MEAGER MOUNTAIN
GEOTHERMAL PROJECT
1979
ENVIRONMENTAL PROGRAM
TERMS OF REFERENCE

Prepared by

REID, CROWTHER & PARTNERS LIMITED

In Association

with

VTN CONSOLIDATED INC.

May 1979

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PLEASE REFER TO FILE No.

30,158

May 2, 1979

Mr. J.J. Stauder
B.C. Hydro & Power Authority
Generation Planning
24th Floor - P.O. Box 12121
555 West Hastings Street
Vancouver, B.C.

Dear Mr. Stauder:

RE: Meager Mountain Geothermal Project
1979 Environment Program

We are pleased to provide herein a terms of reference for the above project.

The program for environmental work in 1979 is set out in two parts. Phase I would provide an inventory of certain components of the air quality, meteorology, hydrology, water quality and geology within a budget of $112,000.00 according to the tasks set forth.

Phase II would enable B.C. Hydro to call upon sound environmental expertise with experience on geothermal projects, to assist you in the planning of further exploration and development activities. The budget allowance is $38,000.00.

Phase I would ideally proceed with field work beginning June 4, 1979 terminating in a report by the end of the year. Phase II would not proceed until you so request.

The work would be carried out jointly by Reid, Crowther & Partners Limited and VTN Consolidated Inc.

In the event that you have any queries or require additional information please contact us.

Yours truly,

G.C. Seagel

G.C. Seagel
Manager, Environmental Analysis Division

GCS/mb

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Letter of Transmittal

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SECTION 1

INTRODUCTION

The terms of reference contained herein are based on the initial proposal submitted by Reid, Crowther & Partners Limited and VTN Consolidated Inc. (Appendix A), and various discussions with B.C. Hydro personnel.

The following text indicates the activities, approach, associated costs and schedule of events for a 1979 environmental program oriented toward exploration activities.

1.1 OBJECTIVES

The program reflects three principle aims. These aims are to provide, (1) support data for the 1979 exploration program, (2) indicators of ambient conditions in areas of prime concern and (3) facilitate plans for any future project exploration activities.

1.2 SCOPE

The scope of work and program structure reflects the fact that a geothermal resource has not yet been proven in the Meager area.

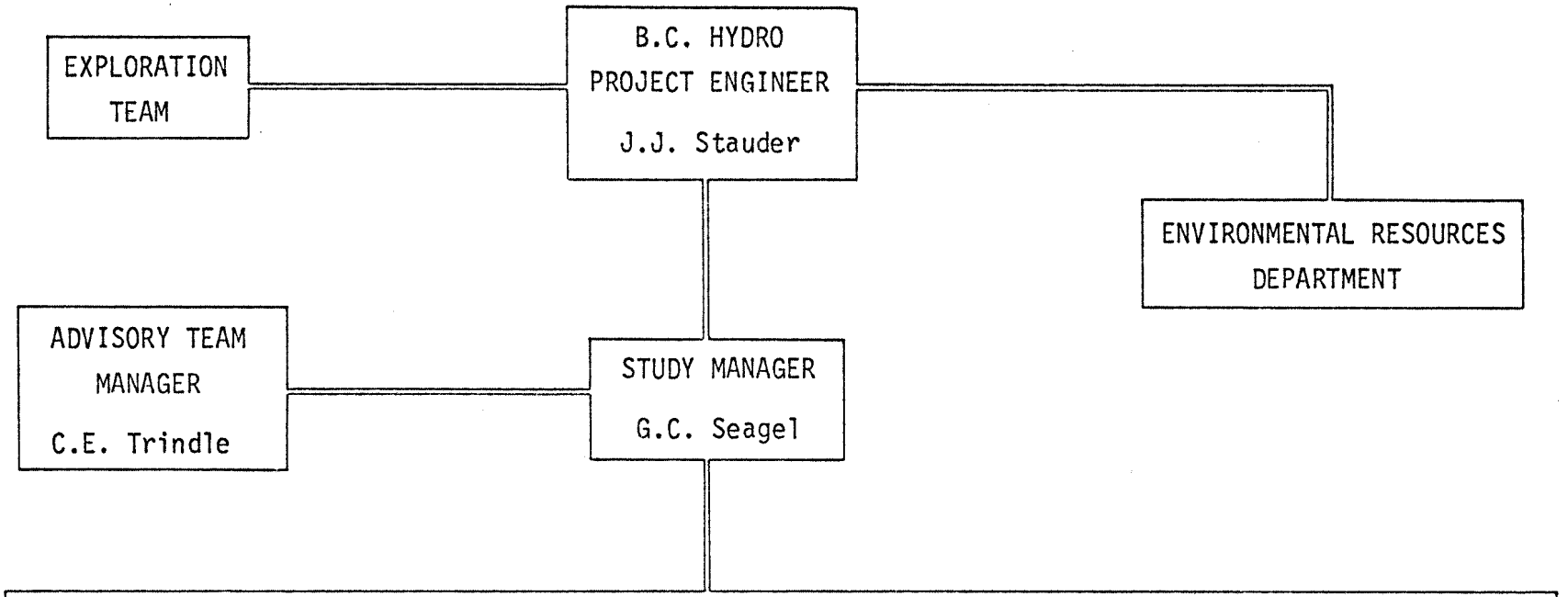
The work scope is based on the deployment of available funds to meet the minimum data collection outlined herein. The parameters selected reflect the gross deficiency of such data in the study area, and are directly related to activities involved in geothermal exploration drilling.

The program structure is in two parts. Phase I comprises an inventory program which would be carried out between June and October (inclusive) 1979. Phase II involves use of the Phase I data, in conjunction with available environmental (B.C. Hydro, 1979, Meager Mountain Geothermal Project, An Environmental Reconnaissance Report) and exploration data to input environmental considerations to future exploration plans. The performance of Phase II work would be subject to a request to proceed being granted by B.C. Hydro.

1.3 STUDY ORGANIZATION

Figure 1 shows the various roles and responsibilites in the study team. This organization would enable the B.C. Hydro project engineer to closely scrutinize the activities and provide a mechanism for information exchange.

For reference purposes personnel resumes for those who would be carrying out the various activities are included in Appendix B.



GEOLOGY	HYDROLOGY	WATER QUALITY	METEOROLOGY	AIR QUALITY
R. Sydnor*	G. Seagel *	M. Knezevic*	R. Missen*	R. Missen*
W. Loo	Technician	E. Neil	L. Howard	L. Howard
Technician	M. Knezevic	M. Pugh	Technician	Technician

* Responsible Team Member

FIGURE 1
STUDY ORGANIZATION

SECTION 2

PHASE I - INVENTORY

The Phase I program would commence with field investigations in the first week of June, 1979. Data collection is scheduled to continue periodically through mid-October, with the work terminating upon compilation of the data into a report by the end of 1979. The schedule of activities is shown in Figure 2.

2.1 GEOLOGY

2.1.1 Activities

The geologic research for the Meager Mountain Geothermal Area for the summer of 1979 would emphasize the geologic hazards and constraints related to physical development of the site. The principal focus would be upon stability of natural and man-altered slopes. Two maps would be prepared: a surficial geologic map, and land-use capability map which would evaluate the constraints for geothermal exploration and development. A selected number of bag samples of representative earth units would be obtained.

The object of the research would be directed towards minimizing geologic hazards which may adversely affect the physical development of site facilities, such as access roads, drilling sites, bridges, pipelines and utilities.

Dangers to public attracted to such facilities & personnel working at the ~~facilities~~ facilities. Are pressures so low that no effect in seismicity is expected from reinjection or effect on stability

The office study would include a review of all pertinent published and unpublished geologic reports and maps. Stereoscopic aerial photographs would be used to evaluate stability of existing slopes in the Meager Creek-Lillooet River area.

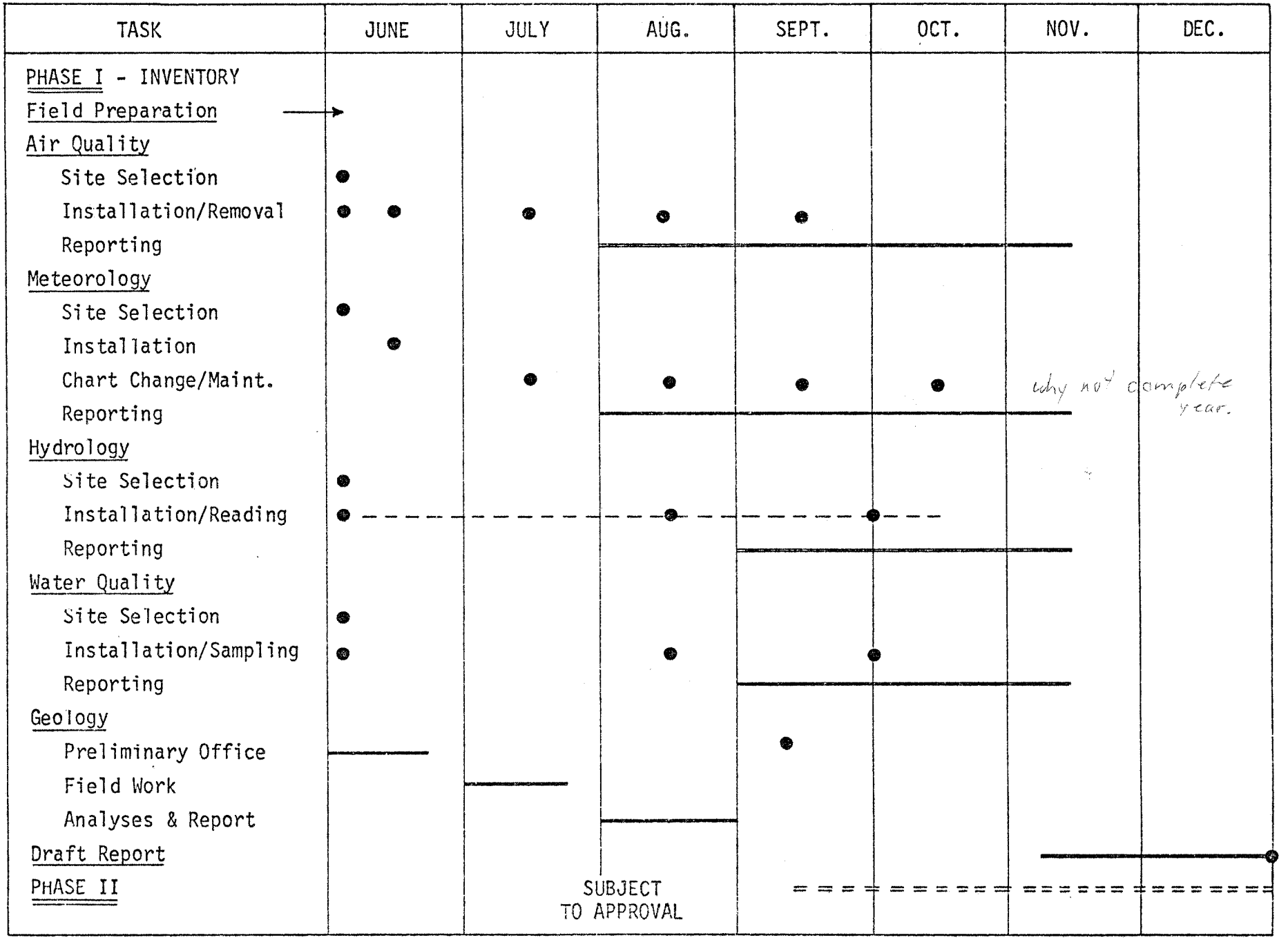


FIGURE 2
SCHEDULE

The geologic field mapping program is planned to be about three weeks duration. The emphasis of this task would be to determine the major bedrock units, and the thickness and distribution of all regolith units (alluvium, glacial moraines, colluvium, talus, landslides, and debris flows). All geologic mapping would be plotted on a base map enlarged from the presently available 1:50,000 scale topographic base map. to what scale?

