

## INVESTIGATING THE POTENTIAL FOR DIRECT-USE GEOTHERMAL IN BRITISH COLUMBIA – A NEW GEOSCIENCE BC PROJECT

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### Project Information for communities

Geothermal energy in British Columbia has long been discussed as a potential renewable (i.e. green) energy source for the province. The 2015 study by Kerr Wood Liedel and GeothermEX evaluated 18 geothermal manifestation sites and provided more detailed information regarding 11 sites deemed “favourable” for electrical generation. They reported that the combined potential for the 11 sites was up to 400 MWe of power. However, the hurdle for economically viable geothermal electrical power generation development is not just the confirmation of suitable resources, but also the need to identify acceptable financial and economic factors. Electrical generation can have significant long term pay-back but it entails very high up-front costs. In addition, the length of time to develop a resource can also be long-drawn-out and the exploration required for development is complex and costly. However, ‘Direct-use’ applications at lower temperature are easily attainable resources than electricity generation. Direct-use applications have simpler and lower cost of exploration. This study seeks to quantify and evaluate the potential for Direct-use in British Columbia communities and create a ‘Road-Map’ for development opportunities. Figure 1 below shows the known application of geothermal resources at different temperatures. Some lower temperature Direct-use applications include soil warming, greenhouse gardening, fish and aqua culture, spa, food processing, mushroom culture, pulp and paper processing, and lumber drying.

Geoscience BC is funding the joint proposal by Tuya Terra Geo Corp (TTGeo) and Geothermal Management Company Inc. (GMC) to carry out this study. TTGeo is a BC based company while GMC is based in Colorado. The two companies have combined expertise in various aspects of the project and will complete the evaluation and also document the results. The project will be carried out over the next six months with products expected in mid-2016.

