GWICHYA GWICH'IN CLIMATE CHANGE ADAPTATION PLANNING PROJECT

FINAL DRAFT

March 2010

ACKNOWLEDGEMENTS:

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EXECUTIVE SUMMARY:

Tsiigehtchic originated as a traditional seasonal fishing camp, located at the confluence of the Arctic Red and Mackenzie Rivers. A Roman Catholic Mission was established here in 1868 and a trading post soon followed. By 1940 only three permanent families lived in the settlement until the construction of the Dempster Highway attracted more residents.

Tsiigehtchic - which translates in the Gwich'in language as "at the mouth of the iron river" - was formerly known as Arctic Red River. The name may refer to the iron or mineral deposit found in the soil further up the Arctic Red River.

Tsiigehtchic is still a traditional community with trapping, fishing and hunting still being key aspects of many residents livelihood. Ferry crossing maintenance and operation provides a few jobs and the local retail store/post office is run by the band.

Under the Gwich'in Comprehensive Land Claim Agreement, the Gwich'in Tribal Council was granted ownership of 16,264 square kilometres of land in parcels located throughout the GSA and Yukon. (Excerpt: from Tsiigehtchic Community Profile).

Gwichya Gwich'in Climate Change Adaptation Planning Project

The Tsiigehtchic Adaptation Project was loosely based on a process developed by the Northern Climate Exchange for the Dawson City Adaptation Plan (NCE. 2009). The resulting collaborative process drew knowledge and expertise from both the community and technical experts from the Northwest Territories.

A community-based Local Advisory Committee (LAC) met with the project team on December 8th and 9th in Tsiigehtchic. This report is based on the work and ideas that were developed in that workshop (Appendix A – Workshop Report).

The Local Advisory Committee developed this vision for Tsiigehtchic in 2050:

"Our community of Tsiigehtchic will be a resilient, self-sufficient community which celebrates and practices its culture and promotes renewable economic development within our traditional lands."

The results from the LAC workshop were further developed by the project team including a risk assessment analysis of the impacts. This was reviewed by a Technical Advisory Committee (TAC) on February 11th, 2009. This diverse group reviewed the impacts and vulnerabilities of the community and suggested recommendations. A draft copy of the Adaptation Plan was presented to the LAC, Gwich'in Renewable Resources Council (GRRC), the Designated Gwich'in Organization (DGO), and the public on February 23rd and 24th , 2010.

Climate Scenario's for Tsiigehtchic

The Mackenzie Valley is a global hotspot for climate change, but due to the vast size and small population the climate remains little understood. The Canadian Climate Change Scenarios Network (CCCSN) developed ensemble reports for the Western Arctic which used global climate models (GCMs) to create projections of the future climate for the region in the period from 2041 to 2070.

These scenarios provide a picture of the future climate around Tsiigehtchic that was used to develop vulnerabilities and determine potential impacts. The CCCSN scenarios are meant to guide the process but it is acknowledged that there are still considerable unknowns regarding the prediction of climate in the next fourty to fifty years.

The scenarios predict annual temperatures increasing between 3 and 4 ºC by 2050 (above the 3 to 4ºC already observed). The greatest temperature change will be in the winter with changes of 4 to 6 ºC, Autumn will warm by 3 to 4ºC while spring and summer the weather will warm less by only 1.5 to 3ºC.

Precipitation is more difficult to predict, but the scenarios suggest that Tsiigehtchic will get wetter by 12 to 20% annually. Most of this will come as snow in the fall and winter, with predictions of up to 40% more snow.

Other factors that are predicted by climate scientists for this area of the world is more cloud cover as a result of greater evaporation, and more open water in the Beaufort Sea, and freshwater lakes. There is expected to be more extreme weather events such as strong winds, floods and droughts. It is also likely there will be more thunderstorms with the hotter, wetter weather in the summer.

Vulnerabilities to Climate Change

There are six broad landscape level categories of change which were found to represent the range of impacts that the LAC developed.

- Seasonal and Weather Changes
- Changes to the Flooding Regime
- Changes to Forest Fire Regime
- Changes to Wildlife
- Permafrost Degradation
- Water Quality

These changes along with socioeconomic changes within the community itself are expected to lead to significant impacts on the community within the fourty year timeline the plan is using. The impacts and potential solutions developed in the workshop with the LAC were run through a risk assessment exercise by the project team, estimating the consequence, likelihood and the adaptive capacity of the community for each impact. High priority risks were characterized by high consequence, high likelihood and low adaptive capacity (Northern Climate Exchange, 2009).

The results of this analysis were assessed by the Technical Advisory Committee for errors and gaps. High priority impacts from this exercise were very similar to the stated priorities of the Local Advisory Committee.

Local Advisory Committee Priorities:

- Church Hill erosion
- Permafrost degradation and building and house foundations
- Town roads, flooding and drainage concerns
- Remove contaminants from community
- Caribou concerns
- Preserving the river
- Assessing fuel tanks
- Pellet stoves and alternative energies

High Priority Impacts:

- Potential slumping of Church Hill and Cemetery
- Damage to community building foundations caused by permafrost degradation
- Foundation shifting and rotting pilings in housing
- Decline in caribou numbers
- Increase in landslides along Mackenzie River
- Potential of forest fires

Opportunities:

Climate change will also have some positive impacts on the Community. These were noted throughout the planning process, and include potential opportunities such as:

- longer growing season for agriculture,
- better tourism opportunities,
- faster tree growth, and
- hunting opportunities for new species.

Recommended Adaptations:

The most important part of this plan is ensuring its implementation. This plan has a set of recommendations that range from extremely easy to very difficult to implement, some will cost nothing, while others will have a substantial cost. Thirty-four recommended adaptations were developed for review by the community:

1. Work within the community to develop community resilience by promoting;
   - traditional values; and
   - community ties and social networks / relations.
2. Encourage elders to work with youth to pass on traditional knowledge including;
   - harvesting skills; and
   - safe travel on the land.
3. Promote the role of the Gwich'in Renewable Resources Board through;
   - Education and monitoring of caribou numbers; and
   - Encouraging and educating people about good hunting practices.
4. Encourage more healthy lifestyles and eating habits for community members.

5. Mainstream climate change issues and adaptation into other planning processes and community development activities.
6. Train Tsiigehtchic community staff on the basics of climate change.
7. Maintain the Local Advisory Committee for three more years with quarterly meetings to help guide adaptation implementation activities.
8. Hire a part-time Climate Change Coordinator to direct the implementation phase of this project.
9. Link to a sister community such as Mayo (Yukon) or Fort McPherson that is at a similar stage in the adaptation planning process. Have a liaison member from that community on the adaptation committee.
10. Document and publicize successes and failures on the community website.
11. Revisit this adaptation plan in 2015, and maintain it as a living plan.
12. Develop a public bulletin system and use radio station to promote safe travel and highlight dangerous areas.
13. Revisit the Tsiigehtchic Emergency Response Plan taking into account climate change and new projections for extreme weather events and forest fires.
14. Develop a drainage plan (as per Tsiigehtchic Land Use Plan) to deal with drainage issues taking into consideration future climate change predictions.
15. Work with Housing Corporation to monitor and prevent mold in houses.
16. Inventory and replace rigid fuel line connections with flexible connections in all heating oil tanks.
17. Inventory water tank overflow lights and install or repair lights on all buildings.
18. Work with Department of Transportation (DOT) to ensure fuel is stored safely at the helipad.
19. Work with DOT on a ferry landing study.
20. Fence off snowmobile access to Church Hill to reduce vegetation loss (ensure the use of fencing that doesn't encourage snow build up).
21. Develop a desktop level Community Permafrost Map. Use it to inform future land-use and development.
22. Work with INAC to establish a permafrost monitoring station in the community of Tsiigehtchic. If possible use the data to monitor permafrost changes in Vik'ooyendik (Church Hill).
23. Further study of permafrost maintenance, skirting and drainage issues regarding foundations of houses and community buildings (with an emphasis on preventative maintenance).
24. Arrange a permafrost and housing foundation assessment with permafrost experts in the community.
25. Commission an engineering study of options for Cemetery and Church Hill remediation or stabilization.
26. Engage Indian and Northern Affairs Canada (INAC) officials about the potential to locate a Cumulative Impact Monitoring Program (CIMP) site in the community of Tsiigehtchic.

