,460,000	m^3
Spillway		
Chute type with three gates and flip buckets		
Gates each	13.5 m high by 13.67 m	wide
Crest length	41	m
Design flood (overflow)	4,600	m^3/s
Power tunnel		
Concrete-lined horseshoe		
Diameter	5	m
Length	8.3	km
Power tunnel surge tank		
Concrete-lined circular central shaft		
Diameter	6.2	m
Height	140	m
Concrete-lined horseshoe lower expansion chamber		
Diameter	8	m
Length	25	m
Concrete-lined horseshoe upper expansion chamber		
Diameter	8	m
Length	78	m
Main penstock		
Concrete-lined circular		
Design head for transient conditions	560	m
Diameter	4.5	m
Length	480	m
Powerhouse		
Underground		
Length	62	m
Width	20	m
Approximate volume	37,000	m^3
Units		
Vertical Francis-type turbines		
Three		
Total installed capacity	340	Mw
Tailrace tunnel		
Concrete-lined horseshoe		
Diameter	6	m
Length	250	m
Access tunnels		
Concrete-lined rectangular		
Height	6.95	m
Width	6	m
Total length	390	m

SIRIKIT POWER DEVELOPMENT

P1616B

Location Nan River, Thailand

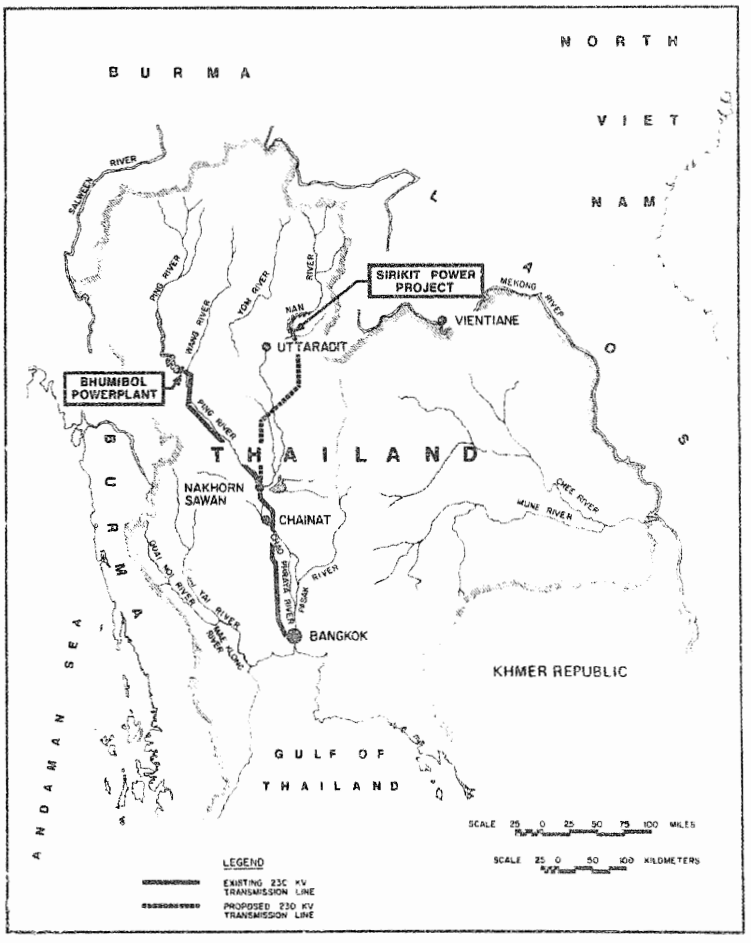
Client Electricity Generating Authority of Thailand (EGAT)

1967 – Current

Engineering layout studies, detailed designs and supervision of construction of the penstocks and powerhouse of the Sirikit Power Development of the multipurpose Nan River Project (irrigation, flood control, power).

The power development has a capacity of 375 Mw, comprising three units, each rated at 125 Mw, under a head of 76 metres. Space has been provided for a fourth unit. The project is scheduled for initial operation in 1973, and the estimated capital cost is $50 million.

The project was originally called the Phasom Power Project.



NAM NGUM PROJECT

P1460

Location — The Nam Ngum, 70 km north of Vientiane, Laos

Client — The Kingdom of Laos
The Laotian National Mekong Committee

1966 – 1971

Value — $29,000,000 (Approximate capital cost)

Engineering management and supervision of the design, construction and initial operation of the Nam Ngum Project.

As engineering management consultants, Acres was responsible for the administration and supervision of the execution of the project. Acres work included:

the review of proposed designs, schedules and construction procedures;

the control of the methods used for the supply of materials, equipment and services;

the review of specifications, the supervision of tendering and the awarding of contracts;

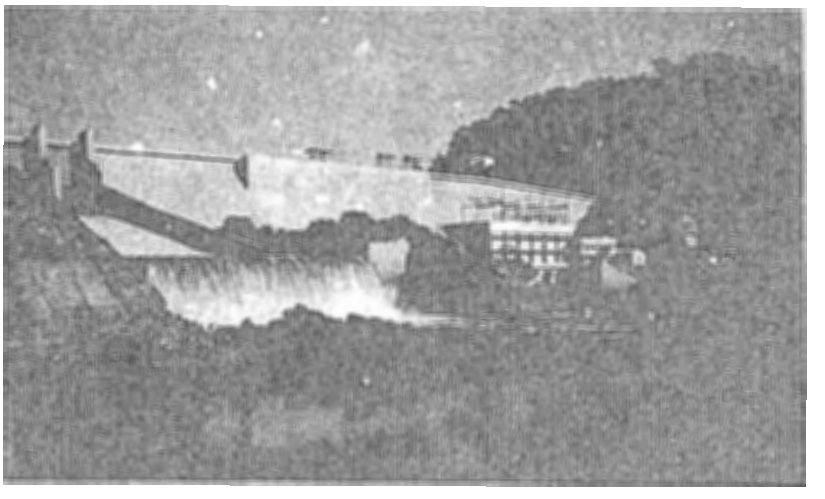
the certification of payments due;

the preparation of cost estimates and expenditure forecast;

the direction of accounting procedures;

the preparation of progress reports;

the supervision of initial operation, and training of operating and maintenance staff.



APPENDIX C3

PROJECT DESCRIPTION SHEETS SELECTED STUDIES FOR HYDROELECTRIC, UNDERGROUND PUMPED STORAGE, AND RELATED DEVELOPMENTS

TYGART LAKE HYDROPOWER EVALUATION P5273.00

CLIENT: Department of the Army
Pittsburgh District
Corps of Engineers

LOCATION:

A study to identify and evaluate alternative plans for the development of hydroelectric power at the existing Tygart Lake project on the Tygart River near Grafton, West Virginia. Tygart Dam is a concrete gravity structure, approximately 230 feet high with a crest length of 1900 feet, and at the time of its completion in 1938, the highest dam in the Eastern United States. Tygart Dam and Lake is a multi-purpose project providing flood control and low-flow augmentation, principally for navigation purposes on the Monongahela River. The lake has a total surface area of 3440 acres, and has developed into a popular recreational area over the years. The study will examine the technical, economic and environmental aspects of hydropower development at Tygart for a number of alternative schemes ranging from no change in the existing operation of the project to progressive elimination of the stream flow augmentation and flood control functions of the development, with re-regulation of flows downstream.

The study will also examine the feasibility of pumped storage facilities at two potential sites using Tygart Lake as a lower reservoir. Installed capacities at these sites ranging up to approximately 3000 MW will be examined, depending on the site location and the volume of available storage diverted for pumped storage purposes.

The study will involve assembly and review of baseline data and identification of potential economic, social and environmental impacts of the various alternative schemes. The program will also include the development of alternative generation expansion plans for the Allegheny Power Service Corporation system to assess the ability of the system to absorb the power generated from the Tygart Lake Project.

ACRES

ERDA/EPRI ENERGY STORAGE STUDY
UNDERGROUND PUMPED HYDRO

P4800

Client — **Potomac Electric Power Company**
Department of Energy
Electric Power Research Institute

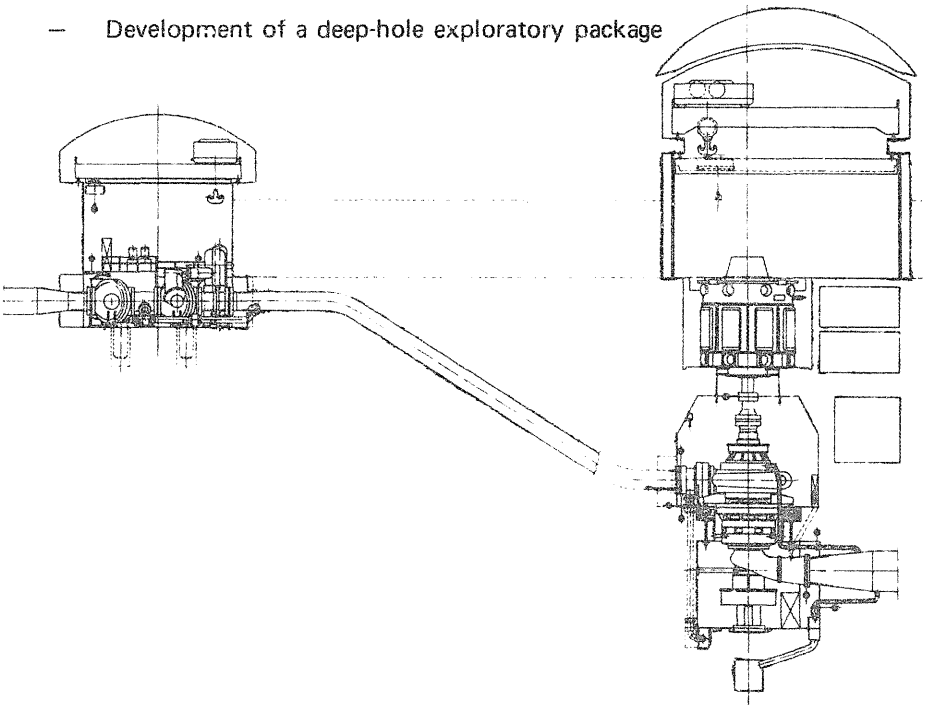
Location — **Washington, D. C.**

Value — **$500 million (Approx. capital cost)**
$2 million (Approx. engineering cost)

The study involves a program of both office and field investigation aimed at the development of site-specific preliminary designs and the comparative evaluation of both underground pumped hydro (UPH) and compressed air energy storage (CAES) systems. The program is devoted exclusively to hard-rock cavern siting applications, and includes the development of designs, outline specifications, and firm estimates of cost and schedule.

Specific objectives of the UPH study include:

- Identification of the most appropriate operating head in relation to available pump/turbine equipment
- Development of a suitable heavy hoist system
- Development of the least-cost approach to the excavation of the lower caverns
- Development of a deep-hole exploratory package



- Identification of key safety and environmental issues
- Identification of appropriate energy storage requirements and system simulation approach

The study is being undertaken in a series of five primary tasks:

Task 1 – Establishment of design criteria and analysis of impact on power system

Task 2 – Selection of the site and preliminary field investigation, including exploratory drill hole to 5,000 feet and associated geophysical package

Task 3 – Formulation of the optimum facility configuration including the assessment of alternative machinery options and investigation of the economics of major underground openings

Task 4 – Preliminary review of the safety and environmental aspects of the project at the generic level and at the selected site

Task 5 – Preparation of layouts, arrangement drawings and outline specifications for both the proposed facility and for a demonstration facility

Subcontracting consultants to Acres for the study include Jacobs Associates of San Francisco, California, NUS Corporation of Rockville, Maryland, Terra Tek Incorporated of Salt Lake City, Utah, and G. W. Tiley & Associates of Burlington, Ontario.

PUMPED STORAGE FEASIBILITY STUDY

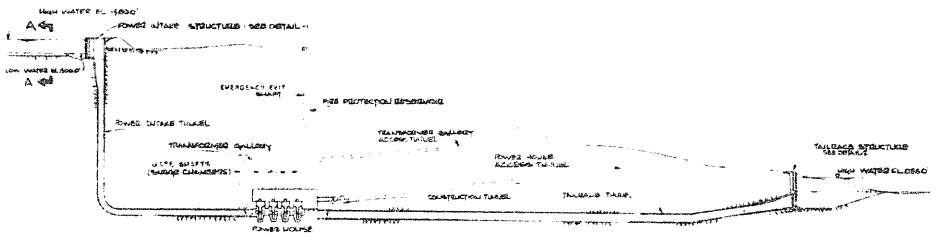
P4252

Location	**North East United States**
Client	**Not For Release**
Year	**1976**
Value	**$265,000,000 (Estimated capital cost)**

A feasibility study and conceptual construction cost estimate for two conventional pumped storage facilities, utilizing a common upper reservoir. The first installation studied would comprise four reversible units totalling 825 MW at 550 feet net rated head in an underground powerhouse. The upper and lower reservoirs for this plant would be obtained by enlargement of the reservoirs associated with an existing 640 MW pumped storage plant already in operation. The facility would also include two main step-up transformers located in a separate gallery.

The enlarged upper reservoir would have an area of about 350 acres. The lower reservoir, about 600 acres in area, would require raising of existing dykes to a maximum height of 90 feet. A 120 foot high protective structure would also be required for the existing surface plant, to be constructed with minimal interruption of power generation.

The second installation would consist of a five unit 640 MW underground plant using the same upper reservoir and a lower reservoir planned to be constructed for flood control purposes.



PROFILE ALONG WATER PASSAGES

HYDROELECTRIC POWER GENERATION STUDY P4944.00

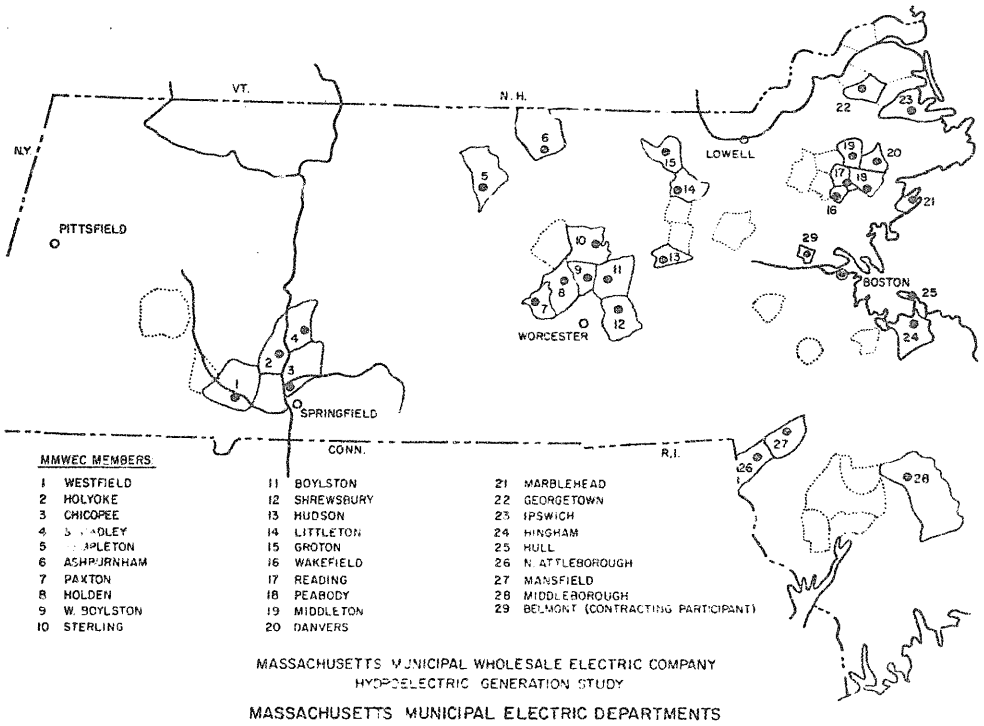
Location **Massachusetts**

Client **Massachusetts Municipal Wholesale Electric Company**

Year **1978**

Evaluation of the potential benefits of the MMWEC member utilities of the development of available hydroelectric facilities to meet forecast demands through the year 1989. The study includes the identification, evaluation and ranking of potential hydroelectric and pumped storage sites, including:

- construction of new facilities at hitherto undeveloped sites
- installation of power generation facilities at existing dams at which no such facilities currently exist
- rehabilitation, redevelopment and/or expansion of existing or abandoned hydroelectric installations.



OSWEGO RIVER – HYDRO REDEVELOPMENT STUDY

P3648

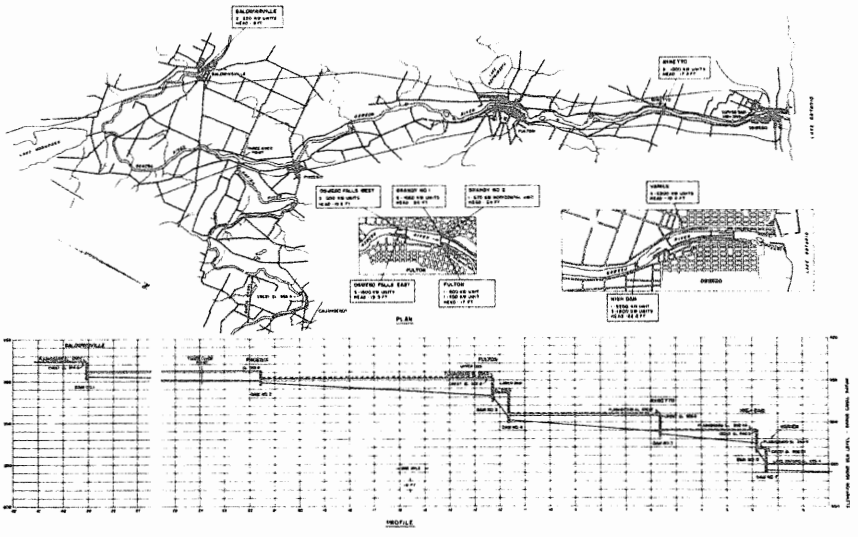
Location Oswego River, New York State

Client Niagara Mohawk Power Corporation

An investigation of alternatives for increasing the hydro-electric power generation from existing plants along the Oswego River was completed. Optimizing storage development within the 5,000 square mile basin under existing flow regulation constraints combined with potential modification at plant sites were considered. The study provided a ranking of the possible alternatives available to Niagara Mohawk for redevelopment of the hydro-potential on the Oswego River.

Detailed analysis was made of the flow regulation constraints because the Oswego River is a major source of water supply for the Erie Barge Canal system. An important aspect of this study was the consideration of the "Finger Lakes" recreational area.

The capital cost of plan implementation was estimated as well as annual operating and maintenance costs based on Federal Power Commission Guidelines.



DICKEY LINCOLN PROJECT
POWER ALTERNATIVES STUDY

P420 3

Location New England

Client Corps of Engineers, New England Division

Year 1976

A study carried out as part of the environmental impact statement for the 830-MW Dickey-Lincoln School Lakes hydroelectric project in the state of Maine. The primary objective of the study was to evaluate the economic and environmental impacts of alternative power generation and energy storage options on the New England System through the year 2000.

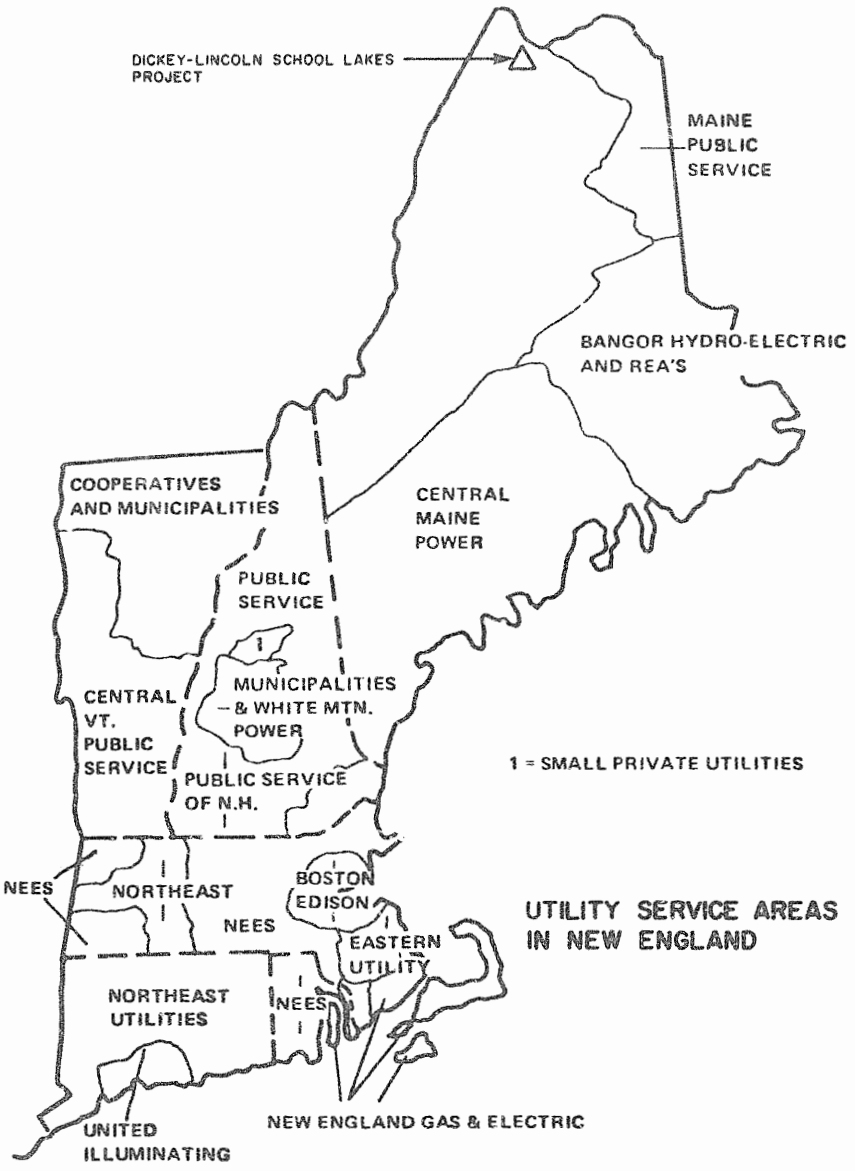
Two system capacity and energy forecasts were derived for the study period, one under conditions of current load growth and energy conservation expectations, a second taking account of the probable effects of implementation of load management.

Annual system costs were computed for the 20-year period from 1981 using the General Electric OGP-3 program. A comprehensive range of potentially available generation and storage alternatives were considered, including nuclear, conventional thermal, gas turbines, hydroelectric, combined cycle, geothermal, tidal, fuel cells, magneto-hydro dynamic, solar, wind, conventional and underground pumped hydro, batteries, fly-wheels, superconducting magnetic storage, thermal storage and compressed air storage.

A total of ten options were selected for inclusion in system generation expansion plans on the basis of technical and economic feasibility within the considered time frame and minimum unit size requirements consistent with the scale of system expansion.

Capital and operating costs of the selected alternatives and optimum system expansion plans were developed for the two forecasts, using the OGP-3 program, both with and without the Dickey-Lincoln project. Two variants of the Dickey-Lincoln project incorporating pumped storage were also considered. System reliability, spinning reserve, scheduled maintenance and forced outage requirements were stipulated. Fixed, operating and maintenance and fuel costs for each option, including transmission, were factored into the evaluation of system costs for each year of the study period.

Optimal generation expansion programs were thus developed on the basis of minimum cost. Results of the study were incorporated in a series of five reports, forming part of the environmental impact statement.



VERMONT POWER STUDY P4072

Location Vermont

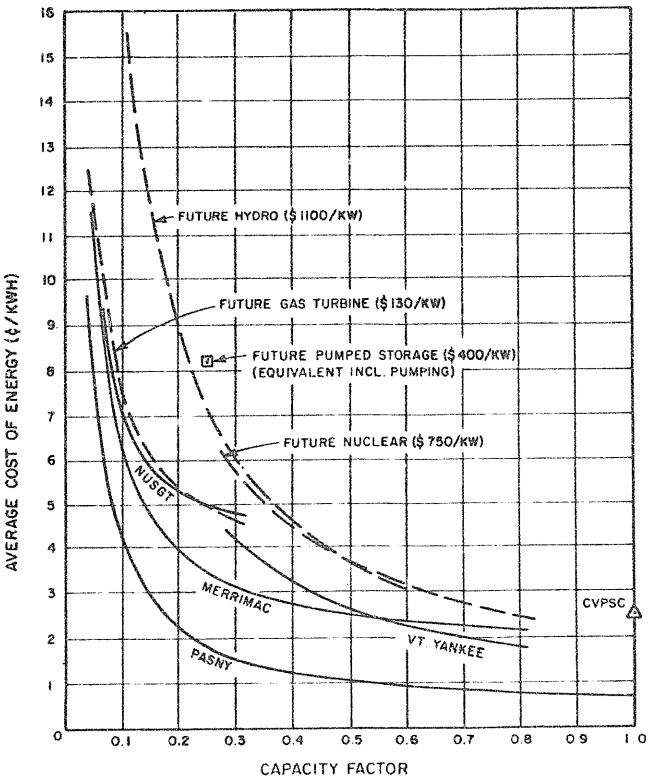
Client Vermont Electric Cooperative, Inc.