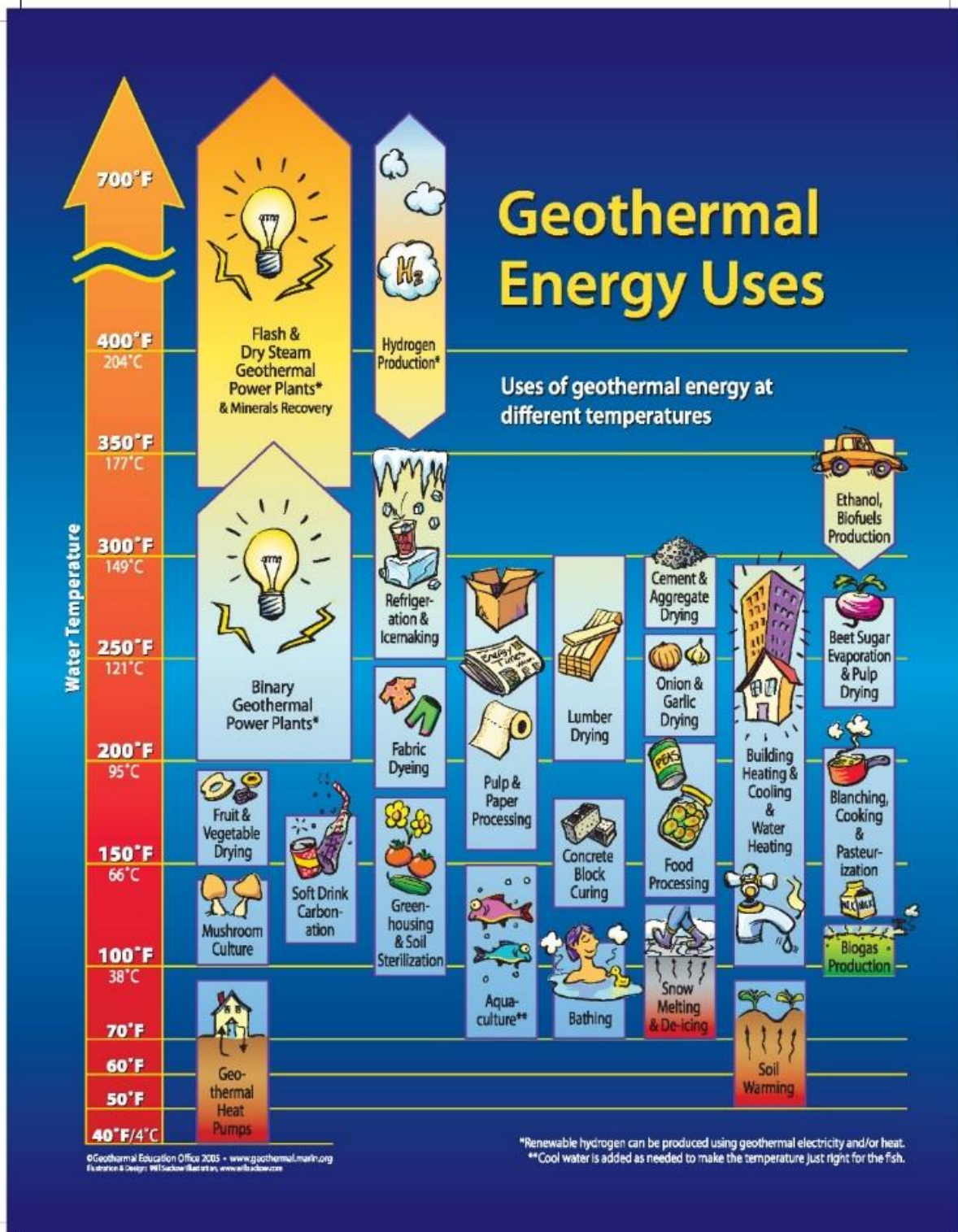


Figure 1: Known uses of geothermal resources

## Methodology and Project Structure:

This project will be divided into three phases as summarized below.

**Phase 1:** Identify regions and communities in British Columbia with potential for Direct-use geothermal energy development.

As a first step, a list of existing British Columbia geoscience data sets useful for the evaluation of Direct-use geothermal energy has been compiled. The team will build on the existing geothermal data collected for the 18 locations studied by Kerr Wood Leidal and Geothermex. These sites are Canoe Creek – Valemount, Clarke Lake, Clearwater Volcanic Field, Iskut, Jedney, King Island, Kootenay, Lakelse Lake, Lower Arrow Lake, Meager Creek/Pebble Creek, Mt. Cayley, Mt. Garibaldi, Silverthorne - Knight Inlet, Nazko Cone, Okanagan, Sloquet Hot Springs, Sphaler Creek, Upper Arrow Lake. The data will be analysed and compared with the results of some earlier studies.

As a first step the eleven sites for which detailed economics calculation were completed and additional development information was compiled are being considered as areas with potential for Direct-use geothermal. These sites are Canoe Creek, Valemount, Clarke Lake, Kootenay, Lakelse Lake, Lower Arrow Lake, Meager Creek/Pebble Creek, Mt. Cayley, Okanagan, Sloquet Hot Springs, and Jedney. The list of communities in these regions will form the basis for further study of Direct-use potential.

**Phase 2:** Review of community and technical information gathered.

During this phase, all communities in areas surrounding the Canoe Creek, Valemount, Clarke Lake, Kootenay, Lakelse Lake, Lower Arrow Lake, Meager Creek/Pebble Creek, Mt. Cayley, Okanagan, Sloquet Hot Springs, and Jedney sites will be contacted. Semi-structured interviews will be conducted to gather data about land use and economic development interests of these communities.

During this phase, some community research capacity would be built. Community knowledge and awareness of geothermal resources and opportunities presented would be increased. Data gathered during interviews will be reviewed along with technical information gathered for the sites.

**Phase 3:** Summarizing and analyzing the results and completing the Geothermal Direct-use Road Map.

During this phase, the final report will be produced. The report would include conclusions and recommendations regarding the next steps for assisting communities that may wish to move forward with development planning. The Road Map will include, but is not limited to:

- 1) Conduct of ground-surface based activities designed to characterize the resource (geology and geochemistry, possibly some geophysics depending on cost, location and other circumstances);
- 2) Acquisition of land control;
- 3) Information about First Nations consultation, acquisition of all federally, provincially, and locally required permits;
- 4) The cost of drilling shallow thermal gradient holes;

- 5) The cost of drilling of either slim-hole(s) or production/injection well(s) (depending on the amount of money available);
- 6) Testing of wells;
- 7) Design and construction of facilities for beneficial, commercial use and disposal of the produced thermal fluids; and
- 8) The cost of transporting the Direct-use product(s) to the potential end user(s).

## **Additional Information**

Attached are the following documents which form part of this study:

- Appendix 1: Direct-Use Geothermal Resources In BC - Research Ethics Protocol
- Appendix 2: Direct-Use Geothermal Resources in BC - Participant's Interview Information Sheet
- Appendix 3: Direct-Use Geothermal Resources in BC - Participant's Consent Form for In-depth Interview
- Appendix 4: Direct-Use Geothermal Resources in BC - Discussions/Interview: Guide Questions

It is anticipated that through this study more information about geothermal resources and its Direct-use applications in British Columbia will become available. The final report will be publically accessible. The updated geoscience and development data, when combined with the Direct-use Road Map and community capacity building would assist communities and developers in carrying out successful Direct-use geothermal projects.

