ENVIRONMENT CANADA PRELIMINARY ENVIRONMENTAL REVIEW -

PROPOSED B.C. PETROLEUM CORPORATION REFINERY

July 15, 1975

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Environment Canada Preliminary Environmental Review - Proposed B. C. Petroleum Corporation Refinery

Sites in the Surrey area, Merritt area and Clinton area are now being considered for this development. It is our understanding that the Roberts Bank area is no longer a potential site due to engineering considerations. This report outlines in a preliminary manner the readily available environmental resource data for each of the three potential refinery sites. A number of major environmental concerns that must be studied are also delineated in the report. This report is not intended to be an environmental impact study. It will, however, serve as a guide to a consultant carrying out a detailed environmental impact study at any of the sites.

A Resource Considerations

i) Water

a) Surrey, Nicomekl River System

Water Survey of Canada operates a gauging station on the Nicomekl River below Murray Creek, near the Town of Langley. The annual mean flow in the Nicomekl River at this station is 65.6 cubic feet per second (c.f.s.) for the period of record 1965-1973. Average monthly flows in the river range from 5.2 c.f.s. in August to 148 c.f.s. in December and January. The extreme minimum daily discharge for the period of record at this station was 3.2 c.f.s. on July 25, 1965.

It appears that the Nicomekl River is already heavily committed to fishery and agricultural uses. However, groundwater holds some promise as a water supply source as does the Greater Vancouver Regional District System.

Limited information is also available for the Little Campbell River system.

b) Merritt, Nicola River System

Water Survey of Canada operates a gauging station on the Nicola River approximately 5 miles downstream of the Town of Merritt. The annual mean flow in the Nicola River at this station is 523 cubic feet per second (c.f.s.) for the period of record 1911-1915 and 1957-1972. The river is characterized

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by average monthly flows ranging from 121 c.f.s. in September to 1970 c.f.s. in June. The extreme minimum daily discharge for the period of record at this station was 5.0 c.f.s. on December 12, 1913.

Water Survey of Canada also operates a gauging station on the Coldwater River at Merritt. The annual mean flow in the Coldwater River is 314 c.f.s. for the period of record 1913-1921 and 1961-1973. Average monthly flows in the river range from 50.1 c.f.s. in September to 1140 c.f.s. in May. On October 18, 1914, there was no measurable flow in the Coldwater River at the Merritt Station.

The Nicola River system is heavily committed to fishery and agricultural use. The Town of Merritt domestic water comes from a series of wells. The town water usage is about 0.5 million gallons per day (m.g.d.).

c) Clinton, Bonaparte River System

Streams in the Clinton area (e.g. Clinton Creek and Chasm Creek) form part of the Bonaparte River system. The Bonaparte River flows south-west from Bridge Lake to its confluence with Clinton Creek. From the confluence the flow is southward to the Thompson River. Water Survey of Canada operates a gauging station on the Bonaparte River just upstream of the confluence of Bonaparte River and Clinton Creek. The annual mean flow in the Bonaparte River at this station is 255 c.f.s. for the period of record 1968-1971. The river is characterized by average monthly flows ranging from 41.2 c.f.s. in January to 1230 c.f.s. in May. The extreme minimum daily discharge for the period of record at this station was 4.6 c.f.s. on November 4, 1970.

Water Survey of Canada also operates a gauging station on Clinton Creek just upstream of the confluence with Bonaparte River. The annual mean flow in Clinton Creek at this station is 10.3 c.f.s. for the period of record 1969, 1971,

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1973. Average monthly flows in the Creek range from 8.0 c.f.s. in August to 15.5 c.f.s. in July. The extreme minimum daily discharge for the period of record was 1.7 c.f.s. on July 30, 1973.

Little is known about the availability and quality of groundwater in the Clinton area. The Town of Clinton municipal water supply source is Clinton Creek.

Additional flow information for the Nicomekl, Nicola and Bonaparte River systems is available from Water Survey of Canada, Inland Waters Directorate, Environmental Management Service. The Environmental Protection Service have a limited amount of water quality data for the Nicomekl River system and the Water Quality Branch, Inland Waters Directorate, Environmental Management Service have a limited amount of water quality data for the Nicola River system. Additional water quality information may be available through the B.C. Department of Lands, Forests and Water Resources.

ii) Fisheries

a) Surrey

The Nicomekl River system supports runs of coho salmon, steelhead and cutthroat trout. On the average, 2500 coho salmon spawn in Nicomekl River system in a given year. This figure is based on salmon spawning records for the period from 1965 to 1973.

Most spawning occurs in the upper reaches of the river below the mouth of Anderson Creek. Some coho spawn in Murray Creek and Trigg Creek, two small tributaries of the Nicomekl River.

The oyster beds near Crescent Beach at the mouth of the Nicomekl River were once the most valuable commercial and recreational beds on the west coast. These beds have been closed to harvesting for a number of years due to bacterial contamination of the waters of that area. The high bacteria

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counts are caused by municipal type sewage and land wash discharges into the Nicomekl drainage area. With the improving situation regarding municipal sewage treatment and disposal, a significant source of bacterial contamination is being eliminated. The Nicomekl River estuary is also very important for rearing salmon, herring and crab populations.

The Little Campbell River supports runs of both coho and chum salmon. On the average, based on records for the period from 1965 to 1973, 1700 coho and 120 chum spawn in the river annually. The most important salmon spawning area is located between 184th Street in the Municipality of Surrey and 200th Street in the Township of Langley.

b) Merritt

The Nicola River system is one of the more productive salmon streams in the interior of British Columbia. The Coldwater River, the largest tributary of the Nicola River, is also an important salmon producing stream. The following table illustrates the average numbers of spawning salmon in this river system and is based on records for the period from 1966-1973. It should be noted that pink salmon runs occur every second year.

	Chinook	Coho	Pink
Nicola River	2700	1000	1000
Coldwater River	200	1700	-

Maximum excapement into the Nicola River system (i.e. post Hell's Gate) occurred in 1955. Fisheries Service records indicate that a total of 27,750 salmon spawned in the Nicola River system during that year.

Steelhead also spawn in the Nicola River system, salmon and steelhead fry rear in the river. Resident species of fish include Rocky Mountain whitefish, rainbow trout, char and coarse fish species. The Nicola River fish populations are presently under pressure from low river flows, physical disturbance of the river, agricultural activities on the river and sewage discharges to the river.

A map illustrating the location of spawning grounds and the relative spawning intensities appears in Appendix I of this report.

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c) Clinton

An obstruction located on the Bonaparte River four miles upstream from the confluence of the Bonaparte and Thompson Rivers prevents salmon from entering the upper reaches of this river and its tributaries. Thus, salmon have access to only the lower four miles of the river. Fisheries Service records for this stream are not complete but indications are that on the average, 100 coho, 200 chinook and 500 pink salmon spawn in the lower reaches of the river annually. It is not considered a major salmon stream although the removal of the obstruction would give the river a much higher fish production potential.

Not a great deal of information is readily available on the resident species of fish in the upper Bonaparte River system. However, it is known that trout reside in the small streams flowing into the Bonaparte River. The Provincial Fish and Wildlife Branch operate a trout hatchery on Loon Creek, another tributary of the Bonaparte River.

iii) Air

Meteorological parameters which control the dispersion of airborne pollutants are:

a) wind speed - affects the concentration downwind;
b) wind direction - the prevailing flow delineates the affected quadrant; variability affects the lateral concentration;
c) air stability - affects the vertical transport and dispersion;
d) precipitation - reduces airborne concentration by washout or rainout.

Long-term records of these parameters, where they exist, are presented for the three proposed sites. It is noted that the local topography may have a major effect on any or all of the parameters so that a site-specific study by the proponent is essential to confirm the representativeness of the long-term regional data.

a) Surrey

The refinery site is located in the broad,

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relatively flat, northeast/southwest valley of the Fraser River, just southwest of Langley. No anemometer record is available for the immediate area, however that for Abbotsford Airport would very closely depict the wind flow at the site, while a short period of wind records for the proposed Surrey Airport would add additional information.