Year 1975

The primary objective of this study was to evaluate the potential benefits (if any) of the VEC system of the introduction of hydroelectric or pumped storage capability to meet forecast load demand to the year 1995.

This Cooperative has a peak demand of 25 MW and currently purchases all of its power requirements from large neighboring utilities. Sources include nuclear, coal-fired thermal, gas turbines and run-of-river hydroelectric plants in which VEC has various interests either in the form of part ownership or long-term power purchase contracts.

Potential hydroelectric and pumped storage developments were identified and ranked. Future system loads were evaluated to the year 1995 and power purchase costs for available New England sources were compared with fixed, operating, and maintenance costs of available hydroelectric or pumped storage sources.



GENERATION EXPANSION STUDY
KPONG HYDROELECTRIC PROJECT

P3796

Client — Canadian International Development Agency and Government of the Republic of Ghana

Location — Volta River, Ghana

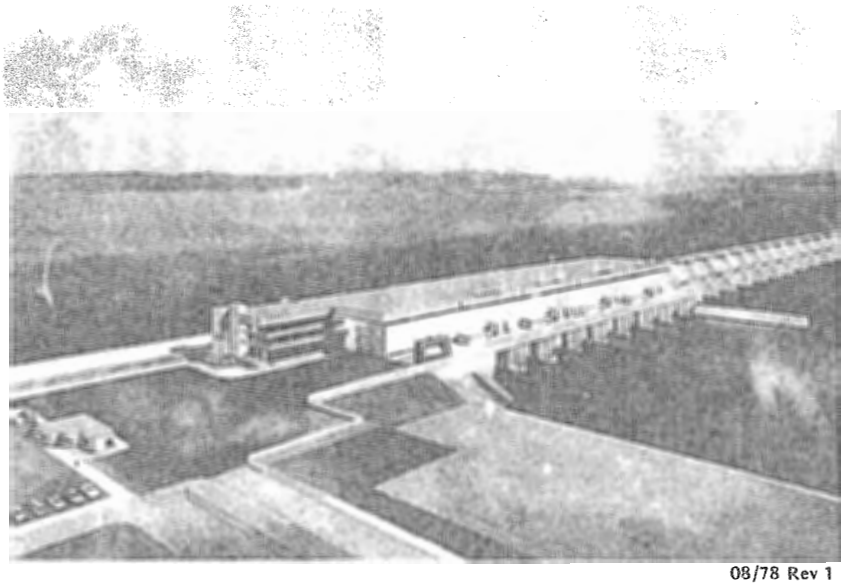
The study developed a generation expansion program to 1995, to meet the forecast electrical load of the Volta River Authority system. The prime undertaking was the detailed feasibility study of the development of the Kpong hydroelectric project on the Lower Volta River.

The feasibility study included hydrological, topographical and geologic surveys, drilling and test-pit exploration, ecological assessment, sociological impact, preliminary designs and cost estimates.

The existing generation and transmission facilities were studied to determine the present system capability. Available data on potential hydroelectric and thermal power projects in Ghana, including Kpong, were reviewed to establish a ranking order of the projects on the basis of energy cost and power capability. As a result of the studies, alternative generation expansion programs were studied by computer simulation of the VRA system to 1995.

Detailed economic analyses were carried out in selecting the best generation plan, and the plan was further subjected to economic sensitivity testing for capital cost, discount rate, fuel cost, and variations in foreign currency values.

A significant aspect of the project was the need to compress the study schedule in order to meet the foreseen critical construction program for the Kpong project. To meet the study deadline, the main engineering services were performed by a study team in the field.



ACRES

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SYSTEM STUDIES P1616A

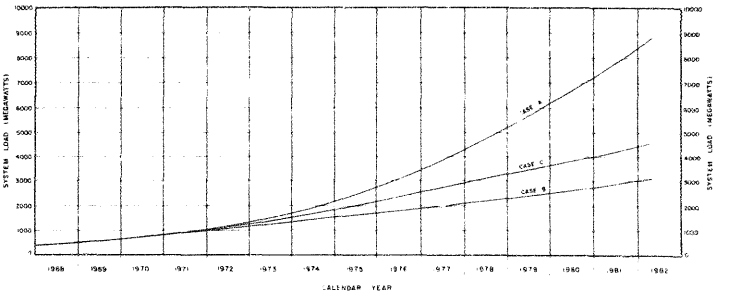
Location Thailand

Client Electricity Generating Authority of Thailand (EGAT)

1967

Comprehensive studies of the electric power generating and transmission system of the EGAT, of the present and probable future load of the system, and of the possible sources, both hydro and thermal, of additional generating capacity to determine the means for making optimum use of all available water resources.

The studies involved the preparation and use of a digital computer simulation model of the system. The effects of future irrigation development in the areas supplied by each of the Ping and Nan rivers were fully integrated into the simulation. All reservoir releases in the model were governed by irrigation demands derived from a study of probable cropping patterns, incorporating both single and double cropping of rice in combination with other crops for a complete range of hydrological sequences. Various rates of growth of the irrigation systems were used in the program, and optimal degrees of development established. The effects of water releases for irrigation and power of the flow regime below the confluence of the Ping and the Nan, particularly as regards salinity intrusion at the mouth of the river system, were also integrated into the study.



APPRAISAL OF SITES FOR UPH AND CAES FACILITIES

P4490

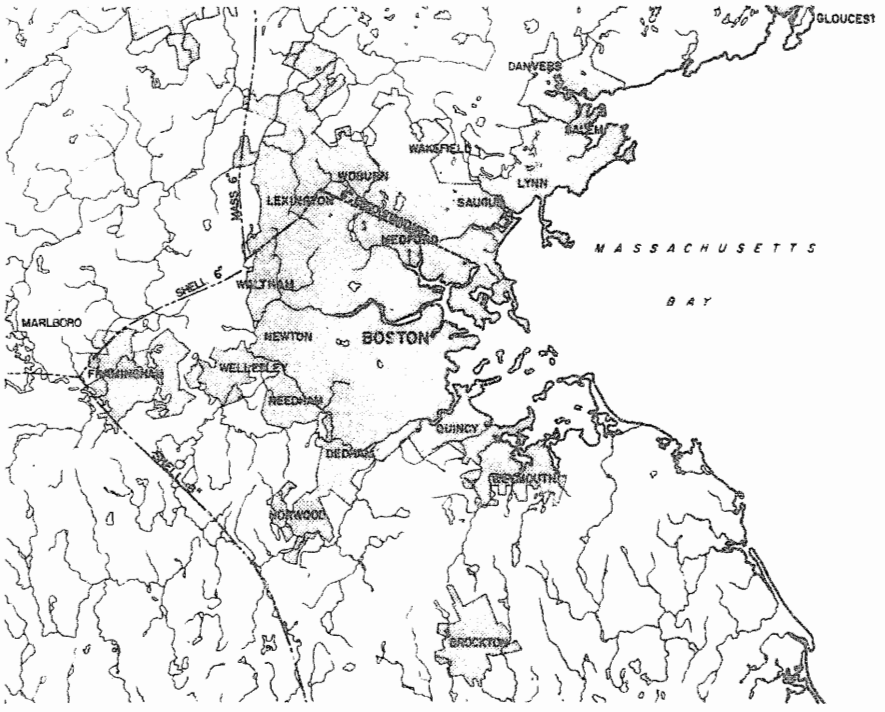
Location **Massachusetts**

Client **Boston Edison Company**

Year **1976–1977**

A preliminary study to identify potential sites for underground pumped storage (UPH) and compressed air storate (CAES) facilities for installed capacities of 500 and 2000 MW to serve the Boston Edison system.

The study included collection of data and a comprehensive examination of the geology of Eastern Massachusetts. Consideration was given to potential sites in the sedimentary rocks of the Boston Basin as well as the more competent granitic rocks to the north and west. Siting criteria were established and potential sites were selected and ranked taking into account geological conditions, surface conditions, and environmental impact. Estimates of capital costs, operating costs, and preliminary construction schedules were prepared for the highest ranking sites. The study also included preparation of a detail engineering program for optimization and site exploration leading to license application for the selected site or sites.



July 1978

RESEARCH PRIORITY STUDY FOR UNDERGROUND PUMPED STORAGE

P4155

Location **Palo Alto, California**

Client **Electric Power Research Institute**

Year **1975**

A study designed to examine the technical and financial aspects of underground pumped storage which require research to confirm their viability and to provide the level of confidence necessary to encourage further development of the concept.

The study includes a review of all available material dealing with underground pumped storage. Potential areas of research required to bring the concept to demonstration plant stage are listed and were reviewed with utilities and manufacturers. The results of the study are presented in a comprehensive report to EPRI.

UNDERGROUND PUMPED STORAGE STUDY

P2969, 2892

Location **Muskingum, Ohio**

Client **American Electric Power Service Corporation**

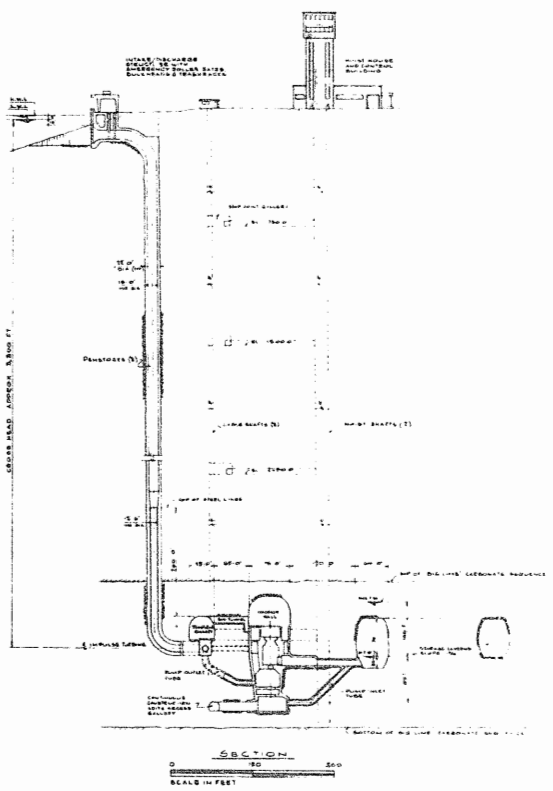
1972

Value **$434,000,000** (Approximate capital cost)

Two reports (Phase 1 – Preliminary, Phase 2 – Technical and Economic Assessment) of the feasibility of the construction of an underground pumped storage development at Muskingum, Ohio.

Feasibility study of an underground pumped storage plant to develop a gross head of approximately 3,300 feet between the surface pond and a lower reservoir to be excavated in a selected stratum of the Big Lime sequence. Installed generating capacity of 2,500 Mw operating for a daily 10-hour generating cycle.

The study included preliminary layout and sizing of the plant to house twelve separate pumps and turbines rated at 208 Mw. The study examined access, construction techniques, scheduling and equipment handling and installation. A detailed estimate of cost was developed for the project for comparison with conventional surface-type pumped storage.



APPENDIX D

SELECTED PAPERS FROM
THE COLLECTION ENTITLED
"THE SUCCESSFUL
ACCOMPLISHMENT OF
GIANT PROJECTS"

APPENDIX D -
SELECTED PAPERS FROM THE COLLECTION ENTITLED
"THE SUCCESSFUL ACCOMPLISHMENT OF GIANT PROJECTS"

D.1 - Introduction

An international conference was held in London on 17-18 May, 1978, for the purpose of identifying and presenting the critical factors necessary for succcessful accomplishment of giant projects. The proceedings were published as a series of ten essays, each of which addressed a separate aspect of the problem, and each was presented from a different vantage point. Indeed, the group included a Financial Director with a large financial management firm, the Vice President of a consulting engineering firm, the President of a construction management company, a Group Consultant from a reinsurance company, a Lawyer and Partner in a large international law firm, the Chairman of a Government Corporation involved in national design and industrial services, the Managing Director of an international investment banking firm, the Executive Director of another international bank, the President of an international publishing group whose journals are primarily devoted to oil matters, and the Executive Director of an international recruitment consulting firm. We are pleased to include as members of the Acres team both the engineer and the construction manager from this elite group of conferees. Their papers are reproduced on the following pages.

Mr. Gavin Warnock, Vice President and Manager of the Power and Heavy Civil Group for Acres American Inc., addresses design risk and engineering management, particularly as it pertains to the Churchill Falls experience. In the second paper, Mr. Frank P. Moolin, Jr., discusses effective project management organization as it pertains to the construction phase.

A Giant Project Accomplished- Design Risk and Engineering Management

by J Gavin Warnock

J GAVIN WARNOCK is a Vice President of Acres American Inc. and General Manager of their Power and Heavy Civil Engineering Group. An honours graduate in mechanical engineering from Glasgow University, he later obtained a Diploma in Hydro Power from Imperial College. Following a total of 20 years with the English Electric Company, he emigrated to Canada to join Acres, an international consulting firm. With Acres, he was involved in a number of major hydro-electric projects including the Churchill Falls power development and the Bay of Fundy Tidal Power projects. Mr Warnock led the preparation in 1967/8 of the comprehensive documentation which supported the placement of $550 million first mortgage bonds for Churchill Falls. He has lectured widely, particularly on underground engineering and the future of energy.

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INTRODUCTION

In his keynote address dealing with the essential need for a fundamentally superior approach to all aspects of giant projects to ensure their success, Allen Sykes identified a range of $1 - $15 billion into which they might be classified. While size, in monetary terms and financing need, is often the most significant characteristic of a giant project, other factors such as logistics, influence of the natural elements, manpower and technical complexity can also call for the truly superior performance in reaching the most demanding goals which are set.

We might list possible ingredients of a giant project as:—

- Large financial commitment
- Product or service of relatively high value
- Involvement of many thousands of individual people (1 million to 2 million man hours per month has been suggested as a "threshold" level for giant projects)
- Difficult location, climate or terrain
- Widespread project area involving logistic and construction management difficulties
- Schedule for construction of 5 years or more
- Environmental impact demanding great care
- Technological advances and/or complexity
- Enterprising sponsors or owners capable of taking - albeit well considered - risks
- Timeliness
- In the extreme cases, an element of improvement of the quality of life and possibly a change in the social order!

We would find that most, if not all, these ingredients are involved if we are considering a wide variety of giant projects:—

(A)
- petrochemical complexes
- an LNG system spanning from North Africa to USA
- desalination plants for national demand
- northern and transcontinental pipelines

(B)
- an offshore oil field development
- a 7600MW hydroelectric project on a major international river
- nuclear power plants of 5000MW or more

(C)
- mineral resource developments
- a rapid transit system for a major metropolitan area
- university or military cities in the Middle East

These might well represent (A) $1000m to $1500m, (B) $5000 to $10000m and (C) $1000m to $5000m projects, all of a giant nature. The scale of these projects in relation to earlier undertakings which are similar, or smaller, demand is influenced by a number of factors. The world population is growing, and its demand for

material goods and services grows even more rapidly. Depleting resources force frontier developments in remote and inhospitable locations. Man's capability for applying massive effort has increased dramatically in the past 15 to 20 years. Cost escalation sustained at a two-digit rate in many parts of the world for several years has doubled, trebled and even quadrupled the level of funding needed for particular giant projects in the same period.

Ten years of progress from the "large" to the "jumbo" now to the "giant" (and perhaps yet to the "super") project has taught a few hard lessons. It is my intention in this paper to reflect on the testing experience of a very large project of the late 1960s/early 1970s to show how management of design risk and engineering management contributed to its accomplishment. My comments are based on the now well proven, successful undertaking of the Churchill Falls Power Project which pioneered many of the most successful techniques for the successful accomplishment of giant projects.

Churchill Falls involved a total capital cost of some $965 million at the 1967 estimate level (well over $2000m at today's values); a project spanning seven years; a labour force peaking at 6300 and then applying about 150,000 man hours per month; a project area of 2500 square miles; movement to a remote site in Labrador of ¾ million tons of materials, supplies and equipment; a mammoth undertaking in a frontier environment with many, many challenges. It clearly had many of the giant project ingredients. It demonstrated, with its laudable success, the merits of a multi-disciplined overview from the outset of the project and adopted as a continuing technique for ensuring confident and successful management throughout.

Design (as well as the risk it imposes) and engineering management were prime elements in the approach to Churchill Falls and are equally and vitally important in today's giant project. Design of the project defines its form and substance. Engineering management sees that the project is built in optimum fashion to meet design and financial requirements. Many other factors play important roles - construction, manufacture, quality assurance, commercial risk assessment and control, insurance, risk analysis and contingency determination, contracting policies and, above all, project management of the total enterprise to ensure a certain success.

Design of a major project encompasses the initial conceptual planning, preliminary engineering and feasibility study work as well as the "engineering" of a project from the "release date" for actual construction to final completion. Design inputs may, in fact, also be required during initial phases of operation and later to minimize future maintenance needs.

Design risk enters the project picture at its inception. Initial plans, and engineered approaches to meeting them, involve risk. Questions may well be posed — Is the design based on proven technology? — Does it involve appreciable increase in a scale of application adequately proved in the past? — Is the "capacity" for throughput reasonably assured? — What are the prospects for obsolescence? — Is the scope adequately defined for a reliable capital cost estimate? Are operating and maintenance expenditures reliably determinant? — What *are* the risks?

When dealing with the issue of "design risk" we should explain at the outset that it is not the role of the designer, nor of the engineer, nor of the manager, to assume risks arbitrarily. However, they each have a vital responsibility of *identifying* those risks which may be associated with a variety of approaches or courses of action. These risks must then be thoroughly analyzed and presented to the owner for judgement. It is the owner who must decide on the vital project issues, and it is the role of the manager and the engineer to ensure that all facts are presented in a way that a sensible and informed decision can be taken. Close integration of the engineer's and manager's roles, as has been achieved in modern project management concepts, has proved to be a most effective method of controlling risks and of achieving the demanding goals set for giant projects. To a substantial degree, potential design risk can be kept in line by effective engineering management.

II DESIGN AND ENGINEERING MANAGEMENT IN THE PROJECT PLAN

Let us follow a typical project over its course from initial concept to completion. Where, when and what input can design and engineering management provide in achieving a prescribed goal? Which style of managment is most appropriate to modern giant projects, and how does it interface with other vital elements of a project structure?

We shall be looking at these elements, and at management, from the point of view of providing the necessary degree of protection to the owners' capital funds in accomplishing the goals he has set. We are primarily concerned with bringing a project into full realization in a form which fulfills all its initial commercial objectives and fully lives up to the fundamental financial performance for which it was launched.

a) Traditional Approaches Inadequate

It will become apparent that traditional design and engineering approaches are usually no longer appropriate in that these did not always adequately address the true business needs of the owner. Certainly traditional engineering approaches have led to many fine engineering achievements. In the majority of cases, the owner's objectives have also been met. In many instances, however, failure to mold the engineering design need to the overall requirements of the project's economy and viability has led to the failure to initiate the project at all, or else, which is perhaps worse, to a project which was built but which, in fact, falls short of true economic viability. The bigger the project, the greater the commitment of capital funds, and the greater, too, is the need for assurance of true economic viability.

b) The Course of a Typical Project

— Concept Phase

Let us journey through the course of a typical giant project from concept to completion. In Figure 1 the initial schematic plot of a project plan to project cost relationship is shown. Because we are are at the concept stage, various alternatives are still being considered and submitted to coarse optimisation; differences in scope, in output, in arrangement, have all to be taken into consideration before achieving the near optimum plan at which capital available funds, or achievable funding, will match a desired commercial performance.

We may reach this stage many months, or perhaps years, ahead of a final project release date. The setting of an initial project plan may be followed by a substantial amount of study, review, evaluation, and more than one "back to the drawing board" operation. Finally, the plan is accepted in its broad conceptual terms, estimates are refined, schedules are constructed, economic viability is established, and "bankability" accepted at a sufficiently high level of confidence.

— Project Release

We pass from the conceptual pha e to project initiation, and the course of the project is shown on Figure 2. Refinement of engineering and cost estimates may now have led to some reduction in demand for capital funds. However, this demand must comprehend prudent provision for cost escalation, for contingency funds, and for the necessary level of completion guarantee. The ceiling capital budget cost is established within which the project manager, operating under the direction and control of the owner, must perform.

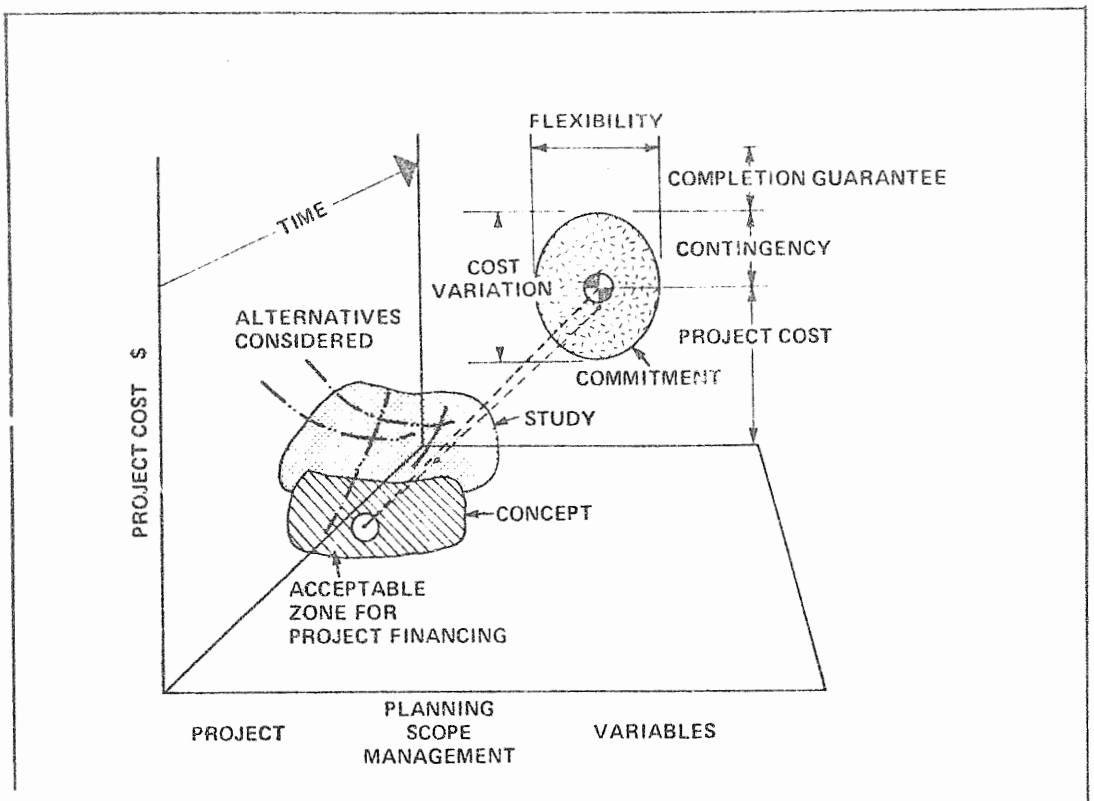

Figure 1

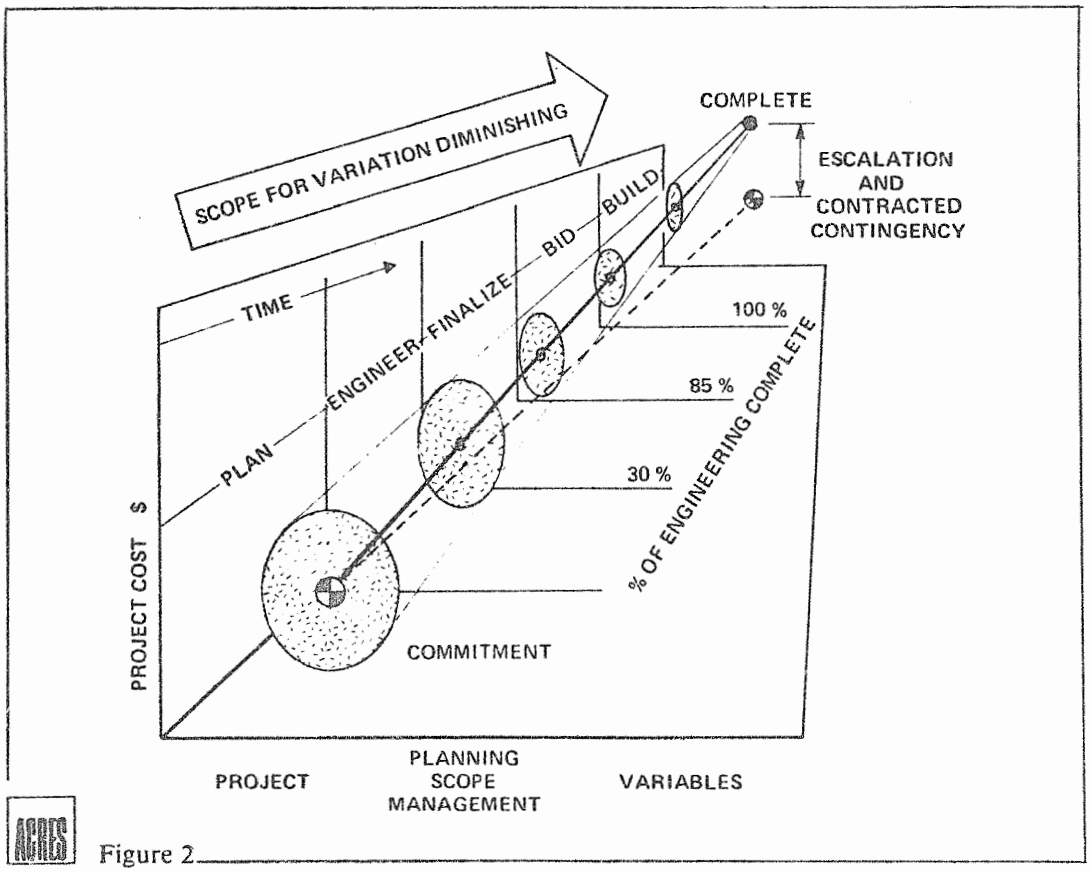

Figure 2

If everything in life was certain, if escalation did not exist as a brutal reality of economic considerations, if no variations from the plan could be anticipated, the project capital cost determined, as shown for the "release date," could simply be projected out to completion at the same target level. The course of the project from initiation to completion, however, is rarely entirely protected from either variations or unexpected influences which may be of many kinds. The engineers and management have to keep these variations continually in balance, clearly identified and constantly under review. They can both still do much to control and constrain such variations.