27. Encourage the Gwich'in Tribal Council (GTC) and INAC to map and monitor landslides in the GSA.
28. Develop linkages with scientists, Department of Fisheries and Oceans and local harvesters to monitor breeding times, invasive species, population trends and water quality. Ensure this information is available broadly.
29. Develop closer links with Aurora Research Institute to bring scientific study results back to the community.
30. Work with GTC and INAC on an industrial sump management plan in the Gwich'in Settlement Area, to ensure sumps are not polluting waters.
31. Develop closer ties with Arctic Energy Alliance.
32. Work with Environment and Natural Resources Forestry Management Division to complete a forest resource assessment for Tsiigehtchic.
33. Investigate the potential of using willows and forests as a biomass fuel source.
34. Investigate using wood pellets and in-stream hydro as options to reduce dependence on fossil fuels.

CONTENTS:

GWICHYA GWICH'IN CLIMATE CHANGE ADAPTATION PROJECT:

The Gwichya Gwich'in Climate Change Adaptation Plan was conceived as a project when the community of Tsiigehtchic approached Ecology North out of concern for the structural integrity of their landmark church. This church sits high on a bluff called Vik'ooyendik (church hill) overlooking both the Arctic Red and Mackenzie Rivers. The white church has been a landmark for travelers on the Mackenzie River and more recently the Dempster Highway since it was built in the late 1920's, although the original church building was built in 1896 (Gwich'in Social and Cultural Institute, 2007).

Local people have become concerned for the church in recent years after a landslide removed a portion of the hillside to the southwest of the church and observed cracking along the hill below the church which indicates permafrost melting. A slope stability investigation of the hill showed that there are concerns about the church and neighbouring cemetary, although they are not in imminent danger of sliding into the river (Johnson, Robert, 2007). It is believed that climate change is the defining factor in the permafrost melting and subsequent bank erosion.

A primary goal of this adaption plan is to help Tsiigehtchic develop resilience, so that they can adapt to the changing climate. For this project **resilience** is defined as the ability of the community to maintain its functions in the face of internal and external change.

Tsiigehtchic is one of the first small communities in the NWT to start work on a climate change adaptation plan. Funding for the project was provided by INAC's Adaptation and Impacts Research Division (AIRD). The project team includes Doug Ritchie of Ecology North, Craig Scott of CS Environmental and Itai Katz (the Community Coordinator).

Work began in the fall of 2009 with the development of a community profile for Tsiigehtchic and a literature review of climate change in the Gwich'in Settlement Area. These documents can be found on the Ecology North website www.ecologynorth.ca. The project team held a workshop in Tsiigehtchic on December 8th and 9th. A Local Advisory Committee (LAC) was formed who provided the majority of the input for this report. A public open house session was also held which attracted several more local residents to learn more about the project. A workshop report is found in Appendix A.

Vision for Tsiigehtchic in 2050

The Local Advisory Committee was asked to develop a vision and for how they see Tsiigehtchic in fourty years. The vision they came up with was:

> **"Our community of Tsiigehtchic will be a resilient, self-sufficient community which celebrates and practices its culture and promotes renewable economic development within our traditional lands."**

The results from the workshop were assessed by a Technical Advisory Committee (TAC) on February 11th, 2010. This group of multi-disciplinary experts helped to assess the impacts and solutions identified during the workshop and find any gaps in knowledge. The group also helped recommend adaptations and provided direction for the plan. The draft plan was presented to the Local Advisory Committee, and Gwich'in Renewable Resources Council (GRRC), the Designated Gwich'in Organization (DGO) and the public on February 23rd and 24th, 2010. Comments from these presentations were incorporated into this final draft.

Limits of Adaptation Plan:

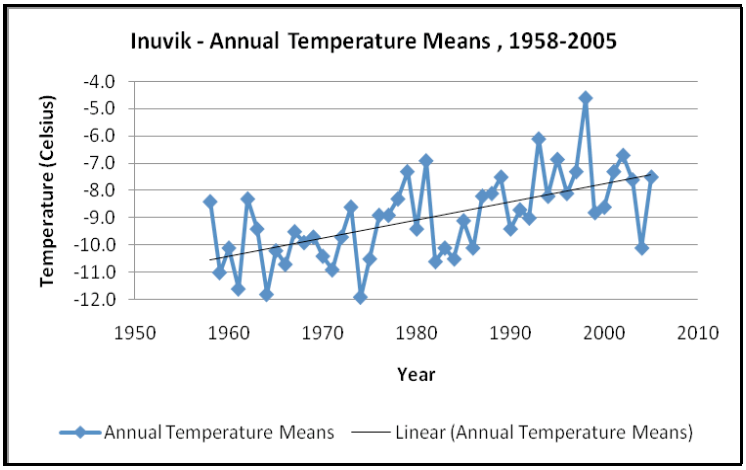
The Tsiigehtchic Adaptation Project Team was given a challenging time-line to complete the Draft Adaptation Plan. This Plan was developed from the results of community consultation, and a technical review. A snow free community visit was not possible within the time constraints of this project which limited the ability of the project team to thoroughly inspect some priority areas (ie. Church Hill).

The impacts of climate change in such a dynamic environment as the Mackenzie Valley is nearly impossible to accurately predict. The project team used trend analysis, local knowledge and global climate models (GCMs) to determine a likely scenario by 2050. Regional downscaling was not considered essential for this plan, and a regional climate scenario was used from Environment Canada's Canadian Climate Change Scenarios Network (CCCSN). Therefore, climate predictions in this plan are relatively general and are not intended as an accurate depiction of future climate in this region.

We recommend this plan be considered a living document which is revisited every five years by the community, and reassessed based on better climate predictions and recent local observations.

CLIMATE PROJECTIONS:

Dene harvesters and elders have been noticing rapid changes in the climate of the Mackenzie Valley for decades. Scientists agree with their assessment of changing climate, the Arctic Council declared the Mackenzie Valley a global hotspot for Climate Change in its Assessment report in 2004 stating that temperatures have increased by 3 to 4 ºC in the Mackenzie Valley in the past 50 years (ACIA, 2005). This is further supported when looking at trends in climate data kept by Environment Canada from the Inuvik airport that shows an annual increase of over 3ºC since 1958 (ENR, 2010).



Environment and Natural Resources

The Mackenzie River has proven sensitive to this change in temperature with the average break-up date in the 1990's being nine days earlier than it was just 50 years ago (Marsh et al, 1996). Future changes are anticipated to include an earlier spring peak and lower spring and summer water levels offset by higher fall and winter levels, and more variable flows (Arora, V., 2007).

How Much is the Climate Likely to Change in the Next Fifty Years?

Climate scientists have developed complex global climate models which predict the future of global climates. Environment Canada is at the forefront of this work and has assembled the results from GCMs from around the world to project the climate of the Mackenzie Valley by the year 2050 using three potential different scenarios of carbon reductions:

- Low Scenario - SRES-B1 scenario
  - The world makes immediate progress toward carbon reductions
- Medium Scenario - Mean SRES-B1 and SRES -A1B projections
  - the world starts to make progress towards reducing carbon dioxide, and
- High Scenario - SRES-A1B
  - not much progress is made and climate changes rapidly.

The Canadian Climate Change Scenarios Network (CCCSN) created a series of ensemble maps that show the change in temperature and precipitation annually and in all four seasons for the period of 2041 to 2070 (CCCSN, 2009). These maps were provided to the LAC and TAC for reference along

with a synopsis of anticipated climate changes. The scenarios were based a summary of findings from the most recent Intergovernmental Panel on Climate Change (IPCC) AR4 (2007) modeling assessment for Canada.

Tsiigehtchic Climate Scenario for 2050

Using conservative principles, a combination of medium and high projections are used to predict the likely climate in Tsiigehtchic in the decade of 2050. These climate projections are meant to guide the process but it is acknowledged that just like the weekly weather prediction, there are still considerable unknowns regarding the prediction of climate in the next fourty to fifty years.

The scenarios predict annual temperatures increasing between 3 and 4 ºC by 2050. The greatest temperature change will be in the winter with changes of 4 to 6 ºC, Autumn will warm by 3 to 4ºC while spring and summer the change will warm less by around 1.5 to 3 ºC.