The attached figures of percentage frequency wind direction (Appendix 2A) and mean wind speed for Abbotsford Airport (Appendix 2B) show that the wind flow is influenced by the broad valley orientation, with low-level winds prevailing in the following directions: south to southwest winds prevail in late spring, summer and early fall while north to northeast winds prevail in late fall, winter and early spring. Calms are fairly frequent as well, particularly in late summer and early fall. Strongest mean wind speeds occur with south to southeast winds, particularly over the winter, and these are associated with the passage of Pacific storms. Additionally, winds are strong with northeast directions in winter, being the result of outflow of Arctic air from the B.C. interior. The display of percentage frequency of calm winds by hour and month (Appendix 2C) shows that these calm winds occur principally overnight and in the early morning, particularly in summer and early fall. The displays of the percentage frequency of the two prevailing directions by hour and month (Appendices 2D and 2E) show that there is a marked up-valley flow during daylight hours and a down-valley component at night during the warmer months, but that there is little diurnal flow change in the winter.

The display of limited data from the old, proposed Surrey Airport (Appendix 2F) shows a similar seasonal pattern to that for Abbotsford Airport except that the principal prevailing direction is southeast rather than south. There is, however, an additional south to southwest component in the warmer months which conforms with the summer

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daytime up-valley flow at Abbotsford Airport. Study of topographic maps indicates that the higher terrain just east and southeast of Abbotsford Airport would locally deflect winds associated with the passage of Pacific storms from a southeast to a south direction. Hence it is concluded that at the refinery site winds of this nature would be from the southeast. The percentage frequency and diurnal patterns of winds from other directions would be similar to those of Abbotsford Airport.

A measure of air stagnation is indicated by the frequency of extended periods of light winds. For Abbotsford Airport, during a ten-year period, the seasonal occurrences of episodes of light winds (0-7 MPH) of duration 24-47 hours and longer than 47 hours are given in the following table:

	Winter	Spring	Summer	Fall
24-47 hours	86	74	67	115
≥48 hours	38	12	12	40

Thus, for example, in any typical three-month fall season, twelve episodes of "light" winds lasting 24-47 hours could be expected, with an additional four episodes lasting longer than 47 hours.

The frequency of ground-based inversions is indicative of the suppression of vertical transport and dilution of airborne pollutants. For the proposed refinery area, the percentage frequency of days in each season with ground based inversions present in the mid-afternoon and early morning is as in the following table:

	Winter	Spring	Summer	Fall
P.M.	59	26	19	43
A.M.	63	64	70	71

Thus ground based inversions are very frequent in all seasons overnight and in the early morning and quite frequent through the day as well in fall and winter. Limited meteorological measurement indicates that the thickness of typical ground based inversion layers in the proposed refinery area is up to 1500 feet above mean sealevel (MSL).

The attached Climatological Summary for the area (Appendix 2G) indicates that with approximately 55 inches of precipitation annually, and measurable precipitation of 47% of days, the effects of rainout and washout of airborne pollutants should be quite noticeable, particularly in fall and winter.

In summary, during daytime operation of the refinery, there should be little, if any buildup of airborne pollution concentration. Overnight and in the early morning, particularly in the summer, with high percentage frequency of ground based inversions and frequent light or calm winds, concentrations could increase locally or be drifted toward Greater Vancouver.

b) <u>Merritt</u>

The proposed refinery site is located at approximately 2300 feet MSL in the valley of the Nicola River, just east of Merritt. From the site, valleys extend northeastward toward Nicola Lake, westward down the valley of the Nicola River, and southwestward up the valley of the Coldwater River. There are terrain features above 4000 feet MSL within five miles in all quadrants. The low level wind circulation and temperature stratification are accordingly dominated by this topography.

No anemometer record is available from Merritt, however, that from Kamloops and Ashcroft are influenced by somewhat similar, though less constricting, valley topography. The attached figures of percentage frequency wind direction (Appendix 3A) and mean wind speed (Appendix 3B) at Kamloops may be considered to represent the circulation at Merritt if certain adjustments are made, namely that the easterly winds recorded at Kamloops would blow more from the

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northeast at Merritt and be 15 to 20% less frequent in all months, with these percentages being added to the corresponding frequencies of calm winds. Northeasterly winds would prevail, particularly through the winter, while west to southwest winds would prevail in other seasons, as at Ashcroft and Kamloops (Appendices 3C and 3D). Calm winds would be very frequent in all months, but particularly over the winter, and as shown on the display of percentage frequency of calm winds by hour and month (Appendix 3E), these would occur principally overnight and in the early morning in spring, summer and fall, with little diurnal fluctuation in winter months. Considering the hourly variation of winds in the prevailing directions, west to southwest winds are more frequent in daytime hours than overnight in spring, summer and fall (Appendix 3F), while northeasterly winds would be more frequent during the night period than during the day in these months (Appendix 3G). These factors are important in assessing the probable drift of emitted pollutants during differing hours of the day.

From a study of extended periods of "light" winds (0-7 MPH), occurrences of these in a ten-year period would be at Merritt, in two duration classes by season, as in the following table:

	Winter	Spring	Summer	Fall
24-47 hours	120	60	110	120
≥48 hours	90	20	40	60

For example, in any typical three-month winter season, twelve episodes of "light" winds lasting for 24 to 47 hours could be expected, with an additional nine episodes lasting longer than 47 hours.

For the refinery site, the percentage frequency of days in each season with ground based inversions present in the mid-afternoon and early morning is as in the following table:

	Winter	Spring	Summer	Fall
P.M.	45	20	20	25
A.M.	60	70	80	65

Thus, ground based inversions are very frequent in all seasons overnight and in the early morning and fairly frequent through the day as well in winter. The ground based valley inversions at Merritt extend most frequently through the layer up to 3000 to 3500 feet above mean sea level.

The attached Climatological Summary for Merritt (Appendix 3H) indicates that with only ten inches of precipitation annually and measurable precipitation on 22% of days, the effects of rainout and washout would not be a factor in reducing the amount of airborne pollutant.

In summary, with very frequent episodes of light or calm winds, high frequency of ground based inversions, and topography which limits horizontal dispersion, there could be numerous occasions at Merritt when airborne pollutants would not be flushed from the valley but would increase in local concentration.

c) Clinton

The proposed refinery site near Clinton is located on a flat plateau at approximately 3600 feet MSL roughly mid-way between Clinton and 70 Mile House. Isolated hills well removed from the site are the only topographical constraints to the local wind flow so that the Coastal Mountains and Rocky Mountains, orientated northwest/southeast, constitute the principal topographical influence on wind direction.

The brief period of wind record from the automatic MARS weather station six miles northeast of Clinton (Appendix 4A) and the longer records from Dog Creek (Appendix 4B) and Williams

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Lake Airports (Appendix 4C) show that winds over central B.C. plateau prevail from the southeast and south, particularly in the fall, winter and spring, with a secondary frequency of north to northwest winds. Mean wind speeds are fairly light (Appendix 4D) while calm winds are quite frequent. The display of the percentage frequency of calm winds by hour at Williams Lake (Appendix 4E) indicates that at the refinery site calm winds would occur principally overnight and in the early morning in spring, summer and fall, with only a slight diurnal difference in frequency in winter.

The seasonal occurrences of "light" winds (0-7 MPH) in a ten-year period for the refinery area, in two duration classes, would be as in the following table:

	Winter	Spring	Summer	Fall
24-47 hours	115	107	110	120
≥48 hours	60	20	30	70

Thus, in any typical three month fall season, there would be twelve episodes of "light" winds lasting from 24 to 47 hours with an additional seven episodes lasting longer than 47 hours.

The seasonal percentage frequency of days in which ground based inversions would be present in the proposed refinery area at two times of day (mid-afternoon and early morning) would be as in the following table:

	Winter	Spring	Summer	Fall
P.M.	35	5	5	15
A.M.	50	55	70	55

Thus, ground based inversions are quite frequent overnight and in the early morning in all seasons and fairly frequent through the day as well in winter. In general, ground based

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inversions should extend through the layer up to 4000 feet above mean sea level.

The attached Climatological Summaries for Dog Creek Airport (Appendix 4F) and 150 Mile House (Appendix 4G) indicate that with approximately sixteen inches of precipitation annually in the area, and measurable precipitation on 30% of days, the effects of rainout and washout of airborne pollutants would be minimal.

