

**APPENDIX 6-A
GALORE CREEK METEOROLOGY, AIR QUALITY AND NOISE
BASELINE STUDIES REPORT**



Galore Creek Meteorology, Air Quality and Noise Baseline Studies Report



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EXECUTIVE SUMMARY



Executive Summary

Environmental baseline studies for meteorology were started in July 2004 with installation of four automated meteorological stations in the Project area to support future project planning and for environmental impact assessment. Two additional automated meteorological stations were added in June 2005. Four snow courses were monitored between February and May 2005 to determine snowpack and snow-water-equivalent. During summer 2005 baseline sampling for noise and ambient air quality (*i.e.*, fine particulate – PM10 and PM2.5) was conducted. This report presents the Galore Creek Project environmental baseline data that has been collected for meteorology, air quality and noise.

The Galore Creek valley is located in a remote, mountainous region of north-western British Columbia. The property is within the Stikine River drainage basin which empties into the Pacific Ocean near Wrangell, Alaska. The climate of the Stikine basin is primarily influenced by the Pacific Ocean to the west and continental Arctic regions to the northeast. Hence, the Galore Creek valley is in a transition zone between wet coastal and dry/cold interior climate zones. The orographic influence of the mountain ranges on the Pacific and the continental air masses results in precipitation and air temperatures that are extremely variable over the Project area.

The meteorology in the Galore Creek Valley is characterized by cool summers and cold, humid and wet winters, with several months of snow cover. The mean daily summer temperatures may be above 20°C and mean daily winter temperatures may fall well below -25°C. Semi-permanent air temperature inversions occur during winter when the air temperature in the higher slopes can be 5 to 15°C warmer than the valley. Average annual precipitation for the Galore Creek site is estimated to be 2,240 mm with approximately 65% of this volume falling as snow between November and April. Maximum precipitation occurs in the fall and winter due to frequent development of Pacific storms. A maximum snowpack of approximately 3.8 m was recorded in the upper Galore Creek valley and the snow-water-equivalent was roughly 1,300 mm.

Strong winds occur in all seasons at high elevations, with flow from the north-east through south-east in cold months and south through west flow at other times. Winds at low elevations are funneled through the valleys with a light to moderate down-valley flow of Arctic air during cold months and a light up-valley flow of Pacific air at other times. Calm winds (*i.e.*, less than one meter per second) were frequent in the Galore Creek valley occurring 60% of the time. The extreme wind gusts recorded at the drainage divide between West More and Sphaler Creeks were approximately 23 m/s (81 km/hr).

Solar and net radiation is monitored at the automated stations in the East Fork of Galore Creek, West More Creek and More Creek valleys. Generally there is an energy deficit during winter months (October through March) and an energy surplus during summer months (April through September). Visibility recorded in the Porcupine River valley was greater than 15 km for 85% of the time. There was a distinct diurnal trend for the visibility data – the lowest average visibility values are recorded during the early morning with the values gradually improving through the middle of the day reaching their maximum values in the late afternoon.

Executive Summary

During July 2005 twenty nine samples of ambient air were collected and analyzed for baseline concentrations of fine particulate (PM10 or PM2.5). The overall average baseline concentrations for PM10 ($3.4 \mu\text{g}/\text{m}^3$) and PM2.5 ($1.3 \mu\text{g}/\text{m}^3$) were in the range expected for uninhabited areas.

Noise sampling was conducted during July 2005 at several locations within the Project area. A baseline average noise level of 38 dBA was determined to be representative of the Project area with no contributions from anthropogenic sources including mineral exploration activities.

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1. DESCRIPTION OF STUDY COMPONENTS AND METHODS

1. Description of Study Components and Methods

1.1 Introduction

Meteorological, air quality and noise baseline studies were conducted during 2004 and 2005 in the Galore Creek project area for both future project planning and for environmental impact assessment. Meteorological data were collected from the project area using both automated stations and manual equipment. Baseline ambient air quality (*i.e.*, fine particulate) and noise studies were conducted during July 2005. Below is a summary of the methods that were used for the baseline meteorology, air quality and noise studies. The results from the 2004 and 2005 field seasons for meteorology, air quality and noise are summarized in Chapter 2.

1.2 Methods

The methods used for the Galore Creek Project baseline studies for meteorology, air quality and noise are presented below.

1.2.1 Meteorology

On-site meteorological data are required for a variety of purposes. Wind speed and direction data are usually required to select sites for permanent camp and mineral processing facilities in order to accommodate predominant wind patterns and mitigate the effects of fugitive dust. Wind and air temperature data are required for air dispersion modelling that would likely be conducted during the environmental impact assessment to determine the Project's potential air quality effects. Solar radiation and precipitation data are required for design of any water reservoir(s) and water balance calculations. Precipitation data will also be important for documenting the meteorological conditions that are associated with potential avalanche conditions. Meteorological data was collected using a variety of automated and manual methods. The bulk of the meteorology data was collected from automated stations to allow for a more comprehensive data set.

1.2.1.1 Automated Meteorology Stations

A total of four automated meteorological stations were installed and commissioned for the Galore Creek Project as part of the 2004 baseline program. Two stations were added in June 2005. The location of these stations is summarized below and shown in Figure 1-1.

1. **East Fork of Galore Creek:** A meteorological station was installed on July 9th 2004 within the East Fork of the Galore Creek watershed near the area where potential infrastructure will be positioned (*e.g.*, conveyors, crushing plant(s), potential tailings management area, *etc.*).
2. **West More Creek:** A second station was installed on July 11th 2004 within the upper reaches of the West More Creek watershed. The West More Creek watershed holds the potential for placement of some components of Project infrastructure such as a tailings management area, a processing plant and a road access corridor.

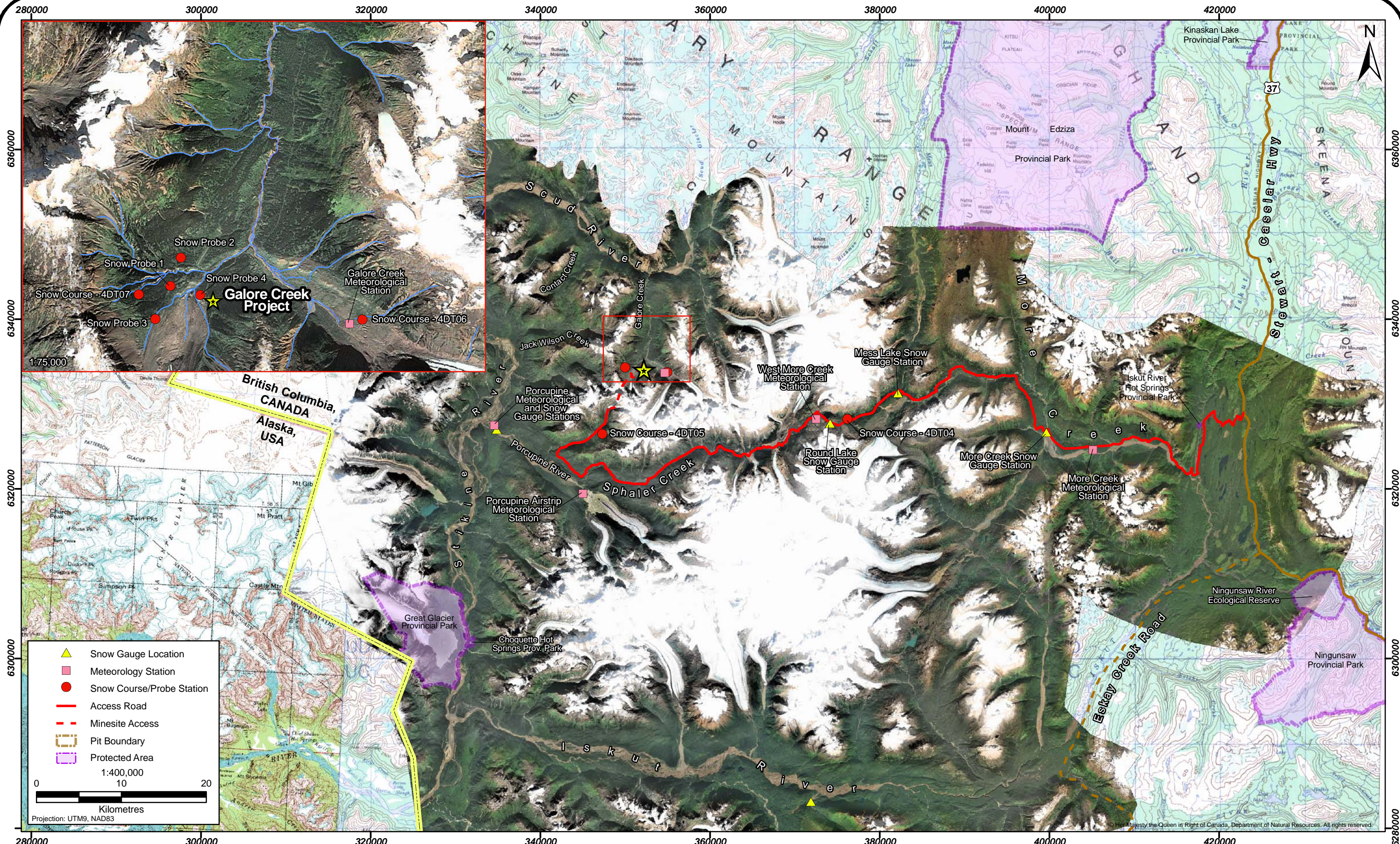
Description of Study Components and Methods

3. **Potential Porcupine River Crossing:** The third station was installed on August 14th 2004 near the potential future access road crossing of the Porcupine River. Data from this station will be required to assess potential road impacts on air quality and to support detailed engineering.
4. **Potential Iskut River Crossing:** The fourth station was installed on August 17th 2004 at Bronson Creek fish camp near the potential road crossing on the Iskut River west of Bronson Creek. Similarly to the third station, data from this installation was to be used to assess potential road impacts on air quality and also support detailed engineering. However, this station was essentially phased out in June 2005 when the modified northern access route was selected over the southern access route. This station was removed in October 2005 and moved to a different site.
5. **Potential Porcupine Airstrip:** The fifth station was installed on June 22nd 2005 near the potential future Porcupine Airstrip near the junction of the Porcupine River and Sphaeler Creek. Data from this station will be required by the engineering and feasibility studies associated with development of the Porcupine gravel airstrip that will be used during project construction and operation.
6. **More Creek:** The sixth station was installed on June 24th 2005 near the modified northern road access route. The station is located near More Creek between “three valley junction” and the More Creek Canyon where More Creek joins the Iskut River. Data from this station will be required to assess potential road impacts and to support detailed engineering.

In order to ensure the stations collect representative data the sensors were located according to guidelines set by Environment Canada (*i.e.*, Meteorological Services of Canada (MSC) Guidelines for Co-operative Climatological Autostations, MSC 2004). Environment Canada has adopted, and wherever possible, follows standards set by the World Meteorological Organization (WMO). The Environment Canada guidelines were established to promote standardization and describe practices, procedures and specifications for proper siting of instruments, precision and accuracy of measurements and archive formats.

The five meteorological stations were programmed according to the standard set by the MSC. Automatically logged meteorological data included:

1. Two minute wind speed, wind direction and standard deviation of wind direction;
2. Hourly average wind speed, wind direction and standard deviation of wind direction;
3. Hourly average air temperature;
4. Hourly average relative humidity;
5. Total precipitation for the last hour;
6. Hourly average global solar radiation (site facilities stations only);
7. Hourly average snow depth;
8. Hourly average net radiation (site facilities stations only);
9. Hourly average barometric pressure (Porcupine Airstrip station only); and
10. Hourly average visibility (Porcupine River and Porcupine Airstrip stations only).



Galore Project - Location of Automated Meteorological Stations, Snow Depth Monitoring Stations and Snow Probing Sites

Description of Study Components and Methods

Each day at midnight, the following data was also automatically recorded:

1. Daily maximum and minimum air temperature;
2. Daily maximum wind speed, wind direction at maximum speed and time;
3. Total daily precipitation; and
4. Diagnostic information.

A continuous record of these data is being maintained at the Rescan office for use in both environmental impact assessment and engineering feasibility studies.

The primary concerns when selecting an appropriate location for each of the meteorological stations was to avoid obstructions (*e.g.*, future infrastructure, trees, *etc.*) that would bias the wind speeds and directions, and to avoid shaded areas that would bias solar radiation data as well as limit full exposure of the solar power panel to the sunlight. The wind sensors were, where possible, located over open and level terrain, at a distance of at least ten times the height of any nearby building, tree or other obstruction. Sensors were protected from thermal radiation, and adequately ventilated. Because these stations are located in remote regions and unattended for long periods of time, consideration was also given to accessibility.

Generally, sites on flat land with few obstructions will yield representative data. In forested, mountainous, undeveloped areas, such as Galore Creek, moderately sheltered sites that meet the minimum distances from obstructions were selected because they would yield data that are representative of that particular region.

Table 1-1 summarizes the data collected at the five automated meteorological stations.

It should be noted that only the Galore Creek (East Fork), West More Creek and More Creek stations included sensors for solar radiation and net radiation. These variables were not required for the fourth and fifth stations installed near the potential road crossing at Porcupine River and the proposed Porcupine Airstrip. The West More Creek meteorological station installed in July 2004 is shown in Plate 1-1.

The sensors were mounted on a 10 m high tower that was rock-anchored at its base and strengthened with guy wires as necessary. Ten metre towers are the standard for collection of wind speed and wind direction data when the data will be used for air dispersion modelling. A certified wind sensor was mounted at the top of the tower to provide data for future air dispersion modelling. Wind speed is measured in metres per second (m/s) and wind direction in degrees from true north by a RM Young Model 05305 Air Quality wind sensor. The meteorological stations at Galore Creek (East Fork) and West More Creek were installed in areas of exposed bedrock. The stations at Porcupine River, Porcupine Airstrip and More Creek were anchored using concrete bases dug into the glacial till.

Description of Study Components and Methods

**Table 1-1
List of Galore Creek Meteorological Stations and Parameters**

Station name	Date Established	Temperature & Relative Humidity	Wind Speed & Direction	Snow Depth via Ultrasonic Gauge	Precipitation - GEONOR gauge	Precipitation - Tipping Bucket Rain Gauge
Galore Creek (East Fork)	July 9, 2004	3	3	3	3	3
West More Creek	July 11, 2004	3	3	3	3	3
Porcupine River	August 14, 2004	3	3	3	3	3
Porcupine Airstrip	June 22, 2005	3	3	n/a	n/a	3
More Creek	June 24, 2005	3	3	3	n/a	3

Station name	Date Established	Visibility	Solar Radiation	Net Radiation	Atmospheric Pressure	Evaporation - Class A Pan
Galore Creek (East Fork)	July 9, 2004	n/a	3	3	n/a	3
West More Creek	July 11, 2004	n/a	3	3	n/a	n/a
Porcupine River	August 14, 2004	3	n/a	n/a	n/a	n/a
Porcupine Airstrip	June 22, 2005	3	n/a	n/a	3	n/a
More Creek	June 24, 2005	n/a	3	3	n/a	n/a

Notes:

n/a = this type of sensor was not installed at this particular meteorological station.

The temperature and relative humidity sensors are combined into one unit (Campbell Scientific Model HMP45C212). The combination sensor was mounted on the tower protected from direct radiation by a multi-plate solar radiation shield. Air temperature is measured in degrees Celsius and relative humidity in percent. The solar radiation sensor (*i.e.*, silicon pyranometer) and net radiometer were also mounted on the tower. Solar radiation is measured in units of kilowatts per square meter using a Kipp & Zonen SP LITE sensor. Net radiation is measured in units of watts per square meter using a Kipp & Zonen NR LITE sensor.

GEONOR Model T-200B all-season precipitation gauges are being used to measure rain and snow-water-equivalent (SWE) precipitation at each station. The GEONOR precipitation gauges are mounted on 2.5 m pedestals to ensure the collection orifice is always above the snow level. The GEONOR gauges are surrounded by Alter wind screens to increase the capture efficiency. Snow depths are monitored with a Campbell Scientific Model SR50 ultrasonic sensor that is mounted to the tower with a cross arm. The snow depth sensor was installed at least 0.5 m above the maximum expected snow depth. Tipping bucket rain gauges (Texas Electronics Model TE525M) were installed at all five meteorological stations during June and July 2005.

