B. C. Hydro

PRELIMINARY INVESTIGATION OF THE METEOROLOGY OF MEAGER CREEK AND LILLOOET VALLEYS

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PRELIMINARY INVESTIGATION OF THE METEOROLOGY OF MEAGER CREEK AND LILLOOET VALLEYS

INTRODUCTION

There are no historical climatological data available for the Meager Creek valley and environs. The Atmospheric Environment Service (AES) operated a volunteer climatological station at Pemberton Meadows from August 1912 to January 1967, but since the site was 50 kilometres down the Lillooet valley from Meager Creek, and approximately 350 metres lower in elevation, the representativeness of the data is doubtful.

In order to assess the meteorology of the area, specifically those parameters which would affect the dispersion of natural, as well as project, emissions, a meteorological network was established.

METHODOLOGY

During the summers of 1979 and 1980 studies were conducted by personnel of the B. C. Hydro Civil and Environmental Engineering Department (CEED) to document the frequency, depth, strength and diurnal changes in the vertical temperature stratification, as well as the wind flow, within the Meager Creek valley.

A proven, expedient method of documenting the gross vertical temperature structure in a valley is to position thermographs on outcroppings, roughly in line, up the same side of a valley and to examine the recorded hourly temperature differences between instruments. The accuracy of results is highly dependent on using matched instrumentation as to response, timing and calibration. It is also dependent on site location such that the instruments, mounted in Stevenson screens, are free of local cold air drainage or solar radiation effects due to differing underlying surfaces (e.g. rock vs vegitation) and are, as much as possible measuring free air temperatures (Reference 1 and 2).

Measurements of temperature, humidity and mean hourly wind direction and speed were recorded continuously at points in the study area from June through September in both 1979 and 1980. Four stations were established in 1979 from #1 at 562.4 metres MSL, in the bottom of Meager Creek valley, up the south slope of the valley to Station #4 at 1,720.6 metres MSL. Sites were located so as to receive approximately equal daily exposure to sunlight. Site selection was most difficult due to the rugged and heavily wooded nature of the valley slope, giving limited helicopter access.

In 1979, Station #3 was located at 1,310.6 metres MSL on an overgrown rubble pile at the base of an avalanche run out. Subsequent analysis of the hygrothermograph data showed that it was being affected by cold air drainage from the permanent snow field on the ridge above, making the data incompatible with those of the other three sites, except through mid day. In 1980 this station was moved several hundred metres further out on a promentary on the valley wall and slightly higher. Additionally, in 1980 lower slope logging allowed access for another hygrothermograph, Station #5, located at 858 metres MSL, to get better temperature profile definition between Stations #2 and #3. The stations, and their respective instrumentation, are described in Table 1.

In addition to the weather stations in the Meager Creek valley, a standard AES climatological station was established at the B. C. Hydro base camp in the Lillooet valley at 432.8 metres MSL for eventual comparison with historical data from Pemberton Meadows. As well as the standard maximum and minimum thermometers and rain gauge, a Weather Measure model WS-755 on a ten foot tower, was located at the base camp for analysis of the wind flow in the main valley.

Because of the potential activity on the north side of Meager Mountain, a site was selected for a MATER automatic weather station in that area following installation of a road and bridges in 1980. The unit, mounted on a ten metre tower, records wind, temperature and precipitation on magnetic tape on a year round basis.

NETWORK OPERATION PROCEDURES

Prior to installation of the hygrothermographs and Weather Measure instruments, a rigorous program of calibration and monitoring was carried out in the CEED laboratory to insure complete accuracy and compatibility of the units.

Following installation of the network in June 1979 and 1980, a schedule was set up for instrument chart change. The hygrothermographs record data on a seven day chart. Since weather Stations #3 and #4 could be serviced only by helicopter, a six day schedule was established in order to reduce data loss if flying weather was inclement that day.

At each chart change the time on the clock driven drum of the hygrothermograph was checked and noted and the temperature checked against a sling psychrometer.

A Reid Crowther technician carried out the chart checks and changes except that every third change was done by a CEED technician when he also changed and field calibrated the Weather Measure units.

DATA HANDLING

1. The hygrothermograph charts were forwarded to CEED routinely where hourly temperatures were manually abstracted and listed, taking into account any time or temperature corrections.

2. The Weather Measure charts, which contain analog records of wind direction, wind run, temperature and humidity, were abstracted to mean hourly values under a B. C. Hydro contract. The hourly values were then computer processed as per the standard B. C. Hydro format.

3. The records from the base camp climatological station were forwarded to the Atmospheric Environment Service for their processing and publication.

4. MATER tapes, containing wind, temperature and precipitation data are electronically abstracted at AES headquarters and the data listings are forwarded to B. C. Hydro for computer processing.

ASSESSMENT OF REPRESENTATIVENESS OF HYGROTHERMOGRAPH DATA

In order to assess if, in fact, the hygrothermographs were recording temperatures which were, roughly, representative of temperatures above mid valley a minisonde program was conducted. On 16 and 17 September 1980, a series of seven vertical temperature profiles were obtained in Meager Creek valley using B. C. Hydro's double theodolite minisonde system. The sondes were released from the vicinity of hygrothermograph Station #1 with the other end of the theodolite baseline in the direction of Station #2.

Immediately following the last minisonde ascent the charts were retrieved from all of the hygrothermographs. Unfortunately, it was found that on the previous chart change the Reid Crowther technician had failed to wind the clock drive on hygrothermograph #5, so its temperatures were unavailable for comparison.

Table 2 contains the comparisons of temperatures from hygrothermographs #1, #2, #3, #4 at the times of the ascents with those at the respective elevations on the minisonde profiles.

The comparison shows that the average departure from the tethersonde values was $0.6^{o}C$, with only five of the 26 values in excess of one degree. It, thus, may be concluded that the hygrothermograph data collected during 1979 and 1980 reasonably documented the gross vertical temperature structure in the Meager Creek valley during those periods.

RESULTS

1. Hygrothermograph Data

Because of the physical constraints of access, and the unavailability of personnel to service the instruments, it was not possible to monitor the vertical temperature structure of the Meager Creek valley in months other than late June to late September during 1979 and 1980.

The results from the hygrothermograph data of 1979 were presented and discussed in a report dated 27 December 1979 (Reference 3).

Data from 1980 were analyzed in a manner similar to that of the 1979 data set. The data for both summers were then combined to produce a larger data base. Table 3 displays the percentage frequency and depth of inversions by hour of the day through the layers delineated by the hygrothermograph sites. As noted, Station #5 was in operation only from 27 August to 30 September 1980 and Station #3 from 4 July to 30 September 1980 so the percentage frequencies for these levels in Table 3 cover a much shorter period of time. Line one displays the percentage of hours for the study period when there were no inversions recorded between any of the hygrothermographs. Lines two, three, four and five display the percentage of hours of the study for each hour of the day when an inversion was present between Station #1 and Stations #2, #5, #3 and #4 respectively. Line six displays the percentage occurrence of inversions which were not surface based.