In summary, with no topographical constraints lateral dispersion of airborne pollutants should be fairly good in all seasons, particularly through the day. There would be overnight and early morning periods with calm or light winds, but with generally shallow ground based inversions vertical dispersion of emitted airborne pollutants could be assured with properly designed stacks.

Climatological Assessment of Dispersion Parameters

Based on fairly extensive climatological data in the area of the proposed Surrey site, but on principally only extrapolated data for the other two sites, dispersion of airborne pollutants at the Clinton site should be such that there would rarely be a problem of local buidup in concentration. At the Surrey site, dispersion parameters should be adequate most days, but there could be episodes overnight and in the early morning, particularly in the summer, when concentrations could increase locally. At Merritt meteorological parameters of dispersion would be inadequate most days to prevent extensive buildup in concentration of airborne pollutants due to severe topographic constraints.

Additional Meteorological Data Requirements

It is mandatory that the proponent conduct extensive on-site meteorological measurement to confirm that data at the proposed plant agrees with the regional meteorological measurements. This program should include measurements of surface wind speed and direction, wind profiles in the boundary layer and vertical temperature profiles.

iv) Land

a) Surrey

Lands in the immediate vicinity of the proposed refinery site do not have a particularly high capability for agricultural purposes. Under the Canada Land Inventory classification system the general rating for the area is 5 (out of a rating system of 1 to 7 where the higher values represent the lower quality agricultural lands).

However, in both Surrey and Langley municipalities areas containing good to moderate capability for agriculture (mainly classes 3 and 4) lie within the possible zone of influence of the refinery. These lands, situated generally to the northwest, southwest and east of the refinery have been included in the Agricultural Land Reserves established by the B.C. Land Commission.

Although soils in the Lower Mainland have a wide range of physical and chemical properties, it should be noted that both the upland and lowland soils tend to be of an acidic nature.

b) Merritt

Merritt is located in the valley of the Nicola River and is situated in the bed of an ancient glacial lake. The lowlands and benchlands of the valley have a reasonable capability for agricultural use. Under the Canada Land Inventory classification system, lands in the upper Nicola River drainage area (i.e. upstream of Merritt) are rated from class 2 to class 6. Lands in the lower Nicola River drainage area have less agricultural potential and are rated from class 3 to class 6 with the greatest acreage being rated as class 5 to class 6 lands. Upland soils in the Nicola River drainage area have a lower agricultural capability than the valley lands and are rated as class 5 to 7 lands.

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The total Merritt area is a part of the important valley and plateau grazing lands lying east of the Coast Mountain. In this region native grasses are an important source of natural forage. A large portion of the land around and within the zone of influence of the proposed refinery, have been included in Agricultural Land Reserves established by the B.C. Land Commission.

c) Clinton

Valley lands in the vicinity of Clinton are rated under the Canada Land Inventory as having a fair capability for agriculture. They are rated as being mainly of class 4 lands although there is also a reasonable amount of class 3 land in the valleys.

The uplands are less important agriculturally and are rated as class 5 and 6 lands and with a few exceptions the upland soils of this area are of more value for forestry and summer grazing than for crops.

The valley lands in the vicinity of Clinton have been included in the B.C. Land Commission Agricultural Land Reserves.

v) Wildlife

a) Surrey

The proposed Surrey refinery site is located on the Fraser River lowlands approximately five miles northeast of tidewater. The area surrounding the site is classified low for waterfowl production but is less than one mile from the largest waterfowl wintering area in Canada. Migratory bird use of the area is not positively known but is believed to be mainly by passerine forms.

b) Merritt

The area east of Merritt lies within the Thompson Plateau landform which contains the Douglas Lake grasslands. Within the grasslands zone lie very productive waterfowl habitats.

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The rolling open aspect of the land provides the physical basis for a wide distribution and abundance of water bodies ranging in size from a few acres to several square miles. The gentle topography results in relatively shallow ponds or lakes with good peripheral marsh vegetation which provides both food and cover for large numbers of ducks and Canada geese.

West of Merritt the Nicomen Plateau, the northerly Promontory Hills and the southerly Coutlee Plateau are rugged, well timbered and generally lacking in waterbodies useful to waterfowl. Ponds or lakes in this area are generally rated low for waterfowl nesting or migration.

c) Clinton

The Clinton area lies on the southern edge of The Fraser Plateau, a physiographic region containing the largest portion of the grasslands of British Columbia. The area is similar in physical characteristics but larger than the Thompson plateau east of Merritt. Within the grassland zone of the Fraser Plateau lie the most productive waterfowl habitats of the entire province. These grasslands are most important nesting grounds for ducks, geese and many other migratory birds.

The wildlife section of this report has dealt only with birds. Information with respect to mammals frequenting the three sites is available through British Columbia Fish and Wildlife Branch.

B Environmental Concerns

i) Construction

Refinery construction at any of the three sites under consideration would probably necessitate the partial removal of forest cover at the site and excavation work would disturb the soil, thereby contributing to erosion of the land and the sedimentation of streams in the drainage area of the refinery site. The

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construction of support facilities such as crude and products pipelines, off-site loading terminals, road and railroads could also create stream sedimentation problems. The possibility of sediment released during construction destroying salmon spawning and rearing areas and/or affecting other downstream water users must be examined. An environmental impact study must be used to determine the specific environmental concerns relating to the construction phase and to delineate the procedures to be followed in order that environmental damage during construction be minimized.

Water Supply

ii) In order to protect the fishery resources, the taking of water from low flow surface water streams would not be considered acceptable. The rights and needs of licensed water users of a stream must be recognized in the determination of an acceptable water supply source. The use of water from a municipal system or from wells are alternatives worthy of consideration. An environmental impact study should be used to determine an environmentally acceptable water supply source.

iii) Effluent Treatment and Disposal

It is essential that the refinery discharge meet the requirements of the Federal Petroleum Refinery Effluent Regulations and Guidelines. It is assumed that the refinery will also have to meet the requirements of the Provincial Pollution Control Branch level A objectives. Treatment facilities must be installed that will guarantee that these requirements are met on a continuing basis.

It is recognized that refinery upsets do occur. In order to minimize the effect of the upset on the final treated effluent quality and hence the receiving water, it is essential that a very comprehensive equalization facility be incorporated in the waste treatment facilities. It is also recognized that the sublethal effects of treated refinery effluent to aquatic life are not well known. Hence, the treated refinery effluent (if discharged to a receiving body of water) must be discharged to a surface water

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stream with sufficient flow to accept the refinery effluent and minimize its impact on aquatic life.

The discharge of treated effluent into a municipal sewer system may be acceptable but must be reviewed in light of the fact that the routine disinfection of the sewage treatment plant effluent, including the refinery effluent, could create problems. The chlorination of the combined municipal and refinery effluents could produce stable chlorinated phenols and other chlorinated hydrocarbons that are toxic to fish and can have unknown sublethal effects on the fish populations of the receiving waters. Accordingly the impact of the refinery effluent on the resulting municipal sewage treatment plant discharge, generally speaking, would be expected to be greater in the smaller municipalities.

An environmental impact study should be used to determine whether it is possible to discharge treated refinery effluent to particular receiving water streams without causing environmental damage. The environmental impact study should also examine other effluent disposal techniques.

iv) Air Emissions

Sulfur dioxide, carbon monoxide, hydrocarbons particulates and nitrogen oxides are the major air pollutants normally associated with a refinery operation. In terms of emission requirements, it is suggested that the criteria for emission limits for the above mentioned pollutants be based on future national emission guidelines due to be promulgated in 1976, together with all requirements of provincial and municipal control agencies. Federal and provincial ambient air quality objectives must also be met.

In light of the emission controls to be practised by the refinery and the emission limits to be met, an environmental impact study should assess the contributory effect(s) of the expected refinery emissions on the environment.

y) Lands

Due to the presence of agricultural lands in the vicinity of the proposed refinery sites, the effect of sulphur dioxide emissions from the refinery on the productive capability of the soil is of concern. Sulphur dioxide emissions can contribute to an increasing acidification of the soil. This is a complex problem as the impact of the emissions depends upon the design of the refinery, amount of sulfur dioxide released in the atmosphere, wind and distribution characteristics, quality characteristics of the soil receiving the emissions, the crops grown, and the character of the terrain and vegetation. Before the refinery plans are finalized the impact of the emissions, whether air-borne or liquid discharge, on long-term land capability must be determined.

vi) Wildlife

It is apparent, irregardless of the site chosen, that the change from undeveloped land to an operating refinery site will affect the wildlife habitat. The refinery site should be developed in such a way as to minimize these effects.

