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1st SPRINGHILL GEOTHERMAL
ENERGY CONFERENCE
SPRINGHILL, NOVA SCOTIA
28-29 OCTOBER 1992

SUMMARY REPORT

K. Arkay

Katherine Arkay Consulting
Ottawa, Ontario

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1st Springhill Geothermal Energy Conference

Springhill, Nova Scotia
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Summary Report

March 1993

The Conference was organized by the Town of Springhill and funded by the Town, the Cumberland Development Authority, Nova Scotia Department of Natural Resources, Nova Scotia Power Corporation, and Energy, Mines and Resources Canada.

This Report provides: (1) a summary of the presentations, working group sessions, and open-discussion at the Springhill Geothermal Conference; and (2) an analysis of the Conference results, and identification of major concerns, opportunities, and action required.

The Report preparation and the post-conference analysis were carried out under contract for the Town of Springhill. The views expressed in the Report are those of the Conference participants and of the consultant who produced the Report.

Prepared by Katherine Arkay
Katherine Arkay Consulting
Ottawa, Ontario

Executive Summary

Objectives and Organization

This report documents the results of the First International Geothermal Energy Conference held in Springhill, Nova Scotia (28-29 October 1992). The Conference brought together individuals and organizations interested in aspects of the recovery of geothermal energy from abandoned mines. The Conference consisted of eleven formal presentations, a site visit, working group activity, and question/discussion periods. Over ninety individuals participated in the technical sessions.

The Conference provided an opportunity: (1) to exchange information on a range of issues relevant to development of low-temperature geothermal energy from abandoned mines; and (2) to identify opportunities, problems, needs, and recommended priority actions regarding the assessment, development, protection, and marketing of low-temperature geothermal resources in Nova Scotia.

Issues addressed include: the nature of low-temperature geothermal resources; the technology for finding, assessing and recovering the energy; district (shared) energy systems; aquifer/data management systems; the economics of geothermal energy use; and ownership of the resource.

Results

The following are the major conclusions from the Conference:

Development of geothermal resources from mines is of interest to several Nova Scotia communities in proximity to large abandoned mines, and to the federal and Nova Scotia governments which are interested in encouraging energy self-sufficiency and diversification.

The use of low-temperature geothermal energy from abandoned mines is a recent application in Canada, and still uncommon anywhere (internationally). The early steps in the use of geothermal energy have been taken. The development of the Springhill geothermal resource has demonstrated a number of advantages and benefits related to the use of geothermal energy; cost-effective recovery and use of the energy is possible. The work at Springhill has also identified some broad legislative and technical issues that need to be addressed.

More needs to be done to integrate the use of geothermal energy into routine consideration, and to facilitate effective decision-making regarding geothermal resources. The next steps are important ones. Action is needed to facilitate beneficial use, and effective management and protection of geothermal resources in general. Action is also needed to advance the use of the geothermal resource at Springhill, and to assist other communities in considering and developing similar resources. A broad range of needs and recommendations were identified in the course of the Conference.

The Conference results and recommendations are relevant to several parties including: the Town of Springhill and other communities considering development of geothermal resources; government organizations (municipal, regional, provincial, and federal) with an interest in geothermal-related issues such as land and resource ownership, energy use, and environmental protection; and the private sector (as providers of geothermal expertise and services, and as potential users of the resource).

Priority Action Items (Needs)

With respect to the recovery of geothermal energy from abandoned mines, the time is appropriate to take stock, set priorities, and establish an action plan.

A number of actions are required to foster the efficient assessment, protection, promotion, and development of geothermal resources from abandoned mines. Some of the required actions are site-specific, others are more generic and involve action/policies at the provincial or federal level. It has to be demonstrated that the energy can be effectively and economically recovered; the ownership of the geothermal resource has to be clarified; a regulatory/jurisdictional framework for the use of the resource has to be established; a decision framework has to be developed to guide interested individuals and organizations in the work required to delineate, assess, and develop a specific site; and markets for the energy must be found.

Specific needs include:

- a sound technical and information base on aspects of locating, assessing, developing, and managing geothermal energy resources;
- a comprehensive set of guidelines and codes-of-practice regarding different aspects of recovery and use of the resource;
- legislation/regulations (where appropriate) to clarify ownership of the resource, and to protect the resource;
- a policy regarding licensing and fees for use of the resource; and
- a focal/co-ordination point to assist in identifying needs, available information, and the work required.

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SECTION 1

INTRODUCTION

This section provides information on the Conference objectives, format, and participants, and on the organization of the Report.

Section 1: Introduction

First Geothermal Energy Conference:

Date: 28-29 October 1992
Place: Springhill, Nova Scotia (DND Springhill Armouries)

The Conference was organized by the Town of Springhill and jointly funded by the Town, the Cumberland Development Authority, the Nova Scotia Department of Natural Resources, the Nova Scotia Power Corporation, and Energy, Mines and Resources Canada.

Objectives

The broad objective was to bring together individuals and organizations interested in development of geothermal energy from abandoned mines. The intent was to use the development of the Springhill resource as a focus for exchanging information and discussing how best to proceed with the development of low-temperature geothermal energy resources at Springhill and elsewhere.

More specifically the Conference objectives were:

- To provide information on the steps taken (to date) to assess and develop the Springhill geothermal resource;

- To provide information on a range of issues relevant to development of low-temperature geothermal energy from abandoned mines. Issues addressed include:
  - the nature of low-temperature geothermal resources;
  - an inventory of Nova Scotia mines with geothermal potential;
  - the technology for finding, assessing and recovering the energy;
  - district (shared) heating systems;
  - aquifer/data management systems;
  - the economics of geothermal energy use;
  - ownership of the resource;
  - approaches to funding.

- To identify opportunities, problems, needs, and recommended action (next steps) with respect to the assessment, development, protection, and marketing of geothermal energy resources in Nova Scotia.

Conference Format

The Conference consisted of a mix of formal presentations, a site visit, working group activity, and an open-discussion/wrap-up. The agenda is provided in Appendix 1.

There were eleven formal presentations, each followed by a question/discussion period. The presentations covered a broad range of geothermal issues including:

- the nature of geothermal resources;
- technologies for finding and developing low-temperature geothermal resources;
- the different stages, and related considerations, in the development/use of the Springhill geothermal resource;
- the broader context for the use of low-temperature geothermal energy (e.g. developing energy self-sufficiency, optimizing use of local energy resources, developing district energy systems);
- issues relevant to locating, developing, protecting, and marketing geothermal energy resources from abandoned mines (e.g. legal/ownership issues, aquifer management systems).

The site visit consisted of a tour of Ropak Can-Am Ltd. in the Springhill Geothermal Industrial Park. The Ropak facility uses geothermal energy for heating and cooling. The Ropak geothermal energy recovery system was described in a number of the formal presentations. The tour provided an opportunity to view the system, and for more discussion of technical and economic aspects.

When the presentation component of the agenda was completed the Conference participants spent two hours in Working Groups. This provided an opportunity to discuss issues of specific interest, and to develop conclusions and recommendations. There were four topic-specific groups respectively addressing geothermal technology, economic issues, ownership/legal issues, and planning. Participants chose the Working Group (topic) they wished to participate in.

In the final open discussion/wrap-up session some conclusions and recommended next steps were identified. In addition, the Conference Organizing Committee made a commitment to provide the Conference participants with a report which: (1) summarizes and documents the results (outcome) of the Conference; and (2) provides a post-Conference analysis that includes development of a proposed action plan.

The meals were an important part of the Conference process. The lunches at the Springhill Senior Citizen Complex, and the formal Conference dinner at the Wandlyn Inn (Amherst) provided opportunities for good food, ongoing geothermal discussions, and additional presentations regarding the potential and use of the geothermal resource.

Participants

Ninety-one individuals participated in the Conference technical sessions. A list of participants is provided in Appendix 2, and a breakdown by affiliation is provided in Box 1.

BOX 1
Breakdown of Participants by Affiliation

Affiliation	# individuals	%
Town of Springhill	14	16
Other communities and regional authorities	21	23
Nova Scotia Government	16	18
Private Sector (technical and legal services)	16	18
Federal Government	15	16
Private Sector (geothermal energy users)	3	3
Other Provinces	3	3
Students	3	3
Total	**91**	**100**

Note:
Affiliation does not always clearly indicate the nature of the interest of the participants. For example, half of the federal participants are involved in development of policies to promote geothermal energy or aquifer management; the other federal participants were Corrections Canada staff interested in using geothermal energy at the Springhill facility.

The majority of participants were from municipalities or regional governments interested in the potential of their geothermal energy resources; regional development authorities interested in the economic development potential of the resources; provincial and federal agencies interested in particular technical and policy aspects of geothermal energy from abandoned mines; and the private sector involved with (or interested in) the provision of technical and legal services related to developing the geothermal energy.

There were also representatives from other provinces, students, and a few participants from Springhill facilities actively using the geothermal energy.

Some conclusions from the "breakdown" of participants by affiliation and interest:

- The participation of several municipalities indicates the growing interest in geothermal energy resources. The resource is not only of interest to the Town of Springhill.

- The focus of the participants was primarily on developing the technology, infrastructure, and markets for the geothermal resources.

- There were a significant number of current or potential users of geothermal energy present at the Conference. In addition to the (few) private sector participants currently using geothermal energy, several of the participants were from municipalities which are potential users as well as promoters of the resource. In addition, a number of federal (Corrections Canada) participants are interested in use of geothermal energy at the Springhill Corrections Canada facility.

- The visit to the Conference by the Honourable Don Cameron (Premier of Nova Scotia), and the participation by Mr. Guy Brown (MLA for Cumberland Centre), Mr. William Casey (MP for Cumberland-Colchester), and the Honourable John Leefe (Minister of Natural Resources) are an indication of the degree of interest in the development of geothermal energy and its potential contributions to the Cumberland region and more broadly to Nova Scotia.

Context

Mineral exploration and mining played an important role in the colonization and development of Nova Scotia. Many of the major communities were established and grew in response to the development of mines. In addition to Springhill, there are numerous other Nova Scotia communities located near (if not over) large abandoned mines. While the majority of the coal mines and many metal mineral mines have been abandoned, the flooded underground workings are offering a new resource and new opportunities to adjacent communities.

Since the early 1980's the Town of Springhill has been actively involved in investigating and demonstrating the feasibility of using the groundwater in the abandoned coal workings underlying the Town as a source of geothermal energy. As a result of pioneering work there are a number of commercial and industrial buildings in Springhill using the geothermal resource for heating and cooling.

The geothermal applications at Springhill have demonstrated that use of geothermal energy from the abandoned mines is technically feasible and cost-effective. There is considerable potential for more applications of the Springhill geothermal resource, and for use of other similar geothermal resources.

The time is appropriate to take stock and decide how best to proceed in development of the geothermal resource. The recovery of geothermal energy from abandoned mines is a new use of minewaters. To assist in the development and protection of the geothermal resource it is important to ensure that the requisite technical information is collected and reviewed; that an appropriate legislative framework is in place; and that potential users are made aware of the possibilities and benefits of geothermal energy.

The proposed directions and required action items are relevant to several parties including:
- the Town of Springhill;
- other communities considering development of geothermal resources;
- government organizations (municipal, regional, provincial and federal) with an interest in geothermal-related issues such as land and resource ownership, energy use, and environmental protection; and
- the private sector (as providers of geothermal expertise and services, and as potential users of the resource).

Report Organization and Contents

The Conference Report consists of five sections:

- Section 1, the *Introduction*, provides information on the Conference objectives and format, the participants, and the organization of the Report.

- Section 2, the *Overview*, summarizes the results of the Conference and provides a post-Conference analysis by the author.

- Section 3, the *Presentation Summaries*, provides a summary of the information provided during the formal presentations and related question/discussion periods.

- Section 4, the *Working Group Reports and Wrap-up*, summarizes major points reported by the four Working Groups, and raised during the open discussion.

- Section 5, the *Appendices*, provides auxiliary information: the Conference agenda and list of participants. Background papers provided by some of the speakers are included in a freestanding document (Appendix 3) available on request (see Appendices for details).

Acknowledgements

A number of individuals and organizations assisted in the delivery of the Conference and preparation of this Report. Jack MacDonald co-ordinated the organization of the Conference. The Springhill Town Council assisted with logistics. Funding was provided by the Town of Springhill, the Cumberland Development Authority, the Nova Scotia Ministry of Natural Resources, the Nova Scotia Power Corporation, and Energy, Mines and Resources Canada.

A number of individuals contributed their time and ideas. Particular thanks are due to:

- the Conference Organizing Committee members (Jack MacDonald, Ron Jefferson, Alan Jessop, Douglas Jewkes, Chris Kavanaugh, Rosemary Mullins, Ralph Ross, Howard Spence, Cathy Ward, and Michael Wiggin) who assisted in numerous ways; and

- the individuals conscripted into delivering presentations for the technical sessions. Additional thanks are due to Len MacKinnon for arranging and guiding a tour of the Ropak Can-Am Ltd. facilities.

All the Conference participants warrant thanks. Almost everyone chose (or was forced) to truly take part. The success of the Conference stems directly from the interest and involvement of the participants.

The members of the Springhill Senior Citizens Complex provided excellent lunches, and dispatched the participants back to the technical sessions on schedule both days. In the expert opinion of the Report author the luncheon desserts provided one of the Conference highlights (with the Thursday desserts considered slightly the more exceptional).

This Conference Report was prepared by Katherine Arkay under contract to the Town of Springhill. A draft of the Report was reviewed by the Conference Organizing Committee.

SECTION 2

OVERVIEW
(Post-Conference Analysis)

This section summarizes the Conference outcome and provides a post-conference analysis (including priority action items).

Section 2: Conference Overview

This section of the Report provides a summary of the major points arising from the Conference and a post-Conference analysis.

Summary

The pioneering work at Springhill has resulted in a number of successful industrial and commercial applications of the geothermal resource from the abandoned mines underlying the Town. The work at Springhill has shown that the geothermal resource can be used effectively and economically.

Nova Scotia is well positioned to develop low-temperature geothermal resources because of the availability of geothermal energy from abandoned mines, the commitment to improving energy self-sufficiency (and reducing dependence on imported fossil fuels), and the experience gained at Springhill.