## APPENDIX 1: DIRECT-USE GEOTHERMAL RESOURCES IN BC

### RESEARCH ETHICS PROTOCOL

This document defines the ethics protocol in which the study will be carried out and how the publication of the findings will be handled. This protocol is guided by the 2014 Canadian Tri-Council Policy Statement on the Ethical Conduct for Research Involving Human Subjects. The three federal research agencies - the Canadian Institutes of Health Research, the Natural Sciences and Engineering Research Council of Canada, and the Social Sciences and Humanities Research Council of Canada - jointly introduced the ethics framework as a guideline for research and researchers.

#### WHEREAS:

1. Titi Kunkel ("TK") and Leah Hjorth ("LH") are working with Tuya Terra Geo Corp ("TTGEO") to investigate Direct-use geothermal within identified BC communities.
2. The research will determine what Direct-use geothermal resources opportunities are available for communities for economic purposes.
3. The information will be used along with publicly available data to develop a road map for Direct-use geothermal resources in BC.
4. The findings of this research will be documented in a report to Geoscience BC.

#### 1 GUIDING ETHICAL PRINCIPLES

##### 1.1 Respect for participants

The TTGEO and its representatives ("The Team") shall protect the cultural, mental, spiritual, physical and emotional interests of participants throughout the research process. This principle forms the foundation for all other ethical principles outlined below.

##### 1.2 Respect for Free and Informed Consent

The Team shall comply with the exercise of individual and community consent. Consent would be achieved through a letter of consent or verbal consent from representatives of the community.

Participants have given free and informed consent when they have freely, without coercion or intimidation, agreed to participate in the study based on well-understood information regarding the research objectives and potential benefits and risks of participation. Objectives of the study include information regarding the ways in which the research results shall be published and how the participants will be informed of the results.

Continuing voluntary participation requires that participants understand that at any time their withdrawal of consent to the research project shall not result in penalty, including any loss of promised benefit, which are not contingent upon completion of participation.

Evidence of free and informed consent by the participant or authorized third party will be obtained in writing or recorded with name, date, and form of consent.

### **1.3 Respect for Vulnerable Persons**

The Team will ensure that high ethical obligations are maintained regarding those who are vulnerable or lack decision-making capacity.

### **1.4 Respect for Anonymity and Confidentiality**

The Team members shall not solicit confidential information; however, shall respect the participants' rights to anonymity and confidentiality if so required. This includes protection of access and dissemination of personal information.

### **1.5 Respect for Intellectual Property**

The Team recognizes and acknowledges that the community has inherent rights to control and determine their proprietary interests in the collection, use, and storage and potential future use of data.

Individuals and/or members of the community will retain ownership of any traditional knowledge, cultural practices and traditions that are shared with the research team.

Other research data that does not pertain to traditional knowledge, cultural practices and/or traditions will be used in the study.

The findings of the research will be published as a report and submitted to Geoscience BC. This report could be made publicly available Geoscience BC.

The Team will ensure that each community participants have *reasonable* opportunity to participate in the interpretation of data and review of conclusions drawn from the research to ensure accuracy and sensitivity of interpretation.

### **1.6 Minimizing Harm and Maximizing Benefits**

The Team will ensure anticipated benefits outweigh potential harms when conducting the research. In the process of conducting research, The Team will ensure that participants are not subject to

unnecessary risks or harm and shall be obligated to assist the participant in reducing or eliminating any adverse effect that may arise.

**1.7 Access**

Research participants will be able to obtain copies of material and any research findings and reports by prior arrangements with The Team. A summary of findings will be given to all participants.

## APPENDIX 2: DIRECT-USE GEOTHERMAL RESOURCES IN BC

### PARTICIPANT'S INTERVIEW INFORMATION SHEET

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**Researcher:** Ms. Leah Hjorth  
**Phone No:**  
**E-mail:**

**Researcher:** Dr. Titi Kunkel  
**Phone No:** 250.XXX.XXXX  
**E-mail:** titi.kunkel@alumni.unbc.ca

**Researcher:** Dr. Catherine Hickson  
**Phone No:** 604.XXX.XXXX  
**E-mail:** [TTGeo@telus.net](mailto:TTGeo@telus.net)

### Project Information: Purpose, Benefits, and Potential Risks

**Purpose of research:** The purpose of this research is to find out more information about Direct-Use geothermal resources that are available within communities in BC. The aim of the study is to gather as much information about the available Direct-Use geothermal resources, provide information to communities about possible uses, understand community aspirations, and develop a detailed road-map for development. This study is being carried out by Tuya Terra Geo Corp Inc (TT Geo). The Funds for this project was received from Geoscience BC.