Table 4 displays the strength and occurrence of inversions for the four instrumented atmospheric layers in the valley. Most of the occurrences would be classed "E" type stability according to the Pasquill-Gifford classification (Table 5), while there were 11 hours when the "extremely stable" class occurred in the lowest layer.

2. Wind Data

As shown in Table 1, hourly wind data were recorded at Station #1 and Station #4 by Weather Measure model WS-755 instruments in 1979 and 1980. An additional instrument was located at the base camp to record the wind flow in the Lillooet valley. (In the B. C. Hydro meteorological station listing, and subsequent computer printout of data analyses, the base camp station is numbered 116550, Station #1 is 116551 and Station #4 is 116554.)

Tables 6 and 7 are computer printouts of monthly wind frequency distributions for these three stations for 1979 and 1980 respectively. Added to the June display for each station is a summary of the seasonal percentage frequency wind direction and mean wind speed (km/hour) derived from these computer printouts.

3. Other Data

In addition to wind data, the model WS-755 records hourly humidity and temperature. A computer listing of these data is available for the three stations for each year but the data have not been summarized.

Tapes from the MATER automatic weather station near Job Creek are being processed by AES headquarters in Toronto. Due to modifications in their data tape handling procedures, insufficient data have been returned to B. C. Hydro for analysis up to this time.

DISCUSSION OF RESULTS

In a comparison of 1979 hygrothermograph and wind data sets with those of 1980, it was noted that there were some significant differences. For example, inversions were more frequent and more intense between Stations #1 and #2 and between #1 and #4 in 1979 than in 1980. In the Station #4 wind data, west winds prevailed by a large margin in 1979, while in 1980 southwest winds were very frequent. Discussions with meteorologists at the AES Pacific Weather Centre revealed that the study months in 1979 were warmer and drier than normal over southwestern British Columbia, while 1980 was colder and wetter. As an example of these climatological departures from normal, Table 8 contains the 30 year normals of climatological data for Vancouver International Airport for July, August and September and the same parameters for these months in 1979 and 1980. The table shows that the months in 1979 were slightly drier than normal, while in 1980 precipitation exceeded normal by almost half. Other climatological stations in southwestern British Columbia showed similar trends.

The implication here is that there was very much more cloud in 1980 and that storm activity was much greater, both of which would inhibit inversion formation. As for the discrepancy in the upper level wind flow, the Pacific ridge of high pressure which develops off the British Columbia coast in summer and dominates the weather pattern, was depressed in 1980 as a series of storms crossed the coast, hence upper winds which are normally westerlies were backed to southwesterlies.

The fact that Meager Creek weather departed to both sides of normal is a benefit since Tables 3 and 4 include data from both years and hence describe a situation close to normal for the shallow and deep inversions. Inversions delineated by Stations #5 and #3 are calculated from only 1980 data and, therefore, are probably more frequent than indicated in Table 3.

The pattern of diurnal inversion occurrence is as expected, with surface based inversions most frequent overnight, while inversions aloft have their greatest frequency a few hours after sunrise when the most rapid surface warming occurs.

The wind patterns exhibited in Tables 6 and 7 are in good agreement with the topography for the base camp data and for the large scale flow pattern for the mountain top data from Station #4. Data from Station #1 show a complex circulation in the valley bottom, being a combination of valley flow, cross valley flow and slope flow. A diurnal analysis of the wind data will reveal the hours when each of these occur.

STUDIES BEYOND 1980 - RECOMMENDATIONS

Hygrothermograph studies in 1979 and 1980 have revealed the gross vertical temperature structure in Meager Creek valley and its diurnal changes. Seasonal changes cannot be investigated in this manner so the method will be replaced by intensive minisonde studies during selected meteorological situations on a seasonal basis.

The climatological station at the base camp should be continued on a year round basis, if possible.

Surface wind data should continue to be collected, on a year round basis, if possible, at the base camp and at a site in Meager Creek valley.

It is recommended that a Fischer-Porter precipitation guage be installed in Meager Creek valley adjacent to the drill area.

The MATER automatic weather station should continue to operate in the Job Creek area and the station should be augmented with a Fischer-Porter precipitation guage for winter snowfall measurement.

REFERENCES

1. "Ground Based Inversion Frequencies Determined From Surface Climatological Data", J. H. Emslie, 1978, Boundary Layer Meteorology, 16 (1979), 409-419.

2. "A Comparison of Atmospheric Temperature Structure at the Wall and in the Middle of a Valley", S. Barr, et al, Proc. Am. Meteorol. Soc. Second Conference on Applications of Air Pollution Meteorology, 1980, New Orleans, La.

3. "Meager Creek - Preliminary Investigation of the Temperature Stratification in the Valley", 27 December 1979.

LIST OF TABLES

TABLE 1

METEOROLOGICAL STATIONS AND INSTRUMENTATION
IN THE MEAGER CREEK VALLEY, 1979/80

Station Number	Location Elevation (MSL)	Elevation Above Station #1	Instrumentation
1	562.4 m in logging clear cut at valley bottom	0	Cassella hygrothermograph model T9154 in Stevenson screen. Weather Measure model WS-755 on ten foot tower. Fischer Porter precipitation gauge model 35B-1559 (not available in 1980).
2	679.7 m in logging clear cut	117.3 m	Cassella hygrothermograph model T9154 in Stevenson screen.
5	858.0 m (1980 only) in logging clear cut	295.7 m	Cassella hygrothermograph model T9154 in Stevenson screen.
3	1,310.6 m (1979) on avalanche run out	748.3 m	Cassella hygrothermograph model T9154 in Stevenson screen.
	1,322.8 m (1980) on wooded promentary	760.5 m	
4	1,720.6 m on shrub covered rocky knoll at treeline	1,158.2 m	Cassella hygrothermograph model T9154 in Stevenson screen. Weather Measure model WS-755 on ten foot tower.

TABLE 2

HYGROTHERMOGRAPH/MINISONDE TEMPERATURE COMPARISON

Date	Time PST		Station #1 (0 m)	Station #2 (117.3 m)	Station #3 (760.5 m)	Station #4 (1,158.2 m)
16 Sep./80	1455	hygro	24.5°C	24.0	19.5	14.0
		mini	24.1	22.8	17.7	13.3
		diff	+ 0.4	+ 1.2	+ 1.8	+ 0.7
	1530	hygro	24.0	23.5	19.5	13.5
		mini	23.7	22.8	-	-
		diff	+ 0.3	+ 0.7		
	1555	hygro	23.5	23.5	19.0	13.0
		mini	23.7	22.7	16.4	12.5
		diff	- 0.2	+ 0.8	+ 2.6	+ 0.5
17 Sep./80	0720	hygro	12.0	11.8	9.0	7.2
		mini	12.1	12.3	8.8	7.0
		diff	- 0.1	- 0.5	+ 0.2	+ 0.2
	0812	hygro	13.4	12.6	10.0	7.8
		mini	13.6	12.9	8.8	7.1
		diff	- 0.2	- 0.3	+ 1.2	+ 0.7
	0902	hygro	13.6	13.5	10.1	7.9
		mini	13.6	13.2	9.5	7.7
		diff	0.0	+ 0.3	+ 0.6	+ 0.2
	1045	hygro	17.4	15.0	12.8	9.2
		mini	17.5	16.2	12.8	9.5
		diff	- 0.1	- 1.2	0.0	- 0.3