The Springhill Conference brought together individuals and organizations interested in aspects of the recovery of geothermal energy from abandoned mines. The Conference provided an opportunity to exchange information of mutual interest; to review the history and current status of geothermal energy recovery in Nova Scotia; to identify geothermal-related wishes and concerns; and to identify action needed to advance the consideration and development of Nova Scotia geothermal resources.

The following are the major conclusions rising from the Conference:

Development of geothermal resources from mines is of interest to several Nova Scotia communities in proximity to large abandoned mines, and to the federal and Nova Scotia governments which are interested in encouraging energy self-sufficiency and diversification.

The development of the Springhill geothermal resource has resulted in information that would be useful to other municipalities or businesses interested in developing similar geothermal resources. The work at Springhill has also identified some broad legislative and technical issues that need to be addressed.

The use of low-temperature geothermal energy from abandoned mines is a new application in Canada, and still uncommon anywhere (internationally). The early steps in the use of geothermal energy have been taken. Cost-effective recovery and use of the energy has been demonstrated to be feasible. A number of advantages and benefits related to the use of geothermal energy have been identified.

More needs to be done to integrate the use of geothermal energy into routine consideration, and to facilitate effective decision-making regarding geothermal resources. The next steps are important ones. Action is needed to facilitate beneficial use and effective management of geothermal resources in general, and to help protect the resource and avoid potential problems. Action is also needed to advance the use of the geothermal resource at Springhill, and to assist other communities in considering and developing similar resources.

It is time to take stock, set priorities, and develop an action plan. Specific needs include:

- a sound technical and information base on aspects of locating, assessing, developing, and managing geothermal energy resources;

- a comprehensive set of guidelines and codes-of-practice regarding different aspects of recovery and use of the resource;

- legislation/regulations (where appropriate) to clarify ownership of the resource, and to protect the resource;

- a policy regarding licensing and fees for use of the resource.

Geothermal Energy from Abandoned Mines

Geothermal energy results from the original heat of the formation of the earth, and from heat generated by the decay of radioactive isotopes within the earth. In the context of human activity, geothermal energy is a renewable resource.

Current world-wide use of geothermal energy involves resources over a range of temperature from 7°C to at least 340°C. The factors which affect whether the geothermal energy can be economically recovered from a specific site include: the characteristics of the specific resource, the available technology for extracting/transporting the heat, the cost and economic benefits of exploitation, and the proximity to a market for the energy.

Large, flooded mines are substantial reservoirs and present excellent opportunities for recovery of geothermal energy. The near-surface minewater draws on heat from the deeper mineworkings and reaches temperatures higher than normal shallow aquifers.

Benefits of Low-Temperature Geothermal Energy

The use of low-temperature geothermal energy offers potential benefits at the national, provincial, regional, community, and individual energy-user level. Geothermal energy can assist in meeting energy, environmental, and economic objectives.

- The federal and Nova Scotia governments are encouraging the use of innovative energy sources and approaches in order to conserve non-renewable energy resources, decrease the dependence on imported fossil fuels, develop a more diversified energy base, and reduce the use of fuels which cause environmental problems. The use of geothermal energy from abandoned mines fits well into meeting these objectives.

- Use of fossil fuels and electricity to heat buildings is "overkill". A number of low-temperature sources, many of which are seen as waste heat, can be used instead.

- Communities are looking more openly and innovatively at how to meet their energy needs. The energy choices communities make can result in lower costs, less environmental impact, more flexibility in energy sources, and more stability of energy supply and price. There is growing interest in the use of local energy resources and in district (i.e. shared) energy systems.

- Geothermal energy from abandoned mines is an excellent example of local energy for consideration. Communities with access to abandoned mines (and their geothermal energy) may be able to use the resource to provide lower-cost community services, and to attract industry/commerce. Local geothermal energy can be used in tandem with other energy sources (e.g. fossil fuels) in a district system. The geothermal energy can provide the base requirements with the fossil fuels providing the peak requirements.

- Use of local energy resources provides local jobs and keeps energy-dollars in the community.

- Advantages of district energy systems include improved energy efficiency, reduced emissions, economies of scale (e.g. bulk fuel purchases), more diversity and flexibility in sources of energy, and use of community-specific resources.

- Evolving technology is improving the technical and economic feasibility of using innovative energy and district heating options.

- Several countries developed an interest in alternative energy sources and district heating earlier than Canada (which had more fossil and hydro electric energy sources and less imperative to find alternatives). Both in Canada and internationally there are a growing number of successful examples to demonstrate the benefits of these energy options. Canadian examples include:
  - the use of geothermal energy for heating at Carleton University, Ottawa;
  - the use of local wood chips to provide a significant portion of energy needs at Charlottetown, P.E.I;
  - the cogeneration plant that meets the energy needs of Queen's University and portions of downtown Kingston;
  - the use of geothermal energy from the mines underlying the Town of Springhill to supply heating and cooling for industrial and commercial facilities.

- For individual users, geothermal energy can result in lower energy costs and additional benefits (e.g. air-conditioning, dehumidification, cleaner environment). These benefits have been realized by Ropak Can-Am Ltd. in the Springhill Geothermal Industrial Park.

- Use of geothermal energy from abandoned mines fits into the provincial energy strategy aimed at diversifying energy sources and developing greater energy self-sufficiency. There are also numerous local benefits. The geothermal resource is environmentally friendly, compatible with sustainable development, and can produce spin-offs (e.g. pump equipment for Springhill geothermal applications is manufactured locally).

Use of Low-temperature Geothermal Energy From Abandoned Mines: Lessons from the Springhill Geothermal Project

The Springhill population has been decreasing since the late 1950's. In the early 1980's the Town of Springhill, in an attempt to find local advantages and to spur economic development, turned its attention to the energy in the abandoned coal mines. Warm water seeps at surface were a well known local phenomenon.

Over a decade, the Springhill Geothermal Project has demonstrated that low-temperature geothermal resources can provide an effective, economic, energy alternative - and can contribute to sustainable development. The Project has resulted in some successful industrial/commercial applications, jobs, and investment in the community. In the process, much has been learned about the technical and economic aspects of assessing and developing similar geothermal resources.

- The development of the Springhill geothermal resource demonstrates the evolution of an innovative concept through the research, trial and pilot stages, to the ongoing growth of interest and applications.

- The Project started as an idea vigorously and tenaciously pursued by Ralph Ross.

- The early work led to an entrepreneurial stage that involved risk takers (Ropak Can-Am Ltd. and the Town of Springhill) and seed money to advance the concept. The seed funding was provided from a number of sources including the Town, Ropak, the Nova Scotia Ministry of Natural Resources, Energy Mines and Resources Canada, and the Atlantic Canada Opportunities Agency. This stage proved that cost-effective energy recovery was possible.

- The current growth stage involves the systematic development and implementation of an action plan to facilitate and advance the use of the geothermal resource.

- The Springhill development is an example of effective partnership. The Geothermal Project reflects involvement from the community, region, province, federal government, and the private sector.

- In the course of the Springhill Project valuable experience has been gained in how to position supply and return wells; how to most effectively locate, and drill into target zones; and on the nature of minewater chemistry, and the implications to well and heat pump equipment and systems.

- The innovative use of geothermal energy from the flooded mines has created a highly efficient and economic heating/cooling system for Ropak Can-Am's Springhill facility. The conversion has helped Ropak improve productivity and expand into new markets.

- The Town is considering the development of geothermal-energy-based district heating systems. Studies indicate that (because of the distances involved) the best alternative in the Town may be a number of supply and return wells each serving a cluster of users. For the foreseeable future individual return and supply wells are the best alternative in the Industrial Park.

- The Town has been designated as the Springhill Geothermal Area, and has received a license to develop the geothermal resource.

- The work at Springhill has identified a number of technical, policy, and legislative issues that need to be addressed to ensure that development/application of geothermal resources proceeds effectively and efficiently. Some of the issues are specific to the Springhill resource, but most are relevant to other similar resources.

- The work at Springhill is leading to changes in attitude and legislation (e.g. amendments to the Mineral Resources Act) to accommodate geothermal energy use.

- Growth in the use/application of the geothermal energy resource will also depend on effectively promoting the resource and finding users.

Management of Geothermal Resources

Successful, sustainable development of groundwater (including minewater) resources depends on wise use and reuse. The characteristics of the resource must be understood, and the demands of all potential uses (industrial, agricultural, domestic, energy) must be balanced.

- Each aquifer use project should be considered on its own merits, with due consideration to the nature of the aquifer, the range of proposed uses, and land use in the area.

- Effective management of geothermal resources requires good data and data management systems. Data bases are being established and data management systems are available.

- Geothermal resource management and decision support systems (like those outlined in the presentation by Frank Cruickshanks) could be useful, but many communities would need assistance in using the systems and in interpreting the results.

- At present Nova Scotia provincial guidelines are being developed to assist in the management of geothermal resources, and to help prevent problems.

Legislation and Policy re Use of Low-Temperature Geothermal Resources

The use of abandoned mines as a source of geothermal energy is new to Canada and relevant legislation and guidelines are not yet in place.

- At present the ownership of geothermal energy in Nova Scotia is not covered by specific government regulations. Common law principals apply, but provide no separate recognition of geothermal resources. The person who owns the rock or water also owns the geothermal energy.

- Under common law, landowners have the rights to underground water that is percolating, but not to water that is part of an underground stream. Landowners can remove percolating subsurface water, even if this causes a loss of water under adjoining land. If a geothermal resource extends under the property of a number of landowners, action by any of the landowners can affect the quantity or quality of the resource.

- The current Nova Scotia legislation and common law do not encourage development of geothermal resources. A developer could invest considerable time and money, and subsequently lose access to the water/energy because of the activities of adjacent landowners.

- There are also potential conflicts in resource use. In the case of an abandoned mine the owner of the mineral rights could reactivate the mine and pump out the minewater, thereby destroying the geothermal resource.

- At present Nova Scotia is dealing with geothermal energy resources on a case-by-case basis. The province can designate an area as a geothermal resource area, and vest the area's geothermal resources in the Crown. Separate legislation may be enacted later, if it is considered necessary. The province has yet to decide how to proceed with permits, licenses and fees.

Current Status of the Development of Geothermal Energy from Abandoned Mines In Nova Scotia

The Springhill work has confirmed the technical and economic feasibility of recovering geothermal energy from abandoned mines. Springhill is continuing the work needed to manage and develop its geothermal resources. A number of other Nova Scotia communities located in proximity to abandoned mines are also interested in the potential use of geothermal energy from the minewaters.

- The Town of Springhill is interested in proceeding with the development and promotion of its geothermal resource, and is currently considering how to proceed.

- To ensure effective decisions and good management of the geothermal resource the Town is in the process of collecting additional technical information on the resource (e.g. temperature/depth information, sustainable pumping rates).

- The Town is investigating different options/mechanisms for funding geothermal developments, particularly district (shared) systems.

- Other communities are at different (but earlier) stages in investigating the benefits of geothermal energy and in deciding how to proceed regarding their specific resources.

- The potential benefits of geothermal energy from abandoned mines have been demonstrated and will not have to be proven again from first principles. However, Springhill and other communities will have to determine whether specific application are technically and economically feasible and desirable.

- All geothermal resources have their own characteristics, and all towns and industries have their own specific needs. The use of geothermal resources has to be considered on a case-by-case basis as well as generically.

- The work at Springhill has identified a number of opportunities, potential concerns, and questions (unresolved issues) to be addressed in the process of advancing the use of geothermal energy.

Major Issues (Concerns)

The Conference participants identified a number of concerns and wishes regarding aspects of assessing, developing, and promoting geothermal resources.

- Interest is growing but the recovery of geothermal energy from abandoned mines is still considered unusual and unconventional. There is not adequate awareness of the related benefits and potential.

- Based on the Springhill experience, several Nova Scotia communities are interested in their potential geothermal resource but do not know how to proceed in assessing and developing the resource.

- Maintaining the quantity and quality of geothermal resources was considered a priority. More information is needed to ensure that effective decisions can be made regarding resource use and management. There are many unanswered questions. How long will specific geothermal resources last? Will energy depletion occur?

- The issue of licensing and fees is of considerable concern to communities considering development of geothermal resources. There are many unanswered questions:
  - What legislation will cover geothermal resources?
  - Is there new legislation coming re ownership?
  - Will a public utility board set a minimum price for geothermal energy?
  - Will the province try to use fees to turn geothermal energy into a money-maker?
  - Will the geothermal resource be taxed? Will there be fees for use?
  - Is the provincial approach to the Springhill geothermal resource going to be the model for geothermal resources. Will other communities interested in developing geothermal resources get the same rights and privileges as Springhill?

- There was concern that licensing and taxation may be used to collect provincial revenues from the use of geothermal resources. The resultant cost (and even the current uncertainty regarding fees) may discourage development. Potential users of the resource will want to be assured that, for at least a specified time period, no major fees will be instituted. Without such a commitment potential users cannot estimate the cost of the geothermal energy and determine whether it is a good economic choice.

- There is concern over how to stimulate interest and investment in the new technologies, and in how to fund development of geothermal resources that are part of a district energy system (with shared equipment and costs).

- The current business environment and market uncertainty (the recession) make it more difficult to bring in new technologies and to take risks. However, geothermal resources could be of great interest to individual users and to communities trying to cut their energy costs and attract industry/business - if the resource can be demonstrated to have technical advantages and to be cost-effective.

Needs and Recommendations

The development of low-temperature geothermal energy from abandoned mines in Nova Scotia is at an important stage. There is considerable work to be done to prepare for and foster the efficient assessment, documentation, development, protection, and promotion of the geothermal resources.

The Conference identified a number of needs and related actions which will involve communities, interested potential users of the resource, and different government levels. The actions address four major needs:

- The need to develop an information base/decision framework to assist in delineating, assessing, developing, managing, and promoting geothermal resources;
- The need to improve awareness of the potential benefits of geothermal energy from abandoned mines, and to identify and address unresolved policy and legislative issues;

- The need to proceed with the development of the geothermal resources at Springhill and in other Nova Scotia communities;
- The need to market and promote (carefully and thoughtfully) the use of geothermal energy from abandoned mines.