One reliable method of doing this is to institute regular capital cost and engineering reassessments of the various work package elements of the undertaking. Such reviews might well take place at 30 per cent and 85 per cent levels of engineering completion at which some flexibility still remains - albeit diminishing as time proceeds - to permit an effective measure of cost control. As this process goes on it is important that sufficient freedom is maintained for additional design and engineering input to achieve, possibly, lower cost construction alternatives. As long as there is a net saving, the engineering effort (and cost) is nearly always well worthwhile.

— Engineering to Construction Phase

We proceed past the 85 per cent completion level to the point at which the design package definition is complete. We are now ready to go for contract bids. Prudent project management calls, at this stage, for a further detailed and complete "contractors type" estimate against which bid responses will be measured. This estimate must take into consideration the form of contracts proposed and likely contractors' reactions to this be it fixed unit price, fixed lump sum, target price, or a blend of fixed price and cost reimbursement.

At this stage, the vital comparison will be the design and engineering achievement against the best estimate of competitive bidding in the construction marketplace. The actual bidding stage is, of course, the next and more conclusive test.

At this phase of the engineering-design-management process, there may be recognition of a demand for additional capital funds from the "provision for escalation" to meet cost increases arising from price inflation. There may be, furthermore, either positive or negative variations in the capital funds set aside as a contingency allowance.

A conscious decision must be taken whether to cover any departure from the original plan by drawing on contingency amounts, or whether re-engineering, re-packaging, or re-negotiation could be relied on to bring anticipated costs on target. It is important to leave any disposition of funds from the vitally important "cushioning elements" to the clear discretion and control of the owner with the project manager having to justify fully and conclusively the need for variation from the original plan.

It is readily accepted that even at the construction contract award date all is not as certain as the engineer would wish. Unexpected circumstances may arise, unforeseen conditions may have to be met. Today the question is regularly raised as to where the risk of such potential variations is best carried. Experience would show that the contractor should be held responsible for those conditions and circumstances over which he has proper and effective control. Those conditions which are likely to be unforeseen, which are not conducive to measurement or assessment, and which reflect true risk, should be assumed by the owner, with the project manager performing, to the best of his ability, his role of minimizing to the greatest possible extent, variations from plan and cost.

— Contract Risks and Work Packaging

Several cases of major contracts, where unreasonable burdens of exposure were placed on the contractor's shoulders, testify today to the error of this approach. The practice can result in bids at exaggerated cost levels as the contractor clearly must cover himself to the best assessment he can make of the outer limits of risk - and then add a little bit more! The Bay Area Rapid Transit System in San Fransisco and, more recently, the Chicago Underground Deep Tunnel Project, are cases where the attempts to "lay off" too many of the risks in contracts with "global" responsibility have surely worked against the owners' best interests. In both cases, rebidding on a more limited contract package basis allowed for a better spread of risk, for more competition from contractors, and for a manageable project.

The day of the lump-sum firm price-total responsibility-contract at the giant project scale has surely gone. Whether or not it will return is a matter for the future to tell, and I would hope for the engineering contracting industry at least to control. With the size of projects rapidly mounting to levels which naturally demand many, many "players," the newer forms of project management and the owners' acceptance of risk are more likely to be the formula for the future. Even in the Middle East market, the desire for lump sum turnkey responsibility may be reasonably expected to give way to the more modern mode as confidence develops in the more equitable reimbursement systems which benefit both owner and contractor. Already substantial project managed work under these arrangements is underway in Saudi Arabia; we are heavily involved in the project management of the $220 million high voltage electric power transmission system in the Republic of Iraq and initiating work on a very large, multi-purpose power/irrigation project in Iran.

— Construction

I turn next to the implementation of the giant project. As likely as not, design will only be partially complete at the time that mobilization and construction begins. For this reason, close integration between the engineering and construction management elements of the project can be a very real advantage. Subdivision of the overall project into discrete work packages with clearly defined interfaces will enable those elements requiring an early start or advanced procurement to proceed in the full knowledge that subsequent engineering and consideration has well established matching points at which the "package" links up in the overall scheme of things. The main objectives of the contract package approach are to limit commercial risk and to enhance competition.

III CHURCHILL FALLS POWER PROJECT — A GIANT PROJECT ACCOMPLISHED

a) The Concept

The Churchill Falls Power Development emerged from an ambitious venture launched in the early 1950's by British interests to develop the mineral, forestry, and power resources of Labrador, part of Newfoundland, the last province to join Canada's Confederation in 1949. British Newfoundland Corporation (Brinco) secured the rights for exploration and development, under prescribed conditions, of very large areas of hitherto virtually unexplored northern territory.

Right in the middle, at 53 degrees North and 63 degrees West, occurred a quite exceptional waterfall - the Hamilton Falls (subsequently renamed 'Churchill' Falls) on a river of that name which drained the Upper Labrador Plateau to the Atlantic Ocean. After ten years of flow gauging and field survey the prospects of developing the enormous power resource of this potential hydroelectric generating site became real. An average flow of nearly 50,000 cubic feet per second fell over 1,000 feet to develop a continuous output of over 4,000,000 kw at an exceptional location where great volumes of storage capacity could be created without any truly major dam structure.

After many years of considering relatively modest development plans of, say, 1,000,000 kw at a single stage, circumstances arose in 1963 where the bold venture of total development in a single stroke, became feasible. The size of the electrical systems in Quebec, Ontario and New York State were such that the enormous energy output of over 30 billion kwhr per annum could be absorbed. Electrical transmission systems operating at extra high voltage became technically feasible permitting the Churchill Falls output to be carried 800 miles or more at an economic cost. A concept for the practical development of the power then emerged to permit the exploitation of the opportunity.

b) Project Formulation

Despite the enthusiasm and dedication of the proponents of the 1963 plans, the day of the project had not yet arrived. Difficulties arose over the negotiation of acceptable terms under which the energy and power of Churchill Falls could be "wheeled" through the Province of Quebec. The "concept" was given three years in which to mature until steady increases in demand made development at Churchill Falls almost imperative provided confidence in investment could be secured and financing arranged.

In late 1966 the project was launched in earnest. The plan of development involved retaining the flow of the Churchill River in vast reservoirs on the Central Labrador Plateau created by structures built over the river above the Falls and at low points around the basin, to create a great saucer of 2,500 square miles in area. The flow from an area of over 25,000 square miles was to be collected in the reservoir. Adopting what was known as the "Channel Scheme," the regulated flow would be led 16 miles downstream from the Falls, through a series of lakes, rivers, and forebays on the plateau to a point where, within a distance of just over a mile, hydroelectric power could be developed under a head of 1,060 feet. Installed capacities of 4,500,000 kw were being considered with EHV transmission to the Hydro Quebec system about 126 miles from the power site, and from there another 650 miles to Montreal.

c) **Project Financing**

At the time of its inception, the Churchill Falls Power Project involved the largest project financing yet undertaken - a first mortgage bond issue of $550 million (see Kim Brooker's paper). Other projects of similar scope, complexity and challenge remain for us today, and individual financing will be much greater. With rapid escalation in material and service costs, the billion dollar project of the 1960's becomes the multi-billion dollar project of the 80's. It becomes increasingly difficult in periods of rapid cost escalation to keep estimates and final cost comparisons in proper perspective. This in itself requires a high degree of management skill and methods of reporting which clearly identify project performance and demand that this places on contingencies and provisions for escalating costs as work proceeds.

d) **The Owners/Management Team**

When the prospect of development emerged in 1963, Churchill Falls (Labrador) Corporation (CFLCo) formed by Brinco as the owner to undertake the project, had a relatively slender corporate organization. It required the support of an engineering and management group capable of undertaking, with confidence, the largest project yet considered for private financial backing. The owner chose to arrange a joint venture of Acres and Bechtel, to be known in subsequent years as "Acres Canadian Bechtel of Churchill Falls" or "ACB," to take responsibility for engineering and management of construction.

During the three years of deferment of the project from 1963 to 1966, ACB quietly prepared for the "project release." This came in April 1967 following six months of active preparation work involved in updating of the approach and estimates. In the 3,000 days which followed, the project took shape - at times in the face of some drastic setbacks such as a transportation strike which isolated the site for a whole summer, and a tragic air crash which took the lives of six of the very top executives of CFLCo and ACB - and finally Churchill Falls Power Development was completed on budget and substantially ahead of schedule, a rare achievement on any project of such size, complexity, and remote and difficult location.

As mentioned previously, the owners' corporate organization was still at a formative stage when the Power Project was launched. It was necessary for the engineer manager to provide virtually all functions required for the project undertaking except those associated with public affairs and government relations. The interrelationships are shown on Figure 3. CFLCo, of course, undertook its major responsibility of arranging the provision of financial resources to undertake the project. A closely linked client/manager organization evolved; the latter having a direct reporting link to the President of the Corporation. Within this group there was a wide variety of applicable multidisciplinary skills and major project engineering/construction experience. The ACB engineering and management organization was set up with separate but closely coordinated groups attending to the engineering and construction matters as shown on Figure 4. Operations, contracts, labour relations, construction, and engineering each had a senior manager in charge. Functions were delegated, reporting to each of these managers, to cover all aspects of the project needs from local field support in Central Labrador to logistics and to procurement of the equipment, supplies and contracting services.

CHURCHILL FALLS POWER PROJECT
OWNER-MANAGER RELATIONSHIPS

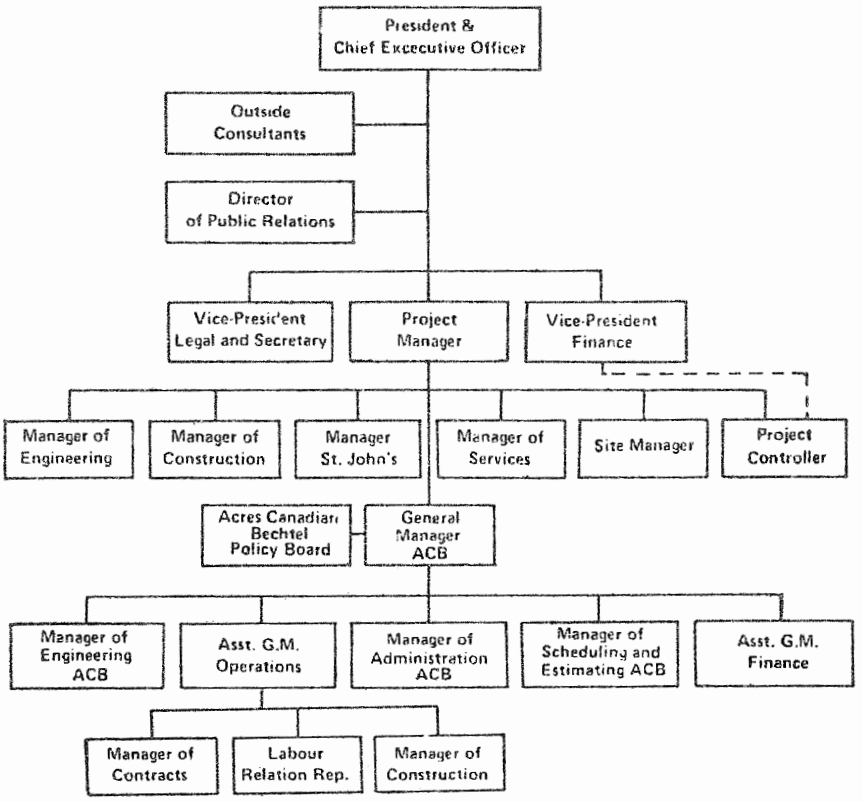

Figure 3

CHURCHILL FALLS POWER PROJECT

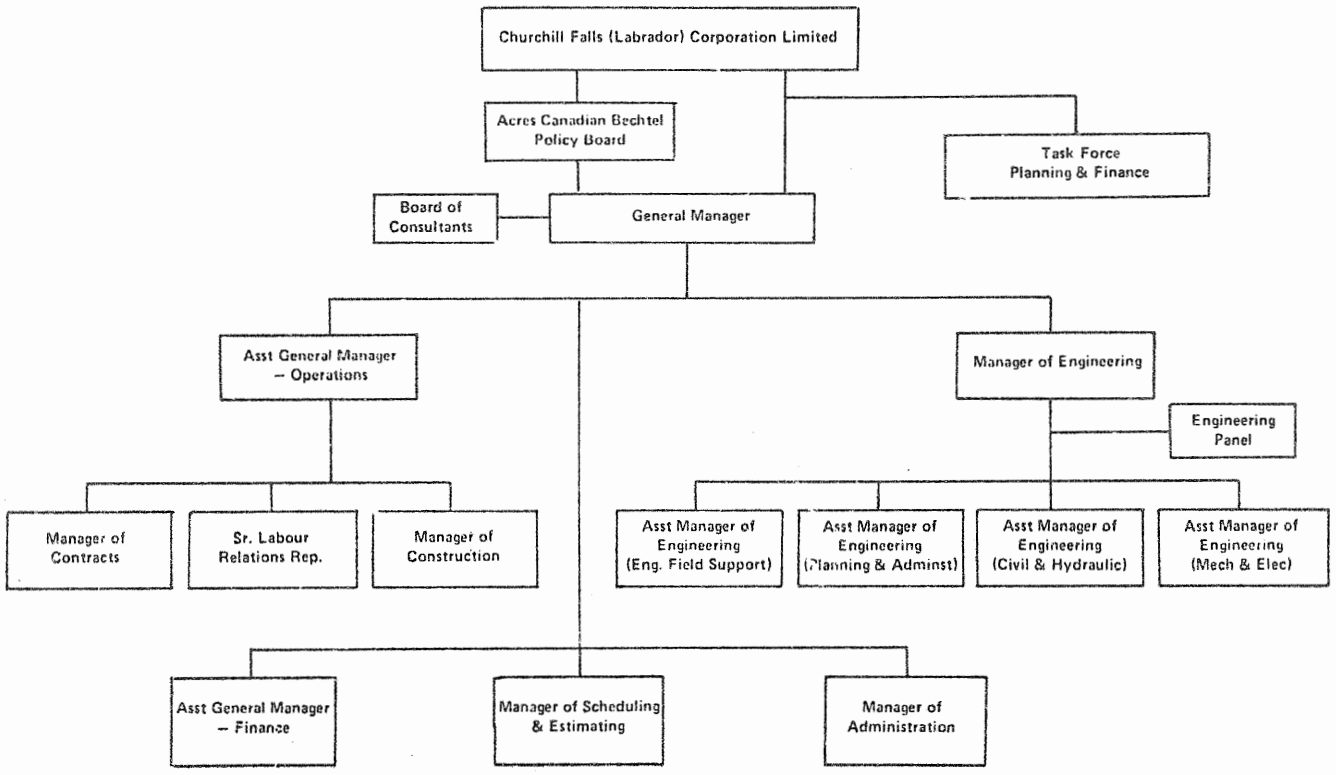

Figure 4

c) **Specific Design Risks Addressed**

Returning now to the subject of design risk and engineering management, we can identify in the Churchill Falls Power Project several important areas where risks had to be faced, appropriate approaches adopted and the consequences of error covered.

— Energy Output

Basic to the whole project's success, the prime element which involved risk was the determination of average energy output. This value determined the scope of the power contract and the revenues to sustain the project. Hydrological records for the area were sparse. Flow guaging records extended over only nine previous years. Precipitation records were available at only a few points in Labrador. Reliable forecasts of water runoff, however, had to be made. The methods adopted involved the reconstruction of a 43-year hydrograph, appropriate to the Churchill River Basin, by transposing the records from other neighbouring watersheds where long-term measurements had been made. The Saquenay and Outardes Rivers bore a reasonably close relationship to the Churchill River, and using multiple linear correlation techniques, a 34-year "transposed" flow record was constructed. This, together with the nine years of record established, with reasonable assurance, that an annual flow for the 43-year period could be set at 48,867 cfs.

There was still a design risk involved. Could periods be anticipated when, owing to successive years of low flow, power contract obligations could not be met? Using probabilistic approaches and Monte Carlo techniques, the potential risks over an extended theoretical 5,000 year period were computed and found to be acceptable. The amount of storage in the reservoir system provided a means of lessening year to year risks of flow deficiency.

Computations were repeated month by month throughout the simulated 43-year period, reservoir rule curves were established and live storage volumes determined which would minimize the amount of spillage and provide an assurance that the contract energy deliveries would always meet the project financing and revenue requirements. Consideration was given to reservoir volumes ranging from 900 to 1,300 billion cubic feet, and a level of 1,100 billion cubic feet finally accepted as the optimum.

(There were, incidentally, risks involved even in establishing these holding capacities of the reservoirs as geodetic levels had to be extended well over 150 miles from the power site to determine the necessary crest heights of the dyke structures.)

Finally annual energy output levels were computed based on the flow records. A plot was constructed showing the range of the highest and the lowest energy output in numbers of successive years. Based on the constructed hydrograph, it showed that long-term output of 34.5 billion kwhrs could be assured over a 40-year period.

— Underground Facilities

The site of the Churchill Falls Power Development is on the Canadian Shield, a massive rock formation of granites and gneisses. Earlier developments, engineered by Acres, along the north shore of the St. Lawrence River had shown that the huge underground powerhouse construction required was a practical and economic alternative. The site at Churchill Falls, where a drop of over 1,000 feet could be developed within a little more than a mile, presented an interesting opportunity for penstocks, powerhouse and tunnels to be excavated at a depth of up to 900 feet below the surface. Major design risks were involved and measures had to be taken to cope with them. Superficial geological exploration showed some indication of fault zones which could lead to difficulties during construction.

Twenty holes were drilled over the proposed site of the powerhouse and a picture of the sub-surface geology was constructed. One of the holes intersected a major fault and prudent engineering practice resulted in the relocation of the proposed site.

A variety of assumptions were made concerning the in-situ rock stress which could not be reliably determined until excavation had advanced. Contingency design approaches were available to cover a range of stress conditions that could be expected. Optimisation of penstock and tunnel lengths, costs and hydraulic losses finally fixed the general position of the powerhouse which was orientated to suit the stress and joint patterns found from initial excavations.

Excavation involving 2,300,000 cubic yards of rock proceeded on program with close integration of engineering, rock mechanics judgement and construction. Risks were well anticipated and adequately managed throughout.

— Generating Unit Capacity

Another interesting aspect of engineering management of a design risk arose in the selection of the capacity of individual turbine/generator units, finally set at 648,000 hp or 475,000 kw each. This was a substantial advance over previous unit sizes adopted in Canada or, for that matter, anywhere in the world. Ten years earlier the largest unit was 150,000 hp - five years earlier the level of 200,000 hp had been reached, so a major increase in size was involved, with inescapable risks.
Each step - the first at Bersimis I for Hydro Quebec, and the second at Chute des Passe for Alcan - had been taken by Acres as engineers in the interest of overall project economy. At Churchill Falls it had been determined that the largest units, compatible with good engineering practice, should be adopted to achieve maximum economy. The operating head of 1,060 feet was relatively conservative for the Francis turbine machines adopted. The size of runner dictated by transportation limits (tunnel sizes on the Quebec North Shore and Labrador Railway) was within previous practice. The combination of the high head and the large size was new but considered well within the state-of-the-art. And thus units of unprecedented capacity were specified - but only after exhaustive discussions with turbine and generator suppliers and designers. It so happened that the combination of speed (200 rpm) and generator output (475 Mw) led to an acceptable air-cooled design and a technological advance to water-cooled stators (a step not without risk) was avoided.

— Total Station Generating Capacity

Total installed capacity also required careful engineering and management judgement. The terms of the power contract with Hydro Quebec were based on payments related to capacity and to energy delivered. The kw capacity which could serve the Provincial power system was of crucial importance; and, in recognition of this, high penalty payments were incorporated into the contract which would apply if power deliveries were deficient. Never before had so much financial risk relied on turbine generator performance.

Prudent judgement prevailed - an eleventh unit was added to the initial ten, at quite reasonable incremental cost, bringing the total station capacity to 5,225,000 kw to meet firm delivery commitments at the connection to Hydro Quebec's system of 4,431,500 kw (with a slight reduction in summer when cooling was less efficient).

— Confidence and Conservatism

The selection process of turbine and generator capacities and, later, of the principle of dual transformation 18 kv/230 kv at the underground power plant and 230 kv/735 kv on the surface were typical of the prudent judgements taken to enhance reliability and confidence.

All in all, the project emerged from its design phase with no major features which lay beyond the current state-of-the-art. No major dams were involved - the highest was 90 feet. No disastrous floods could occur. The power installations, although of world record size, had precedent in the controlling design features. The project thus had built-in security.

— Dyke Structures

The question of dams and dykes is worthy of comment. Forty-two miles of dyke structures were required to contain the 1,100 billion cubic feet (bcf) in the 2,500 square mile Smallwood Reservoir. The terrain covered by these dyke structures was variable - rocks - eskers (characteristic granular deposits left by receding glaciers) - boulder fields - till - water and muskeg. Any comprehensive examination by field exploration, sampling and drilling, would have occupied too much of the schedule. Carefully considered "risks" had to be taken in setting out the scope of the many contracts awarded for dyke construction. Risks were not taken, however, in actual construction. Very close monitoring of foundation excavation allowed engineering management to provide designs which virtually eliminated risk by adjusting the form, material and drainage of structures to match local conditions.

Dykes constructed of the naturally available materials - granular deposits, impervious till, excavated rock, filter zones and clay - must be regarded as "living structures." Their condition is affected by the filling of the reservoir, by a change in groundwater conditions, by seasonal conditions, particularly freezing and thawing cycles. They settle and deflect - some dykes are particularly cantankerous!

Engineering management imposed stringent quality control during construction, and also an exhaustive program of monitoring after reservoir filling. Emergencies did occur, first on the initial filling of the forebay reservoir. This problem was effectively contained by rapid emptying and reconstruction of the dyke by construction contracting forces readily available through a prearranged contingency plan. Other incidents later were attended to by the addition of further zones of fill to certain dykes and by additional drainage of others. The monitoring still goes on - changes and conditions are meticulously recorded and the system is settling in to a healthy maturity.

The 26,000,000 cubic yards (or over 50,000,000 tons) of nature's material is doing the job the designers intended.

— Contract Package Engineering Interfaces

So much for the highlights of engineering management of design risks. There were other contributions made to the overall protection of the project capital structure. One of particular significance was the contract package policy adopted. Historically, as noted earlier, major projects have often been let out to a single general contractor responsible for all aspects of the work. In the mistaken belief that economy results, the practice has been to load risks and responsibilities onto the general contractor which should, by rights be laid off elsewhere. There has been some bitter experience and lessons learned.