TABLE 3

Hour (PST)	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Nil Inversions	18	15	17	17	21	16	19	26	40	45	47	54	54	53	49	53	47	35	20	21	29	26	26	21
Inversion - Surface to 117.3 m	59	61	58	59	52	55	51	43	25	25	32	35	40	40	40	41	39	46	64	65	60	59	57	54
Inversion - Surface to 295.7 m	0	3	0	0	0	0	0	0	0	0	3	0	3	3	9	3	8	11	9	6	0	3	0	3
Inversion - Surface to 760.5 m	6	5	5	4	6	7	6	3	1	1	2	1	1	0	0	1	0	0	2	2	3	3	4	6
Inversion - Surface to 1158.2 m	12	14	17	17	19	19	20	15	11	9	5	3	1	1	0	0	0	1	3	3	4	3	7	12
Inversion Aloft	5	2	3	3	2	3	4	13	23	20	11	7	1	3	2	2	6	7	2	3	3	6	6	4

Percentage Frequency and Depth of Inversions by Hour
Meager Creek (27 June - 17 September 1979, 26 June - 30 September, 1980) *

* NOTE: Data were available from the hygrothermograph at 295.7 m from August 27 to 30 September 1980, and from the hygrothermograph at 760.5 m from July 4 to 30 September 1980.

TABLE 4

Temperature Difference (°C)	Stn. 2 / Stn. 1	% of Total Hours	Stab. Class	Stn. 5 / Stn. 1	% of Total Hours	Stab. Class	Stn. 3 / Stn. 1	% of Total Hours	Stab. Class	Stn. 4 / Stn. 1	% of Total Hours	Stab. Class
0	878	20.7	E	57	7.4	E	49	2.4	E	97	2.8	E
0.5	683	16.1	E	18	2.3	E	47	2.3	E	71	2.0	E
1.0	447	10.5	E	9	1.2	E	40	1.9	E	70	2.0	E
1.5	309	7.3	E	8	1.0	E	34	1.6	E	66	1.9	E
2.0	176	4.2	F	3	0.4	E	30	1.4	E	55	1.6	E
2.5	74	1.7	F	1	0.1	E	15	0.7	E	60	1.7	E
3.0	39	0.9	F	3	0.4	E	25	1.2	E	37	1.1	E
3.5	12	0.3	F	2	0.3	E	15	0.7	E	29	0.8	E
4.0	10	0.2	F				3	0.1	E	25	0.7	E
4.5	7	0.2	F	1	0.1	F	2	0.1	E	27	0.8	E
5.0	4	0.1	G				1	<0.1	E	17	0.5	E
5.5	3	0.1	G							21	0.6	E
6.0	3	0.1	G							17	0.5	E
6.5	1	<0.1	G							10	0.3	E
7.0										5	0.1	E
7.5										4	0.1	E
8.0										6	0.2	E
8.5										3	0.1	E
9.0												
9.5												
10.0										1	<0.1	E
Total Hours	4239	62.4		768	13.3		2085	12.5		3470	18.0	

Occurrences of Inversion by Temperature Difference and Depth, Percentage of the Total Hours for Each Temperature Difference, and Stability Classification

TABLE 5

Classification of Atmospheric Stability
According to AEC Safety Guide 23.

Stability Classification	Pasquill Categories	Temperature Change With Height (°C/100m)
Extremely unstable	A	<-1.9
Moderately unstable	B	-1.9 to -1.7
Slightly unstable	C	-1.7 to -1.5
Neutral	D	-1.5 to -0.5
Slightly stable	E	-0.5 to 1.5
Moderately stable	F	1.5 to 4.0
Extremely stable	G	> 4.0
Dry Adiabatic		-1.0
Moist Adiabatic		-0.7

TABLE 6

BRITISH COLUMBIA HYDRO & POWER AUTHORITY

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116550 YEAR=79 MONTH=6

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	7 W	8 NW	TOTAL
2 - 5	7.20	0.00	2.40	2.40	1.60	5.60	5.60	24.80
6 - 11	12.80	0.00	8.00	12.80	8.00	3.20	22.40	67.20
12 - 19	0.00	0.80	1.60	3.20	1.60	0.00	0.00	7.20
39 +	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.80
TOTAL	25 20.00	1 0.80	15 12.00	23 18.40	14 11.20	11 8.80	36 28.80	125 100.00

SEASON	N	NE	E	SE	S	SW	W	NW	Calm	TOTAL
Total	285	67	255	293	219	105	213	423	102	1962
Percent	15	3	13	15	11	5	11	22	5	

Mean Speed 5.4

BRITISH COLUMBIA HYDRO & POWER AUTHORITY

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116550 YEAR=79 MONTH=7

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.18	4.18
2 - 5	5.80	0.67	1.62	4.31	6.33	2.96	7.55	14.69	0.00	43.94
6 - 11	10.24	0.40	3.37	6.74	7.55	1.89	1.08	16.98	0.00	48.25
12 - 19	0.27	0.13	1.35	1.48	0.00	0.00	0.00	0.40	0.00	3.64
TOTAL	121	9	47	93	103	36	64	238	31	742
	16.31	1.21	6.33	12.53	13.88	4.85	8.63	32.08	4.18	100.00

BRITISH COLUMBIA HYDRO & POWER AUTHORITY

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116550 YEAR=79 MONTH=8

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.09	4.09
2 - 5	5.17	1.08	2.59	3.45	6.68	5.17	11.21	6.03	0.00	41.38
6 - 11	10.13	1.29	5.17	7.76	6.03	1.29	7.11	13.15	0.00	51.94
12 - 19	0.43	0.00	0.65	0.43	0.00	0.00	0.00	0.86	0.00	2.37
39 +	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22
TOTAL	74	11	39	54	59	30	85	93	19	464
	15.95	2.37	8.41	11.64	12.72	6.47	18.32	20.04	4.09	100.00

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116550 YEAR=79 MONTH=9

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.43	8.43
2 - 5	4.55	6.75	21.75	14.50	6.24	5.23	5.06	5.73	0.00	69.81
6 - 11	4.89	0.84	3.88	5.56	0.51	0.51	2.36	2.70	0.00	21.25
12 - 19	0.00	0.00	0.00	0.17	0.00	0.00	0.17	0.17	0.00	0.51
TOTAL	56	45	152	120	40	34	45	51	50	593
	9.44	7.59	25.63	20.24	6.75	5.73	7.59	8.60	8.43	100.00

BRITISH COLUMBIA HYDRO & POWER AUTHORITY

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116550 YEAR=79 MONTH=10

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.26	5.26
2 - 5	15.79	0.00	5.26	5.26	5.26	13.16	21.05	7.89	0.00	73.68
6 - 11	7.89	2.63	0.00	2.63	2.63	0.00	0.00	5.26	0.00	21.05
TOTAL	9	1	2	3	3	5	8	5	2	38
	23.68	2.63	5.26	7.89	7.89	13.16	21.05	13.16	5.26	100.00