Specific needs and actions identified in the course of the Conference are listed below. On a number of issues true recommendations (i.e. specific actions targeted to specific organizations) were made. Conference participants also identified a number of things-that-should-be-done, without specifying by whom.

Information Base/Decision Framework

- There is a need for a better information base regarding geothermal resources and development. Information on available technologies, equipment, and costs relating to the assessment and development of geothermal energy from abandoned mines should be collated and made more readily available to interested parties.

- The existing examples of relevant geothermal energy development and use, and the related technology, benefits etc, should be documented in detail.

- A detailed history of the Springhill Geothermal Project should be prepared documenting the stages in the identification, assessment, and development of the geothermal resource. The history should include the decisions made and the reasons, the work undertaken (the technologies used and costs etc), the successes, problems, and lessons learned. The document could assist Springhill in developing an action plan for future work, and in raising awareness and support. The information could also assist other communities considering development of geothermal resources.

- A User's Handbook (for low-temperature geothermal energy resources) should be developed. The Handbook could cover a broad range of topics (e.g. current legislation, information sources, steps for choosing drilling sites, guidelines for choosing and sizing pump equipment, water quality and quantity parameters to consider).

- A document indicating the relevance and benefits of geothermal energy from abandoned mines should be prepared. Geothermal energy use should be considered in the context of provincial and federal policies and priorities regarding energy, the environment, and regional development.

- The federal, provincial, and regional governments should continue to develop aquifer data bases and management systems to assist in making effective decisions regarding aquifer management and use.

- Codes of practice/guidelines should be developed to cover the range of technical issues surrounding the exploration and recovery of geothermal energy from abandoned mines.

- Appropriate mechanisms should be developed to provide interested municipalities, individuals, and companies with better access to relevant information and expertise available from the federal, provincial, and regional governments.

- The Nova Scotia Ministry of Natural Resources should establish and chair a Geothermal Energy Advisory Committee. The Committee should be made-up of representatives from relevant departments and organizations. The Committee could identify priority policy, legislative, and technical issues that need to be addressed; and could establish a mechanism for providing technical advice.

- A network of experts and individuals interested in low-temperature geothermal issues should be established to assist in exchange of information and in advancing the requisite work (e.g. to help maintain momentum and ensure action).

Policy and Legislative Issues

- The potential of low-temperature geothermal resources should be effectively promoted (e.g. there is a need for ongoing education and dissemination of information regarding the geothermal resource, available technologies, and applications).

- Consideration of low-temperature geothermal energy should be endorsed as a priority by the relevant federal and provincial departments.

- There are a number of legal and jurisdictional issues regarding aquifer use to be resolved. Ownership of the geothermal resource needs to be resolved, and legislation established to protect the resource and ensure appropriate use.

- Policies for licensing and use of geothermal energy resources and the related fees should be established. (Note: The case for low user fees and non-taxation of the resource should be made by documenting the benefits that could accrue to the province through development of the resource.)

Development of the Geothermal Resources

- The work on geothermal energy assessment and development should be continued. Full use should be made of existing federal and provincial programs that could advance the assessment, protection, and promotion of geothermal resources (e.g. the federal program on community energy systems, and the provincial program on energy self-sufficiency).

The Springhill Geothermal Resource:

- The Town of Springhill should give careful consideration to how to proceed with management of the geothermal resource, and should develop an action plan.

- While the capacity of the warm minewater reservoir seems ample for development, more work is required to prove-out (better understand) the resource, refine the existing model, and facilitate good geothermal applications. For example:
    - Long-term flow tests should be run to establish the extent of the resource with some accuracy.
    - Better information is needed to help site wells, target depths to drill, and set pumping rates.

- The Town should continue with the consideration of modified district energy systems using the geothermal energy.

- A small-scale district demonstration system should be developed. The system should consist of 10-11 Town buildings (located close together), and a main plant and heat exchanger. Estimated cost $1M.

- The land acquisition for the Geothermal Industrial Park should be finalized.

- The Town should develop an approach/system for financing (dividing and recovering the cost of) district energy systems.

- The Springhill Townhall should be part of the geothermal system. This would demonstrate the Town's commitment to geothermal development.

Geothermal Resources of Other Communities:

- Other interested communities need to effectively delineate their resource and assess the potential, applications, and opportunities available to them.

- It is critically important for communities considering the use of geothermal energy from abandoned mines to make the decisions that are technically and economically correct: to assess their resources appropriately; to determine the cost and benefits of the geothermal energy relative to other options; to locate supply and return wells appropriately; to ensure success of individual applications; and to protect the resource.

- A number of approaches could be used to assist interested companies and municipalities in deciding how to proceed with respect to specific geothermal resources. A number of the sources of information and advice have been identified above in the Information Base/Decision Framework section.

Promoting Resource Use (Finding Users)

- The Town of Springhill should develop an approach to promoting the geothermal energy resource. The types of businesses (and specific companies) well suited to optimize the benefits from geothermal energy should be identified (e.g. industries which have significant cooling/dehumidification as well as heating needs).

- The Cumberland Regional Authority should be asked to assist in the development and delivery of a plan to promote the resource, and to target and attract specific companies.

- The promotion of specific geothermal applications focuses largely on the Springhill resource as it is sufficiently proven and ready for applications (users). The geothermal potential of other areas should also be promoted.

- Until the geothermal resource and technology become more familiar and the knowledge base is better, municipalities with geothermal resources should absorb some of the economic risk (e.g. share the risk with industry). This would help attract industrial/commercial users.

Second Geothermal Conference

- There should be another Geothermal Conference next year. A core group should be formed to develop the agenda and to organize the Conference.

- The second Conference should continue the general discussion, and also focus on some specific aspects (to be determined).

- Consideration should be given to community support issues as a possible focus for the next Conference. The objective would be to discuss issues that are of interest to communities involved in, or considering, assessing and developing low-temperature geothermal resources.

Post-Conference Analysis

The Springhill Conference provided a useful opportunity to exchange information regarding aspects of geothermal energy development, and to identify needs and work to be done in advancing geothermal development at Springhill and other communities.

The Conference confirmed that there is growing interest. In addition to the Town of Springhill, several other communities are interested in their potential to recover geothermal energy from abandoned mines.

The participation by Guy Brown (MLA for Cumberland Centre), William Casey (MP for Cumberland-Colchester), the Honourable John Leefe (Minister of Natural Resources), and Premier Don Cameron indicates that the relevance of geothermal energy to Springhill, the Cumberland region, and Nova Scotia in general is appreciated.

There is a need to build on the growing awareness of the potential benefits and applications of low-temperature geothermal energy. The recovery of geothermal energy from mines is still viewed more as a fortuitous (but quirky) application, than as an energy alternative that responsible municipal and industry decision-makers (in power suits) should consider as a serious option.

The past decade of work on the Springhill geothermal resource has proved that cost-effective recovery and use of geothermal energy from abandoned mines is possible, and has generated a valuable information base. Geothermal energy recovery offers opportunities for regional benefit and a chance to build innovative Canadian expertise.

However, the use of this specific type of low-temperature geothermal resource is still relatively new. In many aspects policies and legislation are not in place, direct experience is scarce, and information on the technology and processes is not readily available. There is considerable work to be done. At this stage it is important to carefully consider and choose the necessary next steps.

In developing a plan of action it will be essential to keep the overall objective and context in mind. The objective is to improve energy self-sufficiency and increase energy options by encouraging the use of local energy sources that offer technical, environmental, cost-effectiveness, or other advantages. Geothermal energy from abandoned mines is one of a growing number of energy options.

What is needed now is (1) the information base to assist interested municipalities and companies in deciding whether a specific use of geothermal energy is a technical and cost-effective alternative for them; and (2) a legislative framework that facilitates appropriate use of the geothermal resource, and protects both the resource and the users.

There are a number of priority actions (some of which are outlined in the Proposed Action Plan below). Perhaps most important is that both the provincial and federal governments should adopt (or at least foster) the concept of geothermal energy from abandoned mines, and should address the outstanding issues.

Changes are needed to improve local, regional, and provincial energy and economic independence and security. The changes will involve innovation and cooperation between the private sector and all levels of government (municipal, regional, provincial, and federal). Government will play an important role but private sector commitment is also needed.

Caution

For geothermal energy from abandoned mines to be successfully established as an accredited energy option, it is essential to ensure that the components needed for effective decisions regarding use of geothermal energy resources are available. The requisite components include an appropriate information base, a policy/legislative framework, and guidelines and codes of practice.

It is important to be ready for the consideration and development of these geothermal resources. If appropriate care is not taken problems could arise. For example, substantial investment could be made developing a resource that is not capable of sustained energy production; or a geothermal resource being used could be damaged through other conflicting aquifer or land use (or even through poor energy recovery practices).

Even one or two bad experiences could discredit the recovery of energy from minewaters and discourage communities and individual users. In the early stages in the use of the low-temperature geothermal resources it is particularly important to make good resource management decisions, and to accumulate success stories.

Proposed Action Plan

A number of actions and recommendations were identified in the course of the Conference and are documented in the Conference Report. The following is proposed as an action plan to initiate the work required.

- The Conference Organizing Committee should review and follow-up on the recommendations/needs identified at the Conference and documented in this Report:

(a) For recommendations which were targeted to specific organizations, the Committee should contact the relevant organizations and advise them of the Conference results and the particular relevant recommendations.

(b) For needs and recommended actions which were not targeted to particular organizations, the Committee should determine which organizations are best able to address the specific needs/actions, and then should proceed as per (a) above.

- The Conference Organizing Committee, the Town of Springhill, and the Cumberland Development Authority should formally request that the Nova Scotia Ministry of Natural Resources establish and chair a Geothermal Energy Advisory Committee. The proposed responsibilities of the Committee include developing an action plan to follow-up on the range of recommendations and needs identified at the Conference. The Committee could ensure that the technical information needed is collated, and that the legislative framework, guidelines and codes of practice are developed.

- The Conference Organizing Committee should contact Energy, Mines, and Resources Canada and request the department's ongoing involvement in developing and testing low-temperature geothermal energy assessment and recovery technologies.

- A *Low-Temperature Geothermal Energy User's Handbook* should be developed. Decisions are needed on what specific topics and information should be included, and who could/would develop the Handbook.

- A Network of individuals interested in low-temperature geothermal issues should be established to assist in exchange of information and in advancing the requisite work. The Conference Organizing Committee should consider ways in which a Network could be established and administered. The Alternative Energies Division (Energy, Mines, and Resources Canada) is one potential venue for the Network.

- A Second Geothermal Conference should be held in late fall 1993. The Conference could report on action arising from the 1992 Conference, and could specifically address the needs of communities. The current Organizing Committee should assist in establishing an Organizing Committee and sponsors for the 1993 Conference.

Final Words

The cost-effective use of geothermal energy may hold the key to industrial growth in the Town of Springhill, and has potential applications in other mining communities in Nova Scotia and throughout Canada.

The Town of Springhill has demonstrated that abandoned mines can serve as a source of economically and environmentally attractive energy. There are many opportunities for geothermal energy recovery at other Canadian locations. Abandoned mines, relics of a long and important mining tradition, are found throughout Canada. Many of the larger, deeper abandoned mines are located near communities which grew in tandem with the mines and now provide a potential market for the geothermal energy.

It is fitting that this innovative energy application was developed and nurtured in Springhill. The coal mines have been an integral part of the development and life of the Town. At different stages the mines provided regional growth, employment, prosperity, personal tragedy, opportunities for courage, and then economic hardship as the mining declined. Now the abandoned mines are a new source of interest and are providing economic renewal through their recoverable energy.

At Springhill the events of the past (the mining), and the foresight of the current community are providing opportunities and shaping the future.

SECTION 3

CONFERENCE PRESENTATION SUMMARIES

This section provides a summary of the individual conference presentations. More detailed background papers were provided by some of the speakers. The available background papers are included in Appendix 3.

Section 3: Presentation Summaries

The Nature of Geothermal Resources

Alan Jessop, Energy, Mines and Resources Canada, Calgary

This presentation provided an overview of the six major types of geothermal resources world-wide, and set the stage for discussion of low-temperature geothermal energy resources from abandoned mines. For each type of geothermal resource information was provided on the geological setting, physical nature, uses/applications, and examples (locations).

A background paper is provided in Appendix 3. Some major points are provided below.

Geothermal Resources

- Geothermal energy comes from the solid earth in the form of heat. It results from a combination of the original heat of the formation of the earth, and additional heat generated by the decay of radioactive isotopes within the earth. Geothermal energy is not, strictly speaking, a renewable energy resource. However, the total heat of the earth is so great that geothermal energy is regarded as a renewable resource in the context of human utilization (i.e. for the duration of anticipated human activity on this planet).

- Geothermal energy is always present in rock. The factors which affect whether the energy can be economically recovered from a specific site include: the characteristics of the specific resource, the available technology for extracting/transporting the heat, the cost and economic benefits of exploitation, and the proximity to a market for the energy.

- On the basis of physical characteristics geothermal resources can be categorized into six main types:
  1 - Dry steam
  2 - Hot-water
  3 - Hot dry rock
  4 - Warm-water
  5 - Hot springs
  6 - Low-temperature water

- There is no distinct dividing line between systems that in the past have been commonly regarded as "geothermal" and systems using heat pumps to extract heat from low-temperature water in gravel beds and other shallow sources.

- Current world-wide use of geothermal energy involves resources over a range of temperature from 7°C to at least 340°C.

- Canada has most of the six types, but a full exploration and assessment of geothermal resources has not yet been completed.

- This Conference focuses on the use of low-temperature geothermal resources taken from a special source - flooded coal mines. Abandoned mines will generally fill with water once mine operations (specifically drainage pumping) cease.

- Abandoned, flooded mines are artificial reservoirs. The size of the reservoir will depend on the size of the mine, but can be substantial. Large reservoirs present excellent opportunities for geothermal development. The near surface minewater draws on heat from the complete depth of the mine, and reaches temperatures higher than normal shallow aquifers.

- The Town of Springhill is a leader in Canada, and possibly in the world, in developing this form of economically and environmentally attractive energy, but there are many opportunities in other Canadian locations. Old mines are often close to major communities, and therefore near a potential market for the geothermal energy.