One concern for migratory birds at and about the site would be for a possible combination of atmospheric conditions and air emissions from the refinery operation resulting in situations contributing to avian mortality. It is well documented that oil spills have been a plague to both wildlife and fishery resources. A failsafe oil spill prevention system must be incorporated in the refinery design. It is emphasized that the site specific environmental impact studies carried out delineate the wildlife concerns at the sites and determine ways and means of minimizing the effects of the development on the wildlife resource.

vii) Noise

Refinery noise can be offensive to people living near a refinery (e.g.: the Burnaby refineries have received complaints from citizens of the area on numerous occasions). The increased transportation on access roads to the refinery site during both construction and operation phases will also contribute to increased noise.

The design of a modern refinery should include methods - both equipment and layout procedures - to reduce noise levels. It is felt that a 55-65 dba noise level at the refinery fence is achievable if proper noise control procedures are employed within the refinery. A buffer zone of trees around the perimeter of the refinery property will serve to both reduce noise levels and improve the appearance of the refinery. Reducing noise levels created by the increased road transportation cannot be easily dealt with. Noise control should be a consideration in a detailed environmental impact study.

Concluding Comments

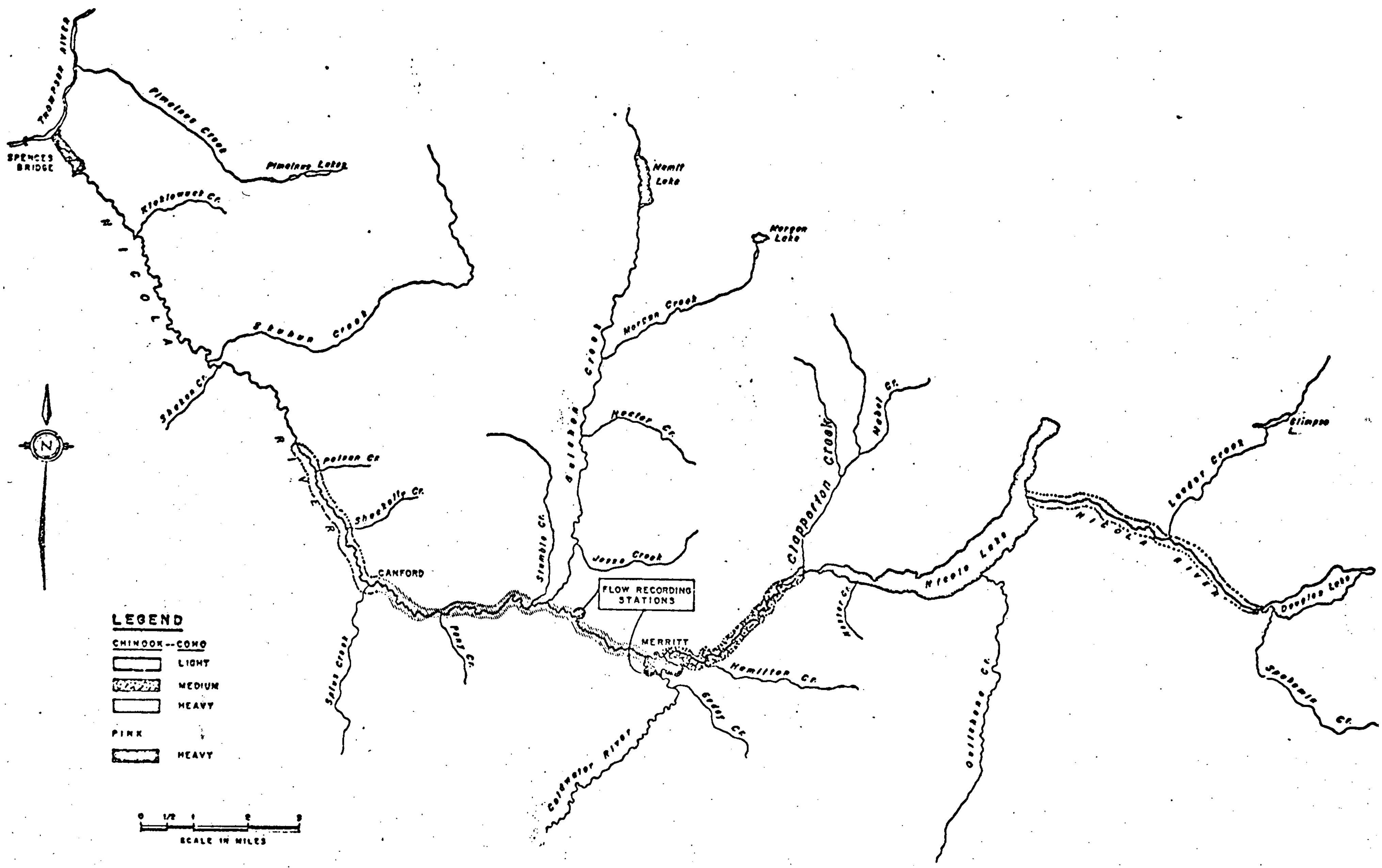
An environmental impact study to determine the most environmentally suitable site for this refinery development is essential. The environmental impact study must delineate all environmental concerns and provide, if possible, ways and means of dealing with and resolving these concerns. The topics to be dealt with in the study should include the following:

a) refinery design criteria
b) site preparation
c) environmental effects of servicing the refinery
d) water supply
e) effluent treatment
f) effluent disposal and receiving water quality effects
g) air pollution control
h) effects of air emissions on the total environment
i) spill control and emergency considerations
j) noise control

k) effects on local land use, wildlife and fishery resources
l) regional long term land use planning
m) impact of urbanization and associated secondary industry development
n) aesthetic and social factors

Environment Canada is prepared to assist the proponent by reviewing the terms of reference of the recommended environmental impact study and also by a final evaluation of the completed report. Environment Canada resource data will be made available to the consultant undertaking the impact study.

Appendix 1



NICOLA RIVER - SALMON SPAWNING DISTRIBUTION

APPENDIX 2A

	J	F	M	A	M	J	J	A	S	O	N	D
N	20	19	17	12	9	8	6	6	14	19	[illegible]	[illegible]
NE	32	28	22	13	8	5	4	5	10	19	27	28
E	7	5	6	3	2	1	1	1	2	3	5	6
SE	2	2	3	4	3	2	2	2	2	3	3	3
S	15	18	20	26	25	21	18	17	15	17	18	18
SW	5	8	12	18	25	31	34	29	18	12	8	8
W	1	2	3	4	7	8	9	9	6	3	2	1
NW	2	2	2	3	4	3	3	3	5	5	4	3
CALM	16	16	16	17	19	21	23	28	28	19	13	13

Abbotsford Airport, B.C. - Percentage Frequency Wind Direction (and Calms) by Months.

APPENDIX 2B

	J	F	M	A	M	J	J	A	S	O	N	D
N	5.0	5.3	8.2	5.7	5.0	4.7	4.6	4.6	5.1	5.4	5.5	5.3
NE	9.8	9.6	9.0	7.2	6.7	5.5	4.9	4.4	6.1	7.4	8.8	9.3
E	8.1	7.6	8.3	7.3	6.8	5.4	4.9	4.4	5.6	6.1	6.3	8.0
SE	11.5	9.4	10.8	9.4	7.6	8.2	6.6	6.8	6.0	11.3	9.2	13.0
S	13.2	12.7	12.3	11.3	9.9	9.2	9.0	8.5	9.0	11.4	12.7	13.5
SW	7.4	7.9	7.9	8.1	7.5	8.2	6.9	6.7	6.2	6.9	7.9	7.6
W	4.8	5.5	5.8	6.7	5.5	5.1	5.0	5.1	4.9	4.4	5.5	5.6
NW	3.8	4.0	4.8	4.8	4.7	5.2	4.2	4.0	4.2	4.2	4.3	4.2

Abbotsford Airport, B.C. - Mean Wind Speed (MPH) by Direction and Month.