Visibility is monitored at the Porcupine River and Porcupine Airstrip stations using Sentry Model SVS1-E-2-P (analog output) visibility sensors manufactured by EnviroTech Sensors Inc. Barometric pressure is being monitored at the Porcupine Airstrip station using a RM Young Model 61205V barometric pressure sensor.

Description of Study Components and Methods



Plate 1-1 Meteorological station installed near West More Creek. The GEONOR precipitation gauge can be seen on the left.

The sensors for the autostation are connected to a Campbell Scientific CR10X datalogger that controls the operation of the station. The datalogger's program monitors the sensors every 5 seconds and generates hourly and daily averages. The hourly and daily averages are stored in a memory module connected to the CR10X datalogger. The modules are changed out on a regular basis and brought back to the office for downloading. The stations are powered with a 50 Watt solar panel and a 12 volt 93 Amp-hr deep cycle marine battery, with the entire station grounded to prevent lightning from damaging the electronics.

A maintenance program is required for each of the meteorological stations. When necessary, the sensors will be returned to the supplier for calibration because specialized equipment is required for the calibration procedures.

A station logbook was initiated for each station and included notes regarding the equipment service/calibration record and any changes or problems that arise. For future maintenance, a CR10X datalogger wiring diagram was stored in the enclosure box at each meteorological station.

Manual meteorological monitoring instruments (*i.e.*, max/min thermometer, manual rain gauge and a sling psychrometer to monitor relative humidity) are used to provide verification of the data collected by the automated stations. These manual instruments were installed in a wooden enclosure box at the Galore exploration camp on July 14, 2004 and monitored daily until the

Description of Study Components and Methods

camp closed on October 17, 2004. During the 2005 mineral exploration season the manual instruments were monitored daily from June 4th to October 25th. The staff member making manual observations at the camp was given appropriate training and a set of instructions and field data sheets.

The equipment required for the meteorological stations was purchased from a variety of suppliers. The equipment was brought to the staging area at the Bob Quinn airstrip where it was slung using a helicopter to the Project exploration camp. After final station locations had been selected, a helicopter was used to sling the equipment to the respective sites. Rock anchors were prepared for the towers and the helicopter was used to position the towers on their rock anchors. Meteorological sensors were installed on the towers and tested.

Table 1-2 lists the regional meteorological stations operated by Environment Canada or the United States Government. Figure 1-2 shows the location of the regional meteorological stations with respect to the Galore Creek Project. The only regional stations that are currently operating are Unuk River/Eskay Creek, Topley Landing and Wrangell, Alaska. The regional stations with a long period of record provide a good comparison for the data collected by the five Galore Creek project meteorological stations.

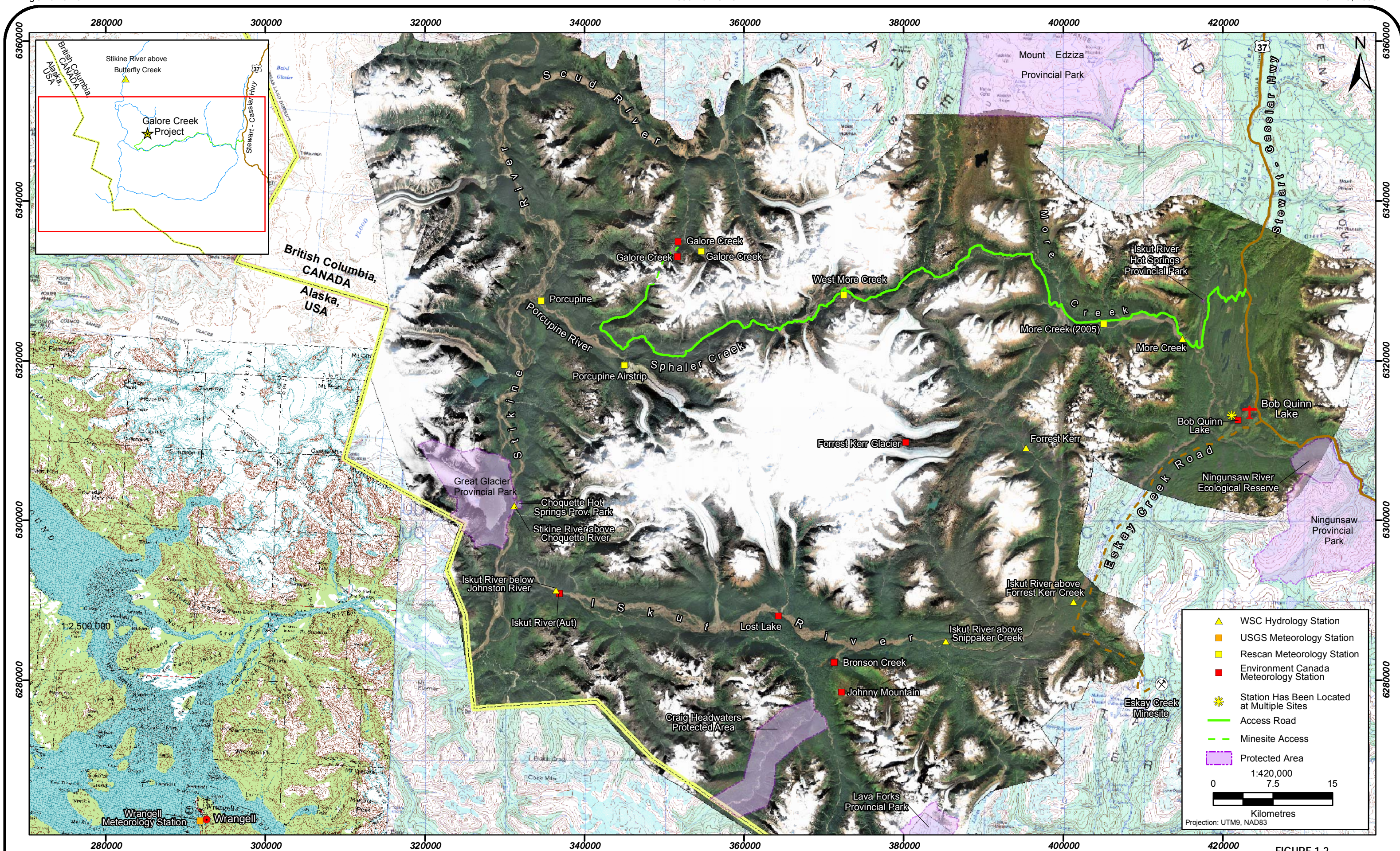
**Table 1-2
Summary of Meteorological Stations in the Galore Creek Region**

Station	Environment Canada Station Number	Station Location (with respect to Galore Creek)	Elevation (m)	Data Record Start	Data Record End
Bronson Creek	1201086	53.6 km south southeast	107	5/14/1989	9/1/1999
Galore Creek	1203046	2.0 km west	789	1/1/1966	11/1/1968
Iskut River (AUT)	120C6PK	44.5 km south southwest	15	8/28/1991	9/1/1994
Johnny Mountain	120CPNA	57.2 km south southeast	1075	4/1/1988	10/31/1988
Lost Lake	120DP19	46.4 km south southeast	90	6/10/1991	9/30/1991
Bob Quinn	1200R0A	72.0 km east southeast	600	9/1/1974	10/1/1974
Bob Quinn Lake	1200R0J	72.0 km east southeast	421	12/1/1977	1/1/1980
Brucejack Lake	1071092	104.8 km southeast	1372	7/1/1988	8/31/1990
Forrest Kerr Glacier	1072900	32.8 km southeast	1128	6/1/1979	9/30/1984
Unuk River Eskay Creek	1078L3D	79.6 km southeast	887	10/1/1989	present
Schaft Creek	1207126	36.0 km northeast	914	6/1/1969	10/1/1974
Topley Landing	1078209	420 km southeast	722	6/1/1962	present
Wrangell, Alaska ¹	509919	92.3 km southwest	13	1/1/1990	present

The Wrangell Airport meteorological station is operated by the Western Regional Climate Center, United States National Climate Data Center / NESDIS / NOAA.

1.2.1.2 Snow Courses

The baseline meteorology program also included snow surveys that were conducted during the winter of 2005. Snow surveys determine the depth and the water content of the snow pack and estimate the amount of runoff from the mountain watersheds.



Regional Hydrological and Meteorological Stations

FIGURE 1-2

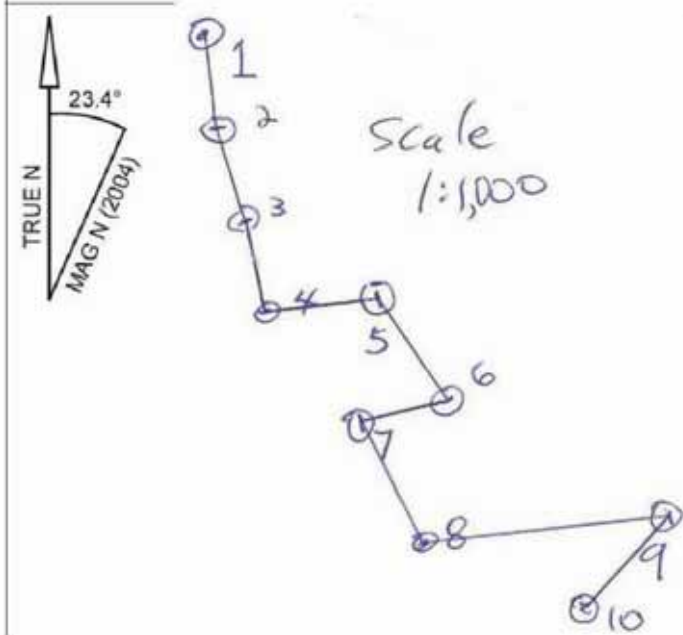
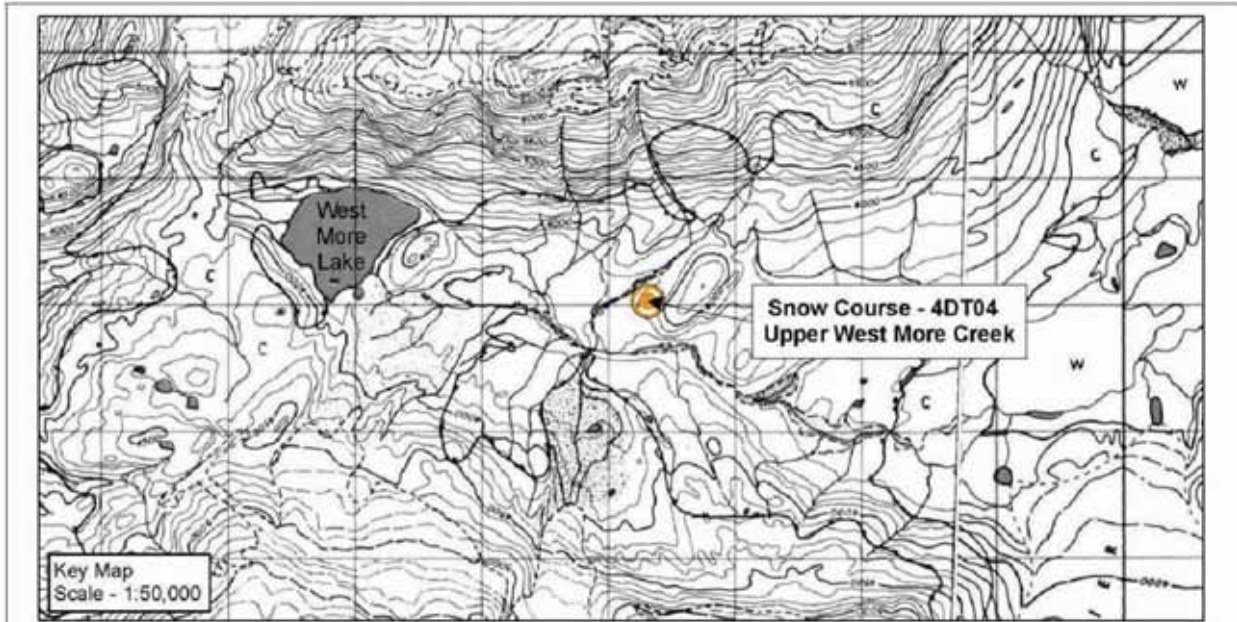
Description of Study Components and Methods

The surveys began in January 2005 and the efforts were focused within the Galore Creek valley and along the potential access corridors in support of both the environmental assessment as well as engineering design. The snow courses are summarized below.

1. **Galore meteorological station (station ID 4DT06):** A snow course was installed in the upper reaches of the Galore Creek (East Fork) watershed near the area where potential infrastructure will be positioned (e.g., potential fresh water dam, tailings management area, *etc.*).
2. **Porcupine River - Scotsimpson (station ID 4DT05):** A second snow course was installed in the upper reaches of the Scotsimpson Creek watershed. The modified northern access road will travel up the Scotsimpson Creek drainage before going into a 4 km tunnel and reappearing in the Galore Creek Valley.
3. **Upper Galore Creek (station ID 4DT07):** The third snow course was installed in the upper reaches of Galore Creek near the proposed open pits. Data from this station will be required to assess runoff and detailed engineering for the major facilities in the Galore Creek Valley (*i.e.*, open pits, tailings impoundment, process plant, accommodations and office facilities, truck shop and fuel station, *etc.*).
4. **Upper West More Creek (station ID 4DT04):** The fourth snow course was installed in the upper section of the West More Creek drainage roughly 2.2 km east of Round Lake. Data from this station will be used for detailed engineering and design studies for the modified northern access road.

Figures 1-3 to 1-6 show the location of the 10 sample points for the each of the four snow courses. The four snow courses were sampled four times during January to May 2005. The snow courses were installed using procedures in the British Columbia Ministry of Environment Procedure Manual for Snow Surveys (Volume 6 Section 9), December 1982. Standard snow sampling procedures were followed in accordance with the British Columbia Ministry of Environment (Water Management Branch, Surface Water Section) Snow Survey Sampling Guide (document no. SS13-81).

The standard snow sampling procedure is the one most often used to sample a snow course. Generally the snow courses are about 300 m long and are situated in small meadows protected from the wind. The snow core sampler consists of a strong, light-weight, graduated aluminum tube and a weighing scale. Snow depth is measured by pushing the tube down through the snowpack to the ground surface and extracting a core. To obtain an accurate snow core sample, the surveyor must verify that the tube has reached ground level by examining the base of the tube and finding soil. After clearing out the soil from the bottom end of the tube, the surveyor determines the amount of water in the snowpack by weighing the tube with its snow core and subtracting the weight of the empty tube. An average of all the ten samples taken is calculated and used to represent the snow course.