**How communities have been chosen:** In 2015, Kerr Wood Leidal and Geothermex, concluded a study for Geoscience BC on the viability of electricity generation for known geothermal resource areas. These areas were Canoe Creek – Valemount, Clarke Lake, Clearwater Volcanic Field, Iskut, Jedney, King Island, Kootenay, Lakelse Lake, Lower Arrow Lake, Meager Creek/Pebble Creek, Mt. Cayley, Mt. Garibaldi, Silverthorne - Knight Inlet, Nazko Cone, Okanagan, Sloquet Hot Springs, Sphaler Creek, and Upper Arrow Lake. This study is for eleven of these sites are now being considered as viable locations for Direct-Use geothermal resources. These sites are Canoe Creek, Valemount, Clarke Lake, Kootenay, Lakelse Lake, Lower Arrow Lake, Meager Creek/Pebble Creek, Mt. Cayley, Okanagan, Sloquet Hot Springs, and Jedney. This study is to provide detailed economics and additional information which is required to develop a ‘road map’ for development options.

**Benefits of this Project:** This project will identify locations with good potential for geothermal resource Direct-Use applications. This project will compile an inventory of current and planned Direct-Use projects as well as provide communities with a “road map” for evaluating their resource as the first steps towards development. This tool-kit will provide guidance for communities as to how to move forward on Direct-Use projects, addressing all technical and non-technical aspects.



The project findings, conclusions, and recommendations will be summarized in a report from having a table of contents, supporting data sets (portable hard drive), references, completed community knowledge matrices, an exploration road map, and methodology. It will also include a discussion of any issues encountered in the data analysis, assumptions made, and corresponding limitations on the interpretation of the results based on sparse data, community engagement limitations or other factors. Spatial data collected will be compiled at a scale suitable for web hosting and/or distribution. Documents and other types of data will be compiled and indexed for future reference on a community by community basis.

The community data collection process is designed to engage local communities, thereby increasing awareness and knowledge of geothermal resources in their area. This study will use inclusionary methods such as semi-structured interviews to increase community knowledge of Direct-Use geothermal resources. A benefit of participating in this study is that the outcome of the project outcome would provide information which can be incorporated into community economic development plans.

**Potential risks of this project:** While this study is not a consultation for resource development and will not be soliciting information about geographic locations of communities' sacred sites or traditional use areas, it is possible these resources are at close proximity to those areas. In such instances, the study will note these other uses but not provide the geographic locations of such. Furthermore, communities are not obligated to provide details of traditional land use or sacred sites.

**What questions will interviewees be asked?** Interview questions have been designed to provide information required to put together the Direct-Use geothermal resources road map for BC. Questions asked will be based on the attached 'In-depth Interview Guide Questions'. Personal or confidential information will not be solicited.

**Voluntary nature of their participation:** Participation in this research is completely voluntary. However, participation will be beneficial for all communities as this study provides opportunities both for current and future discussions about geothermal resources available in the area and the different considerations for community uses. If a community is not available for participation or chooses not to participate, known and publicly available data will be compiled for the area. This will not affect the community's involvement in future discussion about geothermal resources in the area.

### Project Team Members

TT Geo has assembled an impressive team of experienced researchers in the community engagement and Direct-Use geothermal field. With their knowledge of green-field geothermal exploration, depth of experience, intimate knowledge of the geology of British Columbia, and highly advanced skills in community engagement, they will be able to execute the project efficiently. Each member brings a specific expertise to this highly qualified team of geothermal practitioners.

- **Dr. Catherine Hickson P.Geo. – Project Manager and Science Co-leader**

Dr. Catherine Hickson will provide overall project management and team leadership. Dr. Hickson is the President of Tuya Terra Geo Corp. and has more than 35 years' experience in geology, geothermal energy and managing high performance, multidisciplinary teams. For twenty-five years she worked for the Geological Survey of Canada (GSC) in various capacities including executive roles. She began her career with the GSC working on the Mount Meager geothermal project and other heat flow projects. In 1992, she was the scientific authority for the Geothermal Map of British Columbia. In 2008, she joined a private sector energy company, Alterra Power Corp. which focused on geothermal energy exploration and development. She built a global portfolio of green-field concessions for the company, several of which are now partnered to other companies for advanced exploration, including the global geothermal giant, Energy Development Corp. (Philippines). In 2013, she left the company when they ceased green-field exploration. In the last two years she has built a strong client base of Canadian and international companies and continues to work in geothermal energy. She has published numerous scientific papers including a recent publication on "The Geothermal Exploration and Development Process: Graphical Representation Path to Optimal Decision Making" presented at the Geothermal Resources Council meeting, October 2014, Portland Oregon.