The Springhill Geothermal Resource

- The mine workings below Springhill are both extensive and deep. The near-surface water temperature, about 18°C, is the result of convection and circulation within the mine workings. The water is an excellent energy source. It has been demonstrated that the energy can be extracted with heat pumps to effectively and economically heat industrial buildings. Since the flooded mine workings are extensive this resource is likely to last for a long time, probably several hundred years.

- In the geological context there is nothing special about the geothermal nature of the earth's crust at Springhill. The effective surface temperature is about 7-8°C, and the rate of increase with depth is 15 mK/m (°C/km). The crust at Springhill is, if anything, on the cool side of average. The success of the Springhill geothermal applications shows that geothermal resources do not depend on specially hot crust. Provided that there is water in adequate quantities and within reasonable access, a usable geothermal resource may be found in any geological setting.

- The Town of Springhill has been and still is a leader in the development of this form of unconventional, but highly economic and environmentally friendly, energy use.

Points Raised During Question Period

- There is no specific minimum water temperature required to make geothermal energy recovery worthwhile. There is always some heat present in water. Existing technology and economics are the limiting factors. At present heat can be effectively extracted from 5-6° C water. The heat recovery technology will continue to evolve, making even lower temperature waters useful.

- There are a few other North American sites using geothermal energy from sources similar to those at Springhill (e.g. Kingston, Pennsylvania).

- Even if the old mines vent to surface, the geothermal resources should not be seriously affected (harmed). The water will be replaced. However, there are other disadvantages associated with venting. The minewater can contaminate surface waters.

- High temperature (e.g. 80°C) water can be transported for miles in well-insulated pipelines. However the economics of transporting low-temperature water soon turn against geothermal energy, where other more economic energy sources are available.

- There are a number of documented studies available on the environmental impacts of geothermal energy use. There is considerable variation in results. Essentially each resource needs to be considered on its individual characteristics and merit. The use of the geothermal energy reduces emissions and helps conserve non-renewable energy resources. However, there are aspects of water chemistry that need to be considered in making decisions on how to dispose of the minewaters when surface disposal is required.

New Energy Systems
Michael Wiggin, Energy, Mines and Resources Canada, Ottawa

This presentation identified some of the innovative approaches communities can take in meeting their energy needs. The focus was on the use of community-specific energy sources, and the development of district energy systems. Some examples of how communities or the private sector have used innovative approaches to meet their energy needs were outlined.

Background papers are provided in Appendix 3. Some major points are provided below.

Approaches to Meeting Energy Needs

- There are several reasons why communities should look more openly and innovatively at how to meet their energy needs. Choices can result in lower costs, less environmental impact, more flexibility, and stability of source and price.

- Many communities are changing the way they make decisions on how to meet their energy needs. The cost and pay-back period remain important but increasing attention is being paid to health and safety factors, and to the spin-off benefits to the communities.

- The conventional approach involves purchasing oil, gas, or electric energy. Energy is supplied individually to buildings and businesses. To varying degrees the purchase of such energy is expensive, results in emissions, and uses up non-renewable resources.

- There is a need for new ideas in addressing community energy needs. The approaches and solutions must be considered in the context of each community and its specific needs and energy opportunities (options).

- A number of energy sources (e.g. solar, geothermal, wood chips, fossil fuel) can be mixed and used as they are respectively most available and/or needed.

- Wastewater heat recovery systems are available. These technologies are best used very locally (i.e. at the specific building/site) before the heat dissipates.

- District heating also offers economies of scale in the form of bulk fuel purchases.

- Approaches to meeting community energy needs have to be decided at the municipal level, and in the context of technical possibilities and political will. For a number of reasons, there is growing interest in some innovative energy options.
  - There are several successful examples to demonstrate the benefits of such applications;

- Technology breakthroughs are improving the technical and economic feasibility of some of these options;
- There is a growing appreciation of the potential benefits, and a particular interest in advancing the environmental agenda (e.g. local action that can result in local and global environmental improvements).

District Networks

- One useful approach is to focus on a district network that integrates the needs of individual users and serves as a buyers co-operative. This approach efficiently meets energy needs and makes good use of available energy resources.

- The district energy approach emphasizes the use of local resources and helps keep dollars from leaving the community. Every community has individual features, opportunities, and needs. The way to meet energy needs can be customized in very innovative ways.

- There are numerous network advantages including:
  - improved energy efficiency;
  - reduced emissions;
  - effective use of available waste heat;
  - economies of scale (e.g. bulk fuel purchases);
  - more diversity and flexibility in sources of energy;
  - reduced use of non-renewable energy resources;
  - use of community-specific resources (e.g. geothermal energy) as appropriate.

Examples of Innovative Energy Approaches

The following are examples of innovative and effective approaches to energy production and utilization.

- In Malmo Sweden excess (waste) heat from a smelting plant is used in district heating. A variety of other innovative energy sources (e.g. carbon black heat, sugar beets) contribute to the system.

- In communities where electric-fired mass transit is part of a cogenerated district heating system, waste heat can be harnessed and used elsewhere in the district system. Advantages to this approach include more efficient use of energy resources, and better emission control.

- Carleton University (Ottawa) uses groundwater as a heating and cooling source. Evolving technology will allow other geothermal resources to be used. Decisions are very site-specific and depend on the characteristics of the local geothermal resource.

- The Charlottetown project was initiated by the PEI Energy Corporation in 1982-83 to look at local energy options/resources (e.g. wood, wind, solar) for district heating. At the time, the primary source of energy was Venezuelan oil. Only 7 cents of each dollar spent on energy stayed in the community. Now wood-fired boilers use local wood chips to provide a significant portion of the energy needs. Moreover, 80 cents of each dollar spent on energy stays in the community.

- In Chibougamau the current district system uses a central boiler and inexpensive plastic pipe to produce and distribute energy. Wood waste and sawmill waste are used to fire the boiler. Technology advances are providing options. Prior to the district system, cheaper heating was provided by purchasing electricity from Hydro Quebec, but all the dollars spent on energy were leaving the community. The current district system retains resources in the community in a number of ways. Waste wood is purchased and used, and local employment is generated (e.g. trucking, plant operations).

- The Kingston Public Utility Commission built a gas-turbine-fired cogeneration plant which meets the energy needs of Queen's University and portions of downtown Kingston.

- The Deep Lake Water Cooling Project (DLWC) is approaching the advanced feasibility trial stage. The project involves participation by Toronto, Metro Toronto, Government of Ontario, Energy Mines and Resources Canada, and Hydro Ontario. The objective is to construct a 6 km pipeline out into Lake Ontario and bring cool water (from below the thermocline) into Toronto to provide district cooling. It is estimated that this approach could replace 300 MW power currently used for cooling. Related environmental benefits include reduced emissions and reduced use of refrigerants.

- There are a number of options to consider for achieving district cooling. For example, a prototype system which uses ice slurry moved via small pipes is being installed to cool the Bell's Corners Facility (Energy Mines and Resources Canada).

Geothermal Energy

- Geothermal energy can be used in tandem with fossil fuels. The geothermal can provide the base requirements with the fossil fuels providing the extra/peak requirements.

- Capital cost requirements include the building, pumps, and transfer system.

- The development/use of the Springhill geothermal resource is an excellent example of community tenacity and vision, and the approach that communities should take in considering new energy sources.

Points Raised During Question Period

Municipalities should consider their overall energy use and particulary consider sources of waste energy. At present a considerable amount of energy ends up in the sewage system. Is there technology for recovering this energy?

The current push to reduce, reuse, recycle also applies to energy.

Communities should do energy inventories and consider their options.

Opinions and technology are changing. As a result, power plants in a community can be considered an asset rather than a blight. For example, Helsinki generates its own heat via coal and waste heat. With modern technologies their emissions are low and the efficiency of use is high. Fuel use can be reduced by 40%.

The Mines Inventory

Katherine Arkay, Consultant, Ottawa

This presentation summarized the results of a 1992 project to develop and pilot test methodology for an inventory of abandoned mines. Inventories were developed for two provinces: Nova Scotia and Quebec. The work was conducted under contract for Energy, Mines, and Resources Canada (EMR).

A background paper is included in Appendix 3, and some major points are provided below:

The Project Report

The project report, *Geothermal Energy from Abandoned Mines*, submitted to EMR is organized into three components: Part 1 documents the project objectives, methodology, outcome, conclusions, and related recommendations. Part 2 provides a compilation of inventory summary tables, and individual mine information forms. Part 3 is the Appendices and consists of reference lists, detail on source materials, and auxiliary information.

Conduct of the Inventories

- The conduct of the inventories involved two major stages: the identification of abandoned mines; and the collection of the information for the inventory data sheets. For both stages identifying the relevant information sources is critical. The ease of compiling the inventory, and the usefulness of the final product are dependent on choosing the best sources of information.

- The most important factors for a first-assessment of geothermal potential include the location of the mine, the size and geometry of the underground workings, the geology, and the operating period. It is assumed that large abandoned operations, and those close to established communities are most likely to be of interest.

- The allocation of geothermal potential was subjective. By definition, sites within 10 km of a community and with "moderate" production, or sites (anywhere) with greater than 500,000 tonnes of production are considered to have potential. Very small and remote sites are considered "unlikely". Sites for which little information on production is available (from the inventory data sources) are designated "unknown".

Nova Scotia Inventory Summary

- Inventory data sheets were completed for 179 abandoned metallic and industrial mineral mines (or districts) and 213 coal mines.

- Of the abandoned metallic and industrial mineral operations, 67 were gold operations, 98 were metallic mineral operations (gold excluded), and 14 were industrial mineral mines.

- The metallic and industrial mines operated prior to 1920 were generally small and are not likely to offer major geothermal applications.

- For metallic and industrial mineral mines, information on the inventory parameters was not always available from the sources used. Availability of information varied with the type and age of the operation.

- Data sheets for the coal mines are provided separately from the metallic and industrial mineral mines. This is partially because the coal mines are not allocated provincial mineral occurrence numbers, and because a different approach can be used for a first-assessment of their geothermal potential.

- The inventory information on the coal mines is limited to the mine name, area (township, and N.T.S.), closest community, operating period, production, and seam(s) mined. This information is sufficient to identify operations which are of interest on the basis of size and proximity to communities.

Project Outcome/Results

- It is probable that the major abandoned mines in both provinces (Nova Scotia and Quebec) are included in the inventories. It is certain that some of the smaller, older abandoned operations are omitted; but it is unlikely that many sites with significant geothermal potential have been missed as a consequence.

- The inventory data can help to identify sites of potential interest. But to assess the geothermal potential of a site a variety of other information is required. The inventory is an overview; the information is from a few, general sources. The inventory does not reflect an in-depth review of all relevant information on each mine site.

- The Nova Scotia inventory can help to identify sites of interest for further consideration of geothermal potential, and does provide bibliographic information to assist individuals interested in investigating specific sites in more detail.

- The abandoned mines of potential interest as sources of geothermal energy include the major coal mines in the different coalfields, and the metallic and industrial mineral mines operated into/after the 1940's. Abandoned mines in the vicinity of the major coal mining centres warrant particular attention.

- The pilot projects in Quebec and Nova Scotia showed that it is possible to conduct first-assessment inventories, and provide some insight/information on how to do so.

- The value of the inventories will ultimately depend on whether they are used, and prove to be useful.

Recommendations

- The process of reviewing the available data and developing the inventory identified a number of needs relevant to the overall assessment, development, and protection of the geothermal resource. Related recommendations presented at the Conference are included in the background paper (See Appendix 3).

Final Words

- A number of actions are required to foster the efficient assessment, documentation, promotion, and development of geothermal resources from abandoned mines. The actions address four major needs:

  (1) the need to clarify the ownership of the geothermal resource and establish legislation to protect the resource and ensure appropriate use;

  (2) the need to develop a decision framework to guide interested individuals and organizations in the work required to delineate, assess, and develop a specific site;

  (3) the need to identify and address the outstanding, unresolved issues;

  (4) the need to market and promote (carefully and thoughtfully) the use of geothermal energy from abandoned mines.

Major Points from the Question Period

- Care is needed in using the inventory date. The document is not comprehensive; it is a starting-off spot.

- Inventories are useful but addressing the issues covered in the Project recommendations is more important.

- Small communities need assistance in identifying and assessing their geothermal resources. How can they get started? Where can they get technical assistance?

Springhill Geothermal Project: Locating the Resource

Chris Kavanaugh, Nova Scotia Ministry of Natural Resources, Halifax

This presentation provided an overview of the approaches taken to drilling wells to intersect voids in the underground workings. Drilling costs are a major expenditure in preparing for geothermal energy recovery. Successful, cost-effective applications require the ability to identify voids which have good water circulation and to effectively drill into the target voids.

A background paper on the approaches, and pitfalls, to effectively locating and drilling target sites is included in Appendix 3. Some major points are provided below.

Approaches to Choosing Drilling Sites

- The Springhill Geothermal Project has successfully positioned a number of wells to access the warm water and geothermal energy from the underground workings. The wells range from 40-152 m.

- Since 1986 seventeen holes have been drilled. Fifteen of the holes drilled have intersected voids within the abandoned underground coal workings, for an overall Project success rate of 88%.

- The process of selecting well sites is more complex than simply picking co-ordinates off a mine plan or a street map and then surveying in the selected position.

- The key to successful well siting is understanding the relationship between surface structures and underground workings. The Town has many surface structures (e.g. old hoist and building foundations, railroad beds, hydrants) that can be used to identify drilling positions for geothermal wells. However, care is needed because undocumented changes to the features may have occurred.

- Information to assist in site selection can be obtained thorough literature searches of the relevant reports and mine plans. Useful information includes the position of the underground workings, mining methods, depth of specific workings, problem areas in the mine, and interconnections between seams and mines.

- The literature search can help avoid potential problems and reduce costs by identifying features that will affect drilling costs (e.g. amount of rock versus "void" to be intersected) or circulation of water in the abandoned mines (e.g. collapsed workings).

- To date Springhill wells have been targeted for large voids located at the intersection of underground roadways. Providing such large targets compensates for errors/distortion in the plans and for drill hole deviation, and increases the probability of success.

- In the Springhill Project, it is general practice to drill the supply well first. If the well passes through a series of voids and rock layers but is "unsuccessful" in hitting the deeper target (void), it can often be used as an alternate supply well or return well for the system.

