SNOW DRIFT STUDY

CANADIAN FORCES STATION ALERT

by

J. Peter Schofield

A Practicum

presented to the University of Manitoba

in partial fulfillment of the

requirements for the degree of

MASTER OF CITY PLANNING

in

DEPARTMENT OF CITY PLANNING

Winnipeg, Manitoba, 1986

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ABSTRACT

The purpose of this study was to determine experimentally, prior to any actual construction, the optimum location of proposed new structures at Canadian Forces Station Alert to minimize the disruptive effects of snow drifting on patterns of circulation within the site, particularly in cases of emergency.

The study was conducted by constructing two models of the site; one model was tested in a water flume using sand to simulate the snow, while the other was placed outdoors so that actual snow drifting could occur on it.

The model tested in the water flume provided satisfactory results when compared to actual drifting. This model was then revised and tested to provide snow drifting patterns for four alternative site plans. The outdoor model, however, provided poor results because of the extensive snow drifting which occurred.

From the test results in the water flume, the report was able to recommend a specific site layout for Canadian Forces Station Alert, as well as recommendations for new and existing buildings.

ACKNOWLEDGEMENT

The author wishes to thank Professor Basil Rotoff for his excellent support and advice during this study, as well as the helpful comments provided by Professors John Welch and Ian Goulter. The support of Frank Pauls during the construction of the models and Stan Kaskiw during the testing in the water flume are also greatly appreciated.

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CHAPTER 1

BACKGROUND

1.1 Introduction

In siting buildings in southern parts of Canada, some emphasis is given to solar orientation and landscaping, but very seldom are snow drifting or wind directions considered in the site layout. In Canada's north, however, snow drifting becomes very important because of the serious consequences this problem can create such as blocking physical access to buildings in emergencies. The purpose of this study will be to determine experimentally the impact of snow drifting on the selection of new sites for facilities at Canada's most northern permanent establishment, Canadian Forces Station (CFS) Alert.

Canada's Northwest Territories is a vast area of land and water with an area of 3,379,700 square kilometres. The population of this region is only 40,000 or just 1.2 persons per 100 square kilometres. This low density is attributed to the harsh environment of the North which often makes simple tasks, such as deliveries of supplies, a very expensive and difficult undertaking. The land is barren, often being referred to as a desert, but high winds blow snow thousands of kilometres, drifting in and immobilizing entire communities.

Public interest in this desolate land has been generally low over the years, however, the recent controversial voyage of the American Coast Guard ship 'Polar Sea' through the Northwest Passage, has awakened the need for a stronger Canadian presence. The region has also drawn attention because of increased demands for minerals, oil and gas. Any increased commitment to this region will likely mean more military presence in the air with increased aircraft surveillance, on the water or ice with sea patrols, and on the land with more permanent stations being built.

The construction or improvement of existing military stations in the north will necessitate development of additional physical facilities requiring more planning studies into site selection and layout for new facilities so that personnel can undertake essential station operations with minimal disruption from the climate.

1.2 The Environment

CFS Alert is located on the northern tip of Ellesmere Island in the Northwest Territories as shown in Figure 1-1. Being the most northern manned station in the world, the climate plays a significant role in its daily operation. Temperature, which is the most significant factor, has an annual mean of -18.2°C with long periods when it can be below -40.0°C.

Winds in this northern climate are fairly moderate with an average annual speed of 8.1 km/hr. However, at times they can reach over 100 km/hr which, combined with low temperatures, can cause extreme danger when outdoors. The prevailing wind directions are from the west from September to April, making this a critical direction for blowing snow. From observations of people on site, however, the more serious blowing snow storms come from the southwest. Because of the

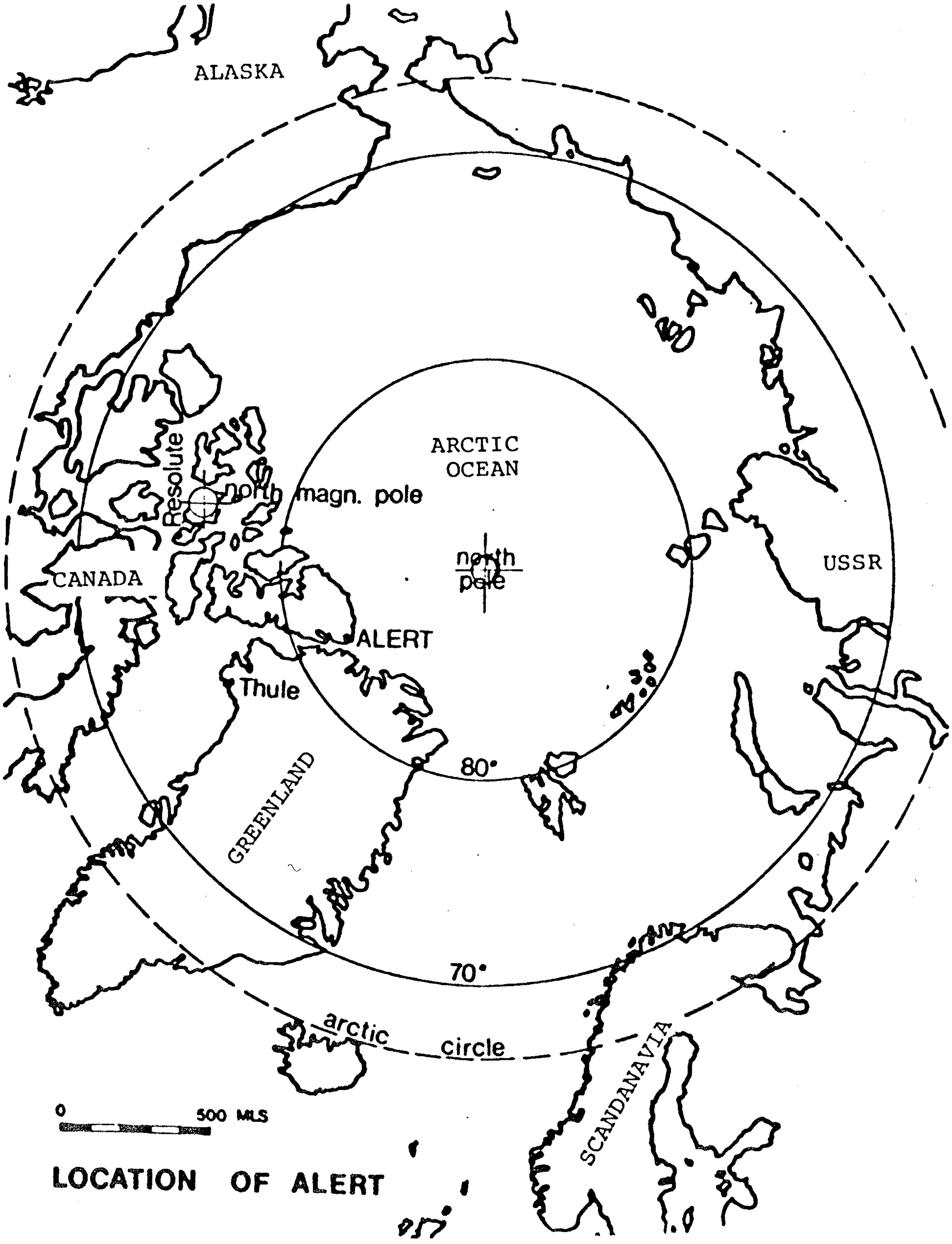


Figure 1-1 CFS Alert - Georgraphic Location

location of the Station on a small plateau, this further enhances the blowing snow problem.

Precipitation at Alert is very light, with an average annual rainfall of 17.5 mm and average annual snowfall of 148.1 cm. Snow is normally on the ground from September to June. Because of the barrenness of the landscape, however, blowing snow can be carried over thousands of kilometres and becomes a serious problem.

There is no sunlight at Alert for 4½ months from about October 11th to March 1st. The months of May to August, however, have sunlight for 24 hours a day. Because of the long period with no sunlight, power supply becomes very critical. The 24 hours of sunlight during the warmer months is a bonus in comparison because it allows work, such as outdoor construction, to be done 24 hours a day.

Permafrost, which is ever present in the north, also causes problems with construction at Alert. The active layer (depth of soil which normally thaws each year) is only 45 cm, however when pressure, such as a new building is placed on an ice lense, it will cause the ice to shrink away from the load, resulting in settlement.

A summary of the climitalogical data for Alert is provided in Table 1-1.

1.3 Statement of Problem

Construction in Alert in the above climatic condition is not only physically difficult, but logistically as well: construction season is very short and so is the time during which materials are brought in

TABLE 1 — MEANS OF TEMPERATURE, PRECIPITATION, HUMIDITY, PRESSURE, WIND AND SUNSHINE / MOYENNES DE TEMPERATURE, PRECIPITATIONS, HUMIDITE, PRESSION, VENT ET INSOLATION — TABLEAU 1

	JAN JANV	FEB FEVR	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUILL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	ANN ANN	
TEMPERATURE(C)														TEMPERATURE(C)
MAXIMUM	-28.2	-29.7	-29.3	-20.8	-8.5	1.4	6.4	3.4	-7.1	-16.0	-22.9	-26.1	-14.8	MAXIMALE
MINIMUM	-35.9	-37.4	-37.0	-28.9	-14.7	-3.4	0.7	-1.6	-13.2	-23.3	-30.3	-33.8	-21.6	MINIMALE
MEAN	-32.1	-33.6	-33.2	-24.9	-11.7	-1.0	3.6	0.9	-10.2	-19.7	-26.6	-30.0	-18.2	MOYENNE
EXTREME MAXIMUM	0.0	1.1	-2.2	-0.2	8.3	17.2	20.0	18.3	7.6	4.4	0.6	3.2	20.0	MAXIMALE EXTREME
EXTREME MINIMUM	-48.9	-50.0	-49.4	-45.6	-27.2	-13.9	-6.1	-15.0	-28.2	-39.4	-43.5	-46.1	-50.0	MINIMALE EXTREME
PRECIPITATION														PRECIPITATIONS
RAINFALL(MM)	T	0.0	0.0	0.0	0.0	2.6	8.1	6.6	0.2	0.0	0.0	0.0	17.5	CHUTES DE PLUIE(MM)
EXTREME IN 24HR	0.3	0.0	0.0	0.0	T	18.5	18.8	17.0	1.5	T	0.0	0.0	18.8	EXTREME SUR 24H
SNOWFALL(CM)	7.4	5.6	7.2	7.8	12.8	9.8	11.1	20.8	33.0	15.6	8.7	8.3	148.1	CHUTES DE NEIGE(CM)
EXTREME IN 24HR	9.4	5.1	5.3	20.6	14.7	9.7	11.4	22.9	25.2	20.3	10.9	11.9	25.2	EXTREME SUR 24H
TOTAL(MM)	7.1	5.2	6.8	7.6	10.4	12.1	19.5	28.3	27.7	13.5	8.3	7.9	154.4	TOTAL(MM)
EXTREME IN 24HR	10.2	5.1	5.3	19.3	11.4	18.5	18.8	23.4	25.2	20.3	9.9	10.4	25.2	EXTREME SUR 24H
HUMIDITY														HUMIDITE
VAPOUR PRESSURE(KPA)														PRESSION DE VAPEUR(KPA)
DEW POINT(C)														POINT DE ROSEE(C)
RELATIVE HUMIDITY(%)														HUMIDITE REL(%)
PRESSURE														PRESSION
SEA LEVEL(KPA)														NIV MER(KPA)
WIND														VENT
PREVAILING DIRECTION	W	W	W	W	NNW	N	E	E	W	W	W	W	W	DIR DOMINANTE
SPEED(KM/H)	7.4	6.6	4.9	5.3	6.5	9.2	10.2	14.8	10.3	8.4	7.2	7.5	8.1	VITESSE(KM/H)
PEAK WIND(KM/H)	93	85	109	113	61	65	87	93	93	87	81	90	113	VITESSE MAX(KM/H)
SUNSHINE														INSOLATION
BRIGHT SUNSHINE(H)	0.0	0.0	66.5	389.5	410.1	303.8	299.0	207.2	82.8	8.5	0.0	0.0	1767.4	INSOL EFFECTIVE (H)
% OF POSSIBLE	0.0	0.0	20.3	56.5	55.1	42.2	40.2	27.8	16.2	8.8	0.0	0.0	38.6	FRACTION D'INSOL (%)

TABLE 2 — MEAN NUMBER OF DAYS WITH OCCURRENCE OF / NOMBRE MOYEN DE JOURS D'OCCURRENCE DES PHENOMENES — TABLEAU 2

	JAN JANV	FEB FEVR	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUILL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	ANN ANN	
TEMPERATURE(MAX)														TEMPERATURE(MAX)
> 0 C	0	*	0	0	2	18	30	24	2	*	*	*	76	> 0 C
> 18 C	0	0	0	0	0	0	*	*	0	0	0	0	*	> 18 C
> 30 C	0	0	0	0	0	0	0	0	0	0	0	0	0	> 30 C
> 35 C	0	0	0	0	0	0	0	0	0	0	0	0	0	> 35 C
TEMPERATURE(MIN)														TEMPERATURE(MIN)
= OR < 0 C	31	28	31	30	31	26	16	23	30	31	30	31	338	= OU < 0 C
> 0 C	0	0	0	0	*	4	15	8	*	0	0	0	27	> 0 C
< -2 C	31	28	31	30	31	18	2	13	30	31	30	31	306	< -2 C
< -20 C	31	28	31	27	5	0	0	0	4	22	29	30	207	< -20 C
< -35 C	19	20	22	5	0	0	0	0	0	*	4	13	83	< -35 C
PRECIPITATION														PRECIPITATIONS
(RAIN)														(PLUIE)
= OR > 0.2 MM	0	0	0	0	0	1	5	4	*	0	0	0	10	= OU > 0.2 MM
(SNOW)														(NEIGE)
= OR > 0.2 CM	8	6	8	6	8	6	6	8	12	9	8	8	93	= OU > 0.2 MM
= OR > 1 CM	3	2	3	3	4	3	4	5	8	4	3	3	45	= OU > 1 CM
= OR > 10 CM	0	0	0	*	*	0	*	*	*	*	*	*	*	= OU > 10 CM
(TOTAL)														(TOTAL)
= OR > 0.2 MM	8	6	8	6	8	7	8	10	12	9	8	8	98	= OU > 0.2 MM
> 10 MM	*	0	0	*	*	*	*	*	*	*	0	*	*	> 10 MM
> 12 MM	0	0	0	*	0	*	*	*	*	*	0	0	*	> 12 MM
> 25 MM	0	0	0	0	0	0	0	0	*	0	0	0	*	> 25 MM
THUNDERSTORMS	0	0	0	0	0	0	0	0	0	0	0	0	0	ORAGE
HAIL	0	0	0	0	0	0	0	0	0	0	0	0	0	GRELE
FREEZING PCPN	*	0	0	0	*	1	1	2	1	*	0	0	5	PREC VERGLACANTES
SMOKE OR HAZE	*	0	*	0	0	0	0	0	0	0	0	0	*	FUMEE OU BRUME
BLOWING SNOW	5	4	3	2	1	*	*	*	2	3	3	5	28	CHASSE-NEIGE ELEVEE
FOG	1	1	1	1	4	7	7	10	7	4	2	1	46	BROUILLARD

TABLE 3 — DEGREE DAYS / DEGRES-JOURS — TABLEAU 3

REFERENCE	JAN JANV	FEB FEVR	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUILL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	ANN ANN	SEUIL
< 18 C	1551	1457	1586	1285	919	571	449	530	845	1167	1337	1484	13186	< 18 C
< 16 C	1489	1401	1524	1225	857	511	387	468	785	1105	1277	1422	12455	< 16 C
< 15 C	1458	1373	1493	1195	826	481	356	437	755	1074	1247	1391	12090	< 15 C
< 10 C	1303	1231	1338	1045	671	331	202	282	605	919	1097	1236	10266	< 10 C
< 5 C	1148	1090	1183	895	516	183	67	136	455	764	947	1081	8470	< 5 C
< 0 C	993	948	1028	745	361	61	1	31	306	609	797	926	6813	< 0 C
< -5 C	838	807	873	595	213	9	0	3	167	454	647	771	5382	< -5 C
> 24 C	0	0	0	0	0	0	0	0	0	0	0	0	0	> 24 C
> 18 C	0	0	0	0	0	0	0	0	0	0	0	0	0	> 18 C
> 15 C	0	0	0	0	0	0	0	0	0	0	0	0	0	> 15 C
> 10 C	0	0	0	0	0	0	1	0	0	0	0	0	1	> 10 C
> 5 C	0	0	0	0	0	2	20	9	0	0	0	0	33	> 5 C
> 0 C	0	0	0	0	0	30	110	59	0	0	0	0	201	> 0 C
> -5 C	0	0	0	0	7	127	263	186	12	0	0	0	597	> -5 C

Table 1-1 CFS Alert - Climatological Data

PRINCIPAL STATION DATA – PSD
Reference Notes

Most of the data are obtained from regular hourly weather observations. Special observations made between the times of regular hourly observations are not included. All observations are made at the same hours of local standard time throughout the year.

* denotes a percentage value less than 0.05 (but not zero) or at least one observation of a specific element during the period of record.

TOTAL OBSERVATIONS refers to all the hourly weather observations regardless of whether the specific element was observed or not.

ALL HOURS is calculated from all available hourly values for 00 to 23 hours, inclusive.

Unless otherwise indicated all frequency tables are expressed to the nearest tenth of a per cent and are obtained by dividing the number of observations of a specified condition for a specific period by the total number of observations with or without that condition and for that same period.

Table 1

Means are for the normal period 1951-1980; extremes are selected without regard to changes in station location during the full period of record to the end of 1980. Total precipitation is the total water equivalent of snowfall and rainfall.

Monthly mean values of humidity, pressure, wind and sunshine are calculated from daily values which are averages of hourly readings.

Peak wind is the maximum gust speed on record observed from a dial indicator or abstracted from a continuous chart record.

% of POSSIBLE (sunshine) is the ratio (expressed as a per cent) of the duration of sunshine that is observed at that station to the duration of sunshine that would be observed if the terrain was level, no obstructions existed, and the sky was clear.

Extreme rainfall, extreme snowfall and extreme total precipitation refer to the greatest accumulation in one day.

Table 2

THUNDERSTORMS: a day when thunder is heard, or when lightning or hail is seen but thunder is not heard because the ambient noise is too loud.

HAIL: a day with an occurrence of precipitation of small balls or pieces of ice (hailstones) with a diameter of 5 mm or more.

FREEZING PRECIPITATION: a day with an occurrence of freezing rain or freezing drizzle of any quantity, even a trace, that freezes on impact.

SMOKE OR HAZE: a day when the visibility is restricted to 10 km or less because small dry particles are suspended in the air. These particles must be sufficiently numerous to give the air a greenish-yellow, light-greyish or bluish hue for smoke, or a milky or pearly hue for haze.

BLOWING SNOW: a day when the horizontal visibility is restricted to 10 km or less because snow particles are raised by the wind to eye level.

FOG: a day when fog occurs, i.e., when the horizontal visibility is restricted to less than 1 km because very small water droplets are suspended in the air.

For PSDs printed in 1983, data are not available for the mean number of days with an occurrence of hail, smoke or haze, blowing snow and fog.

Table 3

Monthly means of degree-days are rounded to the nearest whole degree, but are not adjusted to make the sum of the monthly values exactly equal to the annual total.

Source: Environment Canada, Principal Station Data PSD-70, Alert, Atmospheric Environmental Service.

Table 1-1 CFS Alert - Climatological Data (Continued) by water to Thule, Greenland, located 500 km to the south, whence it is air lifted to the site. It is therefore imperative that all construction be carried out with a minimum of error, for once a structure is in place, there is very little chance of it being rebuilt should problems arise from its design or its location.

Hence, the purpose of this study is to determine experimentally, prior to any actual construction, the optimum location of proposed new structures on the station to minimize the disruptive effects of snow drifting on patterns of circulation within the site, particularly in cases of emergency. The results of the experiments described in this study shall form the basis of the recommendations contained therein.