- **Dr. Titi Kunkel – Science Co-leader**

Dr. Titi Kunkel has over 25 years of international training and education project experience. Her work in the last ten years has primarily been in the Cariboo and Chilcotin regions of BC, working with Aboriginal communities. She received her Ph.D. from University of Northern BC in 2015 and continues to work with the university developing and delivering programs for rural and remote communities. Dr. Kunkel's dissertation assessed the compatibility of geothermal resource development and Aboriginal values within the Nazko and Xeni Gwet'in First Nations communities. Her work sheds new light on Aboriginal values in the region and the significance of these in economic development. She sits on the Board of Directors for Community Futures Development Corporation for the North Cariboo and the Nazko Economic Development Corporation. She has led numerous community-based research projects for Aboriginal communities in the region. Of note is her work with the Tsilhqot'in Nation communities to identify Aboriginal values in an area of cultural interests and significance to the people. She presented her findings at the two Federal Environmental Assessment panels (2010 and 2013) and at the World Mining Congress of 2013 in Montreal.

- **Ms. Leah Hjorth - Research Associates**

Ms. Leah Hjorth has a BA in Education from the University of British Columbia and she is a member of the Nazko First Nation. Ms. Hjorth has been identified as a Research Associate for this project because of her work with Aboriginal communities in the Cariboo region. Ms. Hjorth has worked with Dr. Kunkel on community-based research projects using questionnaire surveys and semi-structured interviews. In addition, she worked with Drs. Kunkel and Hickson on a project to investigate geothermal resource potentials in the Nazko area. Ms. Hjorth will be

working with Dr. Kunkel to compile community interests and use data in areas with high potential for geothermal direct-use resources.

**- Mr. Gerald W. Huttner – Direct-Use Expert and Science Co-leader**

Mr. Gerald W. Huttner is President of Geothermal Management Company, Inc. (GMC). GMC is a consultancy, founded in 1985, specializing in provision of services to the geothermal industry. These are focused on the geoscientific aspects of low, medium, and high temperature projects that have been conducted in 47 geothermally prospective countries. Mr. Huttner is the sole employee of GMC, however he frequently associates with other geothermal experts to establish a team that will be optimally qualified to undertake a specific project as in this case.

Mr. Huttner has collaborated with Dr. Lund, and Ms. Boyd on several Direct-Use projects in the past. Generally, Mr. Huttner studies the geologic and sub-surface situations. Over his more than 40 years in the geothermal industry, Mr. Huttner has gained a wide range of Direct-Use experience including, but not limited to: space heating and cooling, greenhouse and aquaculture pond heating, industrial applications, geothermal (ground-source) heat pumps, snow-melting, and combined heat and power facilities.

Mr. Huttner is a geothermal geologist with a B.A from Dartmouth College and an MS from the University of Washington. He has worked in the geothermal industry since 1969 and has conducted geothermal studies for heat-pump-related, Direct-Use, and electric power generation internationally for entities including the U.S. and foreign governmental agencies, private and corporate entrepreneurs, investment banks, petroleum and mining companies, tribal organizations, and Multi-Lateral Development Banks. He is a past president and multi-term director of the Geothermal Resource Council (GRC), a founding member of the International Geothermal Association and is a recipient of the prestigious Aidlin Award from the GRC. Mr. Huttner's Direct-Use projects include evaluation of the potential for economic development of low to medium temperature resources in: the entire state of Alaska (for the National Renewable Energy Laboratory), the city of Steamboat Springs, Colorado, the City of Glenwood Springs, Colorado, the City of Ouray, Colorado, the City of Pagosa Springs, Colorado, Fallon Naval Base, Nevada, the City of Banya Luka, Bosnia-Hertzegegovia, and the whole of the Western United States (for Geoterma, Paris-Nord, France).

**- Dr. John Lund PE – Direct-Use Expert**

Dr. John Lund is one of the world's leading geothermal Direct-Use expert with more than 45 years in the geothermal industry. He holds BS and PhD Civil Engineering degrees from the University of Colorado and an MS Civil Engineering degree from the University of California, Berkeley. Dr. Lund was associated with the Oregon Institute of Technology Geo-Heat Center from 1980 through 2010 and held Professorial, Dean, and Director Positions throughout these 30 years. He has lectured to governmental, academic, industrial, and private audiences all over the world and has innumerable geothermal publications regarding all surface-related aspects of

Direct-Use. Dr. Lund is a past president of the Geothermal Resources Council and of the International Geothermal Association.

Dr. Lund's most recent presentations include: a four-lecture series on Direct-Use applications to the 2014 ASHRAE Conference in Salt Lake City, Utah, six lectures on Direct-Use applications to the Canadian Geothermal Energy Association (CanGEA) in Calgary in March 2014, and a Keynote speech/overview of geothermal Direct-Uses to the Asian Pacific Energy Conference in Taipei, Republic of China in June 2013. Dr. Lund also has done extensive field work in Klamath Falls and Lakeview, Oregon as well as in Steamboat Springs, Glenwood Springs, and Pagosa Springs, Colorado.