The terrain sensitivity map would be a document for use by planners and engineers to make decisions about locating physical improvements (roads, drilling sites, buildings, and utilities). The geologic parameters would be combined with other physical parameters to achieve a terrain-rating summary. The other physical parameters include: slope angle, thickness and distribution of unstable surficial materials, spring flooding, vegetation cover, logging operations, and avalanche chutes. The land-use capability map would include a matrix table which describes and evaluates the impact of each adverse parameter.

Impact of possible subsidence should also be considered

2.1.2 Budget - Geology

Preliminary Office Work - R. Sydnor	80 Hrs.	4050
Field Reconnaissance & Travel - R. Sydnor	120 Hrs.	6075
Data Analysis - R. Sydnor	40 Hrs.	2025
Report Preparation - R. Sydnor	80 Hrs.	4050
- K. Farnsworth (Graphics)	40 Hrs.	794
- Vydec	40 Hrs.	620
Laboratory Analysis		1296
Expenses - Travel & Per Diem		450
- Equipment		240
TOTAL		$20,000

2.2 HYDROLOGY

2.2.1 Activities

Five sites are to be selected for installation of staff gauges. The sites and the data collected are to fulfill the preliminary needs of the water quality study for 1979, and, to provide a basis for future flow monitoring for the project. It is expected that the hydrology data would be of use to University of Waterloo personnel who may be working in the area for Energy Mines and Resources on a study related to the potential geothermal project.

The hydrology study procedure would involve site selection which would take place between June 4 and 7. The sites would be located in relation to the geothermal reservoirs, hence, two sites on both Meager Creek and the Lillooet River (above Meager Creek), and one site on the Lillooet River below Meager Creek. Sites would be selected in conjunction with water quality monitoring sites and physical characteristics suitable for longer term sophisticated monitoring of flow.

Installation would take place prior to June 22, 1979. The facilities would be tied into assumed datum points, and remain in service until October 15, 1979 or until weather and conditions prohibit further readings whichever is first.

use recorders?

During operation the gauges would be read manually. Thus, readings may be taken by anyone. However, three main uses of the gauges would arise; readings of water level plus discharge measurements would be taken during each water quality sampling period; the University of Waterloo personnel would be free to read the gauges and measure discharge during

their field periods; and finally the drill and/or geological explorations crews would be encouraged to read the gauges as much as possible especially during rainstorms. However, the main readings which justify the work are those taken during the taking of water quality samples.

Results would be tabulated for future reference, with careful site and methodology descriptions.

2.2.2 Budget - Hydrology

Site Selection	- G. Seagel	16 Hrs.	704
	- M. Knezevic	8 Hrs.	267
Installation	- G. Seagel	16 Hrs.	704
	- Technician	16 Hrs.	320
Operation	- G. Seagel	40 Hrs.	1760
Computations	- G. Seagel	16 Hrs.	704
	- Technician	16 Hrs.	320
Reporting	- G. Seagel	8 Hrs.	352
	- Technician	32 Hrs.	640
	- Clerical	4 Hrs.	60
Expenses	- Equipment		250
	- Travel		200
	- Supplies		200
	- Sundries		150
TOTAL			$6631

2.3 WATER QUALITY

2.3.1 Activities

The water quality program would involve quality controlled sampling during three visits to five sites. The sites would be selected in conjunction with the hydrology stations,

during the first week of June, 1979. The field measurements and samples would be for physical/chemical analyses during the June site selection, mid-August and late September - October periods.

The parameters to be measured would be:

Group 1 - Physical

- pH
- Suspended Solids
- TDS (@ 180^{o}C)
- TDS (Sum of constituents)
- Color
- Tanins and Lignins
- Acidity
- Dissolved Calcuim
- " Magnesium
- " Sodium
- " Potassium
- " Chloride
- " Floride
- " Sulphate
- " Silica
- Cation-Anion Balance, Calc.

Group 2 - Nutrients

- Total Kjeldahl Nitrogen (ORG-N and NH_3-N)
- Nitrate - Total (NO_3-N)
- Nitrite - Total (NO_2-N)
- Total Phosphate (T-PO_4^{3-}) - Total
- Ortho (O-PO_4^{3-}) - Total and Dissolved

Group 3 - Organics

- TOC
- Oil and Grease

Group 4 - Trace Elements (Dissolved Phase)

- Arsenic
- Cadmium
- Chromium
- Copper
- Iron
- Lead
- Manganese
- Mercury
- Molybdenum
- Nickel
- Selenium
- Zinc

check w/ govt. agencies

Group 5 - Microbiological

- Total Coliform
- Fecal Coliform

A commercial analytical laboratory would be used for the laboratory analyses. Unit prices for the work would be established prior to field collection and the laboratory handling and methodology procedures reviewed.

An important aspect of the work will be quality control. Hence, well established and tested field and laboratory procedures would be used. Further information on these methods is available upon request.

2.3.2 Budget - Water Quality

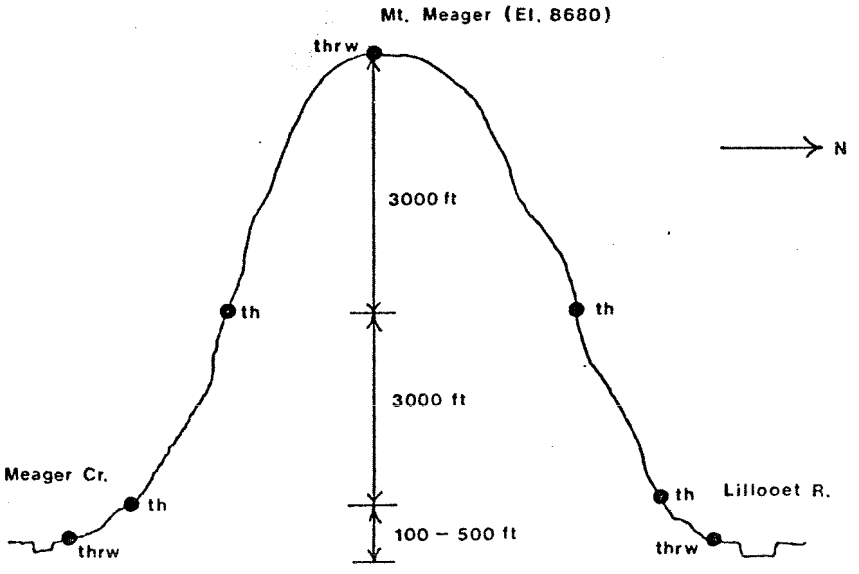
Field and Equipment Preparation Liaison			
	- M. Knezevic	32 Hrs.	1,068
	- E. Neil	40 Hrs.	800
Site Selection			
	- M. Knezevic	24 Hrs.	801
	- E. Neil	16 Hrs.	320
First Sampling			
	- M. Knezevic	16 Hrs.	534
	- E. Neil	24 Hrs.	480
Second Sampling			
	- E. Neil	24 Hrs.	480
	- M. Pugh	24 Hrs.	510
Third Sampling			
	- E. Neil	24 Hrs.	480
	- M. Pugh	24 Hrs.	510
Reporting and Tabulation			
	- M. Knezevic	32 Hrs.	1,068
	- E. Neil	200 Hrs.	4,000
	- Clerical	16 Hrs.	240
Expenses	- Laboratory Analyses		8,000
	- Travel		1,500
	- Sundries		500
	- Supplies		200
	- Equipment		1,000
TOTAL			$22,491

2.4 METEOROLOGY

2.4.1 Activities

The meteorology work for 1979 would involve the monitoring of temperature (t), humidity (h), rainfall (r) and wind speed and direction (W) at up to seven stations located

along a transect from Meager Creek valley bottom, over Mount Meager, to the Lillooet River valley bottom. The stations would be located as ground stations according to the following schematic:



The equipment for this work would be supplied by Reid, Crowther (hydro thermographs) and B.C. Hydro (recording anemometers and rain gauges).

Site selection would occur between June 4 and 9, 1979 and installation would be complete by June 22, 1979.

The equipment will require servicing and chart changing every 28 days. Either B.C. Hydro or Reid, Crowther will perform this function. The equipment will run at least until October 15, 1979 and longer if resources permit.

2.4.2 Budget - Meteorology

Site Selection	- R. Missen	28 Hrs.	1134
	- L. Howard	16 Hrs.	500
Installation	- L. Howard	48 Hrs.	1500
	- Technician	32 Hrs.	640
Operation	- L. Howard	48 Hrs.	1000
	- Technician	32 Hrs.	640
Reporting, Tabulation, Liaison			
	- Clerical	16 Hrs.	240
	- L. Howard	20 Hrs.	625
	- R. Missen	32 Hrs.	1293
Expenses	- Equipment		500
	- Supplies		1500
	- Sundries		500
	- Travel		500
TOTAL			$8932

2.5 AIR QUALITY

2.5.1 Activities

Two primary tasks would be involved in the air quality study for 1979, namely:

- Monitoring for H_2S and SO_2 ambient conditions.

- Monitoring for dust and particulates due to current activities (logging and exploration) and ambient conditions.