1.4 Methodology

This study was carried out by the following method:

a. Research was first conducted by doing a computer search for information on snow and snow drifting through The Canadian Institute for Scientific and Technical Information (CISTI) in Ottawa. This was followed by a search of university libraries and other sources for related materials. (A bibliography and list of references will be found on page 136 of this report.)

b. A model of the existing site was then built and tested in a water flume with simulated snowfall to determine what drifting patterns would occur.

c. A similar model, but on a larger scale, was built and placed outside to determined what drifting pattern would occur in nearly real conditions.

d. The results of model testing were then calibrated by comparing with actual on-site drifting. This comparison was facilitated by snow drift readings in specific locations at the site, and a site visit.

e. Once satisfied with the calibration, testing was carried out on four proposed site layouts. This testing showed the drifting patterns for each of these proposals.

The final part of the study was an analysis of the findings and recommendations were formulated.

CHAPTER 2

CANADIAN FORCES STATION ALERT

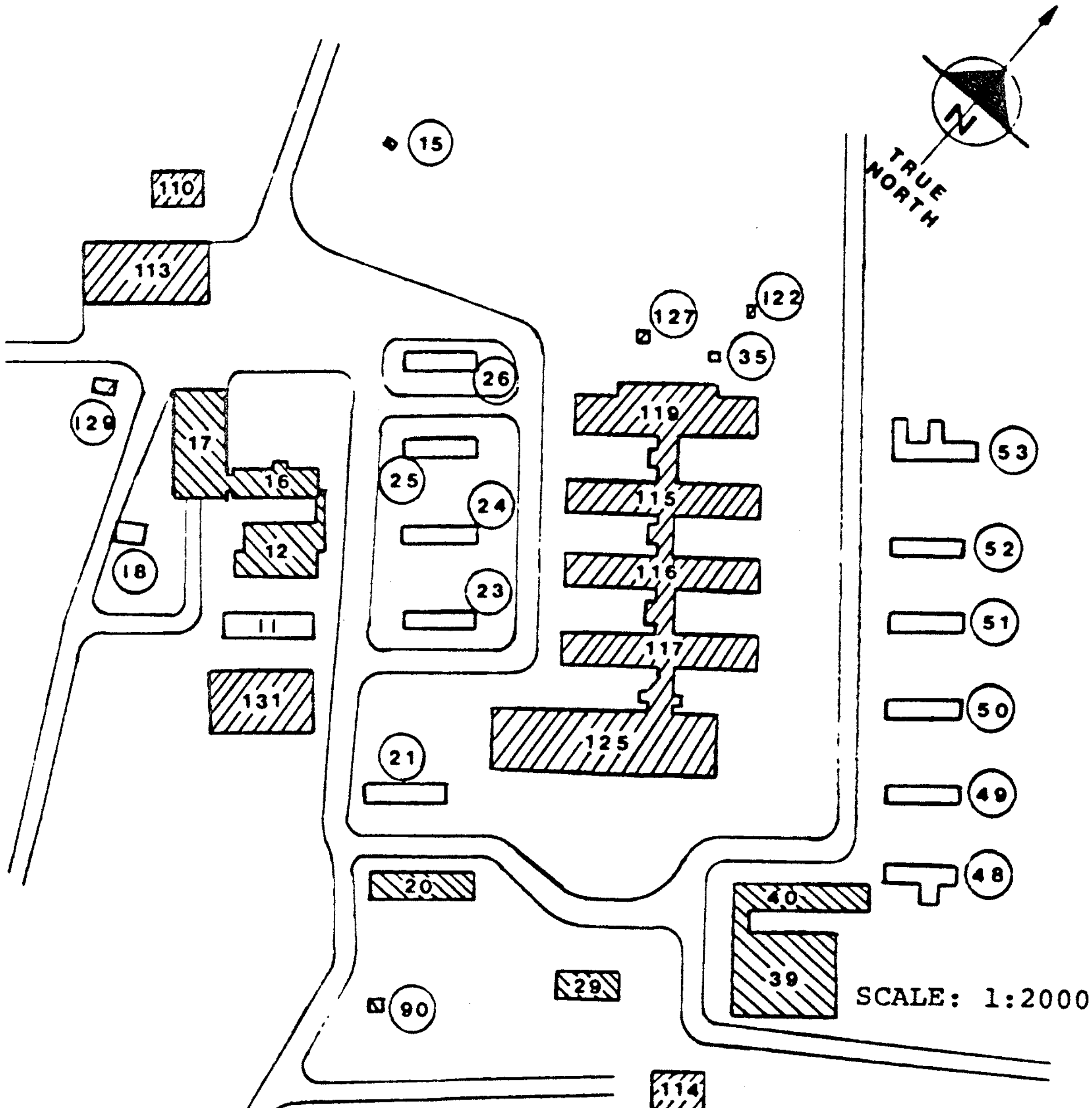
2.1 Introduction

In order to appreciate the present situation at CFS Alert it is important to look first at its historic background and at the plans for its future. In this chapter the stages of its early development will first be looked at, followed by existing proposals being made for future development. Present construction techniques at the Station will then be discussed.

The reason for the present site layout should become apparent from this chapter, as well as the need for the alternatives being proposed to be subjected to a snow drift analysis.

2.2 Historic Background

CFS Alert was first established in 1950 as a radio and meteorological station. The Department of National Defence (DND) presence dates back to 1955, when erection of the first General Purpose (GP) huts took place. The long term requirements for this station were not confirmed until 1965, so up until that time only temporary GP buildings were constructed. From 1964 to 1971, the second phase of development took place. This saw the construction of utilidor services (enclosed links between buildings, carrying all utilities) as well as the first permanent steel buildings. Permanent buildings constructed during this phase are shown in Figure 2-1.



LEGEND

11 FIREHALL
12 CE SECTION
15 POL DAY TANKS
16 MSE SUPPLY
17 MSE GARAGE
18 LUMBER STORAGE
20 POWER PLANT 2
21 1CEU DETACHMENT
23 QUARTERS
24 QUARTERS
25 QUARTERS
26 QUARTERS
29 POWER PLANT 1
35 ELECT. SPLICE HUT
39 GYMNASIUM
40 CURLING CLUB
48 ATCO TLRS (QUARTERS)
49 ALL RANKS LOUNGE (ALICES II)
50 QUARTERS
51 QUARTERS (VIP)
52 QUARTERS
53 SENIOR STAFF MESS
90 CE FLAMMABLE STORES
110 KIMONO BLDG
113 VEHICLE STORAGE
114 WATER TREATMENT PLANT
115 B.B.1 (CHIMO)
116 B.B.2 (LADNER)
117 B.B.3 (WHITEHORSE)
119 OPERATIONS
122 HURRICANE SPLICE HUT
125 HAPS BLDG (CHURCHILL HALL)
127 INCINERATOR
129 POL STORAGE
131 SUPPLY WAREHOUSE

Phase I Construction (1955-1964)
Phase II Construction (1964-1971)
Phase III Construction (1971-1985)

Figure 2-1 CFS Alert - Present Site Plan

The third phase of construction at the station was associated with project 'Trelar' which initially provided $4.9 million to upgrade living accommodations. This project was further extended to provide new operational facilities and to increase the economic viability of the station. It was during this project that a development plan was ordered, the purpose of which was to assess the extent and magnitude of the program. This development plan, which was prepared during 1977 and 1978, also recommended a snow drift study to identify problems with building access and snow removal that might arise from the construction of the new facilities.

Since 1971, this third phase has seen the construction of the several permanent buildings as is illustrated in Figure 2-1.

2.3 CFS Alert - Development Plan

The first CFS Alert Development Plan prepared during 1977 and 1978 was a very comprehensive report consisting of three major components, the building survey, the analysis and the development plan. The purpose of the plan was to outline development at the station for the period 1980-2000. The plan was based on the following assumptions which are still valid today:

a. that the existing role of the station will not change;

b. that the existing personnel strength will not significantly change;

c. that vehicle establishment will remain approximately the same;

d. that resupply will continue by combined sealift/airlift through Thule;

e. that equipment will be more modern providing increased capability, reduced communications, maintenance and manpower per unit, but additional equipment will be added to the inventory; and

f. that Atmospheric Environmental Service (AES) domestic functions will be consolidated with CFS Alert with the ultimate retention of only operational facilities at the AES site.

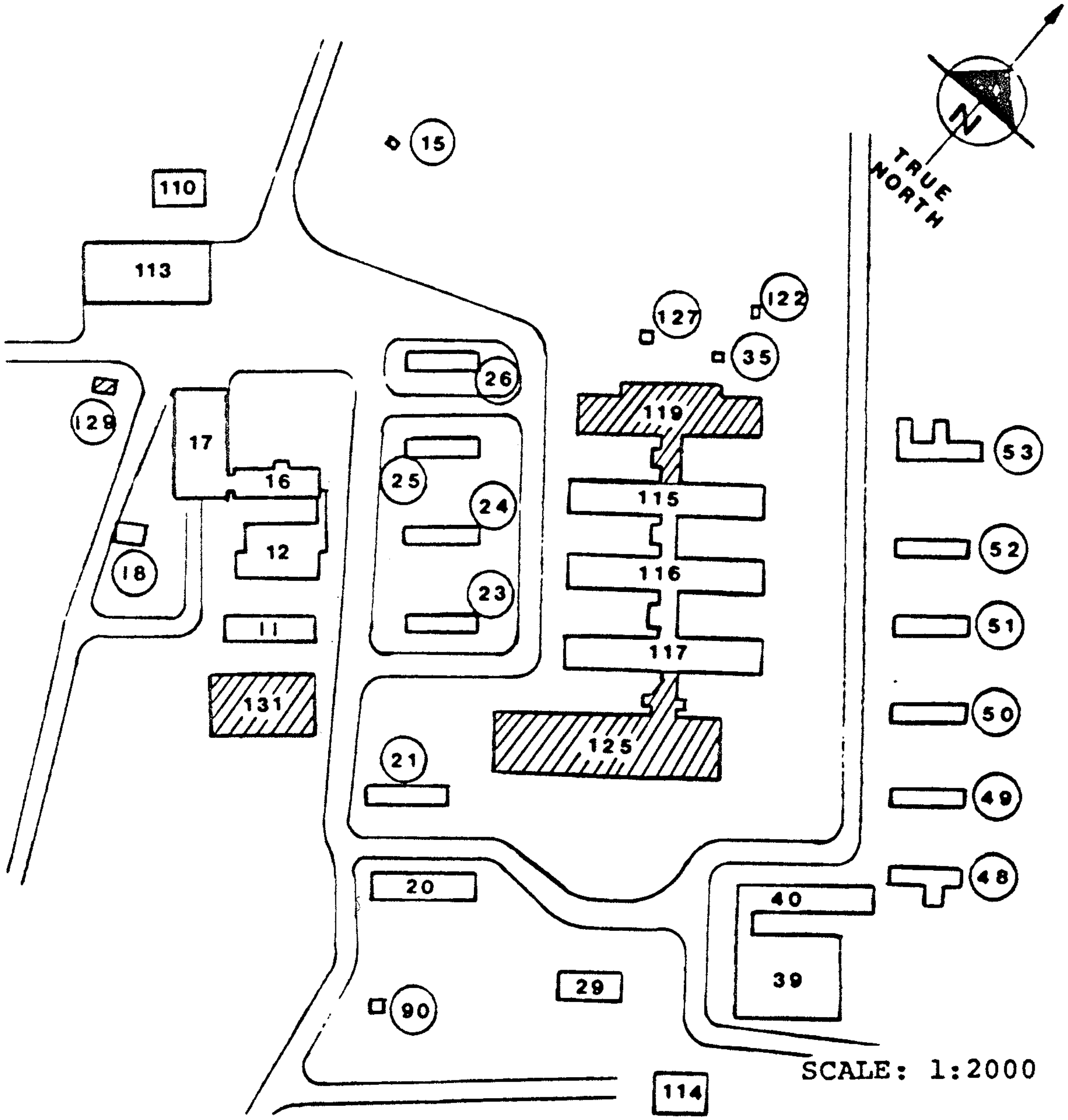
Since 1978, when the plan was completed, CFS Alert has seen the construction of several buildings. These are shown in Figure 2-2. Buildings that have been demolished since the plan was prepared are shown in Figure 2-3.

A building survey of all existing buildings is provided in Annex A.

The new buildings replaced older buildings which had exceeded their life expectancy. These new buildings provide a much more modern, efficient and comfortable environment for personnel at the station.

With new buildings being constructed and older buildings demolished each year for the past several years, the foot print at the station has been in almost constant change. This has made it more difficult to predict what snow drifting patterns will occur each year.

An update of the CFS Alert Development Plan was submitted by Communication Command in March 1985, for the period 1986-2000. This update proposes the construction of the following new buildings in the near future as per Figure 2-4.



LEGEND

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51 QUARTERS(VIP)
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117 B.B.3(WHITEHORSE)
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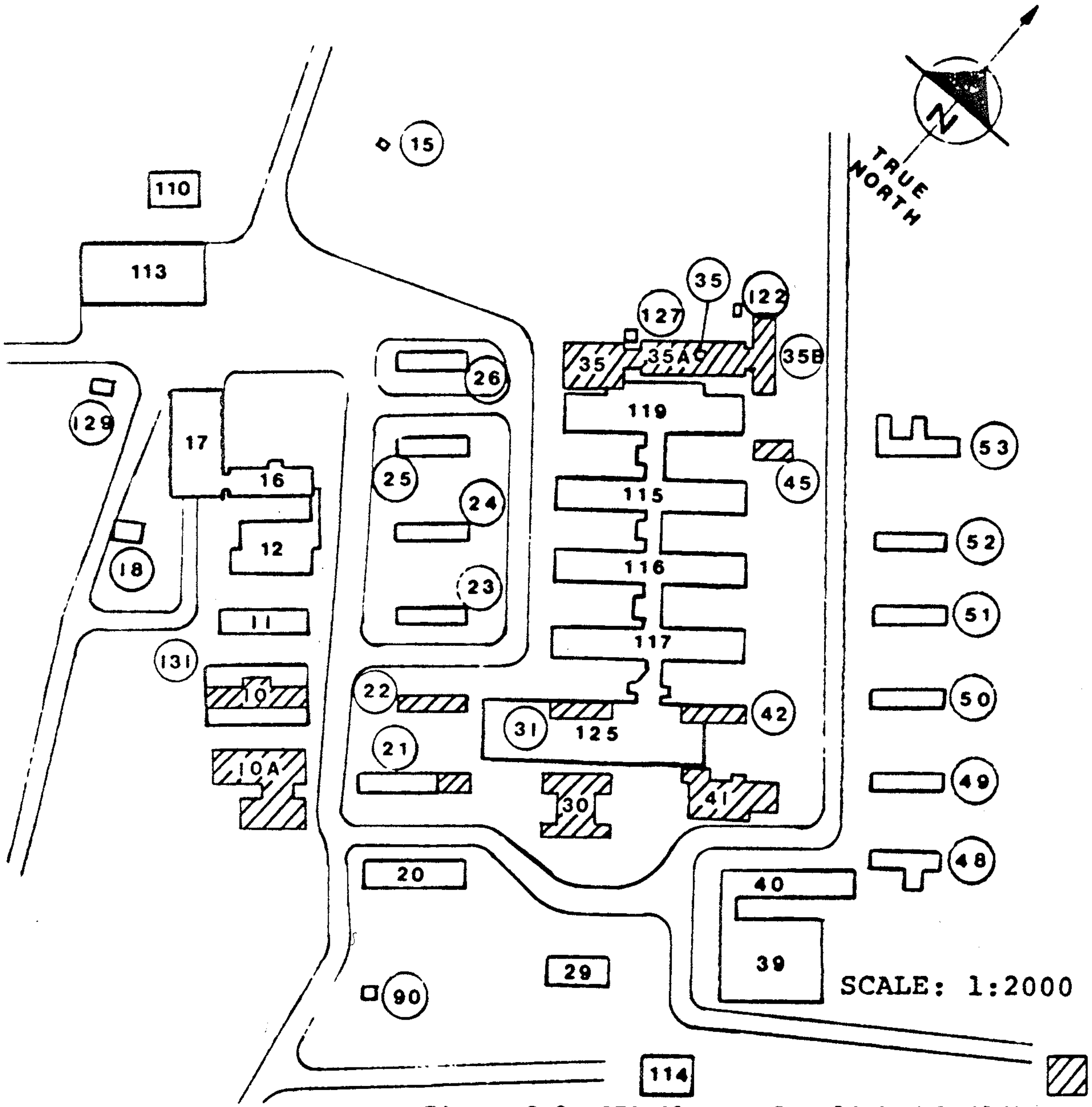
125 HAPS BLDG(CHURCHILL HALL)
127 INCINERATOR
129 POL STORAGE
131 SUPPLY WAREHOUSE

(hatched) Buildings Constructed Since Completion of Development Plan in 1978.

Figure 2-2 CFS Alert - New Buildings



LEGEND

10 STORES
10A STORES/OFFICES
11 FIREHALL
12 CE SECTION
15 POL DAY TANKS
16 MSE SUPPLY
17 MSE GARAGE
18 LUMBER STORAGE
20 POWER PLANT 2
21 1CEU DETACHMENT
22 1CEU STORES
23 QUARTERS
24 QUARTERS
25 QUARTERS
26 QUARTERS
29 POWER PLANT 1
30 RECREATION HALL/JUNIOR RANKS CLUB
31 SEARGENTS/WARRENT OFFICERS LOUNGE
35 ELECT. SPLICE HUT
35 OPERATIONS
35A OPERATIONS
35B OPERATIONS
39 GYMNASIUM
40 CURLING CLUB
41 150-MAN MESS
42 1CEU WORKSHOP
45 1CEU HEADQUARTERS
48 ATCO TLRS (QUARTERS)
49 ALL RANKS LOUNGE (ALICES II)
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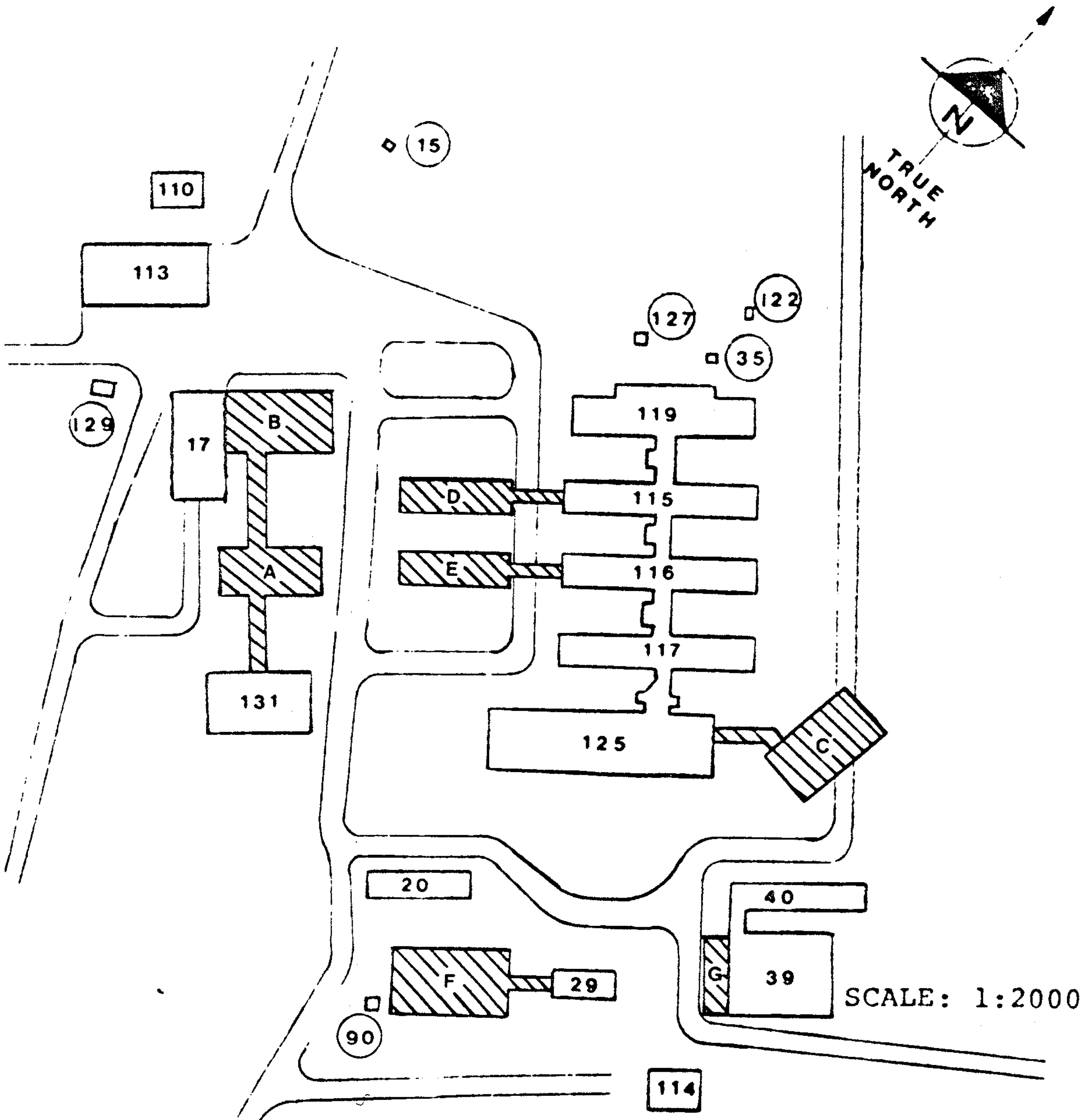
129 POL STORAGE
131 SUPPLY WAREHOUSE

Buildings Demolished Since Development Plan Completed in 1978.