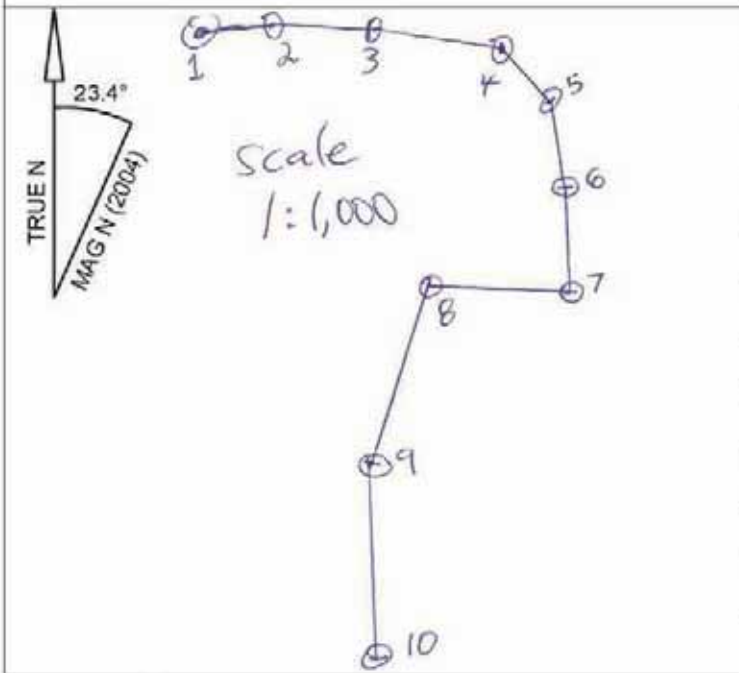
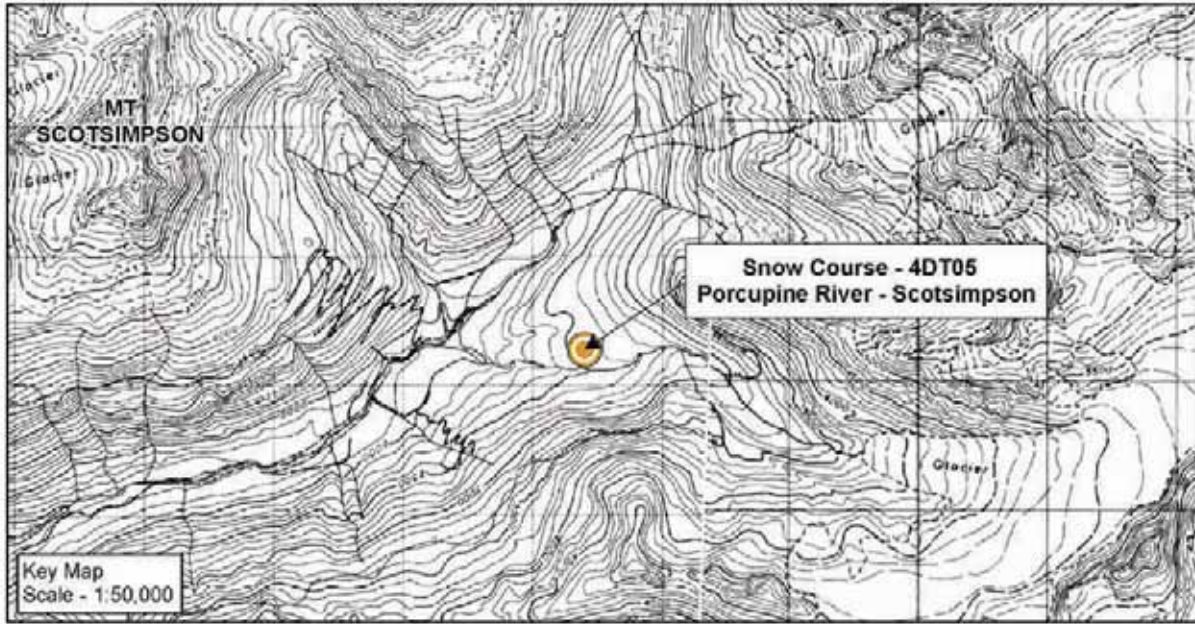
STN	DIST m	BRG MAG	REFERENCE POINTS		
			TREE		DIST m
			DIA cm	TYPE	
1	13.0	178°	300"	258°	5.7
					7.0
2	13.0	153°	80"	258°	5.3
					7.3
3	12.3	164°	40"	258°	4.1
					4.5
4	15.1	73°	240"	118°	7.1
					7.3
5	17.3	130°	102"	290°	7.9
					8.2
6	11.8	250°	22"	98°	9.8
					8.8
7	18.6	154°	244"	324°	6.2
					9.7
8	33.2	72°	198"	29°	8.7
					11.4
9	16.8	206°	248"	114°	7.1
					10.4
10			122"	228°	6.2
					5.7

ELEV.	1192 m	LAT.	57°4'9"	LONG.	131°2'8"
MAP No.	104G/03	MTN. RGE.			
DATE ESTD.	26-Jan-05	DATE ALTERED			
DRAINAGE	More Creek	BASIN			
REMARKS	UTM (NAD83, zone 9V) Easting 376177 Northing 6328248, all bearings magnetic				


Province of British Columbia
Ministry of Environment
 WATER MANAGEMENT BRANCH


Snow Course No. 4DT04
 Upper West More Creek

FIGURE 1-3



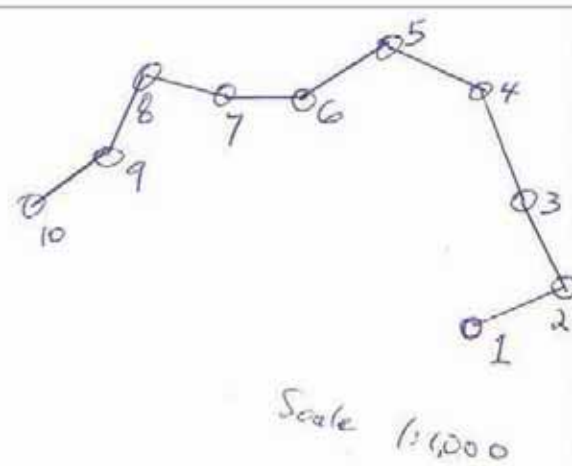
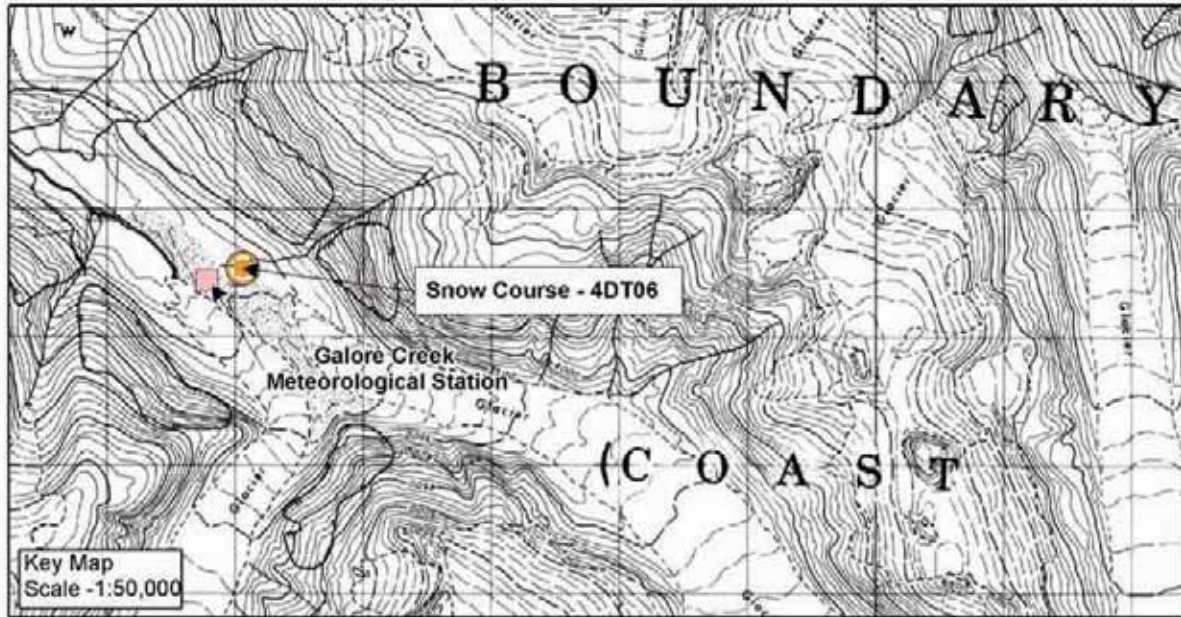
STN	DIST m	BRG MAG	REFERENCE POINTS			
			TREE		BRG MAG	DIST m
			DIA cm	TYPE		
1	10.5	84°			190° 28°	7.7 8.0
					310° 130°	10.2 5.0
3	19.0	115°			240° 16°	8.3 17.3
					"	"
4	10.4	142°			197°	7.5
					"	"
5	13.7	172°			248°	12.5
					"	"
6	15.9	180°			264°	9.9
					"	"
7	21.4	288°			205°	8.4
					"	"
8	28.6	208°			78° 240°	9.8 11.2
					"	"
9	29.5	180°			230°	7.3
					"	"
10					210°	8.3
					"	"

ELEV.	790 m	LAT.	57°34'	LONG.	131°31.1'
MAP No.	104G/04	MTN. RGE.			
DATE ESTD.	28-Jan-05	DATE ALTERED			
DRAINAGE	Porcupine	BASIN			
REMARKS	UTM (NAD83, zone 9V) Easting 347293 Northing 6326463, all bearings magnetic				


Province of British Columbia
Ministry of Environment
 WATER MANAGEMENT BRANCH

Snow Course No. 4DT05
 Porcupine River-Scotsimpson

FIGURE 1-4



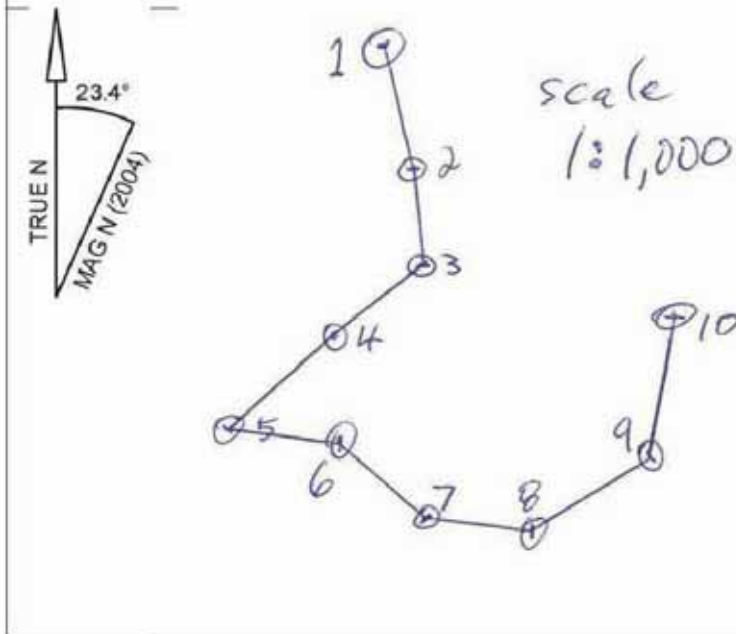
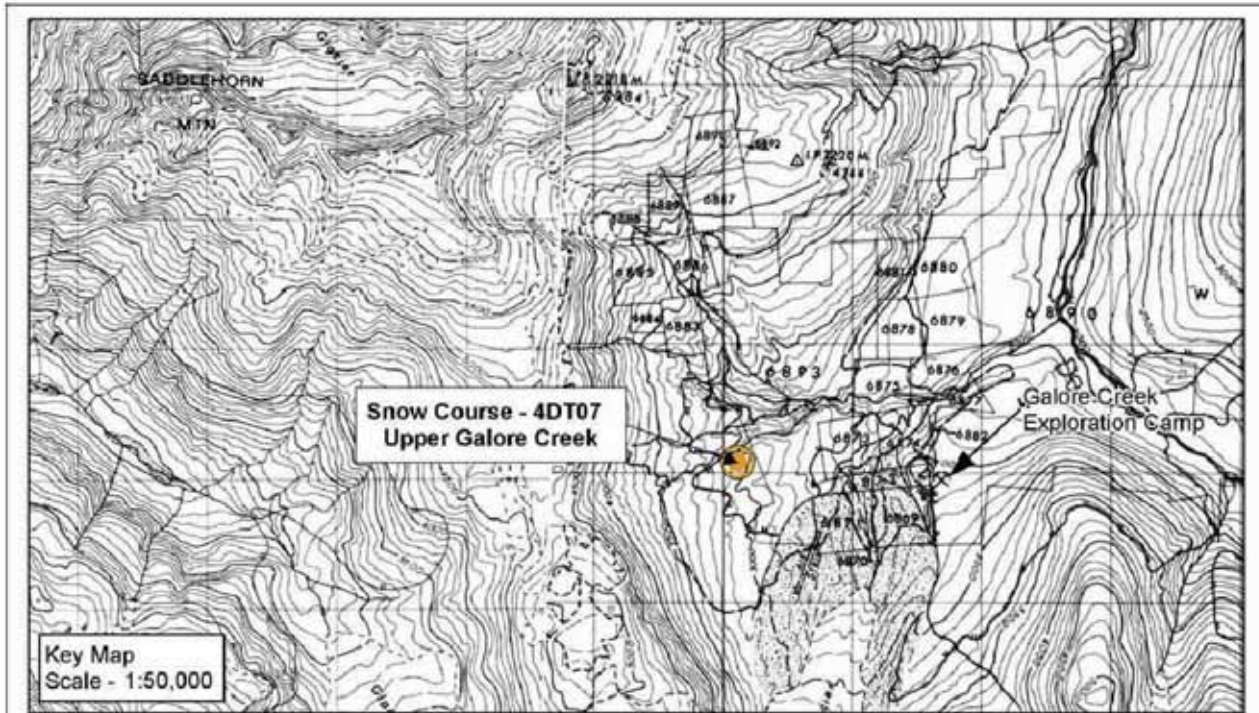
STN	DIST m	BRG MAG	REFERENCE POINTS			
			TREE		BRG MAG	DIST m
			DIA cm	TYPE		
1	15.9	44°			165°	11.8
2	15.7	317°			91°	10.4
3	19.6	321°			44°	5.9
4	17.0	283°			332°	5.1
5	18.4	225°			110°	6.9
6	12.9	251°			351°	11.8
7	13.7	273°			380°	8.0
8	14.7	196°			350°	5.9
9	15.3	215°			338°	8.0
10					196°	8.9

ELEV. 746 m LAT. 57°7.5' LONG. 131°23.8'
 MAP No. 104G/03 MTN. RGE. _____
 DATE ESTD. 29-Jan-05 DATE ALTERED _____
 DRAINAGE Galore Creek BASIN _____
 REMARKS UTM (NAD83, zone 0V) Easting 354027 Northing 6333776, all bearings magnetic

Province of British Columbia
Ministry of Environment
 WATER MANAGEMENT BRANCH


Snow Course No. 4DT06
 Galore Creek (East Fork) Meteorological Station

FIGURE 1-5



STN	DIST m	BRG MAG	REFERENCE POINTS			
			TREE DIA cm	TYPE	BRG MAG	DIST m
1	16.2	157°			260°	4.1
2	12.2	161°			226°	3.0
3	13.8	221°			256°	3.9
4	18.0	216°			167°	3.3
5	13.7	102°			100°	3.2
6	13.7	134°			268°	6.1
7	12.9	104°			78°	3.8
8	17.0	50°			320°	3.9
9	17.4	20°			197°	7.6
10					340°	13.7

ELEV.	952 m	LAT.	57°7.7'	LONG.	131°28.7'
MAP No.	104G103	MTN. RGE.			
DATE ESTD.	29-Jan-05	DATE ALTERED			
DRAINAGE	Galore Creek	BASIN			
REMARKS:	UTM (NAD83, zone 9V) Easting 349987 Northing 6334332, all bearings magnetic				


 Province of British Columbia
Ministry of Environment
 WATER MANAGEMENT BRANCH

Snow Course No. 4DT07
 Upper Galore Creek

FIGURE 1-6

Description of Study Components and Methods

Data collected from the snow courses includes snow depth and snow-water-equivalent precipitation based on 10 samples from each station. This data will be used for the prediction of runoff data for the design of diversion ditches and impoundment water balances. The snow surveys were conducted at the beginning of the month for February to May and the results were reported to the BC River Forecast Center (RFC) - the lead agency for the collection, quality control, analysis and archiving of snow data. The Galore snow course data are compared with regional data from British Columbia Ministry of Environment - Water Stewardship Division stations at; a) Tumeka Creek, b) Kinaskan Lake, and c) Telegraph Creek.