APPENDIX 2C

HOURS (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
JAN.	14	14	15	16	15	12	17	13	14	13	15	12	14	12	9	11	14	16	15	18	16	13	16	16
FEB.	16	17	18	15	16	16	17	16	15	17	16	16	15	14	14	12	15	16	19	21	19	18	19	18
MAR.	23	22	22	19	20	18	15	20	19	17	15	13	10	9	8	8	9	9	13	18	23	26	26	20
APR.	22	22	25	24	26	25	29	24	21	17	14	10	8	8	7	6	8	8	8	11	21	25	30	29
MAY	32	32	33	32	37	37	35	25	22	17	15	10	7	6	7	5	6	5	5	9	19	33	35	31
JUN.	37	36	36	37	44	40	39	28	21	15	14	7	6	6	7	6	6	6	8	10	16	27	34	39
JUL.	47	43	44	45	47	48	46	32	21	15	11	8	5	5	4	2	4	4	4	10	18	33	43	47
AUG.	46	46	50	51	51	50	50	45	31	25	20	10	8	5	4	4	6	5	7	12	28	37	50	47
SEP.	40	40	37	37	40	38	35	36	32	25	23	18	15	12	8	7	9	9	18	30	39	41	43	43
OCT.	26	24	24	23	23	23	26	23	26	22	18	15	14	14	11	10	12	16	22	23	25	26	26	23
NOV.	13	14	15	17	20	16	12	14	14	15	18	14	11	12	11	8	11	18	18	16	16	16	16	16
DEC.	11	13	13	15	18	17	16	15	16	15	16	13	13	12	11	12	15	16	16	15	14	15	13	13

Abbotsford B.C. - Percentage Frequency Calm Winds by Hour and Month

	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
JAN.	47	47	46	46	47	49	46	48	48	49	47	46	43	45	45	45	42	41	47	45	49	49	46	48
FEB.	49	51	50	51	49	50	51	50	50	51	46	42	39	36	36	38	37	38	38	39	44	45	46	48
MAR.	42	42	41	45	44	46	49	45	45	45	41	34	35	29	31	31	29	27	27	31	33	35	39	44
APR.	35	35	33	36	34	35	32	36	32	27	24	21	20	17	18	15	16	14	14	17	18	21	24	30
MAY	30	28	28	28	26	29	26	29	22	18	15	12	10	12	8	9	8	8	9	9	12	14	19	26
JUN.	21	21	22	21	16	18	17	18	15	11	10	11	8	8	6	7	8	8	7	8	8	11	15	17
JUL.	18	20	19	17	15	14	13	13	12	10	9	5	5	4	4	5	5	6	6	5	7	8	12	13
AUG.	18	20	18	16	17	17	16	16	15	13	13	11	6	8	6	6	5	6	7	7	8	11	14	18
SEP.	31	30	34	32	30	31	31	31	32	31	28	24	22	18	13	12	12	11	11	14	19	25	27	28
OCT.	41	42	43	45	43	44	44	41	40	41	37	34	31	31	30	29	29	28	33	36	36	38	40	43
NOV.	49	48	48	46	44	47	49	49	49	48	47	46	44	42	41	42	41	43	45	47	50	50	52	48
DEC.	49	44	46	45	43	45	46	48	48	45	46	46	41	40	40	38	38	39	41	42	47	45	48	48

Abbotsford Airport B.C. - Percentage Frequency of North and Northeast Winds by Hour and Month (Jan. 1953-Dec. 1971)

	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
JAN.	23	23	22	23	22	22	21	23	22	22	22	22	23	25	25	24	25	23	22	22	20	22	22	21
FEB.	25	25	25	24	25	24	24	24	25	24	25	27	30	32	32	33	31	32	28	28	27	28	27	26
MAR.	24	26	26	26	26	27	24	25	24	26	29	34	36	41	44	43	44	45	40	35	31	27	26	25
APR.	32	33	32	31	31	32	31	32	36	41	45	48	53	57	59	57	55	55	58	53	45	42	35	32
MAY	27	28	28	27	26	25	31	36	43	49	52	56	61	60	63	65	64	65	64	65	56	43	35	29
JUN.	29	28	29	29	27	27	33	42	50	56	57	64	64	65	66	65	66	67	67	66	61	47	39	35
JUL.	21	20	22	22	24	23	29	45	55	60	62	68	72	71	71	72	71	71	72	71	58	43	31	24
AUG.	21	20	19	20	19	20	22	30	44	50	50	59	64	65	65	67	64	67	66	64	49	38	27	23
SEP.	19	19	18	19	20	20	20	23	27	31	37	40	46	47	53	54	52	52	50	39	29	23	22	21
OCT.	22	22	24	23	23	22	22	24	23	25	31	33	36	41	43	41	39	37	31	27	25	25	22	24
NOV.	23	24	25	24	25	25	25	25	26	25	24	26	29	30	31	30	28	24	23	22	21	21	21	22
DEC.	28	26	27	25	25	24	24	25	24	24	24	26	28	30	31	31	31	28	27	26	26	27	27	27

Abbotsford Airport B.C. - Percentage Frequency of South and Southwest Winds by Hour and Month (Jan. 1953-Dec. 1971)

APPENDIX 2F

	J	F	M	A	M	J	J	A	S	O	N	D
N	5	5	5	3	2	-	2	5	12	12	9	4
NE	39	31	21	12	10	-	2	4	7	19	28	26
E	2	2	1	1	2	-	1	3	4	2	2	1
SE	31	27	25	32	28	-	32	33	27	29	38	47
S	3	5	5	8	22	-	39	33	24	7	5	3
SW	5	16	25	30	24	-	10	6	4	8	7	9
W	1	2	3	1	3	-	3	4	4	2	1	2
NW	13	10	14	12	8	-	8	8	16	19	9	8
CALM	1	2	1	1	1	-	3	4	2	2	1	0
MEAN SPEED	4.9	5.6	7.0	7.2	5.5	-	4.8	4.3	4.3	5.1	5.7	7.5

Surrey Airport B.C. - Percentage Frequency Wind Direction (and Calms) and Mean Wind Speed by Months (July 1954-May 1955)

APPENDIX 2G

SURREY NEWTON   LATITUDE 49 08 N LONGITUDE 122 51 W ELEVATION 250 FT ASL

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	YEAR
MEAN DAILY TEMPERATURE (DEG F)	35.6	40.0	42.2	47.4	53.2	58.1	62.0	61.6	57.7	49.9	42.0	37.9	49.0
MEAN DAILY MAXIMUM TEMPERATURE	41.0	46.8	50.1	56.2	63.1	67.9	73.1	72.7	68.4	58.4	48.2	42.9	57.4
MEAN DAILY MINIMUM TEMPERATURE	30.1	33.2	34.3	38.5	43.2	48.3	50.9	50.4	46.9	41.4	35.8	32.8	40.5
EXTREME MAXIMUM TEMPERATURE	57	67	69	74	89	92	94	92	86	75	63	62	94
NO. OF YEARS OF RECORD	9	9	9	9	9	9	9	9	10	01	9	10	
EXTREME MINIMUM TEMPERATURE	1	15	20	27	30	37	40	41	31	25	19	-2	-2
NO. OF YEARS OF RECORD	9	9	9	8	9	9	9	9	10	10	10	10	
NO. OF DAYS WITH FROST	17	12	13	5	1	0	0	0	*	2	7	14	71
MEAN RAINFALL (INCHES)	6.75	5.61	4.39	3.44	2.45	2.11	1.27	2.07	3.19	6.74	7.31	7.25	52.58
MEAN SNOWFALL	9.5	2.5	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	5.9	21.5
MEAN TOTAL PRECIPITATION	7.70	5.86	4.61	3.44	2.45	2.11	1.27	2.07	3.19	6.74	7.45	7.84	54.73
GREATEST RAINFALL IN 24 HRS	4.20	2.05	1.95	1.55	1.10	0.98	1.12	1.14	2.39	2.01	2.81	2.55	4.20
NO. OF YEARS OF RECORD	10	10	10	10	10	10	10	10	10	10	11	11	
GREATEST SNOWFALL IN 24 HRS	9.0	8.0	7.0	T	0.0	0.0	0.0	0.0	0.0	0.0	5.0	10.0	10.0
NO. OF YEARS OF RECORD	10	10	10	10	10	10	10	10	10	10	10	11	
GREATEST PRECIPITATION IN 24 HRS.	4.20	2.05	1.95	1.55	1.10	0.98	1.12	1.14	2.39	2.01	2.81	2.70	4.20
NO. OF YEARS OF RECORD	10	10	10	10	10	10	10	10	10	10	11	11	
NO. OF DAYS WITH MEASURABLE RAIN	18	15	16	15	10	9	7	8	10	17	19	17	161
NO. OF DAYS WITH MEASURABLE SNOW	4	1	1	0	0	0	0	0	0	0	1	4	11
NO. OF DAYS WITH M. PRECIPITATION	21	16	16	15	10	9	7	8	11	17	20	20	170