The monitoring would involve the following; based on the camp being located at Pebble Creek.

A portable generator would be used to power both a Hi-Vol particulate sampler and a continuous H_2S/SO_2 monitor. These monitors would operate during the month of July in the Meager Creek area, and then be moved to the exploration area on the Upper Lillooet for operation during August. In addition, the H_2S/SO_2 monitor would operate over a period of two weeks at both Meager Main and Pebble Hot Springs.

In conjunction with the continuous monitors, dust pans and H_2S sensitive detection plates would be given wide distribution in the area.

Siting of equipment would be determined during the first week of June, 1979, at which time the dust pans and H_2S sensors would be located.

Actual in-field operating requirements would be established once the necessary equipment has been obtained and checked for operation.

2.5.2 Budget - Air Quality

Field Preparation	- G. Seagel	8 Hrs.	352
	- L. Howard	16 Hrs.	500
Site Selection	- R. Missen	12 Hrs.	324
	- L. Howard	12 Hrs.	250
Installation-Initial	- L. Howard	16 Hrs.	500
	- Technician	16 Hrs.	300
-Relocations			
	- L. Howard	32 Hrs.	1000
	- G. Seagel	24 Hrs.	1056
Maintenance	- L. Howard	48 Hrs.	1500
	- Technician	48 Hrs.	800
Sub-Total (Carried Forward)			$6582

Sub-Total (Brought Forward)			6582
Reporting, Tabulation, Liaison			
	- R. Missen	24 Hrs.	970
	- L. Howard	16 Hrs.	500
	- Technician	48 Hrs.	960
	- Clerical	16 Hrs.	240
Expenses	- Travel		800
	- Supplies		600
	- Equipment		2500
	- Sundries		250
TOTAL			$13402

2.6 REPORTING

Due to the nature of the Phase I work a report would be compiled which documents the following:

- Methodologies
- Results
- Summary ? of what

Report should include at least preliminary conclusions and recommendations regarding future program.

A draft report (5 copies) would be submitted by December 31, 1979. Within the budget for this phase a small amount has been allocated for review and incorporation of comments from B.C. Hydro. An amount has also been assigned for printing should this be necessary.

The budget for this work is as follows:

- Draft Report Preparation			
	- G. Seagel	16 Hrs.	704
	- E. Neil	32 Hrs.	640
	- C. Trindle	16 Hrs.	446
	- M. Knezevic	4 Hrs.	134
	- R. Missen	4 Hrs.	162
	- R. Sydnor	4 Hrs.	202
	- Clerical	28 Hrs.	420
	- Expenses		300
- Review			1500
- Printing			2000
TOTAL			$6508

2.7 MANAGEMENT AND ADMINISTRATION

This necessary activity provides the means by which the study group would control its activities, liaise with the project engineer, provide cost and schedule control and organize internally.

The cost for this role is as follows:

- Reid, Crowther & Partners Limited			
- G. Seagel	- Meetings	40 Hrs.	1760
	- Coordination	72 Hrs.	3168
	- Administration	72 Hrs.	3168
- Expenses			2000
TOTAL			10096
- VTN Consolidated Inc.			
- C. Trindle	- Office	180 Hrs.	5022
	- Field		1500
- Expenses			1000
TOTAL			7522
- Pre-April 20, 1979 Expenditures:			
TOTAL			$7500

SECTION 3

PHASE II - ENVIRONMENTAL PLANNING

3.1 INTRODUCTION

This phase would provide a mechanism for the logical continuation of the sequence of events begun during Phase I. The work would involve the integration of environmental considerations with the 1980 geothermal exploration activities to enable the conduct of the project in an environmentally acceptable manner.

See comments on p.15. Why is this a separate phase? Would prefer to see the 1979 work report complete with conclusions and recommendations affecting future work

The need for such input would depend upon the results of the 1979 exploration program, as the scope and direction of the Phase II activities would be predicated upon these results. The work, therefore, would proceed upon authorization by the project engineer.

Phase II tasks must accommodate on-going refinements as exploration activities further delineate the nature and extent of the resource, thereby affecting activities proposed for future field seasons. Recognizing this situation the following two work tasks are anticipated.

3.2 STEP 1 - EXPLORATION PLANNING

In this step those planning the exploration and development activities for 1980 would be provided with environmental information relevant to their work. The environmental information supplied would reflect experiences and considerations in geothermal projects elsewhere. This task would be carried out prior to detailed planning of the 1980 exploration program.

3.3 STEP 2 - 1980 ENVIRONMENTAL PROGRAMS

This step would evolve from a review of the 1980 exploration program.

The work would consist of the preparation of specific programs to enable B.C. Hydro to conduct 1980 and future geothermal activities in an environmentally acceptable manner. This would be accomplished through the identification of procedures whereby certain geothermal exploration activities could be conducted within the physical and environmental constraints of the Meager Mountain setting. Specifically, this step would involve identifying procedures to minimize the potential for adverse impacts associated with geothermal exploration activities.

SECTION 4

BUDGET SUMMARY

Based on the estimated man hours and costs shown after each discussion of activities the overall budget is summarized in Table 1.

In addition, the estimated helicopter flying hours are shown below:

Helicopter Hours Required:

- During Site Selection Week	25 Hrs. Flying Time
- Chart Changing and Normal Operational Procedures	10 Hrs. Flying Time
- Allowance for Unscheduled Equipment Failures and Bad Weather	10 Hrs. Flying Time
TOTAL (Estimation)	45 Hrs. Flying Time

TABLE 1

BUDGET SUMMARY

PHASE I - INVENTORY FOR EXPLORATION

Air Quality	13,402
Meteorolgoy	8,932
Hydrology	6,631
Water Quality	22,491
Geology	20,000
Management Administration	
- Reid, Crowther	10,096
- VTN Consolidated	7,522
- General	7,500
Report Preparation	6,508
Contingencies	2,418
Exchange Rate	6,500 — why?
TOTAL	112,000

PHASE II - PROJECT ENVIRONMENTAL PLANNING

Exploration Planning	10,000
1980 Environmental Program	15,000
Meteorology Chart Reading	10,000 → ? Basis? Does this include the 45 hrs helicopter flying time
Exchange Rate	3,000 — why?
TOTAL	38,000
PROJECT TOTAL	$150,000

APPENDIX A

INITIAL PROPOSAL

Why was this included? to compare with the present proposal?

CONTENTS

1979 PROGRAM SCOPE

MEAGER MOUNTAIN GEOTHERMAL PROJECT

- ENVIRONMENT -

1. INTRODUCTION

The following does not constitute a terms of reference; rather, it provides a basis for the request for proposals prepared in sufficient detail to be used as a terms of reference. Lacking are specific details of the inventory sites and methods. It is felt that this approach, at this time, would best facilitate the placing of the work with groups who would thereby have a degree of flexibility in terms of cost and schedule to meet the requirements listed. It is assumed that if the 1979 exploration work is successful that further environmental monitoring would be done past 1979. Hence, monitoring sites established in 1979 may not be permanent, with relocation based on the insights provided by the 1979 data.

As the resource upon which the project is to be based is not yet proven, the environmental work may be considered preliminary with objectives as follows:

1) To supply baseline data for use in the preparation of an environmental assessment of the project.

2) To supply baseline data for use in facility planning and design (including environmental control technology), future monitoring programs and design of impact mitigation measures.

3) To supply baseline data and contingency program options to expedite and safeguard exploration activities.

To meet these three objectives all monitoring should be reproducible, with comparable precision and accuracy. If the environmental studies are to efficiently achieve this it is considered advisable to use personnel with an understanding of geothermal projects to the fullest extent possible in the coordination and advisory roles.

This type of project is new to British Columbia and Canada. Hence, the events and happenings on this particular project will tend to set precedents. Thus, the ability to be able to respond to project needs and provide sound project planning is considered important.

The 1979 program components were selected from the data deficiencies outlined in a previous report prepared by Reid, Crowther & Partners Limited for B.C. Hydro (1979) for this project. The components selected reflect a degree of priority based upon 1979 drilling activities and the nature of the data deficiency.

It is envisaged that a flexible reporting format could be established to facilitate preparation of a baseline data report. This report could be supplemented in future years as necessary; could be available for release; and would reduce the size of an assessment report by minimizing the need to include back-up data in all areas.

All final selection of sites for field monitoring would require approval of the advisory team via the coordinator.

2. TECHNICAL GEOLOGY

2.1 GEOLOGY

2.1.1 Soils

Objective: To assess the location; type and significance of soils present in the study area. The work is to provide a basis for the planning and location of drilling and site facilities.

Scope: The work is to be based on available information and brief site visits. The final report should indicate the type and location of any further work required to adequately assess the environmental and design implication of the soils. The study area is the same as that for item 2.1.2.

2.1.2 Slope Stability

Objective: To assess the location, type and magnitude of unstable slopes in the study area. The work is to provide information for project planning and activity/facility siting.

Scope: The work is to be based on a review and analysis of all available information including but not limited to drill hole records, reports, on-going studies, aerial photographs, historical records and observations based upon a brief field reconnaissance. The study area is defined as the valleys of Meager Creek and the Lillooet River above their confluence. The work will show past instabilities and potentially unstable areas

indicating cause wherever possible. The work will indicate the type, need, and location for future more detailed field work. The assessment of stability should consider the implications of future logging activities, the safety of the project activities and the implications of development to stability of the slopes.

2.2 HYDROLOGY

Objective: To measure and record stream flow, sediment transport and precipitation in the primary study area with particular emphasis on either the Meager Creek and Lillooet River channels depending on the main area of investigation. The purpose is to provide information for physical, chemical, engineering and biological studies.

Scope: The work will require the installation, maintenance and rating of two streamflow recording stations; at least one on each of the Meager Creek and Lillooet River above the confluence of these streams. Sediment transport will largely involve suspended sediment measurement at the two stations established. Precipitation measurement stations (including rainfall, snowfall and snow course data) would require installation and maintenance of at least 3 facilities. Measurements will be maintained until December 31, 1979 subject to extension pending other project study results.

The above hydrology program scope is predicated upon reasonable expectation of continuation in 1980. If this is not the case then the stream-flow recording program should be adjusted as follows:

Locate recording sites, establish bench marks, staff gauge plus crest gauge and record observations at least once per month or daily if persons in the camp can do so. Establish rating curve and sample suspended sediment load over as wider range of flows as possible.