Figure 2-3 CFS Alert - Demolished Buildings



LEGEND

15	POL DAY TANKS
17	MSE GARAGE
20	POWER PLANT 2
29	POWER PLANT 1
35	ELECT. SPLICE HUT
39	GYMNASIUM
40	CURLING CLUB
90	CE FLAMMABLE STORES
110	KIMONO BLDG
113	VEHICLE STORAGE
114	WATER TREATMENT PLANT
115	B.B.1(CHIMO)
116	B.B.2(LADNER)
117	B.B.3(WHITEHORSE)
119	OPERATIONS
122	HURRICANE SPLICE HUT
125	HAPS BLDG(CHURCHILL HALL)
127	INCINERATOR
129	POL STORAGE
131	SUPPLY WAREHOUSE
A	CE/FIREHALL
B	VEHICLE MAINTENANCE
C	SENIOR STAFF MESS/QUARTERS
D	QUARTERS(TRANSIENT)
E	QUARTERS(TRANSIENT)
F	POWER PLANT
G	GYMNASIUM EXTENSION

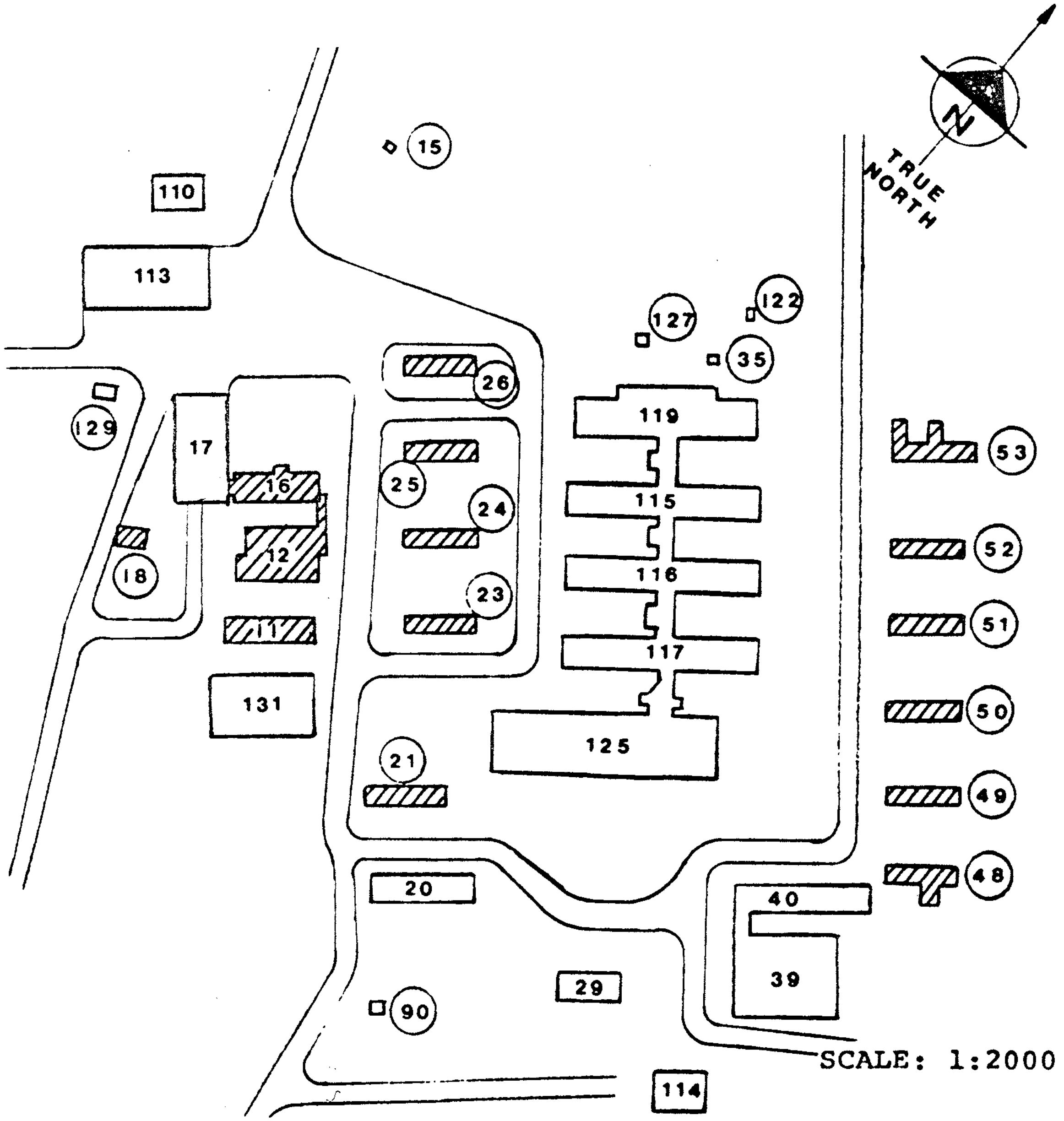
Proposed Construction Post 1985

Figure 2-4 CFS Alert - Future Site Plan

	Use	Planned Year of Const.
a.	Construction Engineering (CE)/Firehall	1986
b.	Vehicle Maintenance Building Extension	1987
c.	Senior Staff Mess and Quarters	1988
d.	Transient Quarters	1989
e.	Transient Quarters	1990
f.	Power Plant	1991
g.	Extension to Gymnasium	1992-2000
h.	Sewage Plant (if required)	1992-2000
j.	Solid Waste Incinerator (if required)	1992-2000

Buildings slated for demolition in this updated plan are as follows (see Figure 2-5):

	Building	Year
a.	No. 12, CE Shops	1986
b.	No. 11, Fire Hall	1986
c.	No. 18, Lumber Storage	1987
d.	No. 16, Mobile Support Equipment Supply	1988
e.	No. 53, Senior Staff Quarters	1989
f.	No. 24, Transient Quarters	1989
g.	No. 52, Quarters	1990
h.	No. 51, Quarters	1990
j.	No. 50, Quarters	1990
k.	No. 49, All Ranks Lounge	1990
m.	No. 48, Quarters	1990
n.	No. 25, Transient Quarters	1990



LEGEND

11 FIREHALL
12 CE SECTION
15 POL DAY TANKS
16 MSE SUPPLY
17 MSE GARAGE
18 LUMBER STORAGE
20 POWER PLANT 2
21 1CEU DETACHMENT
23 QUARTERS
24 QUARTERS
25 QUARTERS
26 QUARTERS
29 POWER PLANT 1
35 ELECT. SPLICE HUT
39 GYMNASIUM
40 CURLING CLUB
48 ATCO TLRS (QUARTERS)
49 ALL RANKS LOUNGE (ALICES II)
50 QUARTERS
51 QUARTERS (VIP)
52 QUARTERS
53 SENIOR STAFF MESS
90 CE FLAMMABLE STORES
110 KIMONO BLDG
113 VEHICLE STORAGE
114 WATER TREATMENT PLANT
115 B.B.1 (CHIMO)
116 B.B.2 (LADNER)
117 B.B.3 (WHITEHORSE)
119 OPERATIONS
122 HURRICANE SPLICE HUT
125 HAPS BLDG (CHURCHILL HALL)
127 INCINERATOR
129 POL STORAGE
131 SUPPLY WAREHOUSE

(hatched box) Buildings Slated for Demolition in Updated Plan.

Figure 2-5 CFS Alert - Proposed Demolition

p. No. 26, Transient Quarters 1991

q. No. 23, Transient Quarters 1991

r. No. 21, 1 CEU Detachment 1992-2000

The Directorate of Construction Engineering Requirements (DCER) at National Defence Headquarters (NDHQ) has looked at this proposal with some interest. DCER is concerned about the site layout and has stated that a feasible site plan should be developed and validated by a snow drift study.

As can be seen from previous, and the proposed future development, Alert is presently in the midst of a major reconstruction programme which should, when completed, provide a very modern and efficient environment for military personnel. Construction for 1986 will be going ahead because the footings have already been placed and all the material is on site. Decisions on whether the other proposals will proceed, must be made soon since some facilities, especially the Vehicle Maintenance Building, are already in the design stage.

In this study, the above proposal will be tested to determine what changes will occur to the present snow drifting patterns. Although the study will look at minimizing the requirement for snow removal in general, the main concern is the safety of this environment during the previously listed developmental stages, particularly if a fire broke out and emergency response were seriously impaired by snow drifts blocking roads and access to buildings.

2.4 Northern Construction

Because of its isolation, all new construction at Alert must be carried out using military labour. Outside contractors are only brought in for technical assistance in areas where the military do not have the expertise readily available.

Although permafrost presents many problems the military have learned to cope with it very well, as is evident by the success of new buildings being built. Since the active layer is only about 45 cm, most building footings are built to a depth of 1 metre or more. For buildings built on slabs, the floor is first insulated and ventilated to prevent the melting of the permafrost layer through heat transfer, before the finished surface is placed. Other buildings are raised above the ground providing about a 1-metre space between the bottom of the floor and the ground to reduce heat transfer to the ground.

Because of the environment, construction at the station must be carefully planned and scheduled so that all outside work can be completed during the short summer. Planning must be done well in advance because construction materials are sent into Thule by sealift and from there to Alert by airlift. Ideally, material is shipped to Thule and then airlifted to Alert a year before the project is scheduled so the work can commence as soon as possible the following year.

Although CFS Alert's geographical location makes it a desolate site for a station, DND has learned to live with the environment with minimal difficulty. Studies such as that reported in this practicum will help in the future development of this station, as well as future sites and thus further expand knowledge of the north.

CHAPTER 3

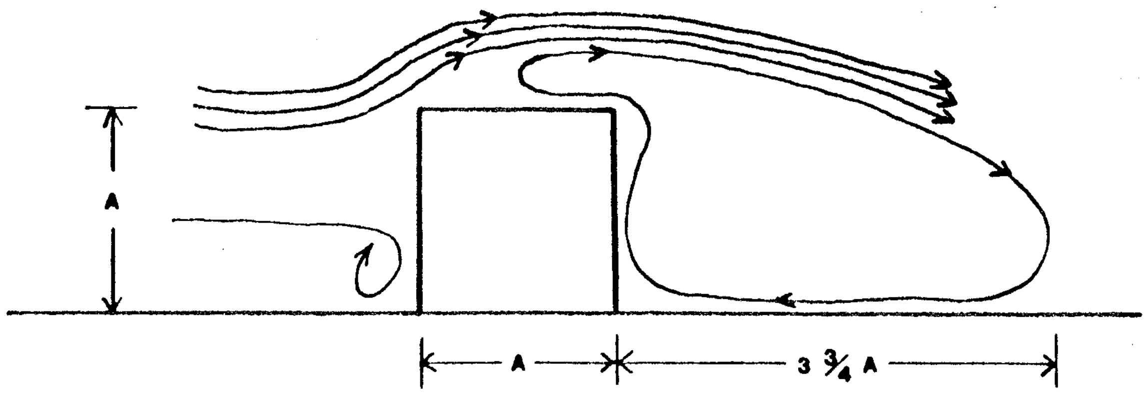
THE WATER FLUME MODEL

3.1 Introduction

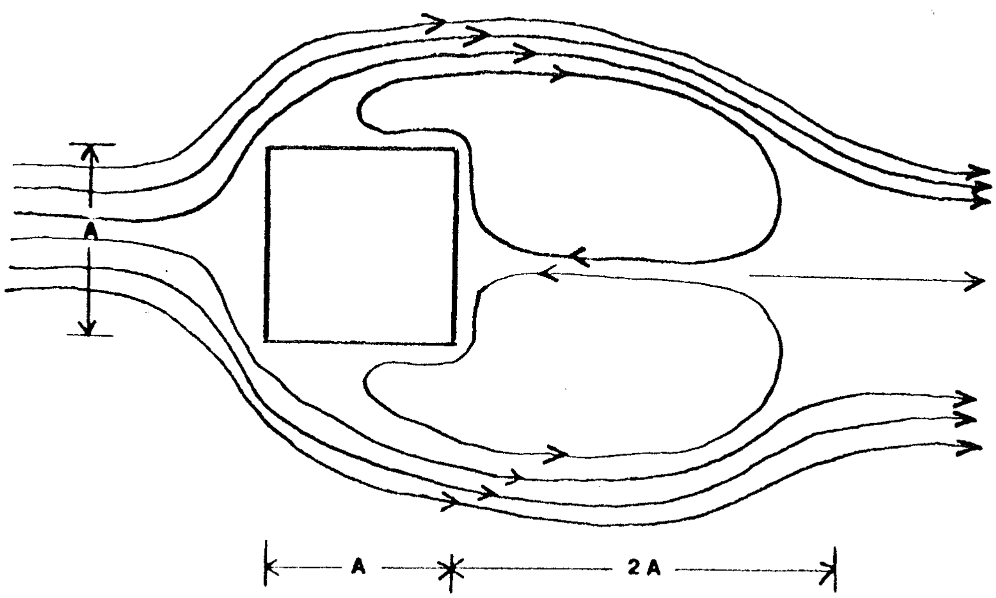
The study of snow drift patterns at CFS Alert was conducted through two simulation models, one in a water flume and the other positioned in a natural snow environment (outside in the open). This chapter will deal with the theoretical concept of snow drift modelling. It will further describe the construction, testing and calibration of the water flume model (1:600 Scale). The outdoor model (1:120 Scale) will be discussed in Chapter 4.

3.2 Modelling Background

The prediction of snow drifting patterns around an isolated building can be made easily using mathematical models if wind direction is well defined (see Figure 3-1). However, when buildings are located in close proximity to one another, the wind flow becomes much more complex making it extremely difficult to determine mathematically the resulting snow drifting patterns. By constructing a model of the site, and by simulating wind direction and precipitation, one can easily obtain qualitative predictions of drifting patterns. The model can also easily provide drifting patterns for various changes to the existing site, therefore, helping to identify possible future problems related to development proposals.



(a)
Side View



(b)
Top View

Figure 3-1 Wind Flow Around an Isolated Building

The snow drifting study of CFS Alert was conducted by testing two models, one in a water flume, and the other outdoors in natural winter conditions. The use of models in a water flume for the study of snow drifting, and its impact on site selection has been applied extensively. For example, one such study by Interdisciplinary Engineering Company of Winnipeg[1], looked at snow drifting problems for the buildings of the small community of Baker Lake, located 240 kms south of the Arctic Circle. The principle of water flume simulation is as follows: for a certain range of velocities of a fluid medium, heavier particles in the denser medium would behave similarly to lighter particles in the lighter medium, hence fine silica sand carried by the water current generated in a hydraulic flume behaves in a manner similar to drifting snow in nature. Thus, through the use of such hydraulic models this study was able to determine the best orientation for a new recreation complex, by minimizing the snow drifting impact on access and snow load on the structure. The study also determined the best location and design of residential development for the community.

In the Baker Lake study it was pointed out that the use of models in a water flume could provide very good qualitative results if snow drifting patterns were known in the field. However, since the ratio of the size of sand particles to the size of snow is much larger then that of the ratio of the model to prototype scale, a theoretical solution providing the same results is impossible.

The United States Army has done extensive research into northern development at its Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, New Hampshire. One of these studies involved the testing of models in a water flume to determine the special criteria that should be followed in order to simulate snow drifting patterns.[2] The tests, which were carried out on several model scales and water flow velocities, showed that model scale and flow velocity had very little impact on the drifting patterns. These patterns were very similar for all models under all velocities of flow. Since in these tests, the sand was placed down wind of the models and not added to the water during flow, the only restriction was that flow velocity had to be greater than the threshold velocity of the sand particle. Threshold velocity is the speed at which sand particles begin to free themselves from the surface.

In another research report by CRREL, drifting snow was investigated using a water flume.[3] In this study, various sizes and types of snow fences were evaluated so that modeling parameters would be defined such that quantitative correlation between measured prototype drift conditions and the model would be possible.

Relevant conclusions from this report were:

a. the use of sand-water analogy for modeling of drifting snow appears useful;

b. simulation of the atmospheric boundary layer is very important;

c. simulation of the precipitation rate in the model is not essential, and a high rate may be used to reduce the time scale; and

d. the model must be constructed in detail.

In an article in Ubique, M.A. Kearsley provides an interesting look at how in the past DND has used models in a water flume to correct snow drifting and wind related problems.[4] Kearsley states that solutions to snow drifting problems can be found using two different approaches. In the first, snow is deflected away from the critical area, while in the second, snow is collected immediately upwind of the critical area.

In a study of snow drifting around The Canada Building in Calgary, de Krasinski and Anson also have used the water and sand analogy to conduct tests on a model of the building.[5] In their study they duplicated the angle of precipitation and the angle required for saltation to occur on the model, in order to satisfy similarity criteria. Saltation is the process whereby sand particles are freed from the surface by water velocity and when they strike the surface again they cause other sand particles to free themselves from the surface, thus making a continuous cycle.

The importance of the angle of fall of the particle being the same for both model and prototype, in order to have kinematic similarily, was also shown in another article by de Krasinski and Szuster.[6]

In contrast, a report by R.J. Kind indicated that the use of the sand and water analogy to represent wind and snow, was not recommended because the saltation process in water is considerably different from saltation in air.[7]

As can be seen, there have been numerous reports on snow drifting using models in a water flume, albeit not all being in agreement. The fact that the water flume in the University of Manitoba Civil Engineering Department's hydraulic laboratory has been used extensively in the past for similar testing certainly supports this approach. Because of previous testing with these facilities, both the angle of fall of sand particles and type of sand used were known and did not require calibration. Also, the water velocity used could be based on previous testing results.

The use of the water flume to determine drifting patterns is definitely a useful approach even though the results are only qualitative. The low cost and the speed with which results can be obtained make it an important tool in any snow drifting study.

3.3 Constructing the 1:600 Scale Model

For the testing in the water flume, a small model to the scale of 1:600 was constructed on a 850 mm circular base made of 16 mm thick plywood. The circular base was designed to fit into the framing on the floor of the water flume and would also make it possible to test drifting for several wind directions by simply rotating the base.