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116551 YEAR=79 MONTH=6

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	3 E	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	2.47	2.47
2 - 5	2.47	0.00	0.00	3.70	9.88	2.47	0.00	18.52
6 - 11	7.41	3.70	3.70	34.57	24.69	0.00	0.00	74.07
12 - 19	0.00	1.23	0.00	1.23	2.47	0.00	0.00	4.94
TOTAL	8	4	3	32	30	2	2	81
	9.88	4.94	3.70	39.51	37.04	2.47	2.47	100.00

SEASON	N	NE	E	SE	S	SW	W	NW	Calm	TOTAL
Total	203	25	227	147	42	342	846	364	146	2342
Percent	9	1	10	6	2	15	36	15	6	

Mean Speed 5.9

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116551 YEAR=79 MONTH=7

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.38	5.38
2 - 5	10.77	0.00	1.35	0.27	0.54	3.63	4.98	7.27	0.00	28.80
6 - 11	6.46	0.13	7.13	0.54	1.62	25.03	20.59	1.75	0.00	63.26
12 - 19	1.21	0.00	1.21	0.00	0.00	0.00	0.13	0.00	0.00	2.56
TOTAL	137	1	72	6	16	213	191	67	40	743
	18.44	0.13	9.69	0.81	2.15	28.67	25.71	9.02	5.38	100.00

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116551 YEAR=79 MONTH=8

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.98	4.98
2 - 5	1.48	1.48	1.62	4.17	1.35	2.96	10.63	9.02	0.13	32.84
6 - 11	0.40	0.00	6.59	4.04	0.00	6.06	30.28	11.44	0.00	58.82
12 - 19	0.00	0.00	2.42	0.27	0.00	0.13	0.00	0.13	0.00	2.96
20 - 28	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.13
39 +	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.27
TOTAL	14	11	79	63	10	68	307	153	38	743
	1.88	1.48	10.63	8.48	1.35	9.15	41.32	20.59	5.11	100.00

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116551 YEAR=79 MONTH=9

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.18	9.18
2 - 5	4.73	1.53	4.73	5.42	1.81	3.62	13.07	13.77	0.00	48.68
6 - 11	1.11	0.00	3.89	4.45	0.00	0.42	26.01	5.42	0.00	41.31
12 - 19	0.00	0.00	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.56
39 +	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.28
TOTAL	42	11	66	71	13	29	283	138	66	719
	5.84	1.53	9.18	9.87	1.81	4.03	39.36	19.19	9.18	100.00

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116551 YEAR=79 MONTH=10

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	7 W	8 NW	TOTAL
2 - 5	3.57	3.57	5.36	7.14	17.86	5.36	42.86
6 - 11	0.00	0.00	5.36	5.36	44.64	1.79	57.14
TOTAL	2	2	6	7	35	4	56
	3.57	3.57	10.71	12.50	62.50	7.14	100.00

BRITISH COLUMBIA HYDRO & POWER AUTHORITY

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116554 YEAR=79 MONTH=6

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.76	4.76
2 - 5	0.95	0.00	3.81	2.86	0.00	3.81	1.90	0.00	13.33
6 - 11	0.00	0.95	2.86	1.90	2.86	10.48	0.00	0.00	19.05
12 - 19	0.00	0.95	0.95	0.00	5.71	12.38	2.86	0.00	22.86
20 - 28	0.00	0.00	0.00	0.00	2.86	22.86	0.00	0.00	25.71
29 - 38	0.00	0.00	0.00	0.00	0.00	12.38	0.00	0.00	12.38
39 +	0.00	0.00	0.00	0.00	0.00	1.90	0.00	0.00	1.90
TOTAL	1	2	8	5	12	67	5	5	105
	0.95	1.90	7.62	4.76	11.43	63.81	4.76	4.76	100.00

SEASON	N	NE	E	SE	S	SW	W	NW	Calm	TOTAL
Total	10	43	136	185	76	167	592	47	31	1287
Percent	1	3	11	14	6	13	46	4	2	

Mean Speed 13.3

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116554 YEAR=79 MONTH=7

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.89	1.89
2 - 5	0.81	0.94	0.81	2.56	2.56	2.96	2.70	1.35	0.00	14.69
6 - 11	0.13	2.70	3.91	4.99	2.56	5.26	10.51	2.43	0.00	32.48
12 - 19	0.00	0.54	4.72	3.23	1.48	3.23	14.15	0.40	0.00	27.76
20 - 28	0.00	0.00	0.54	1.08	0.00	1.75	13.07	0.00	0.00	16.44
29 - 38	0.00	0.00	0.00	0.00	0.00	0.13	6.20	0.00	0.00	6.33
39 +	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.40
TOTAL	7	31	74	88	49	99	349	31	14	742
	0.94	4.18	9.97	11.86	6.60	13.34	47.04	4.18	1.89	100.00

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116554 YEAR=79 MONTH=8

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	3.70
2 - 5	0.31	2.16	1.23	3.40	1.54	3.09	1.85	0.00	0.00	13.58
6 - 11	0.00	0.93	7.41	11.11	2.47	1.54	14.51	1.85	0.00	39.81
12 - 19	0.00	0.00	4.32	4.32	0.00	3.09	18.83	0.31	0.00	30.86
20 - 28	0.00	0.00	0.00	0.62	0.00	2.47	6.79	0.00	0.00	9.88
29 - 38	0.00	0.00	0.00	0.00	0.00	0.00	1.23	0.00	0.00	1.23
39 +	0.00	0.00	0.00	0.00	0.00	0.00	0.93	0.00	0.00	0.93
TOTAL	1	10	42	63	13	33	143	7	12	324
	0.31	3.09	12.96	19.44	4.01	10.19	44.14	2.16	3.70	100.00

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116554 YEAR=79 MONTH=9

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	TOTAL
2 - 5	0.00	0.86	5.17	3.45	4.31	5.17	0.86	0.86	20.69
6 - 11	1.72	0.00	4.31	8.62	3.45	6.90	6.03	2.59	33.62
12 - 19	0.00	0.00	5.17	9.48	0.00	6.03	7.76	0.00	28.45
20 - 28	0.00	0.00	0.86	0.86	0.00	1.72	7.76	0.00	11.21
29 - 38	0.00	0.00	0.00	0.00	0.00	0.00	6.03	0.00	6.03
TOTAL	2	1	18	26	9	23	33	4	116
	1.72	0.86	15.52	22.41	7.76	19.83	28.45	3.45	100.00

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - CLIMAT STATION-BASE CAMP YEAR=79 MONTH=JUNE

RDIR		NSPED	MEANSPED
1	N	25	5.84
2	NE	1	16.00
3	E	15	6.93
4	SE	23	8.07
5	S	14	8.11
7	W	11	5.09
8	NW	36	9.03
99	MEAN	125	7.57