2.3 BIOLOGY

2.3.1 Terrestrial

Objective: To map vegetation types and assess the available (current and potential) wildlife habitat. The most immediate use of this information is to assist drilling and support facility location and, in the longer term to input to the environmental assessment.

Scope: Use available information including recent air photos and forestry plans, augmented by brief field checking; for the area below a level 500 feet above the valley bottom for the full length of Meager Creek, and from the confluence of Meager Creek to Manatee Creek on the Lillooet River valley.

2.3.2 Water Quality

Objective: To sample and record physical, chemical and biological elements at prescribed locations in order to document existing conditions and ultimately to define assimilative capacity and and environmental assessment.

Scope: Establish, sample and record observations at at least five locations in the study area (see item 2.3.3) chosen in relation to the main potential development area. The two principle streams are Meager Creek and the Lillooet River. Refer to report by B.C. Hydro (1979) for physical/chemical parameters that are important to sample.

2.3.3 Fisheries

Objective: To survey available fish habitat in the study area for the purpose of input to development activity siting and constraints to these activities. The information would ultimately be of use in further fisheries studies and an environmental assessment.

Scope: To map at a scale of 1:50,000 or larger, the fisheries habitat in a manner compatible with the system used by the Resource Analysis Branch of the B.C. Ministry of the Environment. The survey should cover both Meager Creek and the Lillooet River upstream from a point 4 miles below Meager Creek.

2.4 METEOROLOGY

Objective: Monitor wind at and near the surface, frequency and intensity of inversions and humidity. The measurements should be supplemented by surface wind measurements at at least four locations in the study area. The data would be used to determine the possible impact of air emissions due to the development.

Scope: Monitoring would continue until December 31, 1979 with the possibility of extension in 1980 subject to other project studies. It is suggested that either properly equipped towers, or a series of stations forming a transect over Meager Mountain, or combination of both, be used. Note that the incidence of low level inversion will be important.

2.5 AIR QUALITY

Objective: To provide baseline air quality measurements prior to any venting of geothermal steam.

Scope: Using the most expeditious means provide coverage of the primary study area to ensure detection of all sources of air emissions such as forestry, access, and on-going geothermal activities, on a seasonal basis. Use of Color Tec, grab samples and high volume sampler should be considered.

2.6 NOISE

Objective: To provide baseline ambient noise information and to document existing noise sources such as

forestry, access and on-going goethermal activity.

Scope: Use hand held equipment to document this information on a seasonal basis.

2.7 LAND USE

Objective: To ensure protection of other legal rights to the land and water.

Scope: Carry out a search of land titles and water licenses, in the study area.

2.8 HERITAGE

Objective: To provide an initial survey of the study area to assess the location of potential or actual sites of heritage value; their potential significance; and to suggest further work required. The work should concentrate on possible 1979 deep hole location(s).

Scope: A field reconnaissance of 1 to 2 mean weeks would suffice at the present time, in the study area defined in item 2.3.1.

2.9 ACCESS

Objective: Due to the project there is an increasing awareness of the study area. To document movements and use install a traffic counter below the junction of the Meager Road.

Scope: Maintain and locate counter for the snow free period. Request logging companies to log all their traffic movements, and, document all traffic movements to and from the camp/drill/work sites (geothermal) and Pemberton.

3. ORGANIZATION

The organization of the program participants to some degree reflects the uncertain nature of the project and the fact that participants have not yet been designated. Largely, however, the organization shown in Figure 1 is a means of encouraging Canadian involvement in the project using known non-Canadian expertise in an advisory role (in the Advisory Team).

The various groups shown in Figure 1 should help to generate the right information at the right time, by recognizing the need to have sound coordination, through a central person (Project Engineer), and the interest shown by B.C. Hydro's own environmental persons.

3.1 TECHNICAL COMPONENTS

Generally, these program components could be undertaken by a variety of organizations. However, it is advised that the Slope Stability, Soils and Water Quality components be undertaken by consultants. The reasons for this arise from the need to select the best persons for the geological work which should be carried out quickly and from a geotechnical point of view. The water quality program may have to be very flexible and able to respond to such needs as possible venting requirements.

STUDY ORGANIZATION

1979 PROGRAM

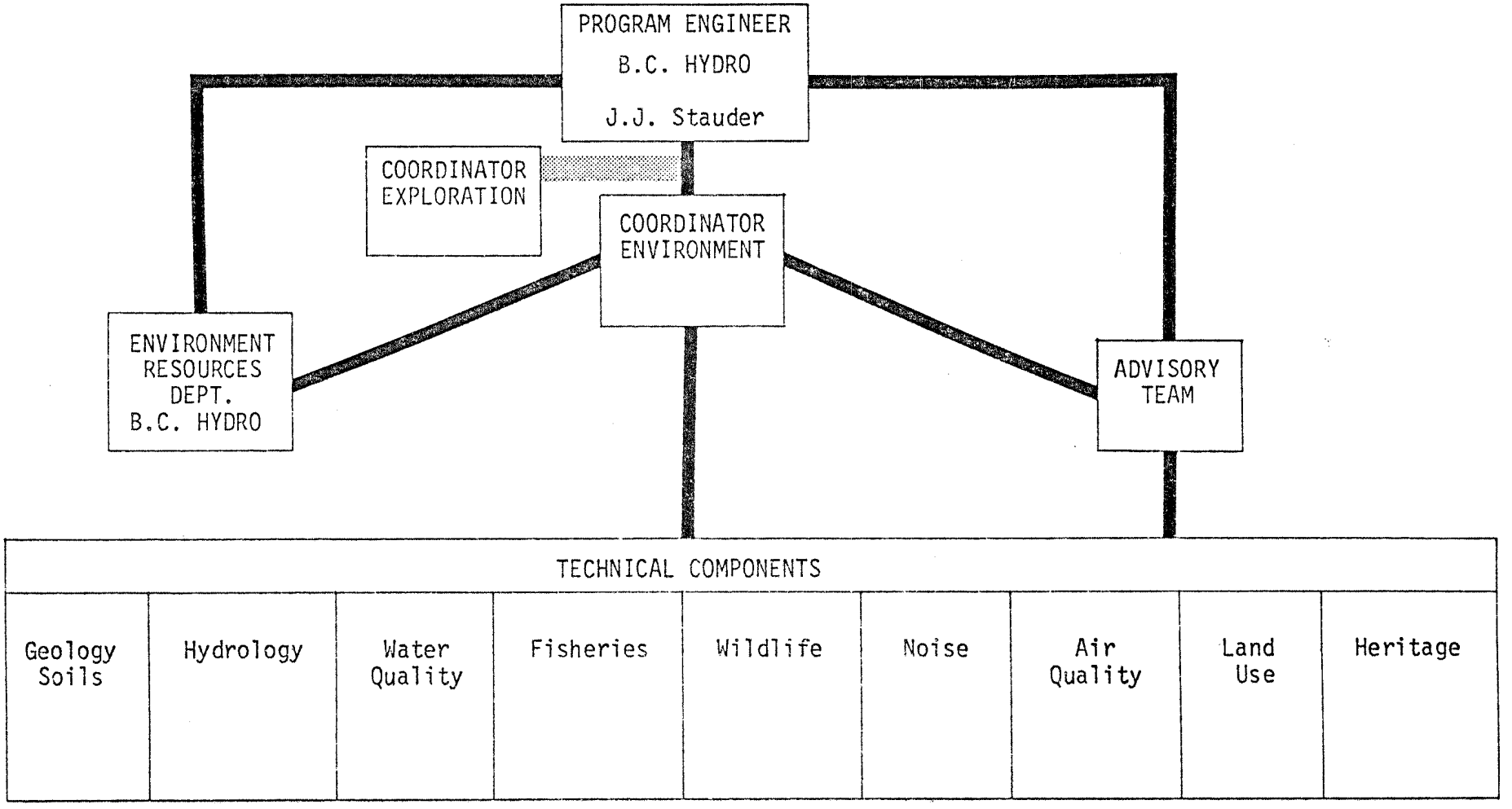


Figure 1

3.2 COORDINATORS AND ADVISORS

In order to ensure a coordinated environmental program at Meager Creek, a coordinator and an advisory team should be employed. These positions would act to coordinate the environmental studies outlined above with this years geothermal exploration activities and to develop an initial framework from which to implement environmentally acceptable exploration, development and engineering programs. Since these activities are interdependent, it is important that environmental investigations coincide with major decision points which occur as the Meager Creek Geothermal Project proceeds.

Within this framework, there is a need for sufficient coordination in order that:

1) The long term continuity of the project be maintained;

2) The needs of B.C. Hydro are appropriately addressed, and

3) Activities of the diverse groups who will be participating in the environmental studies be coordinated with the on-going field and engineering activities conducted by B.C. Hydro.

It is recommended that these objectives be met by an Environmental Coordinator and an Advisory Team.

3.2.1 Environmental Coordinator

The responsibilities of this position include liaison activities for the various groups involved in the 1979 field studies; drawing the E.R.D. into a directional and information interchange whereby E.R.D. may be exposed to and increase their

understanding of the environmental issues; work quality and work control; control of designated sub-groups; directing the deployment of persons designated in the Advisory Team; scrutinizing and ensuring proper report preparation; and participate in the establishment of program terms of reference.

3.2.2 Advisory Team

The function of the advisory team is to provide access to and input from geothermal expertise in environmental and design related matters. Appropriate input will ensure that environmental baseline studies undertaken during the 1979 field season are appropriately related to matters of concern in the geothermal development process. Within this framework, the Advisory Team would provide technical input into the various phases of 1979 environmental studies. This input would centre on four main tasks:

1) Assessment and approval of the final study design, including the various environmental parameters to be measured, frequency of measurements, and location of sampling sites.

2) Provide on-ground assistance during the conduct of the field activities as necessary.

3) Review and comment on interim and final baseline reports, including interpretation of results and their environmental implications.

4) Finalize preparation of design for 1980 field studies.

4. SCHEDULE

Due to the uncertainty of future activities for this project all technical programs would terminate December 31, 1979. However, it would be advisable for the coordinator to ensure that contingency plans, for continuous monitoring requirements, be prepared no later than October 31, 1979. Thus, those selected to do any continuous monitoring should be prepared to continue after December 31, 1979. Such plans could also include other surveys of a more seasonal and sporadic nature if the drilling program proves successful and time becomes important.

In almost all cases work should be designated as soon as possible.