The topography of Alert was modelled by glueing layers of cardboard on top of one another, each layer being cut at the next higher contour line. The contours were initially determined from 1 Construction Engineering Unit (1 CEU) drawings and a survey of ground elevations near each building, which was conducted in August 1985. Since the cardboard stock used to build up the contours was not thick enough to represent each 1 metre rise in elevation it was necessary to draw the contours at intervals of 0.87 metres. The contours for which the model was built are shown in Figure 3-2.

After the cardboard layers had been glued onto the base, it was then necessary to smooth out the ridges on the model. This was done by using plasticine along the edge of each contour so that there would be a smoother drop down to the next contour.

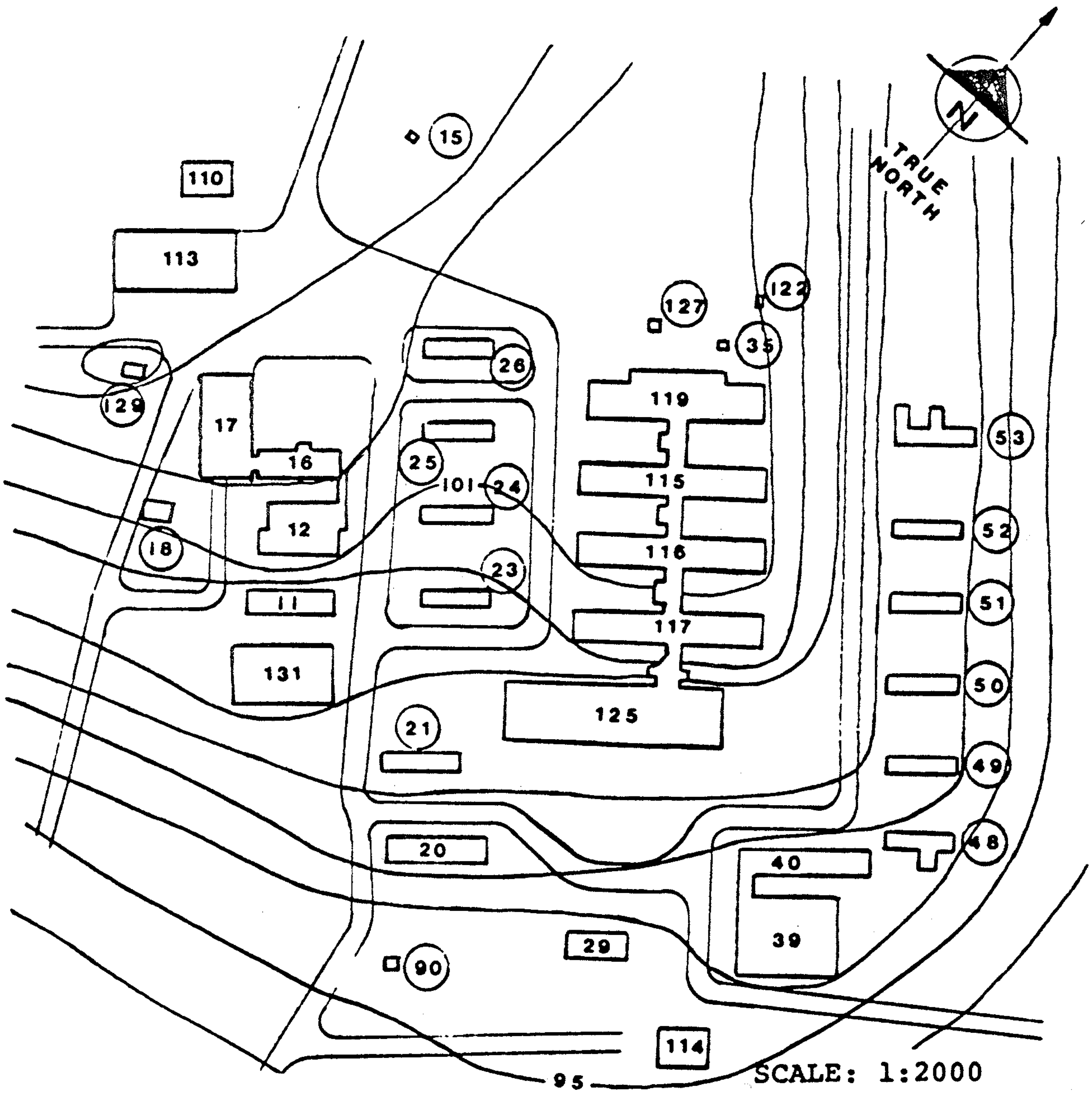
After the plasticine had been used to make a more natural land slope, the entire model was painted with a sealer to make it waterproof. Then the surface was coated with a brown varnish, again to protect the surface, but also to simulate the ground surface.

All the buildings in the model were constructed using wood. Dimensions for the buildings were determined from 1 CEU drawings and measurements taken during the site visit in August 1985. All present buildings at the site were painted orange so that they would show up clearly during the testing. Buildings not slated for future demolition were attached to the model with glue and nails, while buildings slated for demolition were only nailed so that they could be easily removed.

New buildings proposed for the site were painted yellow so that they could be clearly identified during testing. All roads or vehicle parking areas were painted gray. Figure 3-3 shows a picture of the model representing the present site at CFS Alert.

3.4 Testing the 1:600 Scale Model

The water flume model was tested in a 12.8 m long by 908 mm wide water flume in the hydraulics laboratory at the University of



SCALE: 1:2000

Figure 3-2 CFS Alert - Contour Map

LEGEND

11	FIREHALL
12	CE SECTION
15	POL DAY TANKS
16	MSE SUPPLY
17	MSE GARAGE
18	LUMBER STORAGE
20	POWER PLANT 2
21	1CEU DETACHMENT
23	QUARTERS
24	QUARTERS
25	QUARTERS
26	QUARTERS
29	POWER PLANT 1
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49	ALL RANKS LOUNGE(ALICES II)
50	QUARTERS
51	QUARTERS(VIP)
52	QUARTERS
53	SENIOR STAFF MESS
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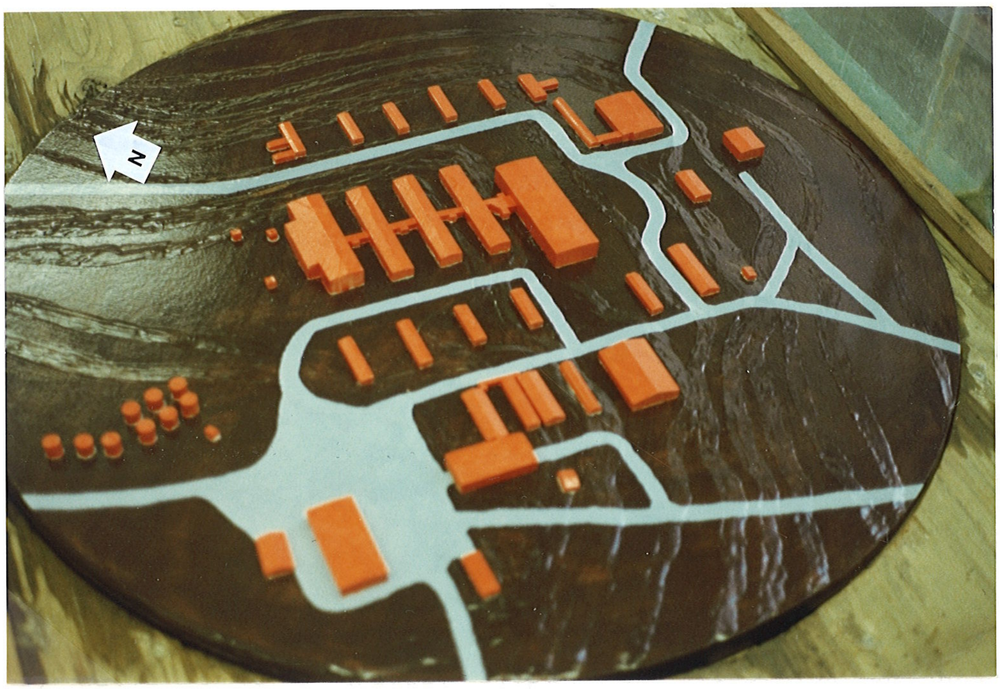
122	HURRICANE SPLICE HUT
125	HAPS BLDG(CHURCHILL HALL)
127	INCINERATOR
129	POL STORAGE
131	SUPPLY WAREHOUSE

Contours at 0.87 Metre Intervals.



1:600 Scale Model of CFS Alert Showing Existing Site Layout

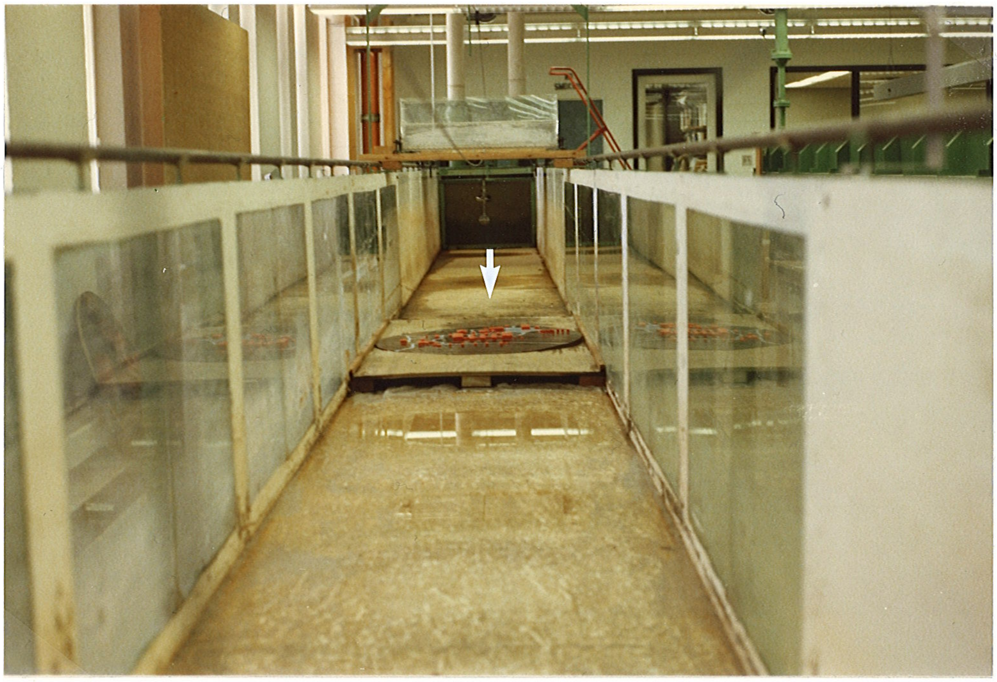
Figure 3-3 CFS Alert - Model

Manitoba's Civil Engineering Department. The centre of the model was positioned 7.47 m from the inflow as shown in Figure 3-4 (a). The model was oriented so that the water flow would be from the southwest since this was determined to be the predominant wind direction when drifting occurred at the site. The determination of the dominant snow drifting wind direction was based on discussions with people familiar with drifting at the site. The model was then screwed to the base supports with four wood screws for stability during testing.

Since the model was built up to represent the contours, this caused a ridge to be present on the edge when it was positioned in the water flume. This ridge had to be eliminated on the front side because it would seriously affect the drifting over the model. Such a ridge would cause a great deal of additional turbulent flow thus completely changing the drifting pattern. In order to eliminate the affect of this ridge on the test, it was necessary to build up the front edge of the model to ensure a smooth flow of water. This was done by building up a gradual slope with plasticine as shown in Figure 3-4 (b).

The water was pumped into the water flume from a storage tank located on a lower level. The depth of water was controlled by a gate located at the out flow end of the water flume, which could be raised or lowered by hand. Velocity was controlled by a valve which regulated flow from the storage tank.

The water depth for the testing had to be sufficient to ensure uniform flow over the buildings with no surface flow interference.



(a)

Model was positioned 7.47 m from the water inflow.
Arrow indicates direction of water flow.

(b)

Arrow indicates where model edge was eliminated with plasticine.

Figure 3-4 Model in the Water Flume

Since the tallest building on the model was less than 20 mm, a depth of 235 mm was considered sufficient for the first test.

Velocity of the water had to be sufficiently strong to ensure that saltation of the sand particles would occur, but not so fast that they would wash all the sand away. Based on past tests, a water velocity of 0.24 m/s was deemed appropriate.* The water velocity was measured by inserting a water velocity meter to a depth of 120 mm in the middle of the water flume, directly in front of the model. Figure 3-5 shows the water velocity meter as well as sample calculations for the first test.

The sand used in the model testing was silica size 60-100. This was selected because of previous satisfactory results.* The sand was dispensed through a plexiglass hopper positioned across the water flume and 1.35 m in front of the centre of the model. The hopper had a series of 30 holes, each 4.7 mm in diameter at 25.4 mm intervals, which allowed the sand to flow evenly out across the width of the water flume.

The position of the sand hopper was critical because if it were too close or too far away, not enough sand would reach the model. The amount of drifting sand that would cover the model was determined by the quantity of sand placed in the hopper. Figure 3-6 (a) shows the sand hopper in its position relative to the model and (b) at the time when sand is being dispensed through it during testing.

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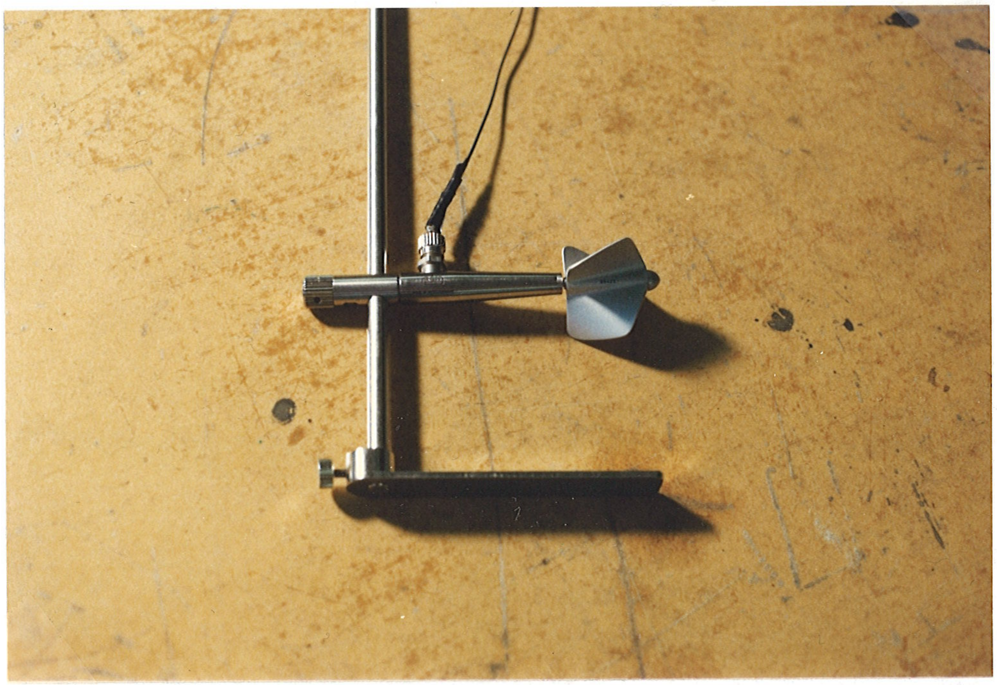
*Appropriate water velocity and sand used for testing was based on extensive testing which the technician in the laboratory had carried out over a number of years.



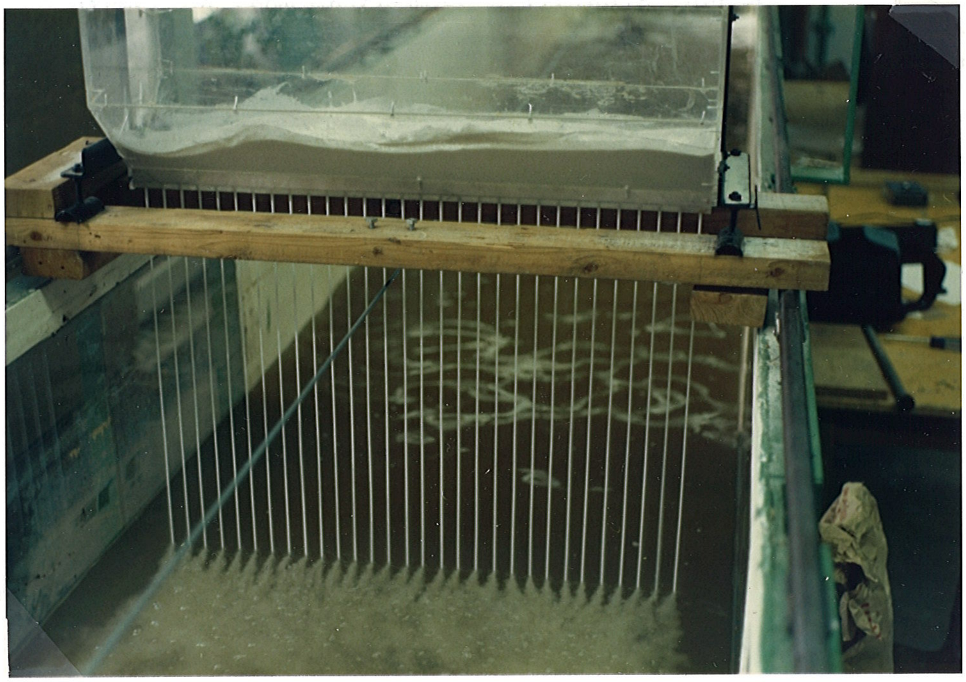
Moulinet Type 10.152 No. 19270 Date 17.7.72

Calculation of water velocity for first test:
X = 51 rev/60 sec = 0.850 rev/sec (measured)
v = (0.7382 x X + 0.151) ft/s x .305 m/ft
v = (0.7382 x 0.850 + 0.151) x .305
v = 0.24 m/s

Figure 3-5 Water Velocity Meter

(a)

Sand hopper relative to model.



(b)

Sand hopper dispensing sand during testing.

Figure 3-6 Sand Hopper

After the sand had been dispensed through the hopper and allowed to drift over the model, the water level was slowly lowered so that the drifting pattern formed was not disturbed. With the aid of flood lights and a polarized filter, photographs were then taken of the results. It must be noted that no photographs were taken during the actual test because turbidity and turbulence of the water in the flume would not allow a clear view of the model.

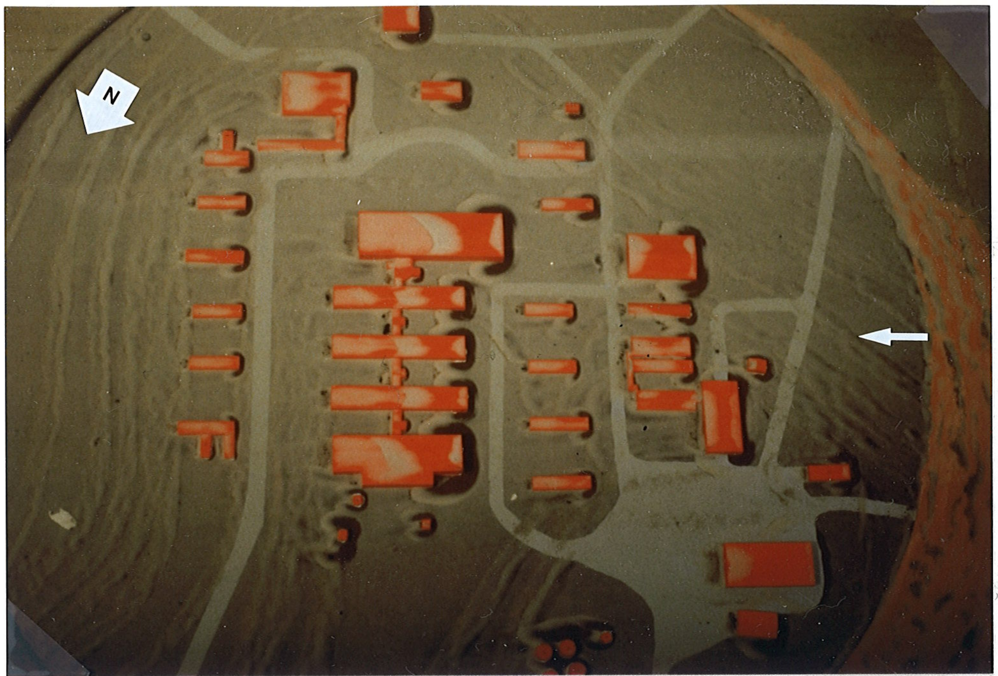
3.5 Initial Test Results

The first model tested was the present site layout at CFS Alert as shown in Figure 3-2. For this test, the model was positioned so that wind direction would be from the southwest since this was considered to be the direction from which most drifting occurred.

