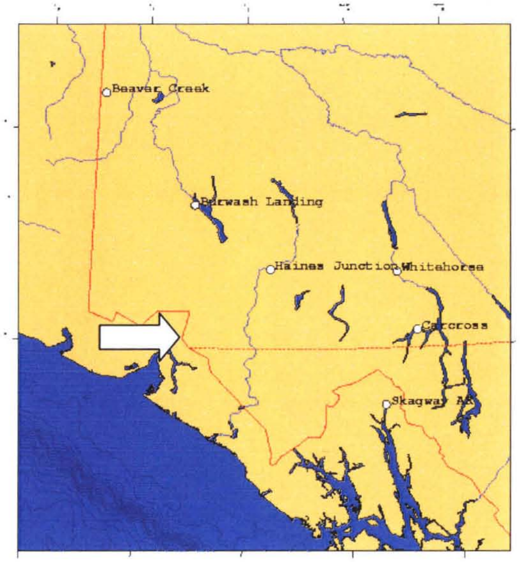
Burwash Landing, Yukon
Integrated Community Sustainability Plan

COMMUNITY OVERVIEW



Burwash Landing is located at milepost 1093 on the Alaska Highway, on the shores of the largest lake in the Yukon, Kluane Lake, and aside the majestic Kluane National Park. Burwash is the administrative centre of the Kluane First Nation Government; Kluane First Nation services most local area residents, not just the KFN owned properties.

The majority of the First Nation people from this area identify themselves as descendants of Southern Tutchone speakers and follow a matriarchal moiety system of two clans, Khanjet or Ägunda; however many ancestors of the Kluane people came from nations such as the Tlingit, Upper Tanana and Northern Tutchone. Today many Kluane First Nation Citizens primarily identify themselves as either Tlingit or Southern Tutchone.

This area was first used as a trading area and summer camp by the nomadic aboriginal people. Burwash Landing was not settled by the aboriginal people until two brothers, Louis and Gene Jacquot opened a trading post in 1904. Many significant changes to the aboriginal way of life were the result of the opening of the Alaska Highway in 1942. The contact with foreign disease took a heavy toll on the aboriginal population in the Kluane region. During the construction of the Highway many military and highway personnel were granted hunting licenses and as a direct result the populations of big game disseminated drastically. In direct response to this over hunting the Yukon Government imposed a ban on all hunting with the establishment of the Kluane Game Sanctuary in 1943; much of this land ran along the Alaska Highway and was in the traditional hunting grounds of the Kluane people. Destroyed by disease and limited by the government to hunt the lands where their ancestors had carved the trails since time immemorial, the Kluane people suffered a great loss; still, using the traditional knowledge of survival passed down through the generations, the people endured.

Today, most of the families residing the Burwash Landing earn their income working for the Kluane First Nation Government, on the reconstruction of the Alaska Highway, or the various local tourism oriented businesses.

In 1994, the Kluane First Nation entered Land Claim and Self Government negotiations with the federal and territorial governments. On March 31, 2002, Kluane First Nation signed a Memorandum of Understanding with the Government of Canada and the territorial government acknowledging that the negotiation of the Kluane First Nation Final and Self-Government Agreements was substantially complete. On April 11, 2003, negotiators for the parties initialled KFN's Final and Self-Government Agreements and recommended the agreements to their principals for ratification. The Kluane people ratified the Kluane First Nation agreements in a vote held in August 2003. On October 18, 2003, a signing ceremony was held in Burwash Landing, Yukon. The Kluane First Nation Final and Self-Government Agreements were signed by representatives of the Kluane First Nation, the Government of the Yukon and the Government of Canada. The Final and Self-Government agreements came into effect in February 2004.

PLANNING/CONSULTATION PROCESS

In April 2006, the Kluane First Nation (KFN) Council created a local board known as the Capital Works Board (CWB) to assist Public Works and Municipal Services Department in development of a new KFN Housing Policy and to assist the KFN Council in decision making in regards to Capital Projects and Housing. In the process, the CWB held 20 community consultations sessions in 2006 and 15 sessions in 2007 and project surveys in May and June of 2006 and March and April of 2008. At all times, Citizens are encouraged to bring forward their ideas and concerns to the board for consideration. After two years of extensive and exhaustive work, the Capital Works Board, Housing and Rental Policies were accepted for implementation and Capital Project prioritization has been completed (appendix “A”). The inventory and assessment charts were distributed to staff and other local area residents; input gathered was merged to best reflect the variety of answers received. **Information gathered from the Capital Works Board Meetings and consultation sessions was used by Public Works staff to develop the Burwash Landing Integrated Community Sustainability Plan.**

B) VALUES, VISION STATEMENT, AND GOALS

GOVERNANCE AND OPERATIONAL STATEMENTS (Our Values)

Capital Works Board: Each CWB member will act respectfully and supportive of his or her fellow board members with a view to making decisions based on consensus where possible. Each member will support board decisions to the best of his or her ability.

Unity: KFN will treat all Citizens with respect, integrity, and fairness. KFN traditions and values will be respected and employed to further such objectives.

Traditional Territory and Kluane Region: KFN recognizes the need to protect its Traditional Territory and the Kluane region for the benefit of its Citizens and others. The Capital Works Board will seek information concerning projects in KFN's Traditional Territory and the Kluane region and assist and cooperate with other KFN departments from time to time to minimize potential negative impacts on KFN, its Citizens and on the CWB and its operations. The CWB will respect and utilize traditional knowledge and values in considering proposed projects.

Operations:

While respecting the obligations to confidentiality and due process, KFN and the CWB will conduct its operations in an open and transparent manner.

In reviewing and assessing applications, the CWB will consider factors including an Applicant's needs, residency and budgetary constraints.

The CWB will strive to make operational decisions in an unbiased manner as reflected within the jurisdiction of the board and in particular concerning equitable distribution of KFN housing and services and vandalism.

The CWB will follow applicable KFN laws and policies, and make such laws and policies that guide its decision-making available and provide these to Citizens on written request.

The CWB will work in conjunction and cooperate with various KFN departments as necessary from time to time to further the objectives set out in the Constitution and applicable KFN laws and policies.

Services: The CWB will ensure that services are provided fairly and in a timely and cost effective manner to all Citizens and/or residents of KFN Housing, and operate within the budgets of the PWMS and in accordance with all applicable KFN laws and policies.

Open Door Policy: The CWB will have an open door policy for Citizens to make submissions, which may include compliments and identification of issues regarding capital works projects and services.

Renovations: The CWB will ensure that all Citizens will be treated fairly, with no family preference concerning who qualifies for renovations.

People: The CWB will help to address the needs of Citizens where applicable regarding capital projects and strive to maintain the high standards of KFN educational achievements.

Elders: The CWB will work to address the inequity of our Elders lost opportunities from discriminatory policies under the federal *Indian Act* and will support enhancing our Elders' quality of life by providing services in a fair and equitable manner.

KLUANE FIRST NATION VISION AND MISSION STATEMENT

It is the vision of Kluane First Nation to create a healthy, happy and economically stable community. Our ideal community would be free of crime and abuse of any kind and our people would go about their day to day activities in a spirit of gentleness and cooperation. In our ideal community, families would work together to help each other and our culture would be shared with our children. We recognize we must live in a modern world as well and will prepare our youth to love and respect our heritage while at the same time gaining the skills to survive in a modern world.

In order to achieve the long term vision, our mission is to build political and administrative systems of governance that will respect and value the past and still be able to communicate and participate with modern government structures.

COMMUNITY GOALS

VALUE	GOAL	MEASURES OF SUCCESS
Unity	To treat all citizens with respect, integrity and fairness	• The KFN Housing Policy is reviewed annually and followed. • Citizens concerns are heard. • Meaningful and appropriate feedback is provided.
Traditional Territory	To protect the Kluane First Nation's traditional territory	• Citizens wishes are incorporated in the planned of land use areas. • CWB works with other departments within KFN.
	To minimize potential negative impacts on KFN lands	• Emergency response plan is developed and in use. • Proper consultations are held with citizens and government. • Projects do not negatively affect the beauty of the land or disturb natural areas. • Projects do not disturb traditional use areas.
Capital Works Board	Each board member will act respectfully	• Employ a code of conduct and incorporate into the Capital Works Board Policy. • Take steps to ensure all board members are properly orientated. • Employ team and skill building activities to foster solidarity
	Each board member will support other board members and decisions made by the board.	• We envision a unified board where lateral violence is unacceptable and gossip is immediately stopped. • Public Works employees operate in a transparent manner. • The board will review past decisions made.

VALUE	GOAL	MEASURES OF SUCCESS
Operations	To work in a transparent manner	• Meeting time, date and place are posted • Citizens are invited to attend meetings and community consultations.
	To consider applicants needs, residency and budgetary constraints when making decisions on housing applications.	• A Priority list is established • Allocations are made based on a point system • PWMS budget and work plan will be reviewed quarterly and followed.
	To make decisions in an unbiased manner.	• We realize this is a small community with many family connections and relations. Board members will endeavour to remove themselves from a meeting when they are in a position of conflict.
	To follow applicable KFN Law and Policies when making decisions and will provide these to KFN Citizens upon request.	• Minutes are taken and made available • Decision documents are available • The CWB will follow the guidelines as provided by the CWB and Housing Policies.
	To work in conjunction with other departments within KFN as necessary	• Staff meetings are held and all employees are updated of ongoing and completed projects. • KFN Employees are invited and encouraged to attend community consultations.
Services	To ensure services are provided fairly and in a timely and cost efficient manner.	• PWMS will ensure services are delivered equitably. • Time management software is put into effect. • A review of such software will be completed annually to ensure system is working for employees and any improvements are made.
Open Door Policy	To have an "open door" policy	• All concerns will be heard and addressed.
Renovations	To ensure all Citizens are treated fairly when considering which houses qualify for renovations.	• Health and Safety issues will be priority. • Other requested renovations will be inspected by proper personnel and prioritized on a list.

VALUE	GOAL	MEASURES OF SUCCESS
People	To address the needs of Citizens regarding capital projects To strive to maintain the high standards of KFN educational achievements	• Community consultation is held. • The PWMS department encourages staff and citizens to further their education and training in the realm of this department.
Elders	To help address the inequity of KFN Elders' lost opportunities from discriminatory policies under the Federal "Indian Act" To support the enhancement of Elders' quality of life	• PWMS will take steps to consult with the Elders to review what their needs are. • Old policies have been reviewed and amended to reflect the needs of KFN Elders. • PWMS will assist with the development of the KFN Elders Policy when it comes to issues of rent, housing and services. • PWMS will take the findings from consultations with the Elders and incorporate programs or services based on their needs.