5. BUDGET

Due to uncertainties with regard to who would be appointed to carry out any of the work items it is suggested that initially funds could be dispensed as follows:

1.	Slope Stability	$15,000
2.	Soils	15,000
3.	Water Quality	20,000
4.	Coordination-Environment	10,000
5.	Advisory Team	15,000
	TOTAL	$75,000

Items 1, 2 and 3 above are indications of level of effort and may vary within approximately 10 percent. Items 4 and 5 are initial figures which should be reviewed during preparation of terms of reference. The advisory team budget should be held by the project engineer and amounts released subject to justification by the coordinator in cooperation with the E.R.D.

All other funds could be held in reserve for program expansion and contingencies. The contingencies which might be considered may involve well testing, venting, blow out and investigations of exploration and support service sites.

APPENDIX B

RESUMES

Participants:

1. W.S. Akiyama
2. L. Howard
3. M.Z. Knezevic
4. W.W. Loo
5. R. Missen
6. E.M. Neil
7. M.F. Pugh
8. G.C. Seagel
9. R. Sydnor
10. C.E. Trindle

Support Staff

11. D. Bernard
12. R.W. Davies
13. D.E. warkley
14. T.E. Meehan
15. M.J. Passarini
16. J.L. Sakaguchi

WAYNE S. AKIYAMA **GEOLOGIST**

Claremont Men's College: B.A., Chemistry – Biology
San Diego State University: B.S., Geology

Member: Geothermal Resources Council
American Chemical Society

As a geologist at VTN, Mr. Akiyama's areas of responsibility include field geology, stratigraphy, ground water hydrology, geophysics, structural geology and sedimentology. Specific tasks involve compilation of data from exploration drill holes, soil sampling, analysis of seismic data, mapping, and profiling for baseline studies related to siting and facilities planning of mine and tailings disposal areas, and for geothermal development.

Mr. Akiyama's background has provided him with experience in project management, drilling technology, and the analysis and interpretation of well data. Project management experience includes coordination of events in the preparation of geothermal exploration projects, including supervision of the drilling operation, collection of the well data, and final abandonment procedures. Knowledge in drilling technologies includes the drilling in various formations, and working on various sized drill rigs with depth capacities ranging from 500 to 8,000 feet. Analysis of data includes hand specimen identification, field geology, aerial photo analysis, geologic mapping and geophysical analysis of the drill hole (temperature gradient, gamma ray and electric log data). These tasks involve both the compilation and graphic presentation of the geologic data.

In addition, Mr. Akiyama has experience mapping hard rocks (e.g. igneous and metamorphic) and is familiar with petrology and petrographic methods of identification of these rocks.

VTN

LESLIE HOWARD

ASSOCIATE

SPECIALIST IN ATMOSPHERIC MONITORING

EDUCATION	High School Graduation 1939 Atmospheric Environment Services Numerous Courses
EXPERIENCE	
1979	Associate of REID, CROWTHER & PARTNERS LIMITED Consulting Engineers & Partners
1945-1978	Atmospheric Environment Service of Environment Canada

Supervisor Meteorological Inspection for Pacific Region

The duties of the position of Supervisor of Meteorological Inspections entailed selection of sites for installation of Meteorological instruments, recruiting contractors for obtaining data from equipment installed, acquisition of data, quality control of data, selection and installation of instruments, and servicing of instruments; throughout B.C. Other duties involved the supervision and training of a staff of Meteorological Inspectors, coordinating projects with other government departments and outside agencies and maintaining an operational budget within government guidelines.

Meteorological Inspector & Port Meteorological Officer:

Duties as a Meteorological Inspector and Port Meteorological Officer consisted of installation of meteorological equipment, servicing and maintenance and public relations work in recruiting observers for the climatological and ship programs.

Instructor in meteorological technician program.

Forecast Office Technician:

Duties of a Forecast Office Technician consisted of taking surface weather observations, plotting weather maps, compiling climatological data and dissemination of data received from outside stations.

MIRO Z. KNEZEVIC, Ph.D.

SENIOR ENGINEER
WATER QUALITY SPECIALIST

University of Maryland: B.S., Civil Engineering
University of Maryland: M.S., Environmental Engineering
University of Southern California: Ph.D., Environmental Engineering

Member: American Association for the Advancement of Science
American Chemical Society
American Society for Engineering Education
American Society of Civil Engineers
Chi Epsilon

As a water quality specialist with VTN, Dr. Knezevic is responsible for the design of hydrology and water quality monitoring programs, impact assessments, and mitigation programs as they relate to the siting of mines, mills, tailings disposal areas, and large industrial developments.

Dr. Knezevic is currently acting as assistant project manager for a comprehensive baseline data collection program in Southeastern Alaska, and as water quality monitoring coordinator for a similar project on Admiralty Island. He was responsible for the design and implementation of the water quality sampling activities in hard to access areas, as well as maintaining liaison with analytical laboratories performing analysis on both the water and biological matrices. The interpretation of water quality and fish tissue data centered around postulation of possible pathway mechanisms as well as controlling factors in pristine environments. Resulting "worst possible" scenarios from project development were also analyzed in light of existing Alaska water quality regulations.

Dr. Knezevic is involved in a major geochemical study of 8 geothermal energy development sites in California and Hawaii, as well as development of a potential geothermal resource in British Columbia, Canada. He is familiar with the existing data bank in British Columbia on water resources and water quality. He has extensive experience in assessing potential impacts on water resources as they relate to geothermal resource development. He is currently working on application of best available technology in mitigating hydrosulfide impact from geothermal drilling and power generation.

Dr. Knezevic has experience in writing water resources sections of environmental impact analysis reports related to development of transportation and mining operations. He has knowledge of both water quality criteria and application of best available technology as it pertains to the point source category. In addition, he has a working knowledge of potential water quality problems encountered in the disposal of mine tailings and sump wastes. He is quite familiar with the impacts associated with non-point source emissions primarily related to petroleum hydrocarbon spills.

During his professional career, Dr. Knezevic gained broad experience in water quality monitoring instrumentation used in both marine, surface and ground water systems. Dr. Knezevic has advanced training in environmental chemistry, geochemistry, marine sediments and water column chemistry and water treatment systems. Additionally, he has working knowledge of computer simulation of mineral speciation and equilibrium under various physical and chemical conditions.

WALTER W. LOO

GEOLOGIST
GEOHYDROLOGIST

Oklahoma State University: B.S., Geology
Oklahoma State University: M.S., Geohydrology

Registered Professional Geologist

Member: American Society of Civil Engineers
American Geophysical Union
National Water Well Association

Mr. Loo is manager of geoscience services for VTN, in the areas of in-situ solution mining, in-situ coal gasification, mine dewatering, baseline groundwater monitoring, groundwater restoration, geohydrological testing, analysis and well field design, and digital computer simulation studies. As a geohydrologist with VTN, Mr. Loo is presently responsible for a major groundwater availability study of 14 geothermal energy development sites in California and Hawaii for the U.S. Department of Energy. He also has a broad range of experience in land subsidence evaluation in southern Florida and the Texas Gulf Coast areas. These evaluations include both elastic and inelastic deformation due to decline of piezometric levels in multiple aquifer systems.

As a geohydrologist with VTN, Mr. Loo is presently responsible for a major groundwater availability study of 14 geothermal energy development sites in California and Hawaii for the U.S. Department of Energy.

He also has a broad range of experience in land subsidence evaluation in southern Florida and the Texas Gulf Coast areas. These evaluations include both elastic and inelastic deformation due to decline of piezometric levels in multiple aquifer systems.

As the chief geohydrologist with a major uranium mining company, Mr. Loo was responsible for field hydrologic testing, pump test analysis, well field design, computer optimization studies, design of programs for groundwater monitoring and restoration, permit applications, and negotiations with various federal, state and local agencies for pilot testing facilities and full-scale production plants. He has conducted 18 aquifer tests on five major uranium bearing sandstone in Wyoming, Texas and Colorado. These tests provide basic data required by regulatory agencies and also two-dimensional well-field spacing design parameters. Mr. Loo has also developed computer programs to solve two and three-dimensional aquifer and geohydrologic analyses.

During his professional career, Mr. Loo was the principal investigator of the regional groundwater resources evaluation of the Navajo Indian Reservation. The study covered a 25,000 square mile area with six major regional aquifers which were then classified by water quality and their productivity. A detailed water budget balance was also performed and included the analysis of recharge, discharge and water use of the entire Navajo Indian Reservation.

Mr. Loo was in charge of a major groundwater supply investigation in southern Florida which included exploration deep-well drilling, design of a 6,500-gpm pump test, well-field design and saltwater intrusion analysis.

Many of the studies conducted by Mr. Loo have included the assessment of the integrity of well sumps and mine tailings ponds to withstand landslides and other seismic events. Mr. Loo is versed in the properties and constituents of drilling muds and the requirements of SWQCB for sumps and other related containment structures.

ROBERT MISSEN

ATMOSPHERIC SCIENTIST

University of California, Los Angeles: M.S., Atmospheric Sciences
Air Pollution Control Institute, University of Southern California: Graduate Studies
University of London, England: Graduate Studies
University of London, England: B.S., Aeronautics

Member: Air Pollution Control Association
Royal Meteorological Society

Certified: Visible Emissions Inspector

Mr. Missen's expertise in the atmospheric sciences covers a broad spectrum of activities ranging from air pollution dispersion studies to the analysis of noise attenuation rates. Air pollution engineering projects have included the preparation of statewide point and area source emission inventories, the preparation of permit applications and the supervision of emissions testing programs. Atmospheric dispersion studies have included research studies to improve the definition of meteorological parameters used in simulation models, field programs to collect data for the validation dispersion models, the performance of air pollution modeling studies in order to determine the impact of various types of sources on ambient air quality levels and the issuance of forecasts for atmospheric pollution concentrations. Among the publications that he has authored for the Environmental Protection Agency are documents outlining the approved procedures for evaluating the opacity of visible emissions and the procedures for analyzing reasons for the non-attainment of the national ambient air quality standards.

Projects involving the impact of airports on ambient air quality levels have been conducted in Honolulu, Hawaii, Oklahoma City and Tulsa, Oklahoma, the Tampa Bay region of Florida and Albuquerque, New Mexico. The emissions categories considered in these studies included commercial and military aircraft, helicopters, general aviation, automobile traffic, support vehicles, test facilities, fuel storage tanks and other stationary sources. Spatial and temporal variations were considered in the analyses and the air quality impacts were determined using the Airport Vicinity Air Pollution Model (AVAP) developed by the Federal Aviation Administration and the Climatological Dispersion Model (CDM) developed by the Environmental Protection Agency.