For the first run of the water flume only a small amount of sand was dispensed through the hopper. The results of this run are shown in Figure 3-7.

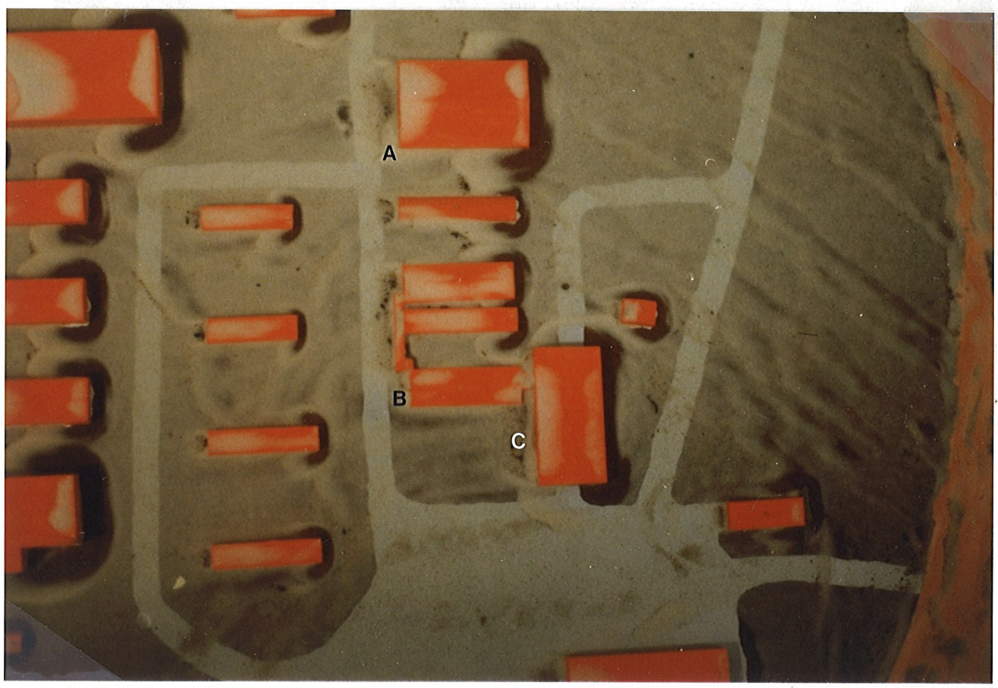
In the second run, a larger quantity of sand was applied in order to cause more extensive drifting to occur on the model. The results of this run are shown in Figure 3-8. An interesting observation during this testing was the minimal drifting which occurred around the fuel storage tanks when compared with drifting around the buildings. This was because the circular shape of the tanks caused a smoother wind flow around them and thus reduced the eddies that caused drifting.

It should also be noted that the heavy drifting, although not



(a)

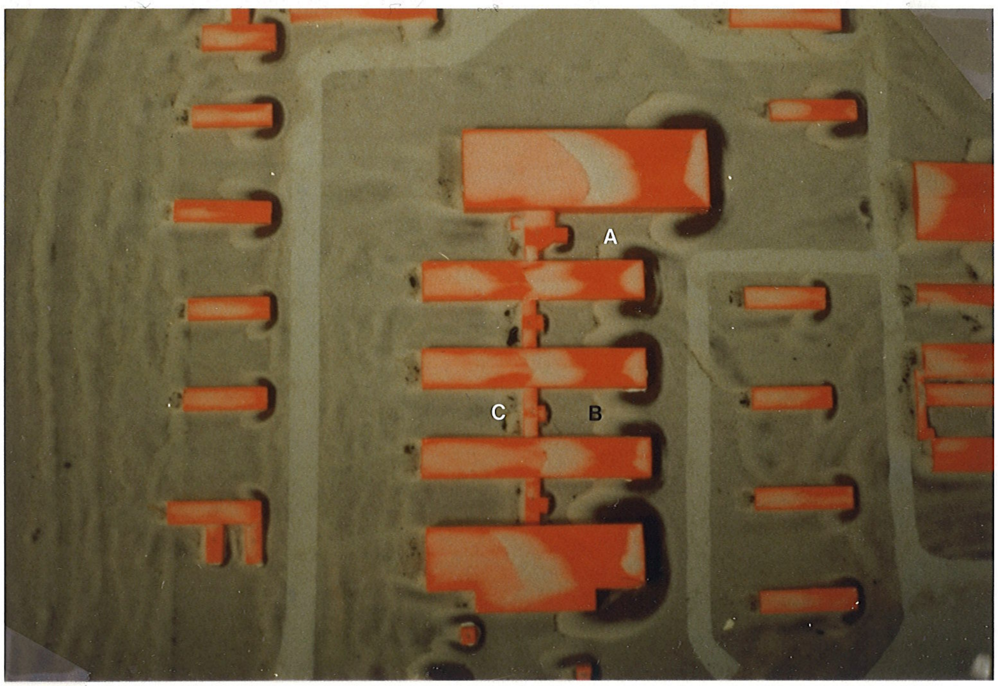
With light drifting pattern, the road network is still visible. The southwest side of all buildings are clear of drifting, while on the other sides drifting has started to develop. Arrow indicates wind direction.



(b)

This figure provides a closer look at the technical buildings. Large drifting is evident at the northeast corner of the new Supply building (A). Drifting is also developing on the northeast side of MSE Supply (B) and on the northeast side of MSE Garage (C).

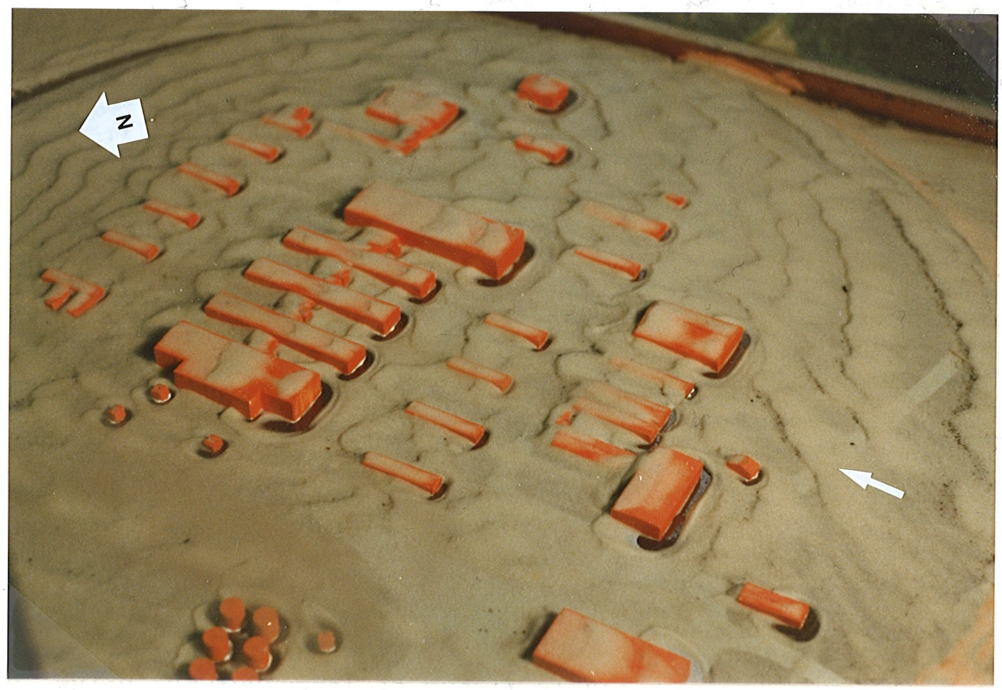
Figure 3-7 Light Drifting - Present Site



(c)

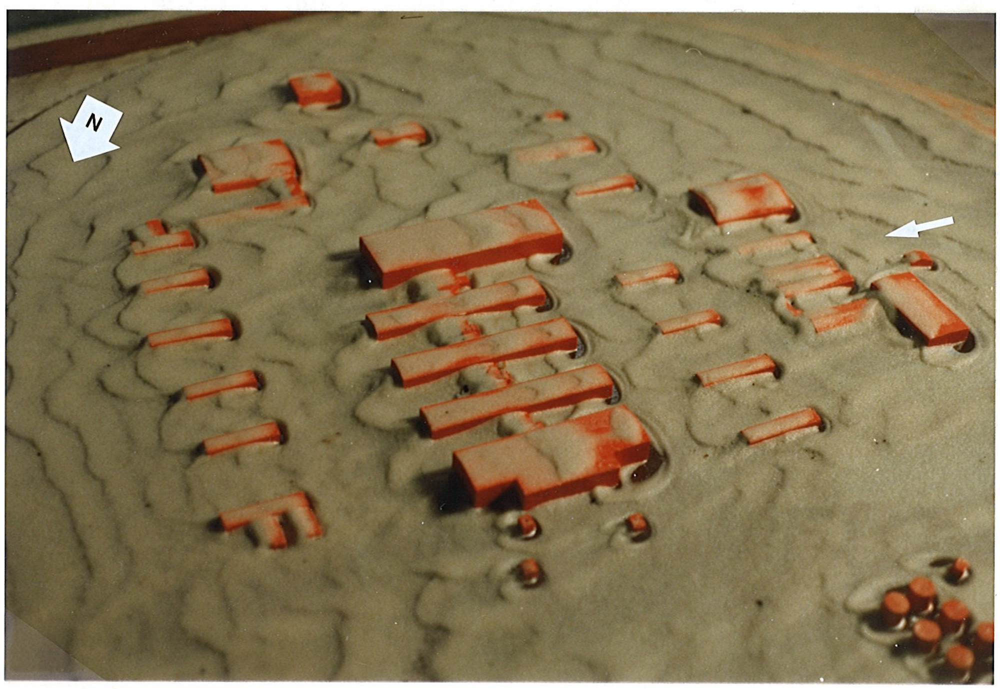
This figure provides a closer look at the new Multi Purpose Building, Barrack Blocks and Operations. Drifting is occurring between the Multi Purpose Building and the adjacent Barrack Block, southwest of the linkway (A). A similar pattern is also developing between the other Barrack Blocks and the Operations Building (B). The northeast side of the linkways are also beginning to drift in (C).

Figure 3-7 Light Drifting - Present Site (Continued)



(a)

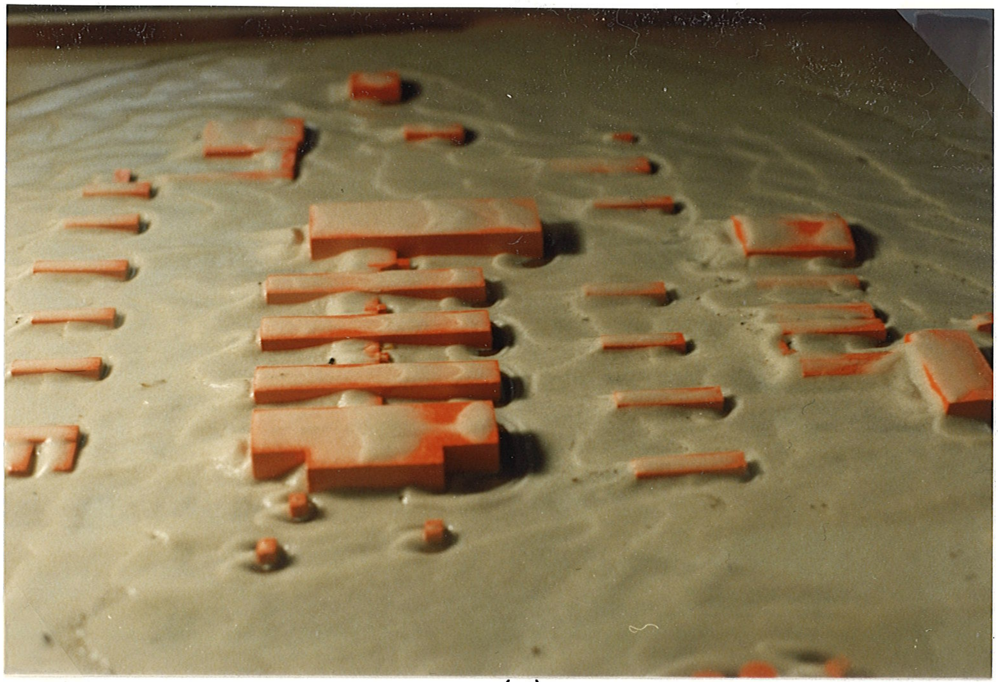
View from the West. Arrow indicates wind direction.



(b)

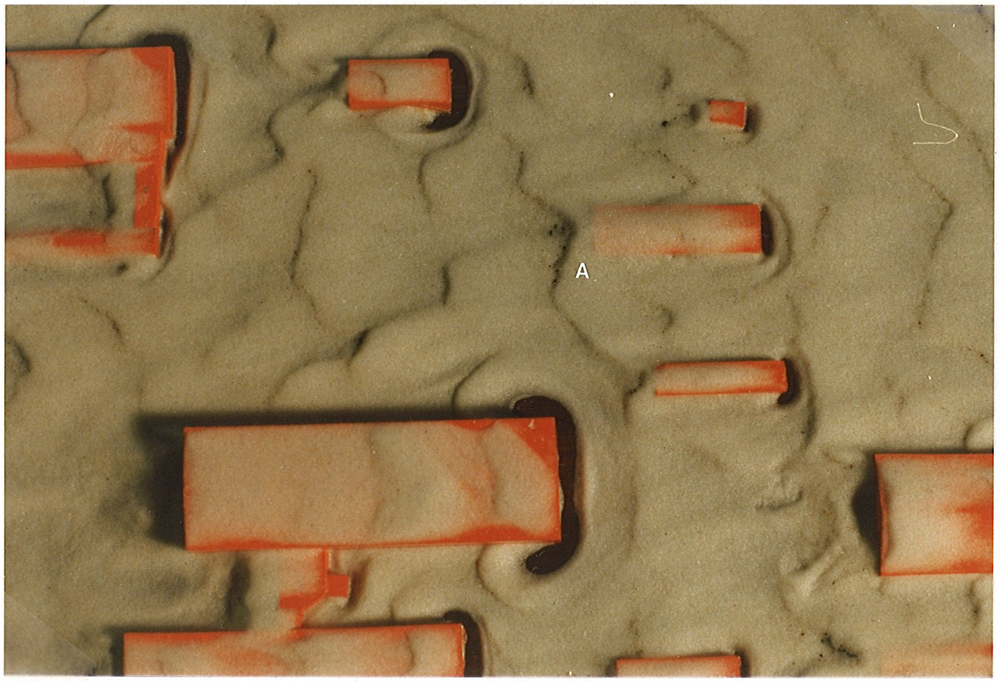
View from the North. Arrow indicates wind direction.

Figure 3-8 Heavy Drifting - Present Site



(c)

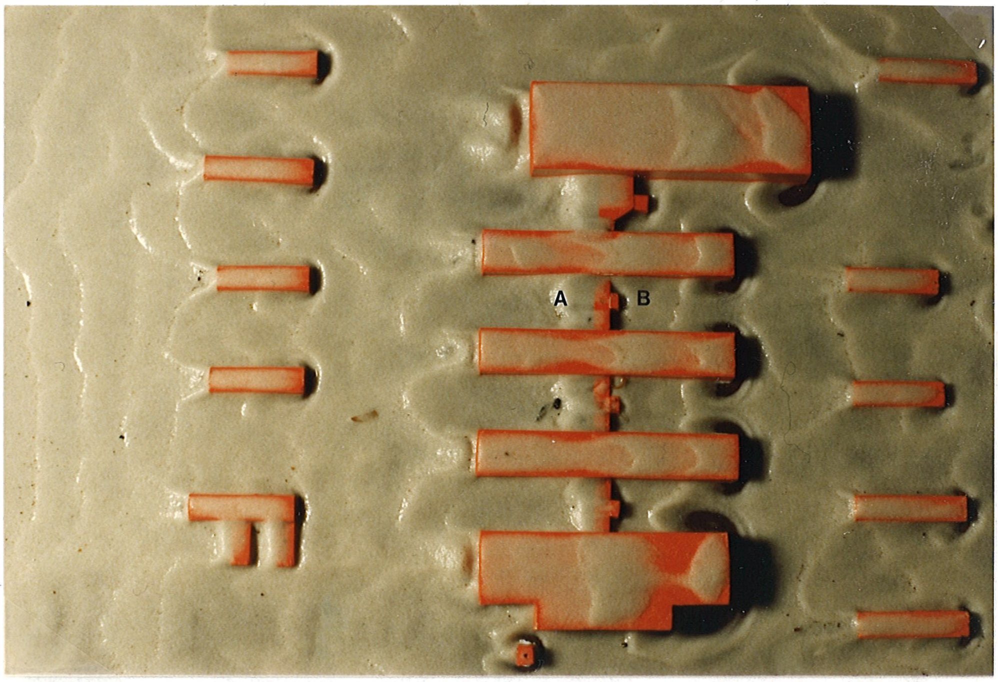
View from the northwest at a low angle. Note that drifting has reached the top of most of the smaller buildings on the northeast side, while the southwest is mostly clear.



(d)

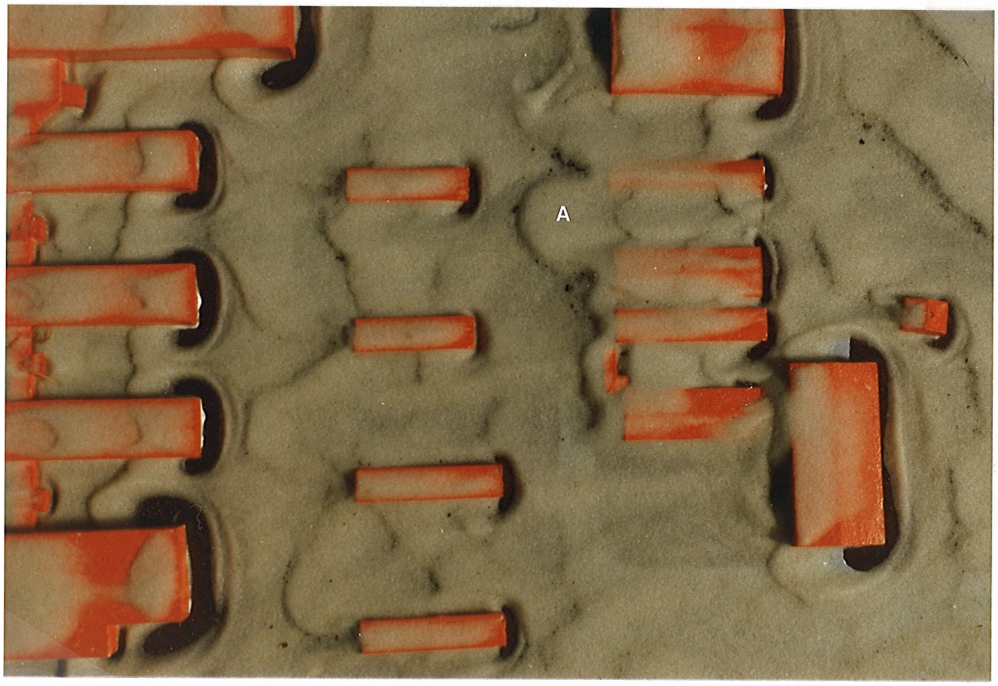
Note the extensive drifting occurring at the northeast corner of the Power Plant, Bldg 20 (A). The power plants exhaust system is located in this corner of the building and a large cover had to be constructed over the exhaust because of serious drifting problems here in the past.