Points Raised in the Discussion Period

- While the information base on the Springhill geothermal resources is growing, there is still much that is not known. Information yet to be obtained includes water temperatures at greater mine depths, sustainable pumping rates for specific minimum water temperatures, and effects of surface activities on the geothermal resource.

- Near-surface groundwater can be a useful source of geothermal energy in its own right. The temperature of groundwater is such that it can be used for heating or cooling depending on seasonal needs. However, at Springhill such groundwater is avoided because it can contaminate the thermal regime of the warmer minewaters.

- There is technology for drilling deeper than 152 m. The cut-off point is based on cost-effectiveness, and will change as technology evolves.

- It is not certain what effects surface activities (e.g. strip mining) would have on the geothermal resource. Each geothermal regime would need to be assessed separately.

The Ropak System

William Hickey, Delta Heat Pumps Inc., Amherst

This presentation provided an overview of the development and use of geothermal energy at the Ropak Can-Am Ltd. Springhill facility.

Background papers detailing the development of the Ropak Can-Am Ltd. geothermal system, and its benefits are included in Appendix 3. Some major points are provided below. Additional information (particularly on the economics of the system) are provided in the presentation by Len MacKinnon.

Developing the Geothermal Resource

- In 1986 a feasibility study was conducted to find out whether the geothermal energy in the mines underlying Springhill constitute a useful energy source. Drilling was carried out in 1986-87. Pump tests and chemical analysis indicated that there is a major geothermal resource in the interconnecting mine shafts under the Town.

- The mine shafts slope at 32 degrees to below 2600 m, which accounts for the warm water temperatures (17.8°C) recovered in the well tests.

- In 1988 Ropak Can-Am Ltd. decided to seriously investigate the use of the geothermal energy as the primary heat source for the Springhill facility.

- The development of the Ropak geothermal system is the result of co-operative activity involving Ralph Ross (the original proponent of Springhill geothermal potential), the Town, the Geothermal Committee, Delta Heat Pumps Inc., the Nova Scotia Ministry of Natural Resources, and Energy Mines and Resources Canada. All parties decided to work together, follow-up on a promising idea, and see what would develop.

- The management at Ropak's Springhill facility (with particular honourable mention to Robin Blake and Len MacKinnon) were prepared to take a chance and seriously consider geothermal energy, although there were many unanswered questions. It was not known whether the system would work, or even whether there would be enough water available.

Technical Details of the Ropak Can-Am Ltd. Geothermal System

- In light of engineering and water chemistry information from the test wells, a closed-loop system was initially proposed with a high tech heat exchanger between the building and well loops. The closed system was proposed because it was felt that the heat pumps would not be able to withstand exposure to the minewater.

- On analysis it was decided that the closed-loop system had major disadvantages. Specifically, the system would require occasional shut-down periods for cleaning of the heat exchangers. Concern over the maintenance requirements led to the development and installation of an open-loop system, using a cupronickel heat exchanger.

- The 5HP submersible pump is installed at 143 m and supplies 3.9 L/s of minewater.

- Water is pumped to a supply header equipped with six branch take-offs: five for the main plant; and one for the main office, plant office, secondary storage, and lunchroom.

- Each loop supplies two heat pumps connected in series: one drops the temperature from 17.8 to 11.7°C; the second drops the temperature to 5°C. Water then flows into the return header and to the recharge well.

- The system can be run in either the heating or air conditioning/dehumidification mode. The water temperature is conducive to either application.

- First system was operating by March 1989.

- The system was expanded in October 1991. The well pump was upgraded from 5HP to 7.5HP, and two additional loops (four additional heat pumps) were added.

Benefits

- Ropak Can-Am's use of geothermal energy is a success story for several reasons. Benefits include: cooling capability and dehumidification, reduced down-time, energy conservation, reduced energy and maintenance costs, environmentally cleaner energy, improved staff morale and productivity, and an expanded product line (food containers) because of the cleaner environment.

Points Raised In Question Period

- It is cheaper to run the pumps in series.

- There have been no freezing problems to date.

- The copper pipes are checked each year and are still fine.

- The iron oxides in the minewater are a potential problem. To date the equipment wear appears due to erosion rather than corrosion.

Aquifer Thermal Energy Storage (ATES)

Frank Cruickshanks, Environment Canada, Halifax

This presentation described Environment Canada work underway to assist potential aquifer users manage data and make decisions. Examples of projects utilizing aquifer thermal energy storage (ATES) were provided.

The information and approach presented do not deal expressly with minewaters, but do apply to minewater which (in effect) is a form of groundwater. The same rules apply in collecting and assessing information and making decisions.

A background paper is included in Appendix 3. Some major points are provided below.

Aquifer Use

- Aquifers can be used in a number of ways including to supply seasonal heating/cooling needs.
- The principal of Aquifer Thermal Energy Storage (ATES) is to store freely available excess heat from summer, or cold from winter, in natural or artificial aquifers to provide seasonal heating or cooling to surface facilities.
- This seasonal use is possible because the ground provides good insulation. Water in aquifers is hot in winter and cool in summer relative to surface temperatures.
- Recovery of the resource involves the use of both a supply well and a recharge well (an open-loop, dual well system). It is important to return the water and recharge the aquifer to protect future use.
- Successful development of groundwater (including minewater) as a resource depends on wise use and reuse. The characteristics of the resource must be understood, and the demands of the range of potential uses (industrial, agricultural, domestic, energy) must be balanced.
- Each aquifer use project must be considered on its own merits with due consideration to the nature of the aquifer, the range of proposed uses, and land use in the area.
- District energy systems have both operating and monitoring advantages over numerous individual wells. A district system allows the wells to be located optimally to protect the geothermal resource, and prevent "interference" between wells.
- At present Nova Scotia provincial guidelines are being developed to assist in the development and management of geothermal resources, and to help prevent problems.

- There are a number of legal and jurisdictional issues regarding aquifer use to be resolved.

Data Systems

- It is increasingly important to plan ahead and to make effective decisions regarding aquifer management and use. To this end data bases, information management systems, and guidelines are important and are being developed (e.g. a national groundwater data base is being established).

- A number of geographic information database systems (GIS) are being developed to allow for the storage, retrieval, manipulation, analysis, and display of data. GIS systems can cope with the two and three dimensional geographical information that is a part of current earth energy databases.

- The database systems will help in assessing the impacts of proposed projects and actions, and of potentially conflicting land use. The systems will help in assessing aquifers, choosing drilling locations, sizing pumps etc.

- Pilot tests are underway to test and demonstrate the effectiveness and usefulness of GIS systems in managing local earth energy resources. Examples include the Amherst pilot test involving numerous partners.

Sussex Area: an Example of Aquifer Use

- A joint project involving the Town of Sussex, DOE, and the New Brunswick Power Commission is under consideration. The objective would be to demonstrate the benefits of groundwater source heating and cooling technologies; to integrate the earth energy technologies with existing groundwater management programs; and to identify potential problems to be addressed.

- In the Sussex area there are a number of current aquifer users (e.g. Kiwanis nursing home) and more uses planned (e.g. power plant for district heating).

- There are also other land uses (e.g. a landfill operation) that could affect some uses of the aquifer. Is the aquifer water affected by the landfill? Understanding the lithology helps to understand how other land uses will affect the aquifer.

- It is important to develop a good data base relevant to the Sussex aquifer, in order to make decisions regarding individual projects, and to demonstrate geothermal benefits and options.

- Energy from ground or groundwater can normally be economically used by a single building. The cost of recovering the energy from other low-temperature energy resources may be high. To be economic such energy recovery may require development of a distribution system which shares the energy, and the related costs, among a number of users.

- Options for district (central production) heating systems include: saturated steam systems (supply temperatures 120-180°C); high temperature hot water systems (supply temperatures 120-180°C); medium temperature hot water systems (supply temperatures 80-120°C); and low-temperature hot water systems (supply temperatures below 90°C).

- The lower the supply temperature the better. Lower temperature water is easier to use, can be run through less expensive pipes, and offers better efficiency (lower heat loss from pipes).

- Distribution of cooling from central production facilities is also possible using water from 7°C to ice slurries.

- Combined heating and cooling can be provided by a central heating and cooling system augmented by decentralized heat pumps and/or chillers.

- The lower limit of water temperature that can be used for heating depends on the energy demands of existing heating systems.

- The costs of establishing a central heating system based on low-temperature energy resources can be high (e.g. total cost of drilling wells, piping, heat pumps). However, the operating (energy) costs are low. Therefore it is effective to use the low-temperature resource as the "base load" in a heating system.

- It is estimated that an energy source that provides only 20% of peak energy demand, provides 50% of total energy consumed. An energy source that provides 50% of peak energy demand provides over 90% of total energy consumed.

District Heating Examples

- In Lyckebo, district heating for 500 homes is provided by solar heated water. The maximum supply temperatures are 75°C and the water is distributed using pre-insulated copper and steel pipes. The project was a trial, and solar collectors to provide 15% of the required energy were built. Total energy produced is 10,000 MWh of which the solar collectors provide 1,500 MWh. The remaining energy needs are met using an electric boiler. Eventually more solar collectors will be built. Seasonal energy is stored in a 100,000 m^3 rock cavern.

- In Upsala, district heating provides a population of 140,000 with 95% of domestic spaceheating and hot water needs. Sewage water is used as an energy source and meets 10-50% of the energy demand. The sewage temperature is similar to minewater temperature. Oil is used to top up and provide the remainder of the energy needs. The peak heat demand is 750 MW, and the annual heat production is 1900 GWh.

- The Upsala recovery of heat from the sewage has decreased slightly in recent years to reflect the best economic and environmental balance of energy from different available sources. In the winter more heat is available from the cogeneration plan as a byproduct of electricity. In the summer more energy is available as a byproduct of waste incineration - the preferred alternative to landfilling.

Geothermal Energy From Mines

- In Sweden there are 120 mines with capacity greater than 100,000 m^3. The majority of the mines are not deep enough to serve as effective heat sources, but can be used for energy storage. 36 mines are within 10 km of a potential heat load (source).

- At Norberg a 300 m deep mine has a capacity of 1,440,000 m^3. Water temperatures are 4-7° C. The mine is flooded to within 20 m of ground level. The minewater is used as an energy source. The water is transported by plastic pipes. Heat pumps are used to recover 1,800 MWh of energy; oil fired boilers produce an additional 500 MWh for peak production.

- At Ljusnarsberg a 310 m deep mine with water temperatures of 2-13°C is used in district heating. In the summer river water is used to raise the minewater temperature. The additional heat required to raise the water temperature to the desired distribution temperature is provided by oil and electric boilers.

Points From Question Period

- On the basis of a national referendum on nuclear energy held in the early 1980's, the 12 existing nuclear fired reactors will be maintained for their natural/technical life. Nuclear energy will be gradually phased out, but the existing plants will be around for a while. A feasibility study suggests that the waste energy from the plants could be effectively transported a distance of 120 km in insulated pipes. There are energy markets within the stipulated radius. At present the waste energy is not being used in district heating.

- The decision in Sweden was to diversify the energy base, and to find and use many energy sources. In short to decrease dependence on specific energy sources (particularly imported fossil fuels).

Site Visit to Ropak Can-Am Ltd., Springhill

Following the presentations on the afternoon of 28 October, the Conference participants reconvened at (descended upon) the Ropak facility. Len MacKinnon led a tour, and described in detail the sequence of events leading to the use of the geothermal resource for heating and cooling of the facility, the technology in place, and the related benefits.

The tour consisted of on-site viewing of the technical information provided in the Conference presentations given by Len MacKinnon and Bill Hickey. Interest level was high and the tour was frequently delayed by a barrage of questions which threatened the probability of anyone getting to the formal Conference dinner in time.

Tour participants were particularly interested in the quality of the minewater and the related effects on the down-well pump and heat exchangers; the life-expectancy of equipment; the maintenance requirements; contingency plans (if the geothermal system is "down" for any reason); and cost-effectiveness of the system.

Dinner Session (Wandlyn Inn, Amherst)

Wednesday evening (28 October 1993) a dinner for Conference participants was hosted by the Town of Springhill and province of Nova Scotia.

The Master of Ceremonies was Mr. Jack MacDonald (Geothermal Co-ordinator). Members of the head table were Ms. Rosemary Mullins (First Lady Mayor of the Town of Springhill), Mr. Guy Brown (MLA for Cumberland Centre), Mr. William Casey (MP for Cumberland-Colchester), Mr. Ron Jefferson (Springhill Economic Development Officer), Dr. Alan Jessop (Energy, Mines and Resources Canada), Mr. Chris Kavanaugh (Nova Scotia Department of Natural Resources), The Honourable John Leefe (Minister of Natural Resources), Mr. Doug Marshall (Chairman of Springhill and Area Economic Development Commission), and Mr. Jim Stanley (Executive Director, Cumberland Development Authority).

The Honourable John Leefe, Minister of Natural Resources, Government of Nova Scotia gave the keynote speech. In addition, all individuals seated at the head table were required to speak, albeit briefly, as a duty accompanying the honour.

- Jack MacDonald thanked everyone for participating in the Conference and for their interest in advancing the consideration and use of geothermal energy resources.
- Rosemary Mullins particularly thanked Ralph Ross and Ron White for their important (even essential) contributions to the development of the Springhill geothermal resource.
- Mr. Guy Brown and Mr. Bill Casey both noted that geothermal resource development has much to offer the community and region, and that the approach taken to date is a good example of effective community economic development.
- Jim Stanley noted that the geothermal resource provides exciting economic opportunities, and that the Cumberland Development Authority is interested in working with the community/region to help market the resource.

Keynote Speech: The Honourable John Leefe (Minister of Natural Resources)

Mr. Leefe considered it fitting that the first geothermal conference in Eastern Canada was being held in Springhill - a community that is in the forefront of low-temperature geothermal energy technology and development. Major points made include the following:

- The work leading to the development of the Springhill geothermal resource reflects the evolution of an innovative concept through trial and demonstration stages, to ongoing growth of interest and applications, and advances in the technology.

- The Springhill geothermal energy resource contributes to the development of effective, economic energy alternatives, and to sustainable development. In addition, the energy source is less environmentally harmful than many other forms of energy use, and is renewable. Using the resource contributes to environmental improvements (local and global) and to conservation of non-renewable energy resources.