Other recent projects have included the preparation of the climatology, air quality and noise sections of environmental impact reports for various redevelopment programs. Typical studies include the redevelopment of the central San Diego area, a realignment of the U.S. Marines training facilities at Camp Pendleton and San Diego, and an assessment of the proposed transportation plan for Long Beach and Los Angeles Harbors. These projects involved the description of existing air quality and noise levels using available data sources and field measurements, and an analysis of future emissions burdens and noise levels. Mr. Missen is currently supervising meteorological and air quality data acquisition programs for proposed mineral developments in Alaska, Colorado and Nevada, in connection with the "Prevention of Significant Deterioration" requirements of the Clean Air Act. The data from these field programs are being analyzed to determine the probable worst-case atmospheric dispersion characteristics and the impacts of the sources on air quality levels are being determined by means of various dispersion models.

In his capacity as an aerodynamics engineer, Mr. Missen was responsible for experimental and analytical studies concerning the performance and handling characteristics of rotary-wing aircraft. Typical projects included the analysis of techniques for reducing the noise signature of helicopters and the analysis of the vibrational and aerodynamic characteristics of rotor blades.

vtn

ELIZABETH M. NEIL, B.Sc.

BIOLOGIST

EDUCATION — B.Sc. Zoology, University of Calgary - 1974

EXPERIENCE

1975-Present — REID, CROWTHER & PARTNERS LIMITED
Consulting Engineers and Planners

Biologist, projects include:

Chronic toxicity study on Fish Creek for the City of Calgary, Alberta.

Environmental planning study for a sour gas extraction development in the Alberta Foothills.

Water quality assessment for the Calgary Regional Planning Commission and report on development costs.

Environmental assessment of the Sarcee Trail Highway Project, City of Calgary, Alberta.

1974-1975 — PollEcol Ltd.
Consulting Biologists

Projects in association with
Reid, Crowther & Partners Limited:

Impact assessment of waste treatment plant discharges on the Waterton River. Recommendations concerning pipeline route and discharge point into the Waterton River.

Assessment of effects of construction and operation of the Brooks Fertilizer Plant on pronghorn antelope.

Recommendations concerning route of gas pipeline for Husky Oil.

Water quality assessment of Bow River adjacent to Fish Creek Sewage Treatment Plant.

ELIZABETH M. NEIL, B.Sc.

(continued)

EXPERIENCE

PollEcol projects:

Partical size and analysis on sediment samples for Shell Oil Limited.

Impact assessment of Ram River Gas Plant effluents on the receiving waters.

1971
1973-1974 University of Calgary

Research Assistant:

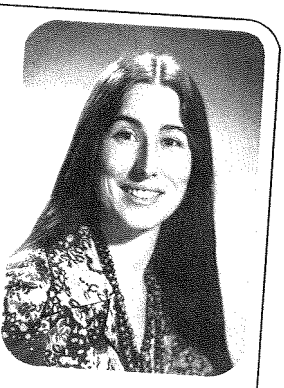
Study of the effects of thermal effluents on aquatic communities.

Assistance in collection of data for population studies on small mammals, aquatic invertebrates.

1972 Canadian Wildlife Service

Inventory of aquatic communities in Banff, Jasper and Yoho Parks.

Analysis of phytoplankton and zooplankton samples from Waterton Lakes National Park



MARIAN F. PUGH, B.Sc.

BIOLOGIST,
ENVIRONMENTAL ANALYSIS DIVISION

EDUCATION

B.Sc. Botany, University of Calgary - 1975

EXPERIENCE

1977-Present

REID, CROWTHER & PARTNERS LIMITED
Consulting Engineers and Planners

Public Participation Project Manager, for planning and development of Lake Louise Visitors Centre, Banff National Park, for Parks Canada. Involved design and conduct of programs to encourage full public participation, managing work of a Public Advisory Committee, and processing and reporting public input

Impact analysis and report preparation, Environmental Impact Assessment of McGregor River Diversion for B C Hydro

1975-1977

Central Mortgage & Housing Corporation
Land & Infrastructure Division

Design and implementation of an intensive land use mapping program of the Greater Vancouver Region

1974-1975

PollEcol Ltd., Consulting Biologists

Projects in association with
Reid, Crowther & Partners Limited:

Vegetation survey in and around Waterton Lakes National Park. Analysis of impact of pipeline right-ofway through the park

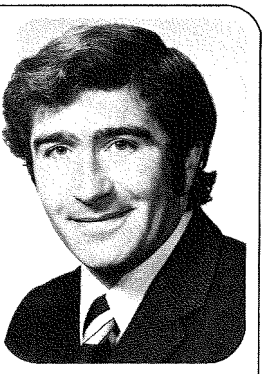
Identification of periphyton samples from Waterton River

Vegetation survey in Glenmore Dam - Weasel Head area of Elbow River. Mapping vegetation associations and impact analysis of a freeway project on the area

1973-1974

University of Calgary

Research Assistant. Classification and mounting vascular plants for the Herbarium at University of Calgary



GRAHAM C. SEAGEL, B.Sc., M.Sc.

GEOGRAPHER

EDUCATION	B.Sc. (Honours) Geography, University of London - 1968 M.Sc. Geography, University of Alberta - 1971
PROFESSIONAL MEMBERSHIP	American Right-of-Way Association Alberta Geographical Society Canadian Geothermal Resources Association

EXPERIENCE

1975-Present — REID, CROWTHER & PARTNERS LIMITED
Consulting Engineers and Planners

Environmental Co-ordinator for:

Preliminary environmental study, Geothermal Energy Prospect near Pemberton for B C Hydro

Watershed Research Project for Procter & Gamble Cellulose Ltd. - centred on forestry practices and effects on the bio-physical environment

Environmental Impact Assessment for B C Hydro - McGregor River Diversion Project. Co-ordination of recreation, socio-economic, hydrology, forestry, soils, climate, archaeology, land use, fish & wildlife aspects

Technical input to an environmental overview for an airport in the East Kootenays

Environmental Impact Assessment for Sarcee Trail Highway Project - co-ordination of air, noise, ecology, recreation, planning and archaeological disciplines in a complex area of Southwest Calgary

Monitoring stream crossings for a gas pipeline near Vancouver

1972-1975 — Bolter, Parish, Trimble Limited

Hydrologist and Environmental Advisor:

McKenzie Highway, Meziadin Railway & Arctic Railway. Hydrologic, climatic and stream behavioural assessment for stream crossing location and impact minimization

GRAHAM C. SEAGEL, B.Sc., M.Sc.
(continued)

EXPERIENCE

Clinton-Ashcroft Railway Project. Hydrologic assessment of stream crossings and irrigation works for the purpose of railway location and impact assessment

Athabasca Tar Sands Corridor Study. Geographical and hydrologic input to an assessment of multi-use transportation corridors (roads, railways, pipelines and power lines). Study compared various impacts of different combinations of these transportation modes in Northeast Alberta. Recommendations concerned route location, methods for implementing corridors, and the siting of petrochemical plants

Vermilion River Basin Study & Vermilion River Study. Assessment of hydrologic components of the environment for the purpose of flood reduction, agricultural enhancement and minimization of land alienation and severance

Burke Mountain Development, B.C. Environmental input concerning storm sewer design & natural drainage protection

Big Eddy Waterworks, near Revelstoke. Recommendations for alignment of transmission line through Dolan Creek watershed for purpose of protecting natural flow regime

Lytton Railway Siding. Hydrologic assessment and conceptual design of structures for grade protection along Thompson River and local drainage

On behalf of Canadian National Railways, numerous stream crossing assessments from the hydrologic and environmental point of view for purpose of stream crossing improvement

1971 Research Council of Alberta

Derivation and initiation of a practical stream classification system for Alberta

1968-1969 Quilter and Atchley

Research assistant, responsible for stock and shares analysis and adaptation of company files and operations to the computer

ROBERT SYDNOR

PROJECT MANAGER
SENIOR ENGINEERING GEOLOGIST

University of California, Riverside: M.S., Geology, 1975
Whittier College, Whittier, California: B.A., Geology, 1969

Registered Geologist: California, Oregon, Arizona
Certified Engineering Geologist: California, Oregon
Certified Professional Geologist: A.P.G.S.

Member: Association of Engineering Geologists (Vice Chairman 78-79, So. California Section)
Geological Society of America
American Association of Petroleum Geologists
National Association of Geology Teachers
Association of Professional Geological Scientists
Southcoast Geological Society
American Geological Institute
Branner Geology Club of Southern California
Natural History Foundation of Orange County, California
Transportation Research Board, National Research Council
Society of Economic Paleontologists and Mineralogists, Pacific Section
California State Board of Registration for Geologists and Geophysicists, Examination Committee Chairman, 1978-1979

As senior engineering geologist with VTN, Mr. Sydnor has seven years of experience in landslides, seismic hazards, geologic mapping, and soil mechanics. As project manager, he is responsible for budget preparation and cost control, and liaison with geotechnical consultants and regulatory agencies.

Mr. Sydnor previously served as an engineering geologist for the Environmental Management Agency of the County of Orange. In that capacity, he reviewed 1,500 soil engineering and geology reports for grading permits in residential hillside development. He is experienced in grading codes, building codes, grading plan requirements, and foundation engineering.

During previous work for the consulting firm of Leighton and Associates in Irvine, Mr. Sydnor prepared geologic reports on several dozen large residential tracts in all phases of grading, from preliminary geologic mapping through final as-built reports. He worked closely with government planners on Seismic Safety Elements for General Plans for local cities and counties in California. As a consultant he has worked on subsurface geologic mapping of active faults, retaining walls and earth buttresses, ground-water investigations, highway cut-slope stability, sand and gravel studies, bridge abutments, rock quarries, and coastal bluff stability investigations. He has prepared seismicity reports for several public schools and large buildings.

In 1970 and 1971 Mr. Sydnor worked in arctic Alaska for Mobil Oil Corporation as an exploration petroleum geologist and paleontologist. He is experienced in physical stratigraphy, invertebrate fossils (Foraminifera, brachiopods, gastropods, cephalopods and pelecypods), gravity survey, and uranium exploration using a scintillometer.

As an instructor in geology at several colleges in Orange County, Mr. Sydnor has taught extended-day courses in mineralogy, petrology, engineering geology and mining geology. He currently serves as Chairman of the Examination Committee of the State Registration Board, and as an officer in the local section of the Association of Engineering Geologists.