~ PART ONE~

Capital Project Infrastructure Inventory and Assessment

Capital Project/ Infrastructure	Do You have it?		What is the condition?			Is there enough?		Do you need it?	
	Yes	No	Good	Average	Poor	Yes	No	Yes	No
City Hall		✓							✓
Airport	✓		✓			✓			✓
Community buildings	✓			✓			✓	✓	
Community Hall	✓			✓			✓	✓	
Dock facilities	✓				✓		✓	✓	
Community energy systems	✓				✓		✓	✓	
Fire station	✓		✓			✓			✓
Health clinic		✓						✓	
Housing	✓				✓		✓	✓	
Internet service	✓			✓		✓			✓
Library	✓			✓			✓		✓
Police building		✓						✓	
Post office	✓				✓	✓			✓
Recreation (parks)	✓				✓		✓	✓	
Roads	✓			✓			✓	✓	
Schools		✓						✓	
Sewage collection and disposal	✓			✓		✓			✓
Solid waste disposal	✓				✓	✓		✓	
Water service	✓				✓		✓	✓	
Public transportation		✓							✓
Active transportation	✓				✓		✓		✓
Youth centre		✓						✓	
Laundromat	✓			✓			✓		
Sport Centre		✓						✓	

RESOURCES		Does this exist?		Can it be improved?	
Category	**Type of Program**	**Yes**	**No**	**Yes**	**No**
Health	Nutrition	✓		✓	
	Weight loss	✓		✓	
	Aids prevention	✓		✓	
	Substance abuse	✓		✓	
	Family planning	✓		✓	
Public Safety	Police protection		*(Haines Junction)*	✓	
	Fire protection	✓		✓	
	Emergency response	✓		✓	
	Search and rescue	✓		✓	
Recreation Programs	Small children		✓	✓	
	Teens		✓	✓	
	Adults		✓	✓	
Social Service Programs	Child care	✓		✓	
	Domestic violence	✓		✓	
	Seniors	✓		✓	
	Disability services		✓	✓	
	Counselling — adults		✓	✓	
	Counselling — teens		✓	✓	
	Legal services		✓	✓	
	Suicide prevention	✓		✓	
Self Government	Self government status	✓		✓	
Cultural Programs	Elders group	✓		✓	
	Music		✓	✓	
	Dance group		✓	✓	
	Arts and crafts		✓	✓	
	Language programs	✓		✓	
	Spirit camps		✓	✓	
	Storytelling	✓		✓	
	Children's Cultural Group		✓	✓	

Economic Inventory and Assessment

Typical Job	Number of jobs	Is it filled by a community person?		Full Time		Seasonal		Wage
Type	**#**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Example**
Arts and crafts	6	✓			✓		✓	
CAO	1		✓	✓			✓	45,000
Accounting officer	1		✓	✓			✓	40,000
Environmental specialist	1							33,000
Logger/Forester	2	✓			✓	✓		25,000
Health aide/Nurse	0							
Heavy equipment operator	*Local Community Contractors are usually hired, prices vary*							
Mechanic								
Construction								
Housing manager	1	✓		✓			✓	30,000
Public safety officer	0							
Fire fighters	11	✓			✓		✓	Volunteers
Emergency response	6	✓						Volunteers
Business owners	12	✓		✓	✓	✓	✓	
Counsellor	*Counselling services provided in the community by Many Rivers*							
Water treatment operator	1	✓		✓			✓	25,000
Sewage treatment operator	1	✓		✓			✓	25,000
Landfill operator	*Local Landfill operated by YTG*							
Power plant operator	1		✓					

Environmental Inventory and Assessment

Environmental Assets/Needs	**Do you have it?**		**If this is lacking, does your community need it?**	
	Yes	**No**	**Yes**	**No**
Safe drinking water	✓		✓	
Adequate supply of water		✓	✓	
Certified water treatment operators	✓		✓	
Safe sewage disposal and treatment	✓			✓
Permitted landfill	✓		✓	
Recycling program	✓		✓	
Used oil storage area		✓	✓	
Lead acid battery collection area		✓	✓	
Developable land	✓		✓	
Fuel spill prevention plan		✓	✓	
Hazardous waste response plan		✓	✓	
Erosion control		✓		✓
Contaminated sites identified	✓		✓	
Healthy subsistence food	✓			✓
Environmental Education programs		✓	✓	
Healthy wildlife populations	✓		✓	
Hazardous waste collection area		✓	✓	
Protected watershed plan		✓	✓	
Environmental impact statement		✓	✓	

Capacity Building and Job Training Inventory and Assessment

Capacity Building/Training/Education Opportunities		Existing job in the Community?		Training/Education needed?		Is training available in the community?	
Category	**Type**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Municipal or First Nation Administrative Positions	CAO	√			√		√
	Accounting Officer	√			√		√
	Self Government Implementation Officer	√		√			√
	Executive Assistants	√		√			√
	Youth Coordinator	√		√			√
Education	Principal		√		√		√
	Teachers/Teacher aides		√	√			√
Environment	Environmental specialist	√		√			√
	Conservation officers	√		√			√
Health	Health aide		√	√			√
	Nurse practitioner		√	√			√
	Doctor		√	√			√
Transportation	Driver/pilot						
Utilities	Water treatment operator	√		√			√
	Sewage treatment operator	√		√			√
	Landfill operator		√	√			√
	Power plant operator		√	√			√
	Water delivery service operator	√		√			√
Justice	Coordinator/Councellors		√	√			√
	RCMP		√	√			√

Asset or Need	Do You Have It?		How Would You Rate It?			Do you need it?	
	Yes	No	Good	Average	Poor	Yes	No
Base Ball Diamond	✓			✓			✓
Covered Ice Skating Rink		✓				✓	
Basketball/Tennis Court	✓				✓	✓	
Swimming Pool		✓				✓	
Community Green Houses		✓			✓	✓	
Recycling Centre	✓			✓		✓	
Grocery Store		✓				✓	
Gas Station	✓				✓	✓	
Park/Play Ground Equipment	✓				✓	✓	
Gym (Work-Out Centre)		✓			✓	✓	
Day Care Centre	✓				✓	✓	
Interpretive/Visitors Centre		✓				✓	
Adult Education Centre		✓				✓	
Ski Hill		✓					✓
Sliding Hill		✓					✓
Curling Rink		✓				✓	
Youth Centre		✓				✓	
Commercial Zone		✓				✓	
Residential Zone	✓					✓	
Traditional Use Zone		✓				✓	
Sawmill		✓				✓	
Campground	✓				✓	✓	
Community Beautification	✓				✓	✓	
Meat Caches	✓				✓	✓	
Residential Wells	✓				✓	✓	
Boat Launch/Dock		✓				✓	
Alternative Residential Heating		✓				✓	
Street Lights	✓		✓			✓	
Community Development Plan		✓				✓	

Inventory and Assessment of Other Items

Evaluation of Inventory

Eligible Project/Infrastructure Facility	**Positive Effects of Existing infrastructure**	**Negative impacts of Lacking Infrastructure**
Community energy systems		With only one service provider, KFN and local area residents are subject to their rates.
Roads	There is a benefit from having a system in place.	
Sewage collection and disposal	There is a benefit from having a system in place.	
Solid waste disposal		Each individual must bring their own garbage to the YTG dump. Dump is located 6 Kilometres from the community; all garbage is being burned releasing toxins into the air.
Water service	There is a benefit from having a system in place.	
Public transportation		Individuals must walk everywhere they go.
Active transportation		Pedestrians are forced to walk on the road where vehicles drive or on unlit and unmarked paths through the bush.

~ PART THREE ~
PRIORITY SETTING

Priority One: Upgrades for District Heating

Description

This project consists of three parts:

1. The removal of existing oil fired furnaces and the installation of boiler furnaces in 37 residential units and to tie in the government buildings to the wood chip boiler system.
2. Roof repairs at the KFN Council Chambers to increase energy efficiency.
3. Some housing units require "water house" additions to isolate the water tanks from the furnaces in order to comply with building codes. Currently, all residential units have a designated room which houses furnaces, water tanks, hot water tanks and water pumps.

Who is being affected and how?

Individuals that currently reside in KFN Housing are paying increasing rates to heat their homes with fuel.
Kluane First Nation funds could be spent towards programs instead of furnace repairs and heating inefficient buildings, thus all KFN Citizens are being affected.

What is the importance?

To replace the aging existing oil-fired furnaces with higher efficiency furnaces that can be later tied into the wood chip boiler system.
To reduce Burwash Landing's dependency on non-renewable energy.
To improve the existing heating and water systems in KFN owned housing units.

Who will benefit?

KFN Citizens would pay less for heating costs of homes, government and community buildings, these dollars could be spent towards other programs and services.

See appendix "B" Conceptual Design Analysis
See appendix "C" Village Biomass Heating Infrastructure Upgrade (MRIF Application)

Priority Two: Well Development

Description

The 2006 Kluane First Nation General Assembly directed the KFN Public Works and Municipal Services department to address the concern of quality, cost and quantity issues in regards to water resources.

1) It has been determined that KFN requires a backup and/or new main water supply to meet existing and future needs of the community.

2) KFN is located in a high probability location for accessing both potable and geothermal water that will address the water supply issue as well as address high heating costs (oil) by replacing the current forced air furnaces with boilers and to tie in to the existing Biomass Heating infrastructure and an expansion to a district heat system to all households.

Who is being affected and how?

The sustainable yield is below the National supply standard for the existing population of 98 for Burwash Landing and there is no provision for fire fighting. Population growth is expected to increase by 30 over the next year with the completion of ten new housing units putting greater pressure on the existing aquifer.

What is the importance?

KFN requires the ability to

a) supply water meeting all Canadian Drinking Water Quality Guidelines for health based and aesthetic objectives.
b) supply water with the highest potential for open loop geoexchange application (acceptable temperature, sufficient yield and acceptable water quality); and,
c) have a well optimally located for wellhead protection and proximity to existing infrastructure.

Who will benefit?

The community at large would benefit by the resulting capacity building within the community.

See appendix "D" KFN General Assembly Resolution 2006-4: Community Water Resource Management
See appendix "E" Analysis of Geothermal Potential in the proximity of Burwash Landing

Priority Three: Water House Expansion and Protection

Description

This project consists of the expansion of the current water treatment plant to include a lab and chemical storage unit, disinfection storage and equipment, mechanical storage, more office space, toilet with emergency shower and storage for water & sewer areas. The garage houses the water truck and holding tanks on one side and the septic truck on the other side. The garages require upgrades to ensure proper separation of the two functions. 20 Old Allen has been identified as a possible risk to the water supply; this house is to be relocated to another location in the community.

Who is being affected and how?

The current infrastructure has no room for the lab; staff have to conduct water quality testing in the truck garage. The storage facility is smaller than the amount of equipment needed to meet the new federal regulations.

What is the importance?

We are required to meet the guidelines set out by Environmental Health.
We need to protect our source water.
Te remove the possible points of contamination.

Who will benefit?

Without the proper infrastructure and protection, we cannot deliver water. All citizens and local area residents that use water would benefit from this project.

See Appendix “F” KFN Water Supply Recommended Upgrades
See Appendix “G” Table 6: Protective and Preventative Management Strategies
See Appendix “H” KFN Wellhead Protection, Site Plan

Priority Four: District Heat Expansion

Description

We propose to expand the existing district heat system to include the Youth and Elders' Centre, once it is built, and 37 existing private residences. The residential sector utilized 74% of the energy and 71% of the greenhouse gasses emitted. Incorporating the existing residential units within the KFN Village results in a target reduction of 60% of heating energy and GHG emissions.

Who is being affected and how?

Tenants of Kluane First Nation Housing are currently paying the increasing rates of fuel.

What is the importance?

Environmental benefit/outcome would consist of a diesel heating fuel reduction of approximately 60% of the total usage, or 22540L with the corresponding non-neutral greenhouse gas emissions.
Another environmental benefit would be the cleanup and use of the 1999 fire kill timber and beetle kill (carbon neutral emissions) in the wood chip boiler.

Who will benefit?

All tenants of KFN Housing who must rely on oil-fired furnaces would benefit by reducing the amount of fuel they need to purchase.
All citizens of KFN would benefit be reducing the direct costs to KFN.
Local labourers would find employment for harvesting and chipping operations.
The community at large would benefit by the resulting capacity building within the community.
Local residents would have a sustainable source of heating their homes.

See appendix "B" Conceptual Design Analysis
See appendix "C" Village Biomass Heating Infrastructure Upgrade (MRIF Application)
See appendix "I" Proposed expansion to wood-heat district heating system

Priority Five: Copper Joe Subdivision Phase II

Description

Phase II consists of future lot development for new housing, survey marker pins and to complete the road design by extending the current "cul-de-sac" into a "crescent" leading back to the Alaska Highway and an additional road providing direct access from the subdivision to the village of Burwash Landing.

Who is being affected and how?

The Kluane First Nation has historically been unable to house all the citizens that wish to reside in Burwash Landing.

What is the importance?

To increase the capacity of KFN
To provide housing to as many KFN Citizens as possible

Who will benefit?

Local labourers will find employment clearing and developing lots for future housing.
KFN would benefit by the ability to provide housing and/or lots to KFN Citizens
KFN would benefit by the increased housing for Citizens and Staff.
Service personnel would have improved routes.

See appendix "J" Aerial map of Copper Joe Subdivision

Priority Six: Copper Joe Phase III

Description

This project consists of building a road from the Village of Burwash Landing to the newly developed Copper Joe Subdivision. There is an existing route that has been cleared of trees and bushes. The lots along the existing route could potentially be developed as housing lots, tying the two areas together. This would eliminate the need to build another subdivision in the future.

Who is being affected and how?

The current residents and service people must travel on the Alaska Highway when commuting between the Copper Joe Subdivision and the main service and business area located at Burwash Landing.