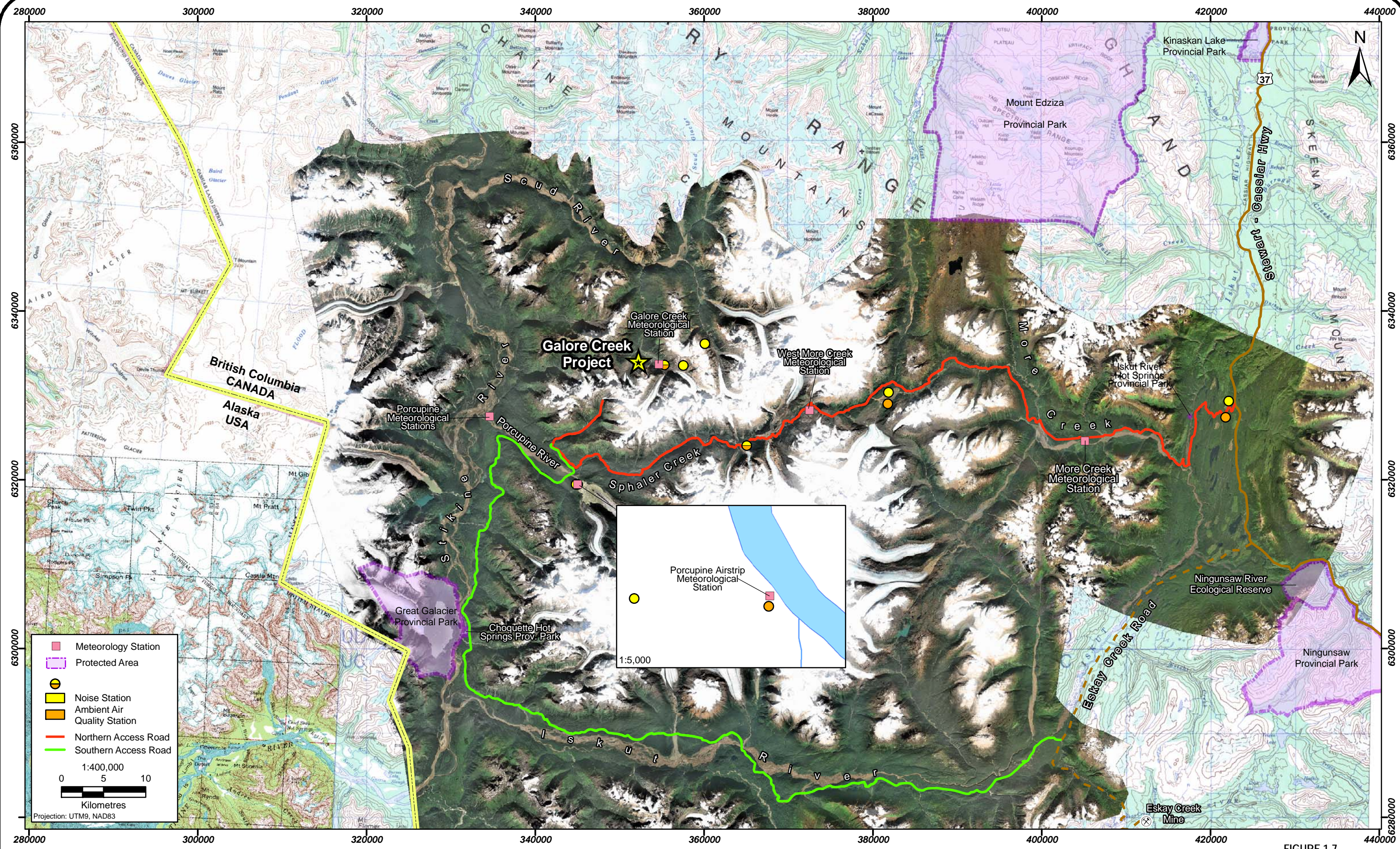
1.2.2 Air Quality (Fine Particulate)

Baseline ambient air quality sampling was conducted at the Galore Project site during summer 2005. The two air pollutants of greatest concern in British Columbia are particulate matter (PM) and ozone (O₃), because they are widespread and can have serious impacts on our health and the environment. Gaseous ambient air quality contaminants (*i.e.*, nitrogen oxides, sulphur oxides, ozone, *etc.*) are not usually a concern for baseline studies because there are currently no anthropogenic sources near the Galore Creek exploration site. Hence, literature values can be used to classify the baseline concentrations for these parameters.

PM includes dust, soot, and tiny bits of solid material. PM is classified according to its particle size, total suspended particulate (TSP) includes all PM less than 30 µm diameter, and fine particulate is less than 10 or 2.5 µm diameter (PM₁₀ and PM_{2.5}, respectively). PM would be generated during the future mining activities by traffic along unpaved roads, blasting in open pits, construction activities, *etc.* Baseline concentrations for TSP, PM₁₀ and PM_{2.5} were sampled during July 2005 since it is one of the driest month of the year (*i.e.*, historical records for Galore Creek indicate that June and July are the driest months). As shown in Figure 1-7, portable ambient air quality samplers were located; a) at the proposed concentrate filter plant and truck loadout facility near Highway 37, b) along the modified northern access road corridor near Mess Lake, c) along the modified northern access corridor near Sphaeler Creek, d) at the proposed Porcupine River Airstrip, and e) in the East Fork of Galore Creek.

Rupprecht & Patashnick Co. Partisol® Model 2000H samplers were used for the Galore baseline ambient air quality study. These low volume air samplers (sample rate = 16.7 litres per minute) were powered using portable gasoline generators. To prevent biasing the results by sampling the exhaust from the portable generator, a long extension cord (*i.e.*, 30 or 50 m) was used to maximize the distance between the Partisol air sampler and the portable generator. The Partisol air sampler locations were selected to conform to siting recommendations listed in the British Columbia Ministry of Environment (BC MOE) Air Monitoring Guidelines, Volume 1 Particulate Non-continuous (BC MOE 1996). Prior to starting the Galore Creek baseline monitoring for fine particulate the Partisol air samplers were calibrated using the manufacturer's guidelines; the calibration sheets are included in Appendix 1.

The optimal Partisol sample period would be 24 continuous hours after which the 47 mm diameter filter would be changed. Due to the remote location of the sample stations (helicopter access only) the sample periods were not exactly 24 hours. Plate 1-2 shows one of the Partisol air samplers in operation during the baseline study.



Location of Baseline Ambient Air Quality and Noise Sample Stations

Description of Study Components and Methods

The filters were pre and post weighed to determine the mass of PM collected. The 24 hour average concentration of PM was calculated based on the mass of PM collected and the volume of air that was drawn through the filter.

Baseline PM concentrations from the Galore ambient air quality study are compared with literature/published values for other undisturbed areas and the Canada and British Columbia ambient air quality objectives and standards (Table 1-3).

**Table 1-3
British Columbia and Canada Air Quality
Objectives and Standards ($\mu\text{g}/\text{m}^3$)**

Contaminant	Averaging Period	Canada (maximum desirable)	Canada (maximum acceptable)	Canada (maximum tolerable)	B.C. (level A)	B.C. (level B)	B.C. (level C)
Total suspended particulate	24 hour		120	400	150	200	260
	annual geometric mean	60	70		60	70	75
Date of Reference		1989	1989	1989	Several	several	several
Ambient Air Quality Objectives Established in 1995							
PM10	24 hour					50	
Canada-wide Standards Established in 2000							
PM2.5	24 hour			30			

Both the National and Provincial governments have ambient air quality objectives which are intended to ensure long-term protection of public health and the environment. These objectives were established for Criteria (or Common) Air Contaminants (CACs) using the categories “desirable”, “acceptable” and “tolerable” for the National objectives, and Levels A, B and C for the Provincial objectives. The Desirable and Level A objectives are the most stringent and protective. In general, the three Provincial categories follow the same objective levels as the three National categories. The general meaning/definitions of the Provincial and National Objectives are described in Table 1-4.

Canada-Wide Standards (CWS) are national objectives that were established pursuant to the Canada-Wide Accord on Environmental Harmonisation of the Canadian Council of Ministers of the Environment (CCME) and its Canada-Wide Environmental Standards Sub-Agreement. The CWS are intended to provide long-range targets for Ozone and PM2.5 management, and represent a balance between the desire to protect human health and the environment in the near-term and the costs of reducing pollutant emissions.

Description of Study Components and Methods

**Table 1-4
Descriptive Definitions of the Provincial and
National Air Quality Objectives**

Jurisdiction	Objective	Objective Description
Provincial	Level A (most protective)	Provides long-term environmental protection. Required for new and proposed discharges and, within the limits of the best practicable technology, to existing discharges by planned staged improvements for these operations.
	Level B	Provides adequate protection against adverse effects on human health, vegetation and animals. Usually set as an intermediate objective for all existing discharges to reach within a specified time period, and as an immediate objective for existing discharges which may be increased in quantity or altered in quality as a result of process expansion or modification.
	Level C	Appropriate action is necessary to protect the health of the general population.
National	Maximum Desirable	Long-term goal for air quality that provides a basis for an anti-degradation policy for unpolluted parts of the country and for continuing development of control technology.
	Maximum Acceptable	Provides adequate protection against adverse effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well-being.
	Maximum Tolerable	Denotes time-based concentrations of air contaminants beyond which, due to a diminishing margin of safety, appropriate action is required without delay to protect the health of the general population.

Source: EcoLog Canadian Pollution Legislation (www.ecolog.com)



Plate 1-2 An R & P Partisol Model 2000H air sampler in operation at the Porcupine River sample site. The Partisol air samplers were used to determine background concentrations for fine particulate (*i.e.*, PM10 and PM2.5).

Description of Study Components and Methods

1.2.3 Noise

Baseline noise sampling was conducted during July 2005, the same time as the ambient air quality sampling. The sample sites for noise coincided with the five sample sites for ambient air quality. Baseline noise samples were collected using a Quest Model 2900 sound level meter capable of logging data. The sound level meter sampled in decibels using the “A” standardized frequency rating (dBA, designed to match the frequency response of the human ear) for both average sound levels and maximum peaks. The sound level meter was calibrated before measurement. Noise measurements were made once every 60 seconds 1.5 m above ground, the sound level meter was set for a slow response. The Quest 2900 sound level meter is a Type 2 instrument with a tolerance of +/- 2 dB. Due to the remote location of the sample sites (helicopter access only), the duration of the separate baseline noise studies varied between 7 and 20 hours. Plate 1-3 shows the sound level meter in operation during the baseline study.



Plate 1-3 The Quest 2900 sound level meter with its environmental enclosure kit monitoring baseline noise levels during July 2005. The microphone is protected by a wind screen/weather shield and bird spikes. The weather resistant case protects the meter and battery pack and provides a stable base for the kit.

2. RESULTS

2. Results

The baseline data collected from June 2004 to October 2005 for air temperature, precipitation, wind speed and direction, solar radiation, net radiation, visibility, atmospheric pressure, evaporation, snow, air quality (fine particulate) and noise are summarized below. Where possible the Galore Creek data is compared to long term historical records from regional meteorological stations.

2.1 Meteorology

A general summary of the Galore Creek climate is provided below, followed by the specific data that has been collected since the start of the baseline study program in June 2004. The property is located in the Galore Creek valley in a remote mountainous region of north-western British Columbia. The Galore valley is steep and encircled on three sides by high mountains. The property is within the Stikine River drainage basin which empties into the Pacific Ocean near Wrangell, Alaska. The Galore Creek Project is in a transition zone between wet coastal and the dry/cold interior climate zones. The area is characterized by large gradients and high variability for air temperature, precipitation and wind speed and direction.

The climate of the Stikine-Iskut basin is dominated by its proximity to the Pacific Ocean on the west and to the source regions of Continental Arctic air to the north and east. The massive barrier of the Coast Mountains, with peaks over 3,000 m, limits the incursion of moist, mild Pacific air masses which are forced to release much of their moisture on the windward slopes of these mountains over the lower reaches of the Stikine and Iskut Rivers. Successive mountain ridges east of the Coast Mountains each further reduce the moisture content of Pacific air as it pushes into the upper reaches of the Stikine and Iskut basins.

Maximum precipitation occurs in the Coast Mountain areas in fall and winter due to frequent development of Pacific storms. East of the Coast Mountains, maximum precipitation occurs in summer when extended solar radiation promotes the development of daytime convective clouds.

The build-up of Arctic high pressure areas over north-western Canada in winter results in the penetration of cold, dry Arctic air through valleys in the Cassiar Mountains into the Stikine and Iskut Valleys. Drainage of cold air into the valley bottoms allows winter overnight minimum temperatures in these areas to frequently reach the -40 to -45°C range under cloudless skies. In these situations, temperatures on the higher slopes remain 5 to 15°C warmer, resulting in semi-permanent valley inversions. The outbreaks of Arctic air occasionally reach the Pacific Ocean, but normally in winter there is a strong temperature transition in the valleys of the Coast Mountains.

In other seasons, daytime temperatures are relatively uniform over the basins, with warmer temperatures in the valleys and cooler temperatures aloft. Valley inversions develop overnight east of the Coast Mountains, while in the lower reaches of the Stikine and Iskut rivers, increased cloud cover reduces outgoing radiation.

The influence of the mountain ranges on the Pacific and continental air masses means that precipitation and air temperature are extremely variable over the Project area. For example, as of 1984, mean annual precipitation ranged from 309 mm at Mount Klappan, 2,200 mm in Upper Galore Creek Valley to 1,726 mm at the lower Iskut River/Stikine confluence. Elevation enhances rainfall by an average of 0.3 mm/month per 100 m increase in elevation in summer (June to August) and by 0.5 mm/month per 100 m increase in elevation (water equivalent) of snowfall in winter (November to February).

During winter, the mildest temperatures occur within the Coast Mountains, with little temperature gradient either horizontally or vertically, because maritime Pacific air overruns modified Arctic air. East of the Coast Mountains, semi-permanent valley inversions are created by the sinking of Arctic air to valley bottoms. In summer, maximum temperatures are in the valley bottoms. East of the Coast Mountains, the lapse rate (the rate of decrease of temperature with height) is sufficient to produce afternoon convective clouds, but over the Stikine and Iskut basins, the lapse rate is considerably lower (Rescan 2005).

2.1.1 Air Temperature

Table 2-1 and Figure 2-1 summarize the mean monthly air temperatures at the Galore Creek and regional meteorological stations. For 15 months of data the mean monthly air temperatures for the Galore Creek (East Fork) station range from a low of -11.5°C in January 2005 to a high of 13.1°C for August 2004. Generally the lower elevation stations have the highest monthly average air temperatures. One exception would be January 2005 where it appears that a temperature inversion condition predominated. The higher elevation station at West More Creek (1,354 m) had a warmer average monthly air temperature (-8.6°C) than either Porcupine River (43 m, -9.9°C) or Galore Creek (East Fork) (671 m, -11.5°C). The mean annual air temperatures for the Galore Creek and regional meteorology stations are included in the bottom row of Table 2-1. As expected, the higher elevation stations have a lower mean annual air temperature.

Table 2-2 and Figure 2-2 summarize the mean daily maximum air temperatures at the Galore Creek and regional meteorological stations. For 15 months of data the mean maximum air temperatures for the Galore Creek (East Fork) station range from a low of -8.2°C in January 2005 to a high of 19.0°C for July 2004. It should be noted that the air temperature records for July 2004 were incomplete because the Galore Creek (East Fork) meteorological station was established on July 9, 2004. Generally the lower elevation stations have the highest monthly average air temperatures. One exception would be January 2005 where it appears that a temperature inversion condition predominated. The higher elevation station at West More Creek (1,354 m) had a warmer maximum monthly air temperature (-5.3°C) than either Porcupine River (43 m, -7.0°C) or Galore Creek (East Fork) (671 m, -8.2°C).

Table 2-3 and Figure 2-3 summarize the mean daily minimum air temperatures at the Galore Creek and regional meteorological stations. For 15 months of data the mean minimum air temperatures for the Galore Creek (East Fork) station range from a low of -14.7°C in January 2005 to a high of 9.3°C for July 2004. Again, the air temperature records for July 2004 at the Galore Creek (East Fork) meteorological station were incomplete because the station was established on July 9, 2004. Generally the lower elevation stations have the highest monthly average air temperatures.