N=8

BRITISH COLUMBIA HYDRO & POWER AUTHORITY

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - CLIMAT STATION-BASE CAMP YEAR=79 MONTH=JULY

RDIR		NSPED	MEANSPED
1	N	121	5.99
2	NE	9	5.39
3	E	47	8.18
4	SE	93	6.88
5	S	103	5.44
6	SW	36	4.50
7	W	64	3.84
8	NW	238	5.93
9	CALM	31	1.02
99	MEAN	742	5.67

N=10

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - CLIMAT STATION-BASE CAMP YEAR=79 MONTH=AUGUST

RDIR		NSPED	MEANSPED
1	N	74	6.76
2	NE	11	5.59
3	E	39	7.28
4	SE	54	6.60
5	S	59	5.48
6	SW	30	4.28
7	W	85	4.77
8	NW	93	6.60
9	CALM	19	1.32
99	MEAN	464	5.82

N=10

BRITISH COLUMBIA HYDRO & POWER AUTHORITY

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - CLIMAT STATION-BASE CAMP YEAR=79 MONTH=SEPTEMBER

RDIR		NSPED	MEANSPED
1	N	56	5.37
2	NE	45	3.82
3	E	152	3.88
4	SE	120	4.62
5	S	40	3.42
6	SW	34	3.40
7	W	45	4.90
8	NW	51	4.68
9	CALM	50	1.29
99	MEAN	593	4.04

N=10

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - CLIMAT STATION-BASE CAMP YEAR=79 MONTH=OCTOBER

RDIR		NSPED	MEANSPED
1	N	9	4.11
2	NE	1	6.50
3	E	2	3.25
4	SE	3	4.50
5	S	3	5.33
6	SW	5	3.50
7	W	8	3.63
8	NW	5	5.00
9	CALM	2	1.00
99	MEAN	38	4.03

N=10

BRITISH COLUMBIA HYDRO & POWER AUTHORITY 20

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - MACHINE SHOP YEAR=79 MONTH=JUNE

RDIR		NSPED	MEANSPED
1	N	8	6.94
3	E	4	9.88
5	S	3	7.17
6	SW	32	7.22
7	W	30	7.07
8	NW	2	2.50
9	CALM	2	0.75
99	MEAN	81	6.99

N=8

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - MACHINE SHOP YEAR=79 MONTH=JULY

RDIR		NSPED	MEANSPED
1	N	137	5.74
2	NE	1	5.50
3	E	72	8.00
4	SE	6	5.92
5	S	16	6.03
6	SW	213	6.97
7	W	191	6.56
8	NW	67	4.07
9	CALM	40	1.13
99	MEAN	743	6.13

N=10

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - MACHINE SHOP YEAR=79 MONTH=AUGUST

RDIR		NSPED	MEANSPED
1	N	14	3.86
2	NE	11	3.05
3	E	79	8.39
4	SE	63	5.81
5	S	10	3.50
6	SW	68	6.18
7	W	307	6.65
8	NW	153	5.42
9	CALM	38	0.93
99	MEAN	743	6.03

N=10

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - MACHINE SHOP YEAR=79 MONTH=SEPTEMBER

RDIR		NSPED	MEANSPED
1	N	42	3.74
2	NE	11	2.82
3	E	66	5.73
4	SE	71	5.18
5	S	13	3.92
6	SW	29	3.40
7	W	283	6.39
8	NW	138	4.33
9	CALM	66	1.13
99	MEAN	719	4.96

N=10

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - MACHINE SHOP YEAR=79 MONTH=OCTOBER

RDIR		NSPED	MEANSPED
1	N	2	3.25
2	NE	2	3.25
3	E	6	6.42
4	SE	7	5.86
7	W	35	5.51
8	NW	4	5.13
99	MEAN	56	5.46

N=7

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - MOUNTAIN YEAR=79 MONTH=JUNE

RDIR		NSPED	MEANSPED
2	NE	1	4.50
3	E	2	11.25
4	SE	8	6.94
5	S	5	5.20
6	SW	12	14.46
7	W	67	20.60
8	NW	5	11.10
9	CALM	5	1.00
99	MEAN	105	16.41

N=9

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - MOUNTAIN YEAR=79 MONTH=JULY

RDIR		NSPED	MEANSPED
1	N	7	4.07
2	NE	31	7.89
3	E	74	11.72
4	SE	88	10.09
5	S	49	7.39
6	SW	99	11.00
7	W	349	17.82
8	NW	31	7.53
9	CALM	14	1.07
99	MEAN	742	13.41

N=10

BRITISH COLUMBIA HYDRO & POWER AUTHORITY

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - MOUNTAIN YEAR=79 MONTH=AUGUST

RDIR		NSPED	MEANSPED
1	N	1	3.00
2	NE	10	4.50
3	E	42	9.80
4	SE	63	9.16
5	S	13	5.62
6	SW	33	11.55
7	W	143	14.73
8	NW	7	8.86
9	CALM	12	1.00
99	MEAN	324	11.33

N=10

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - MOUNTAIN YEAR=79 MONTH=SEPTEMBER

RDIR		NSPED	MEANSPED
1	N	2	5.75
2	NE	1	4.50
3	E	18	9.69
4	SE	26	11.40
5	S	9	5.44
6	SW	23	10.33
7	W	33	18.64
8	NW	4	7.13
99	MEAN	116	12.22

N=9

TABLE 7

BRITISH COLUMBIA HYDRO & POWER AUTHORITY

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116550 YEAR=80 MONTH=6

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.09	9.09
2 - 5	1.30	2.60	6.49	9.09	1.30	3.90	10.39	11.69	0.00	46.75
6 - 11	1.30	10.39	7.79	10.39	1.30	1.30	6.49	3.90	0.00	42.86
12 - 19	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.30
TOTAL	3 3.90	10 12.99	11 14.29	15 19.48	2 2.60	4 5.19	13 16.88	12 15.58	7 9.09	77 100.00

SEASON	N	NE	E	SE	S	SW	W	NW	Calm	TOTAL
Total	476	54	169	399	214	61	148	536	425	2482
Percent	19	2	7	16	9	2	6	22	17	

Mean Speed 4.2

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116550 YEAR=80 MONTH=7

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.71	4.71
2 - 5	11.57	1.08	3.90	6.59	1.88	2.69	7.00	13.59	0.00	48.32
6 - 11	9.15	1.75	9.29	10.23	1.48	0.13	4.85	8.08	0.00	44.95
12 - 19	0.13	0.00	0.81	0.94	0.00	0.00	0.00	0.13	0.00	2.02
TOTAL	155	21	104	132	25	21	88	162	35	743
	20.86	2.83	14.00	17.77	3.36	2.83	11.84	21.80	4.71	100.00