- At present imported oil provides 68% of energy used in the Maritimes. This is a serious problem. The work at Springhill fits into the provincial sustainable energy strategy aimed at diversifying energy sources and developing greater energy self-sufficiency. Alternate energy sources being considered include waste oil, wood chips, coal gas extraction, as well as geothermal energy.

- There are numerous local benefits. The Springhill geothermal resource is environmentally friendly, compatible with sustained developments, and cost-effective. The resource is producing local spin-offs (e.g. pump equipment is manufactured locally).

- The changes needed to improve provincial and regional energy and economic independence and security will involve innovation and cooperation between the private sector and all levels of government (municipal, regional, provincial, and federal). Government will play an important role but private sector commitment is also needed. The Springhill geothermal development is an example of effective partnership at work.

- Springhill has been designated as the Springhill Geothermal area. The Town has received a license to develop the geothermal resource.

- The Town, and all involved parties, are to be commended on the first rate innovation and initiative shown in advancing the use of geothermal energy. The work at Springhill is leading to changes in philosophy and legislation (e.g. amendments to the Mineral Resources Act) to accommodate geothermal energy use.

Award Presentations

The Town of Springhill made four presentations of local art in appreciation of special contributions to the Conference, and to the overall development of the Geothermal Project. A presentation was made to The Honourable John Leefe in appreciation for his participation, and delivery of the keynote speech. A presentation was made to Ingvar Larsson for providing information on geothermal applications in Sweden (and for travelling the furthest). Presentations were made to Alan Jessop and Chris Kavanaugh in very sincere appreciation for their long-term (and ongoing) interest and technical assistance, which have contributed to the development and success of the Geothermal Project.

Ownership of the Resource

Michael Wood, Burchell, MacAdam and Hayman, Halifax

This presentation provided an overview of legal issues and current legislation regarding ownership of the geothermal resource. Interest in low-temperature geothermal resources is recent. At present some of the related resource ownership and legislative issues are unresolved.

A background paper is included in Appendix 3, and major points are provided below.

Ownership of the Geothermal Resource: Status

- Land owners' rights to the geothermal resource will depend on the nature of the underground water and on legislation (current and new).

- Ownership will ultimately depend on how the resource is defined. Is the resource the heat, the material bearing the heat, or both?

- At present the ownership of geothermal energy in Nova Scotia is not covered by specific government regulations. Common law principals apply, but provide no separate recognition of geothermal resources. The person who owns the rock or water will also own the geothermal energy.

- Under common law, geothermal water resources have not been treated any differently than other subsurface waters. Landowners have the rights to underground water that is percolating, but not to water that is part of an underground stream. What is the definition of a discrete stream? What definition will do for legal purposes?

- The definition of a stream probably would not apply to the flow of water through man-made underground mine workings.

- Landowners can remove subsurface water, even if this causes a loss of water under adjoining land. The only exception is where there is a distinct underground stream. Percolating waters can be removed, but adjacent landowners have the right to receive the continuous flow of the stream.

- Geothermal resources are not covered under the Water Act if the water is part of an underground stream; the Act only applies to percolating water.

- The current legislation and common law do not encourage development of geothermal resources. A developer could invest considerable time and money into development of the geothermal resource, and subsequently lose access to the water because of the activities of adjacent landowners.

- If a geothermal resource lies (extends) under the property of a number of landowners, action by any of the landowners can affect the quantity or quality of the water.

- As it stands, for an individual to control access to a geothermal resource it will be necessary to make arrangements with a number of different landowners.

- There are also potential conflicts in resource use. In the case of an abandoned mine the owner of the mineral rights could reactivate the mine and pump out the minewater, thereby destroying the geothermal resource.

- Changes in legislation are needed to clarify ownership, protect the geothermal resource, and make the resource more stable and attractive to potential users.

- In jurisdictions which have recognized the importance of the geothermal resource, governments have responded by passing specific legislation and vesting the resource in the crown.

- A comparison of the approaches taken by British Columbia, New Zealand, and Nova Scotia is provided in the background paper.

Nova Scotia Approach

- The approach being taken in Nova Scotia is somewhat different from that in British Columbia and New Zealand. Nova Scotia has not adopted separate legislation, but has adapted the *Mineral Resources Act* to include geothermal resources.

- The government can designate an area as a geothermal resource area, and vest the area's geothermal resources in the Crown.

- There is no provision against accessing and using geothermal resources, other than in designated geothermal resource areas where the geothermal resource has been vested in the Crown.

- Nova Scotia may choose to enact separate legislation later, if it is needed. The province has yet to decide what the regulatory scheme will be and how to proceed with permits, licenses and fees.

- The low-temperature geothermal resources from abandoned mines occur at specific sites. At present the province will proceed with a case-by-case consideration of the resource, rather than with broad vesting of the resource in the province.

Points Made During Discussion Period

- This presentation raised substantial interest and many questions. There are many unanswered questions of significant interest to communities considering development of geothermal resources. Participants wanted to known:
  - Will the geothermal resource be taxed? Will there be fees for use?
  - What legislation will cover geothermal resources? Is there new legislation coming re ownership?
  - The province will lease out the resource but for how long and how much? Who will decide?
  - Will other communities interested in developing geothermal resources get the same rights and privileges as Springhill?

- The probable intent of the province is to protect the resource, and use it to stimulate development. The objective is not likely to be the generation of funds (for the provincial coffers) from the use of the resource.

- The Town of Springhill requested that the province enact legislation to protect the Springhill geothermal resource.

- The interrelationship between mineral and geothermal rights still needs clarification. This is particularly relevant for geothermal resources associated with abandoned mines.

Analysis of a Community Geothermal System

Clyde Beer, Vaughan Engineering Associates, Halifax

This presentation provided an overview of a 1992 feasibility study conducted for the Town of Springhill. There have been successful, site-specific, industrial and commercial applications of the Springhill geothermal energy resource. The feasibility study considered the possibility of developing a district heating/cooling system for the Town of Springhill, using geothermal energy from the flooded coal mines as the principal energy source.

A detailed report was submitted to the Town, some major points are provided below.

The Feasibility Study

- The study was intended to consider options, and outline the most effective way of utilizing the geothermal resource - with due consideration to both supply and demand.
- The study compared the use of conventional oil, electricity, and the geothermal resource.
- Because of time constraints, it was impossible to do a detailed energy study of the whole Town. Instead, the energy needs of a candidate group of thirty-one buildings were studied in detail. The results can be extrapolated.
- The number of buildings included in the study grew during the course of the study. There was substantial interest in the work and many owners asked that their buildings be included in the study.
- For each building included in the study, consideration was given to location, current heating method and cost, and whether cooling is used/wanted.
- A hypothetical model consisting of buildings in the commercial centre, the main street and the industrial park was used to review the cost-effectiveness of converting buildings to use geothermal energy.
- Three options for using the geothermal resource were considered: the current approach using individual wells; a combination of individual wells and clustered/shared wells; and a central warm water distribution system.

Major Findings

The study generated many questions as well as some answers. The following are some of the major findings.

- The economics of geothermal conversion depend on the energy needs of a specific building. The most significant factor affecting the economic feasibility of geothermal conversion is the necessity of providing dehumidification and cooling as well as space heating. If dehumidification and cooling are needed the capital cost for a geothermal based system is only a small incremental cost above a conventional heating and cooling system, and the payback period is attractive. For "heat only" applications the payback period can be several years.

- The Town should promote the geothermal energy source for industries that have significant cooling/dehumidification as well as heating needs. Ropak Can-Am Ltd. is an excellent example of a highly suitable industry.

- The piping required for distribution of the minewater is a major cost. As a result one plant serving both the industrial park and the Town is not economic/practical.

- Even the use of a single central station to pump warm Town water (heated by the minewater) to local heat pumps appears uneconomic because of the piping distances involved. The preferred option is smaller, localized central systems for specific Town areas.

- In the Industrial Park the best (most cost-effective) option is the current approach: localized wells for individual plants. In the future, if there are clusters of buildings in the industrial park, centralized (shared) systems could be a viable option.

- For the Town main street a central system should be considered although the economics still appear to favour the individual well approach.

- Clustering (a number of buildings sharing a well) is technically the preferred option. It will not always be practical to drill individual wells because of site characteristics. Moreover, with a large number of individual wells in close proximity there is a good chance that the wells will interfere with each other.

- The district system considered is a medium temperature system. The costs associated with a high water temperature system could only be justified (cost-effective) for a much larger district system than the Springhill model.

- The payback period for a medium temperature system is estimated at 7-10 years. The payback period for a high temperature system would be much longer (50-60 years) because of the high equipment costs.

- While the capacity of the warm minewater reservoir seems ample for development, there is more work required to prove-out the resource. Long-term flow tests should be run to establish the extent of the resource with some accuracy.

- A small-scale district demonstration system should be developed. The system should consist of 10-11 Town buildings (located close together), and a main plant and heat exchanger. Estimated cost $1M.

- The existing heat plants in the building should be kept and used in parallel as needed.

- At least initially, the Town should not anticipate more than breaking even on the energy conversion to geothermal. However, the Town could benefit from the increased economic activity that the geothermal energy will stimulate. This could result in increased revenues for the Town.

- The Town would have to decide how to cover the costs of shared geothermal systems. Options include dividing the costs among the buildings on the system, or having the Town pay and then recover the costs.

Funding Sources

Jim Stanley, Executive Director, Cumberland Development Authority, Amherst

This presentation provided an overview of funding sources and options for all stages of a project from the original concept through to marketing of the proven product. Some major points are provided below.

Springhill Geothermal Development: Why and How it Happened

- For the Springhill geothermal development a number of different funding sources have contributed to date. In addition, many individuals donated a lot of volunteer time.

- The Springhill development is an excellent example of effective partnership between different levels of government and the business sector. The Springhill Geothermal Project reflects involvement from the community, region, province, federal government, and the private sector.

- The Springhill population has been decreasing since the late 1950's. The community/region realized that to turn things around and attract industry they would have to take stock and action. The Town decided to make the most of the opportunities/advantage offered by the cheap energy available under the Town. The results were new industry, jobs, and investment in the community.

- Springhill has a strong base of entrepreneurs willing to go out after investments, and a history of developing and following-up on concepts. Examples are as diverse as the Ann Murray Centre and the geothermal energy from mines.

- Money is just another need to be met in advancing an idea (e.g. bringing an idea to fruition).

Stages in the Development of the Springhill Geothermal Energy Resource

The Springhill Geothermal Project went from an idea to a reality. The experience gained can be useful for other similar projects. In developing the geothermal resource there have been a number of stages, with some different players and needs at each stage.

1. The vision/idea stage. This stage requires someone with the ideas and vision, and lots of persistence. This was Ralph Ross in the case of the Springhill geothermal resource.

2. The entrepreneurial stage. This stage requires risk takers and seed money to advance the concept. At Springhill the risk takers included Robin Blake and Len MacKinnon (Ropak Ltd), and the Town of Springhill. The seed funding was provided from a number of sources including the Town, Ropak, the Nova Scotia Ministry of Natural Resources, Energy Mines and Resources Canada, and the Atlantic Canada Opportunities Agency.

3. The growth stage. This stage requires group/team activity and the systematic development and implementation of an action plan. This is the current stage of the geothermal work at Springhill.

4. The sustained growth phase. This stage occurs when the technology is proven, accepted, and sought. At this stage the users fund the ongoing development.

Advancing Stage 3

- The time and resources invested in the Springhill geothermal project will grow. The Town needs to give careful consideration to how to proceed and what action is needed.

- Moving the geothermal resource development at Springhill (and other communities) ahead will require a number of actions. A network of interested individuals to help maintain momentum and ensure action would be very useful.

- One of the needs is for team activity to recruit new industry to the area. This is one area in which the Cumberland Development Authority can play a useful role. The Authority will be pleased to work with the community to achieve this objective.

Points Made in Discussion Period

- Before too much vigorous recruitment of geothermal energy users is undertaken, the resource/reserves should be proven.

- Knowing the details of the resource will assist in targeting specific markets/users (e.g. best sectors, and specific companies).

- A comprehensive action plan should be prepared by the Town detailing the work that needs to be done to advance the use and protection of the geothermal energy resource.

- The land acquisition for the industrial park needs to be finalized.

Economics

Len MacKinnon, General Manager, Ropak Can-Am Ltd., Springhill

This presentation outlined the use of geothermal energy at the Ropak Can-Am Ltd. facility. Additional information on Ropak is provided in the presentation by Bill Hickey, and in background papers in Appendix 3.

Len MacKinnon was unable to attend the Thursday technical session. Therefore, the presentation was by Jack MacDonald, based on material provided by Len MacKinnon.

The Ropak Facility

- Ropak Can-Am Ltd. is a manufacturer of rigid plastic packaging products for the fishing, forestry, agricultural, and dairy industries.

- Until 1989 Ropak operated out of a 6,000 m^2 facility in Springhill. Space was limited. The plant could not meet the air quality regulations (e.g. dust, climate control) for production of food containers.

- The decision was made to add 7,900 m^2 for additional manufacturing, storage, and office space. The heating options considered for the new facility were oil, propane, electric, and geothermal.

- After extensive study the geothermal energy/heat pump was considered viable and was chosen. The system was based on use of the warm minewaters underlying the Town.

- A supply and return well system to remove and return the minewaters to the mine workings was established. The supply well draws water from the main haulage of the #2 Mine. The return well deposits the water in the #3 Mine.

- In March 1989 eleven Delta heat pumps were installed. The system uses the minewater to provide both heat and air conditioning in the newly constructed facility (extension). In 1991 four heat pumps were added to convert the original portion of the facility.

- The entire facility is now climate-controlled, environmentally clean, and energy conserving. The Ropak facilities now meet the requirements for production of food containers, and Ropak products are making in-roads into the food processing industry.

Economic Considerations

- In making the decision to switch to geothermal energy, the economics of installing, operating, and maintaining the geothermal energy system were considered. The additional benefits of geothermal energy use were also considered.

- The capital cost to purchase and install the geothermal system was approximately 20% higher than for a conventional energy system. Items such as well drilling were the major cause of the additional expenditures.