Figure 3-8 Heavy Drifting - Present Site (Continued)



(e)

Drifting on the northeast side of the linkways is up to the roof (A), while the southwest side is not as extensive (B).



(f)

Drifting has been very extensive along the northeast side of the technical buildings, especially between Buildings No. 11 and 12 (A).

Figure 3-8 Heavy Drifting - Present Site (Continued)

(g)

Drifting around the fuel storage tanks has been minor since the circular shape allows the flow to be more laminar, thus reducing eddies on the leeward side.

Figure 3-8 Heavy Drifting - Present Site (Continued)

realistic in magniture with respect to actual drifting on site, provides an indication of what could happen if there was unlimited snow.

3.6 Calibration of the Model

In order to validate results in a laboratory it was necessary to show that these results relate to what actually happened at the site. The model snow drifting results for the present site were therefore compared with actual drifting.

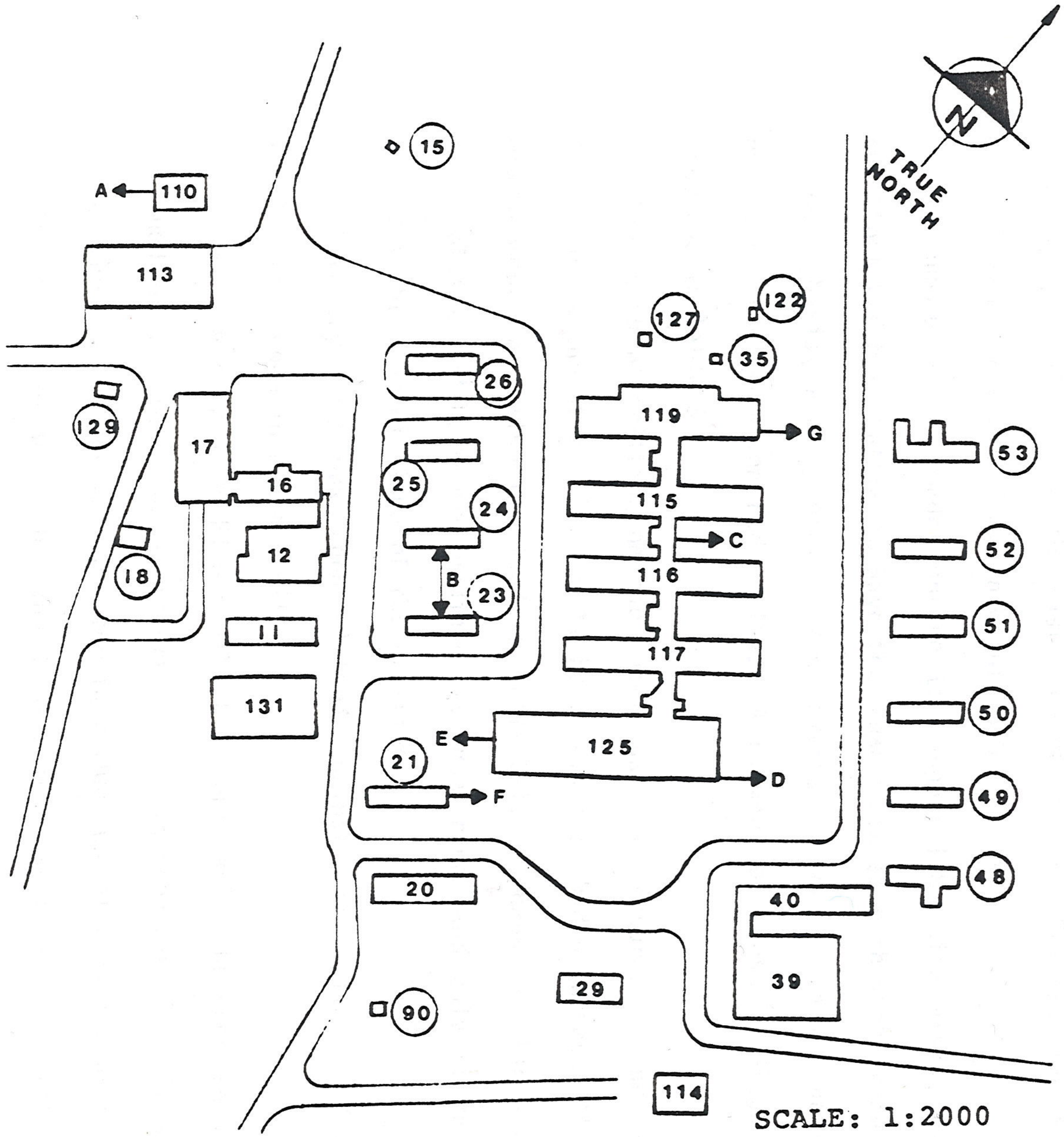
The comparison between the laboratory and actual drifting patterns was carried out in three ways:

a. snow drift patterns on the model were measured at specific locations and compared with measurements taken at the same locations at the actual site;

b. snow drift patterns on the model were compared with reports from informants who had visited the site or were aware of where drifting occurred in the past; and

c. an on-site survey was carried out during the winter to compare laboratory results with the actual snow drifting that had occurred.

In order to compare the snow drifting patterns with measured data, snow stakes were positioned on site in August 1985 and readings were collected weekly commencing in October. Figure 3-9 shows the location of the snow stakes at the site. The snow stakes had to be positioned in areas where they would not normally interfere with snow clearing. The snow stakes were 2"x2"s 10 feet long with a coating of white



LEGEND

11	FIREHALL
12	CE SECTION
15	POL DAY TANKS
16	MSE SUPPLY
17	MSE GARAGE
18	LUMBER STORAGE
20	POWER PLANT 2
21	1CEU DETACHMENT
23	QUARTERS
24	QUARTERS
25	QUARTERS
26	QUARTERS
29	POWER PLANT 1
35	ELECT. SPLICE HUT
39	GYMNASIUM
40	CURLING CLUB
48	ATCO TLRS (QUARTERS)
49	ALL RANKS LOUNGE (ALICES II)
50	QUARTERS
51	QUARTERS (VIP)
52	QUARTERS
53	SENIOR STAFF MESS
90	CE FLAMMABLE STORES
110	KIMONO BLDG
113	VEHICLE STORAGE
114	WATER TREATMENT PLANT
115	B.B.1 (CHIMO)
116	B.B.2 (LADNER)
117	B.B.3 (WHITEHORSE)
119	OPERATIONS
122	HURRICANE SPLICE HUT
125	HAPS BLDG (CHURCHILL HALL)
127	INCINERATOR
129	POL STORAGE
131	SUPPLY WAREHOUSE

↑ Indicates location and direction of snow stakes from building. Each location is also indicated by a letter from 'A' to 'G'.

SCALE: 1:2000

Figure 3-9 CFS Alert - Snow Stake Locations primer. They were marked at 1 foot intervals with red tape. They were spaced with the first stake adjacent to or within 1 foot of the building and subsequent stakes at 10 foot intervals in a direction perpendicular to the side of the building. Because the ground was so hard, it was necessary to drive angle iron, which had been cut to 5 foot lengths and pointed at one end, into the ground and then tie the snow stakes to the angle iron with wire. Figure 3-10 shows the snow stakes positioned on the east side of Building No. 125, which is one of seven locations shown in Figure 3-9.

Arrangements were made, during the August 1985 site visit, with the Alert Weather Station to have the snow depth at each stake read on a weekly basis, and to provide the information on a monthly basis, once some precipitation had fallen. A summary of these readings is provided in Table 3-1.

The depth of drifting on the model was also measured at the same locations as the stakes, after the heavy drifting had occurred. These measurements are also provided in Table 3-1. Because of the small scale of the model, these readings are very rough and only serve to indicate the general slope of the drifting.

Laboratory data was then plotted against field data. These results are shown in Figure 3-11.

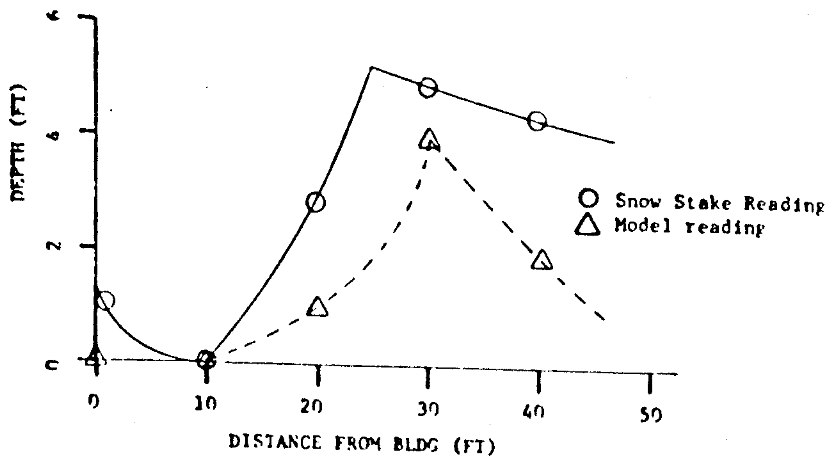
As can be seen from Figure 3-11 the correlation between results obtained in the field and laboratory results is somewhat inconclusive. One of the reasons for this was the fact that actual drifting at Alert was the result of winds blowing from a more westerly or northerly

Snow stakes are positioned on east
side of Building 125, location "D".

Figure 3-10 Snow Stakes Positioned

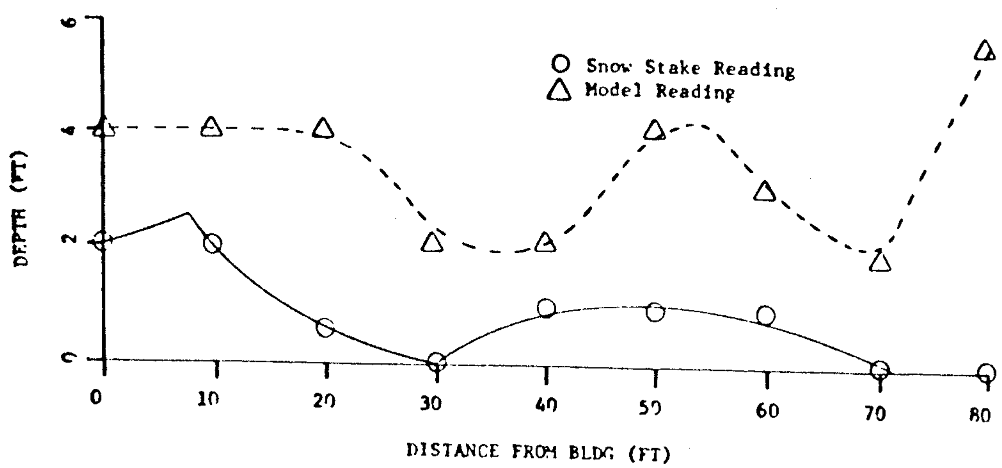
Stake No.	Dist. from Bldg (ft)	Snow Depth Readings (ft) October 9	16	23	30	November 6	13	20	27	December 4	11	18	25	January 1	8	15	22	29	February 5	12	19	26	Water Flume Model Readings (ft)
A1	1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0
A2	10	0	1.0	0.5	1.0	0	0	0	0	0	0	0	0	0.5	0.5	0	0	0	0	0	0	0	0
A3	20	1.0	1.5	1.5	1.5	1.5	1.5	1.5	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	1.0
A4	30	2.0	2.5	2.5	2.5	3.0	3.0	3.5	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	5.0	5.0	4.0
A5	40	2.0	2.0	2.5	2.5	2.5	2.5	3.0	2.5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	4.0	4.5	2.0
B1	0	0	1.0	0	0	0.5	0.5	0.5	1.0	1.5	1.5	1.5	1.5	1.	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	4.0
B2	10	0	0.5	0.5	0.5	1.0	1.0	1.0	1.0	1.5	1.5	2.0	2.0	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	4.0
B3	20	0.5	0.5	0.5	0.5	1.0	1.0	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	4.0
B4	30	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0.5	0	2.0
B5	40	0	0.5	0.5	0.5	0.5	0.5	1.0	1.0	0.5	0.5	0.5	0.5	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	2.0
B6	50	0	0.5	1.0	0.5	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	4.0
B7	60	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	3.0
B8	70	0	1.0	0.5	0	0.5	0.5	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	2.0
B9	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6.0
C1	1	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0	0.5	0	10.0
C2	13	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.5	2.5	3.0	4.0	10.0
C3	20	0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.5	1.5	1.5	1.5	1.0	1.5	1.5	1.5	1.5	2.0	2.0	2.0	3.0	10.0
C4	30	0	0.5	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	10.0
C5	40	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	10.0
D1	1	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6.0
D2	10	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.0
D3	20	0	0.5	0.5	0.5	1.0	1.0	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	4.0
D4	30	0	0.5	0.5	0.5	1.0	1.0	1.0	1.0	0.5	0.5	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0
D5	40	0	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0
E1	1	0	0	0	1.0	1.0	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E2	10	0	0.5	0.5	1.0	1.5	1.5	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0
E3	20	0	1.0	1.0	0	0	0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	0.5	0.5	0.5	0.5	1.0	1.0	1.0	0
E4	30	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2.0
E5	40	0	0.5	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2.0
F1	0	0.5	0.5	1.0	0	0	0	1.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.5	4.5	5.0	12.0
F2	10	0.5	1.0	1.0	0.5	1.0	1.0	1.0	1.5	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	12.0
F3	20	0	0.5	0.5	1.0	1.0	1.0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0.5	1.0	10.0
F4	30	0	0.5	1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	6.0
F5	35	0	0	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0.5	0.5	0.5	4.0
G1	1	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	0.5	4.0
G2	10	0	0.5	0.5	0.5	0.5	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	4.0
G3	20	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	0.5	0.5	1.0	1.0	1.0	1.0	1.0	4.0
G4	30	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0
G5	40	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	2.0

Table 3-1 Snow Stake Data



(a)

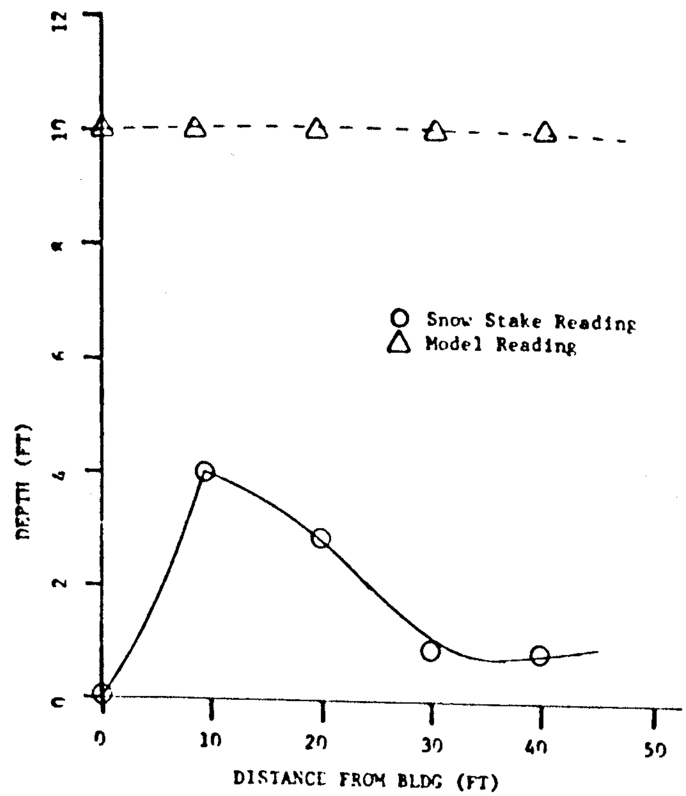
Area "A"



(b)

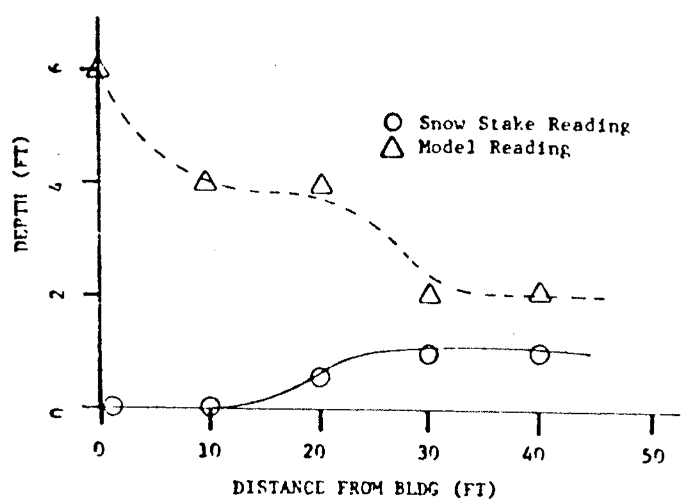
Area "B"

Figure 3-11 Snow Stakes and Model Readings



(c)

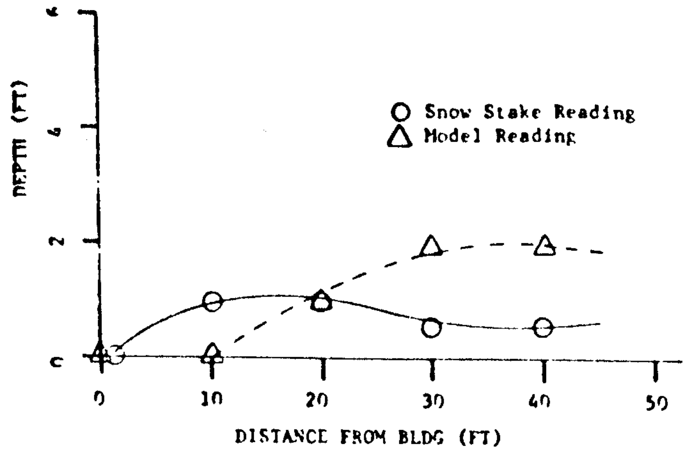
Area "C"



(d)

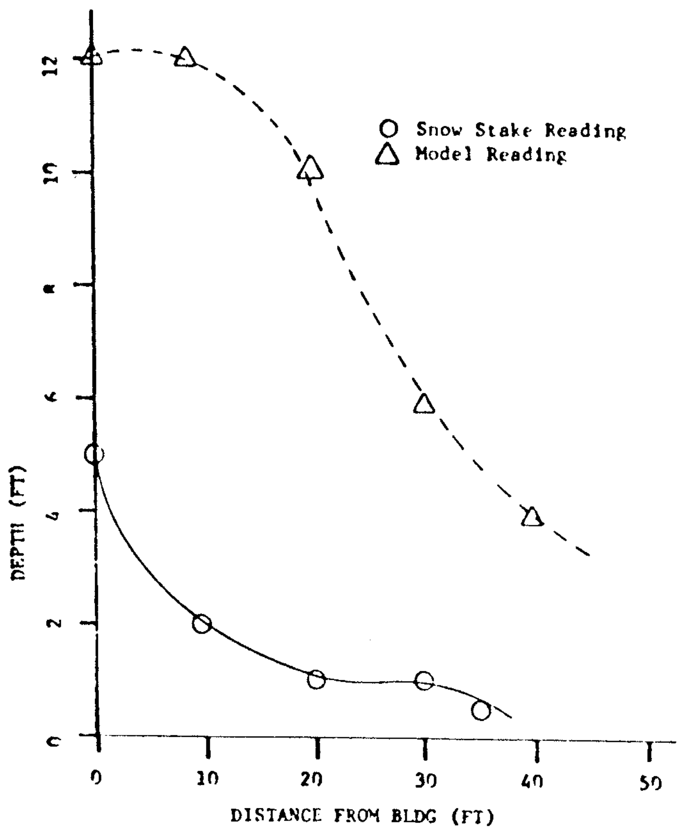
Area "D"

Figure 3-11 Snow Stakes and Model Readings (Continued)



(e)

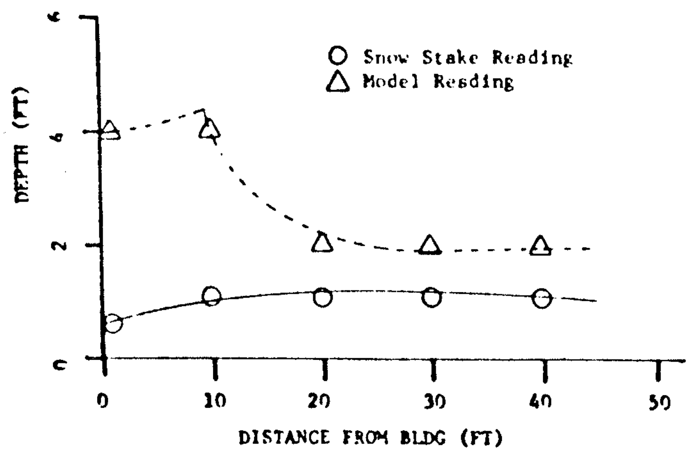
Area "E"



(f)

Area "F"

Figure 3-11 Snow Stakes and Model Readings (Continued)



(g)

Area "G"

Figure 3-11 Snow Stakes and Model Readings (Continued)

direction and not the southwest as was simulated in the laboratory. The other was that there was very little precipitation in 1985-86 on the basis of available weather information. These findings were not made until a site visit in February 1986.