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116550 YEAR=80 MONTH=8

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.01	7.01
2 - 5	21.70	0.40	1.89	5.12	5.66	1.89	3.10	20.89	0.00	60.65
6 - 11	5.12	0.13	1.35	9.57	7.55	0.54	0.94	4.58	0.00	29.78
12 - 19	1.21	0.00	0.27	0.40	0.13	0.00	0.13	0.27	0.00	2.43
29 - 38	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.13
TOTAL	208	4	27	112	99	18	31	191	52	742
	28.03	0.54	3.64	15.09	13.34	2.43	4.18	25.74	7.01	100.00

BRITISH COLUMBIA HYDRO & POWER AUTHORITY

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116550 YEAR=80 MONTH=9

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.57	33.57
2 - 5	11.42	1.67	0.84	11.56	6.69	1.25	1.25	14.76	0.00	49.44
6 - 11	1.39	0.00	0.97	6.55	3.34	0.28	0.00	2.23	0.00	14.76
12 - 19	0.14	0.00	0.28	0.14	0.00	0.00	0.00	1.39	0.00	1.95
20 - 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.28
TOTAL	93	12	15	131	72	11	9	134	241	718
	12.95	1.67	2.09	18.25	10.03	1.53	1.25	18.66	33.57	100.00

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116550 YEAR=80 MONTH=10

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44.55	44.55
2 - 5	8.42	1.98	1.98	3.96	6.93	3.47	3.47	15.84	0.00	46.04
6 - 11	0.00	1.49	1.49	0.50	0.99	0.00	0.00	2.48	0.00	6.93
12 - 19	0.00	0.00	2.48	0.00	0.00	0.00	0.00	0.00	0.00	2.48
TOTAL	17	7	12	9	16	7	7	37	90	202
	8.42	3.47	5.94	4.46	7.92	3.47	3.47	18.32	44.55	100.00

BRITISH COLUMBIA HYDRO & POWER AUTHORITY

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116551 YEAR=80 MONTH=6

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	3 E	4 SE	5 S	6 SW	7 W	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	10.00	10.00
2 - 5	0.00	2.50	13.75	32.50	3.75	5.00	0.00	57.50
6 - 11	7.50	1.25	7.50	11.25	1.25	0.00	0.00	28.75
12 - 19	3.75	0.00	0.00	0.00	0.00	0.00	0.00	3.75
TOTAL	9	3	17	35	4	4	8	80
	11.25	3.75	21.25	43.75	5.00	5.00	10.00	100.00

SEASON	N	NE	E	SE	S	SW	W	NW	Calm	TOTAL
Total	290	172	25	220	1079	415	59	14	208	2482
Percent	12	7	1	9	43	17	2	1	8	

Mean Speed 5.3

BRITISH COLUMBIA HYDRO & POWER AUTHORITY

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116551 YEAR=80 MONTH=7

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.57	4.57
2 - 5	4.30	1.34	1.34	4.84	13.71	6.32	1.08	0.81	0.00	33.74
6 - 11	8.87	2.55	0.40	12.37	29.17	6.99	0.13	0.13	0.00	60.62
12 - 19	0.40	0.40	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.94
39 +	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.13
TOTAL	101	32	13	128	321	99	9	7	34	744
	13.58	4.30	1.75	17.20	43.15	13.31	1.21	0.94	4.57	100.00

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116551 YEAR=80 MONTH=8

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.99	4.99
2 - 5	3.23	2.83	0.94	4.99	16.98	8.76	1.62	0.27	0.00	39.62
6 - 11	8.63	4.18	0.13	3.10	29.11	8.89	0.13	0.00	0.00	54.18
12 - 19	0.54	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.21
TOTAL	92	57	8	60	342	131	13	2	37	742
	12.40	7.68	1.08	8.09	46.09	17.65	1.75	0.27	4.99	100.00

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116551 YEAR=80 MONTH=9

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.76	16.76
2 - 5	6.42	4.19	0.14	1.40	14.80	12.29	3.63	0.70	0.00	43.58
6 - 11	3.77	4.33	0.00	0.14	21.23	8.10	0.56	0.00	0.00	38.13
12 - 19	0.00	1.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.54
TOTAL	73	72	1	11	258	146	30	5	120	716
	10.20	10.06	0.14	1.54	36.03	20.39	4.19	0.70	16.76	100.00

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116551 YEAR=80 MONTH=10

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	4 SE	5 S	6 SW	7 W	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	4.50	4.50
2 - 5	5.50	4.50	2.00	26.00	7.50	1.50	0.00	47.00
6 - 11	2.00	1.00	0.00	35.50	9.50	0.00	0.00	48.00
12 - 19	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.50
TOTAL	15	11	4	123	35	3	9	200
	7.50	5.50	2.00	61.50	17.50	1.50	4.50	100.00

BRITISH COLUMBIA HYDRO & POWER AUTHORITY

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116554 YEAR=80 MONTH=7

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61	0.61
2 - 5	0.41	0.41	0.82	1.43	1.22	4.69	1.02	0.41	0.00	10.41
6 - 11	0.61	1.22	1.02	0.61	0.82	14.29	1.22	0.61	0.00	20.41
12 - 19	0.00	0.20	0.41	0.20	0.00	22.65	5.31	0.00	0.00	28.78
20 - 28	0.00	0.00	0.00	0.00	0.00	19.80	8.37	0.00	0.00	28.16
29 - 38	0.00	0.00	0.00	0.00	0.00	7.35	3.67	0.00	0.00	11.02
39 +	0.00	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.00	0.61
TOTAL	5 1.02	9 1.84	11 2.24	11 2.24	10 2.04	340 69.39	96 19.59	5 1.02	3 0.61	490 100.00

SEASON	N	NE	E	SE	S	SW	W	NW	Calm	TOTAL
Total	31	137	239	77	80	1039	488	34	31	2156
Percent	1	6	11	4	4	48	23	2	1	

Mean Speed 14.2

BRITISH COLUMBIA HYDRO & POWER AUTHORITY

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116554 YEAR=80 MONTH=8

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.08	1.08
2 - 5	1.48	1.21	0.94	0.40	1.35	4.44	1.21	0.27	0.00	11.31
6 - 11	1.62	5.65	5.92	0.67	0.00	12.25	5.25	1.48	0.00	32.84
12 - 19	0.00	4.17	3.63	0.54	0.00	13.86	6.59	0.00	0.00	28.80
20 - 28	0.00	0.81	0.27	0.00	0.00	9.29	4.44	0.00	0.00	14.80
29 - 38	0.00	0.13	0.00	0.00	0.00	5.79	4.17	0.00	0.00	10.09
39 +	0.00	0.00	0.00	0.00	0.00	0.94	0.13	0.00	0.00	1.08
TOTAL	23	89	80	12	10	346	162	13	8	743
	3.10	11.98	10.77	1.62	1.35	46.57	21.80	1.75	1.08	100.00