Table 2-1
Mean Monthly Air Temperature (Celsius)

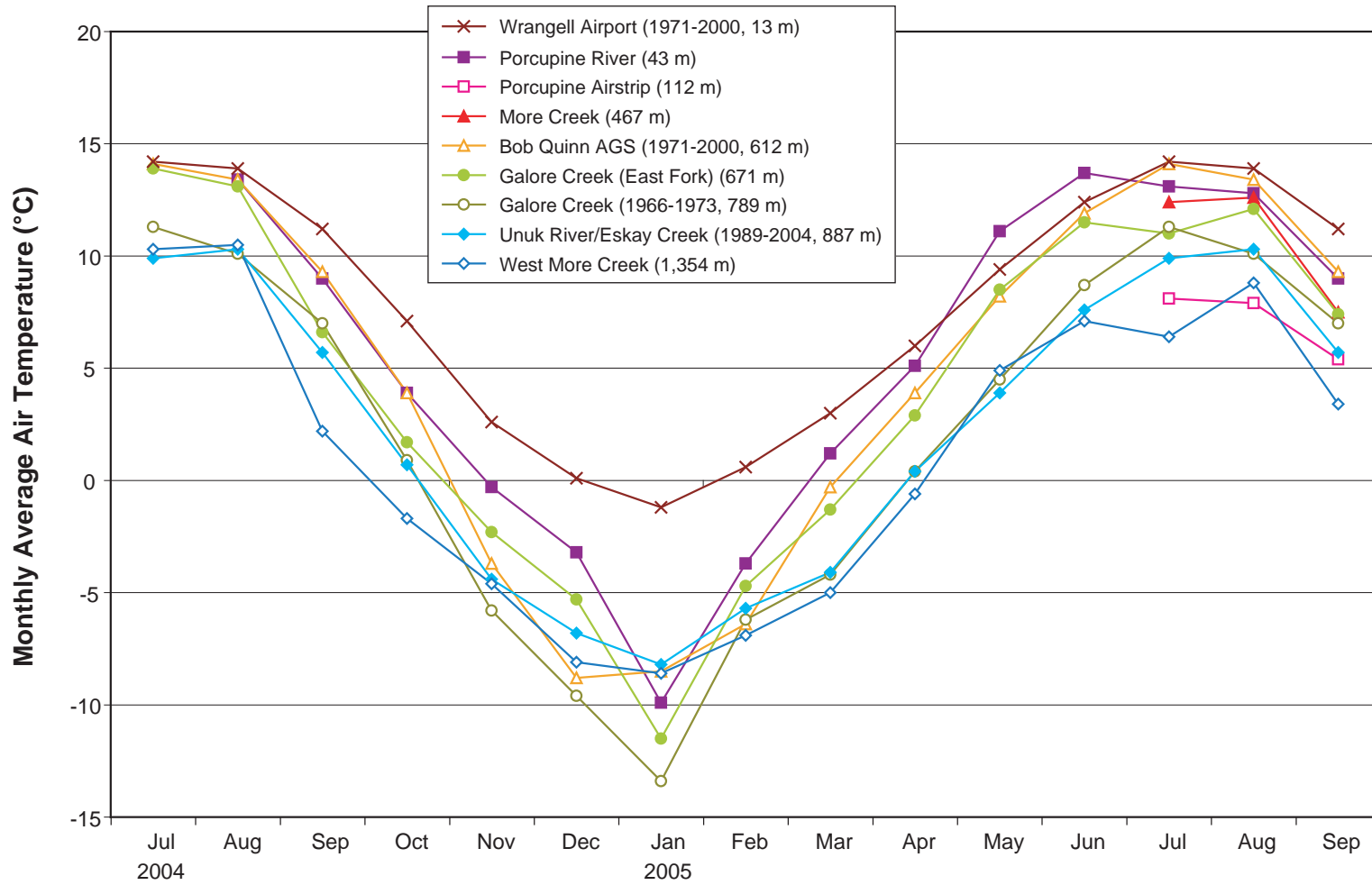
Month	Wrangell Airport (1971-2000, 13 m)	Porcupine River (43 m)	Porcupine Airstrip (112 m)	More Creek (467 m)	Bob Quinn AGS (1971-2000, 612 m)	Galore Creek (East Fork) (671 m)	Galore Creek (1966-1973, 789 m)	Unuk River/Eskay Creek (1989-2004, 887 m)	West More Creek (1,354 m)
July 2004	14.2	n/a	n/a	n/a	14.1	13.9	11.3	9.9	10.3
August	13.9	13.4	n/a	n/a	13.4	13.1	10.1	10.3	10.5
September	11.2	9.0	n/a	n/a	9.3	6.6	7.0	5.7	2.2
October	7.1	3.9	n/a	n/a	3.9	1.7	0.9	0.7	-1.7
November	2.6	-0.3	n/a	n/a	-3.7	-2.3	-5.8	-4.4	-4.6
December	0.1	-3.2	n/a	n/a	-8.8	-5.3	-9.6	-6.8	-8.1
January 2005	-1.2	-9.9	n/a	n/a	-8.5	-11.5	-13.4	-8.2	-8.6
February	0.6	-3.7	n/a	n/a	-6.4	-4.7	-6.2	-5.7	-6.9
March	3.0	1.2	n/a	n/a	-0.3	-1.3	-4.2	-4.1	-5.0
April	6.0	5.1	n/a	n/a	3.9	2.9	0.4	0.4	-0.6
May	9.4	11.1	n/a	n/a	8.2	8.5	4.5	3.9	4.9
June	12.4	13.7	n/a	n/a	11.9	11.5	8.7	7.6	7.1
July	14.2	13.1	8.1	12.4	14.1	11.0	11.3	9.9	6.4
August	13.9	12.8	7.9	12.6	13.4	12.1	10.1	10.3	8.8
September	11.2	9.0	5.4	7.5	9.3	7.4	7.0	5.7	3.4
Mean Annual (October 2004 to September 2005)	6.6	4.4	n/a	n/a	3.1	2.5	0.3	0.8	-0.4

n/a = data not available because the monitoring station did not exist
Shaded values indicate months with incomplete data.

Table 2-2
Mean Daily Maximum Air Temperature (Celsius)

Month	Wrangell Airport (1971-2000, 13 m)	Porcupine River (43 m)	Porcupine Airstrip (112 m)	More Creek (467 m)	Bob Quinn AGS (1971-2000, 612 m)	Galore Creek (East Fork) (671 m)	Galore Creek (1966-1973, 789 m)	Unuk River/Eskay Creek (1989-2004, 887 m)	West More Creek (1,354 m)
July 2004	18.2	n/a	n/a	n/a	20.4	19.0	16.5	14.7	13.4
August	17.8	22.8	n/a	n/a	19.7	18.7	14.4	14.7	13.6
September	14.5	13.8	n/a	n/a	14.4	10.8	10.6	9.1	4.4
October	9.7	7.9	n/a	n/a	7.4	4.9	3.5	3.4	0.7
November	4.9	2.6	n/a	n/a	-0.9	0.8	-3.1	-1.9	-2.2
December	2.5	-0.6	n/a	n/a	-5.8	-1.3	-6.7	-4.0	-4.9
January 2005	1.4	-7.0	n/a	n/a	-5.2	-8.2	-10.0	-5.4	-5.3
February	3.4	0.4	n/a	n/a	-2.1	-0.8	-2.5	-2.5	-3.7
March	6.2	5.9	n/a	n/a	4.7	3.4	0.0	-0.5	-1.9
April	9.9	12.9	n/a	n/a	9.9	7.6	6.2	4.6	3.0
May	13.7	18.9	n/a	n/a	14.8	14.3	9.5	8.0	8.9
June	16.8	21.0	n/a	n/a	18.5	17.1	14.3	12.4	10.6
July	18.2	19.0	14.3	17.7	20.4	15.7	16.5	14.7	9.1
August	17.8	20.1	14.1	19.8	19.7	17.0	14.4	14.7	11.6
September	14.5	14.7	11.2	13.3	14.4	11.9	10.6	9.1	5.8

n/a = data not available because the monitoring station did not exist
Shaded values indicate months with incomplete data.



Note: only partial data available for;
 a) Galore Creek (East Fork) and West More Creek - July 2004.
 b) Porcupine River and West More Creek - August 2004.

Monthly Average Air Temperature (Celsius)

FIGURE 2-1

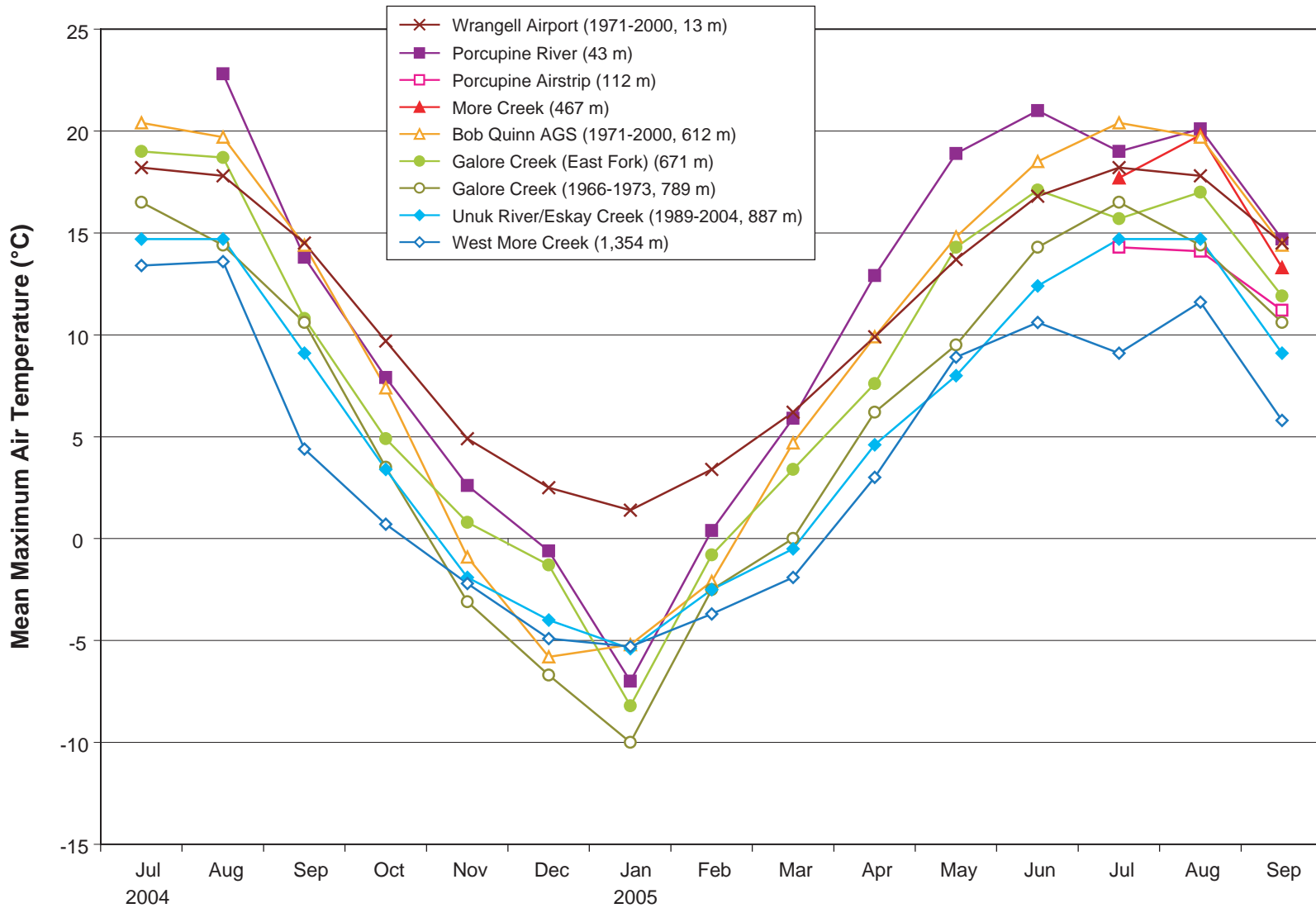


Table 2-3
Mean Daily Minimum Air Temperature (Celsius)

Month	Wrangell Airport (1971-2000, 13 m)	Porcupine River (43 m)	Porcupine Airstrip (112 m)	More Creek (467 m)	Bob Quinn AGS (1971-2000, 612 m)	Galore Creek (East Fork) (671 m)	Galore Creek (1966-1973, 789 m)	Unuk River/Eskay Creek (1989-2004, 887 m)	West More Creek (1,354 m)
July 2004	10.1	n/a	n/a	n/a	7.8	9.3	6.1	5.7	7.5
August	10.1	6.6	n/a	n/a	7.1	8.1	5.8	5.9	7.6
September	7.8	5.0	n/a	n/a	4.2	3.2	3.3	2.7	0.2
October	4.4	1.1	n/a	n/a	0.4	-1.1	-1.7	-1.9	-3.5
November	0.2	-2.4	n/a	n/a	-6.4	-5.1	-8.5	-7.0	-6.2
December	-2.3	-5.3	n/a	n/a	-11.8	-8.5	-12.3	-9.2	-10.9
January 2005	-3.8	-12.9	n/a	n/a	-11.7	-14.7	-16.7	-11.1	-12.2
February	-2.2	-6.6	n/a	n/a	-10.7	-8.2	-9.8	-8.8	-9.3
March	-0.2	-2.0	n/a	n/a	-5.3	-4.8	-8.3	-7.6	-7.3
April	2.1	-0.5	n/a	n/a	-2.2	-1.0	-5.4	-3.7	-2.9
May	5.2	3.7	n/a	n/a	1.5	3.0	-0.5	-0.2	2.2
June	8.1	6.0	n/a	n/a	5.3	6.1	3.1	3.0	4.2
July	10.1	8.1	4.3	7.3	7.8	7.2	6.1	5.7	4.5
August	10.1	7.2	3.4	6.5	7.1	8.0	5.8	5.9	6.5
September	7.8	4.7	1.6	3.2	4.2	3.8	3.3	2.7	1.6

n/a = data not available because the monitoring station did not exist
Shaded values indicate months with incomplete data.

One exception would be January 2005 where it appears that a temperature inversion condition predominated. The higher elevation station at West More Creek (1,354 m) had a warmer minimum monthly air temperature (-12.2°C) than either Porcupine River (43 m, -12.9°C) or Galore Creek (East Fork) (671 m, -14.7°C).

Table 2-4 summarizes the extreme maximum and minimum air temperatures recorded at the Galore Creek and regional meteorological stations. Generally the higher elevation stations recorded the coldest extreme air temperature; this is expected due to the dry adiabatic lapse rate that estimates a decrease in air temperature of 0.98°C for every 100 m gain in elevation. The moist adiabatic lapse rate is less than the dry adiabatic lapse rate and depends on the moisture content of the air mass (Cooper and Alley 1986). The extreme maximum air temperature recorded at the Galore Creek (East Fork) meteorological station (elevation 671 m) for a 15 month period of record was 26.0°C on August 12, 2005. For comparison the historical Galore Creek meteorological station (elevation 789 m, 1961 to 1973) recorded an extreme maximum air temperature of 25.6°C on July 3, 1968.

The extreme minimum air temperature recorded at the Galore Creek (East Fork) station was -31.3°C on January 13, 2005. For comparison the historical Galore Creek meteorological station recorded an extreme minimum air temperature of -38.3°C on January 30, 1968.