What is the importance?

It is our goal to keep the traditional areas free from further development for housing and businesses. The route has already been cleared and identified by KFN Citizens as a viable option for development.

Who will benefit?

Local labourers will find employment clearing and developing lots for future housing.
KFN Citizens not wishing to relocate to the Copper Joe Subdivision will have another option from which to choose.
Residents of Copper Joe Subdivision will not have a daily community on the main highway.
Service personnel (i.e. water truck, septic truck, garbage removal truck, school bus, etc) will not have to travel on the main highway, improving the routes and safety of those individuals.

See appendix "K" Aerial map of Burwash Landing to Copper Joe Subdivision

Priority Seven: Bear Creek Subdivision Development

Description

Bear Creek Subdivision is lands owned by Kluane First Nation located in Haines Junction. The land needs to be surveyed, zoned, infrastructure installed including power, telephone, roads, and lot development for housing and commercial use.

Who is being affected and how?

KFN Citizens that currently rent homes in the Haines Junction area are waiting for the subdivision development to build homes in the area.

KFN Elders that wish to live in the community with more services (i.e. grocery store, YTG services) are waiting for development to have homes in the area.

What is the importance?

To provide housing to more KFN Citizens, not just those that choose to live in Burwash Landing.

To provide business opportunities for KFN and KFN Citizens.

Who will benefit?

Currently, KFN Families (with school age children) must move to a larger community for their children to continue school past the 8th grade. If KFN had a subdivision in Haines Junction, this would allow families to remain closer to home, and allow their children to continue schooling.

KFN Elders that wish to live close to home, but must live in a community that offers more services then Burwash Landing has to offer. (i.e. grocery store, YTG, etc.)

Local area labourers would benefit from having employment close to home.

References

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"Kluane First Nation Capital Works Board and Housing Policies"
Accepted by the General Assembly and KFN Council: March 18, 2008

Bruce, Gerry "Kluane First Nation Comprehensive Community Development Plan" Report produced for Kluane First Nation
Completed: February 2001

PWMS/Capital Work Plan
Completed January 2009

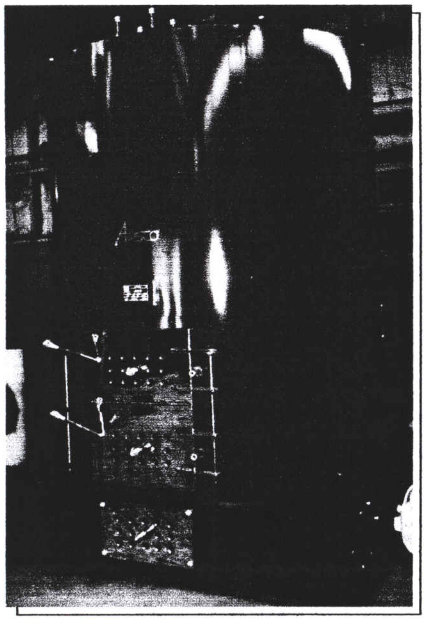
Project Title	Project Description
Arctic entries	Identify which houses require arctic entry
Building Housing	Ensure KFN has available housing
Eaves on houses	Install eaves as required
Fix all heat trace	Inspect all heat traces, repair or replace as required
Fix Oil Furnaces	Ensure furnaces in good running condition, parts available, document installation dates
Fix siding on homes	Identify which houses require siding
Fixing Freeze-Ups	Stop Freeze Up, Fix those that do Freeze
Health and Safety	Ensure health and safety in KFN Houses
Hot Water Tanks	Ensure Hot Water Tanks in good running condition, parts available, document installation dates
Housing Applications	Follow KFN Housing Policy
Identify Particulars	Identify which houses require what renos
Meetings with Contractors	Ensure Housing Mgr meets with Contractors
Move log homes	Old homes to be moved, dismantled, sold or destroyed
Rental Units	Ensure rental units are available, healthy and safe, invoicing is sent and paid each month
Repairs to house steps (nails)	Inspect steps and repair as required
Secure floor under water tanks	Ensure all floors under water tanks are capable of supporting weight
Updates to Housing Mgr	Ensure Housing Mgr is updated regularly on any work being done
Back fill houses	Back fill 8 houses that did not get backfilled or siding installed
Home Ownership	Follow through with applications, consultations, cost est. and proposals
Move House 404 Copper Joe	Due to house settling, house must be moved
Capital Plan	Develop the five year plan
Meeting with Community	Consult with Community
Short term/long term (planning)	Regulatory requirements and codes
Move House 13 Southwick	Remove the house, renovate for EHOP, allow space to build compound at Red Garage
Renovate 1 D.Bay	Renovate for EHOP (Elders' Home Ownership)
Renovate 25 Southwick	Renovate for EHOP (Elders' Home Ownership)
Renovate 28 Sedata	Renovate for EHOP (Elders' Home Ownership)
2 Pump System	Install 2 pump system on the Destruction Bay Houses
Move House 20 Old Allen	To protect KFN's aquifer, the house must be moved to Burwash Heights
(Build) storage yard	Consult with community and staff:
(purchase) tools	Ensure servicemen have equipment available (avoid rentals)
(purchase) truck for garbage	Purchase and use a separate truck for garbage pick up
Back up water and sewer trucks	Ensure that back up systems are available in the case of failure
Change water fill pipes	Ensure all water fill pipes to houses and govt buildings are up to code.
Circuit Riders	Training and Maintenance
Clean Shop & Trucks	Ensure shops and vehicles are clean
Copper Joe Phase II, Road/Lot Devel	Consultation, Access Funds, Plan and Renovate
Drainage	Fix and Maintain Drainage Ditches and Culverts

PWMS/Capital Work Plan
Completed January 2009

Emergency Response Plan	Develop Plan
Garbage Pick Up	Develop Policy
Install back up water pump	Waterhouse in case of breakdown
Janitorial Services	Ensure all buildings are serviced
Maintenance Plan	Develop plan in consultation with Community
Move Sharon (Kabanak's) House	House to be moved to protect KFN's aquifer
Networking and Water Board	Network and follow up
New trucks	Garbage, Mechanical and W & S replacements
Operation Plan	Develop Plan
Operation Plan Evaulation	Ensure Op Plan meets the needs of the community
Road Access: Village-Copper Joe	Consultation, Access Funds, Plan and Renovate
Road Maintenance	Fix and Maintain Roads
Safe Water & Delivery	Ensure Water and Safe, delivery is efficient
Seal water shack floor	Env. Health concern (Regulatory)
Service Equipment	Users of equipment to ensure equipment is kept in good running condition
Sewer Truck	Ensure Septic Pump Outs are safe and efficient
Signage	install proper signage on new roadway
Van for O&M	Look into feasibility of purchasing a cube van for PWMS
Water Office Structure	Ensure water office is properly set up with all equipment, computer, software, etc.
Water Pumphouse Expansion	Laboratory, storage etc
Water Tanks	Ensure tanks are regularly cleaned
Wood Chip Boiler	Operate and Maintain
Back up heat in Govt buildings	Identify best method for back up heat and install
Build back up boiler	Back up for Jacquot Building
fuel tank for Council Chambers	Purchase and install a new fuel tank to standard
Heating Council from Boiler	Tie into Wood Chip Boiler system, and insulate ceiling w/ rigid and cover with t&g wood
Heritage Bldg heating	Install heat system
Improve parking at PWMS	Consult with Staff, Make a plan, Post Parking
Inspect all stairs	Ensure stairways are safe, make repairs as required
Install Heat Trace at Jacquot Building	Install heat trace from main well to Jacquot Building
Install heat trace at Wash House	
Jacquot Building/Admin Building	Install heat trace and water line from Jacquot Building to Admin Building
Laundromat repairs	Inspect and Identify what needs to be completed
Lauromat and Operation	Re-evaluation: services are available and building run efficiently
Pump House Buildings	Remove old building, build new buildings
PWMS Secure Storage Compound	Consultation, Access Funds, Plan and Renovate
Steps, decks painted	Ensure safety of all steps/decks to govt buildings are safe
"Putting out Fires"	Stop Rumours/Gossip thru Public Education
Capacity Building	Building Capacity through in house training and job sharing

PWMS/Capital Work Plan
Completed January 2009

Demolish old buildings	Consult with Community to demolish/move older community buildings
Future Housing	Consultation, Access Funds, Plan and Renovate
Identify staff housing needs	Consult with Directors and KFN Council
Jacquot Building Renovations	Consultation, Access Funds, Plan and Renovate
Material Pick Up	Set up Policy
PWMS Education	Train and maintaining tickets, etc.
Reports to other Govts	Ensure reports are completed and sent
Review old files & box	Set up Retention Schedule in conjunction with Archives Dept.
Safety	Train, Maintain and Delveop OSP
Water and Sewer Billing	Ensure water and sewer invoices are sent and paid every three months
Weekly Meetings	Hold weekly Tuesday morning meetings to inform tasks
Working with Health Board Guidelines	Meet or Exceed Required Standard;
Finish RRC bldg	Inspect and Identify what needs to be completed
Bear Creek Subdivision	Consultation, Access Funds, Plan and Renovate
Clear house numbers installed	Purchase and install numbers on all the houses
Fire Smart	Continue planning with zone protection manager and YTG
Youth and Elders' Centre	Complex with Daycare, youth & elders areas, Library etc



Conceptual Design Analysis

Central Boiler/Village Heating Extension

Kluane First Nation

Burwash Landing
Yukon

APSCO ENGINEERING LTD.

Conceptual Design Analysis

Overview

- Site Plan – Cluster Groupings
- Peak Heating Demands
- Fuel Requirements
- Boiler Schematic
- Boiler Building Loop Schematic
- Piping Design Schematic
- Residential Piping Schematic
- Expenditures
  - Capital Costs
  - Operating Costs
- Projected Time Schedule
- Benefits
- Apsco Engineering's Role

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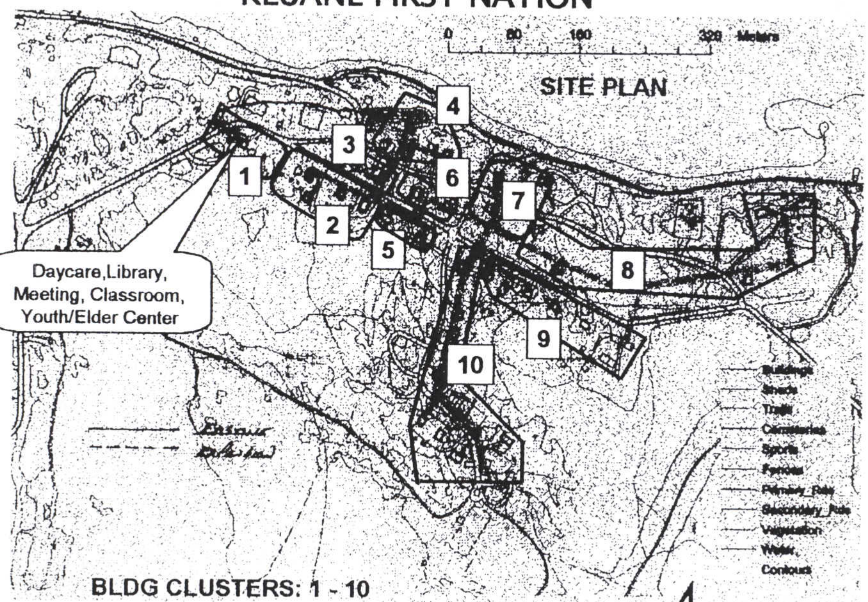
Conceptual Design Analysis

KLUANE FIRST NATION



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Conceptual Design Analysis

Peak Heating Demands

Cluster No.	Bldg's	Fuel Type	Heating Load	Note
1	Youth Elder Center	Wood	300,000 BTU/Hr	Connect to existing System
2	4 Residences	Wood	400,000 BTU/Hr	New
3	2 Residences	Wood	200,000 BTU/Hr	New
4	4 Residences	Wood	400,000 BTU/Hr	New
5	2 Residences	Wood	200,000 BTU/Hr	New
6	2 Residences	Wood	200,000 BTU/Hr	New
7	3 Residences	Wood	300,000 BTU/Hr	New
8	5 Residences	Wood	500,000 BTU/Hr	New
9	4 Residences	Wood	400,000 BTU/Hr	New
10	11 Residences	Wood	1,100,000 BTU/Hr	New