BRITISH COLUMBIA HYDRO & POWER AUTHORITY

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116554 YEAR=80 MONTH=9

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	1 N	2 NE	3 E	4 SE	5 S	6 SW	7 W	8 NW	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.50	2.50
2 - 5	0.42	0.83	1.67	0.56	3.06	5.01	3.34	0.70	0.00	15.58
6 - 11	0.00	0.00	5.70	1.67	1.67	13.35	6.54	1.53	0.00	30.46
12 - 19	0.00	1.39	5.56	1.95	0.14	9.32	7.23	0.00	0.00	25.59
20 - 28	0.00	3.06	2.50	0.28	0.00	6.54	7.51	0.00	0.00	19.89
29 - 38	0.00	0.14	0.00	0.00	0.00	1.39	2.78	0.00	0.00	4.31
39 +	0.00	0.00	0.00	0.00	0.00	0.56	1.11	0.00	0.00	1.67
TOTAL	3	39	111	32	35	260	205	16	18	719
	0.42	5.42	15.44	4.45	4.87	36.16	28.51	2.23	2.50	100.00

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=116554 YEAR=80 MONTH=10

TABLE OF RSPEED BY RDIR

RSPEED SPEED (KM/H) RDIR DIRECTION

PERCENT	3 E	4 SE	5 S	6 SW	7 W	9 CALM	TOTAL
CALM	0.00	0.00	0.00	0.00	0.00	0.98	0.98
2 - 5	3.92	2.45	7.35	10.78	1.96	0.00	26.47
6 - 11	3.92	1.47	4.90	15.69	1.47	0.00	27.45
12 - 19	8.82	6.86	0.00	14.22	3.43	0.00	33.33
20 - 28	1.47	0.00	0.00	3.43	0.49	0.00	5.39
29 - 38	0.00	0.00	0.00	1.47	3.43	0.00	4.90
39 +	0.00	0.00	0.00	0.00	1.47	0.00	1.47
TOTAL	37	22	25	93	25	2	204
	18.14	10.78	12.25	45.59	12.25	0.98	100.00

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - CLIMAT STATION-BASE CAMP YEAR=80 MONTH=JUNE

RDIR		NSPED	MEANSPED
1	N	3	7.33
2	NE	10	7.90
3	E	11	5.36
4	SE	15	5.87
5	S	2	4.50
6	SW	4	4.50
7	W	13	4.69
8	NW	12	4.17
9	CALM	7	1.00
99	MEAN	77	5.10

N=10

BRITISH COLUMBIA HYDRO & POWER AUTHORITY

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - CLIMAT STATION-BASE CAMP YEAR=80 MONTH=JULY

RDIR		NSPED	MEANSPED
1	N	155	5.34
2	NE	21	6.38
3	E	104	6.78
4	SE	132	6.74
5	S	25	5.28
6	SW	21	3.29
7	W	88	4.92
8	NW	162	4.92
9	CALM	35	1.00
99	MEAN	743	5.41

N=10

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - CLIMAT STATION-BASE CAMP YEAR=80 MONTH=AUGUST

RDIR		NSPED	MEANSPED
1	N	208	4.12
2	NE	4	5.25
3	E	27	6.70
4	SE	112	6.61
5	S	99	6.08
6	SW	18	4.17
7	W	31	4.74
8	NW	191	3.95
9	CALM	52	0.83
99	MEAN	742	4.61

N=10

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - CLIMAT STATION-BASE CAMP YEAR=80 MONTH=SEPTEMBER

RDIR		NSPED	MEANSPED
1	N	93	3.52
2	NE	12	2.63
3	E	15	6.67
4	SE	131	4.56
5	S	72	4.57
6	SW	11	4.05
7	W	9	3.28
8	NW	134	4.65
9	CALM	241	1.01
99	MEAN	718	3.24

N=10

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - CLIMAT STATION-BASE CAMP YEAR=80 MONTH=OCTOBER

RDIR		NSPED	MEANSPED
1	N	17	2.62
2	NE	7	5.00
3	E	12	8.46
4	SE	9	3.83
5	S	16	3.66
6	SW	7	2.50
7	W	7	2.71
8	NW	37	3.18
9	CALM	90	1.06
99	MEAN	202	2.59

N=10

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - MACHINE SHOP YEAR=80 MONTH=JUNE

RDIR		NSPED	MEANSPED
1	N	9	9.56
3	E	3	6.00
4	SE	17	5.12
5	S	35	5.03
6	SW	4	3.25
7	W	4	3.00
9	CALM	8	0.38
99	MEAN	80	4.94

N=8

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - MACHINE SHOP YEAR=80 MONTH=JULY

RDIR		NSPED	MEANSPED
1	N	101	6.68
2	NE	32	7.56
3	E	13	4.69
4	SE	128	6.27
5	S	321	6.47
6	SW	99	5.66
7	W	9	4.89
8	NW	7	3.43
9	CALM	34	0.76
99	MEAN	744	6.06

N=10

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - MACHINE SHOP YEAR=80 MONTH=AUGUST

RDIR		NSPED	MEANSPED
1	N	92	7.36
2	NE	57	7.05
3	E	8	4.13
4	SE	60	5.02
5	S	342	5.91
6	SW	131	5.51
7	W	13	3.38
8	NW	2	3.00
9	CALM	37	0.97
99	MEAN	742	5.72

N=10

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - MACHINE SHOP YEAR=80 MONTH=SEPTEMBER

RDIR		NSPED	MEANSPED
1	N	73	4.70
2	NE	72	6.64
3	E	1	2.00
4	SE	11	3.00
5	S	258	5.61
6	SW	146	4.83
7	W	30	3.98
8	NW	5	3.00
9	CALM	120	0.88
99	MEAN	716	4.54

N=10

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - MACHINE SHOP YEAR=80 MONTH=OCTOBER

RDIR		NSPED	MEANSPED
1	N	15	4.83
2	NE	11	4.18
4	SE	4	2.75
5	S	123	5.47
6	SW	35	5.70
7	W	3	2.83
9	CALM	9	1.06
99	MEAN	200	5.10

N=8

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - MOUNTAIN YEAR=80 MONTH=JULY

RDIR		NSPED	MEANSPED
1	N	5	5.30
2	NE	9	7.67
3	E	11	8.23
4	SE	11	6.09
5	S	10	4.95
6	SW	340	17.51
7	W	96	21.02
8	NW	5	5.60
9	CALM	3	0.83
99	MEAN	490	16.95

N=10

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - MOUNTAIN YEAR=80 MONTH=AUGUST

RDIR		NSPED	MEANSPED
1	N	23	6.37
2	NE	89	11.53
3	E	80	10.46
4	SE	12	8.17
5	S	10	4.45
6	SW	346	16.58
7	W	162	18.18
8	NW	13	7.08
9	CALM	8	1.25
99	MEAN	743	14.72

N=10

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - MOUNTAIN YEAR=80 MONTH=SEPTEMBER

RDIR		NSPED	MEANSPED
1	N	3	3.67
2	NE	39	19.21
3	E	111	12.51
4	SE	32	11.06
5	S	35	4.56
6	SW	260	13.31
7	W	205	17.04
8	NW	16	5.88
9	CALM	18	1.03
99	MEAN	719	13.53