Precipitation is more difficult to predict, but the scenarios indicate that Tsiigehtchic will get wetter by 12 to 20% annually. Most of this will come as snow in the fall and winter, with predictions of up to 40% more snow.

Other factors that are predicted by climate scientists for this area of the world is more cloud cover as a result of greater evaporation, and more open water in the Beaufort Sea, and freshwater lakes. There is expected to be more extreme weather events such as strong winds, floods and droughts. It is also likely there will be more thunderstorms with the hotter, wetter weather in the summer.

Although it is impossible to say with precision what the climate will be like in fourty years, it is nearly certain that there will be more volatility in weather and as elders have been saying for decades the weather is getting harder to predict and is changing more quickly than in the past (Arctic Borderlands Society, 2009). These projections were used to help determine what the future impacts of climate change will be in the Gwich'in Settlement Area (GSA) and particularly around Tsiigehtchic.

Anticipated Landscape Level Changes for Tsiigehtchic

Stewart Cohen wrote in a 1997 paper on climate change and the Arctic that the Mackenzie Valley and its people will likely experience climate warming through changes in weather, stream flow, water levels, ice and snow cover, permafrost, plant growth, wildlife patterns, fire, pests, and diseases (Cohen, S. 1997). These anticipated changes have not changed much today. In this plan the impacts that were identified by the community have been organized based on six themes. Many of them overlap to a certain degree, for example more volatile weather will affect the forest fire regime. The impacts noted below are largely resulting from the December 8-9th workshop in Tsiigehtchic. The six landscape level changes are:

- Seasonal and Weather Changes
- Changes to the Flooding Regime
- Changes to Forest Fire Regime
- Changes to Wildlife
- Permafrost Degradation
- Water Quality

Seasonal and Weather Changes

It is anticipated that changes in weather and climate currently noted by the Gwich'in people will continue or become more extreme in future years. Longer summer seasons, shorter and warmer winters, more precipitation (particularly in the fall) among other changes will affect many factors of life in the community. These include more difficult and dangerous travel on the land, and changing hunting and trapping seasons. It is anticipated that there will be more storms that affect buildings (such as the windstorm that broke the Tsiigehtchic sign and blew the roof off a house). Warmer summers may cause health impacts to seniors, and require air conditioning to reduce heat stress. Positive benefits include reduced money spent on heating houses, and the potential for improved agriculture.

Changes in Flooding Regime

Climate scientists foresee considerable changes in the Mackenzie River. In the last fourty years the average season for the Fort Providence Ice bridge has been reduced by thirty days (Bastedo, 2006). A longer open water season, and shorter ice season will affect transportation infrastructure of ferries and ice roads. The Department of Transportation is already adapting with innovative ice road building techniques (such as flooding and spraying).

Scientists predict more annual flow in the Mackenzie, with greater flows in early summer and lower flows in the fall (Arora, V., 2007). There will also likely be greater seasonal variability that could create low water levels for transport in the fall. There is the potential that this could affect ferry service to the community.

Spring floods have been smaller and less spectacular in the past ten years, and that is likely to continue, although flooding is still a distinct risk in Tsiigehtchic. Local observations indicate that the Arctic Red River used to break up before the Mackenzie, which has been reversed in the past ten years. This could be a result of more rapid warming in northern areas than in the south that is changing the balance of break-up. This trend tends to reduce the seriousness of ice jams at the confluence, and reduces flooding potential.

Changes to Forest Fire Regime

Forest fires are a natural part of the Boreal Forest ecosystem. Forest fires have been decreasing in number in the NWT and the Gwich'in Settlement Area in the past ten years due to timely rains and more cloud cover. There is a possibility that this may increase the potential for major fire years, as were seen in the late 1990's, as forests are more mature and there is more fuel available.

In general, foresters are unsure about what to expect in the future and caution is still recommended to protect against forest fires. Continued precautions such as the new 2009 firebreak, and ensuring there is a solid evacuation plan in place (as part of the Emergency Response Plan) are essential to mitigate the risk.

Changes to Wildlife Species and Populations

Although hard to attribute to climate change alone, there are many changes occurring among wildlife populations. Gwich'in harvesters have noted new species of birds, fish, insects and mammals that were never seen in the Mackenzie Valley before (Arctic Borderlands, 2009). Some species are increasing their range and population size such as moose, and some fur bearers. Others are decreasing in population such as the caribou. It is impossible to say for certain what the reasons for these changes are, but most agree there are links to climate change. It will be important for the Gwich'in to document these changes and work with scientists and resource managers to adapt to changing wildlife populations.

Permafrost Degradation

Permafrost degradation is the largest immediate cause for concern in Tsiigehtchic. The community faces the possibility of significant infrastructure damage should permafrost degradation become more severe. A large slump on the banks of the Arctic Red River, the cracking of the bank that the church and cemetery sit upon, widespread landslides along the river valley and foundation issues under houses and buildings have the potential to cost the community millions of dollars (Hoeve, T.E., 2006)

Trends show that permafrost is melting throughout the Arctic, and Tsiigehtchic is in an area scientists believe is most at risk of short-term permafrost melt (Palmer, M. 2010). However, little is known about the permafrost underlying the community. More research is needed to map and monitor permafrost and preventative measures are needed to reduce the potential for damage or catastrophic bank failure on the hill the church sits on.

Water Quality Changes

With numerous rivers, lakes and the mighty Mackenzie River flowing through the area, the GSA has some of the best quality water in the world. Although there are concerns about how climate change will affect that water. Permafrost melt has been shown to affect lakes in the delta (Palmer, M. 2010), and landslides on riverbanks may have an impact on water quality in the Arctic Red and Mackenzie Rivers.

To date, the water quality is still excellent, but concerns exist about industrial development upstream. Most notably the Alberta Oil Sands, mining operations, the planned Mackenzie Gas Pipeline, and older exploration sumps that all have the potential to negatively affect water quality in the GSA. Continued rigorous monitoring of these potential hazards will be required to maintain the excellent water quality that has always been plentiful in the Gwich'in Settlement Area.

IMPACTS OF CLIMATE CHANGE FOR GWICHYA GWICH'IN:

The workshop participants stressed the need to maintain a connection with the land and the ability to live a traditional lifestyle in Tsiigehtchic. Many community members have fishing camps and hunt caribou and other game for food, and as an essential component of their culture. The wage economy and social changes have provided alternatives to a traditional lifestyle and reduced people's dependence on the land, but country foods and their harvesting are still a critical part of the diet and culture of Gwichya Gwich'in.

The Gwich'in find themselves in a prolonged state of change from a traditional culture dependent on the land to a more modern culture with satellite communications and broader economic opportunities. A settled land claim, greater opportunities for education, transportation, and development, and improved infrastructure, along with a wage-based economy is changing the amount of time people are able to spend on the land.

These factors change the ability of the Gwich'in people to adapt to climate change. In many ways it creates a more resilient society able to adapt to changes on the land by using modern equipment (ie. GPS, internet), but it also has created challenges by affecting cultural values (ie. sharing the harvest, family values) which helped generations of Gwich'in to thrive and build a unique culture in a difficult, and variable environment.

It is difficult to attribute social change to any particular factor, but it is undeniable that climate change is affecting the ability of the Gwich'in to travel safely on the land, and harvest traditional foods and medicines, resulting in food security issues. It is likely that climate change will have a greater impact on the non-wage (traditional) economy, than the wage economy (Cohen, S. 1997). The vision developed by the Local Advisory Committee stresses the importance of self-sufficiency and culture to Tsiigehtchic and therefore, impacts affecting important cultural values (in particular traditional harvesting) were given high priority during the planning process.

RISK ASSESSMENT METHODOLOGY:

This adaptation plan is loosely based on the work of the Northern Climate Exchange in the Yukon Territory, who have been actively working on adaptation plans in Dawson City, Whitehorse, Mayo and Atlin (NCE. 2010). The Dawson City planning process was used as the basis for Tsiigehtchic adaptation planning with some notable changes.

Tsiigehtchic is considerably smaller, with a different economy, a largely aboriginal population with closer ties to the land and a shorter time frame to complete the planning process, which meant that the Tsiigehtchic adaptation plan needed to be somewhat streamlined.