APPENDIX 3A

	J	F	M	A	M	J	J	A	S	O	N	D
N	1	1	1	2	2	2	2	1	1	1	1	1
NE	6	5	5	5	5	6	5	5	6	7	7	6
E	43	35	35	25	24	24	23	25	31	45	48	46
SE	8	7	10	8	9	9	9	8	9	9	9	9
S	2	3	4	7	6	7	6	6	4	3	2	1
SW	5	6	9	12	13	13	13	12	9	7	6	5
W	14	15	18	23	24	23	23	21	20	11	11	11
NW	2	2	2	3	3	3	3	3	2	2	1	2
CALM	22	25	17	16	15	15	17	19	18	15	16	18

Kamloops, B.C. – Percentage Frequency Wind Direction (and Calms) by Months

APPENDIX 3B

	J	F	M	A	M	J	J	A	S	O	N	D
N	4.7	5.7	5.7	7.5	6.9	7.3	7.7	6.3	6.6	4.6	4.9	5.0
NE	7.4	[illegible]	[illegible]	7.8	7.2	7.3	7.0	6.7	6.9	[illegible]	7.7	8.4
E	8.8	8.8	9.9	9.2	8.0	7.8	6.9	6.8	7.5	9.5	9.4	10.3
SE	8.4	8.3	8.9	8.2	7.2	6.6	6.2	6.2	6.6	8.1	9.0	8.5
S	8.1	5.8	9.6	11.7	8.9	9.3	8.5	9.2	9.7	9.1	6.7	7.0
SW	7.5	7.4	[illegible]	10.4	9.1	9.0	8.3	7.9	8.0	8.9	8.3	8.3
W	12.5	9.3	10.6	11.0	10.3	9.2	8.6	8.3	9.8	9.8	11.3	11.8
NW	[illegible]	9.7	8.9	8.6	7.7	7.4	7.3	6.5	8.6	6.9	7.1	8.9

Kamloops, B.C. - Mean Wind Speed (MPH) by Direction and Month

APPENDIX 3C

	J	F	M	A	M	J	J	A	S	O	N	D
N	5	7	6	6	5	5	6	4	6	4	6	5
NE	7	6	7	5	6	5	6	6	6	6	7	6
E	5	6	5	4	4	4	6	5	6	6	5	5
SE	2	2	3	3	3	3	3	3	4	4	3	2
S	4	5	11	17	17	19	17	13	10	9	5	6
SW	9	10	15	21	25	29	22	22	14	13	12	12
W	4	4	5	7	8	9	7	7	6	7	5	4
NW	3	5	7	8	6	6	9	7	7	6	5	3
CALM	61	55	41	29	26	20	24	33	41	45	52	57

Ashcroft, B.C. - Percentage Frequency Wind Direction (and Calms) by Months.

APPENDIX 3D

	J	F	M	A	M	J	J	A	S	O	N	D
N	8.7	9.7	9.8	8.9	8.7	8.1	8.3	7.1	8.6	7.6	8.6	8.6
NE	6.1	6.6	6.9	7.2	7.5	7.2	7.3	6.7	6.9	5.8	5.2	6.2
E	3.6	3.4	3.7	4.9	5.4	4.9	5.1	4.2	3.9	3.8	3.4	3.4
SE	3.3	4.4	4.9	7.3	5.7	5.1	5.1	5.4	4.0	4.0	3.5	3.2
S	6.0	8.2	12.0	14.4	12.7	13.2	11.9	11.5	10.4	11.7	6.2	6.9
SW	5.1	6.2	8.4	10.7	9.7	10.5	9.1	8.9	8.5	8.4	5.7	4.7
W	5.0	5.4	5.8	7.4	6.7	7.0	6.5	5.8	5.4	4.6	3.9	4.3
NW	7.7	8.9	8.0	8.0	7.6	8.7	8.2	7.8	6.5	7.0	6.6	7.9

Ashcroft, B.C. - Mean Wind Speed (MPH) by Direction and Month.

APPENDIX 3E

HOURS (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
JAN.	29	32	27	27	24	21	20	21	18	18	18	16	18	20	19	19	23	25	26	31	36	30	25	35
FEB.	38	37	35	36	30	27	26	25	22	21	25	26	21	19	19	20	22	24	25	34	34	37	28	38
MAR.	28	30	28	23	28	22	22	19	18	17	19	11	10	9	9	8	13	10	12	20	21	21	25	24
APR.	31	34	37	36	36	30	28	27	22	16	16	7	4	4	4	3	4	4	5	9	11	19	19	28
MAY	29	34	39	36	39	37	32	22	17	9	10	6	4	3	3	3	4	4	6	11	15	18	21	31
JUN.	29	32	41	36	40	36	33	22	14	7	10	5	5	3	3	3	4	4	4	9	13	18	18	24
JUL.	32	38	41	48	46	43	36	31	20	12	13	7	3	3	3	4	5	4	5	8	12	14	19	22
AUG.	30	39	44	44	42	37	34	29	25	17	14	10	6	6	6	4	5	7	9	18	16	18	22	29
SEP.	30	34	32	38	34	30	30	26	20	18	18	11	8	6	8	6	9	10	12	23	16	17	21	23
OCT.	22	24	25	23	23	18	20	19	18	17	16	13	10	8	7	8	9	11	12	14	18	24	22	26
NOV.	23	21	22	23	22	18	18	18	19	17	16	13	13	10	10	13	14	17	15	22	16	19	18	23
DEC.	19	19	24	22	21	17	19	19	20	17	19	15	14	14	13	15	18	20	21	24	19	17	20	22

Kamloops, B.C. – Percentage Frequency Calm Winds by Hour and Month

	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	
JAN.	13	14	16	15	12	12	14	14	14	14	16	17	16	15	15	14	14	13	10	9	10	14	11	13
FEB.	9	11	9	7	14	15	13	12	13	14	18	17	17	18	17	17	17	14	15	11	11	7	14	9
MAR.	14	14	16	17	13	15	14	17	17	19	21	24	21	20	21	21	21	19	17	16	15	15	13	14
APR.	18	16	17	15	15	14	17	18	23	25	27	31	29	27	27	31	28	27	21	19	17	16	16	18
MAY	13	13	17	10	16	17	18	27	31	32	32	29	28	28	29	29	30	27	22	17	19	16	14	15
JUN.	9	11	11	14	13	14	17	26	31	32	32	28	28	27	27	28	26	23	22	20	15	12	14	13
JUL.	12	13	15	10	14	13	16	23	31	34	32	31	26	25	26	26	28	24	22	15	20	13	15	13
AUG.	8	6	11	9	12	12	13	17	25	30	31	29	30	28	27	28	30	26	22	15	15	8	12	10
SEP.	11	11	10	9	12	13	14	15	20	24	24	25	24	27	25	30	28	23	20	14	9	13	13	12
OCT.	11	9	9	7	9	10	9	9	8	10	11	14	14	17	15	14	14	10	10	7	9	7	6	8
NOV.	8	7	9	10	10	9	11	11	11	12	15	15	14	14	14	12	11	10	9	8	10	11	9	9
DEC.	12	10	11	11	10	11	11	11	11	12	10	13	11	13	12	11	10	11	10	11	10	12	10	11