N=10

HOURLY AVERAGE WIND SPEED BY WIND DIRECTION
FREQUENCY DISTRIBUTION

STN=MEAGER - MOUNTAIN YEAR=80 MONTH=OCTOBER

RDIR		NSPED	MEANSPED
3	E	37	11.62
4	SE	22	10.98
5	S	25	5.14
6	SW	93	11.14
7	W	25	21.68
9	CALM	2	1.50
99	MEAN	204	11.67

N=7

TABLE 8

CLIMATOLOGICAL DATA - VANCOUVER INTERNATIONAL AIRPORT

	July	August	September	Mean	% of Normal
1941-70 Normals					
Precipitation (m.m)	29.7	37.1	61.2	42.67	
Mean Temperature (^{o}C)	17.4	17.1	14.2	16.23	
Mean Maximum (^{o}C)	22.2	21.6	18.5	20.77	
Mean Minimum (^{o}C)	12.7	12.5	9.9	11.70	
1979					
Precipitation	26.6	18.6	78.9	41.37	97%
Mean Temperature	17.8	17.7	15.5	17.00	105%
Mean Maximum	22.7	22.1	19.4	21.40	103%
Mean Minimum	12.9	13.2	11.5	12.53	107%
1980					
Precipitation	67.6	22.8	97.9	62.77	147%
Mean Temperature	16.6	16.4	13.9	15.63	96%
Mean Maximum	20.7	20.5	17.5	19.57	94%
Mean Minimum	12.4	12.3	10.3	11.67	100%

APPENDIX A

27 December 1979

Meager Creek - Preliminary Investigation of the Temperature Stratification in the Valley

Introduction

During the summer of 1979 a study was conducted at Meager Creek to document the frequency, depth and strength of inversions, and the diurnal changes of these, in the Meager Creek valley.

A proven, expedient, method of doing this is to position thermographs on outcroppings on a valley side and to examine the recorded hourly temperature differences between instruments. The accuracy of results is highly dependent on using matched instrumentation as to response, timing and calibration. It is also dependent on site location such that the instruments, mounted in Stevenson Screens, are free of local cold air drainage and are, as much as possible, measuring free air temperatures.

Network Layout

Site selection in the Meager Creek valley was most difficult due to the rugged and heavily wooded nature of the valley sides, thus making access by helicopter limited and very difficult. Four sites were selected and instrumented; #1 on the valley floor, #2 on a logged-off ridge 385 feet above the valley floor, #3 on an avalanche runout at 2,455 feet above #1 and #4 at 3,750 feet above #1 on an exposed ridge below the summit. The four screens were, roughly, in line up the south side of the valley, and received approximately equal daily exposure to sunlight.

Site #3 was suspect from the outset, being on an avalanche track it was in the natural path of cold air drainage from the permanent snowfield on the ridge above. Even though the screen was positioned as high as possible on the mound of rubble at the base, the data from the instrument show that they are not compatible with those of the other three sites except through mid-day. Time and financial constraints of the study prohibited carving a suitable site and helicopter landing pad on any of the more desirable locations at that elevation.

Results

A. Inversion Frequency and Depth

Figure 1 displays the analysis of temperature differences by hours of the day. (Data from site #3 are not included.) Line one shows the percentage of the data period, by hours, in which no inversions were recorded between sites #1, #2 and #4. In other words, these are the hours in which the vertical dilution of emissions from a source

... 2

at the valley floor would not be inhibited by air stability.

Line two shows the percentage of the time in which hourly temperatures at site #2 were equal to, or higher than, those at site #1, i.e. hours in which in inversion was present from the valley floor to a depth of at least to site #2, with unstable air at higher levels. Line three shows the percentage of the time in which an inversion was present through the entire measured depth of the valley (3,750 feet).

Line four shows the percentage of the time in which no inversion was present between the valley floor and site #2, but was present between sites #2 and #4, i.e. the air was unstable at the surface, with a capping inversion.

B. Inversion Strength

An inversion was present in the layer from the valley floor to 385 feet on 81.5% of data hours during the study, and in the layer from the valley floor to 3,750 feet on 25.7% of hours. Figure 2 displays the number of occurrences of these inversions for each of the measured temperature differences, in increments of one half degree. As the temperature difference increases, the effective plume rise of emissions decreases. Thus the figures can be converted directly into frequencies of the various stability classifications.

Conclusions

Considering the very deep, narrow valley with permanent ice and snow fields capping the upper levels, the high frequency of inversions is not surprising. These are due to the continuous drainage of cold air from the ice fields down the valley sides. Overnight this drainage is reinforced by radiative cooling of the valley walls, resulting in the maximum frequency of very deep inversions just prior to sunrise. Following sunrise, warming of the valley bottom promotes inversion breakdown at the surface, while the inversion is still present aloft. During this period any overnight emission trapped within the inversion would be mixed, or fumigated, to the valley floor.

Inversions are least frequent during mid-day when the sun's heating is greatest and, combined with stronger daytime winds, promotes air mixing and the breakdown of inversions.

Through the depth of the valley, these preliminary measurements indicate that, overnight and in the early morning at least, the air is moderately to extremely stable for a considerable number of hours in the summer season. Accordingly, dispersion within the valley, and removal from the valley, of airborne emissions would be principally horizontal.

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Concurrent measurements of wind speed and direction at three sites during the study period will, when analysis is complete, show the magnitude and direction of the horizontal dilution and removal processes.

Recommendations

This study produced data from stationary sites for only one season. Continuation of this type of analysis in other seasons (including a relocated site #3) will document seasonal trends.

This study measured temperature differences through specific layers. It may not, and probably did not, document the actual depth of the in-valley inversion. A continuation of the study should include a number of concurrent vertical profiles of temperature, using the minisonde or tethersonde to obtain the fine-scale structure.

J.H. Emslie
21 December 1979

HOUR (PST)	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Nil Inversions	8	8	6	8	10	10	10	17	25	27	27	32	32	31	21	29	25	20	10	8	18	9	12	4
Inversion - Surface to 385 ft	65	61	60	57	52	51	51	45	38	39	52	57	67	68	79	71	74	75	83	84	73	83	70	68
Inversion - Surface to 3750 ft	27	31	34	35	38	39	39	31	23	21	12	7	1	1	0	0	0	3	7	7	9	8	17	28
Inversion - Aloft	0	0	0	0	0	0	0	7	14	13	9	4	0	0	0	0	1	2	0	1	0	0	1	0

Figure 1 - Percentage Frequency and Depth of Inversions by Hour
Meager Creek (27 June - 17 September 1979)

Temperature Difference (°C) Site #2/Site #1	Occurrences	Temperature Difference (°C) Site #4/Site #1	Occurrences
0	434	0	58
0.5	396	0.5	46
1.0	266	1.0	43
1.5	236	1.5	57
2.0	150	2.0	46
2.5	61	2.5	47
3.0	29	3.0	30
3.5	7	3.5	22
4.0	8	4.0	22
4.5	6	4.5	20
5.0	3	5.0	12
5.5	2	5.5	20
6.0	3	6.0	15
6.5	1	6.5	9
		7.0	5
		7.5	4
		8.0	6
		8.5	3
		10.0	1

Figure 2 - Occurrences of Inversions Of Various Strengths.