- The operating cost of the geothermal system offers significant savings relative to conventional heating/cooling systems. The oil-fired heating costs for 1,500 m^2 of the old building were $35K/year. The heat pump system is estimated to cost $7.K/year and provides the bonus of summer air-conditioning as well.

- The pay-back was less than 1 year, for the additional capital cost of the geothermal installation.

- Maintenance costs consist of cleaning or replacing the filters 2-3 times annually at an approximate cost of $5.K/year. The major components of the heat pumps have a life expectancy of 10 years. Maintenance costs compare favourably with those for conventional heating systems.

- A number of additional benefits have been realized through the switch to the geothermal system. These benefits include: domestic hot water supplied as a by-product; air-conditioning and improved worker comfort during the summer months; improved product quality, additional product lines, and production efficiency.

Conclusion

- The innovative use of geothermal energy from the flooded mines has created a highly efficient and economic heating/cooling system for Ropak Can-Am's Springhill facility. The conversion has helped Ropak improve productivity and expand into new markets.

- The cost-effective use of geothermal energy may hold the key to industrial growth in the Town of Springhill, and has potential applications in other mining communities in Nova Scotia and throughout Canada.

SECTION 4

WORKING GROUP REPORTS AND WRAP-UP

This section provides a summary of major points from the individual Working Group reports (verbal), and the open discussion/wrap-up session.

Section 4: Summary of Working Group Reports and Conference Wrap-Up

Working Group Activity

On the second day of the Conference the participants separated into four Working Groups addressing different issues. The Group topics were:

Group 1 Geothermal Technology (Leader Michael Wiggin)
Group 2 Economic Considerations (Leader Clyde Beer)
Group 3 Ownership/Legal Issues (Leader Michael Wood)
Group 4 Planning and Resource Issues (Leader Alan Jessop)

The Working Groups were asked to discuss issues of interest, and to try to develop statements of need, action items, and recommendations to bring back to the plenary. At the conclusion of the Working Group session the Conference participants reconvened and each of the Groups reported.

Working Group Reports
Group 1 Geothermal Technology (Leader Michael Wiggin)

The Group discussed how to proceed with accessing, extracting, transporting, and using geothermal resources. Some major points and recommendations from the discussion:

- Concern was expressed over how long specific geothermal resources would last, and the possibility of depletion. Maintaining the quantity and quality of the resource was considered a priority.

- It is critically important to make the correct technical decisions in developing geothermal resources: to locate supply and return wells appropriately; to ensure success of individual applications; and to protect the resource.

- More work is needed to better understand the Springhill resource, refine the existing model, and facilitate good geothermal applications. Better information is needed to help decide where to locate wells, target depths to drill, and how much to pump.

- Interest in the geothermal resource is high but many communities do not know how to proceed in assessing and developing the resource.

- The province and the Cumberland Development Authority should help to ensure that the development of the geothermal resource can proceed effectively. As a priority, better information and a model for making management decisions regarding development and use of geothermal resources should be developed. The model can assist in the ongoing development of the Springhill geothermal resource, and could also assist other communities interested in developing geothermal resources.

Group 2 Economic Considerations (Leader Clyde Beer)

The Group discussed technical and economic issues. The Group focused on industrial and municipal applications. Residential applications of geothermal energy are not considered imminent. Some major points and recommendations from the discussion:

- An operation/facility should be considered a potential user of geothermal energy if two (or more) of the following services are required: heating, cooling, ventilation, and dehumidification.

- Rather than retrofitting buildings, an attempt should be made to integrate geothermal energy at the original construction stage.

- For decisions regarding geothermal energy recovery and use there is a need to consider capital equipment options and costs, and operating and maintenance needs and costs.

- The legislative aspects of geothermal resource development need to be addressed as they will ultimately affect the cost and feasibility of applications. For example, resource ownership issues and environmental requirements will affect the security of the geothermal resource and the relative benefits of geothermal vs other energy sources.

- In promoting use of geothermal resources it is worth identifying (and addressing) the factors that are currently limiting applications. What are the obstacles/limiting factors? Factors identified include the current business environment and market uncertainty (the recession); lack of general awareness of the benefits and potential of geothermal energy; the cost of retrofitting existing facilities; and politics and priorities at all political levels (municipal to federal).

- Approaches to removing the economic-related obstacles to geothermal applications include the following:
    1. A specific effort should be made to target industries most likely to benefit from geothermal energy;
    2. The municipalities with geothermal resources should absorb some of the economic risk (e.g. share the risk with industry);
    3. The geothermal resources should be effectively promoted (e.g. there is a need for ongoing education and dissemination of information regarding the geothermal resource, available technologies, and applications);
    4. The municipalities with geothermal resources should practice what they preach (e.g. the Springhill Townhall should be part of the geothermal system).

Group 3 Ownership/Legal Issues (Leader Michael Wood)

The Group focused its discussion on two points: ownership and control of the geothermal resource; and taxation of the resource. Some major points and recommendations from the discussion:

- Land use control can affect where geothermal development takes place.
- Provincial control will ensure that a shared resource is protected.
- Ideally, the license for the geothermal resource should be given to the municipality which would then be responsible for appropriate development and use of the resource.
- There will be some complex issues to resolve in cases where geothermal resources extend outside municipal boundaries. Consideration should be given to how such situations should be handled.
- Will a public utility board set a minimum price for geothermal energy? Will the province try to use fees to turn geothermal energy into a money-maker?
- The geothermal resource should not be used as a direct provincial money-maker through taxes, fees etc. The economic benefits should (will) be achieved through increased economic activity which will yield taxes etc.
- The case for the benefits of low user fees and non-taxation of the resource should be made by documenting the benefits that could accrue to the province through development of the resource. Benefits will include indirect revenue to the province through other taxes (e.g. real property tax, sales tax, income tax). It is probable that these benefits will exceed the potential revenue from direct taxation of the resource.
- Industries considering geothermal energy will want to be assured that, for at least a specified time period, no major fees will be instituted with respect to their use of geothermal energy. Without such a commitment potential users cannot estimate the cost of the geothermal energy and determine whether it is a good economic choice.
- It is likely that some form of user fee will still be needed to help set up and maintain geothermal systems.
- There was some concern expressed that other utilities (e.g. electric) will try to have a minimum price, user fees, and taxation imposed on geothermal resources to prevent movement of clients away from their products to geothermal energy.

Group 4 Planning and Resource Issues (Leader Alan Jessop)

The Group focused on how communities can obtain information and proceed with the assessment and development of their geothermal resources. Specifically, how communities can access existing experience and knowledge regarding applications of low-temperature geothermal energy resources from abandoned mines. Some major points and recommendations from the discussion:

- Small communities need help in understanding and managing their geothermal resources.

- The stages in the identification, assessment, and development of the Springhill geothermal resource should be documented. The sequence could serve as a model to assist other communities.

- The Springhill example is valuable but more is needed. Communities need information and guidance regarding what to do, where to find information, how to proceed through the stages of geothermal development, how to interpret the results at different stages, and how to find funds to cover the requisite work. The information requirements relate to all aspects including funding, assessing, developing, and promoting geothermal resources.

- A number of approaches could be used to assist interested companies and municipalities in how to proceed with respect to specific geothermal resources.

- A handbook on low-temperature geothermal resource development would be useful. The handbook could provide information on technical issues, sources of expertise, legislative aspects, marketing and promotion etc. The handbook could provide check lists and flow charts indicating how to proceed, and leading to specific decision points.

- Decision support systems, like those outlined in the presentation by Frank Cruickshanks, could be useful, but many communities would need assistance in using the systems and in interpreting the results.

- A network of experts and individuals interested in geothermal issues would be very beneficial. The network would assist in exchange of information and in advancing the requisite work.

- The federal and provincial governments have relevant information and expertise. There is a need for ways/mechanisms to provide interested municipalities, individuals, and companies with better access to this information and expertise. Appropriate mechanisms should be developed. A multi-disciplinary Geothermal Energy Advisory Committee is one option.

Open Discussion Period Following Working Group Reports

In the open discussion following the Working Group reports a number of major points and recommendations were made.

- The availability of geothermal resources from abandoned mines, the overall interest in increasing energy options (to reduce dependence on imported fossil fuels), and the Springhill experience place the province in a unique situation to develop low-temperature geothermal resources. This should be built on.

- Decisions are needed on how to advance consideration and use of geothermal resources, on how to proceed, and on the role different interested parties could/should play. There are two streams of related activity required: (1) Work related to advancing the geothermal work at Springhill; and (2) Work to assist other communities in considering and making good decisions regarding their geothermal resources.

  Recommendations:
  Action items/recommendations arising from the Springhill Conference should be identified and appropriate action initiated. The Conference organizers, while assessing the Conference results/outcome, should identify items that could constitute an action plan.

  The existing work on geothermal energy should be continued and existing relevant federal and provincial programs that could advance the assessment, protection, and promotion of geothermal resources should be fully used (e.g. the Federal program on community energy systems, and the provincial program on energy self-sufficiency).

- There is a need for a better information base to assist individuals interested in their geothermal resources with the work required to assess and proceed with development. A User's Handbook (for low-temperature geothermal energy resources) would be a useful document. The Handbook could cover a broad range of topics. Not all material would need to be generated "from scratch". Some information required for the Handbook already exists and could be adopted (compiled) from other sources.

  Recommendation:
  A User's Handbook should be developed. Decisions are needed on what specific topics and information should be included, and who could/would develop the Handbook.

- The Conference has provided a useful opportunity to exchange information regarding aspects of geothermal energy development, to identify needs and work to be done in advancing geothermal resource assessment and use at Springhill, and to assist other interested communities in considering/managing their geothermal resources.

- Future meetings would be useful in advancing discussion on specific aspects of geothermal energy.

Recommendations:
There should be another Conference next year. The meeting could continue the general discussion, and focus on some very specific aspects (to be determined).

The focus of the next conference could be community support. The objective would be to discuss issues of interest to communities at different stages in the work related to assessing and developing low-temperature geothermal energy resources.

A core group should be formed to develop the agenda for the next meeting.

- The development of low-temperature geothermal energy from mines is at a critical stage. The concept is still new. There is considerable work to be done in preparing the way for useful applications of geothermal energy. To assist in identifying and advancing the work to be done, and in providing information there would be benefit in establishing an advisory committee of interested parties and organizations.

  Recommendation:
  The provincial Ministry of Natural Resources should establish and chair a Geothermal Energy Advisory Committee. The Committee should be made up of representatives on a range of relevant technical, policy, and economic aspects of low-temperature geothermal energy development/use.

- The discussion period was brought to a close and the formal Conference Proceedings were deemed concluded when a number of out-of-province participants were required to return (at break-neck speed) to Halifax to catch planes.

- Jack MacDonald thanked the Conference participants and noted that much information and many ideas and suggestions had been aired over the two days; and that there was not sufficient time for a detailed summary, let alone analysis, of the Conference results before adjourning. On behalf of the Conference Organizing Committee, Jack committed to providing the participants with a Conference Report that would include a post-Conference analysis, and a summary of major conclusions and recommendations (see Section 2 of this Report).

- After the formal Conference proceedings adjourned the majority of participants remained and continued the discussions in small groups. Premier Don Cameron visited, met with a number of the Conference participants, and discussed aspects of geothermal energy development.

SECTION 3

APPENDICES

This section consists of auxiliary material.

Appendix 1: The Conference Agenda

Appendix 2: The Conference Participants List

Appendix 3: Background Material including background papers provided by some of the speakers at the Conference, and additional material relating to the Springhill Geothermal Project.

Attention!! **Appendix 3 is a free-standing (separate) document and can be obtained on request by contacting:**

Mr. Ron Jefferson
Economic Development Officer
Springhill Townhall
29 Main Street
Springhill, Nova Scotia
B0M 1X0
Tel: (902) 597-8216
Fax: (902) 597-3637

Appendix 1: Conference Agenda

WEDNESDAY OCTOBER 28, 1992

8:30 Coffee

9:00 Welcome Rosemary Mullins-
Mayor of Springhill

9:15 Geothermal Overview - Alan Jessop
Energy Mines & Resources, Calgary

9:45 Heat Pump Technology -
Michael Wiggin, Energy Mines &
Resources, Ottawa

10:45 Coffee Break

11:00 The Mines Inventory -
Katherine Arkay, Consultant,
Ottawa

11:30 Locating the Resource -
Chris Kavanaugh, Department of
Natural Resources, Halifax

12:00 Luncheon - Senior Citizens
Complex

2:15 New Energy Systems -
Ingvar Larsson, Sweden

3:00 The Ropak System - Bill Hickey
Delta Heat Pump, Amherst

3:30 Tours - Ropak Can-Am

7:00 Cocktails

7:45 Dinner Wandlyn Inn, Amherst
Hosted by Town of Springhill & the
Province of Nova Scotia

THURSDAY OCTOBER 29

8:00 Coffee

8:30 Ownership of the Resource-
Wood/Wildsmith, Halifax

9:00 Economics - Len MacKinnon
General Manager, Ropak Can-Am

9:30 Analysis of a Community
Geothermal System - Clyde Beer
Vaughan Engineering Associates

10:00 Funding Sources -
Jim Stanley, Executive Director,
C.D.A.