- **Dr. Glenn Woodsworth P.Geo. – Structure, Hot Springs of British Columbia**

Dr. Glenn Woodsworth has over 45 years geological experience in British Columbia and brings to the project a thorough understanding of the geology of British Columbia. After receiving his Ph.D. from Princeton University, he joined the Geological Survey of Canada (GSC) as a Research Scientist. His work focused on bedrock geological mapping and structural and metamorphic studies at various scales, and on regional geological syntheses of Cordilleran geology. He has a long interest in hot springs and was a contributor and editor of the Fairbank and Faulkner's 1992 Geothermal Map of British Columbia. Since leaving the GSC, he has consulted on various geothermal and regional geology projects within B.C. He was the first scientist to call attention to the geothermal potential of the Knight Inlet/Hoodoo Creek area. Dr. Woodsworth has published over 120 papers, reports, and maps on the many aspects of Cordilleran geology, and his *Hot Springs of Western Canada* (3rd edition, 2014) is the standard work on the topic.

- **Dr. Jacek Majorowicz – Heat Flow**

Dr. Jacek Majorowicz is a global expert in heat flow. He brings to the team a deep understanding of the subsurface thermal regime as determined through boreholes and other data. He has studied thermal problems on a variety of scales applied to geothermal systems including the state of the lithosphere, geothermal energy of the sedimentary basins, engineered geothermal systems (EGS), and thermal maturation-basin studies. Previous works have included heat flow and magnetotelluric work done for the Cordillera and sedimentary basins in B.C. which included the B.C. part of Western Canadian Sedimentary Basin, and Bowser and Nechako basins in the Intermontane Belt. The majority of these studies and resulting study reports have been published as scientific papers in top geophysical and geological journals in America and Europe. Of note is his work on enhanced geothermal systems in Canada and the identification of high potential regions.

- **Dr. Michal Moore – Energy Economist**

Dr. Michal Moore is one of the leading thinkers on energy economics in North America. His major research areas and interests include the operation and oversight of energy markets, including the interaction of oil and gas and electric systems. Dr. Moore's recent research has focused on the integration of geothermal and solar energy facilities with the national grid in Australia and in Canada. He holds academic appointments in energy economics and systems engineering at both Cornell University and the University of Calgary. He is the current Area Director of Research for Energy and Environment at the School of Public Policy in Calgary and works with researcher faculty at Carleton University on a broad range of public education and literacy projects oriented to improving public perception and understanding of energy systems. He recently co-authored a major report on geothermal resource potential in Australia, and was a co-author of the first report to comprehensively identify geothermal resources throughout Canada. Dr. Moore is currently teaching classes in renewable energy technologies, and developing a low temperature geothermal system to assist in neutralizing pathogens in human waste for developing nations.

- **Mr. Ron Yehia – Geochemistry and Geomatics**

Mr. Ron Yehia is an experienced geothermal and grassroots exploration geologist. Mr. Yehia was the Canada Exploration Lead at Vancouver-based Alterra Power, where he was responsible for planning and managing exploration in Western Canada as well as managing the geoscience hardware and software. At Alterra, he also participated in overseas exploration including assessment of various exploration tools and techniques. Prior to Alterra, Mr. Yehia was an exploration geologist at Ormat Technologies based in Reno, Nevada, where additional duties included responsibility for British Columbia exploration and as Manager of the Resource Group geodata. Currently, Mr. Yehia is consulting as an exploration geologist offering expertise and services in real-time hydrogeology results acquisition, and geoscientific solutions specializing in open source tools. He has also compiled a GIS database of geochemistry results for British Columbia. This is available online at:

<http://www.arcgis.com/home/item.html?id=cebc4e70ad4c48fd8314a681ae65f09c>

- **Ms. Toni Boyd – Geomatics Specialist and Direct-Use Expert**

Ms. Toni Boyd holds BSc degrees in Civil Engineering Technology and Civil Engineering from the Oregon Institute of Technology (OIT). She has been involved in all aspects of geothermal Direct-Use projects for more than 21 years and rose from her initial Lab Testing Technician position at OIT to Senior Engineer and Acting Director. Ms. Boyd has extensive computer experience and has edited and been responsible for graphics on numerous OIT and international publications. She is also an expert in creation of geothermal data bases both for resources and for surface applications. She is a multi-term director of the Geothermal Resources Council (GRC) and was the Direct-Use Chair of the GRC Annual Meetings from 2001-2015 as well as for the World

## APPENDIX A: Information package and questionnaire

Geothermal Congresses in 2005, 2010, and 2015. Ms. Boyd has also authored and co-authored a great many articles and publications regarding geothermal Direct-Use.