Total: 4,000,000 BTU/Hr

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Conceptual Design Analysis

Fuel Requirements (Wood Chips)

Cluster No.	Bldg's	Peak Load	Seasonal Average
1	Youth Elder Center	42	21
2	4 Residences	55	28
3	2 Residences	28	14
4	4 Residences	55	28
5	2 Residences	28	14
6	2 Residences	28	14
7	3 Residences	42	21
8	5 Residences	70	35
9	4 Residences	55	28
10	11 Residences	153	77

Totals: 556 lbs./hr 280 lbs./hr

- **Seasonal average estimated at ½ peak load**
- **This is in addition to the existing system**
- **Fuel: Woodchips < 16% MC (Wet Basis)**

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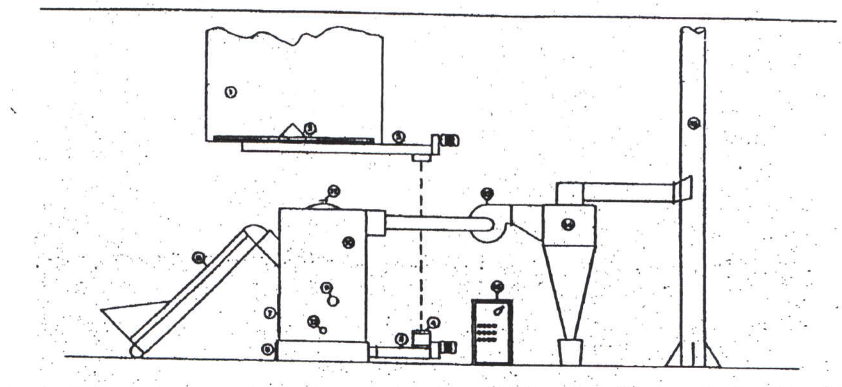
Conceptual Design Analysis

Boiler Schematic



LEGEND:

1 FUEL SILO
2 LIVE BOTTOM
3 PRIMARY FEED AUGER
4 ROTARY-AIR-LOCK
5 STOKER
6 OFFCUTS CONVEYOR
7 MANUAL LOADING DOORS
8 PRIMARY AIR INLET
9 SECONDARY AIR INLET
10 HOT WATER BOILER
11 BOILER WATER OUTLET
12 BOILER WATER RETURN
13 INDUCED DRAFT FAN
14 ASH SEPARATION CYCLONE
15 CHIMNEY
16 CONTROL PANEL

APSCO HOT WATER, WASTE-FIRED BOILER SYSTEM SCHEMATIC

FIG. 2

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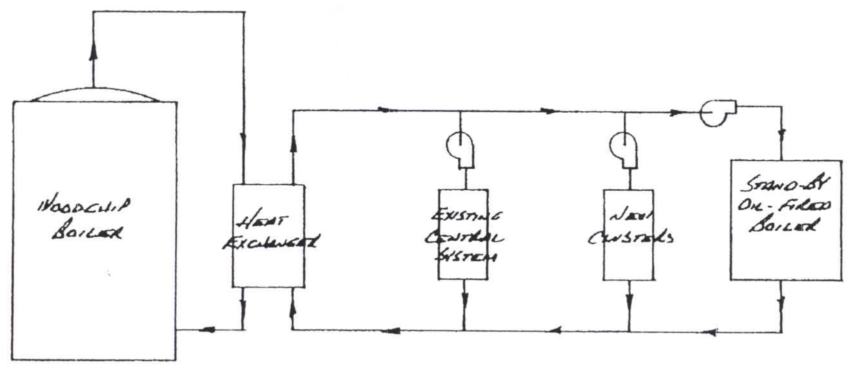
Conceptual Design Analysis

Boiler Building Loop Schematic



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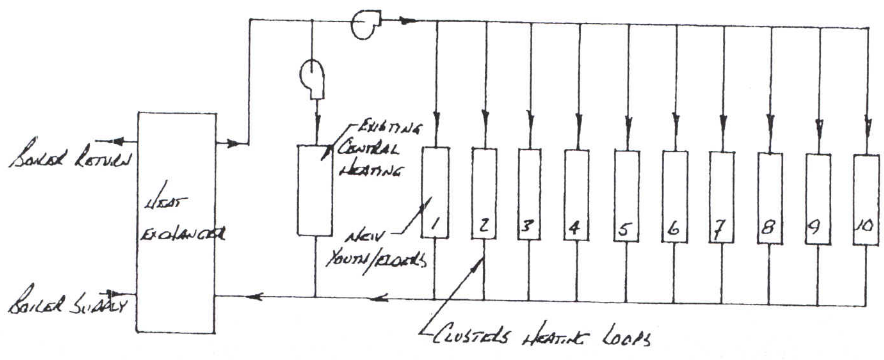
Conceptual Design Analysis

Piping Design Schematic



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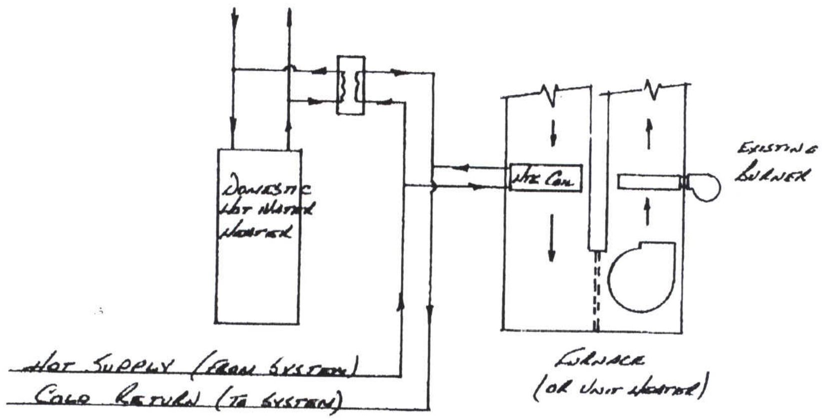
Conceptual Design Analysis

Residential Piping Schematic



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Conceptual Design Analysis

Expenditures: Capital Costs

Boiler c/w peripherals as required:	$ 270,000
Boiler Building Addition:	$ 100,000
Piping:	$ 390,000
Building Hook-ups (38):	$ 190,000
Engineering & Misc.:	$ 95,000

Total Projected Capital Costs: $ 1,045,000

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Benefits

- ✓ Cost Savings
- ✓ Local Employment
- ✓ Utilization of Local Fuel Supply
- ✓ Environmental
- ✓ First Nation Self-Sufficiency

APSCO ENGINEERING LTD.

Apsco Engineering's Role

- Financial and Cost- Benefit Analysis
- Engineering Design
- Product Manufacture, Supply and Installation
- Customer Service and Support

It has been our privilege to design, manufacture and supply quality products for over 35 years. In reviewing our work and efforts over these years, it is apparent that we have strong repeat business with our clientele base. These customers have come to depend on the quality and support we offer, and this also signifies value and performance to those new to our products and services.

We are committed to meeting your demands, and serving you with the best value for your cost outlay. This is our pledge to you.\

J.P. Dueck,
President

APSCO ENGINEERING LTD.

Village Biomass Heating Infrastructure Upgrade MRIF Application #1
Kluane First Nation

General Information	
Project Name:	Village of Burwash Landing Biomass heating to all residences
Initiated By:	T.D. Danyluk CET, Manager, Public Works and Municipal Services; Kluane First Nation
Location:	Burwash Landing
Author Signature	
Approvals Signature	
Band Resolution	BCR, May 10, 2006 as part of Capital Works Plan (attached)

1.0 Project Description Abstract

It is proposed to expand the existing APSCO Engineering Ltd. District Heat System at Kluane First Nation Village, to include a Daycare and teacher buildings and 37 private residences. The following is a description of the requirements in equipment, materials and labour to effect this addition.

Description:

The existing system will need to be increased to handle the increased demand. The existing boiler is rated at 2,000,000 BTU/H output and will put out about 25% more. The new system increased demand is estimated at 4,700,000 BTU/H. Consequently the existing boiler will need to be replaced with a 4,000,000 BTU/H unit, capable of an output of about 5,000,000.

In addition to replacing the boiler, additional heat exchangers, circulators, etc. would need to be furnished and installed, along with required piping and trim.

The replacement of all residence furnaces with new duct hot-water coil unit heaters or to add a hot water heating coil in each furnace return duct. The existing furnace fan need not be replaced, and the furnace with its existing burner could be used as a back-up system.

The district heat piping would be schedule 40 pipe with Victaulic fittings. It would be installed above ground on steel cradles at approximately 10' on centers. The piping would be insulated and wrapped with a 'Blueseal' protective wrap.

The heating medium would consist of a 50/50 solution of glycol/water for freeze protection.
Replace the stand-by oil-fired boiler with a larger capacity unit to meet the new expanded system demand.

2.0 Project Rationale

Burwash Landing is located in an area of discontinuous permafrost in a remote location of the Yukon Territory. As a result of this remoteness costs associated with heating are high and access to main grid electricity is unavailable. Heating of homes is confined to oil burning furnaces and wood burning stoves as supplementary heat

The rationale behind this project is:

- The provision of affordable green heat to 37 residences and two community buildings in rural Yukon.
- Removal of a major Green House Gas emissions for heating homes in an arctic environment with a minimum net benefit to the environment of a reduction of 300 tonnes of GHG emitted into the atmosphere.
- A direct cost saving to KFN members for the cost of heating fuel and electricity for water heaters
- A saving of approximately$115,000 per year split amongst the residents
- Enhanced Quality of life for residents who spend a major portion of their available income on heating fuel and electrical costs
- Creation of a sustainable heated community, serviced from a proven technology utilizing an abundant fuel source (wood) from the 1999 forest fire and wood salvaged from the spruce beetle kill infestation areas.
- Environmental benefit/outcomes would consist of a diesel heating fuel reduction of approximately 60% of the total usage or 100,000L with the corresponding non-neutral GHG emissions. Another environmental benefit would be the cleanup and use of the 1999 fire kill timber (neutral emissions) in the wood chip boiler for fuel.
- Social benefit/outcomes consist of local employment for harvesting and chipping operations and the resulting capacity building within the KFN for workers and their families. A more secure source of heat for KFN and KFN infrastructure.
- Economic benefit/outcomes consist of local employment where job availability is scarce increasing income generation; a reduction of heating fuel and electrical costs; full utilization of existing wood chip boiler; and an increase to the value of existing capital assets.

3.0 Detailed Project Description

3.1 Project Scope & Location

Refer to attached Power Point presentation "Kluane Boiler Presentation"

3.2 Response to Problems Identified in Project Rationale

- Boiler operation costs to residents will be between $30.00 and $50.00 per month.
- Change from oil burning and electricity for water heater will reduce GHG emissions by at least (from Energy Baseline study) 300 tonnes.
- Heating fuel replacement of $3100.00/year per resident.
- Project can be used as a model for other communities to follow to reduce dependence on fossil fuels and in reducing GHG's and reducing our impacts on global warming. The project also addresses an environmental disaster in utilizing trees destroyed from spruce beetles, which otherwise have no or little economic uses.
- The use of the 1999 fire kill timber in the wood chip boiler provides for clean up and economic use of a readily available wood source for heating.
- Local employment is created for the provision of wood for the boiler system at a rate of $100.00 per cord.
- Local employment is also created for the wood chip boiler's operations and maintenance, and the system adds to the capital asset base of Kluane First Nation.

3.3 Project Location (See attached as follows)

- "Burwash Community Overview"
- "Burwash Site Plan Expansion"

3.4 Who Will Benefit From the Project?

KFN and its beneficiaries benefit directly. By servicing the 37 residencies, the community will get affordable, environmentally friendly heating and infrastructure for future expansion as desired.
MRIF support illustrates governments support for environmental and cost effective alternative heating for small rural communities that are severely affected by the high costs of fuel oil dictated by global pressures.
The government and the Canadian Public benefit from the reduction in GHG emissions and an increase in income from the reduction of heating costs alleviating social supports requirements.
The world benefits from the reduction of GHG emissions.