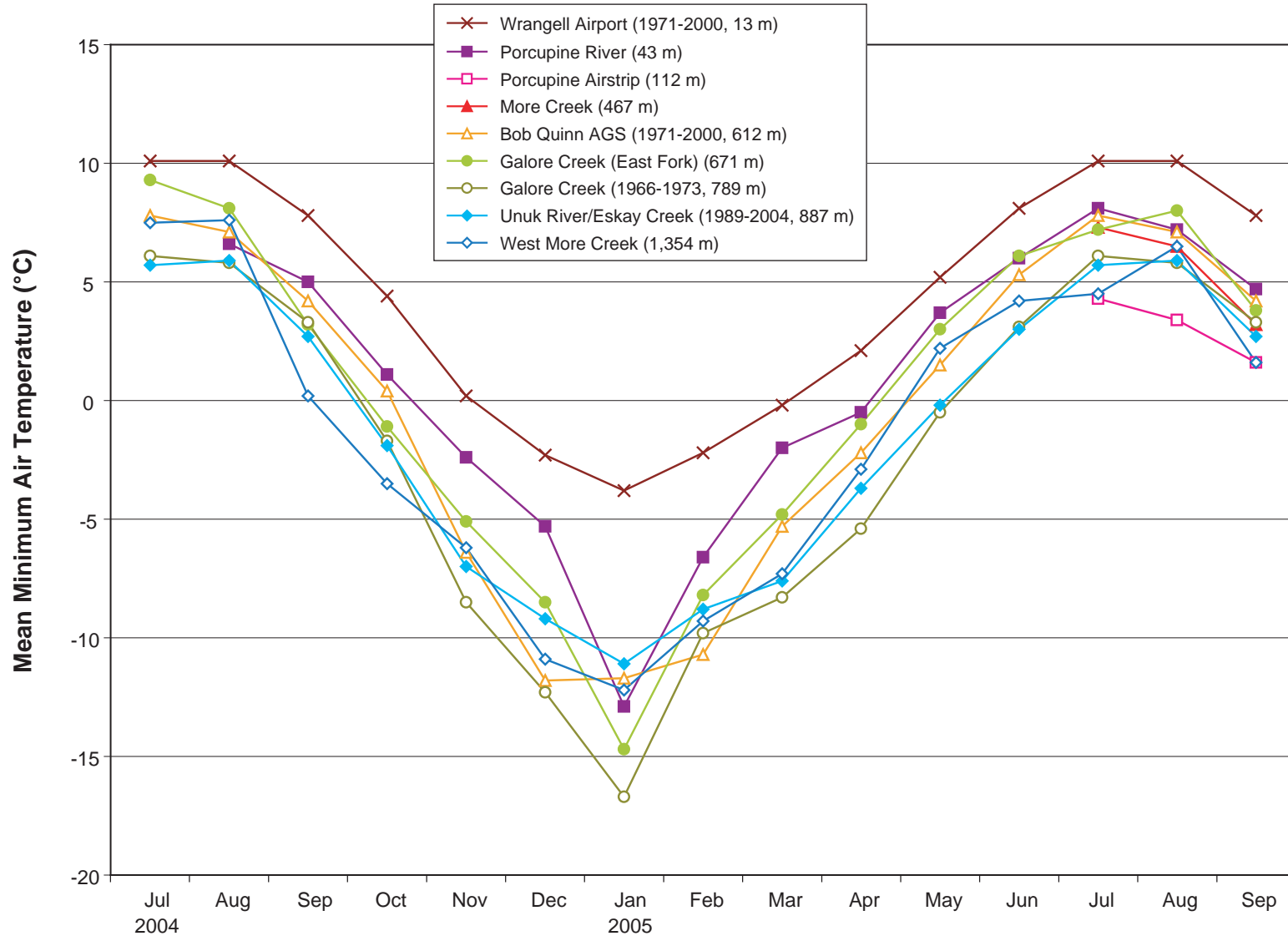


Table 2-4
Galore Creek Project Extreme Maximum and Minimum Air
Temperatures (Celsius)

Station	Elevation (m)	Extreme Maximum Air Temperature	Date	Extreme Minimum Air Temperature	Date	Period of Record
Porcupine River	43	29.9	Aug. 15, 2004	-27.1	Jan. 13, 2005	14 months
Porcupine Airstrip	112	22.4	Jul. 24, 2005	-2.9	Oct. 3, 2005	3 months
More Creek	467	30.7	Aug. 12, 2005	-3.7	Oct. 3, 2005	3 months
Galore Creek (East Fork)	671	26.0	Aug. 12, 2005	-31.3	Jan. 13, 2005	15 months
West More Creek	1354	23.2	Aug. 16, 2004	-32.6	Jan. 12, 2005	15 months
Regional Stations						
Wrangell Airport (1971 to 2000)	13	28.9	Jul. 7, 1975	-23.3	Jan. 14, 1974	30 years
Bob Quinn AGS (1971 to 2000)	612	32.5	Aug. 11, 1990	-37.0	Dec. 30, 1984	30 years
Topley Landing (1971 to 2000)	722	34.4	Jul 31, 1971	-41.7	Jan. 25, 1972	30 years
Galore Creek (1961 to 1973)	789	25.6	Jul. 3, 1968	-38.3	Jan. 30, 1968	13 years with large gaps
Unuk River/Eskay Creek (1989 to 2004)	887	30.0	Aug. 11, 1990	-30.0	Dec. 7, 1995	16 years

2.1.2 Precipitation

Table 2-5 and Figure 2-4 summarize the total precipitation values for the Galore Creek site specific and regional meteorological stations.

The project area lies in a transition zone between the very wet coastal region and the drier interior of British Columbia. The regional hydroclimate of north-western British Columbia is dominated by weather systems generated from the Pacific Ocean, and is also strongly influenced by orographic effects caused by the local mountainous topography. This results in complex interactions between incoming weather systems and local topography that produce a high degree of spatial variability in snowfall and precipitation.

Precipitation decreases in an easterly direction away from the coast. For example, almost 3,400 mm of precipitation was measured at the mouth of the Porcupine River in 2005, while 1,600 mm was recorded at West More Creek and the average annual precipitation at Bob Quinn is only 640 mm. Within the study area the precipitation gradient will also vary spatially, depending on local topography (*e.g.*, presence of orographic effects) and will vary over time depending on the tracks of individual storm events and annual weather patterns.

**Table 2-5
Summary of 2004 & 2005 Total Monthly Precipitation (mm)**

Month	Wrangell Airport 13 m (1971-2000)	Porcupine River (43 m)	Porcupine Airstrip (112 m)	More Creek (467 m)	Bob Quinn AGS 612 m (1971-2000)	Galore Creek (East Fork) (671 m)	Galore Creek 789 m (1961-1973)	Unuk River/Eskay Creek 887 m (2004-2005)	West More Creek (1,354 m)					
Jul 2004	114.0	M	M	M	M	M	56.7	48.1	I	61.2	113.6	M	35.3	I
Aug 2004	141.0	70.8	I	M	M	M	M	49.7	70.1	125.8	98.5		80.7	
Sep 2004	237.0	448.8		M	M	M	M	86.4	312.3	263.4	135.0	M	214.3	
Oct 2004	326.0	376.1	E28	M	M	M	M	101.8	152.4	E27	309.5		249.0	E20
Nov 2004	218.0	410.6	E7	M	M	M	M	62.1	169.5	E5	267.3		177.0	E5
Dec 2004	203.0	584.5	E3	M	M	M	M	69.0	313.4	223.6	194.8	M	191.5	
Jan 2005	176.0	428.1	E8	M	M	M	M	59.8	251.7	353.3	288.5	M	163.7	
Feb 2005	137.0	342.8	E6	M	M	M	M	41.4	157.5	274.5	252.0	M	125.4	
Mar 2005	132.0	292.8	E1	M	M	M	M	27.1	146.6	133.9	134.5		162.5	
Apr 2005	116.0	163.0		M	M	M	M	25.4	97.0	161.3	116.0	M	102.1	
May 2005	117.0	63.6		M	M	M	M	28.7	45.5	97.4	13.8	M	51.7	
Jun 2005	98.0	207.6		M	M	2.6	I	33.6	53.9	42.8	14.5		55.3	
Jul 2005	114.0	172.4		22.2	I	26.7		56.7	93.2	61.2	83.9		94.1	
Aug 2005	141.0	146.2		104.9		not available		49.7	138.3	125.8	206.9		110.2	
Sep 2005	237.0	227.4		145.6		not available		86.4	160.6	263.4			124.0	
12 month total (Oct 04 to Sep 05)	2015.0	3415.1	E	not available		not available		641.7	1779.6	E	2314.0	not available	1606.5	E

=months with incomplete data due to the GEONOR precipitation gauge collection bucket filling

=months with incomplete data due to the station being installed part way through the month

=data has not been verified by Environment Canada

Explanation of codes:

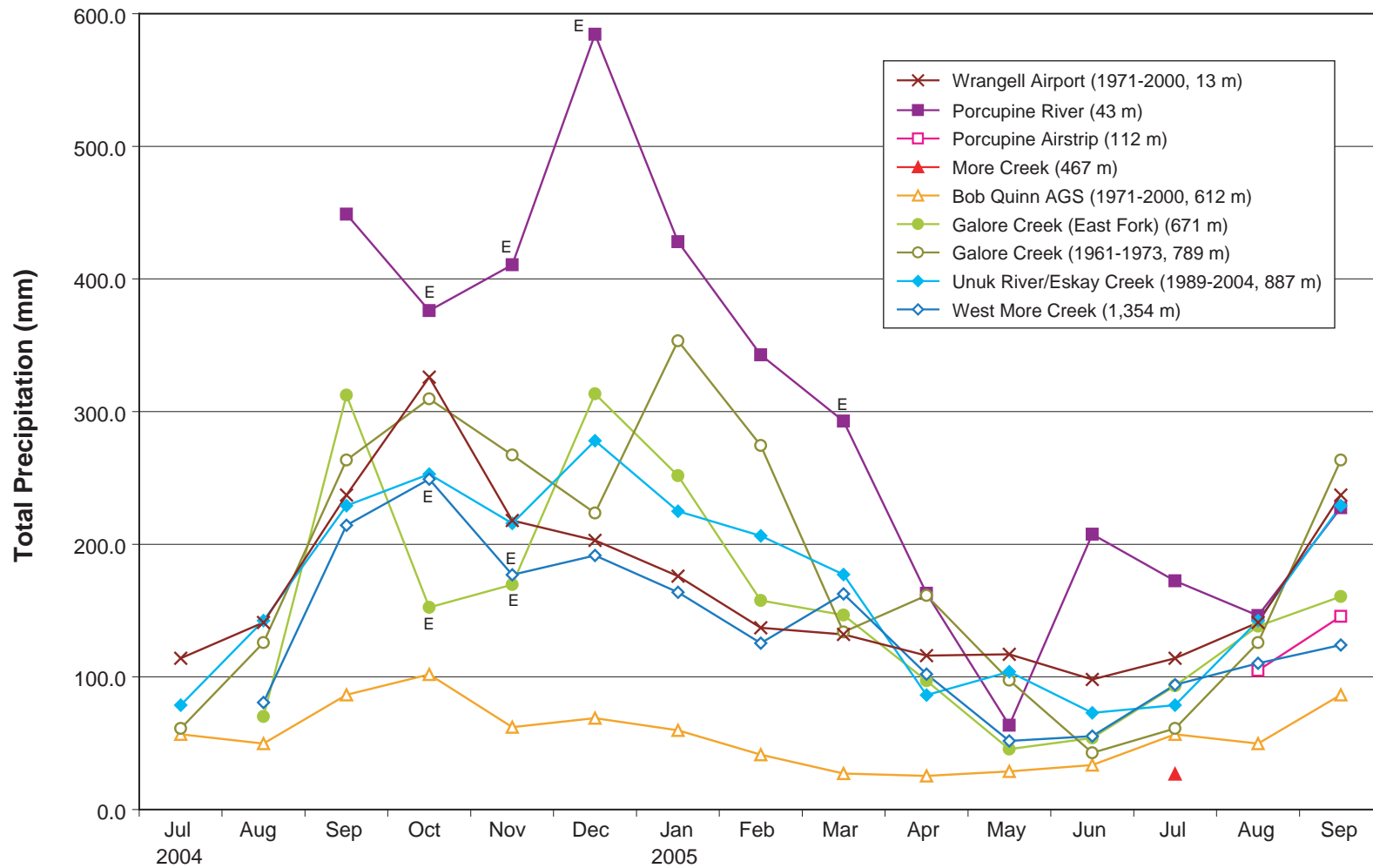
C = precipitation occurred

M = missing

E = estimated and the number of days for which data had to be estimated

I = incomplete month due to the station being commissioned part way through a month

not available = not enough data is available to calculate a monthly or 12 month precipitation total



Note: Total monthly precipitation values for Galore Creek, West More Creek and Porcupine River were estimated for October and November 2004.
 Porcupine River values for December 2004 to March 2005 were also estimated.
 E = values were estimated.

Total Precipitation at Galore Creek and Regional Meteorological Stations

FIGURE 2-4

The annual precipitation measured at the Galore Creek (East Fork) meteorological station (elevation 761 m) during the 2005 hydrological year (October 2004 to September 2005) was approximately 1,800 mm. This was 15 % lower than the estimated annual average precipitation for Galore Valley, which is approximately 2,080 mm at the elevation of the monitoring station. The annual precipitation total for West More Creek was only 1,600 mm, even though the station is located at 1,350 m elevation. This suggests substantially less precipitation in More Valley than in Galore Creek. The More Creek gauge is located further east than the Galore Creek gauge which may explain the lower precipitation totals. However, the More Creek gauge was also located in a region with high wind speeds which might have impacted the amount of snowfall in the area. As discussed above the measured precipitation at the mouth of Porcupine River was 3,400 mm.

An annual average precipitation total of 2,241 mm was calculated using data from the old Galore Creek meteorological station, which was located at an elevation of 789 m (Table 2-6). There are 4 full years of precipitation data from the period 1965 to 1968, and data from the active meteorological station in Galore Valley can be used to estimate precipitation for the year extending from July 2004 to June 2005. The values can be used to calculate the average annual precipitation close to the proposed mine site. However, there are problems with data for 1965 and for 2004 to 2005 and these values are excluded from the calculation of average annual precipitation. The annual precipitation total for 1965 is significantly lower than for other years. Analysis of precipitation data at other Environment Canada stations that covered the same time period did not suggest that this year was particularly dry. This leaves a question mark over this data point and as the inclusion of the 1965 value would have a proportionately large impact on the calculation of the average annual precipitation it is excluded from the calculation. In October and November 2004 there were problems with the precipitation gauge at the Galore Creek (East Fork) station which meant that precipitation during this period was underestimated. As a result the annual total is also an underestimate and the value for this period was not used in calculating the annual average precipitation.

**Table 2-6
Precipitation Data from Galore Creek Meteorological Station**

Year	Annual Precipitation (mm)
1965	1,262 ^a
1966	1,910 ^a
1967	2,457 ^b
1968	2,356 ^{b, c}
2004 to 2005	1,873 ^d
Average	2,241^e

^a Data from original 1967 report on meteorological monitoring in Galore Valley (MacAusland 1967)

^b Data from Environment Canada database

^c Precipitation for December missing, estimated by taking average for other years of data

^d From on-site meteorological station. Note some missing data and also likely under-prediction of precipitation due to gauge malfunction in October and November 2004

^e Calculated excluding data from 1965 and 2004 to 2005

The annual average precipitation total of 2,241 mm is valid for the approximate elevation of the proposed mine site. Precipitation varies greatly with elevation in mountainous regions and data

from field monitoring stations only provides information on precipitation totals at the elevation of the station. Precipitation would be expected to increase with elevation and be higher in the headwaters of the watershed. Results from a field rainfall monitoring experiment (multiple rain gauges were located at different elevations within the valley), UBC Watershed Model runs and discussions with experts indicated that precipitation might increase by up to 7% per 100 m increase in elevation, with the rate of increase becoming less toward the height of the watershed divide. Analysis of the available Galore Creek precipitation data indicates that 65% of the annual precipitation total falls as snow.