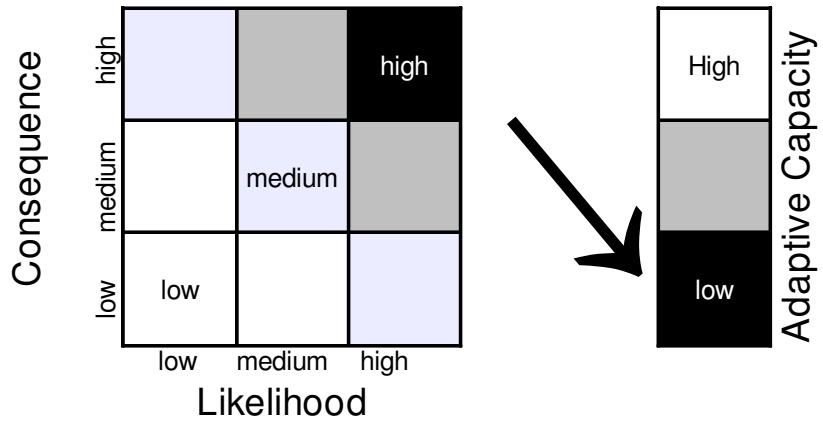
Impacts of Climate Change were initially developed during the December 8-9 workshop in Tsiigehtchic. Concerns were broken down into four sectors: The Land, The People, The Economy and Infrastructure. The Local Advisory Committee worked through an exercise to identify the impacts and potential solutions to the community in each of these quadrants. The results are summarized in the Workshop Report in Appendix A.

The impacts and potential solutions were run through a risk assessment exercise by the project team, estimating the consequence, likelihood and the adaptive capacity of the community for each impact. A simple low, medium and high rating was given to each level of risk. Each of these levels of risk can be summarized as:

Consequence – Seriousness of the impact
Likelihood – What are the chances of it happening by 2050
Adaptive Capacity – Can Tsiigehtchic do anything to adapt to this impact.

The assessment of the adaptive capacity was evaluated based on: the familiarity of the impact, the resources available within the community with which to respond to the impact, the motivation of residents to respond to the impact, and the level of education/skills required to effectively respond to the impact. High priority risks are characterized by high consequence, high likelihood and low adaptive capacity (Northern Climate Exchange, 2009).

HIGH PRIORITY = high consequence + high likelihood + low adaptive capacity



The results of this analysis were taken to the Technical Advisory Committee to be screened for gaps and errors. The resulting impacts were assigned a lead partner whom it is assumed would be the best group to deal with these impacts and the resultant solutions. Four spreadsheets (below) outline the results of the risk assessment (the full results were not shown due to space constraints). The results of the assessment show that the high priority impacts are similar to the stated priorities of the Local Advisory Committee, with the addition of forest fires, and omission of drainage issues.

Local Advisory Committee Priorities:

- Church Hill erosion
- Permafrost degradation and building and house foundations
- Town roads, flooding and drainage concerns
- Remove contaminants from community
- Caribou concerns
- Preserving the river
- Assessing fuel tanks
- Pellet stoves and alternative energies

High Priority Impacts (from risk assessment):

- Potential slumping of Church Hill and Cemetery
- Damage to community building foundations caused by permafrost degradation
- Foundation shifting and rotting pilings in housing
- Decline in caribou numbers
- Increase in landslides along Mackenzie River
- Potential of forest fires

CHARTS OUTLINING RESULTS OF WORKSHOP:

CLIMATE CHANGE IMPACTS AND SOLUTIONS ON 'THE LAND'

AREA of CONCERN	CLIMATE CHANGE IMPACT	PRIORITY	LEAD PARTNER	SUGGESTED ADAPTATIONS
Water	Lakes draining (for example Ghost Lake below town has needed some engineering)	Low	INAC	Better monitoring of lakes, and documenting of traditional knowledge
Vegetation	Spruce pine beetles	Low	ENR forestry	Monitoring, forestry resource assessment
	Invasive plants (ie thistles)	Low	ENR	Education – photos and awareness especially in schools
Caribou	Decline in caribou numbers	High	ENR / GRRB	Allow only community hunt and more sharing
				Gwich'in Renewable Resource Council should monitor hunting
				Hunting quotas for all
				Better monitoring of caribou numbers
	Change of caribou migration routes			More communication between hunters
	Caribou have greater risk of flash floods			
	Caribou at greater risk of falling through ice			
	Less food for caribou			
	More snow = harder travel			
Fish	Loche liver diseases	Medium	GRRB	Demand feedback from scientists studying fish
				More monitoring
	More open water in winter leading to difficult and dangerous travel	Medium	Band / Individuals	More communication and education of dangerous areas and safe travel
River	Some streams are drying up others are appearing where there previously wasn't a stream	Low	ENR	trapping of beavers (they cause some stream problems)
	Shorter winter travelling season	Low / Medium	DOT / Individuals	
	Ground seeping surrounding Ghost Lake	Low	Band	Trench to connect river was dug which helped
	Early spring break-up and late freeze up of River	Low / Medium	DOT / Individuals	
	Adding granular material to ferry landings decreasing depth of fishing eddy		DOT / DFO and Band	Better communication with DOT and DFO
				Ferry landing study
	Lower River water levels	Medium	DOT / INAC /	Mapping of sandbars (already being done but could have better communication with people)
	Low water affects potential of in-stream electrical turbine	Low	ENR / ITI / NTPC	More work needs to be done to determine potential of instream hydroelectricity production
	Many more landslides along river	High	INAC	Monitoring of slides, more study and sharing of results (slides mapped in ISR)
	More natural runoff of sulphur	Low	INAC	Study to determine the cause of this
Other Animals	More variable crops of mosquitoes, bees and berries (connection?)	Low / Medium	Band / Individuals	Better monitoring
				Harvest and storage of berries in good year
	New bird species (magpies, woodpeckers)	Low	INAC	Better monitoring
				Cumulative Impact Monitoring Program (CIMP) monitoring station in Tsiigehtchic

CLIMATE CHANGE IMPACTS AND SOLUTIONS ON 'THE ECONOMY'

AREA of CONCERN	CLIMATE CHANGE IMPACT	PRIORITY	LEAD PARTNER	SUGGESTED ADAPTATIONS
Oil and Gas	Equipment can bring in invasive plant life			Wash and/or quarantine equipment
	Oil and Gas sumps could melt	Medium	INAC / GTC / Industry	All sumps should be mapped
				GTC should monitor these sumps
	Concern about pipeline running through permafrost rich areas	Low	INAC / MGP	Pipeline should be running through safer ground like in the mountains
	Seismic lines crisscrossing GSA will cause permafrost melting and erosion	Low / Medium	INAC	
Forestry	New and more pests	Low	ENR Forestry	
	Forest fires are fewer now, but unsure about future risk	Medium / High	ENR Forestry / MACA	Prescribed burns near communities
				Fire breaks
				Revisit Emergency Response Plan
Trapping	Long-term there will be less demand for furs	Low	ITI	Promote arts and crafts and traditional foods
	Harder to get out on the land in the winter	Low / Medium	ITI / Band	Develop a public bulletin system to promote safe travel
Agriculture				Local resources must be managed by locals
Mining	Tailing ponds upstream could damage water quality	Low	INAC	
Fishery	Crooked back whitefish changing breeding season	Low	DFO, Fishermen	Listen to Fishermen / better communication
				Monitoring of fish breeding times

CLIMATE CHANGE IMPACTS AND SOLUTIONS ON 'INFRASTRUCTURE'