Yukon Electric benefits from the reduction in load on the remote diesel electric generating system that is often limited out, frequenting brown outs and the occasional black out, and saving on expansion or construction of a new electric generating system.

3.5 Benefit Realization

Benefits have already been realized with the construction of the existing boiler system servicing the KFN administration buildings since 1998. There is an annual cost savings of approximately $40,000.00 per year.

3.6 Innovative Technology

SEE "Kluane Boiler Presentation"

3.7 Significant Project Risks and Mitigation Strategy

- Weather related delays could affect the timing of completion.
- MRIF refusal to fund 2/3rds of the $900k applied for will not allow KFN to utilize approved ANCAP funding of $250k

4.0 Environmental Assessment

An assessment of potential environmental risks and associated impacts was carried out as part of the original 1996 feasibility study. Under the present Yukon Environmental Assessment Act, currently in place, the proponent is responsible for preparation of an environmental screening. In this case the proponent is the Kluane First Nation and the work will be undertaken on settlement land.

The Kluane First Nation has not yet prepared a formal screening document. It is worth noting that the project would not be captured by any of the 21 criteria on the exclusion list regulation provided in the Business case Guidelines. No other Federal authorizations or approvals would be required for this work.

CATEGORY 9: ENVIRONMENTAL ENERGY IMPROVEMENTS

The objective of this category is to construct, restore or improve Local Government-owned Infrastructure that optimizes the use of energy sources (e.g. in buildings and other installations) and reduces GHG emissions and air contaminants arising from local sources.

To fall within this category, a Project must be directly related to one of the following subcategories:

- Retrofits of Local Government-owned buildings;
- Energy Systems such as renewable energy, combined heat and power (CHP), cogeneration and district energy; and
- Street Lighting.

WHEREAS:

KFN's water supply is at risk in producing sustainable yields to meet any additional demand on the existing well;

WHEREAS:

KFN's water quality does not meet new more stringent Canadian Water Quality Standards for potability;

WHEREAS:

KFN is located on a geologic area where there exists a high probability of constructing a high production potable water geothermal well;

WHEREAS:

Geothermal energy can be utilized to address and reduce the cost of energy to all KFN residents

THEREFORE BE IT RESOLVED:

The KFN General Assembly directs

1. Public Works and Municipal Services and Capital Works Board to prepare or have prepared a test production well (Phase II) proposal complete with cost estimates;

2. Public Works and Municipal Services and Capital Works Board to present (Phase II) proposal and to negotiate for full funding through INAC programs to address the serious concern of water quality and quantity issues and to address the rising costs of energy.

Moved by: Kluane Martin
Seconded by: Alyce Johnson
Motion is passed by consensus.

ANALYSIS OF GEOTHERMAL POTENTIAL IN THE PROXIMITY OF BURWASH LANDING (KLUANE)

REPORT

Re: Contract from KFN Council dated 13th day of January 2006.

Reporting by Dr. Jacek A. Majorowicz,*

*NGC (operating as Northern Geothermal) EDMONTON, 105 Carlson Close, Edmonton, Alberta, T6R 2J8, Canada, majorowicz@shaw.ca; phone/fax 780 4389385

May 15, 2006

SUMMARY

The estimates of peak temperatures point to a possibility of high temperatures (mainly 46 ^{o}C/km at bedrock) in the Burwash Landing area (APPENDIX Fig. 1, for location and APPENDIX Fig. 9 -10 for geological setting). Such high maximum temperatures are suggested by high present heat flow derived from limited logs and measured bottom -hole temperatures (BHTs) in the Cordillera. It is confirmed by other geophysical and geological indices and results of deep well in Haines Junction (some 17-20 ^{o}C at 137m). Present thermal gradient in the sediment overlaying bedrock is expected to vary and lower thermal gradient can be expected closer to the surface due to cooling by downward water flow carrying cooler surface waters. These would influence shallower gravel/sand aquifer's temperatures and lower geothermal gradient (expected 20-30 C/km vs. observed by EBA in Haines Junction wells #2 and #4, 22 and 25 C/km respectively). "Normal" (normal average thermal gradient for basins of the Canadian Cordiliera is some 30 C/km). Near-surface equilibrium temperature is -1 – 0 C (APPENDIX Fig.'s 2-4). This high gradient and lithology estimated average thermal conductivity of 2.5-3. W/mK gives high heat flow 75-90 mW/m^2. This agrees with heat flow map (APPENDIX Fig. 5) and predictions of high heat flow and high temperatures based on the geological model (APPENDIX Fig. 6 and 7 respectively). Lower geothermal gradient is confirmed at deep well #4 (EBA) in Haines Junction as measured and corrected BHTs reach gradient of 25mK/m in clastic sediments (gravels, tills etc...). Deeper aquifer in well #5 (EBA log) suggests even higher temperatures and thermal gradient (>46 mK/m). Other pertinent geophysical data confirm high heat flow in the Mobile Belt. These include low elastic thickness of the lithosphere from topography-Bourger gravity analysis. Thermal isostasy explains lithospheric equilibrium at high elevation over thin crust as high temperatures in the lower crust/upper mantle (900-1000^{o}C at Moho) cause reduced rock density. High elevation, low crustal thickness and relatively high heat flow (70-90 mW/m^2) suggest that estimated geothermal gradient varies from 25 C/km to 45 C/km (APPENDIX Fig. 8) for the

area. Heat flow uncertainties of 20 +/- 10 mW/m^2 are expected across the study Kluane region. Heat generation variations (0.6-6 $\mu W/m^3$) in the batholiths suggest heat flow variations is related to high heat generation changes rather than mantle heat flow variation. High lower crustal/upper mantle temperatures are characteristic, especially in the present and former backarc.

These good expected bedrock temperatures are favorable for development of geothermal energy heating. The main uncertainty is due to uncertainty in knowledge of the deep water aquifers. It is expected (as in case of deep Haines Junction wells) that the water recharged from high elevation – high hydraulic head areas will penetrate deep gravel/ sands aquifers in the Burwash Landing area and gets heated by the bedrock heat flow with depth. Depending on the depth of such aquifers we can expect temperature increase in access of 45 C/km at the aquifer bedrock contact. The aquifers above will be less heat due to large cooling by the recharge of the surface waters, especially during thawing in the spring time.

The other source of heat – shallow heat below diurnal and seasonal changes can be expected to be usable with the use of heat pump system. Such system can be especially useful in pick periods in the Fall-Winter–Spring. Mean annual ground temperatures are expected to be close to -2 – 0 C (APPENDIX Fig. 2-4) (according to measurement done along the highway in 1970^{th}, while at present ground temperature is higher, some 0-1 C due to recent climatic surface warming), while winter lows are some -15 C. Mean monthly January and December temperatures can be as low as -18 C.

The other source of heat can be derived from a system of deep tectonic faults. The town site of Burwash Landing is located essentially on top of the Denali Fault (APPENDIX Fig. 10), a crustal scale structure, which is still active in Alaska and strands of which are still active in the Yukon. These and related structures may provide the necessary network of fractures that could bring deep waters recharged in high hydraulic head areas (APPENDIX Fig. 11 for a conceptual sketch) through a network of faults, cracks to the surface in the Burwash Landing – Destruction Bay areas.

Geothermal water can be used directly in residential and district heating systems (APPENDIX Fig. 12-13) or with the use of heat pumps.

HEATING SYSTEMS

Geothermal Energy is heat (thermal) derived from the earth (geo). It is the thermal energy contained in the rock and fluid (that fills the fractures and pores within the rock) in the earth's crust.

Direct use (Distric heating or Residential heating; see APPENDIX Fig. 12 for an sketch of such system), as the name implies, involves using the heat in the water directly (without a heat pump or power plant) for such things as heating of buildings, industrial processes, greenhouses, aquaculture (growing of fish) and resorts. Direct use projects generally use resource temperatures between 38°C to 149°C. Heat from geothermal source water is extracted by the District Heating Heat Exchanger (see APPENDIX Fig. 13).

Low- and medium-grade resources can be used most economically in direct use of heat or in combination with the underground thermal energy storage (UTES) systems that provide seasonal energy for heating and cooling (e.g. Aquifer Thermal Energy Transfer Storage (ATES) systems at Pacific Agricultural Research Centre (PARC) in Agassiz, B.C.; Carleton University, Ont.). There are many advantages to using geoexchange rather than conventional heating systems, and faced with the current uncertainty in rising oil prices, the interest and investment in geoexchange is increasing throughout western Canada.

Ground-source heat pumps use the earth or groundwater as a heat source in winter and a heat sink in summer. Using resource temperatures of 0°C to 38°C , the heat pump, a device which moves heat from one place to another, transfers heat from the soil to the house in winter and from the house to the soil in summer

In Canada, 10-20°C groundwater is used directly or with heat pumps to heat more than 30,000 buildings, including Carleton University in Ottawa and factories in Nova Scotia (using water from the flooded Springhill coal mine of the ballad).

In the Yukon geothermal keeps city water pipes from freezing (Jessop, Geothermal Energy In Canada, GSC Open File).

Heat naturally flows "downhill", from higher to lower temperatures. A heat pump is a machine which causes the heat to flow in a direction opposite to its natural tendency or "uphill" in terms of temperature (see APPENDIX Fig. 12). Because work must be done (energy consumed) to accomplish this, the name heat "pump" is used to describe the device. In reality, a heat pump is nothing more than a refrigeration unit. Any refrigeration device (window air conditioner, refrigerator, freezer, etc.) moves heat from a space (to keep it cool) and discharges that heat at higher temperatures. The only difference between a heat pump and a refrigeration unit is the desired effect--cooling for the refrigeration unit and heating for the heat pump. A second distinguishing factor of many heat pumps is that they are reversible and can provide either heating or cooling to the space.

One of the most important characteristics of heat pumps, particularly in the context of home heating/cooling, is that the efficiency of the unit and the energy required to operate it are directly related to the temperatures between which it operates. In heat pump terminology, the difference between the temperature where the heat is absorbed (the "source") and the temperature where the heat is delivered (the "sink") is called the "lift." The larger the lift, the greater the power input required by the heat pump. This is important because it forms the basis for the efficiency advantage of the geothermal heat pumps over air-source heat pumps. An air-source heat pump must remove heat from cold outside air in the winter and deliver heat to hot outside air in the summer. In contrast, the GHP retrieves heat from relatively warm soil (or groundwater) in the winter and delivers heat to the same relatively cool soil (or groundwater) in the summer. As a result, geothermal heat pump, regardless of the season is always pumping the heat over a shorter temperature distance than the air-source heat pump. This leads to higher efficiency and lower energy use.

WORKING EXAMPLE

The Carleton University Aquifer Thermal Energy Storage (ATES) System

"Since 1990, Carleton University, Ottawa, Canada has been using groundwater directly to cool building air in the summer months and to pre-heat building air in the winter months without the use of heat pumps. The ambient temperature of the groundwater is approximately 9°C, and the climate in the Ottawa area is such that the load on the buildings can be balanced on an annual basis. The groundwater energy system applies Aquifer Thermal Energy Storage (ATES) technology, which allows for seasonal storage and recovery of heat and cold energy in an aquifer. The ATES system was to be implemented in phases, which would sequentially bring on line different areas of the campus over several years. Phase 1 (for the residence area) was completed in 1990. A five-well configuration can supply groundwater at a combined rate of 125 L/sec through simultaneous pumping and re - injection. The configuration is designed to be reversed on a seasonal basis, such that winter pumping wells become summer re - injection wells, and vice versa. Well rates range from 25 L/sec to 95 L/sec depending on the productivity of individual wells. The groundwater remains in a closed loop with the aquifer, and thus, is exposed to minimal environmental contamination. Carleton University has taken steps toward the further expansion and redesign of the system. Five additional Phase 2 wells were drilled in 1994, but the system continues to operate only in a small portion of the campus. The water equirement for Phases 1 and 2 of the system is 265 L/sec, thus, high yielding production wells were sought. A detailed examination of bedrock topography and stratigraphy, in combination with borehole and surface geophysics, greatly improved the success rate for drilling high yielding wells. Aquifers in the Ottawa area include unconsolidated surficial deposits, and Paleozoic sedimentary rocks that consist predominantly of limestone and dolostone, with some sandstone, shale and siltstone units. The productivity of the deeper rock aquifers is highly variable and is attributed to major faults or fault zones in the Ottawa area. One major fault zone, the Gloucester Fault zone, underlies the Carleton campus. On campus, well yields vary from less than a few L/sec to over one hundred L/sec, depending on the proximity to individual faults. The aquifer test data indicated a hydrologic regime dominated by vertical fracture flow associated with the major faults. These faults provide the high aquifer permeability necessary to obtain large volumes of water, but impose constraints on the maximum pumping and re - injection rates for individual wells. Groundwater flow and heat transport models were used to design a configuration of wells that would minimize thermal breakthrough between wells and maintain low levels of drawdown and positive head. The thermal model consisted of calculating the maximum pumping rates for well couplets, at specified separations and under maximum interflow conditions, at which no thermal breakthrough should occur within a 6 month period. These maximum pumping rates imposed constraints on the hydrologic model, which consisted of superimposing pumping and re - injection wells and calculating the resulting hydraulic head at each well. These simplistic analytical models served as first estimates of pumping and re - injection capability of the aquifer system, and were later supplemented by numerical models that could incorporate the heterogeneity of the system".