For Churchill Falls, contract packages were sized by the project management to encourage many contractors to bid. Their mobilization costs were met in full, and once on site they were available to bid on further work as appropriate. Those contract package contractors with expertise in earth-moving were able to concentrate on dykes; those experienced in work excavation came in on underground works. Altogether, 80 major construction and supply contracts were let, varying in size up to $60,000,000, but mostly less than half of this amount.

— Engineering/Construction Input

Engineering management input still played an important part in execution of these contract packages. For instance, close liaison of the contractor with geologists and rock mechanics engineers was established to judge the blasting patterns most appropriate to minimize overbreak and rock removal. Precise "dental" excavation resulted in significant economy.

Quality assurance played a significant part in reducing risk. Those of us involved in major project undertakings today are very humbly conscious of the boon and benefit of the highest possible standard of overall inspection and quality control programs now available.

IV ENGINEERING MANAGEMENT AND FINANCING

Let us now consider the other activities essential to a giant project in which the engineer plays a vital role in bringing forth conclusive evidence on which confidence in financing may be built. Again, let us look at the tactics used on Churchill Falls to secure equity and debt funding and to protect the project capital structure.

a) **Bond Offering Documentation** (see Figures 5 and 6)

In early May 1967 - thirty days after the project release date - it became apparent that the size of the first mortgage bond offering was such that Churchill Falls (Labrador) Corporation would have to go to unprecedented lengths in presenting an unquestionably high degree of confidence in all aspects of the project. Bond offering documents, issued in support of major power plant financing in the U.S.A., had to meet certain distinct requirements of the Securities Exchange Commission. They required the supporting opinions of the "Utility Engineer" and of the "Architect Engineer" responsible for cost estimates and for implementation of the budget. Certain additional "boiler plate," substantiating the financial worthiness of the utility, was well understood from precedent financings. However, bond offering memoranda had in the past been provided with relatively limited background data and any analysis of the risk had been left largely to the investors.

For Churchill Falls, however, it was decided that financing documentation would be produced *which left virtually no questions unanswered*, an unusual but wise choice. The completeness of the power contract provisions, adequacy of engineering designs, reliability of construction cost estimates, adequacy of escalation and contingency provisions, security of schedule, were all to be supplemented with detailed documentation setting out the approach and the contractual policies to be adopted by CFLCo. The "contract packages" in which the work was to be assigned, the principles and basis of the "no strike, no lock out" master labour agreement, the insurance provisions, and the steps that were to be taken to meet all statutory obligations of the Province of Newfoundland/Labrador were also to be treated in detail. In addition, reports, plans, and estimates were required for the permanent townsite facilities, the costs of maintaining this and the cost of operation and replacement expenditures. Management information systems were to be clearly defined and outlined.

In order to meet potential questions concerning reliability, cost and schedule performance of the contracting industry, a review was made of experience on large civil engineering capital projects throughout Canada in the years immediately prior to 1967. It was recognized, too, that the general economic activity in the country at large, and particularly in Eastern Canada, could have a significant bearing on the availability of adequate contracting forces and on the competitiveness of bidding; so, a comprehensive project economic review was commissioned.

The impact of future nuclear power generation on system energy costs was still another question that had to be addressed. A study was made of the likely trends in nuclear generation capital and operating costs over the 40-year term of the power contract envisaged for Churchill Falls.

A final document in the bond offering support series related to the assessment of project contingencies. A rigorous analysis was made of risks to which the project was exposed, and a comparison made between the financial implication of these and the contingencies provided in the capital cost estimate.

3,000 DAYS PROJECT SCHEDULE-CHURCHILL FALLS POWER PROJECT

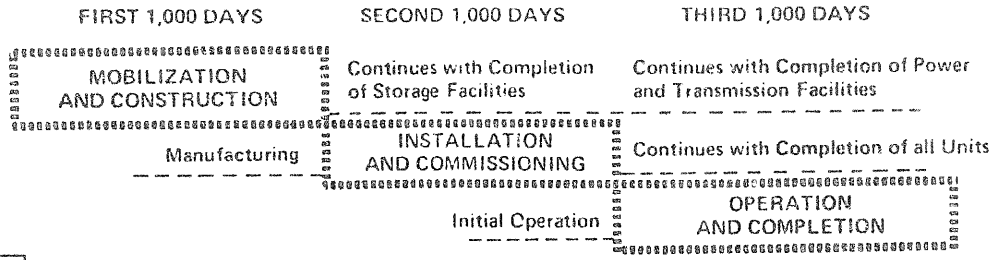

Figure 5

CHURCHILL FALLS POWER PROJECT
BOND OFFERING MEMORANDUM DOCUMENTS

VOLUME	DOCUMENT	
1	POWER CONTRACT	PRIMARY
2	TECHNICAL ABSTRACT AND ENGINEERS' EVALUATION	
3	ENGINEERING REPORT	
4	CONSTRUCTION COST ESTIMATE	
5	CONSTRUCTION SCHEDULE PROJECT EXPENDITURE PROGRAM AND ESCALATION STUDY	
6	MASTER LABOUR AGREEMENT	
7	NEWFOUNDLAND STATUTORY AGREEMENTS	
8	INSURANCE	
9	OUTLINE OF PROPOSED CONTRACT PACKAGES	
10	OUTLINE OF CONTRACTING PRACTICES	
11	MANAGEMENT CONTROL AND INFORMATION SYSTEM	SECONDARY
12	CORPORATE DOCUMENTS	
13	OPERATING AND REPLACEMENT EXPENDITURES GENERATING PLANT AND SUPPORTING FACILITIES	
14	PLANT AND CORPORATE EXPENDITURES	
17	REVIEW OF MAJOR CONSTRUCTION PROJECTS	SUPPORT
18	EVALUATION OF CERTAIN PROJECT CONTINGENCIES	
19	PROJECT STATUS REPORT JULY 1970	

Figure 6

b) **Risk Analysis**

This element of the task force activity and the separate related issue of insurance are particularly relevant to the issue of design risk and engineering management.

The risk analysis for the Churchill Falls Project involved inputs from all sectors of the management team. Each element of the project was categorized as being one of "High" - "Medium" - "Low" or "No" risk. Appropriate ranges of potential overrun and underrun were assigned, and the probability of occurrence predicted from the combined judgement of the engineering, construction and contracting groups. The analysis viewed overrun risk from two points of view as shown on Figure 7. It first assumed that overhead risks were related to 27 or so relatively *independent* components of the project. Then similar judgements were applied on the basis of 8 major *dependent* groups of cost elements. Accepting the fact that dependency was unlikely to be absolute, intermediate cases were also reviewed on a selected basis.

An important aspect was the trend in the risk with the project schedule since potential investment institutions would be vitally interested in the level at the time of financial commitment. In the case of giant projects, certain purchase and contract commitments may well be made by the time financing is fully in place and degrees of risk may be thus lessened. Churchill Falls risks were sensitive to this factor as shown on Figure 8 and to the increasing knowledge, with time, of design data relating to field conditions.

The outcome of the overrun risk analysis was the acceptance by the management and the owner of a "line item" project contingency of $41 million (or 7.8 per cent of the direct construction cost). That it could be so low (realistically as it turned out) is a tribute to the thoroughness of the design engineering, planning and costing.

An entirely separate provision was made for esacalation due to price changes in materials, labour and services anticipated over the project schedule. This amounted to $102 million (equivalent to a composite annual average rate of 4.5 per cent). The Churchill Falls Project was fortunate to some degree because its construction was completed before the days of two-digit inflation rates. Nevertheless, potential cost increases presented a severe enough challenge and a high degree of management skill and reporting methods were required throughout to identify clearly the project performance and the demand that this placed both on contingency funds and on provisions for escalation, as work proceeded.

It will be appreciated that, with giant projects, risks, potential project delays, and possible overruns make the completion guarantee a critically important element of the financing plan. The level to which this must be provided can be determined with greater confidence if a first-class risk analysis is made by the design engineer and manager, on both the project in question and on similar past undertakings. The technique of risk analysis has progressed significantly since the days of Churchill Falls; but, even then, the very extensive and convincing work done proved invaluable in arranging finance.

c) **Insurance**

The issue of confidence in design and project approach has also a most important bearing on the protection afforded to a project capital structure by insurance. It is vitally important that there is a close and effective liaison at the interface between design/engineering/management and the insurance market. Proper interpretation of engineering related issues to the insurer, clear demonstration of relative risks involved in the various elements of the project, and of the separation and distribution of these can be most helpful in determining proper levels and costs of insurance.

CHURCHILL FALLS POWER PROJECT
PROBABILITY OF UNDERRUN OF
ESTIMATED CONSTRUCTION COST

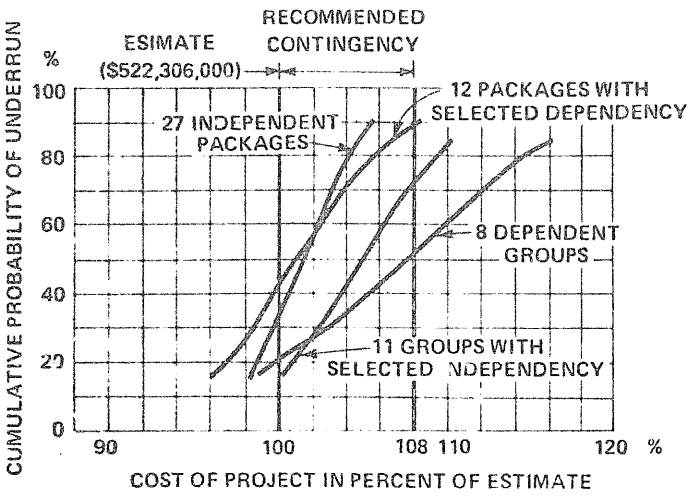

Figure 7

CHURCHILL FALLS POWER PROJECT
VARIATION IN RISK FROM
MARCH 31, 1969 (DAY 1)
TO SEPTEMBER 30, 1969 (DAY 549)

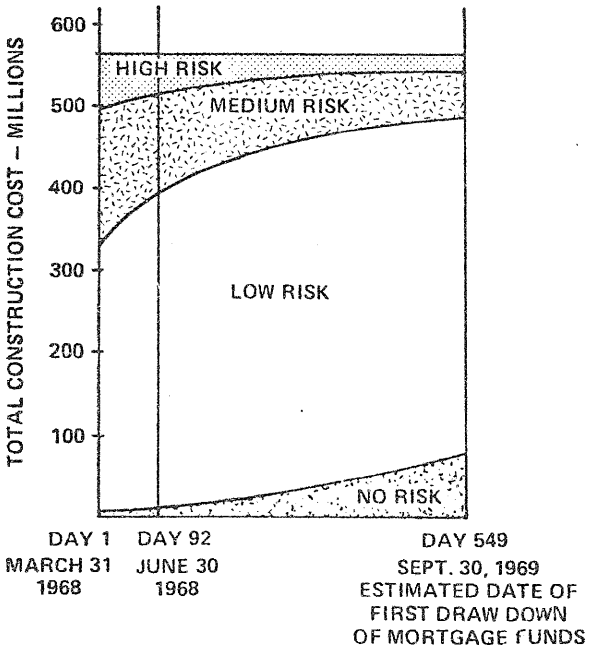

Figure 8

In the case of Churchill Falls, insurance provisions were heavily influenced by potential loss of revenue arising from incidents which impaired the ability to generate or transmit power and energy or which caused loss of stored energy in the form of water in the reservoir. Design considerations weighed heavily in the judgements required.

Initial insurance provisions were arranged at the start of construction 1967. By 1971 there had been sufficient progress and change in the insurance market to justify reappraisal of the situation. Once again design risks were reviewed; this time against the background of well defined completed engineering. A new task force, involving elements of the 1967 group, working closely with the insurance advisors, were able to confirm that the project was firmly on course and risks were, in fact, diminishing.

The importance of the interface between design/engineering and the insurance sector cannot be too heavily stressed. This should be developed at the outset of the giant project in a collaborative spirit with the objective of improving information flow and the confidence of underwriters, thus bringing to play the maximum insurance support. Thus, the interdisciplinary action of insurer and engineer can further assist in benefiting overall financing and the provision of completion guarantees.

V WHAT IS REQUIRED OF WESTERN EUROPEAN COUNTRIES?

We have reviewed a particular giant project - admittedly a giant of some 12 years' standing - to determine the contribution of management, of engineering and design risk to the overall success. In summary, we see this contribution as involving:—

- An unquestionably high degree of technical skill and experience
- Ability to provide engineering properly related to project need
- Provision of design with sufficient degree of conservatism to build confidence
- Flexibility to adjust the engineering approach to the best interests of owner and project
- Close interaction with construction management to achieve optimum costs
- Active participation in construction policy and contract packaging consideration
- Ability to identify risk, analyse it and provide compensatory measures
- Close interface with insurance and financing sectors to build confidence
- Ability to work effectively in project management system (see Appendix A)
- High quality field engineering to ensure quality and cost control
- Ability to judge future operation requirements and assess costs
- Continuing involvement in project overview reporting.

All these contributions could well be made by Western European firms and no doubt are made on a regular and continuing basis. It is not any shortage of engineering talent that is holding back Western Europe's pursuit of giant projects.

In any giant project, three closely related functions must proceed in harmony and relate efficiently: engineering, management of construction, and project management. Could it be from here that the predominant success of the North American firms stems? They have been able to develop a style of operation which permits a very large (a giant) firm to fit the needs of the giant project with the three major inputs properly balanced. In the case which has been reviewed in this paper, there was a deliberate blending of firms, each eminent in the prime role it played: Acres for hydroelectric engineering, and Bechtel for construction management, both having experience in overall project management of the style applied by the owner. With the combined effort in joint venture, the resources were there at the scale needed when called for. Systems were properly in place from the outset which employed the resources effectively. Design and engineering developed in close collaboration of the construction management team. There developed a proper recognition of the value of intensive engineering to achieve cost savings. There was a strong engineering/construction interrelationship in the field particularly on dykes, in underground works and for transmission line construction.

Most successful projects have enjoyed good relationships and effective interfaces such as those that existed at Churchill Falls. They are not the prerogative of North America, although I believe that joint venture groupings are, in general, more cohesive and successful there than in Europe. It is here that I would look for a possible guideline for future success: further development of the ability of the consulting engineer, the managing contractor and the project manager to work in truly close harmony with a virtually integrated group.

Another issue worth review is the question of organizational size in relation to the giant sized project being managed, engineered or directed. It appears that the capacity of North American firms to handle the larger capital works has had much to do with the extent to which the world's giant sized projects have grown. A current project will demand an overseas employment by a major, and already busy, U.S. concern of 1,000 staff and 30,000 tradesmen and others - obviously a daunting task, but one accepted with usual U.S. aggressiveness and no doubt for a handsome return!

Growth to the 2, 3 or 4 billion dollar a year turnover of major U.S. firms involved in giant-sized projects presents almost insuperable difficulties for most European concerns; and possibly the David stance - which we often adopt - as opposed to that of Goliath is the desirable alternative for many European firms. This would involve developing the necessary abilities to interrelate more effectively on a *multi-disciplinary basis* with the legal, financial, insurance, surety, labour and management interests involved in the giant project. If greater efficiency is developed from such relationships and confidence developed, then the undertaking will most surely benefit, and there will be more successful accomplishments. I strongly commend this approach by West European firms.

APPENDIX A

PROJECT MANAGEMENT FOR GIANT PROJECTS

Giant projects are best handled on a **full project management** basis, and we set out some principles which could assist in a better understanding of the implications of this approach:

- PROJECT MANAGEMENT is a means to an end and not an end in itself. It is a mode of organization, communication, motivation, coordination and execution of tasks to achieve a defined objective.
- PROJECT MANAGEMENT involves a process that unifies the objectives of the owner, consultants, engineers, manufacturers, contractors, insurers, and others to achieve a common purpose - the successful completion of the project.
- PROJECT MANAGEMENT should make use of the best available commercial and professional entities and should recognize profit as a motive and reward for excellence of performance.
- PROJECT MANAGEMENT is neither a "risk-taker" nor a "risk-giver" for it must always evaluate causes objectively, determine effects accurately, identifying implications and solutions clearly, and initiate actions following the judgement and decision of the owners who must remain the ultimate controlling authority on the project.

APPENDIX B

GIANT PROJECTS PAST AND PRESENT

12 GIANT PROJECTS COMPLETED 2640 BC TO 1977 AD

PYRAMID OF CHEOPS
GREAT WALL OF CHINA
ST. PAULS CATHEDRAL
SUEZ AND PANAMA CANALS
CANADIAN PACIFIC RAILROAD
HUDSON RIVER TUNNELS
EMPIRE STATE BUILDING
"MANHATTAN" PROJECT
CHURCHILL FALLS POWER PROJECT
WORLD TRADE CENTRE
B.P. FORTIES FIELD
ALEYSKA PIPELINE

12 TYPICAL GIANT PROJECTS UNDER WAY 1978

PETROCHEMICAL PLANTS
DESALINIZATION PLANTS
ITAIPU HYDROELECTRIC PROJECT
ALASKAN GAS PIPELINE
UNIVERSITY OF RIYAD
KING KHALID CITY
NORTHEAST (US) RAILROAD CORRIDOR
WASHINGTON METRO
BRUCE 6,200-MWe CANDU NUCLEAR PLANT
HARTSVILLE 4,800-MWe LWR NUCLEAR PLANT
GURI HYDROELECTRIC PROJECT
TRANS SIBERIAN RAILROAD

The Effective Project Management Organisation for Giant Projects

by Frank P Moolin, Jr.

FRANK P MOOLIN is President of his own firm based on Anchorage, Frank Moolin & Associates Inc., a company providing executive project and construction management services to the energy industry. He graduated in civil engineering from the University of Illinois in 1956 and has since been design and resident engineer for a number of major public works projects. He was senior project engineer for the $1.3 billion San Fransisco Bay Area Rapid Transit project, and for the Exxon refinery in Singapore. More recently he has been senior project manager in charge of the $4.3 billion pipeline portion of the Trans Alaska Pipeline. This project involved some 1,200 management and supervisory personnel, 14,000 workers and 200 contractors. In 1976 Mr Moolin was elected Engineering News Record's "Construction man of the Year", the major honour in the North American construction world.

CONTENTS Page No.

1 INTRODUCTION

Several years ago, when I was fortunate enough to be selected as Engineering News-Record's 'Construction Man of the Year', and was then unfortunate enough to be called upon to deliver an address to accept the award, I said the following:

> "There's a new generation of super projects just around the corner in America . . . in the world, for that matter, and frankly, I wonder if the construction industry and private owners can cope with what's coming. The Alaska Pipeline job has given us a glimpse of the types of problems we may encounter in the future on multi-billion-dollar projects.
>
> We have learned that industry is hard pressed to furnish the management for an undertaking of this size. We have a great capacity to design but we fall short of the mark in execution, in the planning, and the follow-up.
>
> We continue to re-invent the wheel. About the only breakthrough to come out of project management in the past 20 years has been critical path or network scheduling techniques. There is much more to project management and we must identify it."

I wish that I could report to you that the ability to manage giant projects cost-effectively has significantly improved in the past two years. Unfortunately, I believe the opposite situation is closer to the truth.

a) Recent Experience

It is interesting to look at the performance of a few major projects over the last 10 years[1]. At the same time the Trans-Alaska Pipeline was being built, a group of major Federal Government projects experienced an average cost increase per project of 43%. The Dulles International Airport, with which many will be familiar, cost 64% more at completion than estimated three years before completion. The terminal facilities alone increased 171% in cost during the three years.

The cost of recent steel industry construction projects has risen some 20% from the contracted cost to their final cost. And, a sample of petrochemical facilities built during the mid-1970's showed cost increased in excess of 50% over the two or three years duration of each project.

b) The Effective Type of Project Organization

The project management organization for giant projects is a complex subject on which I could spend many days. Here, however, I will concentrate on several observations I have made recently relating to the effectiveness of large projects. These comments are based on my personal involvement in three multi-billion-dollar projects over the past 13 years, two of them in remote areas, and one in an urban area. If I had to sum up in one brief sentence my observation of the effectiveness of various project management organizations, it would have to be "Small is Beautiful". As many will know, this title is borrowed from E.F. Schumacher's book.[2] I think it is revealing that the most significant statement about the organization of large projects comes from an economist instead of from an engineer or project manager. It almost seems to be a contradiction of terms to mention the word "small" at a giant projects conference but I intend to let this thought dangle and not attempt to prove it one way or another. I expose the idea now because I believe the concept of project organization that flows from this concept to be unique and to hold great promise for executing giant projects successfully over the next ten years.

(1) TAPS: A Synopsis of Engineering & Cost Factors, prepared and published by the owner of the Trans-Alaska Pipeline System, March 1978.

(2) "Small is Beautiful, a Study of Economics as if People Mattered", by E.F. Schumacher, Harper & Row, 1973.

II THE BASIC FACTORS AFFECTING GIANT PROJECTS

Why do we have problems executing giant projects in a cost-effective way? Of course there is little in the way of a formal body of knowledge about project management as compared with corporate management. Project successes and failures are very rarely documented. If you spend time searching through literature to find the project management side of the story behind some of the huge projects of the past such as the Trans-Continental Railroads, the Panama Canal, the Suez Canal, the Moon Shots, and even the Concorde Project you will find that very, very little practical description exists.

a) The Need for Different Concepts

Since we cannot rely too much on past history to point the way in this field we have to do it ourselves. Project management of giant projects involves new approaches; it is an emerging branch of management theory. The basic differences between the organization of giant projects and the more traditional business organization are as follows:

(i) Projects are in business to go out of business while corporations are in business to perpetuate themselves. This sounds such a simple statement yet it is one of the more significant aspects which has to be dealt with in designing a workable project organization for giant projects. Many techniques of corporate management just do not apply, and in fact do not make sense when applied to a project situation.

(ii) Large numbers of people are involved in projects for very short and intense periods of time.

(iii) Frequent and often brutal organizational changes are essential to the success of giant projects. In fact, changing the project organization of a giant project, at the most opportune time, is one of the most significant factors that will effect the success or failure of that project.

b) The Particular Characteristics of Giant Projects

Looking at the characteristics of the new breed of giant projects in more detail we find the following:

(i) **Multi-Agency/Organization Involvement and Influence.** Certainly no other single factor has as much influence on the way we conduct giant projects than the myriad of external organizations that have a direct influence on the project.

(ii) **Long Realisation Period** The time period from conception of the project to a positive cash flow is often much longer than is normal on lesser sized projects.

(iii) **Labour Intensive** A large number of people are involved, often for only short but intense periods of time.

(iv) **Different Objectives** There is often a lack of dedication by either or both of the management and the work force to the goals of the owners.

(v) **Excessive Litigation** This occurs before, during and after the project.

(vi) **Inescapable Conflicting Requirements** In particular:— growing materials/scarcity, increasing labour demands, increasing environmental demands, and growing lack of infrastructure.

(vii) **Political Pressures** Use of the project to correct real or imaginary social problems.

III THE REQUIREMENTS OF GIANT PROJECT MANAGEMENT

What is wrong with the construction industry? What prevents giant projects from being controlled effectively? This requires that we look at the construction industry in some depth.

a) Inadequate Approaches

(i) In the United States the construction industry is the largest single industry, yet there is no basic, fundamental agreed approach to teaching the complete construction management process.

(ii) Business schools teach corporate management endlessly, but seldom project management which is so very different.

(iii) Practitioners of project management seldom write about their successes never mind their failures.

(iv) There is a lack of a business-oriented middle-management group working for and available to contractors.

(v) Project management, more so than any other type of management, requires that decisions be made with:

a) imperfect knowledge,
b) little or no precedent, and
c) usually no well-defined procedures.

Successful project management therefore requires a particular type of manager . . . it requires a risk taker.

b) Reasons for Inadequacies

In the light of the above characteristics of the new breed of giant projects let us consider why the construction industry so often handles them inadequately.

First, we must examine what comprises an effective project management organization for giant projects. The issues that have to be considered in the design of a successful project organization are the following:

(i) **The Composition of the Team**
Selecting a balanced, inter-disciplinary and business-oriented team. This may sound like a lot of motherhood and apple pie but selecting the top two tiers of the project team organization so that they have a diverse background, inter-disciplinary with business-oriented bottom-line track records, is probably the most significant element in the successful implementation of a giant project.

(ii) **Leadership**
The business schools tend to down-play the importance of leadership in large corporations. They stress management skills rather than leadership. I have found that exactly the opposite situation is true on giant projects. Giant projects, in many respects, are military-type beach-head operations and military-type esprit de corps is almost always required to save the project from the numerous assaults it suffers during its movement from an individual's concept to a living, effective and functioning entity. Leadership comes essentially from the skills of a very limited number of personnel in the top two tiers in the organization.