AREA of CONCERN	CLIMATE CHANGE IMPACT	PRIORITY	LEAD PARTNER	SUGGESTED ADAPTATIONS
Ice Roads	Shorter winter road season	Low / Medium	DOT / Transport Canada	Better ferry for ice breaking
				Pier to improve ferry landing
Roads / Highways	Municipal drainage issues, resulting in flooding, road erosion	Medium / High	Band	Develop a municipal drainage plan
				Bigger culverts
Community Buildings	Damage to foundations caused by permafrost degradation – shifting, erosion, rotting pilings	High	MACA, PWS, Band	Better foundations on new buildings
				More research on building design and skirting
				community permafrost mapping
	Potential Catastrophic slumping of Church Hill and Cemetary	High	Band	Revegetate slope (willows or grasses)
				fencing to keep of snowmobiles
				Move church and houses
				More research on remediation options (ie wood chip insulation)
				Engineering study to determine remediation options and costs
	Stronger winds	Low / Medium	Band / Housing Corp	Build new buildings to withstand high wind loads
	Detecting more earthquake tremors			
	Greater snow loads	Medium	Band / Housing Corp / Individuals	Clean off rooves
				New house design (ie octagonal houses – stronger)
Houses	Potential issue of fuel leak from rigid tank connections breaking when building shifts	Medium	Band / Housing Corp / Individuals	More burning of wood
				Inventory of tanks – bring to attention of Housing Corp
	Permafrost and foundation shifting and rotting of pilings	High	Band / Housing Corp / Individuals	Community work parties to repair foundations
				Permafrost foundation assessment by experts
	Water overflow accumulating under houses and rotting pilings in the summer (caused by poor drainage / overflow of water tanks /permafrost melt)	Medium	Band / Housing Corp / Individuals	Overflow lights for houses
				Drainage study
				Study of proper skirting techniques
				Positive drainage to remove ponding water
	Detecting more earthquake tremors			
	Ice and water flooding in Georgetown (area opposite Arctic Red River beside the Dempster highway)	Medium	DOT	Work with DOT to fix the problem. Assumed to be incorrectly installed culverts, perhaps shifted by permafrost.
Sewage and Drinking Water	Reduced water levels in Tso Lake (water lake)	Low	Band	Trap beavers

CLIMATE CHANGE IMPACTS AND SOLUTIONS ON 'THE PEOPLE'

AREA of CONCERN	CLIMATE CHANGE IMPACT	PRIORITY	LEAD PARTNER	SUGGESTED ADAPTATIONS
Human Health	More mould in houses (with more precipitation)	Medium	Housing Corp	Monitoring /education, use of exhaust fans and better house design
	More allergies	Low	HSS	Medication
	More diseases	Medium	HSS	Traditional medicine
	More air pollution	Low	HSS	
	More stress	Low	HSS	Healthy lifestyles
	More cancer?	Medium	HSS	
	Skin rashes	Low	HSS	
Contaminants	Airborne pollutants from down south			Contaminant monitoring
	Contaminants in permafrost might be released	Medium	INAC / Researchers	More study and sharing of findings with communities
Water quality	Tar sands polluting Mackenzie River system			GTC should lobby for clean water
	Water isn't as clear as in the past	Low	Band / GRRB	Remove beavers to keep water flowing
	More beaver fever	Low	Individuals	
	Pollution on River system			Clean up garbage
				Regular water testing
Safe Travel on the Land	Less snow on the land early season	Low		
	Harder to travel on the land in Winter	Low / Medium	Individuals	Education – Listen to elders
	Cannot predict weather as well	Medium	Individuals	Safe snowmobiling lessons in school
				More community gatherings (to pass on information)

OPPORTUNITIES:

Although much is made about the adverse affects of climate change on the North, there are likely to be considerable positive impacts as well. With warmer temperatures comes a decrease in the costs of heating homes in the winter, a longer summer will increase the growing season for plants and trees (creating opportunities for a forest industry and greater self-sufficiency). As part of an Adaptation Plan the Community must look at the potential opportunities and try to encourage activities that take advantage of opportunities. It is as hard to predict the opportunities as it is the impacts, but the Local Advisory Committee was asked to develop a list of opportunities that might occur given the chosen climate scenario. The results may not be exhaustive but are shown in the table below.

CLIMATE CHANGE OPPORTUNITIES

CLIMATE CHANGE IMPACT	Affected by Climate Factor	POTENTIAL OPPORTUNITY
More willows and faster willow growth	Weather	Willows provide food for moose and birds for country food
		Potential for biomass harvesting
Longer growing season taller faster growing trees	Weather	Potential for greater biomass or wood production industry
Invasive Species	Weather	Potential for new food source (ie. Whitetail deer)
More Moose, Bear, Martins and Pickerel	Weather	Greater harvesting opportunities for these species
More opportunities for Ecotourism	Weather	Promote arts and crafts and traditional foods to tourists driving up in summer
Longer growing season for vegetables	Weather	Community garden and cold storage
Shorter winter heating season	Weather	Reduce the high cost of living

RECOMMENDED ADAPTATIONS:

The most important part of any plan is ensuring its implementation. This plan has a set of recommendations that range from extremely easy to very difficult to implement, some will cost nothing, while others will have a substantial cost associated with them. The recommendations are not prioritized, but are organized by theme. No effort was made to place these recommendations in the order that they should be implemented, as that will require the input of the Community and Climate Change Coordinator.

In order to ensure that the community successfully adapts to climate change a healthy well-balanced community is critically important. The following four recommendations are directed at building the adaptive capacity of the Community by strengthening healthy relations within Tsiigehtchic and with the land:

1. Work within the community to develop community resilience by promoting;
   - traditional values; and
   - community ties and social networks / relations.

2. Encourage elders to work with youth to pass on traditional knowledge including;
   - harvesting skills; and
   - safe travel on the land.

3. Promote the role of the Gwich'in Renewable Resources Board through;
   - Education and monitoring of caribou numbers; and
   - Encouraging and educating people about good hunting practices.

4. Encourage more healthy lifestyles and eating habits for community members.

Continuing diligence regarding preparing for climate change is essential in future years. Tsiigehtchic will be in a better position if it is able to be proactive in response to climate change. Therefore, the community should work towards meeting these recommendations:

5. Mainstream climate change issues and adaptation into other planning processes and community development activities.

6. Train Tsiigehtchic community staff on the basics of climate change.

7. Maintain the Local Advisory Committee for three more years with quarterly meetings to help guide adaptation implementation activities.

8. Hire a part-time Climate Change Coordinator to direct the implementation phase of this project.

9. Link to a sister community such as Mayo (Yukon) or Fort McPherson that is at a similar stage in the adaptation planning process. Have a liaison member from that community on the adaptation committee.

10. Document and publicize successes and failures on the community website.

11. Revisit this adaptation plan in 2015, and maintain it as a living plan.

Community planning issues that will help ensure the community is ready for emergencies or to reduce the likelihood of emergencies is critical. To improve the resilience of the community the Tsiigehtchic Band office should:

12. Develop a public bulletin system and use radio station to promote safe travel and highlight dangerous areas.

13. Revisit the Tsiigehtchic Emergency Response Plan taking into account climate change and new projections for extreme weather events and forest fires.

14. Develop a drainage plan (as per Tsiigehtchic Land Use Plan) to deal with drainage issues taking into consideration future climate change predictions.

Housing issues:

15. Work with Housing Corporation to monitor and prevent mould in houses.

16. Inventory and replace rigid fuel line connections with flexible connections in all heating oil tanks.

17. Inventory water tank overflow lights and install or repair lights on all buildings.

Transportation Issues:

18. Work with Department of Transportation (DOT) to ensure fuel is stored safely at the helipad.

19. Work with DOT on a ferry landing study.

Permafrost Issues:

20. Fence off snowmobile access to Church Hill to reduce vegetation loss (ensure the use of fencing that doesn't encourage snow build up).

21. Develop a desktop level Community Permafrost Map. Use it to inform future land-use and development.

22. Work with INAC to establish a permafrost monitoring station in the community of Tsiigehtchic. If possible use the data to monitor permafrost changes in Vik'ooyendik (Church Hill).

23. Further study of permafrost maintenance, skirting and drainage issues regarding foundations of houses and community buildings (with an emphasis on preventative maintenance).

24. Arrange a permafrost and housing foundation assessment with permafrost experts in the community.

25. Commission an engineering study of options for Cemetery and Church Hill remediation or stabilization.

Monitoring was repeatedly brought up as crucial to developing baseline data and determining changes. There needs to be a concerted effort to increase monitoring and reporting of changes in the Gwich'in Settlement Area:

26. Engage Indian and Northern Affairs Canada (INAC) officials about the potential to locate a Cumulative Impact Monitoring Program (CIMP) site in the community of Tsiigehtchic. http://www.nwtcimp.ca/

27. Encourage the Gwich'in Tribal Council (GTC) and INAC to map and monitor landslides in the GSA.

28. Develop linkages with scientists, Department of Fisheries and Oceans and local harvesters to monitor breeding times, invasive species, population trends and water quality. Ensure this information is available broadly.