### - **APEX Geoscience Ltd. – Geology and Geomatics**

Tuya Terra Geo Corp has subcontract APEX Geoscience Ltd. as an integral part of the team to provide geomatics support for the project. APEX has been providing geological consulting services to small and large exploration companies around the world for more than 20 years. APEX brings to the project their experience in British Columbia exploration through their highly experienced team of geoscientists and sophisticated software and database management expertise. They also have considerable experience in technical reporting, geological modelling and resource estimation services.

Through Apex, Ms. Yuliana Proenza P.Geo. will be engaged. Ms. Proenza is a geologist and a geomatics specialist with APEX Geoscience Ltd. She has a B. Sc. in Earth & Planetary Sciences from McGill University followed by a Master of Engineering degree in Clean Energy Engineering from University of British Columbia in 2012. Her thesis built a conceptual model for the Mount Meager geothermal system. She is an expert in GIS, database management, proficient in Geographical Information Systems (ArcGIS and MapInfo), 3D modelling and exploration targeting (Micromine, Leapfrog 3D, Maptek, Vulcan, Gemcom Surpac) and data management solutions (Microsoft Access).

**Names and phone numbers of people to contact in case questions arise or you need more information:** If you have any questions, please feel free to contact me, Titi Kunkel, at 250 XXX XXXX or Catherine Hickson at 604 XXX XXXX.

You will receive a copy of the summary sheet when this research is has been completed.

**You will be given a copy of this information sheet and a copy of your completed and signed consent form.**

Thank you very much for your participation. I look forward to working with you throughout the research period. Your participation is invaluable.

Sincerely

Dr. Titi Kunkel

## APPENDIX 3: DIRECT-USE GEOTHERMAL RESOURCES IN BC

### PARTICIPANT'S CONSENT FORM FOR IN-DEPTH INTERVIEW

You have been asked to participate in a research for the purpose of creating a development road map for direct-use geothermal resources in BC. Information from this interview will be used as the basis of a written summary which will be included in a report submitted to Geoscience BC.

Please read and note your agreement by circling 'Yes' or 'No' in the following questions:

I understand that I have been asked to be in a research study.	Yes	No
I have received and read a copy of the attached information sheet.	Yes	No
I understand that participating in this interview entirely is voluntary.	Yes	No
I am free to terminate the interview at any time without any cause or reason.	Yes	No
I understand that the results of the interview may be used in developing a road map for direct-use geothermal resource development in BC.	Yes	No
I understand the benefits and risks involved in participating in this study.	Yes	No
I have had an opportunity to ask questions and discuss this study.	Yes	No
I give my permission for written notes to be made during the interview.	Yes	No
I give permission for my quotes to be used in the final report document.	Yes	No
I understand that I do <u>not</u> have to give confidential information.	Yes	No
I give permission for my name to be used in the final report document.	Yes	No
I understand that if I require more information regarding the case study, I may contact the lead researchers or any member of the research team.	Yes	No

**APPENDIX A: Information package and questionnaire**

I understand that I will have the opportunity to review the written summary before the final document.	Yes	No
The issue of confidentiality has been explained to me	Yes	No
I understand who will have access to the information I provide	Yes	No

This study has been explained to me by Leah Hjorth or Titi Kunkel. By signing this form, I am providing written consent to participate in the direct-use geothermal resources in BC project and I understand all the terms listed above.

Participant's Signature:	Authorized Signature:
Participant's Name (please print):	Authority given by (please print name):
Date:	Date:

I believe that the person signing this form understands the study. This participant has been provided with all information, and all concerns and questions have been address in relations to their voluntary participation. I have confirmed that I have permission from a person in authority to interview this participant.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Researcher's Name: \_\_\_\_\_



## APPENDIX 4: DIRECT-USE GEOTHERMAL RESOURCES IN BC

### DISCUSSIONS/INTERVIEW: GUIDE QUESTIONS

#### Geothermal Resource Knowledge and Cultural Significance:

This study is looking at how geothermal heat can be used directly to benefit communities in your area. Geothermal heat is heat from the ground which comes to the earth surface. Manifestation of this heat can include hot springs or geysers. There have been studies which show that you have some heat in your area at depths which is accessible. We are seeking to put together a Road Map for developing some of these heat resources to benefit your community. Do note that this study does not constitute a community consultation for resource development. All development activities still have to follow the community's consultation process.

Name of interview participant: \_\_\_\_\_

Name of community: \_\_\_\_\_

Interview date: \_\_\_\_\_

Interviewer: \_\_\_\_\_

#### General geothermal information:

This section is about the general awareness of geothermal resources and its use in the area.

1. **Are you aware of uses of geothermal heat (heat from the earth) in your area?** For example people using hot springs for spa or lakes which do not freeze in winter? These seem to be some of the common manifestation of geothermal resources.
2. **Are you aware of other economic uses of geothermal heat – maybe cultural healing bath or others?** – such as to heat greenhouse gardens which could increase crop production, ground heating in order to get produce to market faster, heating large pools for spa as part of eco-tourism package, and for fish hatchery and fish farming. The hot water can be used for drying vegetables and spices. In some cases the hot water can be used for drying lumber.
3. **Do you know of other uses of heat from the earth/ground?** Are there cultural meanings or interpretation of these?