(iii) **Flat Organization Structure**
Upon taking over a project that is in trouble the first change I normally make to the organization is to reduce the number of

hierarchial tiers. The immediate benefit is a reduction of the total number of management, supervisory and support personnel. The subsidiary benefit is the tremendous increase in communication that takes place and the forced involvement of the top two tiers of senior management in the day-to-day understanding and solving of problems.

(iv) **Training**
Training is required very early in the project, starting with the senior individuals on the project team and extended to all levels in the organization. Most people just do not understand what is required of project organizations and very few people have had experience in the problems associated with them.

(v) **Participation/Acceptance/Commitment (PAC)**
I have found from experience that obtaining the participation, acceptance and commitment of the large numbers of individuals involved in a project team is crucial. It is not the formal organization structure that achieves the PAC; rather it is the informal structure and the leadership ability of the top two tiers of the project team organization that encourage and permit the type of PAC communication that is required.

(vi) **Single Point of Contact Concept (SPOC)**
In the end it is the single manager, identified as the sole individual in charge of a certain element of work, who knows that he will be held responsible for the bottom-line result for that work, who achieves the goals established by a project organization. Yet while I often review organizations, and have often had to make major changes in existing organizations, most project organizations have only a very fuzzy identification of organizational and managerial responsibilities.

(vii) **Cost Center Concept**
Hand-in-glove with the SPOC concept is the Cost Center Concept. A project must be broken in manageable pieces, each identified with a budget and schedule. Managers must then be given the basic responsibility to take those actions necessary to achieve the assigned budget and schedules.

(viii) **Independent Financial and Management Audit**
I want to stress the fact that I am talking about much more than traditional financial audit: I am also talking of a management audit. These audit functions must report directly to the highest levels of the project organization. I have seen what can happen with myopic approaches in a project organization when one manager, thinking that he is taking the best course of action, ends up optimizing his little corner of the world but seriously jeopardizing the mission and the objective of the overall project. I have also seen how the involvement of a very small management audit team can ferret out such situations before they become irrevocably damaging.

IV THE NEED FOR A PROJECT MANAGEMENT ELITE

The standard approach to the management of giant projects has been to inundate the project with so-called planners and managers. The results have been expensive, not only because of the large numbers involved, but much more importantly because of the cost of their mistakes. It has been my experience that a very small close-knit cadre (10 to 20 people), possibly even called a managerial elite, made up of extremely well-qualified and experienced managers and planners, who are involved early and kept in this managerial role for the entire project, have the most significant bottom-line effect on the cost, schedule and quality performance of the project.

Of course a business-oriented approach is required, technical skills in cost/schedule systems must be applied, objectives have to be established, detailed procedures and flow diagrams must be developed. All this is obvious.

But, I believe that the spark that differentiates successful project teams from unsuccessful ones is a crispness, a vibrancy, a cadence, a pulse and an excitement that permeates the successful project team's organization. This comes about from leadership and from encouraging the informal organization to work.

a) Finding the Teams

Where does this management elite come from? That is a very good question and it is extremely difficult to answer. There are very few well-qualified teams of project personnel in the world and even fewer have capabilities and a track record on large projects. If I were a giant project owner I would first look to finding that experienced managerial elite. This elite will often come from outside the owner's organization but it should be retained directly by the owner and assigned basic responsibility for planning of the project, including being the 'Single Point of Contact' for all other entities that affect the project. There are also other ways of organizing the reporting relationships of this management elite and I believe they are really less important than the qualifications and the spark that this group imparts to the organization, almost without reference to the organizational structure.

b) Conflict with Academic Theory

My emphasis on the importance of this concept has really upset students and professors of organization theory. However, I have tried the theories taught by the business schools and under the peculiar and usually unstable conditions prevalent in giant projects they just do not work.

In most organizational theory there is much rhetoric about the formal organizational structure, i.e. the project (line) versus the functional type of organization. And of course it is possible to have both a line and a functional organization or a matrix organization. The theory of these organizational structures is well established, but not for the circumstances of projects. In practice the basic organization element that has to be decided for projects, particularly giant projects, is one of the centralization versus the decentralization of decision making. Everything else follows from this - a strong leadership can work under either organizational concept. In fact, I have had two first-hand experiences of billion-dollar-plus projects where both concepts were used at different times on each project. In general, it is my recommendation on most major projects that the control of all decision making be very centralized during the formative, embryonic stages of the project. Very stringent design change control procedures must be implemented; and organization manuals and authority guides must be developed in detail. Any reasonably successful project that I have ever seen has a high degree of centralized control, bordering on the extreme, during the early phases of the project.

c) **Changing the Project Organisation at Different Stages**

As the project moves to the procurement and field stages a major shift must be made in the project organization, from being highly centralized to being highly decentralized. At this stage, because of the velocity and complexity of the project it is usually essential to transfer significant authority to a number of relatively independent operations such as procurement, transportation, warehousing, infrastructure development, field construction, contract development and the like.

Let me give you several examples of these basic organizational concepts. The San Fransisco Bay Area Rapid Transit Project was an example of a very large project (in excess of $1 billion) executed under extremely difficult environmental and governmental pressures. Because it was a public works project, and because of the good communication facilities that were available in the highly-developed urban area, the conscious decision was made by management to develop and maintain a very highly centralized project management organization.

On the other hand, the Trans-Alaska Pipeline Project was an example of a project that made very basic organization changes at significant turning points in its life. During the early phases of the project a conscious decision was made to exercise highly centralized control, primarily because of the complexity, the almost unprecedented extent of involvement with so many governmental agencies, and the high degree of new technology involved. To ensure that this concept of centralization was properly implemented, the owner installed a large technically-qualified staff and then hired a construction management contractor. The construction management contractor also adopted a very centralized form of organization. This form of organization was reasonably effective in the early stages, prior to major field activities. However, at about the point of 15% physical completion, it became obvious that the organization was becoming bogged down in bureaucracy, ineffective communication, lack of purposeful direction and potentially serious schedule overruns.

A very bold move was then taken by the owners. Almost overnight a decentralized form of management was superimposed upon the project and, in spite of all the bad press associated with the project, the project was then completed on schedule, almost to the day that had been set four years previously, with a 22% cost increase from the budget established when the "go" signal for the project had been given.

Once the decision was made to go from the centralized form of management it was important to implement the change very rapidly, and in a period of three weeks a basic organization change was made that resulted in a net reduction of supervisory and managerial personnel of about 22%. This was a reduction of about 100 professional, managerial and supervisory personnel.

This change, implemented very rapidly once the basic decision was made, shortened lines of communication, resulted in much faster decision making, and in a remarkable improvement in credibility between the owners organization and the monitoring governmental agencies. Of course, it also changed the productivity of the work, improved the overall project productivity and contributed to the on-time completion of the project while minimizing its cost overrun.

Therefore, my experience on these two very large projects, confirms something that I have pondered for many years about project management, namely that the key decision to be made relating to the execution of giant projects is that of centralization versus decentralization. Everything else flows from this decision. And, one must be prepared periodically to re-examine the organization, the status of the project, and the changing nature of the project, and if necessary, to switch from one form of management to

another whenever it's apparent that it is in the best interest of the project to do so.

The Trans-Alaska Pipeline System, probably the largest project ever executed, was highly centralized for the first third of the project and then, in an extremely short period of time, successfully switched to a decentralized form of management. This switch was instrumental in achieving the goals of the owners. In spite of all the problems associated with bringing the Trans-Alaska Pipeline Project to the point where final design, procurement and construction could begin, the project, although it started operation in August of 1977, had, within ten months moved almost 250 million barrels of crude oil, and that equated to a little more than $3 billion worth of positive cash flow.

d) Planning the Plan

So far two of the basic elements that go into setting up and controlling flexible and workable project management organizations capable of accomplishing giant projects have been considered. There is one more that is extremely important. This is the front-end plan or what I call the "Plan for the Plan". I believe that owners now recognize that it is important actually to plan the plan for their giant project. As I indicated earlier in this talk, the tendency in the past has been to inundate a project with a relatively large number of planners and managers. There is nothing wrong with large numbers **if and when they are needed.** But I firmly believe that the larger and the more complex a project, the fewer the number of people there are who can actively and effectively participate in generating the plan. Why? The larger the project, and the fact that large projects tend to be located in areas that lack infrastructure and therefore depend upon outside support to a much greater extent than projects being built in more developed areas, means there are numerous and extremely complex interfaces between various elements of a project. In my experience on giant projects it is essential that a relatively small number of planners actually prepare the specifications for the plan, i.e., they should develop in considerable detail the specific elements that the project manager or construction management contractor or the management organization are to prepare during the planning period.

The Northwest Alaskan Pipeline Company is planned to be the owner of the $4 billion 731-mile 48" diameter gas line transporting Prudhoe Bay gas to the Alaskan-Canadian border (then to be transported across Western Canada to the lower 48 of the United States). Recognizing the complexities of working in the State of Alaska, under a combination of a lack of infrastructure and extreme governmental constraints, Northwest Alaskan retained our company to develop the "Plan-for-the-Plan" for the $4 billion project in Alaska. We tried several combinations of talented personnel and also different time periods to generate the best Plan-for-the-Plan. Our findings were as follows: First, the optimum number of people for the Plan-for-the-Plan was eight managers and planners. Second, a four-month, very intensive period of developing the Plan-for-the-Plan was required. Third, very senior people were required to develop a plan that was rational, practical and which would eventually end up being cost effective.

The managers and planners who developed the front-end plan for the $4 billion Alaska Gas Line initially had a problem. The individuals were selected because of their first-hand managerial and planning responsibilities in a line organization that had a bottom-line responsibility for building a part of a crude line. Now they were operating in a different mode. They were involved very, very early; they were expected to plan and identify situations that would probably not come to pass until five or six years later, and, they did not have an army of subordinates to do their leg work for them. The results are extremeley encouraging. A front-end plan was developed that is highly practical and can be used by the myriad of

engineers, planners, and managers who will follow in the footsteps of the executive task force that actually generated the front-end plan. We now anticipate that the individuals who put together the front-end plan will go on to executive project management positions on the decision/procurement/construction phases of the gas line.

e) **Organizational Summary**

To recapitulate - based upon my experience on three multi-billion-dollar projects there are three important elements which relate to setting up and controlling a flexible and workable giant project management organization:

(i) There should be a relatively small managerial elite at the top two tiers of the organization.

(ii) The critical decisions should be made in a timely and bold way, relating to centralization and decentralization of the project organization.

(iii) There should be an intensive front-end planning effort (Plan-for-the-Plan).

V CONCLUSION

I began this paper by drawing upon the address I gave several years ago relating to project management. I said "one final thought on management . . . do you recall that old boy scout saying . . . "Make it simple, make it fun"? I believe that we tend to complicate projects unnecessarily which slows productivity. We should go into the field and shake the trees to stir up thinking that has gone stale. We do not want anyone feeling too secure since security takes the fun out of a job and allows time for us to become bureaucratic."

Certainly the challenge of giant projects is upon us. I also believe we have the managerial skills and the organizational tools to make the best use of the people available to us. I believe that it will be ten years before a new breed of management develops, with appropriate business-oriented skills, to be able to make real strides and manage giant projects better. In the meantime, we have to make do with what we have available and I firmly believe that the giant project organization can be made cost effective, by following the guidelines in this paper.

APPENDIX E

SELECTED RESUMES FOR ACRES PERSONNEL

SHER BAHADUR

Education
University of Lucknow, Lucknow, India
B.Sc. Geology, 1959
M.Sc. Engineering Geology, 1960
South Dakota School of Mines and Technology, Rapid City, South Dakota
Ph.D. Geotechnology, 1972

Professional Associations
American Society of Civil Engineers – Member
Association of Engineering Geologists – Member
Registered Professional Engineer – States of Colorado, Illinois and New York

Experience

1977 –Acres

1977 **Project Coordinating Engineer, Geotechnical**

Responsible for geotechnical aspects of power and industrial projects, including

- field exploration program, foundation design and structural stability for the 10-MW Granby hydro redevelopment for Niagara Mohawk Power Corporation

- preliminary design of surface reservoir embankments and structures and underground excavations for a large underground pumped/compressed air energy storage complex in Maryland for the DOE, EPRI and Potomac Electric Power Company

- stability analysis of sheet-pile cofferdam and tie-back system for Bethlehem Steel Plant, Buffalo, New York

- design memorandum for embankments and instrumentation systems associated with tailings disposal dam for Union Carbide at Hot Springs, Arkansas

- reasibility study of small hydroelectric projects in the States of Maine, Massachusetts, and Vermont.

1975 –1977 **Principal Geotechnical Engineer,** Envirodyne Engineers, Inc., Chicago, Illinois

Responsible for coordination of geotechnical investigations and associated laboratory testing. Independent design analyses for the foundations of retaining structures, pavements, bridges, sewer tunnels, transmission towers, and industrial buildings; preparation of contracts and specifications; evaluation and selection of sites for commercial airports; and report writing.

1973 –1975 **Geotechnical Engineer,** Sargent and Lundy Engineers, Chicago, Illinois

Responsible for geotechnical exploration program. Evaluation, selection and development of sites for nuclear and fossil power plants in Illinois, Ohio and Texas. Design analyses of plant foundations and earth structures. Review of [illegible] and environmental reports.

1972 –1973 **Soils Engineer,** Commercial Testing Laboratories, Denver, Colorado

Design analyses for the foundation of industrial buildings, retaining walls and pipeline routes.

Supervision of staff for geotechnical field investigations and laboratory testing.

1969 –1972 **Geotechnical Doctoral Fellow,** South Dakota School of Mines and Technology, Rapid City, South Dakota

Research in rock slope stability, experimental rock deformation, in situ rock stresses, and rock strength characteristics and their influence on seismic activity.

1961 –1969 **Assistant Professor,** University of Roorkee, India

Teaching of graduate courses in rock mechanics and engineering geology.

1960 –1961 **Teaching Assistant,** Bureau of Mines and Geology, India

Experimental rock deformation. Measurement of magnetic and gravity anamolies.

Technical Publications

Measurement of In Situ Stresses in the Black Hills, South Dakota
Ph.D. Dissertation, South Dakota School of Mines and Technology, Rapid City, 1972

RICHARD W. CARSON

Education — University of Manitoba, Winnipeg, Manitoba
B.Sc. Civil Engineering, 1970
M.Sc. Water Resources Development, 1973

Professional Associations — Association of Professional Engineers, Manitoba – Member
Canadian Society for Civil Engineering – Member

Experience

1976 –Acres

1974 **Project Coordinating Engineer**

Involved in a study of alternative methods of ice management in the Arctic harbor of Bridport Inlet, Melville Island.

Principal investigator in a study of the effects of extended winter navigation on the ice and flow regimes of the international section of the St. Lawrence River.

Principal investigator in a study of hydraulic improvements and rehabilitation of 2 hydroelectric plants (total capacity 15 MW) on the Winnipeg River.

Conceptual studies for the comparison of a conventional spillway and powerhouse versus an integrated powerhouse using low-level sluiceways for a 1,100-MW hydroelectric power development.

Participation in the hydraulic design of an 1,100-MW hydroelectric power development on the Nelson River.

Principal investigator in a study of hydraulic effects of diking to preserve waterfowl habitat on the upper Columbia River.

1973 –1974 **Generation Planning Engineer,** Montreal Engineering Company (Overseas) Limited, Rio de Janeiro, Brazil

Adaptation of the Pacific Northwest Power Pool system computer model to the power system of south and south-central Brazil and Paraguay for the purpose of analyzing the integration and operation of the Itaipu plant (12,600 MW on the Rio Parana) in the Brazilian and Paraguayan power systems. Determination of optimum operating rule curves, optimum economic installed capacity and reservoir drawdown, and firm energy availability of Itaipu.

1973 –**Engineer,** Acres

Participation in hydraulic designs of structures for diversion of the Churchill River into the Nelson River, including 2 spillway control structures.

1972 —**Generation Planning Engineer**, Centrais Eletricas de Sao Paulo, Sao Paulo, Brazil

Development of a hydrothermal power station simulation computer model for study of expansion of the 9,000-MW power system of south-central Brazil.

1971 —**Hydraulic Engineer**, Manitoba Hydro, Winnipeg

Hydraulic design of a spillway control structure and 3 excavated channels at the outlet of Lake Winnipeg.

CHARLES A. DEBELIUS

Education

United States Military Academy, West Point, New York
B.S., 1954
Columbia University, New York
Graduate work in Physics and Nuclear Engineering, 1958 – 1959
New York University, New York, New York
M.S. Physics, 1963
U.S. Army Command and General Staff College, Fort Leavenworth, Kansas
MMAS (Master of Military Arts and Science), 1968
U.S. Army War College, Carlisle Barracks, Pennsylvania
Graduate 1972
U.S. Army Logistics Management Center, Ft. Lee, Virginia
Construction Management Course, 1969

Professional Associations

Society of American Military Engineers
President, Anchorage Chapter 1974 – 1975
President, Fort Belvoir Chapter 1976 – 1977

Experience

1978 –Acres

1978 **Manager of Engineering**

Responsible for management of all technical resources for projects undertaken by the Columbia office.

1977 –1978 **Chief of Methodology,** U.S. Army Study

Responsible for direction of all operations, research and analysis for a major Army study of officer education.

1976 –1977 **Brigade Commander,** U.S. Army, Fort Belvoir, Virginia

Management and direction of activities of 4,500 soldiers in 7 battalions, including topographic and combat engineering units. Provision of engineering training for officer and enlisted students.

1973 –1976 **District Engineer,** Alaska, U.S. Army

Responsible for planning, design, environmental analysis and construction management for all military and civil works projects in the State of Alaska. Annual budget of $50 million included management of such projects as

- hydropower studies on the Susitna River, Bradley Lake, and other locations
- hydropower development at Snettisham
- major flood control works at Fairbanks
- small boat harbor development
- urban studies
- thermal power plant construction
- construction of military facilities.

1972 –1973 **Director**, Army Forces and Systems Studies, U.S. Army War College

Faculty member at Army's highest-level educational institution. Designed model for economic analysis of alternative military forces.

1969 –1971 **Cost Analyst**, Office of the Secretary of Defense (systems analysis)

Prepared economic studies of proposed new systems including major aircraft and tank procurements as well as construction of major bases.

1968 –1969 **Battalion Commander**

Directed operations of 1,000 military and 500 civilian construction workers. Responsible for design, construction, and maintenance of 100 miles of asphaltic concrete highways, as well as vertical facilities.

1965 –1967 **Project Officer**, Engineer Agency, Army Combat Developments Command

Conducted extensive studies of military engineer needs in the future.

1964 –1965 **Resident Engineer**, Kisimaio Port Project, Somali Republic, Africa

Principal U.S. Government representative on a $10 million port construction project. Contracting officer's representative, and manager of engineering staff involved in construction including

- 1,200 prestressed piles
- 1 mile of breakwater and causeway construction
- dredging
- quarry operation
- various other port-related activities.

1959 –1963 **Instructor and Assistant Professor**, U.S. Military Academy

Taught physics and supervised laboratory work for cadets.

1954 –1958 **Lieutenant**, U.S. Army Corps of Engineers

Staff, command, and management of military engineer activities in Germany.

JAMES D. GILL

Education — University of Manitoba, Winnipeg, Manitoba
B.Sc. Civil Engineering, 1966
M.Sc. Soil Mechanics and Foundation Engineering, 1970

Professional Associations
- American Society of Civil Engineers – Associate Member
- International Society for Soil Mechanics and Foundation Engineering – Member
- Canadian Geotechnical Society – Member
- Association of Professional Engineers, Ontario, British Columbia, and Alberta
- Registered Professional Engineer, State of New York

Experience

1966 – Acres

1977 Head, Civil and Geotechnical Departments

Responsible for administration of staff of approximately 35 in the Civil and Geotechnical departments. Special consultant for strategic oil storage conversion project, Weeks Island Mine, Louisiana, for Gulf Interstate Engineering, Houston, Texas. Visiting lecturer in soil mechanics at the State University of New York, Buffalo.

Responsible for civil and geotechnical contributions to the following projects.

- Dam inspection and small hydro developments for Dan River Inc., Nebraska Municipal Power Pool, Vermont Electric Corporation, and Niagara Mohawk Power Corporation.
- Siting studies and civil/geotechnical aspects of ERDA/EPRI energy storage study, Potomac Electric Power Company, Washington, D.C.
- Evaluation of Wabana Mine, Bell Island, Newfoundland, for strategic oil storage under the National Strategic Storage Program and geotechnical investigation of Weeks Island Mine, Department of Energy, Washington, D.C.
- Siting studies for hard rock and aquifer-based compressed air energy storage (CAES) plans and geotechnical/rock mechanics aspects of CAES plant design, California Energy Commission, Sacramento, California.
- Review of methodology and siting studies for radioactive waste disposal sites in the Middle Piedmont, for Dupont, Savannah River Laboratories.
- Trenton Falls and Granby hydro redevelopments, Niagara Mohawk Power Corporation, Syracuse, New York.
- Design of earth-fill Amos fly-ash retention dam, Winfield, West Virginia, and feasibility studies of underground pumped hydro in an abandoned mine, American Electric Power Service Corporation, New York, New York.
- Design of the raising of a major tailings embankment involving analysis for liquefaction potential during seismic loading, Union Carbide Corporation.
- Stabilization of Terrapin Point, Niagara Parks Commission, Niagara Falls, New York.

1976 Staff Engineer, Geotechnical

Responsible for design and coordination of

- retention pond dikes, Union Carbide Corporation, Ashtabula, Ohio
- mine waste runoff containment facilities, Union Carbide Corporation, Hot Springs, Arkansas
- foundation design, wastewater treatment facilities, Bethlehem Steel Corporation, Lackawanna, New York
- siting studies for underground pumped hydro/compressed air energy storage, Boston Edison Company, Boston, Massachusetts.

1974 **Lend Geotechnical Engineer**

Formulation of investigation programs, staff coordination and geotechnical related studies for

- feasibility studies of Wanita powerhouse, British Columbia
- northern staging areas for pipeline construction for Canadian Arctic Gas
- transmission line from Twin Gorges to Hay River, Northern Canada Power Commission
- Red Deer River off-stream storage study, Capital City Weir, Edmonton.

Geotechnical aspects of preliminary design and feasibility of Capital City Weir, design and construction of McMahon Stadium artificial turf, and foundations for Calgary International Airport refueling systems.

Studies into use of spray-on sealants for petroleum storage dikes in the North.

Geotechnical coordinator responsible for design of Amos fly-ash retention dam, Winfield, West Virginia, including supervision of 3-dimensional stability and finite element analyses.

1973 **Geotechnical Engineer**

Technical consultation and construction supervision including blast monitoring and geological mapping for Nilo Peçanha drainage tunnel, Brazil.

As Geotechnical Coordinator, responsible for excavation design of major railway relocation, main earth-fill dam and saddle dam design on sensitive Leda clay foundation, Arnprior generating station, Arnprior, Ontario.

As Senior Engineer, construction supervision of drainage tunnel, power tunnels, excavation, grouting and drainage works, and monitoring of dam and powerhouse instrumentation, Sirikit power project, Thailand.

Responsible for foundation design on variety of projects including field investigation and design of foundations and tailings dam for 300-ton/d ore milling plant in the Yukon Territory; work involved supervision of access road construction through mountainous and permafrost terrain.

1967 **Graduate Student,** University of Manitoba, Winnipeg, Manitoba

Course work in advanced soil mechanics, foundation engineering, hydrology, hydraulics, flood control and river morphology.

1966 **Field Engineer**

Supervision of field investigation programs for Lower Notch generating station, Ontario.

Construction supervision of dikes and flood control works, Red River Floodway, Winnipeg, Manitoba.

Technical Publications

The Bulk Modulus and Shear Modulus of a Lake Agassiz Clay, 1969
(Unpublished Master's thesis)

The Foundation of the Sirikit Powerhouse
Presented to 1976 ASCE Geotechnical Specialty Conference on Rock Foundations and Slopes, Boulder, Colorado (James D. Gill and Leib Wolofsky)

Economical Investigation for Energy Storage Projects
Presented to 18th Symposium on Rock Mechanics, Keystone, Colorado, 1977 (John D. Lawrence, Michael J. Hobson, and James D. Gill)

Water Compensated CAES Cavern Design
Presented to Asilomar Conference on Compressed Air Energy Storage, 1978 (James D. Gill and Michael J. Hobson)

National Strategic Crude Oil Storage in the Weeks Island Salt Dome Mine: I. Geotechnical Evaluation
ASME Energy Technology Conference, Houston, Texas, 1978 (A. Mahtab, D. W. Lamb, L. Van Sambeek and J. D. Gill)

THOMAS W. GWOZDEK

Education — State University of New York at Buffalo, Buffalo, New York
B.S. Civil Engineering, 1971

Professional Associations — Licensed Professional Engineer
New York State No. 53235

Experience

1971 —Acres

1974 Project Engineer, Civil, Acres American Incorporated

Project engineer for design of mine waste and runoff treatment facilities including retention ponds and treatment plant for Union Carbide Corporation, Hot Springs, Arkansas.