CAROLYN E. TRINDLE

ENVIRONMENTAL SPECIALIST

University of Missouri, Columbia: Bachelor of Journalism
University of Missouri, Kansas City: M.A., English Education

Member: Canadian Geothermal Resources Association
Geothermal Resources Council

As an environmental specialist at VTN, Ms. Trindle has been primarily involved in energy-related projects, having participated in the preparation of all geothermal and transmission corridor reports produced by the Environmental Sciences Division during the past two years. Currently, she is project manager for an Environmental Reconnaissance Report concerning the development of the Meager Mountain Geothermal area in British Columbia, Canada. For this study, Ms. Trindle is also responsible for project planning, and determining the socioeconomic and aesthetic issues and potential impacts surrounding development of the geothermal resource.

Ms. Trindle served in a project manager capacity for the Draft and Final Environmental Impact Reports prepared for the SDG&E/Chevron geothermal development of the Heber KGRA in the Imperial Valley, California, including presentation of the document at public hearings, and preparation of a summary of the Final EIR. Ms. Trindle was involved in the preparation of the Final Environmental Impact Report for Union Oil Company's Cobb Mountain geothermal project, and she performed project management duties in preparing the Draft Environmental Impact Report for Sunedco's geothermal exploration project at the County Line Prospect in Colusa County, California. In addition to project management responsibilities, she prepared the socioeconomic, land use and aesthetic elements of the report. This involved field analysis and data interpretation to characterize the existing environment and prepare an analysis of the impacts of the proposed project.

Ms. Trindle was project coordinator for three geothermal Environmental Assessments prepared concurrently for McCulloch Oil Company's CU I Joint Venture, two for projects in southwestern Utah and one in the Imperial Valley, California. Ms. Trindle also participated in the Environmental Analysis of the two Utah projects, for which she performed field evaluations of existing land uses and visual resources and prepared analyses of the two proposed projects upon these resources.

Ms. Trindle was involved in O'Brien Resources' Roosevelt Geothermal Project in Utah, in which she assisted in preparing the necessary submittals to the Department of Energy. She was also involved in preparation of the Environmental Report, assisting in the design and development of various elements included in the project description and in the analysis of socioeconomic impacts.

Other energy-related experience includes Ms. Trindle's involvement in corridor selection studies. She was assistant project manager for the Environmental Assessment of the Santa Fe Railroad's proposed 115-mile rail corridor from Baca to northwestern New Mexico. In addition to her administrative duties, Ms. Trindle conducted an analysis of existing socioeconomic conditions both on and off the Navajo Indian Reservation and an assessment of the potential impacts of the proposed railroad upon both the Anglo and Navajo societies. She also participated in a utility corridor selection study for a 38-mile, 345-kV transmission line from Ojo to Taos, New Mexico. The corridor selection process involved on-ground field reconnaissance of the study area to analyze preliminary engineering and aesthetic concerns, plus the graphic depiction of areas of visual impact, presented on topographic maps, and an assessment of these impacts. Ms. Trindle is currently conducting a study to determine and assess the aesthetic impacts of constructing a 100-mile, 500 kV electric transmission line in northeastern New Mexico.

DOUG W. BERNARD, B.Sc., P. Geol.

GEOLOGIST,
ENVIRONMENTAL ANALYSIS DIVISION

EDUCATION	B.Sc. Geology, University of Alberta - 1974
PROFESSIONAL MEMBERSHIP	Association of Professional Engineers, Geologists and Geophysicists of Alberta Alberta Water Well Drilling Association National Water Well Drilling Association Geological Association of Canada

EXPERIENCE

1978-Present	REID, CROWTHER & PARTNERS LIMITED Consulting Engineers and Planners Geologist, Environmental Analysis Division
1977-1978	Hydrogeological Consultants Ltd. Hydrogeologist, groundwater supply and mapping projects, including:

Groundwater Reconnaissance and Development, Kananaskis Provincial Park

Development of water injection wells for Water Flood Scheme, West Pembina Oilfield, Alberta

Groundwater supply program, Town of Vermilion, Alta.

Groundwater supply, Whitecourt & Jasper-Hinton Airports

Feasibility study of deep-well disposal of reverse-osmosis effluent, Mundare, Alberta

Sewage effluent mapping, modelling and monitoring of a small sewage treatment plant, Kelowna, B.C.

Groundwater supply programs for various towns and villages in Alberta including Strathmore, New Norway and Paradise Valley

Various suitability studies for the use of septic tanks and water wells in Alberta country residences

DOUG W. BERNARD, B.Sc., P. Geol.

(continued)

1976-1977	Research Council of Alberta Research Officer. Hydrogeological mapping of highway corridors, Jasper National Park
1974-1976	University of Alberta Department of Geology Research Assistant: Groundwater flow between Prairie Lakes, Lake Wabamun and Hastings, Alberta Fluid responses in fractured media Cesium adsorption by clay minerals in glacial tills Various field programs involving installation of piezometers to determine groundwater occurrence and movement
1972-1973 (summers)	Geological Survey of Canada District of MacKenzie, N.W.T. Near shore mapping of marine sediments and erosional activities upon them Surveying and mapping permafrost areas of the MacKenzie Delta, N.W.T. Installation and monitoring piezometers in permafrost terrain
PUBLICATION	"Hydrogeology of Highway Corridors, Jasper National Parks", Alberta Research Council Internal Report and Maps, 1977

RONALD W. DAVIES

ASSOCIATE

SPECIALIST IN AQUATIC ECOLOGY

EDUCATION

B.Sc. (Botany)/University of Wales - 1962
B.Sc. (Hons. Zoology)/University of Wales - 1963
Diploma in Education (Hons.)/University of Wales - 1964
Ph.D. (Aquatic Ecology)/University of Wales - 1967

PROFESSIONAL MEMBERSHIP

British Ecological Society
Ecological Society of America
Canadian Society of Zoologists
Freshwater Biological Association
American Society for Limnology and Oceanography
American Association for the Advancement of Science

EXPERIENCE

Consulting Association with
Reid, Crowther & Partners Limited

1972-Present

Lake Wabamun Study for the Government of Alberta. A study of the effects of thermal discharges on the ecology of a recreational lake.

Water quality survey for the Regional District of East Kootenay, B.C. Study of existing water quality condition in relation to waste discharges.

Report on advanced waste treatment for Waterton National Park and the effects of discharges on the Park environment.

Biological assessment study on the Bow River at Fish Creek Waste Treatment Plant for the City of Calgary. Study to determine design parameters for outfall design and provide base line water quality data.

Vermilion River Basin Study for Alberta Environment. Collection of biological data to define existing water quality conditions and assessment of impact of management schemes on benthos, fish and wildfowl.

Waterton River Study for Environment Canada. Collection of biological data to enable assessment of impact of waste discharges. The study included the impact assessment of a five-mile effluent forcemain on the terrestrial ecosystem.

Chronic toxicity study on Fish Creek for the City of Calgary.

Environmental planning study for a sour gas extraction development in the Alberta Foothills.

RONALD W. DAVIES

ASSOCIATE

SPECIALIST IN AQUATIC ECOLOGY

(CONTINUED)

Areas of Direct Ecological Experience

Ecology of inland waters, including studies on the biology, bacteriology and chemistry of rivers and streams receiving wastes, coal mining effluents, thermal discharges, etc.

The impact of winter road crossings on rivers. The effects of hydroelectric impoundments on rivers.

The assessment of forest, water and wildlife resources in the Tar Sands area.

The assessment of the effects of gaseous discharges on forest vegetation.

Areas of Ecological Interest and Relevance

The impact of human activities on communities and ecosystems.

The taxonomy of aquatic invertebrates.

Professional

1972	Chairman, Division of Environmental Biology Department of Biology, University of Calgary
1972-Present	Associate Professor of Biology, University of Calgary
1969-1971	Assistant Professor of Biology, University of Calgary
1968-1969	Research Scientist, Canadian International Biological Programme
1967-1968	Assistant Professor of Zoology, University of Wales

DALE E. MARKLEY HYDROGEOLOGIST

Wittenberg University: B.S., Geology

Member: National Water Well Association

As a project hydrologist with VTN, Mr. Markley is responsible for geologic and hydrologic environmental assessments and impact reports. He is presently participating in a power line transmission corridor selection study along a 170-mile route for New Mexico. As a member of the corridor selection team, Mr. Markley is analyzing the soils, geology and seismicity on various alternative routes for a 500-kv transmission line from Four Corners to Albuquerque, New Mexico. His analysis includes field investigations and map interpretation.

In addition to corridor selection work, Mr. Markley is participating in planning, baseline and monitoring programs and evaluation of a variety of environmental and energy projects. They include: a major potential water availability assessment of 14 geothermal energy development areas in California and Hawaii for the U.S. Department of Energy; hydrologic data collection and water quality monitoring of two mine sites in Alaska; investigation of the existing geologic environment and impact for a proposed transportation plan for the San Pedro Bay port area and for a proposed transmission power line in northwestern New Mexico for the Public Service of New Mexico.

As a hydrologist, Mr. Markley was involved in a broad range of studies for a consulting firm in Colorado. His responsibilities included: evaluation of well development and analysis for a housing project; determination of ground water supplies by computer modeling, stream transmission losses, flood estimates, baseline sampling and stream gauging, precipitation and snow measurements, and well-field design; and determination of coal resources in the Knife River area, North Dakota.

Prior to his consulting experience, Mr. Markley was a staff hydrogeologist for a major uranium mining company. In this capacity, he was involved in aquifer analysis for in-situ solution mining, where he conducted hydrologic testing and analyzed pump tests for well-field design and licensing with various government agencies. He has conducted over a dozen pump tests in several of the major uranium bearing formations in Wyoming, Texas and Colorado. In addition to this, he has done geophysical interpretations of logging and coring to generate isopach and structural maps.

ECOLOGIST
WILDLIFE BIOLOGIST

THOMAS E. MEEHAN, Ph.D.