Another problem with the snow stakes was that snow clearing operations greatly reduced the readings. This was especially evident in areas "D" and "G" on Figure 3-9. Also, in area "B", the ground was not level because the buildings (Nos. 23 and 24) were on berms, further distorting the readings.

The second method of checking the accuracy of the model was to compare laboratory results with reports from eyewitnesses on present and previous drifting patterns. The drawback with this, however, is the constant change which CFS Alert has been undergoing for the past several years, with old buildings being demolished and new buildings constructed. This creates new drifting patterns almost every year.

Figure 3-12 indicates where some drifting problem areas have existed in previous years, as defined by DCER - Special Projects Officer Northern. Comparing this with laboratory results (Figure 3-8) shows that all areas where drifting has been a problem in the past have shown considerable drifting in the laboratory.

A more recent indication of drifting provided by 1 CEU, as the result of a site visit in November 1985, is shown in Figure 3-13. Although no extensive drifting had occurred up to this time, areas where drifting was noted compared favourably with laboratory results presented in Figure 3-8. 1 CEU's information also appears to indicate

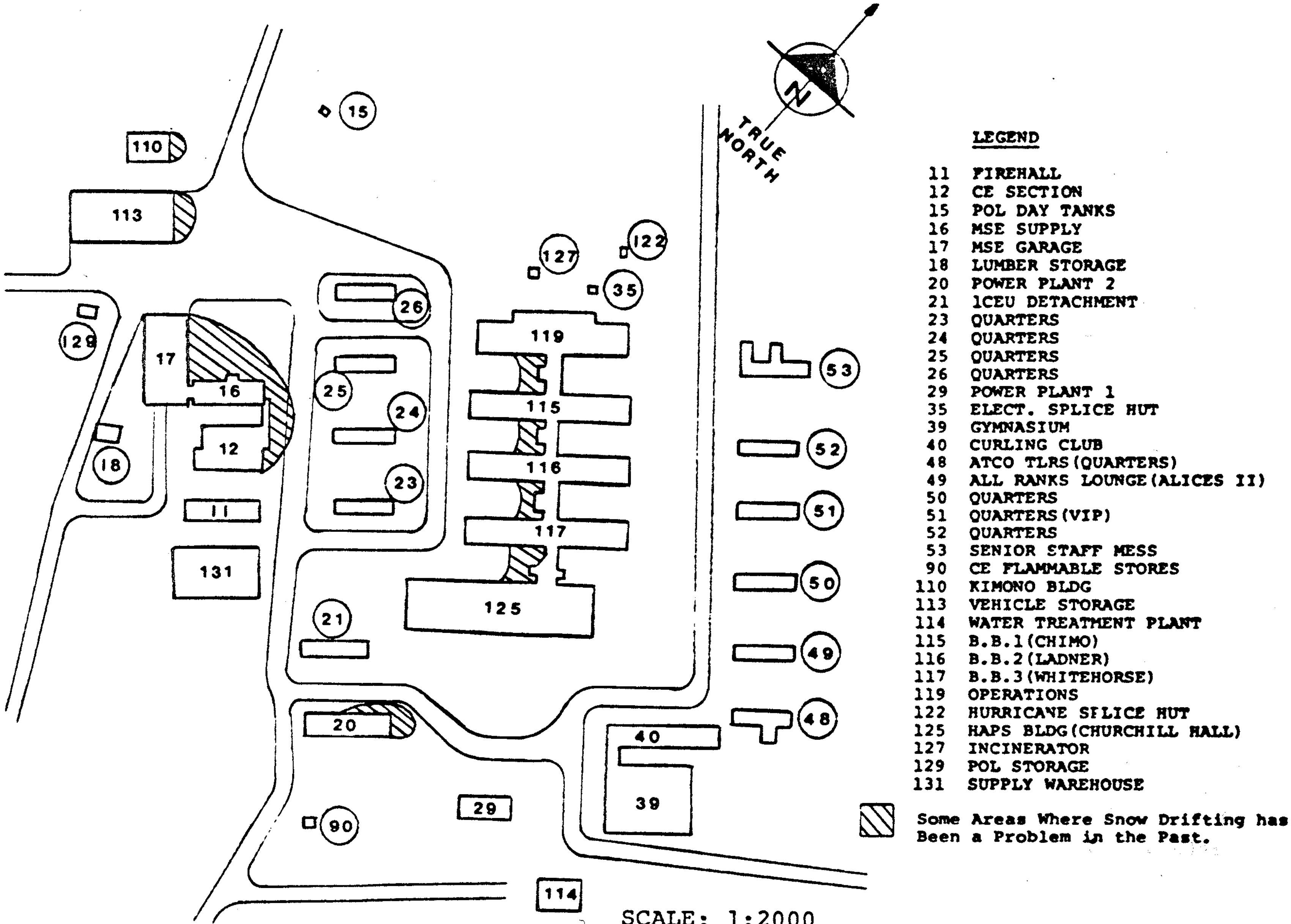
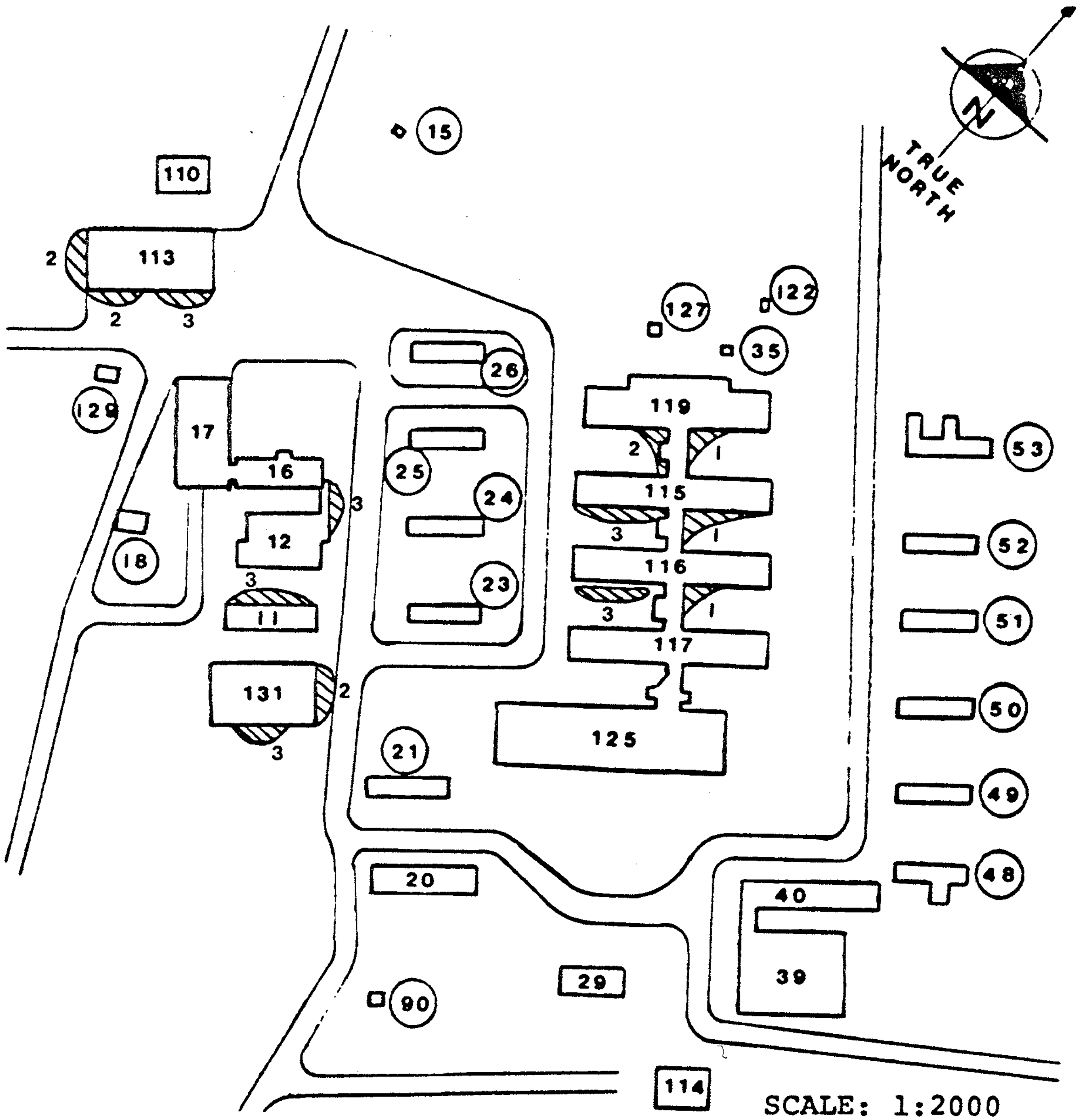


Figure 3-12 CFS Alert - Previous Snow Drifting Problem Areas



LEGEND

11	FIREHALL
12	CE SECTION
15	POL DAY TANKS
16	MSE SUPPLY
17	MSE GARAGE
18	LUMBER STORAGE
20	POWER PLANT 2
21	1CEU DETACHMENT
23	QUARTERS
24	QUARTERS
25	QUARTERS
26	QUARTERS
29	POWER PLANT 1
35	ELECT. SPLICE HUT
39	GYMNASIUM
40	CURLING CLUB
48	ATCO TLRS (QUARTERS)
49	ALL RANKS LOUNGE (ALICES II)
50	QUARTERS
51	QUARTERS (VIP)
52	QUARTERS
53	SENIOR STAFF MESS
90	CE FLAMMABLE STORES
110	KIMONO BLDG
113	VEHICLE STORAGE
114	WATER TREATMENT PLANT
115	B.B.1 (CHIMO)
116	B.B.2 (LADNER)
117	B.B.3 (WHITEHORSE)
119	OPERATIONS
122	HURRICANE SPLICE HUT
125	HAPS BLDG (CHURCHILL HALL)
127	INCINERATOR
129	POL STORAGE
131	SUPPLY WAREHOUSE

Indicates Snow Drifting on Site at End of November, 1985. Numbers Indicate Approximate Height of Drifting in Feet.

SCALE: 1:2000

Figure 3-13 CFS Alert - Snow Drifting End November 1985 that the drifting occurred from a westerly to northerly direction since most drifting occurs on the leeward side of the buildings.

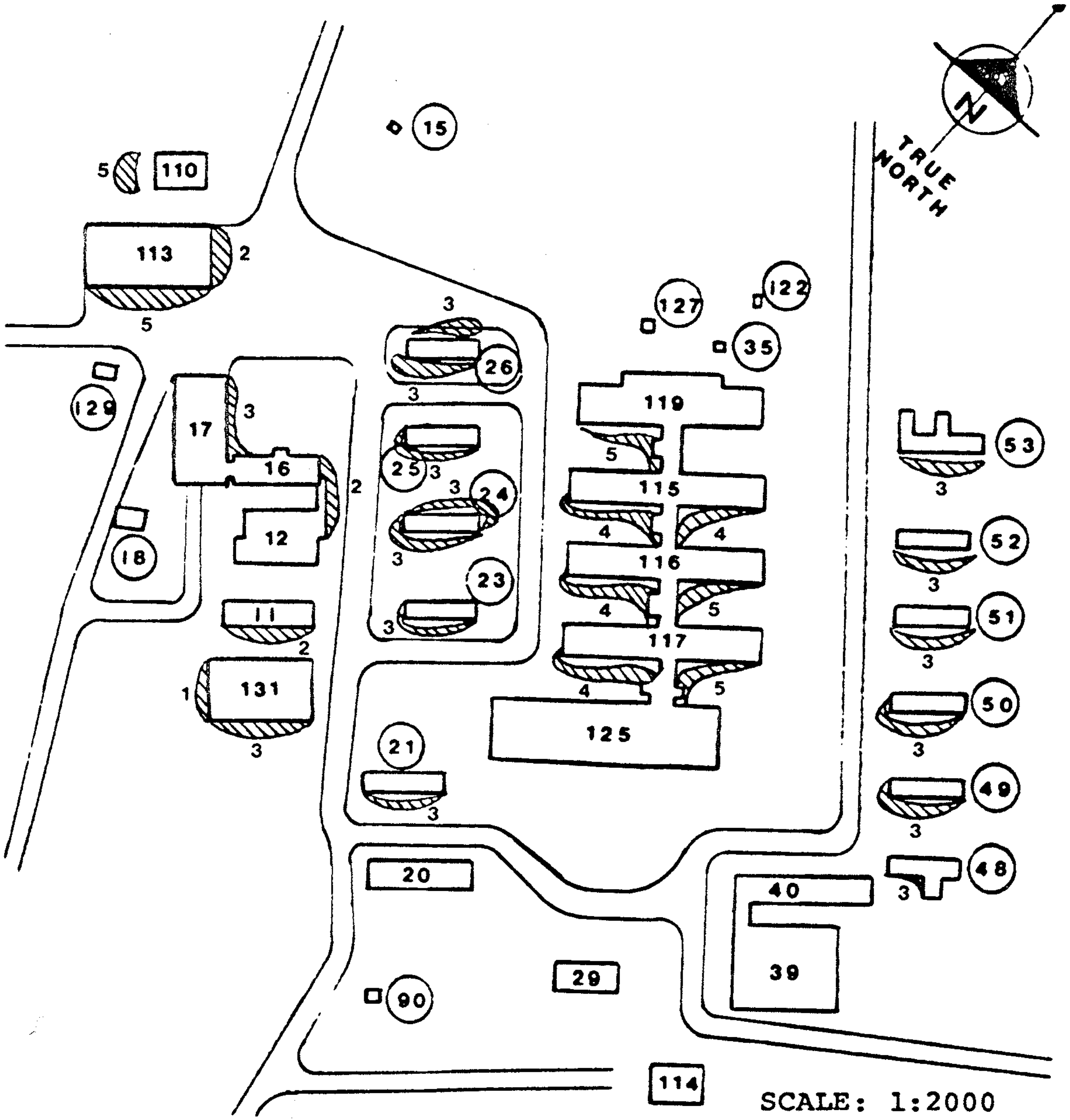
A site visit of Alert was carried out during the period 13-15 February 1986, to compare test results with actual drifting. Figure 3-14 shows the drifting pattern at the site as recorded during this visit. From this information it was evident that the drifting was occurring from a westerly direction and not the southwest as was originally thought.

As can be seen from these comparisons there is little correlation between drifting patterns in the laboratory and actual drifting on site except for Figure 3-12. The main reason for this is that drifting on site was from the west while drifting in the laboratory was based on a southwest wind.

On comparing the drifting pattern in the laboratory with Figure 3-12, however, many similarities were evident. Photographs of laboratory results which were shown to personnel at the Station during the site visit also provided confirmation that drifting patterns similar to the laboratory results had occurred in the past.

Based primarily on the site visit, it was decided to conduct all further testing from the west as well as the southwest. The west was chosen because this was the prevailing wind direction (see Table 1-1) and some drifting was occurring from this direction.

Although the present site plan was not tested from the west, because buildings slated for demolition had already been removed, it was still possible to make some comparisons from other tests, with



LEGEND

11	FIREHALL
12	CE SECTION
15	POL DAY TANKS
16	MSE SUPPLY
17	MSE GARAGE
18	LUMBER STORAGE
20	POWER PLANT 2
21	1CEU DETACHMENT
23	QUARTERS
24	QUARTERS
25	QUARTERS
26	QUARTERS
29	POWER PLANT 1
35	ELECT. SPLICE HUT
39	GYMNASIUM
40	CURLING CLUB
48	ATCO TLRS (QUARTERS)
49	ALL RANKS LOUNGE (ALICES II)
50	QUARTERS
51	QUARTERS (VIP)
52	QUARTERS
53	SENIOR STAFF MESS
90	CE FLAMMABLE STORES
110	KIMONO BLDG
113	VEHICLE STORAGE
114	WATER TREATMENT PLANT
115	B.B.1 (CHIMO)
116	B.B.2 (LADNER)
117	B.B.3 (WHITEHORSE)
119	OPERATIONS
122	HURRICANE SPLICE HUT
125	HAPS BLDG (CHURCHILL HALL)
127	INCINERATOR
129	POL STORAGE
131	SUPPLY WAREHOUSE

(hatched box) Indicates Snow Drifting on Site at Middle of February, 1986. Numbers Indicate Approximate Height of Drifting in Feet.

Figure 3-14 CFS Alert - Snow Drifting Middle February 1986 actual drifting on site. Figure 3-15 (a) shows the drifting pattern obtained when testing Proposal B from the west. This figure provides a close look at the drifting on the southeast side of Building No. 113. Figure 3-15 (b) shows the on site drifting during the February site visit. As can be seen from Figure 3-15, results in the laboratory are almost identical to actual onsite drifting.

In Figure 3-16 another comparison was made between laboratory results and actual on site drifting. Here, drifting is shown between Barrack Block Nos. 115 and 116, and the similarity of results with on site drifting. Although the pattern is similar, some scouring has occurred on site because the barrack blocks are approximately 1 metre above ground, while on the model the buildings were not raised.

In Figure 3-17 drifting between the barrack blocks is viewed from the southwest. Again actual drifting on site, although similar to test results, has been scoured because of the raised barrack blocks.

During the site visit the need was recognized to obtain more information on wind direction when blowing snow occurred. The Alert Weather Station was therefore asked to provide maximum wind speed and direction when blowing snow occurred. From this information (see Annex C) frequency of direction was plotted on a wind rose. From Figure 3-18 it can be seen that the strongest winds more frequently come from the southwest when blowing snow occurs, as was originally thought. Hence it was apparent that the 1985-86 drifting patterns were somewhat incidental. This further justifies the importance of conducting tests from the southwest as well as the west.

(a)

Drifting from the west (Proposal B). A large drift is formed on the southeast side of Building No. 113 (A). Arrow indicates direction from which photograph below was taken.

(b)

Drifting on the southeast side of Building No. 113. Photo taken during site visit, 14 February 1986.