Kamloops B.C. – Percentage Frequency of West Winds
by Hour and Month (Jan. 1953-Dec. 1971)

APPENDIX 3G

	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
JAN.	41	32	38	35	44	44	44	42	46	45	46	45	44	42	41	41	39	36	36	39	34	38	43	35
FEB.	34	36	38	38	39	38	39	41	41	43	37	36	32	32	31	31	30	30	32	32	31	34	35	36
MAR.	32	34	32	36	37	42	41	42	45	40	36	35	33	31	30	29	27	28	29	27	33	37	35	37
APR.	21	22	23	22	29	31	35	39	32	28	25	25	25	21	20	20	18	21	21	17	19	25	26	21
MAY	29	20	23	24	22	26	31	28	24	19	22	20	23	26	23	23	22	22	25	23	19	24	30	30
JUN.	33	27	22	28	25	27	29	26	25	24	22	23	22	23	24	21	22	20	22	23	23	22	28	32
JUL.	29	23	24	19	24	28	31	27	20	18	18	19	19	21	19	21	20	21	23	23	17	25	30	34
AUG.	25	29	23	23	27	30	33	33	28	22	19	19	20	19	22	21	23	22	21	22	19	29	31	36
SEP.	32	26	29	32	34	34	37	43	40	38	30	27	27	25	27	27	28	27	28	23	34	33	34	32
OCT.	48	47	44	48	48	49	51	50	51	53	49	43	40	39	40	40	42	40	43	45	48	46	44	43
NOV.	51	52	48	49	48	51	50	48	49	48	49	50	44	45	45	45	47	44	46	46	52	48	48	52
DEC.	46	50	44	45	46	46	46	46	46	50	49	51	47	47	47	49	47	42	44	39	45	48	42	47

Kamloops, B.C. - Percentage Frequency of East Winds
by Hour and Month (Jan. 1953 - Dec. 1971)

MERRITT

LATITUDE 50 07 N LONGITUDE 120 48 W ELEVATION 1920 FT ASL

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	[illegible]	YEAR
AN DAILY TEMPERATURE (DEG F)	18.2	28.3	35.4	44.7	52.8	58.4	63.5	61.7	54.8	44.7	33.4	24.1	43.3
AN DAILY MAXIMUM TEMPERATURE	27.1	37.8	46.4	57.3	66.1	71.1	77.6	75.8	69.1	55.9	41.6	32.0	54.8
AN DAILY MINIMUM TEMPERATURE	9.2	18.6	24.5	32.1	39.4	45.6	49.3	47.5	40.4	33.4	25.2	16.1	31.8
TREME MAXIMUM TEMPERATURE	59	60	72	84	92	96	102	97	89	80	75	62	102
O. OF YEARS OF RECORD	38	38	38	38	39	39	38	38	38	38	39	39	
TREME MINIMUM TEMPERATURE	-46	-31	-17	10	22	29	34	33	19	- 3	-11	-35	-46
O. OF YEARS OF RECORD	38	38	38	38	38	39	38	38	38	38	39	39	
. OF DAYS WITH FROST	30	26	26	16	5	*	0	0	4	15	25	28	175
AN RAINFALL (INCHES)	0.29	0.07	0.32	0.56	0.71	0.85	0.61	0.73	0.64	0.79	0.46	0.54	6.57
AN SNOWFALL	12.0	5.6	3.0	0.6	0.3	0.0	0.0	0.0	0.0	0.2	4.1	8.7	34.5
AN TOTAL PRECIPITATION	1.49	0.63	0.62	0.62	0.74	0.85	0.61	0.73	0.64	0.81	0.87	1.41	10.02
EATEST RAINFALL IN 24 HRS	0.72	1.50	0.50	1.07	0.93	2.24	0.82	1.05	2.09	1.29	0.98	0.77	2.24
O. OF YEARS OF RECORD	38	38	38	38	39	39	38	38	38	38	39	39	
EATEST SNOWFALL IN 24 HRS	12.0	14.5	12.0	5.0	2.5	0.0	0.0	0.0	5.0	4.5	13.0	13.0	14.5
O. OF YEARS OF RECORD	38	38	38	38	39	39	38	38	38	38	39	38	
EATEST PRECIPITATION IN 24 HRS.	1.20	1.50	1.20	1.07	1.18	2.24	0.82	1.05	2.09	1.49	1.30	1.30	2.24
O. OF YEARS OF RECORD	38	38	38	38	39	39	38	38	38	38	39	38	
). OF DAYS WITH MEASURABLE RAIN	2	2	3	6	6	8	6	7	6	7	6	3	62
). OF DAYS WITH MEASURABLE SNOW	7	3	2	*	*	0	0	0	0	*	3	7	22
). OF DAYS WITH M. PRECIPITATION	8	5	5	6	6	8	6	7	6	7	9	9	82

APPENDIX 4A

	J	F	M	A	M	J	J	A	S	O	N	D
N	13	10	6	8	9	5	14	11	9	7	7	11
NE	3	3	1	2	4	3	7	5	4	3	3	3
E	3	4	3	4	5	5	8	8	4	4	5	4
SE	12	10	15	12	11	11	11	11	11	12	17	12
S	35	40	41	34	28	34	18	21	29	39	39	38
SW	15	17	17	17	18	22	13	15	15	14	11	10
W	2	3	5	7	6	9	8	11	7	4	3	4
NW	9	9	10	13	16	9	16	14	17	13	11	11
CALM	8	4	2	3	3	2	5	4	5	4	4	7
MEAN SPEED	5.4	5.4	6.1	6.8	6.2	5.9	5.3	5.3	5.6	5.5	5.1	4.8

Clinton (MARS) B.C. - Percentage Frequency Wind Direction and Mean Wind Speed by Months (Mar. 1971-Dec. 1973)

APPENDIX 4B

	J	F	M	A	M	J	J	A	S	O	N	D
N	17	16	14	16	15	13	18	16	15	11	10	10
NE	5	4	6	6	6	5	6	7	6	5	6	6
E	5	4	5	5	3	4	4	4	4	5	6	7
SE	12	12	11	8	6	9	5	6	8	13	15	15
S	18	22	22	21	16	18	14	17	20	26	22	24
SW	10	11	15	15	15	18	16	16	15	15	14	13
W	3	4	4	6	9	9	9	8	6	5	4	4
NW	13	17	17	18	24	17	19	18	17	11	9	9
CALM	17	10	6	5	6	7	9	8	9	9	14	12
MEAN SPEED	4.4	6.0	6.3	6.7	6.2	5.9	5.4	5.1	5.4	5.7	4.9	5.1

Dog Creek Airport B.C. - Percentage Frequency
Wind Direction (and Calms) and Mean Wind Speed by Months
(Nov. 1953-Nov. 1960)

APPENDIX 4C

	J	F	M	A	M	J	J	A	S	O	N	D
N	3	3	4	6	8	7	9	7	5	3	3	4
NE	0	1	0	2	3	5	3	4	1	1	0	0
E	3	6	5	5	5	5	5	5	4	4	5	3
SE	45	42	36	26	18	17	15	17	17	55	50	44
S	4	5	6	6	7	6	6	6	4	5	4	4
SW	2	3	5	7	8	9	8	6	3	3	1	2
W	4	5	5	8	9	8	7	6	6	3	4	2
NW	16	11	16	20	18	18	17	14	19	6	13	12
Calm	23	24	23	20	24	25	30	35	31	20	20	29

Williams Lake B.C. - Percentage Frequency Wind Direction

(and Calms) by Months

APPENDIX 4D

	J	F	M	A	M	J	J	A	S	O	N	D
N	4.6	4.6	5.0	7.1	6.7	6.3	6.3	5.2	5.6	5.2	5.2	5.4
NE	4.4	4.5	4.5	5.3	6.7	5.6	6.0	4.8	4.1	3.9	3.8	4.8
E	6.5	5.9	6.5	7.1	7.8	6.9	6.7	5.7	5.5	5.3	5.9	6.1
SE	9.1	9.5	9.8	8.6	8.7	9.0	7.9	6.3	7.4	8.8	9.3	9.7
S	5.3	5.7	8.3	7.1	7.1	6.1	5.9	4.8	5.1	5.8	5.9	6.1
SW	4.6	5.4	6.3	6.5	5.9	5.4	5.8	4.9	4.5	5.6	4.8	4.2
W	6.7	8.5	7.4	7.7	6.9	7.3	6.2	5.5	6.7	6.7	6.7	6.7
NW	7.9	8.1	9.0	8.4	7.8	8.1	7.1	6.7	7.7	7.6	7.7	7.0