GEOLOGICAL BACKGROUND

Burwash Landing –general geological setting

Burwash Landing (on the Alaska Highway, on Kluane Lake), (APPENDIX Fig.1) The Geological (Yukon Geological Survey) map shows a lot of gravel/sand/fluvial sediments at the location which are on top of the crystalline bedrock. The test holes in the region of Haines Junction and surficial geological map (APPENDIX Fig. 9). The geological materials encountered beneath the Village of Haines Junction during the drilling Well # 5 correlate to the expected deposits from the geological history described above. These deposits consist of an alternating sequence of clayey tills and fine-grained glaciolacustrine deposits consisting of silt and clay with occasional sand and gravel lenses. A flowing artesian sand and gravel aquifer was intersected beneath this sequence from 329 to 369.2 metres below ground level (mbgl) according to EBA finding.

All the boreholes that have been drilled along the highway in that area are not very deep, and likewise for the ones drilled along the Foothills pipeline right of way. All the boreholes drilled in that area are generally less than 10 m and usually don't penetrate bedrock. Only few boreholes in that area have thermal data reported by Geological Survey of Canada permafrost temperature data (http://gsc.nrcan.gc.ca/permafrost/).

The geothermal potential of the Burwash area could be related to it's young geology. There are some young volcanics (geologically young) in the area called the Wrangell Volcanics or Wrangell Lavas (references below for these volcanics). They outcrop quite extensively south of Burwash Landing. These get as young as 8 million years and are part of the Wrangell volcanic belt that includes active volcanoes in Alaska. The youngest volcanic activity in the area is Mt. Churchill just across the Alaska border that erupted about 1200 years ago. The Wrangell volcanic field covers more than 10, 000 km^2 in southern Alaska and extends uninterrupted into northwest. Yukon Territory. Lavas in the field exhibit medium-K, calc-alkaline affinities, typical of continental volcanic arcs along convergent plate margins. Eleven major eruptive centers are recognized in the Alaskan part of the field. More than 90 K-Ar age determinations in the field show a northwesterly progression of eruptive activity from 26 Ma, near the Alaska-Yukon border, to about 0.2 Ma at the northwest end of the field. A few age determinations in the southeast extension of the field in Yukon Territory, Canada, range from 11 to 25 Ma. The ages indicate that the progression of volcanism in the Alaska part of the field increased from about 0.8 km/Ma, at 25 Ma, to more than 20 km/MA during the past 2 Ma. The progression of volcanic activity and its increased rate of migration with time is attributed to changes in the rate and angle of Pacific plate convergence and the progressive decoupling of the Yakutat terrane from North America. Subduction of Yakutat terrane-Pacific plate and Wrangell volcanic activity ceased about 200 000 years age when Pacific plate motion was taken up by strike-slip faulting and thrusting.

The town site of Burwash Landing is located essentially on top of the Denali Fault, a crustal scale structure, which is still active in Alaska and strands of which are still active in the Yukon. These and related structures may provide the necessary network of fractures that could bring deep waters to the surface. We do not know of any related hot springs to this or other faults in the area and this needs to be investigated in the future project. Satellite / aerial infrared photos would need to be analyzed. The other option would be interviewing people leaving and working in the Kluane First Nations community might know of something.

Burwash Landing is located in a similar geologic setting to Haines Junction for which recent feasibility study was recently done (EBA Report). Burwash Landing is approximately 185 km north of Haines Junction, adjacent to Kluane Lake at the foot of the Kluane Range.

Regional experience

In the vicinity of the study area most of work related to potable water projects has been done by EBA This include geoexchange feasibility, and geoexchange supply well projects for the Village of Haines Junction, and for the Na-Cho Nyak Dun First Nation and Government of Yukon in Mayo, Yukon. In 2002, an exploratory drilling program for the Village of Haines Junction encountered a warm water source (Well #5) at a depth of 369 m where artesian water reached temperature of 17 °C at the outflow. At assumed mean annual surface temperature 0 C (see APPENDIX Figures 2-4) this gives very high geothermal gradient of 46 C/km. (Bottom hole temperature reading suggest higher maximum temperature; somewhere between 19-20 C! It is expected that the water looses part of its temperature (heat) as it flows up and especially if flow is not fast. Potable water of that well has a potential for using it for district heating in the Village of Haines Junction. A relatively deep water well (200 m) was drilled in Destruction Bay where pump test were completed. EBA's water well database for the Shakwak Trench Region (from Haines Junction to Beaver Creek) contains over 70 water well records. Most of these do not have temperature information, however, recent wells from which we have coordinated drilling in the Shakwak area (2 - including 1 in Burwash and 1 in Destruction Bay in the 60 m depth range) water quality and temperature information exists according to Ryan Martin of EBA.. Recently completed successful water supply projects for YTG in both Burwash Landing and Destruction Bay involved testing of two new water supply wells. Water well database for the Shakwak Trench Region (from Haines Junction to Beaver Creek) contains over 70 water well records. Recent EBA projects in the area include well completion Report- Burwash Landing Airport Terminal Building , Destruction Bay Grader Station, Haines Junction, Yukon the Na- Cho Nyak Dun First Nation, Mayo, Yukon.

SOURCE OF HEAT FLOW

It is well known that high elevation of most continental belts at modest crustal thickness is an attribute of high heat flow and large temperatures at depth. The study area of Kluane region is within high elevation area (APPENDIX Fig. 11). Intrusions and hydrothermal activity are typical for high temperature former backarcs.

The westward growth of North America has progressed by accretion of terranes has started in late Paleozoic and it has been occurring mainly through the Mesozoic and Paleocene. This growth is currently interpreted to have progressed from thin-skinned accretion, as terranes were initially thrust over to North American margin, through thick skinned accretion (see Hammer and Clowes 2004 for literature review on the subject).

Flat and shallow Moho (*ca.* 30-35 km) is observed under much of the Cordillera Terranes. This is accompanied by high heat flow (ca. 70-90 mW/m^2) through most of them. It is more difficult to explain high heat flow in the northern part of the Canadian Cordillera Intermontane than in the south. The southern Canadian Cordillera is still going through a subduction. Eocen extension has been linked to back-arc asthenospheric flow there. This can explain high heat flow in the southern Coastal Plutonic complex and in the southern Omineca. In the northern Cordillera which includes northern B.C and S. Yukon, the extension and manltle upwelling have not been happening recently. Active subduction ended there some 40 mln years ago. Despite this we have similar lithospheric properties. Neogene - Quaternary extension in the Coastal belt can be related to the Northern Cordillera Volcanic Province despite lack of current subduction.

Lewis et al., (2003) has argued that the highest heat flow north of 59°N and in Yukon are a result of a combination of very high heat generation and elevated mantle heat flow. Heat generation is 4.4+/-1.9 $\mu W/m^3$ to the north and much lower (1-3 $\mu W/m^3$) to the south, though very little samples are available to the south (4). Corresponding heat flow averages are 105+/-22mW/m^2 to the north of 59°N and 73+/- 11 mW/m^2 for the sites between 57-59°N.

In the backarc convection model of Hyndaman et al., (2005), convection declines following the termination of subduction and the loss of water as a flux for convection. This process is relatively quick and lithosphere cooling and thickening are conductive. The increase in upper mantle viscosity occurs due to water loss through partitioning into arc and backarc melt fractions and through upward diffusion. Most of the rapid cooling and heat flow decrease is after termination of subduction.

Deep temperature data in the study area are limited and the analysis of thermal state of these basins needs to be assisted by other geophysical data, such as topography, crustal geophysical parameters and tectonic history.

ESTIMATES OF MAXIMUM TEMPERATURE AND HEAT FLOW

Some 200 geothermal heat flow data are available for the Canadian Cordillera, (DENAG data base and the GSC Canadian Heat Flow Data base). The distribution of the data is uneven with few data in Yukon. The heat flow map shows that Burwash Landing (APPENDIX Fig. 5) is in high heat flow area, however, there are no data in the study area of Kluane and map shows patterns interpolated from existing scarce data.

The location of available deep wells with BHT's in western Canadian Cordillera is shown in APPENDIX Fig. Measured BHTs from the Canadian Cordillera are numerous enough to determine general trend with depth. Average thermal gradient after correction is 32 C/km. The process of return of wells to thermal equilibrium (equilibrium between the fluid filling the well and the surrounding rock/ice media) can be as long as one to several years. In such cases equilibrium geotherm is calculated from several BHTs taken in different times over a period of days. As a rough approximation the recovery to equilibrium state is completed to within the accuracy of measurement of temperature in a period that is 10-20 times greater than the time of drilling. It is possible to estimate equilibrium temperature from a series of measurements using extrapolation. The above rule applies also to measurements done in the Haines Junction (EBA wells 2-5) and one needs to take the temperature recording done in time close to a completion of the well drilling with caution. The results of pumping test temperatures and results of Bottom hole temperature records can be underestimated due to a long time circulation fluid in the well stabilize thermally.

The thermal conductivity of rocks determines geothermal gradient for a constant heat flow. Rock conductivity is much lower than, for example, that of metals. The rocks of the earth crust act as an insulator. Such insulating properties have among others shale (1.1-1.5 W/m K) and basalt covers (1.6-1.95 W/mK) like the ones frequent in the Canadian Cordillera. Quartz sandstone can be as high as 4.9 W/mK (generally 3.7 W/mK). Interbeded sandstone and shales will be lower (2-2.5W/mK) depending on the shale/sandstone ratio. In general rock conductivity is in the range 1.5 and 6 W/m K depending on rock type. The conductivity of water filling pores or cracks is rather small (about 0.6 W/m K).

Volcanic rocks (basalts)	1.7 1.9	W/m K
Shale	1.1 1.5	W/m K
Sandstone	3.7	W/m K
Interbedded sandstone/shale	2.5	W/m K
Shale with minor sandstone	1.5	W/m K
Intterbedded shale and pepebbly sandstone	2.0	W/m K
Interbedded conglomerate and shale	2.2	W/m K
Mudstone	2.0	W/m K
Greywacke	2.2	W/m K
Chert	1.4	W/m K
Breccia	1.7 2.0	W/m K
Siltstone	2.7	W/m K

At a common continental geothermal gradient of 30 mK/m likely typical for the Canadian Cordillera and thermal conductivity of 3 W/m K, heat flow will be 90 mW/m^2

Thin crust and high elevation are indicative of high temperatures and thin lithosphere (Bodri and Bodri, 1985; Hyndman and Lewis, 1999). High elevation changes observed along the Canadian Cordillera including Yukon are modest variations in crustal thickness from 34-37 km are indicative of the hot crust and mantle in the Elevation and (based on LITHOPROBE seismic profiles) small crustal thickness (some 30 km) and high Cordillera elevation requires heat flow close to 90 mW/m^2 in order to maintain isostatic balance of the lithosphere. This is of the very same magnitude as observed heat flow (APPENDIX Fig.). Thermal isostasy explains high elevation over thin crust in the SW Yukon as high temperatures in the lower crust/upper mantle (900-1000 C at Moho) cause reduced rock density. Base of the crust – Moho discontinuity temperatures are also high (700-900 C). Low P_n seismic velocities recorded by the LITHOPROBE profiles in the northern Canadian Cordillera suggest hot top of the mantle and high heat flow through the study area . Statistical relationships between heat flow, and P_n velocities and heat flow and temperature was used to estimate heat flow and crustal – mantle temperatures according to formula :
$P_n = 8.55 - (0.73 \times 10^{-4}) \times T(P_n)$, where $T(P_n)$ is temperature at Moho.