### Indigenous laws and governance:

The questions in this section are to capture information about Indigenous laws and governance, and community and economic development in the resource location.

4. The following communities have surface rights in the area: (list of other communities in an overlap area). **Have we missed any other community or group of people who use the area and have rights for example Aboriginal Rights or Aboriginal Title?**
5. Land claims: **Is this community going through Treaty?**  
If yes, what stage are they?  
If no, is there any land claims going on? Court case, etc. ...
6. **Do you have a protocol for community consultation?** If yes, where can we find this information?  
If no, what is your consultation process?
7. **Is there a shared community consultation process for all the communities in the overlap area?**  
If yes, where can we find this information?

### General community and economic development information:

This section is to capture information about community and economic development interests in the area.

8. We are interested in what your community economic development plans are and perhaps geothermal heat can help with some of these. **Tell me more about what your community is doing for economic development.**
9. **Are there community owned businesses or joint ventures?** If no, are there interests in these?
10. **What is the employment situation at the community?**
11. **Where do most people work?**
12. **Do people worry about food security?** For example, bringing in food from the nearest town (how far is the nearest town from the community?)

### Traditional use information:

This section is for information about traditional activities in the area required for sustenance rights.

## APPENDIX A: Information package and questionnaire

13. **Do people hunt around (resource location) area?** If yes, is it a family's hunting ground? If no, are there other areas or hunting grounds close by?
14. **Do people do some trapping in the area?** If yes, about how many people? If no, are there trap lines nearby?
15. **Do people fish in local lakes?** If yes, is this in the winter or year round? If no, where do people get there fish from? Would there be some interests in fish culture?
16. **Do people pick medicine or berries in the (resource location) area?** If not, are there other areas nearby which are used?
17. If people still use the (resource location) area for hunting, fishing, trapping, or gathering medicine and berries, then ask - **About how many people use the (resource location) area? Do you think they would welcome developing some of geothermal resource for food production or fish culture?**

### Cultural use and sacred sites information:

This section is for information about traditional and cultural use of the area.

18. **Are there areas close by or around (name of resource location) that are culturally significant to the community?**
19. **Have the community done anything to protect cultural sites in the area?**
20. **Are there sites with legends or community stories nearby? Are these sites protected?**

### Resource management objectives:

This section captures information about lands management objectives of the community.

21. If the community were to develop direct-use geothermal resources for create more jobs or to increase employment, **which of the following would you consider to be lands management objectives?** (please tick all that applies)

- ☐ Protection of traditional hunting territories;
- ☐ Ecosystem protection in certain areas;
- ☐ Known wildlife habitat protection;

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- ☐ Applying Indigenous stewardship principles;
  - ☐ Allocation of trapping right, fishing ground, berry picking area;
  - ☐ Quality of life;
  - ☐ Visual qualities of the area;
  - ☐ Community development ~ increasing people's health and mental wellbeing;
  - ☐ Cultural revitalization;
  - ☐ Developing training opportunities;
  - ☐ Creation of local employment opportunities;
  - ☐ Generating revenue for the community;
  - ☐ More opportunities for people to live off the land;
  - ☐ Incorporating knowledge of the land in development;
  - ☐ Green and carbon neutral developments; and
  - ☐ Others (please specify).
- 

22. **Can developing Direct-use geothermal resource help the community achieve economic development goals?** Would using geothermal resources to grow local produce help?

23. **Are any there cultural significance associated with drilling for heat on certain parts of the territory?** Knowing some of this information would help ensure that things that are culturally significant are protected.

### Tourism information:

The following tourist information is available about the (resource location) area. This information is from the web and the 2015 study conducted by KWL.

24. **Is tourism an area of interest for the community?**

- 25. Are there known tourist sites in the (resource location) area?
- 26. Are there heritage sites or areas of archaeological interests?
- 27. Are there areas within the vicinity that are 'no-go' for tourism or tourists?
- 28. Are eco-tourists encouraged by the community?

**Other information:**

This section for other information the interview participant or community may want to share.

- 29. Is there anything else about geothermal direct-use that you would like to share with us or other relevant community information that we should know?

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- 30. Geoscience BC would like to continue with community engagement after this study is complete.  
**Who would be the contact person for this?**

**Name:** \_\_\_\_\_

**Email address:** \_\_\_\_\_

**Telephone No.:** \_\_\_\_\_

Thank you for your time in participating in this interview. We will be summarizing what we have heard and will forward a copy of this to you.