2.1.3 Wind Speed and Direction

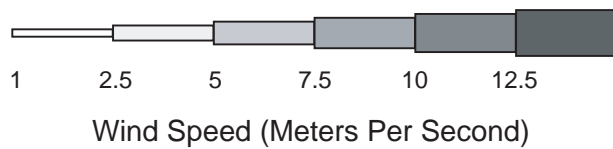
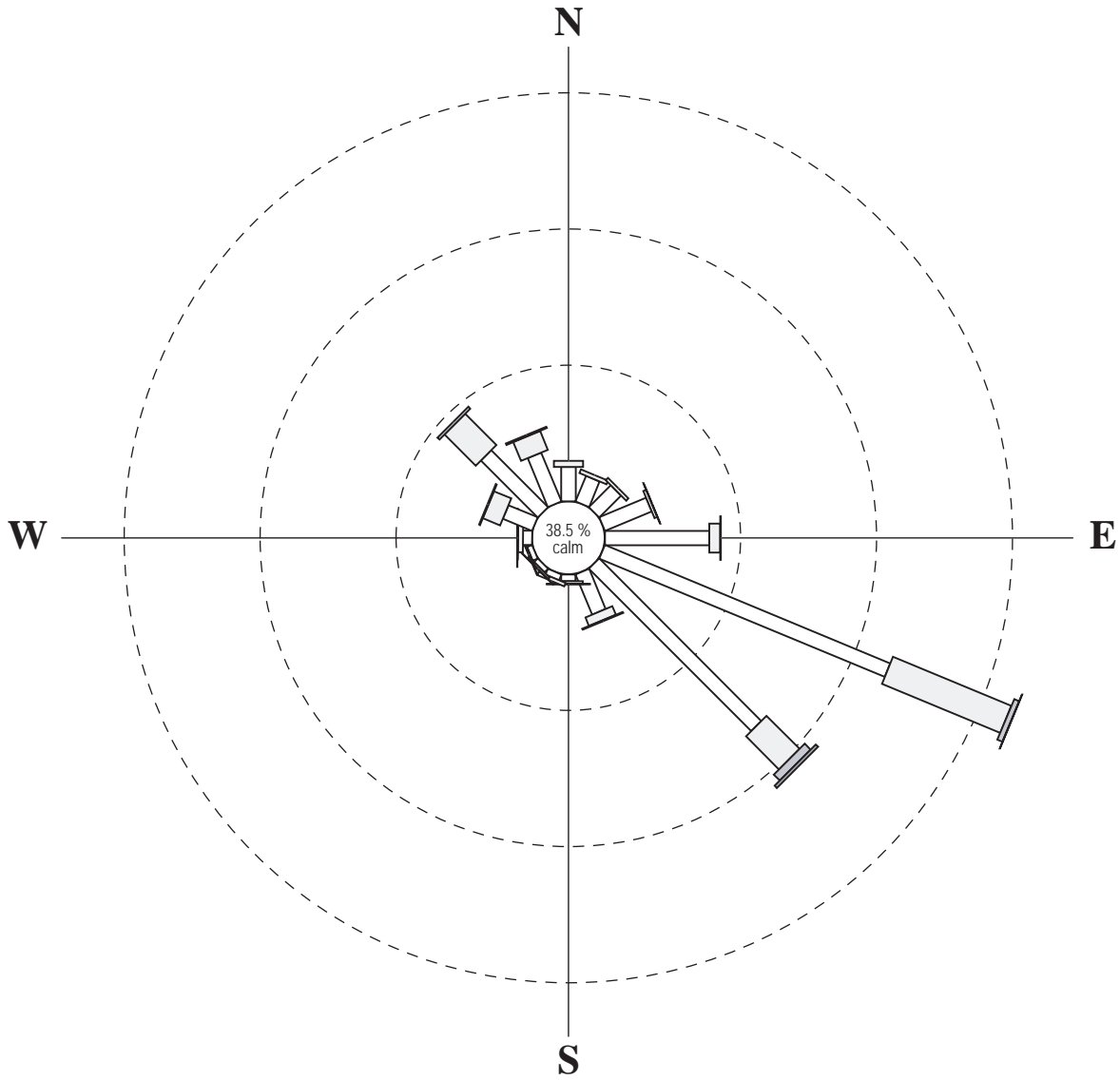
Generally strong winds occur in all seasons at high elevations, with a north-east through south-east circulation in cold months and south through west flow at other times. Winds at low elevations are funnelled through valleys with a light to moderate down-valley flow of Arctic air in cold months and a light up-valley flow of Pacific air at other times. Figures 2-5 to 2-9 are wind roses for the following meteorological stations (respectively), Galore Creek (East Fork), West More Creek, Porcupine River, Porcupine Airstrip and More Creek.

The predominant wind direction for the Galore Creek (East Fork) meteorological station was from the south east quadrant. The wind was from the east south east approximately 33% of the time and the hourly average wind speeds were rarely greater than 7.5 m/s (0.3% of the time). The east south east winds coincide with the axis of the Galore Creek (East Fork) valley where cold dense air from the nearby glaciers is coming down the valley. Calm conditions (*i.e.*, hourly average wind speeds less than 1.0 m/s) prevailed 38.5% of the time.

The predominant wind directions at the West More Creek meteorological station were along the east west axis. The most common wind direction was from west south west; this wind direction was recorded approximately 24% of the time. This predominant wind direction is consistent with the east - west orientation of the nearest valleys (West More Creek and Sphaler Creek). The West More Creek meteorological station is on the drainage divide between the More Creek and Sphaler Creek basins and experiences fewer calm conditions than the Galore Creek (East Fork) station.

The West More Creek station recorded calm winds 4.5% of the time. The higher hourly average wind speeds were greater than 7.5 m/s for 19.8% of the time. There have been several instances during the baseline study program when it was not safe to land a helicopter near the West More station because of high wind speeds.

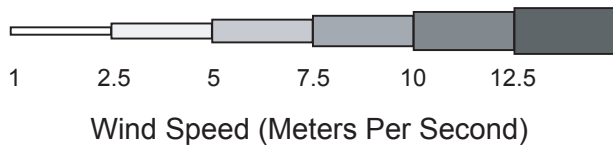
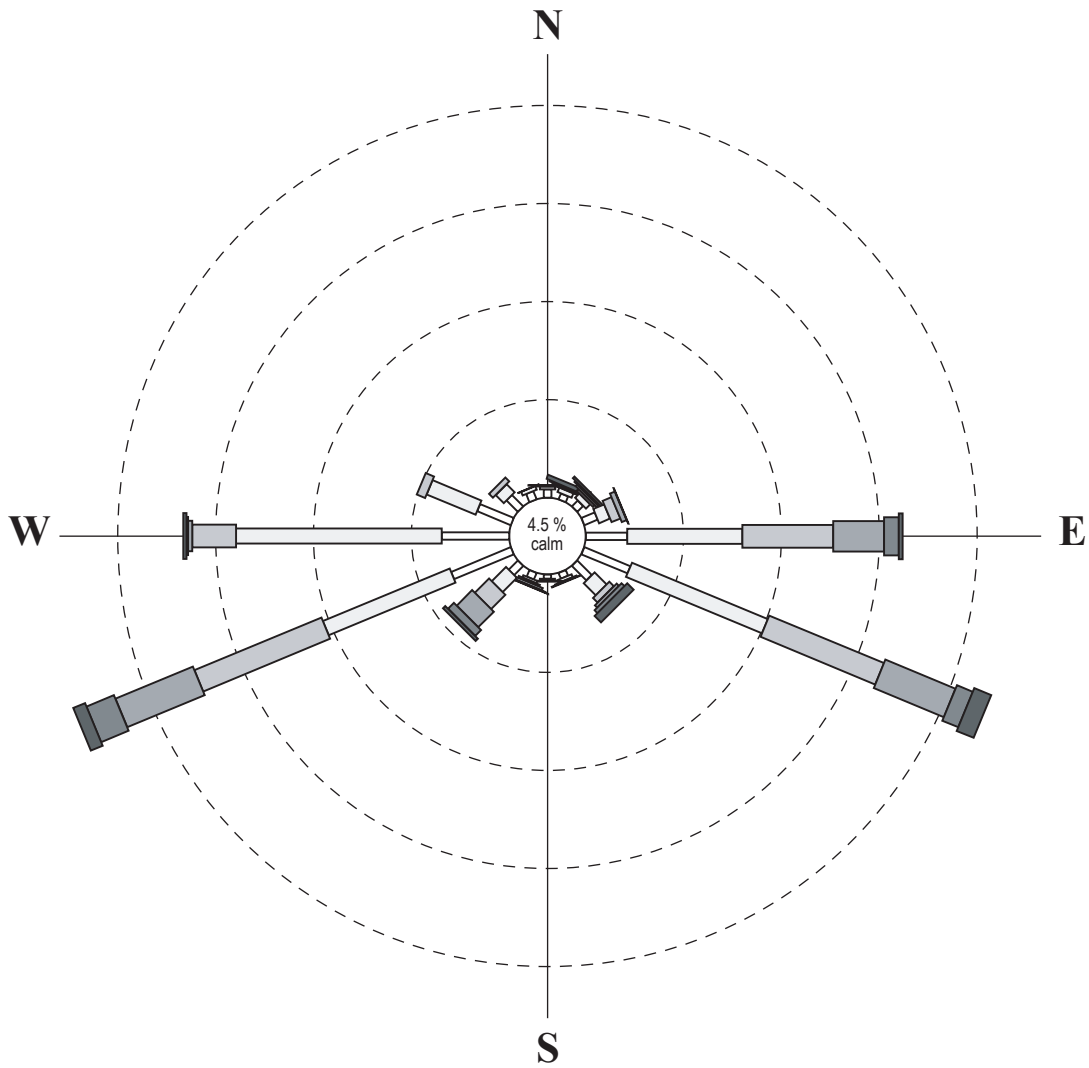
As with the Galore Creek (East Fork) station, the hourly average wind speeds at the Porcupine River meteorological station were calm more often than not. Calm conditions were recorded 60.4% of the time at the Porcupine River station. The most common wind direction was from the north north-east (19% of the time). Hourly average wind speeds never exceeded 7.5 m/s at the Porcupine River station.



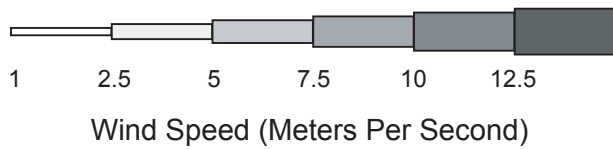
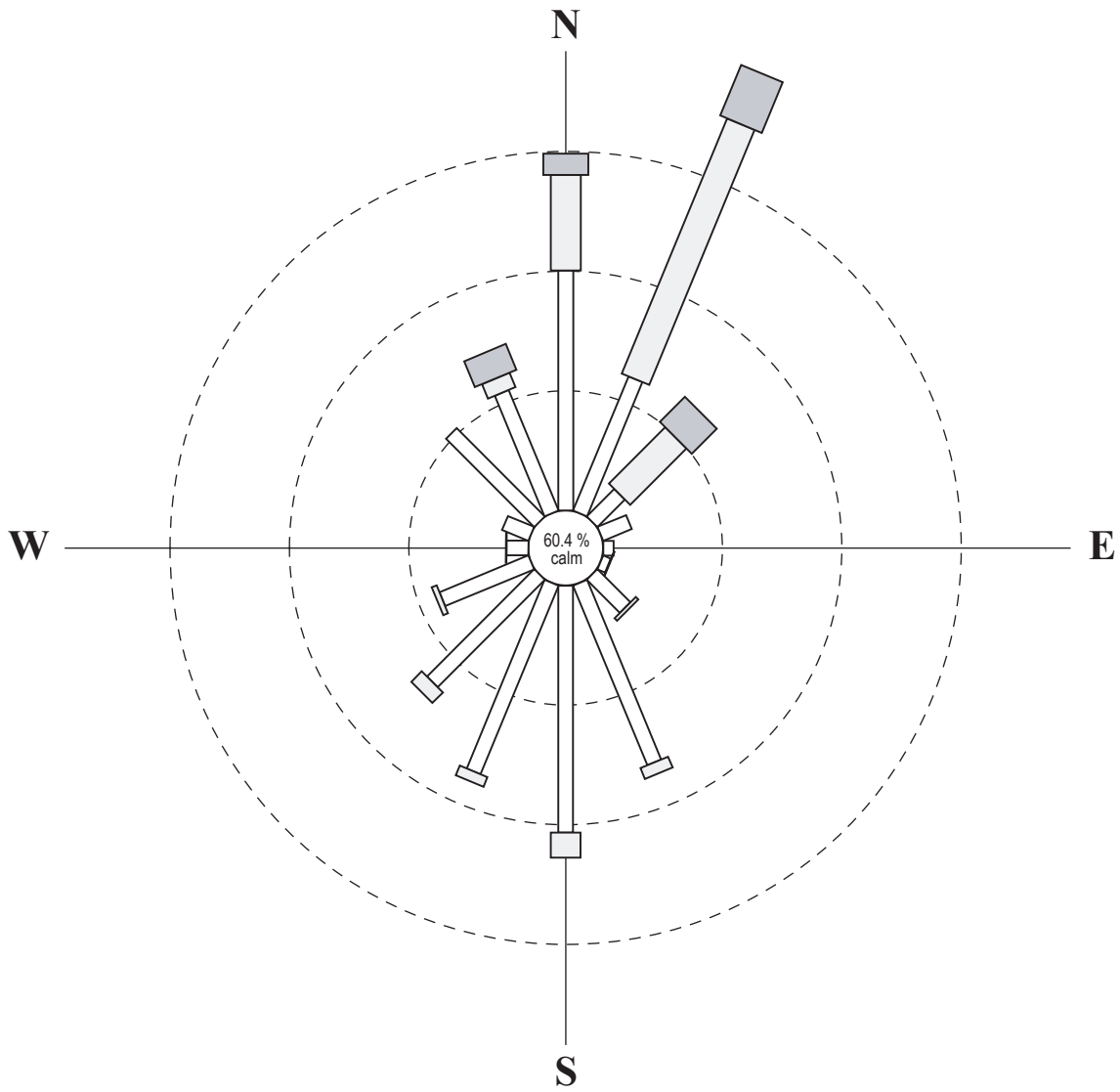
Calms excluded.
 Rings drawn at 10% intervals.
 Wind flow is FROM the directions shown.
 No observations were missing.
 % Calm = hourly average wind speed less than 1.0 m/s.

**Galore Creek (East Fork) Wind Rose,
 July 9, 2004 to October 4, 2005**

FIGURE 2-5

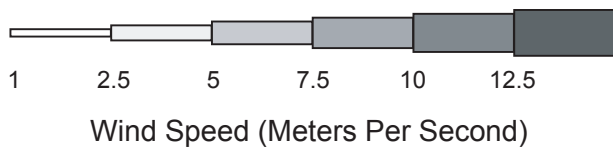
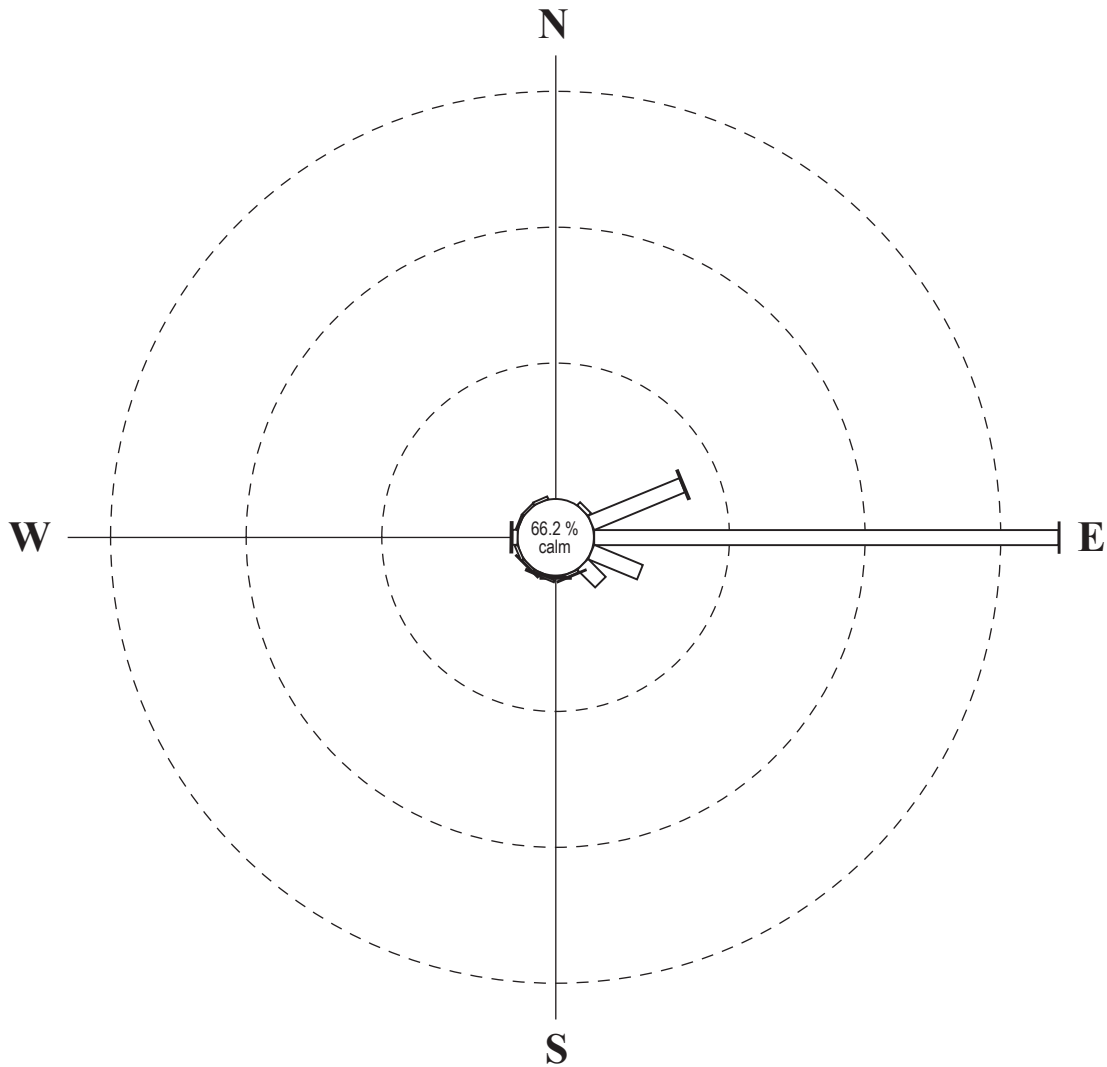


Calms excluded.
Rings drawn at 5% intervals.
Wind flow is FROM the directions shown.
767 observations were missing.
% Calm = hourly average wind speed less than 1.0 m/s.