29. Develop closer links with Aurora Research Institute to bring scientific study results back to the community.

30. Work with GTC and INAC on an industrial sump management plan in the Gwich'in Settlement Area, to ensure sumps are not polluting waters.

Although outside the scope of this adaptation plan, the other side of the climate change issue is mitigation (essentially, the reduction of fossil fuel use). There was considerable interest in the community about mitigation issues in particular as it may lead to reducing the cost of living. The community is developing a Community Energy Plan that will address mitigation and the high cost of living. But several recommendations are made to get started towards this work:

31. Develop closer ties with Arctic Energy Alliance.

32. Work with Environment and Natural Resources Forestry Management Division to complete a forest resource assessment for Tsiigehtchic.

33. Investigate the potential of using willows and forests as a biomass fuel source.

34. Investigate using wood pellets and in-stream hydro as options to reduce dependence on fossil fuels.

MAINSTREAMING CLIMATE CHANGE ADAPTATION:

The Government of the Northwest Territories has shifted the burden of decision making onto the shoulders of Community leaders with the 'New Deal'. This is an exciting step for autonomy, but comes with a steep learning curve and a rigorous schedule for implementation. Tsiigehtchic must complete its Integrated Community Sustainability Plan (ICSP) by March 31, 2010 as well as maintain and develop planning documents such as the Land Use Plan and Capital Plan.

These planning documents are intended to help guide the community to make decisions on the future. When looking at the future one must take into account the effects that climate change will have on the Community. Therefore, the most significant recommendation from this report is to ensure that climate change is recognized in every major planning decision that is made by the Band and Community Councils (#5 Mainstream climate change into other planning processes and community development activities). Ties should be made with the Land Use Plan, Capital Plan, Strategic Plan, Community Energy Plan, and other planning documents. When making decisions regarding future funding, building, and resource allocation it is crucial that decision-makers ask the question: **How will climate change impacts affect this issue?**

NEXT STEPS:

The Draft Climate Change Adaptation Plan was be presented to the community of Tsiigehtchic on February 23rd and 24th 2010. Copies of this final draft will be sent for review by the funders, the community, the Gwich'in Social and Cultural Institute, the Gwich'in Renewable Resources Council, Technical Advisory Council and other interested parties.

Each of these institutions will have the opportunity to comment on the draft plan by the end of March, 2010. The plan will be renewed and finalized in the new fiscal year, by the project team under direction of the Community of Tsiigehtchic. The project team will work with our funders to provide an extension of funding to finalize the report and implement the recommendations.

The Community Councils will be provided with a final copy of the Adaptation Plan in the late spring of 2010. To move forward with the recommended actions from the plan it will be important for Council to pass a motion to accept the plan in order to move forward with implementation. Once this motion has been passed, the community can begin implementing the plan with the support of the Territorial and Federal governments.

Tsiigehtchic is in an enviable position in that it is one of the first communities in the NWT with an adaptation plan, and thus it will be well positioned to access available federal funding for recommended adaptations.

LITERATURE CITED:

ACIA. 2004. Impacts of a Warming Arctic. Arctic Climate Impacts Assessment. Cambridge University Press: Cambridge, UK.

Arctic Borderlands Society. Arctic Borderlands Ecological Knowledge Co-op Community Reports 2007-2008. 2009.

Arora, V. 2007. Potential impact of climate change on Mackenzie River basin hydrology. Conference paper presented at the CWRA BC Branch 2001 Conference – Changing Water Environments: Research and Practice, Whistler Canada, May 2001. http://www.cccma.ec.gc.ca/papers/varora/cwra_bc_conference_paper_2001.pdf

Bastedo, J. 2006. Standing Up To Climate Change. Ecology North.

Canadian Climate Change Scenarios Network: Ensemble Scenarios for Canada 2009. http://www.cccsn.ca/ensemblescenarios/ensembles-e.html

Cohen, S. What If and So What in Northwest Canada: Could Climate Change Make a Difference to the Future of the Mackenzie Basin?, Arctic, Vol. 50, No. 4 (December, 1997) P. 293– 307.

Environment and Natural Resources. 2010. Climate Observations in the Northwest Territories.

Gwich'in Social and Cultural Institute. 2007. Nomination Form for Territorial Historic Sites Vik'ooyendik (Church Hill) Tsiigehtchic.

Hoeve, T.E., Zhou, Fuqun and Aining Zhang. 10-12 May 2006. "Potential Cost Impacts for Adaptation of Building Foundations in the Northwest Territories", *EIC Climate Change Technology, 2006 IEEE*. 1-9.

Johnson, Robert. 2007. Slope Stability Investigation for Vik'ooyendik (Church Hill), Gwich'in Social and Cultural Institute.

Northern Climate Exchange. Dawson Community Adaptation Project Community Climate Change Adaptation Plan – Draft 2, 19 October 2009.

Palmer, M. Personal correspondence, January 2010.

Appendix A - Workshop Report

WORKSHOP REPORT
December 8-9, 2009

Overview:

Doug Ritchie and Craig Scott traveled to Tsiigehtchic on Monday December 7th, 2009 to deliver a workshop on Climate Change Adaptation. Ecology North's Community Coordinator Itai Katz coordinated the logistics of the workshop and the invitation of participants. We'd like to thank Itai and his wife Alistine Andre for providing outstanding hospitality during our stay. The workshop was held on December 8th and 9th at the Aurora College building in Tsiigehtchic. Workshop participants provided many excellent insights and comments during the two days, and good information was provided for the adaptation plan. An open house meeting was held on the evening of December 9th to provide information to interested community members and gain further input. The coordinators were pleased with the results of the workshop and open house. Doug and Craig returned to Yellowknife, via Inuvik on Thursday December 10th, 2009.

List of Workshop Participants:

Peter Ross (Tuesday only)

Maureen Clark
Sonny Blake (Tuesday only)
Ruby Lennie
Charlotte Moore
Archie Norbert (Wednesday only)
Itai Katz

Ken Redman's Senior Class (Tuesday morning)
Chivan Blake
Jacob Gordland
Robert McLeod
Jake Andre-Stewart
Diron Andre-Stewart
Silvia Norman

Tsiigehtchic Climate Change Adaptation Workshop

December 8 – 9, 2009

Tsiigehtchic, NWT

Agenda:

December 8, 2009

9:30 am	Coffee Served
10:00 am	Opening Prayer
10:10 am	Climate Change Introduction
10:30 am	Vision and Objectives Exercise
11:00 am	Community Tour
12:00 pm	Lunch (provided)
1:00 pm	Tsiigehtchic Strengths and Weaknesses
2:00 pm	Impacts and Opportunities of Climate Change Exercise
3:00 pm	Health Break
3:15 pm	Impacts and Opportunities of Climate Change Exercise (cont)
5:00 pm	End of meeting

December 9, 2009

9:30 am	Coffee Served
10:00 am	Opening Prayer
10:10 am	Risk Assessment Exercise
11:00 am	Health Break
11:15 am	Prioritization of Key Impacts
12:30 pm	Lunch (provided)
1:15 pm	Opportunities Highlighted
1:30 pm	Solutions to Key Impacts
3:00 pm	Health Break
3:15 pm	Solutions to Key Impacts (cont)
5:00 pm	End of Workshop

Evening Public Session December 9, 2009

6:30 pm to 9:00 pm	Public Meeting
	All welcome snacks, tea and coffee will be provided

December 8th, 2009

An ambitious agenda was developed (see above) which was mostly adhered too. Certain activities were rearranged, one activity was not completed (risk assessment), but an additional one was added (film viewing). The room was set up with one large square desk configuration to promote discussion, chalkboards, a large activity interactive poster (see photo #4) was used for the impacts and solutions exercise, as were global climate model maps of the Western Arctic showing temperature and precipitation projections in 2050 using two climate scenarios produced by Environment Canada (See climate summary attached). Twenty photos from the NWT Prince of Wales Museum Archive of Tsiigehtchic people, scenes, and activities from the 1930's to 1980 were displayed to prompt discussion.

The meeting started with an opening prayer from Peter Ross and an introductory slide show on Climate Change by Doug Ritchie and a presentation of climate change models and what the climate may be like in 2050 in Tsiigehtchic by Craig Scott (from Environment Canada ensemble report) . This was followed by a discussion of the communities strengths and weaknesses.