University of Redlands, Redlands, California: B.S., Biological Sciences
University of California, Irvine, California: Ph.D., Biological Sciences

Member: American Institute of Biological Sciences
American Society of Mammalogists
Ecological Society of America
California Native Plant Society

Honors:
1967 Edmund Jaeger Award, Outstanding Biology Major, University of Redlands
1968-1971 NDEA Fellow, University of California, Irvine
1971 NSF Fellow, University of California, Irvine
1971 NSF Fellowship to attend the Organization for Tropical Studies' ecology program in Costa Rica
1974-1975 Earl C. Anthony Fellow, University of California, Irvine

Dr. Meehan designs, conducts and coordinates ecological studies in terrestrial ecosystems, with special emphasis on wildlife populations, and has extensive experience with both transmission corridors and geothermal projects. Dr. Meehan is currently evaluating the impacts on vegetation and wildlife for a proposed 170-mile, 500-kV transmission line from the Four Corners area to Albuquerque, New Mexico. Recently, he participated in the corridor selection, assessment, and mitigation formulation for biological impacts for a 40-mile, 345-kV transmission line from Hernandez to Rio Taos, New Mexico. This line involved traversing a wild and scenic portion of the Rio Grande River and impacting a rare plant. Also, Dr. Meehan evaluated existing wildlife and habitat, and assessed potential impacts and their mitigation for a 33-mile railroad corridor from Gallo Wash to the Navajo Indian Reservation in northwestern New Mexico.

Dr. Meehan recently completed an evaluation of the impacts and mitigation measures for the Roosevelt Geothermal Project in southern Utah. This project involved exploratory drilling, proposed full-field development, and the siting and design of a 55-mW power plant. He has also completed three biological studies for McCulloch Oil Corporation's proposed geothermal exploration programs near Beryl and Lund, Utah, and Brawley, California. Currently, he is involved in evaluating the environmental feasibility and potential impacts of a proposed geothermal development and corridor in British Columbia, Canada. In addition, he recently served on a team that evaluated the effectiveness of the California Department of Fish and Game's (CDFG) state-wide review of environmental documents. This study included an examination and evaluation of the department's environmental concerns and mitigation recommendations for Magma Power Company's exploratory wells in East Mesa, California, Union Oil Company's exploratory programs in Brawley and Heber, California, as well as geothermal and corridor projects in other areas of California.

In addition to corridor and geothermal studies, Dr. Meehan has experience in a broad range of project types and biological environments. Currently, Dr. Meehan is coordinating the design and conduct of two terrestrial biological baseline data collection programs, including vegetation mapping and sampling, wildlife census and inventory, and interaction with freshwater and marine investigations including fisheries and invertebrates, for two proposed mines and mills in Alaska. Other projects include a vegetation and wildlife inventory and impact assessment for an open-pit uranium mine and mill in southern Texas; and a live trapping study which extended the range of the "rare" Stephens' kangaroo rat (*Dipodomys stephensi*) in southern California.

Dr. Meehan has conducted field studies in Costa Rica, Central America, and Baja California, as well as in the western United States. He has teaching experience in general zoology, field ecology, ornithology, vertebrate ecology and behavioral ecology.

THOMAS E. MEEHAN, Ph.D. (Continued)

Publications:

Meehan, T.E., P.W. Rundel, R. Ambrose, G. Baker and A. Rappoport, 1977. The influence of intense selective browsing by pocket mice (*Perognathus*) on the spatial distribution of *Polygala deserticum* in Baja California. American Midland Naturalist 97:489-495.

Ambrose, R.F. and T.E. Meehan, 1977. Interspecific Aggressive Behavior between *Perognathus parvus* and *Peromyscus maniculatus* from the Great Basin sage-scrub, Mono County, California. Journal of Mammalogy 58:665-670.

MARK J. PASSARINI AIR RESOURCES ENGINEER/ACOUSTICIAN

University of California, Irvine: B.S., Civil and Environmental Engineering

Member: Air Pollution Control Association
American Society of Civil Engineers
American Institute of Mining Engineers

Honors: UCI Engineer of the Year Award

As an air resources engineer/acoustician with VTN, Mr. Passarini is involved in technical investigations, research and assistant project management concerning the design and conduct of environmental baseline and operational data collection activities, the preparation of environmental baseline reports and assessments and the submittal of required permits and reports through the agency and public hearing phase. Project experience has comprised a variety of projects, including urban and rural developments, airports and related transportation systems, and the planning, design and development of mining and energy-related facilities.

Mr. Passarini is well-versed in the many aspects of air resources management, acoustical engineering and the atmospheric sciences, including meteorology, ambient monitoring, source definition, control evaluation, regulations and standards interpretation/application and estimation of impacts. Current experience includes incineration and odor control design studies for a proposed sewage treatment facility in Lynn, Massachusetts and an air monitoring program for a proposed geothermal exploration project in Colusa County, California. He recently conducted an air resources analysis for a proposed military facilities relocation in Quonset, Rhode Island; acoustical analyses for a proposed petroleum products terminal in Los Angeles, California; a proposed office building development in Newport Beach, California; and the proposed redevelopment of downtown San Diego, California. Mr. Passarini assisted in the air resources impact analyses for the ownership transfer of the Hollywood-Burbank Airport and the proposed Atlantis Hotel in Las Vegas, Nevada.

Mr. Passarini has additional experience in the areas of water and waste management, including water quality analyses and controls, hydrology, dewatering techniques, incineration systems, heat recovery, wet scrubbing and chemical treatment processes. He has conducted incineration and odor control feasibility and design studies for a 26-MGD wastewater treatment plant in Lynn, Massachusetts, in addition to leachate control studies for the Cathcart sanitary landfill in Snohomish County, Washington. He has been involved in studies concerning certain land disposal alternatives relative to the upgrading and expanding of sewage facilities in Vacaville, California. Mr. Passarini's undergraduate design project comprised the design, fabrication and testing of a laboratory-sized activated sludge treatment unit with a 2,000-GPD capacity and complete-mix, step-feed and step-aeration treatment mode capabilities.

Mr. Passarini has been involved with environmental investigations to support permit acquisition programs for a variety of mining and energy-related projects in the western United States, including a 3,000-TPD uranium mine and mill project in Karnes County, Texas. Mr. Passarini has also contributed to environmental feasibility studies for a proposed lead/zinc project north of Kotzebue, Alaska, proposed molybdenum projects in southern Alaska and southwestern Utah, and proposed uranium projects in southern Texas and northern Nevada. Mr. Passarini recently conducted water resources analyses for environmental documents in support of DOE loan guarantee programs for three major potential geothermal power plant projects, including the proposed 45-MW Heber binary geothermal power plant in the Imperial Valley, California. In addition, he coordinated a one-year air and water monitoring program for a proposed geothermal exploration project in Colusa County, California.

JOHN L. SAKAGUCHI

ECONOMIST
ENVIRONMENTAL PLANNER

University of California, Berkeley: B.A., Economics
University of California, Berkeley: M.B.A., Marketing and International Business

As associate manager of urban and regional sciences and an economist with VTN, Mr. Sakaguchi is responsible for quality assurance and the preparation of economic, financial, fiscal, socioeconomic, cost/benefit and demographic analyses. His experience encompasses the application of such disciplines as economic forecasting, cash flow projections, project cost analysis, public utility rate analysis, market research techniques, and public and private financial planning.

Mr. Sakaguchi is acting project manager for a major planning study undertaken for the U.S. Department of Energy, Division of Geothermal Energy. Two primary areas of analysis are involved in this planning project. First, an analysis is being conducted to determine the long-range implementation plans for geothermal power plant development in California and Hawaii. This phase of the study involved extensive review of plans developed by both geothermal field developers/operators and utilities. The second major area of analysis involved water resources availability in the major geothermal areas of California and Hawaii. Potential sources of water, projections of water demand for power plant cooling purposes, and discharge requirements and standards were the critical factors considered. Over 30% of this work effort is directly applicable to the Geyser's KGRA, and includes Lake Sonoma and Mendocino Counties.

Economic effects associated with the proposed San Diego Gas and Electric geothermal demonstration plant were a major study element of the Environmental Impact Report recently prepared for Imperial County, California. This proposed plant, located in Heber, would be the first hydrothermal/binary power generating station built in the United States. The economic analysis analyzed the effects of the geothermal power plant on the agricultural-oriented economy of Imperial County. Economic effects during well drilling operations, plant construction and the power plant operating phase were assessed.

Mr. Sakaguchi also prepared the economic analysis and impact assessment for a proposed 55-mw hydrothermal power plant to be located at Roosevelt Hot Springs in southern Utah. Roosevelt Unit No. 1 will be located in a rural area where direct impacts on housing, employment and labor force, taxes, community services will continue beyond the two-year construction time through the operational life of the project. In recognition of these likely impacts, Mr. Sakaguchi's team developed comprehensive economic cost-benefit and cost-revenue analysis and recommended mitigation measures and action-oriented programs to enhance positive community impacts and benefits resulting from the project.

As part of a corridor selection study and Environmental Impact Statement for Plains Electric, an REA Cooperative, Mr. Sakaguchi performed an analysis of the direct economic impact of an electric transmission line proposed for northeastern New Mexico. Major study elements included analysis of employment effects during construction of the transmission line, right-of-way payments to the landowners and tax benefits accruing from the proposed line. The analysis indicated the cost/benefits to the local area.

The primary emphasis of Mr. Sakaguchi's work on the Hollywood-Burbank (California) Airport EIAR was on the direct economic contribution of the airport to the local area economy. Economic and financial analysis of the businesses located on the property were used as the basis for estimating the airport's contribution to the local community. Assessments of residential dwelling units and home sound insulation in the noise impact area surrounding this urban airport were among the major items addressed in the EIAR.

Analysis of the economic effects was a major consideration related to the City Centre Redevelopment Project in downtown San Diego. Primary concerns included in this master Environmental Impact Report were the effects of major new employment from the redevelopment, projected new retail activity and impacts from the planned convention center. Taxation impacts associated with tax increment financing and various other sources of revenue for redevelopment were also examined in this study.

The economic contribution from the presence of Army activities in the Panama Canal Zone was a key aspect of the Environmental Impact Statement on the realignment of seven military bases in the Canal Zone. Effects of military and civilian personnel on the Panama area economy were key considerations examined in this study. Analysis of employment effects, direct purchases by the military, and personal expenditures by both military and civilian personnel were the main sources of economic effects identified in this analysis.

Analysis conducted by Mr. Sakaguchi was a major portion of the Fort MacArthur Realignment Study, performed for the U.S. Army Corps of Engineers. This study involved the economic analysis of the impacts of five alternative realignments, ranging from closure to the utilization of the Fort by four other Department of Defense activities. Economic analyses of the effects of changes in employment, income, expenditures, and fiscal impacts were among the major objectives of this study.

Economic effects were a major input to a study recently completed for the City of Burbank, California, Public Services Department. This EIR examined the economic impacts of a proposed restructuring of electric utility rates for the City of Burbank. Economic effects on all classes of customers, including residential, commercial and industrial, were evaluated in this study. A similar economic analysis was completed for the City of Oceanside (California) Water Department.