10:30 Coffee Break

10:45 Group Session

12:30 Luncheon - Senior Citizens
Complex

2:00 Resume for discussion

4:00 Adjourn

Appendix 2: List of Conference Participants

A.T. Addis
Town of Stellarton
P.O. Box 2200
Stellarton, NS
B0K 1S0
Tel: (902) 752-2114
Fax: (902) 755-4105

Katherine Arkay
Katherine Arkay Consultant
73 MacKay St.
Ottawa, Ont
K1M 2F4
Tel: (613) 748-6591

Adrien Baillargeon
Correctional Service Canada
1222 Main St., 2nd Floor
Moncton, NS
E1C 1H6
Tel: (506) 851-6313
Fax: (506) 851-6316

Clem Balesdent
P.O. Box 1021
Stellarton, NS
B0K 1S0
Tel: (902) 752-6006

Claude Barraud
Chief
New Energy Supply Technologies
Alternative Energy Division
Canmet
Energy, Mines and Resources Canada
Ottawa, Ont
K1A 0E4
Tel: (613) 996-6087
Fax: (613) 996-9614

Everett Baudoux
C/O Clem Balesdent
P.O. Box 1021
Stellarton, NS
B0K 1S0
Tel: (902) 752-6006

Frank Beaumont
Correction Service Canada
1222 Main St,. 2nd Floor
Moncton, NB
E1C 1H6
Tel: (506) 851-6313
Fax: (506) 851-6316

Clyde Beer
Vaughan Engineering
P.O. Box 2045 Station M
Halifax, NS
B3J 2Z1
Tel: (902) 425-3980
Fax: (902) 423-7593

Darryl P. Bonhower, P.Eng
Alderney Consultants (1987) Ltd
327 Prince St.
Dartmouth, NS
B2Y 1N7
Tel: (902) 465-7300
Fax: (902) 465-4834

Paul Bourque
Octa Greenhouse Sales
R.R. #7
Amherst, NS
B4H 3Y5
Tel: (902) 667-5940
Fax: (902) 667-0677

Guy Brown, MLA
P.O. Box 1049
Springhill, NS
B0M 1X0
Tel: (902) 597-3863
Fax: (902) 597-2336

Premier Donald Cameron
Province House
P.O. Box 726
Halifax, NS
B3J 2T3
Tel: (902) 424-6606
Fax: (902) 424-7648

Dan Baur
N.S. Power Corp
P.O. Box 130
Truro, NS
B2N 5B6
Tel: (902) 893-8051
Fax: (902) 893-8733

Bill Casey, MP
16 Church St.
Amherst, NS
b4H 3Z2
Tel: (902) 667-8518
Fax: (902) 667-1271

Mr. Ken Church
Ken Church Engineering
2260 F Halifax Drive
Ottawa, Ont
K1G 2W6
Tel: (613) 739-3374
Fax: (613) 739-1505

Jean Cochrane
River Hebert Development Commission
River Hebert, NS
B0L 1G0
Tel: (902) 251-2051

Frank Cruikshank
Energy Mines and Resources
Water Planning Management Branch
45 Alderney Drive
Dartmouth, NS
B2Y 2N6
Tel: (902) 426-3266

Mayor Mary Daley
Town of Westville
P.O. Box 923
Westville, NS
B2N 5C5
Tel: (902) 396-4118
Fax: (902) 396-3986

George Cameron
C/O Clem Balesdent
P.O. Box 1021
Stellarton, NS
B0K 1S0
Tel: (902) 752-4656

Albert Dunphy
Cumberland District
Planning Commission
31 Church St.
Amherst, NS
B4H 4A1
Tel: (902) 667-5141
Fax: (902) 667-5873

Phil Elliot
NS Power Corp
P.O. Box 910
Scotia Square, Barrington Tower
Halifax, NS
B3J 2W5
Tel: (902) 428-6423
Fax: (902) 428-6055

Darrell Fagan
Barrensfield Rd
River Hebert, NS
B0L 1G0
Tel: (902) 251-2490

David Fanning
Jacques Whitford Environment
3 Spectacle Lake Dr
Dartmouth, NS
B3B 1W8
Tel: (902) 468-7777
Fax: (902) 468-9009

Wayne Faulkner
NS Dept of Environment
P.O. Box 824
Truro, NS
B3N 5G6
Tel: (902) 893-5880
Fax: (902) 893-0282

George Dashner
NB Power
P.O. Box 2000
Fredericton, NB
E3B 4X1
Tel: (902) 458-3285
Fax: (902) 458-3626

George Dooley
Town of Westville
2020 Queen St.
P.O. Box 923
Westville, NS
B0K 2A0
Tel: (902) 396-4118
Fax: (902) 396-3986

Mike Hartop
Public Works Canada
P.O. Box 1189
Moncton, NB
E1C 8P9
Tel: (506) 851-2379 or 384-7272
Fax: (506) 851-6500

Greg Haverstock
NS Dept of Natural Resources
P.O. Box 1087
1690 Hollis St
Halifax, NS
B3J 2X1
Tel: (902) 424-5019
Fax: (902) 424-7735

Brian Hayes
NS Dept of Natural Resources
P.O. Box 1087
1690 Hollis St
Halifax, NS
B3J 2X1
Tel: (902) 424-5019
Fax: (902) 424-7735

Terry Hennigar
Washburn & Gillis Associates Ltd
Sutie 200, West End Mall
6960 Munford Rd
Halifax, NS
B3L 4P1
Tel: (902) 453-2266
Fax: (902) 453-1226

Richard Frotten
Student
N.S.I.T Engineering Dept
P.O. Box 2210
Halifax, NS
B3J 3C4

Pam Harrison
Cumberland Development Authorit
32 Church St
Amherst, NS
B4H 4A1
Tel: (902) 667-3192
Fax: (902) 667-2270

Jens Jensen
Cumberland District
Planning Commission
P.O. Box 549
Amherst, NS
B4H 4A1
Tel: (902) 667-5141
Fax: (902) 667-5873

Alan Jessop
Geological Survey of Canada
3303 33rd St
Calgary, Alta
T2L 2A7
Tel: (403) 292-7148
Fax: (403) 292-5377

Hazen Jewitt
Municipality of the County
of Cumberland
P.O. Box 428
Amherst, NS
B4H 3Z5
Tel: (902) 667-2313
Fax: (902) 667-1352

Jim Jewkes
NS Power Corp
Springhill, NS
B0M 1X0
Tel: (902) 597-2975

Jim Morris
Municipality of the County
of Cumberland
P.O. Box 428
Amherst, NS
B4H 3Z5
Tel: (902) 667-2313
Fax: (902) 667-1352

Jonathon Nichols
Cumberland Development Authority
32 Church St
P.O. Box 546
Amherst, NS
B4H 4A1
Tel: (902) 667-3192
Fax: (902) 667-2270

R.A. Nixon, Exec. Dir.
Amherst Area Development Commission
P.O. Box 223
Amherst, NS
B4H 3Z2
Tel: (902) 667-2562
Fax: (902) 667-5409

Brian O'Blenes
Correction Service Canada
1222 Main St., 2nd Floor
Moncton, NB
E1C 1H6
Tel: (506) 851-6313
Fax: (506) 851-6316

Jean Reid
River Hebert/Joggins Development
Joggins, NS
B0L 1A0
Tel: (902) 667-2751

Todd Ross
Student
C/O Guy Brown, MLA
Herrett Road
Springhill, NS
B0M 1X0
Tel: (902) 597-3863
Fax: (902) 597-2336

Clarence Porter
Town of Stellarton
P.O. Box 2200
Stellarton, NS
B0K 1S0
Tel: (902) 752-2114
Fax: (902) 752-4105

Gary Porter
NS Dept of Economic Development
P.O. Box 9020 Station A
Halifax, NS
B3K 5M6
Tel: (902) 424-2720
Fax: (902) 424-0508

Carl Powell, P.Eng
44 Dundas St
St. John's, NFLD
A1B 1X2
Tel: (709) 754-6296

Darrell Pupek
NB Dept of Environment
P.O. Box 6000
Fredericton, NB
E3B 5H1

Jim Stanley
Cumberland Development Authority
32 Church St
Amherst, NS B4H 4A1
Tel: (902) 667-3192
Fax: (902) 667-2270

David Stewart
NS Power Corp
P.O. Box 910
Scotia Square, Barrington Tower
Halifax, NS
B3J 2W5
Tel: (902) 428-6423
Fax: (902) 428-6055

Bill Hickey
Delta Heat Pumps
P.O. Box 787
Amherst, NS
B4H 4B9
Tel: (902) 667-2224
Fax: (902) 667-3693

Ken Hussey
NS Power Corp
P.O. Box 130
Truro, NS
B2N 5B6
Tel: (902) 893-8051
Fax: (902) 893-8733

Jeff King
Jacques Whitford Environment
3 Spectacle Lake Dr
Dartmouth, NS
B3V 1W8
Tel: (902) 468-7777
Fax: (902) 468-9009

Harold Langille
Correction Services
R.R. #1
Springhill, NS
B0M 1X0
Tel: (902) 597-3755
Fax: (902) 597-3562

Ken Langille
Correctional Services
Wolsley St
Springhill, NS
B0M 1X0
Tel: (902) 597-3755
Fax: (902) 597-3562

Ingvar Larrson
Project Manager, Energy Systems
Technologies Implementation
Energy, Mines and Resources Canada
Energy Research Laboratories
Canmet
555 Booth St
Ottawa, Ont
K1A 0G1
Tel: (613) 996-8870
Fax: (613) 947-0291

Chris Kavanaugh
NS Dept of Natural Resources
P.O. Box 698
Halifax, NS
B3J 2T9
Tel: (902) 424-3227
Fax: (902) 424-7736

Wayne Kelly
Student
N.S.I.T. Engineering Dept
P.O. Box 2210
Halifax, NS
B3J 3C4

Scott MacDougall
NS Power Corp
P.O. Box 1070
Stellarton, NS
B0K 1S0
Tel: (902) 752-8631
Fax: (902) 752-3437

Mr. David MacFarlane
Jacques Whitford Environment Ltd
3 Spectacle Lake Drive
Dartmouth, NS
B3B 1W8
Tel: (902) 468-7777
Fax: (902) 468-9009

Len MacKinnon
Rapak Can-Am Ltd
P.O. Box 340
Springhill, NS
B0M 1X0
Tel: (902) 597-3787
Fax: (902) 597-8318

Doug MacPherson
C/O Clem Balesdent
P.O. Box 1021
Stellarton, NS
B0K 1S0
Tel: (902) 755-5330

Jim Savage
Correctional Services
P.O. Box 2140
Springhill, NS
B0M 1X0
Tel: (902) 597-3755
Fax: (902) 597-3562

Ed Tattersall
Tallersall's Refridgeration
River Hebert/Joggins Development
River Hebert, NS
B0L 1G0
Tel: (902) 251-2421

Harold Sear
NS Power Corp
P.O. Box 1070
Stellarton, NS
B0K 1S0
Tel: (902) 752-8361
Fax: (902) 755-3437

Town of Springhill
Chief Administrative Officer
D.E. Maddison
P.O. Box 1000
Springhill, NS
B0M 1X0
Tel: (902) 597-3751
Fax: (902) 597-3637

Town of Springhill Council
P.O. Box 1000
Springhill, NS
B0M 1X0
Tel: (902) 597-3751
Fax: (902) 597-3637

Mayor: Rosemary Mullins

Council:
Kumar Uberoi
Douglas Jewkes
Howard Spence
Mary D. MacPherson
Douglas Dobson
David Henwood

Springhill And Area Economic
Development Commission
P.O. Box 1000
Springhill, NS
B0M 1X0

Commissioners:

Doug Marshall - Chairman

Robert Gilroy
Dan Uberoi
Karl Cochrane
David Delaney
Carl Demings
Randy Ryan
Harold Delaney
Mary Ellen MacDougall
Alan Dill

Development Department
P.O. Box 1000
Springhill, NS
B0M 1X0
Tel: (902) 597-8216
Fax: (902) 597-3637

Staff:
Ron Jefferson
Cathy Ward

Michael Laurette
Seagull Pewter & Silver Smiths
P.O. Box 370
Pugwash, NS
B0K 1L0
Tel: (902) 243-2516
Fax: (902) 243-3368

Honourable John Leefe
Minister of Natural Resources
P.O. Box 698
Halifax, NS
B3J 2T9
Tel: (902) 424-0594
Fax: (902) 424-4037

Wayne Lewis
Vaughan Engineering
P.O. Box 2045 Station M
Halfax, NS
B3J 2Z1
Tel: (902) 425-3980
Fax: (902) 425-7593

Jack MacDonald
NS Dept of Natural Resources
P.O. Box 698
Halifax, NS
B3J 2T9
Tel: (902) 424-3227
Fax: (902) 424-7735

Jack Mitchell
Corrrection Service Canada
1222 Main St., 2nd Floor
Moncton, NB
E1C 1H6
Tel: (506) 851-6313
Fax: (506) 851-6313

Chris Moir
NS Dept of Economic Development
P.O. Box 9020 Station A
Halifax, NS
B3K 5M6
Tel: (902) 424-2720
Fax: (902) 424-0508

Deputy Mayor Bill Marshall
Town of Westville
P.O. Box 923
Westville, NS
B2N 5C5
Tel: (902) 396-4118
Fax: (902) 396-3986

Ian Matheson
Correction Service Canada
1222 Main St., 2nd Floor
Moncton, NB
E1C 1H6
Tel: (506) 851-6313
Fax: (506) 851-6316

Jean Melanson
NS Dept fo Economic Development
P.O Box 458
Amherst, NS
B4H 4A1
Tel: (902) 667-3223
Fax: (902) 667-0707

Mark Miller
NS Dept of Envirnoment
P.O Box 6000
Fredericton, NB
E3B 5H1

Patricia Patterson
Porter Dillon Ltd
2701 Dutch Village Rd
Halifax, NS
B3L 4G6
Tel: (902) 453-1115
Fax: (902) 454-6886

Ron Patterson
Town of Amherst
P.O. Box 516
Amherst, NS
B4H 4A1
Tel: (902) 667-3352
Fax: (902) 667-3356

Ron White
Ron White Well Drilling
P.O. Box 596
Amherst, NS
B4H 4B8
Tel: (902) 667-3291
Fax: (902) 667-3291

Mike Wiggin
Project Manger, Energy Systems
Technologies Implementation
Energy, Mines and Resources Canada
Energy Research Laboratories
Canmet
555 Booth Street
Ottawa, Ont
k1A 0G1
Tel: (613) 996-8870
Fax: (613) 947-0291

Bruce Wildsmith
Burchell MacAdam & Hayman
P.O. Box 36
Halifax, NS
B3J 2L4
Tel: (902) 423-6361
Fax: (902) 420-9326

Michael Wood
Burchell MacAdam & Hayman
P.O. Box 36
Halifax, NS
B3J 2L4
Tel: (902) 423-6361
Fax: (902) 420-9326

Appendix 3: Background Documents

This Appendix consist of background papers provided by many of the conference speakers, and of some additional background material relating to the Springhill Geothermal Project.

Appendix 3 is a free-standing document. A copy can be obtained on request from:

Mr. Ron Jefferson
Economic Development Officer
Springhill Townhall
29 Main Street
Springhill, Nova Scotia
B0M 1X0
Tel: (902) 597-8216
Fax: (902) 597-3637