Strengths	Weaknesses
Arts and Crafts	Pollution from south down Mackenzie
Lots of wood and willows	Fuel to costly
Can feed ourselves (country foods)	We use too much fuel
Diversity of food (moose, fish, caribou)	Too much garbage
Mackenzie River and all weather highway	
Can grow vegetables (good soil)	
Excellent water quality	

Craig than followed this up with a visioning exercise (see handout attached), in which a draft community vision was developed:

> **"Our community of Tsiigehtchic will be a resilient, self-sufficient community which celebrates and practices its culture and promotes renewable economic development within our traditional lands."**

Lunch was provided by a local women and was much enjoyed

The afternoon the group, along with four students did a community tour to stimulate thought and discuss ways community is and may be affected by Climate Change. The community 14 passenger van took us to the sewage lagoon, the landfill, tank farm, water lake, helipad, several houses with different foundation types, the store to look at a fuel oil tank and the church hill. This proved a valuable exercise for both coordinators and the participants. From this we noted strengths (well organized landfill, and sewage lagoon, new water infill and tank

farm, good examples of skirting and foundations). As well as, concerns (poor skirting on houses, pilings rotting, lack of flex hoses on oil tanks, and erosion on church hill from snowmobiles).

Photo 2: Church Hill during community tour

Photo 3: Doug discussing fuel oil tank issues

After the community tour the participants returned to the hall to discuss the impacts of climate change on the community. This was done with a large felt board that was split into 4 quadrants, People, Land, Economy and Infrastructure (see photo 4). Within each quadrant were potential areas of concern. Several more were added at the start of the exercise. Participants were than facilitated by Craig through the exercise to write potential impacts on small yellow velcro backed triangles which were placed around each area of concern. This exercise took the rest of the day and part of the next morning.

<u>December 9th, 2009</u>

The day began with a moment of silence. Peter Ross was not able to return but was replaced by Archie Norbert, and the school group was not present. The impact exercise continued until we were satisfied we had come up with a good representation of impacts. At this point we had a discussion of opportunities which may be present in a variety of impact areas in particular the economy quadrant. A risk assessment exercise was started after the break, in which two groups were formed and each impact was rated on a scale of 1 to 5 based on three categories Likelihood of it happening, Seriousness, and Communities Adaptive Capacity.

This exercise was going quite well until lunch when several participants had appointments, and we lost one other to work. Therefore, after lunch we watched the film “Teetlit Gwichin Climate Change” from the Gwichin Renewable Resources Board, 2006, with our one remaining

participant. This film outlined changes noticed by elders in the nearby community of Fort McPherson, and was quite relevant to changes occurring in Tsiigehtchic. After this meeting a discussion of solutions was started and we decided we would not have time to finish the risk assessment exercise (due to time constraints). This was replaced at the end by a discussion of priorities. Two members who had appointments returned and we had an excellent discussion of solutions which took up most of the rest of the afternoon. Solutions were written on the green triangles so they could be directly related to individual impacts (see photo 5). Results of this exercise can be seen in the charts below entitled Results of the Impacts and Solutions Exercise.

Photo 4: Impacts and Solutions Exercise

Photo 5: Impacts and Solutions for Community Buildings

The final activity of the workshop was a discussion of prioritizing the impacts on the community (which will replace the risk assessment exercise for the community):

<u>Priorities:</u>

Church Hill erosion
Permafrost degradation and building and house foundations
Town roads, flooding and drainage concerns
Remove contaminants from community
Caribou concerns
Preserving the river
Assessing fuel tanks
Pellet stoves and alternative energies

Evening Open House:

In the evening of Wednesday December 9th, we moved our exercise poster, Tsiigehtchic adaptation poster, climate change scenario maps, and photos to the School Gym. Desert and coffee were provided. We did not expect a large group, and were happy to have eleven community members show up, five youth (who may have come for the pie), three participants from the workshop (Ruby, Archie and Charlotte), and Alistine Andre, Itai Katz, and Daniel Andre.

Doug presented the climate change slide show, followed by a short presentation on climate scenarios for Tsiigehtchic. An overview of the impacts, opportunities and solutions developed by the workshop was given by Craig. A lively discussion of climate change, mitigation and adaptation, Copenhagen and Canada's role, and impacts and potential solutions for Tsiigehtchic followed for over an hour.

Photo 6: Doug presenting climate change slideshow at Open House

Photo 7: Participant looking at climate change scenario maps

One interesting point of discussion was that of making sure traditional roles were given a monetary value (ie. fishing is viewed as a free resource, while food from store costs money, yet fishermen are losing skills and abilities why should they share their fish around when wage earners don't share their wages).

Another interesting discussion revolved around youth education and creating a youth summer camp. Many potential barriers exist around this but it was agreed that it would be good for the community.

RESULTS OF THE IMPACTS AND SOLUTIONS EXERCISE

	AREA of CONCERN		IMPACT		SOLUTION
The Land	Water	LW1	Lakes draining	LW1a	better monitoring
	Vegetation	LV1	Spruce pine beetles		
		LV2	Faster willow growth		
		LV3	Invasive plants (ie thistles)	LV3a	Education – photos and awareness especially in schools
	Caribou	LC1	Decline in caribou numbers	LC1a	Only on community hunt and more sharing
				LC1b	Renewable Resource Council should monitor hunting
				LC1c	Hunting quota's for all
				LC1d	Better monitoring of numbers
		LC2	Change of caribou migration routes	LC2a	More communication between hunters
		LC3	Caribou have greater risk of flash floods		
		LC4	Caribou at greater risk of falling through ice		
		LC5	Less food for caribou		
		LC6	More snow = harder travel		
	Fish	LF1	New species		
		LF2	Loche liver diseases	LF2a	demand feedback from scientists studying fish
	River	LR1	More open water		
		LR2	Dried out new streams springing up	LR2a	trapping of beavers (they cause some stream problems)
		LR3	Shorter travelling season		
		LR4	Ground seeping surrounding Ghost Lake	LT4a	Trench to connect river was dug which helped
		LR5	Early spring break-up and late freeze up		
		LR6	Adding granular material to ferry landings decreasing depth of fishing eddy		
		LR7	Lower water levels	LR7a	Mapping of sandbars (although already being done)
		LR8	Low water affects potential of in-stream electrical turbine		
		LR9	Many more landslides along river		
		LR10	More natural runoff of sulphur		
	Other Animals	LO1	Martins in town		
		LO2	Fewer mosquitos, bees and berries (connection?)		
		LO3	New bird species (magpies, woodpeckers)	LO3a	better monitoring and reporting
		LO4	More moose		
		LO5	More bears (all species)		

RESULTS OF THE IMPACTS AND SOLUTIONS EXERCISE

	AREA of CONCERN		IMPACT		SOLUTION
Infrastructure	Ice Roads	II1	Could be no ice left in 50 years	II1a	better ferry for ice breaking
				II1b	Pier to improve ferry landing
	Roads/Highways	IR1	Improper planning for municipal drainage	IR1a	better planning
		IR2	Road Erosion		
		IR3	Too small culverts	IR3a	Bigger culverts
	Community Buildings	IB1	Soil erosion caused by permafrost degradation	IB1a	Better foundations on new buildings
				IB1b	More research on building skirting
		IB2	Stronger winds		
		IB3	Detecting more earthquake tremors		
		IB4	Greater snow loads	IB4a	Clean off rooves
				IB4b	New house design (ie octagonal houses – stronger)
		IB5	Erosion on church hill	IB5a	Revegetate slope
				IB5b	fencing to keep of snowmobiles
				IB5c	Move church and houses
				IB5d	More research on options (ie wood chip insulation)
	Houses	IH1	Potential issue of fuel leak from rigid tank connections	IH1a	More burning of wood
				IH1b	Inventory of tanks – bring to attention of Housing Corp
		IH2	Permafrost and foundation shifting and rotting of pilings	IH2a	Community work parties to repair foundations
		IH3	Water overflow accumulating under houses and rotting	IH3a	Overflow lights for houses
	Sewage and Drinking Water	IS1	Reduced water levels in Tso Lake (water lake)	IS1a	Trap beavers
	Helicopter Pad	IP1	Improper fuel storage by heliport (upstream of water lake)		
Economy	Oil and Gas	EO1	Equipment can bring in new plant life	EO1a	Wash and/or quarantine equipment
		EO2	Oil and Gas sumps could melt	EO2a	All sumps should be mapped
				EO2b	GTC should monitor these sumps
		EO3	Concern about pipeline running through permafrost rich	EO3a	Pipeline should be running through safer ground like in the mount
		EO4	Seismic lines crisscrossing GSA		