Cost and economic evaluations for hydroelectric and pumped storage developments in New England for Corps of Engineers, New England Division.

Civil coordinator responsible for all civil and structural engineering aspects for an industrial process facility for Union Carbide Corporation. Responsibilities included development of design criteria, supervision of design and drafting, and coordination with mechanical and electrical aspects of the project.

Civil project engineer for rotary forge foundation and support structures for a U.S. Army Corps of Engineers arsenal. Responsible for development of design criteria, supervision of design and drafting, and preparation of contract documents.

Participated in conceptual and preliminary design engineering and preliminary construction cost estimates for an underground oil storage facility and a pumped storage hydro development.

1973 Structural Design Engineer

Structural design engineer responsible for design of various foundations, buildings and structures for industrial facilities. Foundation designs included compressors, industrial equipment and buildings. Structural designs included gas ductwork, buildings, and a 6,000-foot, 16-inch diameter oxygen pipeline and supports.

Resident engineer for construction of caisson foundations for high-voltage transmission lines for Rochester Gas and Electric Corporation. Responsible for general contract management, construction inspection and supervision, cost estimates, payments and record keeping.

ACRES

1972 Engineer

Coordinated engineering activities for wind tunnel model studies to determine stack effluent dispersion. Responsible for setting up test program, calculation of effluents from data received, report preparation, and liaison.

As construction engineer, participated in on-site field inspection, quality control assurance, general contract supervision, cost estimates, payments, scheduling, and lab testing of soils. The projects involved were installation of rock stabilization devices in a gorge face, installation of a tie-back wall system for the foundation of an industrial building, and construction of a 150-foot high, earth- and rock-fill dam.

1969 –1970 Land Surveyor, Engineering Department, City of Niagara Falls, New York

JOHN W. HAYDEN

Education — Carnegie-Mellon University, Pittsburgh, Pennsylvania
Ph.D. Civil Engineering (Major in Water Resources/Environmental Engineering), 1963

Professional Associations — Registered Professional Engineer, New York No. 52331, Minnesota No. 10891

Experience

1973 – Acres

1973 Manager, Special Services

Manager of the Chesapeake Bay model study for the Corps of Engineers. The model, housed in a 14-acre building is an estuarine model of the entire bay plus all significant freshwater inflows.

Technical Director for development of methodology for assessing the economic impact of modifying the cooling water discharge systems of large thermal power stations including

- Encino power generating station, four 250-MW oil-fired once-through cooling system for San Diego Power and Light Company
- Zion 2,000-MWe nuclear power generating station, Commonwealth Edison Company, Lake Michigan
- Donald C. Cook, two 1,100-MWe nuclear power generating station, American Electric Power Service Corporation.

Measurement of the impact on air quality of the emission from Niagara Mohawk Power Corporation four 100-MW coal-fired Huntley Station.

Assessment of physical impact of cooling water discharged from large power generating stations including

- Perry 2,200-MWe nuclear power generating station, Cleveland Electric Illuminating, Perry, Ohio
- Sterling 600-MW coal-fired electric power generating station, Rochester Gas and Electric Corporation
- Nine Mile Point thermal generating station (Unit 1, 610 MW and Unit 2, 1,100 MW) for Niagara Mohawk Power Corporation
- Fitzpatrick 850-MWe nuclear generating station, Power Authority of the State of New York.

1971 – 1973 Metropolitan Council, Minneapolis-St. Paul Area

Manager of the Physical and Natural Resources program of the Metropolitan Council, responsible for preparation and adoption of the Water Resources Chapter of the Metropolitan Development Guide for the Metropolitan Council seven-county planning area, including the establishment of a public participation program, liaison with local governmental units, and conducting public hearings prior to adoption of the Guide.

Directed a detailed mapping study of all storm and combined sewerage systems in the Metropolitan area.

Represented the Metropolitan Council on the Steering Committee of the U.S. Army Corps of Engineers Upper Mississippi River "Level B" study.

Represented the Metropolitan Council on the task force responsible for the adoption of QUAL II to the Mississippi, Minnesota, and St. Croix rivers system in the Metropolitan area.

Developed guidelines for acceptable types of land use relative to soil type, slope and location including wetlands, floodplains and lake frontage.

1969 – 1972 **Consultant**, Water Resources Engineering, Barr Engineering Company, Minneapolis, Minnesota

Participated in the development of a mathematical model for urban watershed analysis.

Participated in the development of nonstructural flood control plans for the Bassett Creek and Riley-Purgatory Creek watersheds.

Participated in water resources study of the Minnesota portion of the Lake Superior watershed.

Hydraulic analysis of Rum River dam at Anoka, Minnesota; design and preparation of specifications for the tainter gate and stilling basin.

Model test and hydraulic design of St. Cloud Dam across the Mississippi at St. Cloud, Minnesota.

1964 – 1972 **Assistant/Associate Professor, Associate Department Head**, Department of Civil and Mineral Engineering, University of Minnesota

In charge of undergraduate fluid mechanics courses. Teaching and research in water resources with particular emphasis on fluid mechanics and geohydrology. Prinicpal investigator for the following studies:

- unsaturated flow through porous media
- erosion of cohesive soils
- model studies of chlorine dispersion in turbulent pipe flow
- study and hydraulic design recommendations for the intake and discharge structures for Zion nuclear power station
- seepage and stability analysis of Taconite tailings basins
- hydraulic study and development of design recommendations for the expansion of Encina power plant intake system
- study of hydraulic pressures acting on Zion nuclear power station intake structure due to wave action
- study of temperature distribution in lake near discharge structure
- model study and analysis of condensing system for D.C. Cook nuclear power plant.

1962 – 1964 **First Lieutenant**, U.S. Army Engineer School, Fort Belvoir, Virginia

Technical Publications

In excess of twenty-five publications.

ROBERT R. HENSCHEL

Education — State University of New York at Buffalo, New York
B.A. Geology, 1971

Professional Associations — Association of Engineering Geologists – Member
American Society of Civil Engineers – Member

Experience

1973 –Acres

1978 Geotechnical Design Engineer

Responsible for preliminary design and selection of an instrumentation system to monitor the stability of the service shaft at Weeks Island Salt Mine in Louisiana, during and following conversion of the mine for long-term storage of crude oil.

Responsible as Project Engineer for final design and preparation of contract documents for remedial works at Terrapin Point in Niagara Falls, New York, and for selection and supervision of installation of instrumentation to monitor movements in the rock mass.

Responsible for field supervision of

- shallow drilling investigation for PEPCO UPH/CAES project near Washington, D.C.
- geotechnical investigation at Terrapin Point in Niagara Falls, New York, to provide additional information for final design of remedial works
- foundation investigation for NFTA Light Rail Rapid Transit, Buffalo, New York
- additional drilling and piezometer installation at Ironton Mine, follow-up to 1976 geotechnical investigation, Federal Energy Administration
- geotechnical investigation to assess the suitability of Weeks Island Salt Mine, Weeks Island, Louisiana, for storage of crude oil, Federal Energy Administration
- construction of retention pond dikes, Union Carbide Corporation, Ashtabula, Ohio
- final certification inspection of Ironton Mine, Federal Energy Administration, Ironton, Ohio
- foundation investigation, Bethlehem Steel Co., Lackawanna, New York.

Responsible for research and development of deep drilling methods and techniques currently in use and preparation of contract documents for the drilling of a 5,000-ft deep hole for PEPCO UPH/CAES project near Washington, D.C.

Responsible for geotechnical evaluation and assessment of the Wabana Iron Ore Mine in Newfoundland as a potential site for storage of crude oil, as part of DOE strategic petroleum reserve program.

Responsible for design of raising scheme for an existing tailings dam for Union Carbide Corporation in Hot Springs, Arkansas, including internal drainage system, embankment sections, stability analysis, quantity and cost estimates, plans and final design report.

Responsible for preparation of drilling contract for geotechnical investigation of Central Rock limestone mine in Lexington, Kentucky, as part of the Federal Energy Administration oil storage program.

1976 Geotechnical Engineer

Responsible for field supervision of

- foundation investigation for an earth-fill fly-ash retention dam, Union Carbide Corporation, Marietta, Ohio
- siting study for a pumping station in an open-pit vanadium mine, Union Carbide Corporation, Hot Springs, Arkansas
- geotechnical investigation to assess the suitability of a limestone mine in Ironton, Ohio, for storage of crude oil, Federal Energy Administration
- rock-scaling operations at Prospect Point, Niagara Falls, New York.

Responsible as Project Engineer for evaluation and assessment of the short-term stability and preliminary design of remedial works at Terrapin Point, Niagara Falls, New York.

Responsible for study on conversion and development of technical requirements for geotechnical confirmation of selected mined caverns for underground crude oil storage, Federal Energy Administration.

Responsible for preparation of conceptual estimates for Yards Creek underground pumped storage power development.

1975 Geologist

Responsible as Senior Geologist/Senior Drill Inspector for the technical quality of the drilling, inspection, geologic logging, and soils testing during foundation investigation for a hydroelectric development in Gull Island, Labrador.

Responsible for field supervision of

- foundation investigation, pile load test, and foundation construction, General Dyanmics, Charleston, South Carolina
- installation of caisson foundations, Rochester Gas and Electric Company, Rochester, New York
- construction of Cardinal fly-ash retention dam for American Electric Power Service Corporation in Brilliant, Ohio, including a 240-ft high earth- and rock-fill embankment, emergency spillway, grout curtain, pressure relief and underdrainage systems.

Responsible for preparation of geotechnical data for bidders for Amos fly-ash retention dam, Winfield, West Virginia.

DAVID E. HEPBURN

Education — Stafford College of Technology, U.K.
Institution of Electrical Engineers, Diploma, 1952
General Electric Company, Schenectady, New York
Power Systems Engineering, Diploma, 1962

Professional Associations — Ordre des Ingénieurs du Québec – Member
Association of Professional Engineers, Ontario – Member
Institute of Electrical and Electronics Engineers – Associate Member
Institution of Electrical Engineers, U.K. – Fellow

Languages — English, French

Experience

1965 –Acres

1978 Manager of Engineering

Responsible for administration of all technical departments in the Niagara Falls office.

1975 Divisional Chief Electrical Engineer

Technical review of electrical work and staffing levels for Company offices in Ontario and Quebec.

Quality assurance duties on balance of plant for Wolsung-1, a 600-MWe CANDU nuclear station in Korea.

Addition of four 185-MW hydroelectric generators and associated 500-kV substation, Tarbela, Pakistan.

Preparation of fully detailed purchase specification for computerized load dispatch system for 400-kV Iraq Supergrid.

Team member on power system studies in Tanzania, Iraq, Pakistan, and Indonesia.

1971 Head, Electrical Department

Design of manganese oxide recovery project for Union Carbide, including manipulation of ladle car carrying 75 tons of molten metal at 3,500 deg F.

Administration of department and supervision of projects including 300-MVA urban core substation and estimates on a ± 450-kV dc transmission scheme in North Dakota. Studies and cost estimates for underground pumped storage schemes, conventional hydro plants and various industrial projects.

Responsible for production of all electrical construction drawings, schematics and cable schedules for Churchill Falls hydro project.

Conceptual design for a 2,000-MW uranium enrichment plant for BRINCO.

1969 System Planning Engineer, Dacca, Bangladesh, General Consultancy to East Pakistan (Bangladesh) Water and Power Development Agency

Advisor on technical, financial and administrative matters relating to the planning and financial policy of the power system, and assistance in negotiations with international agencies for loans in excess of $25,000,000.

1966 Head, Electrical Department

Administration of the department and electrical engineering responsibility for hydroelectric generation, construction, utility transmission and distribution, thermal power generation, inorganic, chemical, petrochemical and food industry projects including

- a 25-MVA construction power system and technical specifications for 500-MVA, 15—240-kV, 3-phase power transformer and 240-kV cables and auxiliary equipment for 5,225-MW Churchill Falls power project
- an electrolytic plant for production of sodium chlorate, incorporating aluminum bus work rated at 25,000 A, 900 V dc
- long-range planning studies for electric power systems in eastern Canada, involving cost analyses of generation and transmission at 230 kV, 345 kV and 500 kV
- underground electric power supply systems, indoor substation and electric steam generator installations for industrial plants.

1965 Engineer

Responsible for electrical engineering designs, specifications, review of manufacturer's work, coordination of generating units, and auxiliary systems, Manicouagan 1 hydroelectric development, Quebec.

1959 —1965 Shawinigan Water and Power Company, Montreal, Quebec

1963 Supervising Engineer, Projects Division

Supervision of design engineering for 132-, 230- and 345-kV stations on Company system.

1962 Project Engineer, Systems Engineering Department

Coordination of the conversion of hydroelectric power stations to remote supervisory control and investigation of equipment failures.

1961 — 1962 Advanced Studies, Power Systems Engineering Course, General Electric Company, Schenectady, U.S.A.

1959 Engineer, System Planning Department, Analytical Division

Load flow studies, fault calculations and stability studies using computers and network analyses, including planning studies for 345-kV line Ile Maligne at Quebec City, and preparation of specifications for circuit breakers and transformers.

PHILIP MAXWELL HOOVER

Education — Bucknell University, Lewisburg, PA
BS Civil Engineering, 1974

Professional Associations — Engineer-In-Training Certificate, PA, 1974
American Society of Civil Engineers, Associate Member

Experience

1979 - Acres

Civil Engineer

Conducts hydroelectric power studies including feasibility analysis, alternatives evaluation, and licensing and regulatory applications

1978 - May 1979

Civil Engineer, FERC/Dept. of Energy, Washington, D.C.

Responsible for preparation of Water Resource Appraisal Reports for the hydroelectric development of river basins. Review the reports of other agencies pertaining to water resource development; participate in various joint water resources investigations with other governmental agencies, and served on President's Water Policy Implementation Task Force.

1974 - 1978

Civil Engineer, US Army Corps of Engineers, Baltimore District

Study manager for water resource development studies-hydropower, water quality, navigation, flood control. Study team member responsible for plan formulation and economics; responsible for interagency coordination and public involvement programs. Contract negotiation and management.

D. WILLIAM LAMB

Education — Imperial College of Science and Technology, University of London, London, England
B.Sc. (Honours) Civil Engineering, 1953

Professional Associations — Institution of Civil Engineers, U.K. – Member
International Society for Soil Mechanics and Foundation Engineering – Member
Council of Engineering Institutions, U.K. – Chartered Engineer

Experience

1969 – Acres

1977 Executive Engineer, Power and Heavy Civil Division

Responsible for pavement design for Tribhuvan Airport, Kathmandu, Nepal, pavement and airport lighting projects for Niagara Falls, New York Airport.

Proposal preparation; management and supervision of civil engineering projects including earth-fill dams; studies for reuse of dredged material disposal areas, transportation center, remedial works at Niagara Falls gorge, fly-ash utilization, and for feasibility of using fly ash in water-retaining structures. In-house civil engineering and foundations consultant.

Chief engineer for master plan study for new international airport, Jakarta, Indonesia, responsible for all civil engineering works, site investigations, aircraft pavements and lighting, site development, and drainage.

1973 Manager of Engineering

Administration and job assignments for the engineering and technical personnel of the company and quality control of engineering and drafting work.

1969 Senior Soil Mechanics and Foundation Engineer

Supervision of construction of a 200-ft high earth dam for fly-ash retention at Brilliant, Ohio.

Foundation and structural design for electrical substations, facilities and pollution control equipment at thermal power stations, a multistory rotating hotel in New York State, and various industrial installations and transmission line towers.

Planning, supervision and assessment of geotechnical investigations; preliminary designs involving excavation slopes, dewatering, piling, backfilling and groundwater control for marine facilities in South Korea, Newfoundland, Taiwan and Puerto Rico.

Design, contract documents and construction supervision for extensions/improvements to the taxiways and terminal apron evaluation using dynamic testing techniques of the main instrument runway, and installation of runway lighting at Niagara Falls International Airport, New York.

Site investigations and geotechnical design of compacted earth-fill conservation dams for an extension to a float glass plant and for a lakeshore site evaluation for a major industrial development involving land and marine works.

1955 – 1969 Scott, Wilson, Kirkpatrick and Partners, London, England

1968 Project Engineer, London, England

Engineering report on site development, including field investigations of deep soft deltaic and floodplain deposits, preliminary foundation design, flood control facilities, service systems, Asian Institute of Technology, Bangkok, Thailand.

Water supply scheme, including a 35-mile long pipeline, pumping station and reservoirs, Muscat, Arabian Gulf.

1963 Project Engineer, Hong Kong

Report on future raising of the main dam, Plover Cove Water Scheme, Hong Kong. Technical and economic feasibility studies of seaward extensions of the existing reclamation and runway and taxiway pavements, including site investigations, borrow area evaluations, preliminary seawall design in 40 ft of water exposed to typhoons, drainage systems; concrete and asphalt pavements, Hong Kong International Airport.

Participation of first Southeast Asian conference of Soil Mechanics and Foundation Engineering, Bangkok, Thailand, April 1967.

Directed a land reclamation and development project, including excavation of 7 million yd^3 of rock and soft material, dredging of 1 million yd^3 of seabed mud, construction of a large, pile reinforced concrete highway storm culvert, 2 miles of seawall and a typhoon shelter breakwater, and a 4-lane highway on reclaimed land in Hong-Kong.

Supervised engineering design and specifications for a casting basin of cellular cofferdams for immersed-tube tunnel elements; land and marine site investigations for tunnel approaches, Cross Harbour Tunnel, Hong Kong.

1960 Senior Assistant Engineer, Hong Kong

Evaluations of soil borrow areas; supervision of marine boring investigations; design and construction supervision of a large-scale "test mound" to study placement techniques and behavior characteristics of soil when deposited through water; design, manufacture and installation of piezometers and settlement gauges, Plover Cove Water Scheme, Hong Kong.

Supervision of the soil mechanics testing laboratory.

Technical Publications

Decomposed Granite as Fill Material with Particular Reference to Earth Dam Construction
Hong Kong Joint Group of the ICE, IEE, and IME Symposium on Hong Kong Soils, 1962

Ash Disposal in Dams, Mounds, Structural Fills and Retaining Walls
Third International Ash Utilization Symposium, Pittsburgh, Pa., U.S.A., 1973

JAMES K. LANDMAN

Education Michigan Technological University, Houghton, Michigan
B.S.E.E. 1975

Professional Associations Institute of Electrical and Electronics Engineers – Member

Experience

1979 –Acres

1979 **Electrical Engineer**

Design of power plant electrical systems. Conduct systems studies.

1978 –1979 **Senior Associate Electrical Engineer,** Gilbert/Commonwealth Associates Inc, Jackson, Michigan

Preparation of specification documents for large power transformers, 4.16- and 13.8-kV switchgear, isolated-phase and nonsegregated phase bus work, and design of such systems. Detail design of plant service switchgear systems (protective relay selection, equipment sizing, etc).

1975 –1978 **Electrical Engineer,** U.S. Department of the Interior, Bureau of Reclamation

Design and preparation of specifications for large power transformers, isolated-phase and nonsegregated phase bus work, switchgear, high-voltage oil-filled cable, generators and excitation systems, and plant auxiliary equipment. Administration of active contracts, liaison with field personnel and manufacturers' representatives, and factory inspection of equipment manufactured under active contracts.

Technical Publications

Calculation of Frostline Penetration in High-Voltage Cable Trench – Mt. Elbert Pumped Storage Powerplant.
U.S. Bureau of Reclamation, REC-ERC-77-7, Pub. 1979

JOHN D. LAWRENCE

Education

Imperial College of Science and Technology, University of London, London, England
B.Sc. Civil Engineering, 1956
D.I.C. Hydropower Engineering, 1963
University of Birmingham, Birmingham, England
M.Sc. Water Resources Technology, 1972

Professional Associations

Registered Professional Engineers, State of New York – No. 56074
Association of Professional Engineers, Ontario – Member
Institution of Civil Engineers, U.K. – Member
Institution of Water Engineers and Scientists, U.K. – Member
American Society of Civil Engineers – Member

Experience

1974 – Acres

1974 Executive Engineer, Power and Heavy Civil Engineering Division

Management of hydroelectric projects, including

- DOE-funded feasibility studies, 15-MW Lowell hydroelectric project and 3-MW Chicopee project, Massachusetts, for Raython Service Company
- study of power system requirements and potential for hydroelectric developments in State of Maine, for Dirigo Electric Cooperative, Inc.
- hydroelectric power generation study of potential for hydro installations at existing and undeveloped sites, for Massachusetts Municipal Wholesale Electric Company.

Responsible for administration, scheduling and technical direction of water resources and power-related projects including

- comprehensive siting and engineering studies and field exploration for a proposed 1,000-MW, 4,000-ft head underground pumped hydro facility for the DOE/EPRI/Potomac Electric Power Company, Maryland
- DOE-funded feasibility study, 7-MW North Hartland hydro project, preliminary permit applications for development of hydroelectric potential at 6 existing Corps of Engineers flood control dams in Vermont and New Hampshire, and hydroelectric and pumped storage plant siting and system studies for Vermont Electric Cooperative Inc.
- feasibility study for GPU Service Corporation of 2 pumped storage projects in northeastern United States, involving earth dams, hydraulic structures, steel- and concrete-lined tunnels, and 2 underground powerhouses (825 MW and 640 MW)
- Dickey-Lincoln School Lakes hydroelectric project power alternatives and energy conservation studies for U.S. Army Corps of Engineers, New England Division
- feasibility studies, design, licensing and construction supervision for a 230-ft high fly-ash retention dam and tunnel spillway structures for the John E. Amos plant, West Virginia, for American Electric Power.

1972 – 1974 Chief Design Engineer, Public Power Corporation, Athens, Greece

Responsible for civil, mechanical and electrical design, preliminary engineering, contract documents and detail design for the 300-MW Pournari hydroelectric project in western Greece. Work involved an earth-fill dam, hydraulic structures, steel- and concrete-lined tunnels and a surface powerhouse.

1971 – 1972 University of Birmingham, Birmingham, England

Postgraduate course in Water Resources Technology.

1967 – 1971 Project Egineer (Civil), Acres

Responsible for preliminary engineering, economic evaluations, contract documents, costing, scheduling and detail design for hydroelectric projects which included the 250-MW Lower Notch generating station, Ontario; 340-MW station at Alto Anchicaya, Colombia; and 1,800-MW station at Gull Island, Labrador. Work involved earth-fill and concrete-faced rock-fill dams, hydraulic structures, steel- and concrete-lined tunnels, and surface and underground powerhouses.

1961 – 1967 Binnie and Partners, London, England

1965 Senior Assistant Engineer

Responsible for preliminary engineering, economic evaluations, contract documents, costing, scheduling and detail design for hydroelectric and water supply projects including a 1,000-MW station at Mangla, West Pakistan, an 80-MW station at Bentong, Malaysia, and the Seletar water supply reservoir in Singapore. Work involved general soil mechanics, hydraulic structures, steel- and concrete-lined tunnels, surface and underground powerhouses.

1963 Resident Engineer

In charge of site supervision of preliminary contracts for construction of access roads and bridges, tunnels, underground powerhouse, and rock mechanics testing for the 150-MW Batang Padang hydroelectric station, Malaysia.

1961 Assistant Engineer

Design of hydraulic structures, steel- and concrete-lined tunnels and powerhouse, and site supervision of hydraulic model studies for the Mangla Dam project (1,000 MW), West Pakistan.

1960 – 1961 Imperial College, London, England

Postgraduate course in hydropower engineering.

1957 – 1960 Assistant Engineer, Binnie and Partners, London, England

Design and supervision of construction of hydraulic structures, pipelines and pumping stations for various water supply and sewage schemes, U.K.

Technical Publications

Small Hydro – Where Do We Go From Here?
Public Power Magazine, July/August 1977

Economic Exploration for Underground Energy Storage
Presented to the 18th Symposium on Rock Mechanics, Keystone, Colorado, June 1977. John D. Lawrence, Michael J. Hobson, and James D. Gill

KENNETH F. LITFIN

Education University of Hawaii, Honolulu, Hawaii
B.S. Civil Engineering, 1971
State University of New York, Buffalo, New York
Currently enrolled in the MBA program (Master of Business Administration)

Experience

1971 –Acres

1977 **Civil Engineer,** Acres American Incorporated

Engineering design responsibilities during the period included

- preliminary investigation, design, costing, and scheduling for potential sites for underground oil storage facilities for the U.S. Federal Energy Administration

- development of cost estimation methodology for once-through cooling water discharge modifications at existing power plants for the U.S. Environmental Protection Agency

- preliminary investigation of the flooding problems and proposed flood control measures along Cayuga Creek, Erie County, New York for the Buffalo District, U.S. Army, Corps of Engineers

- hydroelectric redevelopment study of the Oswego River basin to assess the potential for increasing the power generating capacity by flow modification and/or plant renovation for Niagara Mohawk power Corporation

- design of the sanitary sewerage system and potable water supply for a new fabrication complex planned and built for General Dynamics at Charleston, South Carolina

- design of overflow and energy dissipator structures for the second phase of the Amos Fly Ash Retention Dam at Winfield, West Virginia for the American Electric Power Service Corporation.