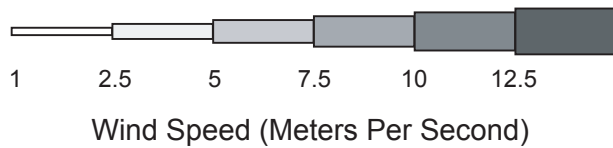
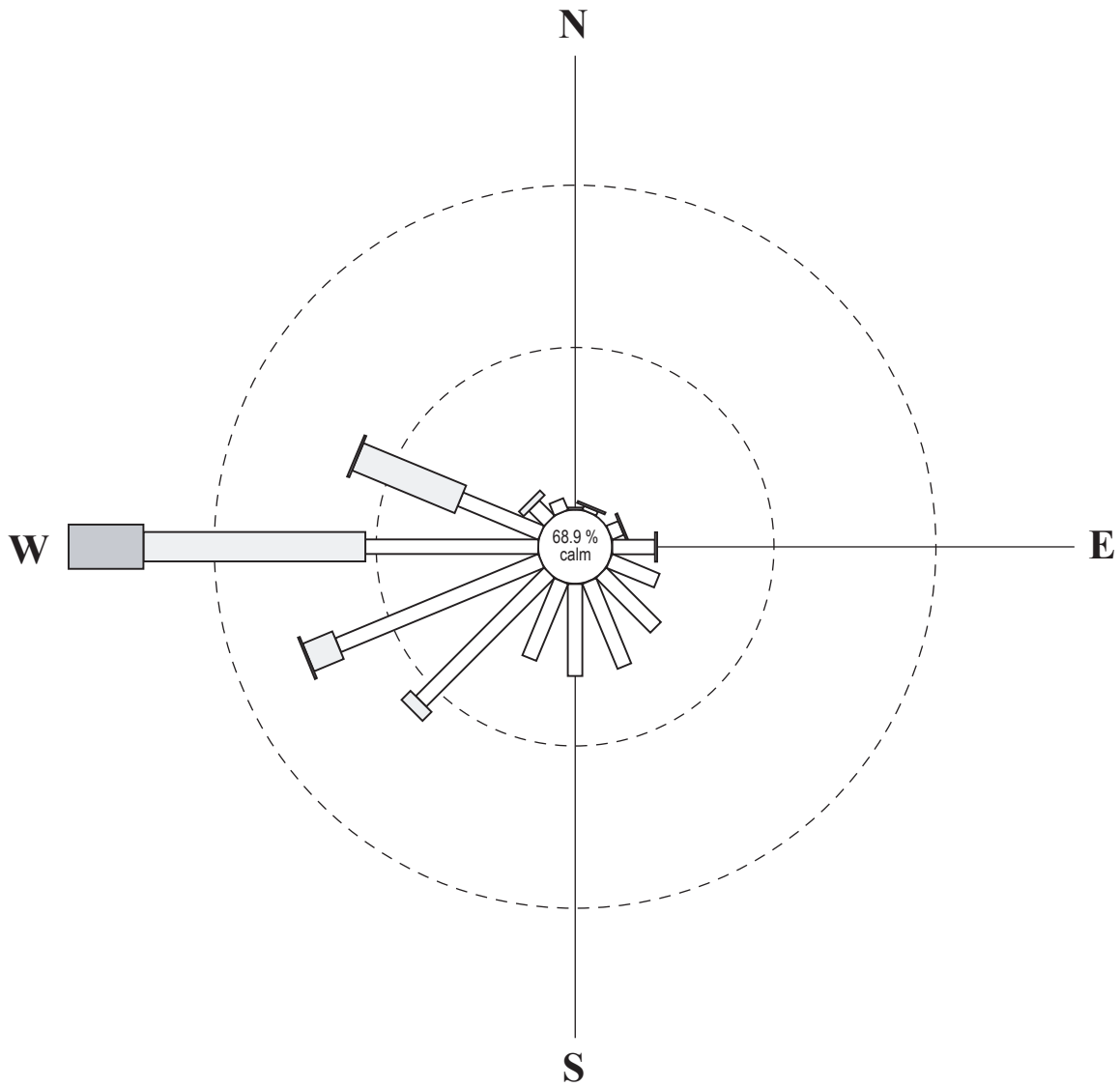


Calms excluded.
 Rings drawn at 5% intervals.
 Wind flow is FROM the directions shown.
 No observations were missing.
 % Calm = hourly average wind speed less than 1.0 m/s.





Calms excluded.
Rings drawn at 20% intervals.
Wind flow is FROM the directions shown.
No observations were missing.
% Calm = hourly average wind speed less than 1.0 m/s.



*Calms excluded.
Rings drawn at 10% intervals.
Wind flow is FROM the directions shown.
No observations were missing.
% Calm = hourly average wind speed less than 1.0 m/s.*

Calm winds also prevailed at the Porcupine Airstrip station where the hourly average wind speed never exceeded 7.5 m/s and the frequency of calms was 66.2% of the time. The most frequent wind direction was from the east at over 65% of the time. This strong tendency for winds from the east is due to the station's close proximity to the Porcupine Glacier. The station is approximately 2 km west of the Porcupine Glacier and the predominant east winds recorded at the meteorological station were caused by cold dense air coming down the Porcupine River valley.

The predominant wind direction recorded at the More Creek meteorological station was from the west at almost 30% of the time. The west winds would likely be caused by dense cold air draining down the More Creek valley from west to east. Calm winds were common and were recorded 68.9% of the time. The hourly average wind speed never exceeded 7.5 m/s at the More Creek meteorological station.

Table 2-7 summarizes the maximum instantaneous and ten minute average wind gusts recorded at the Galore Creek meteorological stations. The maximum instantaneous wind speed recorded was 31.8 m/s at the West More Creek meteorological station on December 16, 2004 and March 19, 2005. The second highest instantaneous wind gust was 22.6 m/s recorded at the Galore Creek (East Fork) station on December 16, 2004. The highest 10 minute average wind gust, 26.9 m/s, was recorded at the West More Creek station on March 19, 2005. The second highest 10 minute average wind gust, 14.4 m/s, was recorded at the Galore Creek (East Fork) station on March 30, 2005. The maximum wind gusts predominantly coincided with winter storm conditions.

**Table 2-7
Maximum Wind Gusts at Galore Creek Meteorological Stations**

Station	Elevation (m)	Instantaneous Wind Gust (m/s)	Date	Maximum 10 Minute Average Wind Gust (m/s)	Date	Available Period of Record
Porcupine River	43	18.2	Dec. 30, 2004	13.2	Dec. 30, 2004	14 months
Porcupine Airstrip	112	12.4	Sep. 24, 2005	6.0	Jul. 16, 2005	3 months
More Creek	467	12.9	Sep. 13, 2005	10.6	Sep. 13, 2005	3 months
Galore Creek (East Fork)	671	22.6	Dec. 16, 2004	14.4	Mar. 30, 2005	15 months
West More Creek	1354	31.8	Dec. 16, 2004 and Mar. 19, 2005	26.9	Mar. 19, 2005	15 months

2.1.4 Solar Radiation

Solar radiation is electromagnetic energy from the sun. Solar energy accounts for 99% of the earth's energy budget. The solar radiation incident on top of the terrestrial atmosphere is called extraterrestrial solar radiation. Ninety seven percent of this radiation is confined to the spectral range of 0.29 to 3.0 microns and is referred to as short-wave radiation. A portion of the extraterrestrial solar radiation penetrates through the atmosphere to the earth's surface, while part of it is scattered and/or absorbed by gases, aerosol particles, cloud droplets and cloud crystals in the atmosphere.

Global solar radiation is monitored at three of the Galore Creek meteorological stations using a pyranometer. Global solar radiation is the total incoming direct and diffuse short-wave solar radiation received from the whole dome of the sky on a horizontal surface.

Figure 2-10 summarizes the mean monthly solar radiation values at the site specific meteorological stations Galore Creek (East Fork), West More Creek and More Creek). The first two stations have 15 months of data available and the latter has 3 months.

The highest daily average solar radiation, 340 W/m^2 , was recorded at the West More Creek meteorological station on June 17, 2005. The maximum hourly average solar radiation value recorded at the West More Creek station on June 17, 2005 was 832 W/m^2 at 1500 hours. The overall maximum hourly average net radiation value recorded at the West More Creek station was 994 W/m^2 on March 30, 2005 at 1400 hours.

The lowest solar radiation values were recorded during winter months when the sun is at its lowest angle and there is a higher frequency for low cloud cover that scatters and absorbs the solar radiation. The minimum average daily solar radiation, 1 W/m^2 , was recorded at the Galore Creek (East Fork) station on January 21st and 22nd, 2005. The hourly average solar radiation values recorded at the Galore Creek (East Fork) station on January 21st and 22nd, 2005 were all below 7 W/m^2 . All of the hourly average solar radiation values recorded during night time hours were 0 W/m^2 . Overall the solar radiation values, both average and max/min, were higher at the West More station compared to the Galore Creek (East Fork) station. This is likely a result of differences in elevation and general patterns for low cloud cover between the two stations.

2.1.5 Net Radiation

Net radiation is measured using a net radiometer at three of the Galore Creek meteorological stations. Net radiation is the resultant of downward and upward total (solar, terrestrial surface and atmospheric) radiation received on a horizontal surface. Terrestrial radiation is the long wave (wavelength longer than 3 microns) electromagnetic energy emitted by the earth's surface and by gases, aerosols and clouds of the atmosphere. It is also partly absorbed within the atmosphere.

Figure 2-11 summarizes the mean monthly net radiation values at the site specific meteorological stations Galore Creek (East Fork), West More Creek and More Creek). The first two stations have 15 months of data available and the latter has 3 months.

The maximum daily average net radiation values were recorded during summer months when the incoming radiation was much stronger than the upward radiation. The highest daily average net radiation, 190 W/m^2 , was recorded at the Galore Creek (East Fork) meteorological station on June 16, 2005. The maximum hourly average net radiation value recorded at the Galore Creek (East Fork) station on June 16, 2005 was 630 W/m^2 . The overall maximum hourly average net radiation value recorded at the Galore Creek (East Fork) station was 668 W/m^2 on May 30, 2005.

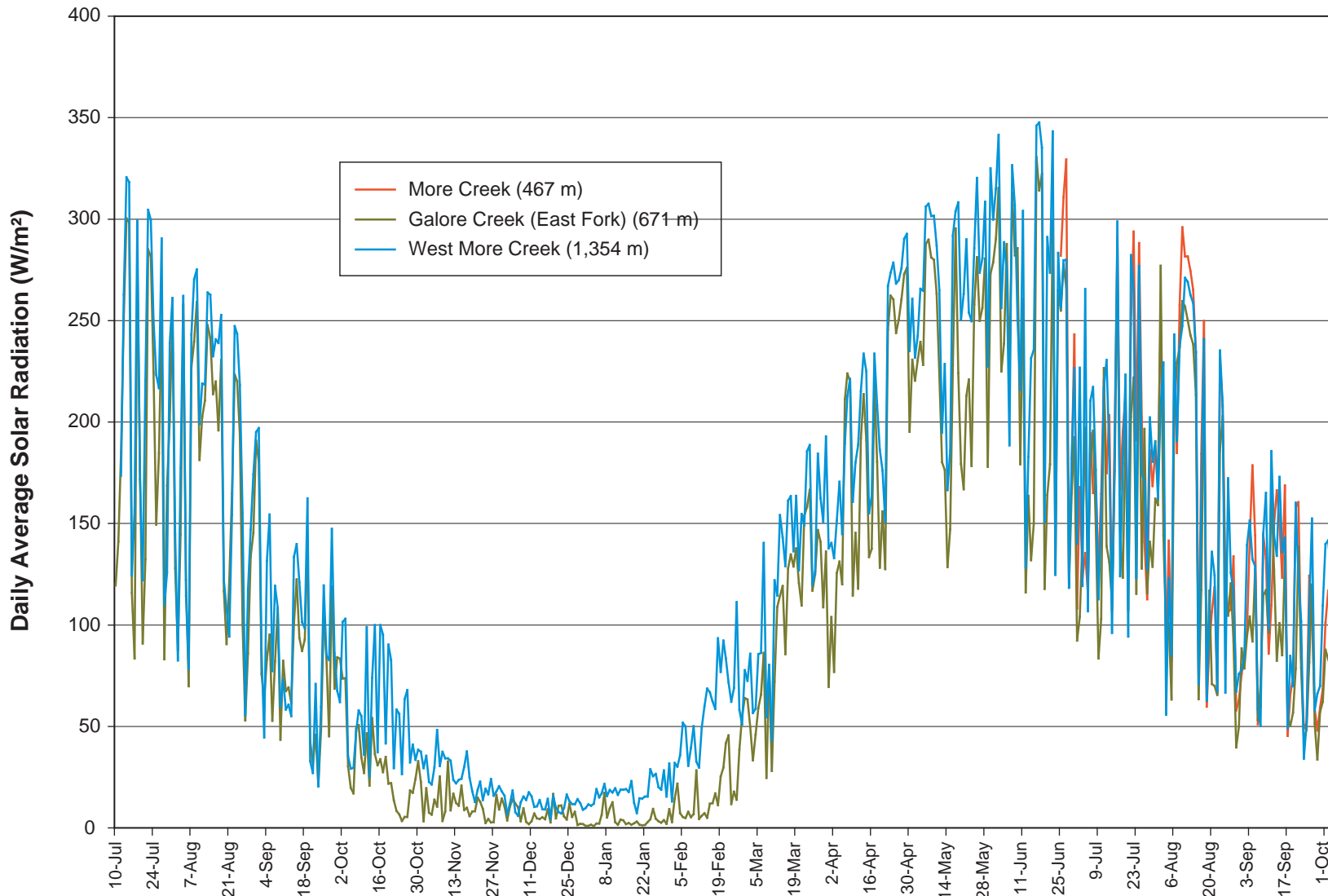


FIGURE 2-10