RESULTS OF THE IMPACTS AND SOLUTIONS EXERCISE

	AREA of CONCERN		IMPACT		SOLUTION
	Forestry	EF1	Longer growing season taller faster growing trees		
		EF2	New and more pests		
		EF3	More willows		
		EF4	Forest fires less now, but unsure about future	EF4a	Prescribed burns near communities
				EF4b	Fire breaks
	Tourism	ETO1	More opportunities for ecotourism	ETO1a	Promote arts and crafts and traditional foods
	Trapping	ET1	Long-term there will be less demand for furs	ET1a	Local resources must be managed by locals
	Agriculture	EA1	Longer growing season	EA1a	Community garden and cold storage
		EA2	More rain		
	Mining	EM1	Tailing ponds upstream could damage water quality		
	Fishery	EFI1	More pickerel		
		EFI2	New species	EFI2a	Listen to fishermen
		EFI3	Crooked back whitefish changing breeding season	EFI3a	Monitoring of fish breeding times
People	Human Health	PH1	More mould in houses (with more precipitation)		
		PH2	More allergies	PH2a	medication
		PH3	More diseases	PH3a	Traditional medicine
		PH4	More air pollution		
		PH5	More stress	PH5a	Healthgy lifestyles
		PH6	More cancer?		
		PH7	Skin rashes		
	Contaminants	PC1	Airborne pollutants from down south	PC1a	Contaminant monitoring
		PC2	Contaminants in permafrost might be released		
	Water quality	PW1	Tar sands polluting Mackenzie River system	PW1a	GTC should lobby for clean water
		PW2	Water isn't as clear as in the past	PW2a	Remove beavers to keep water flowing
		PW3	More beaver fever		
		PW4	Pollution on River system	PW4a	Clean up garbage
				PW4b	Regular water testing

RESULTS OF THE IMPACTS AND SOLUTIONS EXERCISE

AREA of CONCERN		IMPACT		SOLUTION
Safe Travel on the Land	PS1	Less snow on the land		
	PS2	Harder to travel on the land	PS2a	Education – Listen to elders
			PS2b	Safe snowmobiling lessons in school
			PS2c	More community gatherings (to pass on information)
Country Foods	PCF1	Less bees		
	PCF2	Berries unpredictable	PCF2a	Freeze more when they are good
		Potential Opportunities		

Additional Comments from Workshop Participants:

THE LAND:

The sun is coming up earlier and staying longer in winter.

Getting darker in summer

In august as a child needed a flashlight to go to a dance, now it is still bright, we are seeing more sun.

Oil drums on the land are a concern. One company put some on bend in the river, a local man told them they are below high water mark, company didn't agree and next year they were washed away. Another story told of a man who found a crushed drum on shore washed down, still full, used it for heating his cabin. Oil drums kept at heliport, near and upstream of water lake might be a concern.

Oil sumps, the community members know where they are, perhaps there should be better monitoring of these. What would happen if they started melting.

Water levels are getting lower on the rivers.

There is a huge steel deposit up the Arctic Red, what would happen if it were developed
We need a better understanding of the fishery.

There are many more landslides up the river (this was brought up many times)

Travaillant Lake is an important food and historical area, that is losing its value because it is not being used anymore.

Mackenzie seems well-balanced, still many whitefish and other fish, more pickerel, and now there are more sockeye and reports of steelhead, and chinook salmon.

Breeding times of fish are changing. Some people are taking time off to fish and missing the run, and going fishless.
Crooked backs normally spawn in October now are a week later or more.

Concern that some of the fishing lakes are getting overpopulated because they aren't being harvested

Flooding is not as big a problem these days. Big flood in 1947, haven't had a good flood in ten years.

The Arctic Red used to break-up before the Mackenzie, in the last 10 years the Mackenzie breaks up earlier (this likely has reduced flood risk to community).

Break-up is later in general and not as violent as in the past (especially on the Arctic Red), used to line up to watch now it isn't much of a spectacle

Ghost Lake (lake on flats below town) was draining underground on north side. They had to dig a trench to river on northwest to reduce seepage

New species observations (not all in Tsiigehtchic):

- small robin sized black bird with red and yellow patch
- magpies
- turkey vulture in Ft McPherson
- polar bear
- grizzly bears
- coyote tracks in the mountains nearby
- more furbearing animals
- blue heron
- woodpeckers
- thistles

Caribou concerns:

- Must be better monitored
- There is too much killing, people shouldn't be feeding their dogs with caribou
- Not as much sharing as in the past
- Need quotas and better monitoring of who and how many are being shot
- poor hunting practices

PEOPLE:

“Those days (60's and 70's) we were living, now we are just maintaining” Archie Norbert

Education of youth is key concern – must teach Gwichin history and culture and build pride in youth

In the old days people used to dig trenches around their homes to divert spring runoff, no one does this now.

We are the lungs of this world

We can still live off the land here

We want to promote tradition. Every house should have a smokehouse for fish, there should be more sewing classes

Gardening, elder used to grow huge cabbages, would like a food workshop, need a root cellar those skills are lost

Ice safety, need education about safe travel on ice (especially for kids)

We are concerned about water and would like to recycle our waste water.

Waterborne diseases, isn't an issue now, but may be in the future

Wood pollution is a concern

INFRASTRUCTURE:

There has not been a problem with ice build-up on hydro lines

The ground near the bank in the cemetery is easier to dig than the ground further back from the bank

The part of the church further from the edge of the hill is in better shape than that closer to hill edge

More wind, a roof flew off a house a few years ago. It broke the 4x4's holding the Tsiigehtchic sign in half.

Tso Lake (water source) has best water in the delta. New infill plant. Concerns that it is more tea coloured than in the past. Too many beavers in system, and less muskrats. They don't snowmobile on lake, recently told plane that used to land there not to land there anymore. Houses on pilings are having more problems than those on blocks or other

The Ferry landing is a concern, they keep adding more gravel and it is making the fishing eddy below shallower. Perhaps a better system for docking or a better ferry (current one is a retrofitted barge) would help.

ECONOMY:

Would like to trade ideas and resources with other communities

Willows are growing much faster and everywhere. We can use them for energy.

Want to use biomass, wood pellet stoves

In-stream turbine to produce power, the river is swift and deep here.

VISION:

Long-term view how the community wants to see itself in the future.

A GOOD Vision should be:

- Clear
- Vivid
- Describe a bright future
- Realistic aspiration
- Memorable
- Aligned with culture and values

Example:

Dawson City and its hinterlands will be a self sustaining society, a community that lives within the limits of the local ecosystem and serves as a haven for its residents in an uncertain world.

It will achieve this by:
taking steps to increase its resilience,
actively promoting self sufficiency,
increasing our knowledge of the environment around us, and
developing ways to adapt to sudden changes in society and the climate.

Climate in Tsiigehtchic in 2050

The Mackenzie Valley is one of the world's hotspots of climate change. The climate is expected to change rapidly within the next 50 years. The main differences will be increases in temperature and precipitation and more unpredictable weather events.

Environment Canada has compiled information from global climate models to predict climate change throughout Canada by the 2050's. The maps show two possible climate change scenarios:

Medium scenario (with bigger squares) – in which the world starts to make progress towards reducing carbon dioxide

High scenario (with more squares)– in which not much progress is made and the climate changes rapidly

What will Tsiigehtchic be like in 2050?

Temperature: Both scenarios show warmer annual temperatures of between 3 and 4 ºC. Winters will be much warmer, by 4 to 6 ºC, Autumn will be 3 to 4ºC warmer, while spring and summer the change will be a more moderate 1.5 to 3 ºC.

Precipitation: The experts predict that Tsiigehtchic will get wetter by 12 to 20% annually. Most of this will come as snow in the fall and winter, with predictions of up to 40% more snow. But there will be more precipitation throughout the year. This likely means more cloud cover as well.

Storms: Throughout the world there will be more extreme weather events like floods, droughts, strong winds, and storms. With the warmer and wetter temperatures there will likely be more thunderstorms in the Mackenzie Valley as well.