Construction management responsibilities included

- Resident Engineer during construction of the Aeration Test Basin Research Facility in Chickasaw, Alabama, for Environmental Systems. Linde Division of Union Carbide Corporation

- Field Engineer responsible for construction management and quality control for the installation of four electrostatic precipitators, wastewater treatment system, and bottom-ash and fly-ash handling facilities for Niagara Mohawk Corporation at the steam station in Dunkirk, N.Y.

- Resident Engineer during the civil phase of construction for expansion of the oxygen production facility at Suffield, Connecticut, for the Linde Division of Union Carbide Corporation

- Field Engineer for Phase I construction of Amos Fly Ash Retention Dam at Winfield, West Virginia, for the American Electric Power Service Corporation

- Field Engineer involved in the site and geotechnical investigations for increasing the height of the earth-filled Cardinal Fly Ash Retention Dam at Brilliant, Ohio for the Ohio Power Company and development of the fly-ash storage lagoons at Marietta, Ohio, for the Union Carbide Corporation.

1970 –1971 **Engineering Trainee (Part Time)**, Quality Pacific Construction Ltd. (General Contractor) Honolulu, Hawaii

Involved in plan takeoff, bid preparation, equipment and materials inventories, and other related office work associated with the general contracting business.

1969 –**Engineering Trainee (Part Time)**, Nordic Construction Company, Honolulu, Hawaii

Assisted with wide variety of field assignments including surveying, layout and timekeeping.

DONALD H. MacDONALD

Education

University of Toronto, Toronto, Ontario
B.A.Sc. Civil Engineering, 1945
Cornell University, Ithaca, New York
M.R.P. Regional Planning, 1947
Imperial College of Science and Technology
D.I.C. Civil Engineering, 1955
University of London, London, England
Ph.D. Soil Mechanics and Foundation Engineering, 1955

Professional Associations

Association of Professional Engineers, Ontario — Member
Engineering Institute of Canada — Fellow
American Society of Civil Engineers — Fellow
Institution of Civil Engineers, U.K. — Fellow
Geological Society of America — Member
American Concrete Institute — Member
American Railway Engineering Association — Member

Experience

1955 —Acres

1976 Director, Acres 1975 Limited
1971 Director, Vice-President and Senior Consultant, Acres Consulting Services
1964 — 1971 Director, Acres Limited
1964 — 1969 Director and President, H. G. Acres & Company Limited
1962 — 1964 Director and Vice-President
1955 — 1962 Head, Geotechnical Department

In his association with Acres, Dr. MacDonald has been involved in the following projects in technical, administrative or policymaking capacities.

Canada — Churchill Falls power project; Gull Island power project; Mica project; Kettle Rapids generating station; Long Spruce generating station; Limestone generating station; Lower Notch generating station; Arnprior generating station; Mactaquac development; Manicouagan 2 development; Grand Rapids generating station; Bersimis No. 2 project; Lake Ste. Anne Dam: Chute-des-Passes project; Beauharnois No. 3 project; McCormick Dam projects, No. 2 and No. 3; Kelsey generating station; Laurie River No. 2 generating station; Strathcona development; Ladore Falls development; Ash River development; Portage diversion structure; Churchill River diversion; Red River floodway, Inlet and Outlet Works; Westerly Water Purification plant, Toronto; Thorold tunnel; Townline and Road/Rail tunnel, Welland, Ontario; Conestogo Dam; Finch Dam; Saint John thermal station; Atikokan thermal generating station; Mackenzie Valley pipeline studies; Arctic Ocean offshore drilling studies; Downie slide investigations

U.S.A. — Amos Dam, Cardinal Dam

Pakistan — Warsak project; Shadiwal

Colombia — Alto Anchicaya development

Ghana — Kpong hydroelectric project.

Technical involvement in these and other projects has been largely in the heavy civil engineering and geotechnical fields, and it has included all phases such as explorations, studies, laboratory investigations, preliminary and final designs, and field supervision. Particular fields of technical involvement have been with excavations, foundations, cofferdams, dams and dikes (earth fill, rock fill and concrete), tunnels, shafts and underground openings, channels, unwatering and seepage problems, groundwater studies, and river regulation works.

Numerous other projects have involved contract and project management, staffing, claims settlement and arbitrations.

1951 —1955 Postgraduate Student, Imperial College of Science and Technology, University of London, London, England

Research in the fields of soil mechanics and foundation engineering, with particular reference to the settlements of structures on soil.

1947 —1951 Engineer, Toronto Transportation Commission, Toronto, Ontario

Foundation investigations, structural designs, and material testing for the Yonge Street subway.

Committees

National Research Council of Canada
Member, Associate Committee on Geotechnical Research, 1970 — 1976.

International Society for Soil Mechanics and Foundation Engineering
Vice-President (North America), 1969 — 1973
Chairman, Conference Procedures Committee, 1969 — 1971

UNESCO
Member, Working Group on Seismic Phenomena Associated with Large Reservoirs (Representing ISSMFE), 1970 — 1975

Science Council of Canada
Member, Earth Science Committee, 1968 — 1970

International Commission on Large Dams
Canadian National Committee
Member, Executi e Committee, 1968 — 1976

Consulting Engineers of Ontario
Member, Board of Directors, 1976 — date
President, 1978/79

Technical Publications

Dr. MacDonald is the author of a number of technical papers on dam and cofferdam construction, building settlements, and other technical subjects.

RICHARD E. MAYER

Education — Colorado State University, Fort Collins, Colorado
B.Sc. Agricultural Engineering, 1967

Professional Associations — Registered Professional Engineer, State of New York — License 054502

Experience

1973 —Acres

1978 Project Engineer

Responsibilities and assignments included

- supervision of a flood insurance study for Department of Housing and Urban Development
- supervisio. of physical hydraulic model studies of an intake tunnel and condensers, steam suppression pool and cooling water intake structure
- feasibility study to assess the potential for underground oil storage
- study and assessment of state of the art for analytical thermal hydraulic modeling
- design of a potable water system for a manufacturing plant
- hydraulic design of waste water settling ponds
- coordination of study to assess the potential for increasing hydroelectric power generating capacity through river basin flow modification and/or plant renovation
- supervision of analytical thermal hydraulic model study of heated water discharge from a thermal electric generating plant
- preparation of cost estimating methodology for once-through cooling water discharge variations for the United States Environmental Protection Agency (USEPA)
- supervision of studies and testing for physical thermal hydraulic models.

1973 Hydraulic Engineer

Assisted project engineering in conducting various hydrolcgical and hydraulic studies, including supervision of studies and testing procedures for physical thermal hydraulic modeling.

1971 —1973 Assistant to Planning and Hydraulic Engineer, Watershed Planning Staff, United States Department of Agriculture, Soil Conservation Service, Indianapolis, Indiana

Responsible for modifying the engineering portion of existing planning documents to reflect current environmental policies and engineering standards.

Related duties included the design of earth channels and the hydrologic studies of small watershed projects in Indiana.

1970 –1971 Construction Inspector, Small Earth Dams, United States Department of Agriculture, Soil Conservation Service, Canon City, Colorado

Responsible for control of the compaction of earth fill, proper installation of concrete structures and survey work related to the layout of the spillway and the earth fill.

1969 –1970 Commissioned Officer, United States Army, Corps of Engineers

Responsible for planning future developments on an army supply depot.

J. TREVOR MINSTRELL

Education The College, Worcester, England
H.N.C. Certificate
Mechanical Engineering, 1962

Experience

1976 –Acres

1976 Engineering Specialist, Engineering Department

Responsible for review of engineering cost estimates for civil work for Cordoba 600 MWe CANDU nuclear power generating station for Comision Nacional de Energia Atomica, Argentina.

Responsible for preparation of schedules, estimates and the control of progress and costs on power generation plants, water resources and other large projects.

1967 –1976 Bechtel Corporation, San Francisco, California

1972 Cost Engineering Specialist, San Francisco

Responsible for the design and application of project control systems for major mining, hydro and nuclear power projects.

1970 Cost Engineering Supervisor, Melbourne, Australia

Supervision of estimating and cost control functions at the project office for Bougainville Copper Project.

1967 Senior Cost Engineer, Montreal, Canada

Preparation of budgets and estimates for the mechanical and electrical portion of the Churchill Falls hydro project. Cost control studies for the construction, operation and maintenance of support facilities.

1965 –1967 Divisional Coordinator, Du Pont of Canada Ltd., Kingston, Ontario

Responsible for coordination of field construction of nylon textile plant, including quality control and design liaison. Preparation of project planning, weekly and daily manpower schedules. Accountable for field labor costs.

1964 –Design Draftsman, Algoma Steel Corporation, Sault Ste. Marie, Ontario

Preparation of plant layout drawings for cold mill facility. Design of pneumatic, hydraulic, plumbing and other support services. Checking of vendor and subcontract design drawings.

1962 –1963 Designer, Head Wrightson & Company, Thornaby-on-Tees, England

Design of plant for steel and other process industries, such as steel foundry, sand cleaning, organic garbage conversion, heat exchangers for energy conservation.

1958 –1962 Designer, Heenan and Froude Ltd., Worcester

Design of aircraft engine test plants.

1956 –1958 Design Draftsman, Vickers Armstrongs (Aircraft) Ltd., Swindon

Design of components for aircraft fuel systems.

1956 –Test Assistant, English Electric Company, Rugby

Efficiency and cavitation testing of homologous models of hydraulic turbines.

1947 –1956 Royal Navy, England

1951 Engine Room Artificer

Operation and maintenance of main and auxiliary marine machinery. Equipment included steam to 400 psi, 700°F 35,000-hp turbines and diesel electric to 850 kw.

1947 Artificer Apprentice

Training in workshop and classroom for qualification as engine room artificer.

THOM L. NEFF

FOUR PILGRIM ROAD

MARSHFIELD, MASSACHUSETTS 02050

PERSONAL

Height:	6'1"	Born:	October 4, 1938
Weight:	170 lbs.	Birthplace:	Akron, Ohio
Health:	Excellent	Marital Status:	Married
		Phone:	617-837-1515

EDUCATION

UNIVERSITY of ILLINOIS, Urbana

PhD in Civil Engineering with major in soil mechanics, rock mechanics and geology. — January, 1972

NORTHEASTERN UNIVERSITY, Boston, Mass.

Master of Science (major:structures) in Civil Engineering
Teaching Assistant in Graphics — June, 1964

UNIVERSITY of AKRON, Akron, Ohio

Bachelor of Science in Civil Engineering
Sigma Tau Honorary Fraternity — June, 1962

PROFESSIONAL STATUS and AFFILIATIONS

Professional Engineer registered in Ohio, Florida, Massachusetts

Boston Society of Civil Engineers Section, ASCE

American Society of Civil Engineers

Publications Committee, Geotechnical Division of ASCE

Association of Geoscientists for International Development

American Society for Engineering Education

EXPERIENCE

Private Consultant - Work within a group of M. I. T. faculty and staff that engages in a wide variety of projects in the U.S. and South America with primary focus on the safety of geotechnical aspects of constructed facilities, especially dams and industrial waste/product storage.

1975-Present 4/6/79

Director of Field Research, Geotechnical Division Department of Civil Engineering, Massachusetts Institute of Technology - Technical and administrative duties ~~involving sponsored~~ research at M. I. T. Primary emphasis concerned predicting and evaluating performance of real structures, i.e., dams, embankments and foundations.

1973-1975

Project Engineer, E. D'Appolonia Consulting Engineers, Inc. - Analysis, design, research and construction aspects of a wide variety of civil engineering projects including dams, building foundations and tunnels.

1972-1973

Assistant Professor of Civil Engineering - Northeastern University, Boston - Teaching courses in Soil Mechanics, Rock Mechanics, Engineering Geology, also private consulting.

1970-1972

Senior Field Geotechnical Engineer - H. G. Acres, ~~Ltd.~~, Canada - Design and construction work at the Churchill Falls Hydro-electric Power Project (Laborador), including underground powerhouse, surface dams and dikes, and access and support facilities.

1968-1970

Research Assistant, Department of Civil Engineering, University of Illinois, Urbana - General geotechnical research, focusing on rock testing development, and miscellaneous consulting assignments.

1966-1968

Research Engineer, U.S. Army Corps of Engineers, Omaha - Research, design and construction aspects of various Corps projects, such as dams, tunnels and underground facilities (soil and rock mechanics emphasis).

1964-1966

Structural Designer, Sepp Firnkas Engineering Company, Boston - Design of building in steel, concrete, prestressed concrete and wood. Also, foundation design.

1962-1964

PUBLICATIONS

Author or co-author of ten papers in civil and geotechnical engineering. Currently writing textbook under contract with Marcel-Dekker NYC, with title, "An Introduction to Geotechnical Engineering for Non-Geotechnical Engineers."
(see list of specific publications)

PUBLICATIONS

1. Neff, T. L., "Equipment for Measuring Pore Pressure in Rock Specimens Under Triaxial Load," A. S. T. M. Special Technical Publication 402, pp. 3-18, 1966.

2. Neff, T. L., "An Evaluation of Several Types of Rock Extensometers," Sixth Symposium on Rock Mechanics, Montreal, 1970.

3. Neff, T. L., et al., "An Approach to Underground Construction," 15th Annual Meeting of the Association of Engineering Geologist, Kansas City, October, 1972.

4. Neff, T. L., "Qualitative Factors for Evaluating the Stability of Underground Openings," 14th Symposium on Rock Mechanics, Pennsylvania State University, June, 1972.

5. Neff, T. L., "Rock Mechanics Observations Concerning the Behavior of the Churchill Falls Underground Powerhouse, Labrador," Ph. D. Thesis, University of Illinois, 1972.

6. Neff, T. L., "Geotechnical Monitoring at Churchill Falls, Labrador," A. S. T. M. Symposium on Performance Criteria and Monitoring for Geotechnical Construction, Washington, D. C., June, 1974.

7. Neff, T. L., "The Use of Synergy in the Establishment of Priorities for the Development Process," 13th Convention of the Pan American Union of Engineering Associations, Toronto, October, 1974.

8. Troconis, C. M., Lambe, T. W., Wolfskill, L. A., and Neff, T. L., "A Geotechnical Surveillance Program for an Oil Storage Reservoir," 5th Panamerican Conference on Soil Mechanics and Foundation Engineering, Buenos Aires, November, 1975.

9. Lacasse, S. M., Lambe, T. W., Marr, W. A., and Neff, T. L., "Void Ratio of Dredged Material," Presented at ASCE Specialty Conference on Geotechnical Practice for Disposal of Soil Waste Materials, "Ann Arbor, Michigan, June, 1977.

10. Neff, T. L., "Geotechnical Engineering Aspects of Mineral Exploration in Tropical Rain Forests, "5th Venezuelan Geological Conference, Caracas, November, 1977.

PARIMAL C. PAL

Education — Calcutta University, Calcutta, India
B.E. (Civil), 1959
University of Michigan, Ann Arbor, Michigan, U.S.A.
M.Sc. (Civil Engineering), 1964

Professional Associations — Order des Ingénieurs du Québec – Member

Languages — English, Hindi, Bengali

Experience

1978 –Acres

1978 Project Engineer

Participation in EPRI/ERDA research development project for Potomac Electric Power Company involving a 1,000-MW·h underground pumped hydro scheme. Responsible for coordination, design and optimization of all civil and structural related works including upper and lower reservoirs, shafts and penstocks etc.

1974 –1978 Senior Structural Engineer, Asselin, Benoit, Boucher, Ducharme, Lapointe Inc. (Tecsult International Limited) Montreal, Quebec.

Responsibilities included

- structural design of steel surge tank and central concrete pier of spillway, Outardes 2 project, Quebec
- supervision of civil structural design of grain and cold-storage facilities at Port Santos, Rio de Janiero, Brazil
- design of concrete spillway, service bridge and diversion tunnel concrete structure, LG-2 hydroelectric project, Quebec
- supervision of design for low-head powerhouse, including structural steel, LG-1 project, James Bay, Quebec

1969 –1973 Senior Engineer and Group Leader, U.S.S. Consultants of Canada Ltd., Montreal, Quebec

Responsible for design of crusher building structural steel, concrete crushed ore storage, conveyor galleries, steam plant and concentrate handling facility, including concrete load-out silo and steel A-frame structure for support of stockpiling conveyor, Mt. Wright project, Quebec Cartier Minings.

1965 –1969 Senior Engineer, C. D. Howe Company Ltd., Montreal, Quebec

Structural design for various projects including

- grain handling and storage facility, Louis Dreyfus Corporation, at Port Cartier, Quebec

- concrete crib dock, including superstructure, shipping gallery and transfer tower for new ore loading dock at Seven Islands, Iron Ore Company

- structural steel and foundation for dry grinding mill building for pelletizing plant, Wabush Mine

- analysis of structural steel for Taiwan research reactor building, including cost estimates and specifications.

1965 – Design Engineer, H. J. Kaiser Company Canada Ltd., Montreal, Quebec

Design and analysis of structural steel and foundation for heavy industrial structure, conveyor gallery, and concrete tower for cement plant.

1964 –1965 Structural Designer, Foster Wheeler Corporation, Livingston, New Jersey

Structural design and analysis of open steel frameworks for large steam generators.

1961 –1963 Instructor, School of Engineering, Tuskegee Institute, Tuskegee, Alabama

Teaching of theory of structure, strength of material, and engineering drawing.

1959 –1961 Assistant Engineer, Housing Directorate, Government of West Bengal, India

Analysis and design of reinforced concrete structures and supervision of construction.

PETER G. PHILLIPS

Education — Faraday House, London, U.K.
Diploma (First Class), 1954

Professional Associations — Association of Professional Engineers, Manitoba – Member
Institution of Electrical Engineers, U.K. – Member
Chartered Engineer, U.K.

Experience

1977 –Acres

1977 Senior Staff Engineer

Responsible for electrical design of 1,000-MW Limestone hydroelectric project, Manitoba Hydro.

1967 –1977 Montreal Engineering Company Ltd.

1973 Senior Supervising Engineer

Assigned to Empresa Nacional de Electricidad, S.A., in Bolivia, for engineering the expansion of 2 high-head hydro generating stations and associated 138-kV switchyards.

Responsible for technical direction of the electrical design of substations above 400 kV, including application and specification of control and protective relaying equipment for plant up to 500 kV.

1972 Supervising Engineer

Consultant to Jamaica Public Service Co. Ltd. as advisor to the superintendent of the systems engineering group, installing 138-kV substation equipment.

1969 Resident Engineer

Resident Engineer at the Dorsey Terminal of the Nelson River high-voltage dc transmission project. Responsible for contract control and supervision of installations for inversion of ± 450-kV dc to 230 kV ac.

1967 Senior Designer

Design of the electrical control and protective equipment for the conventional aspects of Gentilly 250-MW boiling light-water prototype reactor power station and associated 230-kV substation for Hydro-Quebec.

Involved in the commissioning of relay and control equipment for the initial installation at Bay d'Espoir generating station in Newfoundland, consisting of three 85-MVA generators and a 240-kV switching station.

1960 –1967 **Assistant Engineer**, Central Electricity Generating Board, U.K.

Design specification and application of protective relay and control systems for HV and EHV systems up to 275 kV.

Commissioning, maintenance, troubleshooting of protective relaying, metering, line signaling equipment, control and alarm schemes, as well as major equipment for transmission substations up to 275-kV, and steam generators up to 120 MW.

1954 –1960

Postgraduate training (2 yr), national service (2 yr), and 15 months with a switchgear manufacturer.

PETER RODRIGUE

Education **University of Manitoba, Winnipeg, Manitoba**
B. Sc. Mechanical Engineering, 1971

Professional Associations **Association of Professional Engineers, Manitoba – Member**

Experience

1976 – Acres

1971 – 1976 Crippen Acres Engineering

1978 **Senior Mechanical Engineer,** Acres American Incorporated

Preliminary mechanical design for redevelopment of the Mechanicville Hydroelectric facility for Niagara Mohawk Power Corporation.

1974 **Mechanical Coordinator,** Acres/Crippen Acres Engineering

Coordinator of preliminary mechanical engineering and initial phases of detail engineering for the 1100 MW Limestone Generating Station, Manitoba Hydro. Work included turbine selection and specification, gate selection, preparation of design criteria and arrangement for mechanical equipment and systems.

Coordination of a study to evaluate the cost of installing a 650-kW hydroelectric generating unit at the existing Little Falls station in Minnesota.

Preliminary mechanical design, for tender purposes, of gates and associated hoist and crane equipment, for Wreck Cove Power Project, Nova Scotia, Canron Ltd.

Coordination of mechanical design for two control structures associated with the diversion of the Churchill River into the Nelson River. Work included design approval and contract administration for spillway gate equipment and a 300-kW hydraulic turbine house unit; design of associated mechanical services; preparation of commissioning procedures and instruction manuals; and assistance in site testing of the spillway gate equipment and the house unit.

1971 **Mechanical Engineer,** Crippen Acres Engineering

Participation in mechanical design, including preliminary studies, for design of gate equipment, turbines, governors and compressed air systems; preparation of design criteria, conceptual design, preparation of specifications, tender analysis and design checking for major equipment related to power generation; and capital cost estimating for the 1000 MW Long Spruce generating station, Manitoba Hydro.

Analysis of turbine performance, capital cost estimating and miscellaneous mechanical studies at the completion of the Kettle generating station project, Manitoba Hydro.

EDWARD N. SHADEED

Education — McGill University, Montreal, Quebec
B. Eng. Electrical Engineering, 1950

Professional Associations — Association of Professional Engineers, Ontario – Member
Engineering Institute of Canada – Member
Institute of Electrical and Electronics Engineers – Senior Member

Experience

1967 – Acres

1974 **Executive Engineer**, Acres Consulting Services

Supervising the engineering of the Iraq National Despatch Centre. Supervision and design of automating a hydro plant for Peterborough Utilities Commission. Consultant on Warsak Hydro Development and Larona project in Indonesia.

1973 **Engineering Specialist**

Feasibility and electrical preliminary engineering proposals for underground pumped storage plants. Electrical engineering estimate for 1,620-Mw Salto Grande Development, Uruguay, Argentina. Consultant for various projects, including Long Spruce, Manitoba, Sirikit, Thailand and Arnprior hydroelectric generating station, Ontario. Feasibility study for increasing Nam Ngum project capacity in Laos.

Management and direction of engineering for Rochester Gas and Electric Substation 23, an urban type enclosed substation.

1971 **Commissioning Coordinator** at the Lower Notch generating station

1970 **Senior Project Engineer**

Various feasibility studies and proposals for international projects.

1969 **Project Engineer**, H. G. Acres Limited

Direction and supervision of a project group on modifications of Ontario Hydro generating stations controls to provide automatic and remote operation.

1968 Coordination of preliminary engineering including electrical equipment layout for the underground 340-Mw Alto Anchicaya hydroelectric project, Colombia.

1967 **Senior Electrical Engineer**

Coordinator for electrical engineering aspects, including design, equipment specifications, assessment of tenders, review of manufacturer's drawings for the 228-Mw Lower Notch hydroelectric generating station, Ontario.

1967 – **Chief Electrical Engineer**, Brown and Root Limited, Montreal, Quebec

Responsible for electrical engineering aspects of petrochemical projects, including recommendations on field construction.

1966 – **Senior Engineer**, Geo. Demers, Consulting Engineer, Montreal, Quebec

Electrical engineering responsibility for the 600-Mw Outardes 4 hydroelectric development, Quebec.

1964 – 1966 **Manager**, Electrical Construction, Construction Division, Inspiration Limited, Montreal, Quebec

Management of the department, including budgets; cost estimates, proposals, schedules and construction plants; negotiation of contracts with suppliers, subcontractors, labor unions and bid/performance bonders; staff supervision and allocation; coordination and liaison.

1951 – 1963 The Shawinigan Engineering Company Limited, Montreal, Quebec

1963 **Liaison Engineer**

Liaison between the engineering office, the construction group and the client for twenty substation projects.

1959 **Design Engineer**

Resident electrical engineer for construction of a thermal electric generating station (two 150-Mw units, oil fired), Tracy, Quebec, including preparation of electrical engineering designs.