Williams Lake B.C. - Mean Wind Speed (MPH) by Direction and Month

APPENDIX 4E

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
JAN.	30	32	34	32	35	29	31	30	31	31	28	28	23	24	23	23	26	26	31	32	30	31	36	29
FEB.	32	36	37	33	39	37	39	37	38	31	27	24	21	23	23	22	27	30	36	34	35	35	38	35
MAR.	32	37	34	34	33	32	34	35	27	21	18	20	18	18	15	15	16	20	25	24	25	27	30	31
APR.	28	33	33	35	35	37	38	31	19	16	15	12	8	11	10	8	9	12	15	20	23	27	31	27
MAY	42	43	42	47	50	53	45	29	23	20	17	14	11	10	12	16	16	12	15	21	29	34	40	36
JUN.	45	46	45	45	52	52	39	27	22	22	22	19	14	11	10	12	14	14	19	21	28	33	37	40
JUL.	50	53	53	55	58	62	53	35	34	31	28	21	20	14	16	18	16	20	21	23	31	33	38	45
AUG.	50	50	53	58	60	61	61	49	38	28	28	26	19	20	22	16	18	18	22	24	30	34	39	42
SEP.	45	46	48	49	48	46	46	38	28	23	24	16	17	15	16	19	19	25	28	31	31	36	38	41
OCT.	30	28	28	26	28	29	30	28	24	17	17	11	13	13	12	12	19	22	23	23	24	27	30	27
NOV.	29	28	29	28	28	25	27	26	26	21	19	15	14	15	15	19	22	25	23	21	24	25	25	27
DEC.	31	30	32	31	31	33	31	30	29	28	25	20	20	19	21	21	24	27	31	29	31	27	30	32

Williams Lake, B.C. – Percentage Frequency Calm Winds by Hour and Month

APPENDIX 4F

DOG CREEK

LATITUDE 51 38 N LONGITUDE 122 15 W ELEVATION 3370 FT ASL

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	YEAR
AN DAILY TEMPERATURE (DEG F)	13.4	21.1	27.9	38.7	49.9	54.7	60.4	58.3	52.4	41.1	27.7	20.4	38.8
AN DAILY MAXIMUM TEMPERATURE	20.9	29.4	37.0	48.9	61.7	65.1	72.6	70.0	63.9	50.1	35.0	27.4	48.5
AN DAILY MINIMUM TEMPERATURE	5.8	12.8	18.8	28.5	38.1	44.2	48.1	46.4	40.8	32.1	20.3	13.3	29.1
TREME MAXIMUM TEMPERATURE	55	53	63	74	86	88	94	92	84	75	61	56	94
O. OF YEARS OF RECORD	16	16	16	15	16	16	16	16	17	17	17	16	
TREME MINIMUM TEMPERATURE	-41	-29	-32	- 2	21	29	30	31	16	4	-24	-32	-41
O. OF YEARS OF RECORD	16	16	16	16	16	16	16	16	17	17	17	16	
. OF DAYS WITH FROST	31	28	29	22	7	*	*	*	4	17	27	30	195
AN RAINFALL (INCHES)	0.03	0.04	0.04	0.25	1.15	2.26	1.57	1.48	1.20	0.72	0.12	0.05	8.91
AN SNOWFALL	13.2	10.4	8.5	6.0	1.7	T	0.0	T	0.3	2.6	9.3	13.8	65.8
AN TOTAL PRECIPITATION	1.35	1.08	0.89	0.85	1.32	2.26	1.57	1.48	1.23	0.98	1.05	1.43	15.49
EATEST RAINFALL IN 24 HRS	0.21	0.37	0.18	0.26	0.83	1.21	0.72	0.91	1.85	0.82	0.38	0.22	1.85
O. OF YEARS OF RECORD	16	16	16	16	16	16	16	16	17	17	17	16	
EATEST SNOWFALL IN 24 HRS	10.2	10.2	10.0	5.8	4.9	0.2	0.0	T	2.0	4.5	8.7	16.5	16.5
O. OF YEARS OF RECORD	16	16	16	16	16	16	16	17	17	17	17	16	
EATEST PRECIPITATION IN 24 HRS.	1.02	1.02	1.00	0.58	0.83	1.21	0.72	0.91	1.85	0.82	0.87	1.65	1.85
O. OF YEARS OF RECORD	16	16	16	16	16	16	16	16	17	17	17	16	
O. OF DAYS WITH MEASURABLE RAIN	*	*	1	2	8	13	8	11	7	5	1	1	57
O. OF DAYS WITH MEASURABLE SNOW	12	10	8	5	2	*	0	0	*	3	7	10	57
O. OF DAYS WITH M. PRECIPITATION	12	10	8	7	8	13	8	11	7	7	8	10	109

APPENDIX 4G

150 MILE HOUSE LATITUDE 52 07 N LONGITUDE 121 56 W ELEVATION 2420 FT ASL

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	YEAR
MEAN DAILY TEMPERATURE (DEG F)	11.9	22.5	29.8	40.5	50.3	56.4	60.5	58.3	51.9	41.3	28.9	20.6	39.4
MEAN DAILY MAXIMUM TEMPERATURE	20.3	32.4	41.1	53.2	64.6	70.0	75.4	72.3	66.1	51.7	37.2	28.2	51.0
MEAN DAILY MINIMUM TEMPERATURE	3.6	12.5	18.6	27.8	35.9	42.8	45.5	44.2	37.7	30.9	20.6	13.0	27.8
EXTREME MAXIMUM TEMPERATURE	56	57	67	79	88	93	97	93	86	78	66	53	97
NO. OF YEARS OF RECORD	16	16	16	16	16	16	15	15	16	15	16	16	
EXTREME MINIMUM TEMPERATURE	-49	-39	-39	8	15	25	29	29	15	2	-32	-41	-49
NO. OF YEARS OF RECORD	16	16	16	16	16	16	15	15	16	15	16	16	
NO. OF DAYS WITH FROST	30	27	29	23	11	2	*	1	8	19	26	30	206
MEAN RAINFALL (INCHES)	0.14	0.15	0.18	0.48	1.34	2.42	1.64	1.88	1.42	1.00	0.36	0.13	11.14
MEAN SNOWFALL	14.7	7.5	5.3	2.6	0.3	0.0	0.0	0.0	0.1	2.5	7.4	15.7	56.1
MEAN TOTAL PRECIPITATION	1.61	0.90	0.71	0.74	1.37	2.42	1.64	1.88	1.43	1.25	1.10	1.70	16.75
GREATEST RAINFALL IN 24 HRS	0.64	0.55	0.38	0.40	1.12	1.12	1.73	1.62	0.59	1.13	0.42	0.30	1.73
NO. OF YEARS OF RECORD	16	16	16	16	15	16	15	15	16	15	16	16	
GREATEST SNOWFALL IN 24 HRS	15.8	6.7	5.5	3.0	4.1	0.0	0.0	0.0	2.0	3.0	8.0	13.0	15.8
NO. OF YEARS OF RECORD	16	16	16	16	15	16	15	16	16	15	16	16	
GREATEST PRECIPITATION IN 24 HRS.	1.58	0.67	0.55	0.40	1.12	1.12	1.73	1.62	0.59	1.13	0.80	1.30	1.73
NO. OF YEARS OF RECORD	16	16	16	16	15	16	15	15	16	15	16	16	
NO. OF DAYS WITH MEASURABLE RAIN	1	1	2	5	8	12	10	12	8	8	4	2	73
NO. OF DAYS WITH MEASURABLE SNOW	11	7	6	2	*	0	0	0	*	2	6	9	43
NO. OF DAYS WITH M. PRECIPITATION	11	8	7	6	8	12	10	12	8	10	9	11	112