None of the methods for constraining deep temperatures are completely reliable on their own, including models based upon heat flow- surface heat generation. The range of recorded Pn velocity (interpreted from seismic experiments (7.8-8.0 km/s) results in temperature estimate of *ca.* 700-1000 C at base of the crust . LITHOPROBE SNORCLE magnetotelluric profiles find that the conductor is at low depths of 7- to 17 km . In order to relate temperatures of the 450 C isotherm to MT derived depth of top of the conductor, crustal temperatures need to be estimated. The sub-sedimentary heat flow is here defined as surface heat flow less heat flow contribution of the upper layers of sediments and metamorphosed sediments.The heat production of the uppermost sedimentary layer was estimated 1.0 μ Wm^{-3}. Heat generation of the mantle was estimated at 0.015 μ Wm^{-3}. Results of calculation of depth to isotherm 450°C in the Canadian Cordillera which approximately can be considered the temperature of the top of the ductile crust show 7-17 km indicating that in north western Cordillera 450°C isotherm is quite shallow.

Coherence analysis of gravity and topography allows estimates of so called effective elastic thickness of the lithosphere. Temperature is major control on the strength of the lithosphere and effective thickness of the lithosphere derived independently of heat flow data confirms it. It is strong and its elastic thickness is high (100km) in the low heat flow low, low temperature craton and it is thin (20 km) and weak in the Cordillera where heat flow is generally high. Analysis of the variations of effective elastic lithospheric thickness shows that Cordillera is characterized by low thickness (5-20 km). Such thin effective lithospheric thickness is close to estimates of depth to 450 C isotherm and depth to MT conductor and indicates elevated heat flow (80 mW/m^2+/-10 mW/m^2).

The above consideration (Q vs P_n velocity, depth to MT conductor correlating with top of brittle – ductile zone) confirms single (low data density) observations of high heat flow for northern Canadian Cordillere including SW Yukon.

SURFACE AND NEAR SURFACE GROUND TEMPERATURE IN STUDY REGION

Variations in mean air surface temperature were collected from time series in the Canadian Environment weather station in Whitehorse. Average monthly temperature variations in winter and mean annual temperatures are shown in Appendix Figure 2-3). It is seen that temperatures of 1980th-early 2000th are higher than in previous years due to climatic warming experienced by Yukon. Temperatures are close to 0-1 C anuually.

Winter month average temperatures drop below 15 C as shown. This variations are important as peak heating demand for the geothermal system (eighter heat pump operated or through direct heating) be in Winter. Variations of temperature monthly for the last years of 2000th are shown in APPENDIX Figure3.
This influence subsurface temperatures in the ground as seasonal changes propagate downward and diffuse at depth of some 15 m. Snow cover in the winter will insulate the ground from very low surface temperatures and it is expected that mean ground temperatures be some 1-2C higher annually.
The only measured information available come from few locations along the highway in the vicinity of Burwash landing and are reported in the Geological Survey of Canada data base (GSC Terrain Sciences web) . The map of ground temperatures show range -2 - 0 C. (Appendix Figure 4). Temperature data for the Kluane and vicinity were extracted from the file and are shown below:

TEMPERATURE LOG TYPE	SITE	GSC No,.	NAME				PERMAFROST (m)	DEPTH (m)	TEMP. °C				LATIT.	LON.
point	GT623	583	Alcan Foothills - 6	#226	845	Inactive	Surface (< 10 m)	6.00	-0.9	-	-	-	138.78	61.24
point	GT628	588	Alcan Foothills - 11	#226	823	Inactive	Surface (< 10 m)	4.00	-1.4	-	-	-	138.8	61.25
[point]	GT621	581	Alcan Foothills - 4	#226	820	Inactive	Surface (< 10 m)	6.00	-0.8	-	-	-	139.23	61.45
[point]	GT627	587	Alcan Foothills - 10	#226	777	Inactive	Surface (< 10 m)	6.00	-2.5	-	-	-	139.32	61.51

The above temperatures are not at depth of neutral zone and likely influenced by the seasonality. The measurements were taken more than 25 years ago and present temperatures rose due to global warming in last decades and especially in the 80th and 90th. Nevertheless they are giving some idea about the subsurface temperature.

CONCLUSIONS AND RECOMENDATIONS

The estimates of average present gradient for the study area is some 25-46 C/km (average from the corrected temperatures vs depth) heat flow is in the 70mW/m^2 to 90 mW/m^2 range.

EBA's involvement in gathering information including a review of the Alaska Highway investigation in the Burwash Landing area, relevant information from, and possibly interviews with community members/ elders to identify spring locations in the area would be essential in going into a second phase of the contract. Northern Geothermal could continue geothermal part of the study and the analysis of infrared satellite photos in order to locate hot areas. Also, an important part in assessing a potential for use of geothermal would be the results of the independent study proposed by EBA to look at the feasibility of potential new well locations in the Burwash Landing area for potable water supply.

Good expected bedrock temperatures are favorable for development of geothermal energy heating. The main uncertainty is due to uncertainty in knowledge of the deep water aquifers. It is expected (as in case of deep Haines Junction wells) that the water recharged from high elevation – high hydraulic head areas will penetrate deep gravel/ sands aquifers in the Burwash Landing area and get heated by the bedrock heat flow with depth.

It is also expected that the other source of heat can be derived from a system of deep tectonic faults. The town site of Burwash Landing is located essentially on top of the Denali Fault (APPENDIX Fig. 10), a crustal scale structure, which is still active. These and related structures may provide the necessary network of fractures that could bring deep waters recharged in high hydraulic head areas through a network of faults, cracks to the surface in the Burwash Landing – Destruction Bay areas.

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1.1 Kluane First Nation Water Supply Recommended Upgrades for 2005/2006

There are several outstanding recommended upgrades that have not yet been addressed. These include work that was previously identified, and was delayed to future funding and construction seasons, as well as remedial works for new deficiencies that were identified during Phases 2 and 3. These upgrades are summarized in Table 6 with estimated Class C costs for budgeting purposes. In light of the findings of the Phase 3 assessment, it is likely that some or all of the KFN members will remain on bulk water delivery. As well, it has been assumed that the existing water supplies for institutional buildings (Admin Building, Health and Social Services, Daycare, Teacherage, Laundry Facility will remain on the current well systems. As such, further remedial work to improve the long-term safety of these community systems (KFN-C, KFN-F and KFN-G) is recommended to be completed in 2005/2006 fiscal year.

Table 6 also provides recommendations for upgrades in future years. Some of these upgrades are not considered to pose risk, or, need to be re-evaluated following decisions regarding long term water supply options as presented in Sections 7, 8 and 9. Further details regarding the recommended remedial work and upgrades to the existing community water supply systems are provided by location in the following sections.

1.1.1 KFN-C:

C1 and C2

It is the KFN preference to upgrade the water supply disinfection system to a chlorination system. In light of the fact that there is a relatively significant amount of distribution piping between the source and the other buildings that it serves (Administration building and Laundry facility), it is advisable to install a disinfection system that provides residual protection for potential bacteriological or viral contaminants that could enter the system between the source and the point of consumption. The existing UV disinfection system does not provide residual disinfection after the point of entry into the Health and Social Services Building. The Trihalomethane Formation Potential (THMFP) test completed on this well as part of the additional analytical for Phase 2 indicated that at the time of sampling, trihalomethanes were not formed at levels above the detection limit when the source water was exposed to a 4.8 mg/L concentration of free residual chlorine. Based on community preference and the added security of this type of system, it is recommended that KFN-C be upgraded with a chlorine disinfection system. In the interim, the project team and KFN will endeavor to get the existing UV system operational.

A chlorination treatment system would generally consist of an automatic chlorinator plus an in-line storage system providing at least 20 minutes' retention at peak demand. It is recommended that the softening equipment be retained as part of the treatment system. The new water treatment and delivery system would include:

- Sediment filter;
- Pressure tank;
- Arsenic Removal Treatment System (as required);
- Automatic chlorinator with solution tank;
- In-line retention tanks;
- Water meter; and
- Raw water sampling tap, plus treated water sampling tap following the retention tanks.

An overall peak momentary demand of 2.3 Lps (30 Igpm) for the three buildings was determined based on an analysis using the fixture unit method. A conceptual flow diagram showing the key components of the process is shown in Drawing 4.

There is insufficient space in the existing mechanical room for the additional equipment. As such, an add-on is proposed to contain the existing and new equipment. The proposed location for the add-on is beside the mechanical room in order to make the transition relatively straightforward. Conceptual drawings showing the add-on and treatment system are shown in Figures 4, 5 and 6. An add-on constructed at the location shown will require relocating the exhaust air outlets to opposite walls on the addition as per the conceptual drawings (Figures 4, 5 and 6). Considering the required mechanical equipment and space allowance for the relocated ductwork, it was estimated that the add-on should be at least 3.7 m (12') by 4.9 m (16'). The proposed building would be of wood-frame construction supported by a pad/crib foundation support system as shown in Figures 5 and 6. A space frame support system, similar to the existing foundation, is also a viable option. However, a pad/crib support system will function equally as well for this application and is anticipated to be more cost effective.

Construction costs are estimated as follows:

Add-on structure	$ 24,000
New mechanical and Treatment equipment	$ 10,000
Relocation of exhausts and equipment	$ 5,000

Estimated Subtotal:	$ 39,000
Engineering @ 20%	$7,800
Contingency @ 20%	$7,800
Estimated Total:	**$54,600**

1.1.2 KFN-F

Recommended upgrades for KFN-F main community well that are recommended for 2005 are indicated below:

F1

Construct new well enclosure building with outward opening door and removable bolt down roofing system. Pump controls to be moved inside building. Remove all electrical except for light and electrical outlet to facilitate monitoring and maintenance. Re-grade area to ensure positive drainage away from wellhead. Will require swale between well enclosure and truck garage.

Materials and Labour:	$5000
Engineering @ 20%	$1000
Contingency @ 20%	$1000
Estimated Total:	**$7,000**

F3B

It is recommended that a chlorine analyzer be installed, with a recirculation loop and timer to ensure adequate chlorination at all times during system use.