Design of the electrical control, metering and relaying systems for 120-Mw Twin Falls hydroelectric development, Labrador, Newfoundland.

Feasibility studies, cost estimates and schedules for electric power and industrial projects.

1958 **Resident Electrical Engineer**, Buckingham, Quebec

Liaison between site and engineering office; supervision, scheduling and inspection of the work of major equipment suppliers; commissioning and initial commercial operation of the 30-Mw Dufferin Falls hydroelectric development, Quebec.

1951 **Electrical Engineer**, Montreal, Quebec

Design of the electrical control, metering and relaying systems for the 75-Mw Beechwood development and switching station; Grand Lake and Moncton terminal stations, New Brunswick; various substations including La Tuque and Trenche Developments, Quebec.

Design, testing and commissioning of the autosynchronizing system for six existing units at the La Tuque Development, Quebec.

1950 – 1951 **Chief Electrical Inspector**, Montreal Locomotive Works Limited, Montreal, Quebec

Quality control and initial operation testing of diesel-electric locomotives.

ROBERT O. SHIELDS — Acres American Incorporated

Senior Engineer

Discipline/Year of Graduation — Water Resources/1977 M.S.C.E.
Economics/1975 B.S.

Relevant Area of Expertise:

Performance of hydrological studies; development of rainfall runoff models, hydrological data collection and evaluation, supervision of operating control of major storage facilities, construction supervision of hydraulic structures

Previous Project Responsibilities:

Hydrologist:

Supervision of hydrological data collection and evaluation; control of flow releases for major storage facility for electrical utility; supervision of routine and emergency maintenance for dams and levees; design of hydraulic structures and performance of studies on utility-owned storage reservoirs and watersheds.

Construction Engineer:

Project engineer for construction of underground cable installations, reinforced concrete structures, tunnel crossings and earth retaining structures, field engineer for numerous gas pipeline installations.

ACRES

JAMES P. SINCLAIR

Education	University of Toronto, Ontario B.A.Sc. Mechanical Engineering, 1951
Professional Associations	Association of Professional Engineers, Manitoba, Ontario, British Columbia – Member American Society of Mechanical Engineers – Member International Electrotechnical Commission, Technical Committee No. 4, Hydraulic Turbines – Member New York State Society of Professional Engineers – Member

Experience

1976 – Acres

1977 Executive Engineer, Acres American Incorporated

Coordination of all aspects of design of powerhouse, intake and tailrace, including mechanical and electrical systems, for 10-MW Granby hydroelectric redevelopment on the Oswego River, New York.

Direction and coordination of all mechanical engineering aspects of study to determine technical, environmental and economic feasibility of an underground pumped hydro scheme in Montgomery County, Maryland.

1969 – 1976 Head, Mechanical Department, Crippen Acres Engineering

Managed and directed the operations of the Mechanical Department for various projects undertaken by the Company.

Responsible for mechanical engineering designs involving feasibility studies, plant layout, equipment selection, specifications, drawings, contract administration (engineering phase), site commissioning documents, equipment and mechanical services estimates and schedules for

- hydroelectric projects in Manitoba including Kettle (1,224 MW), Long Spruce (1,000 MW) and Limestone (1,070 MW) generating stations. Responsible for design of turbines, governors, cranes, intake gates, spillway gates, elevators, sewage treatment system, compressed air, water and oil service systems, heating and ventilating systems and other mechanical services and systems

- river control structures in Manitoba for the Churchill River diversion project. Responsible for spillway gates, hydraulic turbine-generator house unit and all mechanical service systems

- merchant section and bar steel rolling mill in Manitoba. Responsible for mechanical service systems

- extension of boiler house and modifications to central steam heating system for Brandon University. Responsible for installation of new oil-fired boiler and control systems

- domestic water, fire protection water and sewerage systems for various construction camps accommodating 300 to 2,600 personnel.

1961 – 1969 CBA Engineering Limited, Consulting Engineers, Vancouver, British Columbia

1968 Resident Engineer

Directed the operations of resident staff of field engineers, inspectors and office staff during the final phase of construction of the Hugh Keenleyside (Arrow) Dam and navigation lock on the Columbia River in British Columbia. Responsible for engineering inspection, cost control, contract administration and site testing of concrete structures, earth dam, and mechanical and electrical equipment and services.

1967 Site Mechanical Engineer

Responsible for activities of mechanical Field Inspection Department during the installation of control gates, cranes, elevators and mechanical service systems for the control structures and navigation lock at the Hugh Keenleyside (Arrow) project.

1961 Chief Mechanical Engineer

Managed and supervised the activities of the Mechanical Department. Responsible for mechanical engineering designs, feasibility studies, equipment selection, specifications, drawings, contract administration, estimates and schedules for

- river control structure and navigation lock at the Hugh Keenleyside (Arrow) project involving low-level port gates, spillway gates, cranes, elevators and mechanical service systems

- mill water supply for Kraft and pulp mill complex associated with Hugh Keenleyside (Arrow) Dam and designed for capacity of 72 million U.S. gal/day

- log handling facilities for construction of Hugh Keenleyside (Arrow) Damconsisting of two 70-ton overhead cranes and runways

- renewal of crane runway and new mechanical and electrical services for a graving dock at Esquimalt, British Columbia.

1956 – 1961 British Columbia Hydro and Power Authority, Victoria, British Columbia

Served in capacity of project engineer for a major gas turbine generating station on Vancouver Island involving installation of four 25,000-hp turbines and generators with associated fuel storage and treatment facilities and mechanical and electrical service systems. Responsible for the administration of contracts, scheduling, estimating, coordinating, purchasing and reporting of all phases of the project. Also acted as project engineer on construction of other small hydro and diesel electric generating stations.

Supervised the activities of the hydraulic power section of the Mechanical Department. Responsible for review of mechanical equipment and services for a number of projects being undertaken by the Authority.

1951 – 1956 Ontario Hydro-Electric Power Commission

1952 Mechanical Design Engineer

Responsible for layout, design, specifications, drawings, and contracts for major mechanical equipment, including turbines, intake gates, spillway gates, cranes, elevators, large valves and similar equipment for the following projects undertaken by the Commission

- Sir Adam Beck No. 2
- Robert Saunders (St. Lawrence)
- Pine Portage (extension)
- Manitou Falls
- Whitedog Falls
- Caribou Falls.

1951 – Junior Engineer, Mechanical Maintenance, North Bay, Ontario

Worked in maintenance engineering on hydroelectric generating stations in northeastern Ontario, involving overhaul and repair of hydraulic turbines, gates and related equipment. Acted as mechanical inspector on field installation of turbines and generators during construction of Otto Holden (LaCave) generating station.

Technical Publications

Trend to Zero Cavitation in Hydraulic Turbine Operation
Canadian Electrical Association, March 1976, Water Power, January 1978, coauthor W. Pawlikewich, P.E.

Kettle Generating Station, Mechanical Equipment
Canadian Electrical Association, March 1970, coauthor E. L. Flook, P.E.

Design and Operating Features of the Navigation Lock at Arrow Dam
Canadian Electrical Association, 1968

River Closure at Arrow Dam
Canadian Electrical Association, 1968, coauthor L. S. McLure

Requirements of Vertical Hydraulic Turbine and Generator Alignment for Equipment Specification
Canadian Electrical Association, 1966

D. C. Power Commissions, Georgia Generating Station
Engineering Institute of Canada, September 1958

STEWART N. THOMPSON

Education — Franklin & Marshall College, Lancaster, Pennsylvania
B.S. Geology, 1968
University of Maine, Orono, Maine
M.S. Geological Sciences, 1973

Professional Associations — Geological Society of America – Member
Association of Engineering Geologists – Member

Languages — English, German

Experience

1977 –Acres

1978 Senior Geologist

Responsible as Project Engineer for

- Department of Energy Strategic Oil Storage Project, Weeks Island Mine – Geotechnical Investigations, Louisiana
- feasibility of hydrofracture and injection, West Valley, New York
- site selection and exploration for the DOE/EPRI Energy Storage Study, for Potomac Electric Company
- radioactive waste repository siting study, Southern Piedmont for Savannah River Laboratories.

Participation in geologic studies and inspection of hydro facilities at Little Falls, New York, Trenton Falls, New York, and Tygart Lake, West Virginia.

1973 –1977 **Lead Geotechnical Engineer,** Stone & Webster Engineering Corporation, Boston, Massachusetts

Responsible for all aspects of geotechnical studies and licensing for the Greene County nuclear plant, Power Authority of the State of New York, (PASNY) and for several fossil-fueled plants.

For the PASNY fossil and nuclear MTA applications, involvement in

- supervision and coordination of geotechnical aspects of 6 Public Service Commission (PSC) license applicants for State of New York, including 4 fossil-fueled and 2 nuclear sites
- supervision of geotechnical field operations for above sites, including geologic mapping, surveys, and test borings
- coordination of specifications.

Supervision and coordination of written preparation and field activities for the Preliminary Safety Analysis Report for Greene County nuclear power project.

Assistance in interpretation of geologic problems for potential power plant sites, Niagara Mohawk Power Corporation.

1971 –1973 Graduate Student and Teaching Assistant, Department of Geologic Sciences, University of Maine, Orono, Maine

1972 (Summer) Thesis research along Maine coast to determine rates of sea-level rise during last 3,000 years.

1968 –1971 United States Army

Served 2-1/2 years in Germany with U.S. Army Intelligence.

1967 –(Summer), Conducted surficial geologic mapping along the Yellowstone River, Montana, on a National Science Foundation undergraduate research grant, Franklin & Marshall College.

Technical Publications

Faulting and Seismicity in the Anna, Ohio, Region
Abst., Geol. Soc. of Am., 1976 Annual Meeting

J. GRAY S. THOMSON

Education — University of Glasgow, Scotland
B.Sc. Civil Engineering, 1950

Professional Associations — Ordre des Ingénieurs du Québec – Member
Association of Professional Engineers, Ontario – Member
Association of Professional Engineers, Newfoundland – Licensed
Institution of Civil Engineers, U.K. – Fellow

Experience

1953 –Acres

1978 **Vice-President**, Acres International Limited and **Assistant Project Director**, Karun II and III Development Projects, Iran

Elected Ontario representative on CANCOLD Executive Committee (1977). Canadian representative on ICOLD Committee for Bibliography and Documentation (1978).

1973 **Vice-President and Regional Manager**, Niagara Falls and Toronto, Acres Consulting Services Limited

1972 **Vice-President and Manager** (Montreal)

Member, Policy Committee, Cochin pipeline project, Calgary, Alberta (1971).

Responsible for the March 1971 formative report on James Bay development (5 rivers).

1965 **President**, Acres Quebec Limited

1964, 1966 – 1970 **Manager of Engineering**, Acres Canadian Bechtel of Churchill Falls

Responsible for all engineering design, including permanent and temporary site facilities and transmission lines, for the 5,225-MW Churchill Falls power development, Labrador, Newfoundland.

Member, Engineering Board, Northumberland Strait Crossing project (1965).

Responsible for the Man and Resources exhibit, Expo '67.

1961 **Head**, Civil Department, H. G. Acres & Company Limited

Administration of the department and civil engineering responsibility for all projects, including

- Grand Rapids hydroelectric development, Manitoba, 340 MW
- Los Esclavos hydroelectric development, Guatemala, 14 MW
- Manicouagan 2 hydroelectric development, Quebec, 1,010 MW

- feasibility studies, Mactaquac hydroelectric development, 630 MW
- Westerly water purification plant, Ontario, 150 million gal/d
- mine caisson and headframe substructure, Manitoba, 55-ft diameter
- steel mill foundations, Hamilton, Ontario.

1956 Project Engineer

Coordination of all engineering for Bersimis 2 hydroelectric project (640 MW), Manicouagan and Outardes rivers economic development studies, Quebec, planning studies for electric power development, and rehabilitation of a flood-damaged power development in Brazil.

1953 Engineer

Economic studies, preliminary explorations and designs, appraisal of geological conditions, flow and silt records, aggregate resources and specifications for all hydraulic gates, Shadiwal and Warsak hydroelectric developments, West Pakistan.

Design and testing of a hydraulic model of the 16,000-cfs tunnel intake, and designs for the intake approach channel, Bersimis 1 hydroelectric development, Quebec.

Site supervision of exploratory drilling for a 39,995-ft long power tunnel.

1950 –1953 Engineer, A.P.I. Cotterell & Sons, London, England

Site supervision of road construction in U.K., and of a water resources survey and exploratory drilling program in Cyrenaica, North Africa.

Technical Publications

Economic Development of Hydro-Quebec Power Resources – System Studies Utilizing an IBM 704 Computer
The Engineering Journal, October 1961 (coauthor)

Concreting at Warsak
American Concrete Institute, Fall Meeting, Toronto, Ontario, November 1963 (coauthor)

Churchill Falls Power Facilities
Proceedings, American Society of Civil Engineers, March 1971 (coauthor)

PETER H. TUCKER

Education — Clarkson College, Potsdam, New York
B.S. Civil Engineering, 1966

Professional Associations — Licensed Professional Engineer – New York State

Experience

1978 –Acres

1978 Project Engineer

Project Coordinator for two engineering feasibility studies of hydroelectric power sites in Massachusetts on the Merrimack River at Lowell and the Chicopee River at Chicopee. Responsibilities include coordination of engineering activities, project reporting, development of design alternatives, review of design data and drawings, preparation of design documents and client liaison. The projects involve the evaluation of power potentials and conceptual designs for installation of a hydroelectric power development at each of the two existing dams. The project sizes are approximately 15 MW and 3 MW respectively.

1968 –1978 **Hydro Engineer,** Niagara Mohawk Power Corporation, Syracuse, New York

Staff and project engineering functions in hydroelectric plant design and study jobs, environmental reports, regulatory reporting and licensing. Responsibilities included acting as Project Engineer on a 10-MW new hydro facility through its preliminary design and licensing stage; undertaking a statewide review of hydro development potentials which resulted in a 15-plant hydro expansion program; studies involving hydro purchases, rehabilitation or other capacity related matters; liaison, review and correspondence with agencies and groups associated with water resources in upstate New York, including preparation and presentation of testimony; and other staff functions incorporating impacts on corporate hydro facilities or involving licenses or permit applications.

1966 –1968 **Design and Maintenance Engineer,** PPG Industries, New Martinsville, West Virginia

Design of modifications or replacements of piping systems, storage tanks, conveyors and other miscellaneous plant equipment and building components. Performed machinery and facility testing and inspections, acted as temporary crew foreman and worked on various preventive maintenance and procurement tasks.

MALCOLM R. VANDERBURGH

Education — Queen's University, Kingston, Ontario
B.Sc. Civil Engineering, 1957

Professional Associations — Society of American Military Engineers – Member
International Society for Soil Mechanics and Foundation Engineers – Member
Association of Professional Engineers, Ontario – Member

Experience

1957 –Acres

1976 Executive Engineer

Project Manager responsible for design of powerhouse, intakes, penstocks and pipeline, including mechanical and electric systems, for Trenton Falls 28-MW hydroelectric redevelopment, West Canada Creek, New York.

Direction of engineering for structural evaluation of 100-ft high Sturgeon Pool concrete gravity dam on Wallkill River, New York.

Direction of engineering and economic feasibility study for liquefied natural gas terminals at two alternative locations in Maine and Rhode Island, capable of delivering 1,300 million ft^3/d of vaporized gas, with gas pipelines to New York and Pennsylvania.

Responsible as Project Manager for all aspects of design of powerhouse, intake and tailrace, including mechanical and electrical systems for 10-MW Granby hydroelectric redevelopment on the Oswego River, New York.

Direction of feasibility studies for compressed air energy storage as peak shaving scheme for California, and underground hydro pumped storage project utilizing existing mine in Ohio.

Direction of siting study for underground pumped hydro or compressed air storage schemes in the greater Boston area.

Responsible as Project Manager for all aspects of design for Long Spruce generating station.

1973 Project Engineer

Coordination of design for gravity structures, earth-fill dams, sand-fill dikes, powerhouse and spillway (including mechanical and electrical systems) for the 1,000-MW Long Spruce generating station on the Nelson River, Manitoba.

Coordination of all aspects of engineering for a 200-ft high earth-fill dam constructed to retain fly ash for the Cardinal plant, Brilliant, Ohio. The work also included a multiple-pipe slurry pipeline from the plant to the retention area.

Coordination of all aspects of engineering for a 180-ft high earth- and rock-fill dam constructed to retain fly-ash slurry, for the John E. Amos thermal plant, New Haven, West Virginia.

Coordination of all aspects of engineering for a 65-ft high earth-fill dam, a concrete chute spillway and a low-level outlet control works for flood control and recreational purposes, G. Ross Lord Dam, Toronto, Ontario.

1965 Civil Engineer

Direction and coordination of civil engineering for the canal, spillway, intake, concrete gravity structures and powerhouse for the 228-MW Lower Notch generating station.

Preparation of a program of erosion control and channel improvement measures for the West Branch of the Don River, Toronto, Ontario.

Engineering responsibility for flood protection measures, water supply and sewer services, and access roads for the site of the Ontario Science Centre, Toronto.

1960 Engineer

Studies for the development plan for Niagara District Airport, St. Catharines, Ontario.

Feasibility report on a water supply dam for Antigua, West Indies.

Report on power requirements for a citrus fruit processing plant in British Honduras.

Soils investigations and foundation design for Stamford-Niagara pollution control plant, Niagara Falls, Ontario.

Studies, designs and specifications for earth- and rock-fill structures of hydroelectric power developments, including Grand Rapids generating station, Manitoba.

Supervision of pumping tests for groundwater hydrology studies and soils explorations for various projects.

1957 Field Soils Engineer

Engineering supervision of construction for earth- and rock-fill structures for hydroelectric power projects, including a 120-ft high rock-fill dam, forebay dikes and two sand-fill dikes on permafrost, Kelsey generating station, Manitoba, and a 2,100-ft long rock-fill forebay dike, Beauharnois No. 3, Quebec.

J. GAVIN WARNOCK

Education
University of Glasgow, Glasgow, Scotland
B.Sc. (Honors), Mechanical Engineering, 1945
Imperial College of Science and Technology
University of London, London, England
D.I.C. Hydropower, 1947

Professional Associations
American Underground–Space Association – President
National Society of Professional Engineers – Member
Canadian Nuclear Association – Director
American Nuclear Society – Member
International Water Resources Association – Board Member
Association of Professional Engineers, Ontario – Member
Engineering Institute of Canada – Member
Institute of Directors, London, U.K. – Member

Experience

1964 –Acres

1977 **Vice-President, Director and General Manager,** Power and Heavy Civil Engineering Group, Acres American Incorporated

Overall direction of group activities covering hydroelectric and heavy civil, electrical services, transportation, environmental, and special services.

1971 **Vice-President, Director and Manager,** Marketing Power and Heavy Civil Engineering Group, Acres Consulting Services Limited

1970 **Vice-President, Director,** Acres American Incorporated

Special projects, business development and corporate external relations.

1964 **Vice-President,** Acres Consulting Services Limited

Business development, public relations, and special projects including direction of the task force preparing supporting documents for the Bond Offering Memorandum for Churchill Falls Power Project.

1947 –1964 The English Electric Company Limited

1960 **Manager, Hydroelectric Division,** Liverpool, England

Overall responsibility for design, development and production of hydroelectric equipment for the world market.

1952 **Manager, Hydraulic Department,** John Inglis Company Limited, Canada – A division of The English Electric Company Limited

1947 **Design Engineer,** Hydraulic Design Section, The English Electric Company Limited, Rugby, England

Technical Publications

Application of Welded Design to Hydraulic Turbine and Valve Manufacture
The Engineering Journal, October 1956

Economics of Variable Pitch Runners for Water Turbine Pumps
World Power Conference, Canadian Sectional Meeting, Montreal, 1958, Proceedings (coauthor)

Reversible Pump-Turbines for Sir Adam Beck–Niagara Pumping–Generating Station
American Society of Mechanical Engineers, Transaction, Journal of Basic Engineering, 1959 (coauthor)

Supporting Documents for Bond Offering Memorandum
Churchill Falls Power Project, 1967 – 1968 (editor in charge)

Giant-Sized Hydraulic Turbines, Review and Forecasts
American Power Conference, Illinois Institute of Technology, April 1968 (coauthor)

The Total Contribution of Tidal Energy to the System
International Conference on the Utilization of Tidal Power, Halifax, Nova Scotia, May 1970 (coauthor)

Tidal Power
The Relentless, Clean and Predictable Energy Sources
68th National Meeting American Institute of Chemical Engineers, February – March 1971 (coauthor)

Pumped Storage Development and its Environmental Effects
University of Wisconsin-Milwaukee and American Water Resources Association, International Conference on Pumped Storage Development and its Environmental Effects, September 1971

Pumped Storage Underground
Symposium on Hydroelectric Pumped Storage Schemes, Athens, Greece, November 1972 (joint author)

Review of Trends of Large Hydroelectric Generating Equipment
Proceedings, IEE, October 1976 (coauthor)

Design Risk and Engineering Management
Jumbo Projects Conference, London, July 6, 1977

A Giant Project Accomplished
Successful Accomplishment of Giant Projects Conference, London, England, May 1978

DAVID C. WILLETT

Education — Imperial College of Science and Technology, University of London, London, England
B.Sc. Civil Engineering, 1955

Professional Associations — Association of Professional Engineers, Ontario — Member
Institution of Civil Engineers, U.K. — Member
American Society of Civil Engineers — Member

Experience

1962 – Acres

1974 Vice-President, Acres American Incorporated

Manager for

- Strategic Petroleum Storage Study for FEA
- Underground pumped hydro and compressed air energy siting studies
- Technical, economic and environmental assessments of underground pumped storage
- Fly-ash retention dams.

1973 Manager, Power Division

- Studies of hydro redevelopment on the Oswego River
- Environmental assessments of river basins
- Thermal hydraulic model tests
- Fly-ash studies
- Rock-fill dam design and construction.

1970 Manager of Projects

Responsible for the general administrative and technical direction of all projects.

1968 Head, Civil Department, H. G. Acres Limited, Niagara Falls

Responsible for the general technical direction of the Civil Engineering Department.

1967 Executive Engineer

Administrative and technical responsibility for all the engineering for the powerhouse complex, 5,225-Mw Churchill Falls power project, Labrador, Newfoundland.

1962 Project Engineer

Coordinated engineering for the study, design and construction of the 630-Mw Mactaquac hydroelectric development, New Brunswick.

Studies of the optimum location of the underground powerhouse, 2,000-Mw Mica hydroelectric development, British Columbia.

Studies for a national power network in Canada, and for a proposed interconnection of the New Brunswick and Nova Scotia electric power systems.

Feasibility studies of potential power sites on the Lower Churchill River, Labrador.

1960 – 1962 Engineer, Shawinigan Engineering Company Limited, Montreal, Quebec

Designs for Carillon hydroelectric development and Navigation Lock, Quebec; studies of diversion, outlet and spillway works for Mica hydroelectric development, B.C.; designs, specifications and contract documents for a small sewage treatment plant.

1957 – 1960 Engineer/Field Engineer, Freeman, Fox and Partners, London, England and Ffestiniog, Wales

Coordination of civil engineering and liaison with electrical and mechanical consultants for 300-Mw Ffestiniog pumped storage hydroelectric development, Wales.

1955 – 1957 Engineer, Sir William Halcrow and Partners, London, England

Designs for small hydroelectric power developments in Scotland.

Technical Publications

Design and Construction of the Mactaquac Hydro-Electric Development
Engineering Institute of Canada, Annual Meeting, Vancouver, British Columbia, September 1969 (coauthor)

Seismic Refraction Surveying on the Hamilton River Survey
Institution of Civil Engineers Library, Miller Prize for Graduate Papers, 1956

The Churchill Falls Power Development
Water Power, November/December 1971

Pumped Storage Underground
Economic Commission for Europe, Athens, Greece, November 6 – 8, 1972 (coauthor)

Underground Reservoirs for Pumped Storage
Association of Engineering Geologists Annual Meeting, Kansas City, Missouri, 1973 (coauthor)

Rock Caverns for Underground Nuclear Power Plant Siting
American Nuclear Society, June 1974 (coauthor)

Underground Pumped Storage Possibilities
Engineering Foundation Conference, Rindge, New Hampshire, August, 1974

Pumped Storage Underground, Preliminary Site Selection Procedures
International Symposium on Multipurpose Storage Pumping Schemes, Madrid, Spain, November, 1974

Environmental Impact of Underground Pumped Storage
Engineering Foundation Conference, Rindge, New Hampshire, August 1975 (coauthor)

Underground Pumped Storage – Technical and Economic Feasibility
American Society of Mechanical Engineers, Winter Meeting, New York, December 1976.