Materials and Labour:	$6000
Engineering @ 20%	$1200
Contingency @ 20%	$1200
Estimated Total:	**$8,400**

F7

There is currently no back-up well for the main bulk water delivery facility. It is recommended that a new well be brought on line to replace/supplement the existing water supply for the bulk facility for KFN-F. The existing well for KFN-F did not identify the bottom of the confined aquifer zone. A test well drilled with the purpose of completion as the main or back-up well could be drilled deeper to explore the aquifer, and could potentially be completed with a longer well screen enabling better flow and more available drawdown. As indicated by the slight difference in water quality between KFN-H and KFN-F, it is likely that there is some variability in arsenic, iron and manganese concentrations in the area. Ideally the new back-up well would intercept an aquifer that produces groundwater with arsenic concentration less than the proposed new guideline, and iron and manganese concentrations below the aesthetic objectives. It is likely that a new well drilled in relatively close proximity (within 100 m) to KFN-F could become the main well, and the existing well could be used as back-up. At the time of the test well, it is recommended to complete a longer-term pump test (72 hours) to ensure the long-term sustainability of the aquifer. The new well and the back-up well should both be utilized frequently to inhibit biofouling and to ensure the proper functioning of the well. The estimated costs are provided below:

Drilling, Testing, Hookup:	$80,000
Engineering @ 20%	$16,000
Contingency @ 20%	$16,000
Estimated Total:	**$112,000**

F8

There are currently utilidors that house the piping, freeze protection and electrical works between the well enclosure and the truck garage, and also between the well enclosure and the Sharon Kabanak Residence. The existing utilidors are unsightly, potentially unsanitary, and have been discussed as a long-term upgrade by KFN and INAC representative. It is recommended that this work be completed following the test well drilling program so that the distribution lines could be installed below grade at the same time. The estimated cost to remove the existing utilidors, and install freeze protected piping below grade is provided below:

Materials and Labour:	$12,000
Engineering @ 20%	$2,400
Contingency @ 20%	$2,400
Estimated Total:	**$16,800**

F9

There is currently an AST located approximately 10 m from the existing KFN well. As well there is a wood fired boiler system located approximately 4 m from the well. The presence of these systems in close proximity to the well increase traffic and use of vehicles in close proximity to the well. Relocation of these systems to the other side of the garage has been discussed with KFN and it is agreed that these systems should be relocated. The estimated costs are presented below:

Materials and Labour:	$4,000
Engineering @ 20%	$800
Contingency @ 20%	$800
Estimated Total:	**$5,600**

F10

Within the water truck garage, the concrete floor slopes from the middle of the garage to the outside corner. This creates a problem with ponding, dirt accumulation, and generally unsanitary conditions. Several options have been considered to rectify this situation, including cutting channels, resurfacing with a veneer, or creating curbs. Estimated costs are provided below:

Materials and Labour:	$3,000
Engineering @ 20%	$600
Contingency @ 20%	$600
Estimated Total:	**$4,200**

F15

Although the turbidity during most sampling events has been below 1 NTU (the recommended guideline for community water supply systems), it was observed to be 1.17 NTU during the most recent sampling event. It has also been reported that some sediment has been observed during certain times of the year. Based on this information, and in lieu of the fact that a chlorination disinfection system is currently in use with this system, it is recommended that a filtration system be installed prior to disinfection. The estimated costs are provided below:

Materials and Labour:	$2,000
Engineering @ 20%	$ 400
Contingency @ 20%	$ 400
Estimated Total:	**$2,800**

1.1.3 KFN-G

G2

As mentioned previously, there are septic systems of unknown design (likely leach pits) that service the Daycare and Teacherage. These sewage systems are both within 60 m of KFN-G. It is recommended that these systems be removed, and sewage holding tanks installed. Estimated costs are provided below:

Materials and Labour:	$9,000
Engineering @ 20%	$ 1,800
Contingency @ 20%	$ 1,800
Estimated Total:	**$12,600**

G3

Construct new building enclosure with outward opening door and removable bolt down roofing system. Pump controls to be moved inside building. Remove all electrical except for light and outlet.

Materials and Labour:		$4,000
Engineering @ 20%		$ 800
Contingency @ 20%		$ 800
	Estimated Total:	**$5,600**

G4

The utilidors in which the distribution piping and freeze protection exist between the well enclosure and the Daycare as well as the Teachery should be removed and replaced. The existing utilidors are unsightly, potentially unsanitary, and have been discussed as a long-term upgrade by KFN and INAC representative. The estimated cost to remove the existing utilidors, and install freeze protected piping below grade is provided below:

Materials and Labour:		$12,000
Engineering @ 20%		$2,400
Contingency @ 20%		$2,400
	Estimated Total:	**$16,800**

1.1.4 KFN-I

I1

The abandoned well KFN-I was not properly decommissioned. This should be located and decommissioned according to INAC specs to reduce risk of potential contamination of the aquifer supplying KFN-C. The estimated cost to complete this work is provided below:

Materials and Labour:		$1,500
Engineering @ 20%		$ 300
Contingency @ 20%		$ 300
	Estimated Total:	**$2,100**

1.1.5 Domestic Water Tanks:

It was previously recommended to install replacement water tanks at 6 locations where tanks were found to be in poor condition. KFN applied for funding to pre-fabricate add-ons to house the replacement domestic water tanks and pumps. It is understood that KFN has applied for funding to install the add-ons, remove existing tanks, and plumb in new tanks within the add-ons. This was estimated by KFN to cost **$36,360**.

1.1.6 Cost Summary

The costs provided herein, are based on preliminary information, and not on detailed design. They should be considered as Class C costs for budgetary purposes. The total additional work recommended for 2005 is estimated at approximately **$216,000 plus GST** for materials and contractor costs. An additional 20% (approximately **$36,000 plus GST**) should be allocated for engineering, inspection and reporting. It is recommended that an additional contingency amount of **$36,000** be allowed for budgetary purposes.

TABLE 6: PROTECTIVE AND PREVENTATIVE MANAGEMENT STRATEGIES	
Action	• Relocate Water Truck Garage's AST to other side of building; • Relocate livestock pen in the event that site MV-B is selected; • Locate and properly decommission abandoned well KFN-I; • Replace improperly constructed septic systems with properly constructed septic tanks (APECs P1 and P2); • Implement a septic tank monitoring program; monitor levels, extra care on pump-outs; develop owner awareness programs of septic tanks; • Purchase or form a land development agreement with the owners of the land to the west of KFN-F and MV-A so as to protect and manage the wellhead and capture zones from commercial and industrial development to the west; • Consider replacing well enclosures for KFN-F and KFN-G; • Complete some re-grading around KFN-F to promote positive drainage away from well – a swale between the water building and the well house should be constructed to divert flow away from the wellhead; • Initiate guidelines or by-laws to control and mitigate potential development activities; • Lock all wells and pump houses; • Fence around wellheads and pump houses; • Post signs around wellhead area; and, • Prepare and make readily available a spill contingency plan and contact list.
Management	• Educate maintenance staff and community members regarding risks; • Incorporate AWHPP into KFN Community Development Plan; • NO septic fields; • NO residential, commercial and industrial development; • NO installation of USTs; • NO livestock operations and manure pile storage; • NO landfills or sewage lagoons; • NO storage of commercial and industrial chemicals (fertilizers, pesticides, salt, cleaning products, fuels, lubricants, etc); • NO storage of contaminated soils and/or water; • Minimize commercial and industrial activity; and, • Minimize or restrict pesticide and herbicide use.

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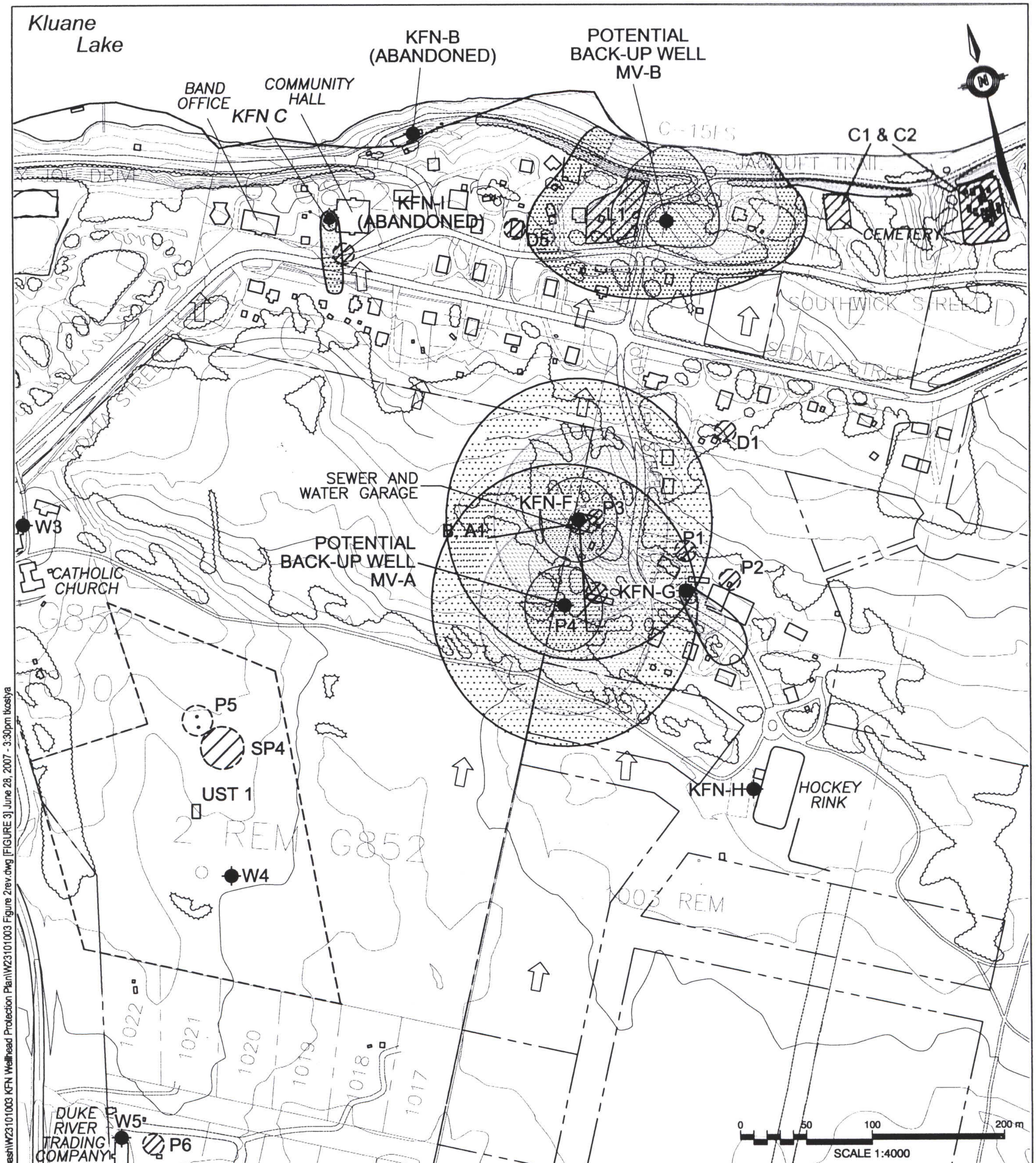

LEGEND:

GROUNDWATER FLOW DIRECTION BASED ON March 21, 2007 Survey by EBA

WELL LOCATION

AREAS OF POTENTIAL ENVIRONMENTAL CONCERN

CAPTURE ZONE 1 (1 YR. TRAVEL TIME)

CAPTURE ZONE 2 (5 YR. TRAVEL TIME)

CAPTURE ZONE 3 (10 YR. TRAVEL TIME)

CLIENT

EBA Engineering Consultants Ltd.

KLUANE FIRST NATION WELLHEAD PROTECTION PROGRAM - BURWASH LANDING, YT

SITE PLAN SHOWING CENTRAL BURWASH

PROJECT NO.	DWN	CKD	REV
W23101003	JSB	JC/RMM	0

OFFICE	DATE
EBA-WHSE	May 23, 2007

Figure 3

\eba.local\CORP\Whitehorse\Data\0201drawings\Burwash\W23101003 KFN Wellhead Protection Plan\W23101003 Figure 2rev.dwg [FIGURE 3] June 28, 2007 - 3:30pm tkostya

PROPOSED EXPANSION TO WOOD-HEAT DISTRICT HEATING SYSTEM

KLUANE FIRST NATION, BURWASH LANDING

Jan. 31, 2006

This first draft of an evaluation of the extension to this system, allows for underground recirculation loops connecting thirty-five residences to the system.

Although the exact routing of the loops needs to be determined from site visits, it is expected it will generally follow the dotted lines shown on the attached site plan.

Actual thermal demands of the heating loads will need to be evaluated and this will determine the line pipe sizes. I expect that the lines and connections will be similar to those already in the existing system, that is, steel schedule 40 pipe, with Victaulic connections, and wrapped in fiberglass pipe insulation, covered with a vapour barrier for protection.

It is also assumed that each residence is currently equipped with a forced air oil fired furnace, and that the installation of a hydronic heating coil in the existing ductwork is feasible. Consequently, there will be a short run of underground piping from the heating loop to the residences together with a return line back to the loop.

The boiler building will need to be equipped to handle this expansion with piping to include circulating pumps, heat exchanger, and piping trim.

I have not included individual thermal energy-use meters to measure heat to the individual residences. This would add to the costs.

On the basis of the above, and in conjunction with the attached drawing, I would allow for capital costs to run between **$750,000** and **$900,000** for the installation. This would include engineering fees and is based on outside contractors doing the work. I believe savings could be achieved by using a project-managing engineer and utilizing in-house labour.

I trust this will serve to your request for an initial expected cost. Your boiler is sized to handle this additional load.

Jack Dueck, P. Eng. M.B.A.