Figure 3-15 Comparison of Results

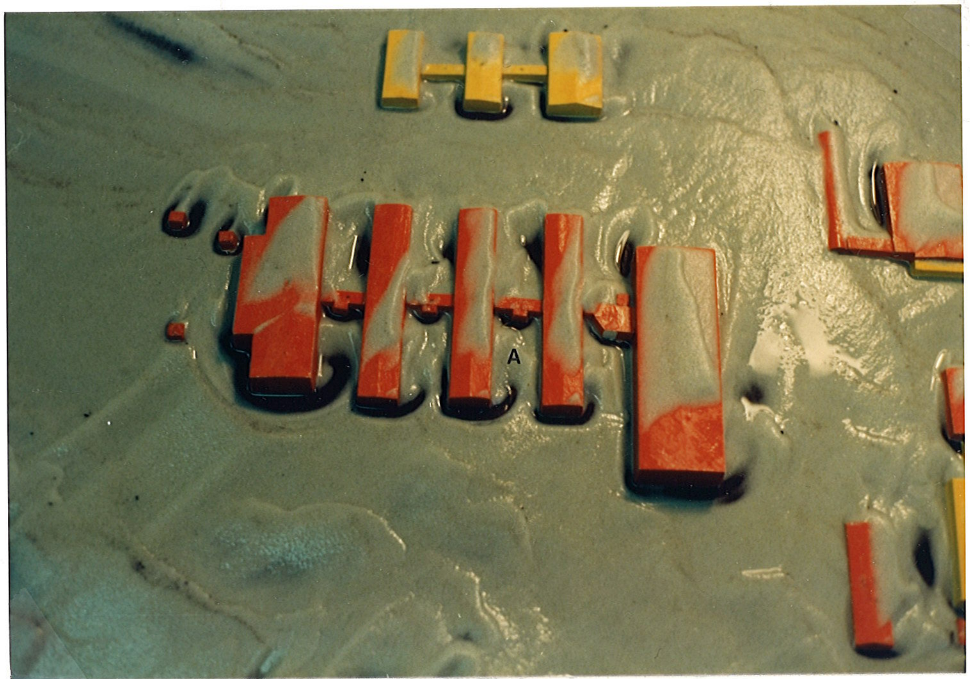
(a)

Drifting from the west (Proposal C). Note the drifting pattern which has occurred between the barrack blocks (A).

(b)

Drifting in area (A) above during site visit, 14 February 1986.

Figure 3-16 Comparison of Results



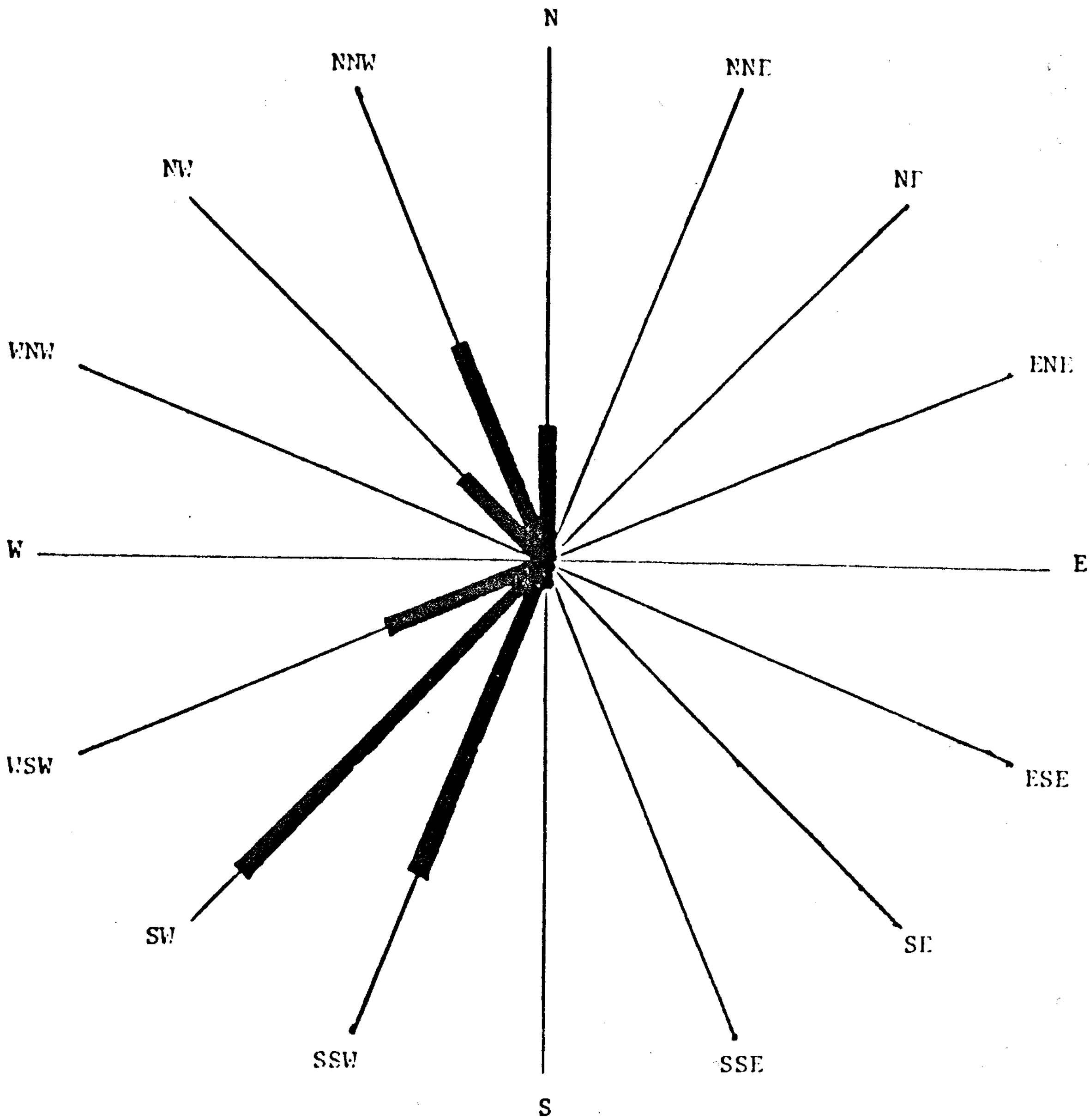
(a)

Drifting from the west (Proposal C). Drifting is evident between the barrack blocks, especially on the southeast side (A).

(b)

Drifting in area (A) above during site visit, 14 February 1986.

Figure 3-17 Comparison of Results



Scale: 2 mm = 1 occurrence

Graph illustrates the frequency of direction for maximum winds when blowing snow is occurring for the period January 1983-February 1986.

Figure 3-18 Direction of Maximum Wind

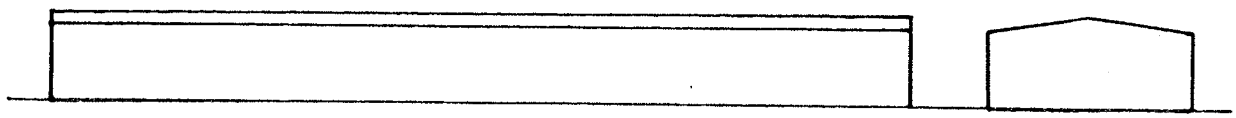
For testing of the model in the water flume, all buildings were placed so that there was no space under them, although many of the buildings (Building Nos. 29, 115, 116, 117, 119, 122 and 125) are actually raised approximately 1 metre above the ground. In order to determine what impact this might have on the drifting pattern it was decided to conduct a test run using four buildings. These four building were identical except that two had a gap of approximately 1.5 mm under them (see Figure 3-19).

The buildings were placed in the water flume on a flat piece of plywood so that the drifting would be directed to the end of two buildings (one building raised and one flat) while the other two buildings were placed at 45° to the first two (again with one building raised and one flat) as per Figure 3-20. One test run was then conducted with the results presented in Figure 3-21.

As can be seen from these results, raising the buildings had almost no impact on the drifting pattern, when viewed from above. When looking from the side, however, one can see that with the building raised the drifting is moved slightly away from the side.

From these results it can be seen that raising the buildings would not change the drifting pattern, but that drifting which is directly against these buildings would be moved slightly away from the side because of scouring.

From the preceeding discussion it can be seen that results obtained with the water flume provided an accurate representation of actual drifting on site. It is, therefore, reasonable to deduce that the testing of alternative site proposals will provide a valid indication of expected drifting patterns.

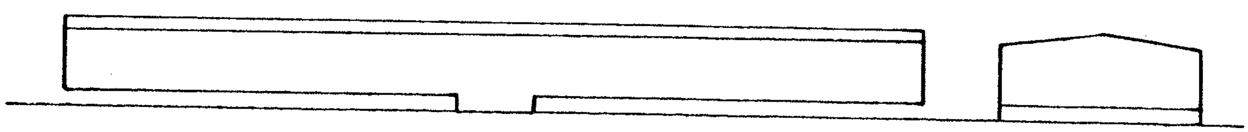


Side View End View

Actual Size

(a)

Ground level buildings.



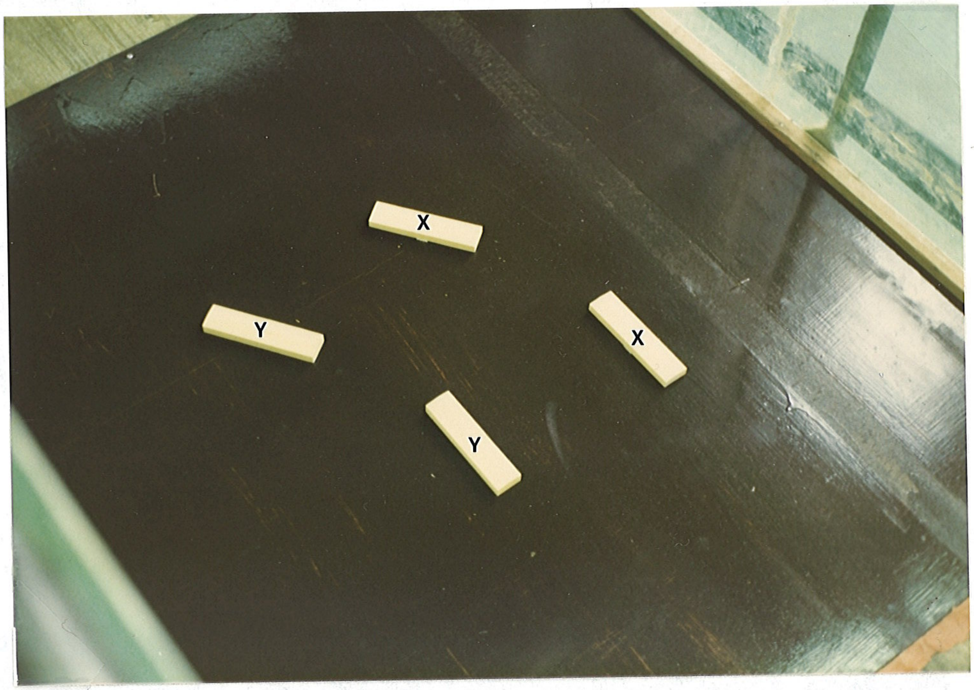
Side View End View

Actual Size

(b)

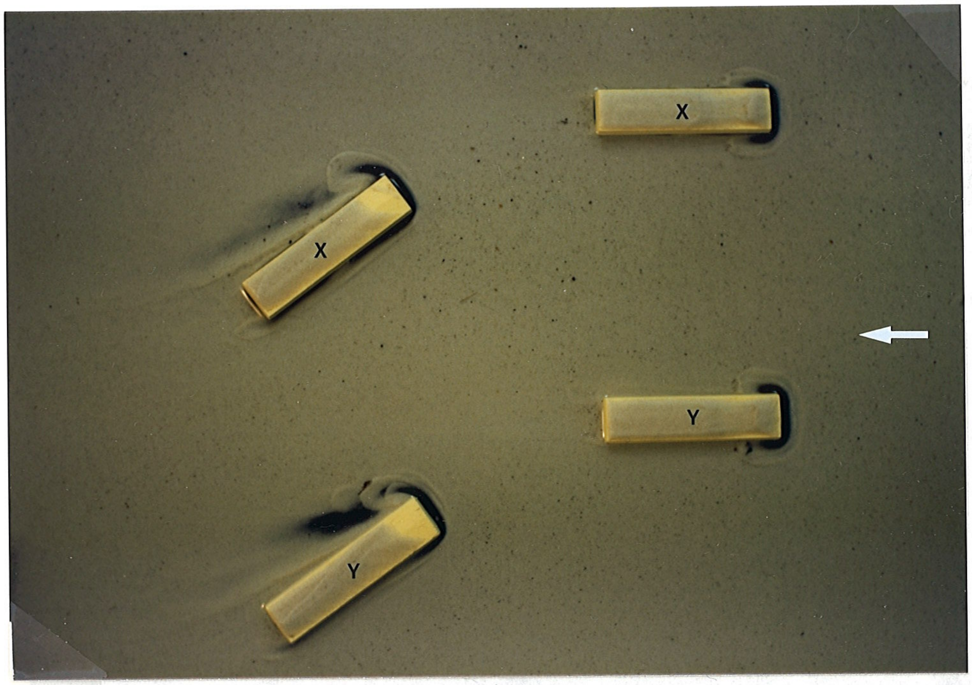
Raised buildings.

Figure 3-19 Test Buildings



The four buildings are positioned in the water flume ready for testing. Raised buildings are identified by "X" while buildings at ground level are identified by "Y". Arrow indicates flow direction.

Figure 3-20 Comparing Raised and Ground Level Buildings



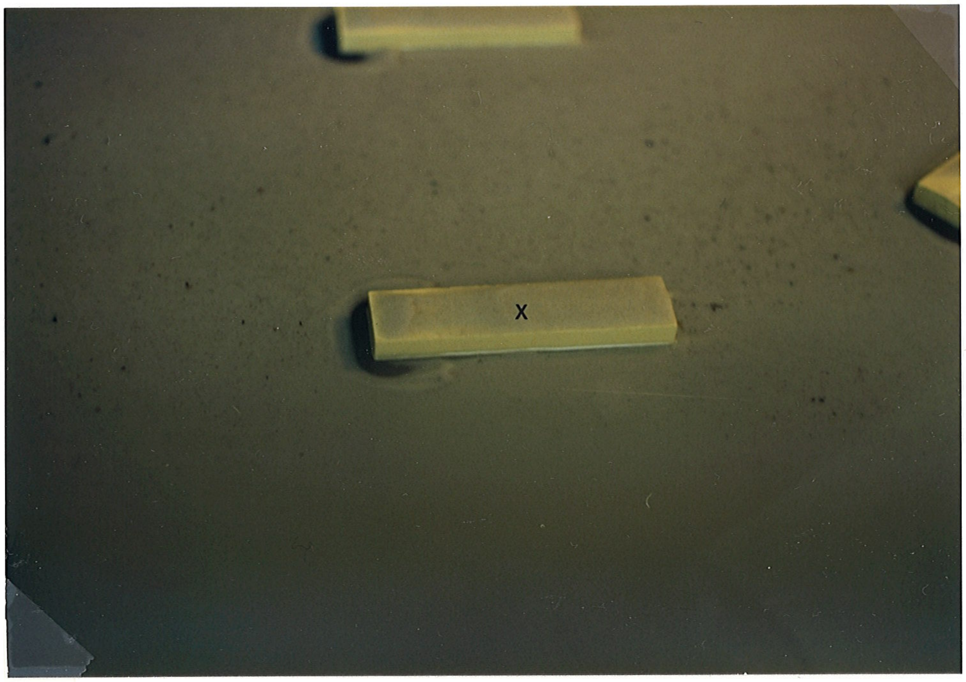
(a)

Drifting appears to be very similar around both pair of buildings. Raised buildings are indicated by "X" while ground level buildings are indicated by "Y". Arrow indicates flow direction.

(b)

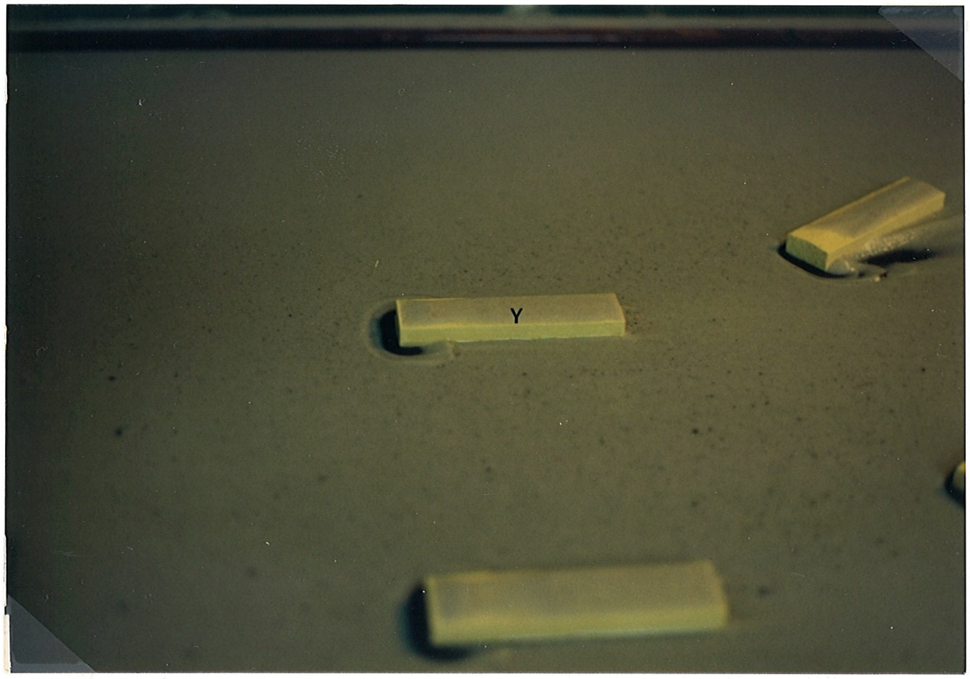
Scouring is occurring along the side of the raised building (X) while the ground level building has drifting against the side (Y).

Figure 3-21 Drifting on Test Buildings



(c)

Drifting has been scoured along the side of the raised building (X).



(d)

Drifting is against the side of the ground level building (Y).

Figure 3-21 Drifting on Test Buildings (Continued)

Footnotes

[1]Kenneth M. Adam and Richard Piotrowski, "Solving Snow-Drifting Problems at Baker Lake, N.W.T., Using Snow-Modelling Techniques".

[2]Darryl J. Calkins, Simulated Snowdrifting Patterns, Cold Regions Research and Engineering Laboratory, Special Report 219, March, 1975 (Hanover, New Hampshire, 1975).

[3]James L. Wuebben, A Hydraulic Model Investigation of Drifting Snow, Cold Regions Research and Engineering Laboratory, Report 78-16, June, 1978 (Hanover, New Hampshire, 1978).

[4]M.A. Kearsley, "Microclimates: Assessment Through Model Testing", Ubique, Summer, 1985, pp. 42-45.

[5]J.S. de Krasinski and W.A. Anson, A Study of Snow Drifts Around The Canada Building in Calgary, Department of Mechanical Engineering, Report No 71, October, 1975 (Calgary: University of Calgary, 1975).

[6]J.S. de Krasinski and T. Szuster, Some Fundamental Aspects of Laboratory Simulation of Snow or Sand Drift Near Obstacles, Department of Mechanical Engineering, Report No. 151, 1979 (Calgary: University of Calgary, 1979).

[7]R.J. Kind, A Critical Examination of the Requirements for Model Simulation of Wind-Induced Ground-Drifting or Erosion Phenomena in Wind Tunnels with Particular Emphasis on Snow Drifting, National Aeronautical Establishment, Laboratory Technical Report LTR-LA-167, August, 1974 (Ottawa: National Research Council of Canada, 1975).

CHAPTER 4

THE OUTDOOR MODEL

4.1 Introduction

The testing of models for snow drifting by placing them outdoors is a relatively new approach with very few reports available on previous testing. Interdisciplinary Engineering Ltd. of Winnipeg has used this technique to study airport design for building a 1:30 scale model of the site. Using this scale for CFS Alert, however, would have required a base of approximately 180 m^2 which was considered too large given the cost and time available to build it. It was, therefore, decided to building the model at a scale of 1:120.

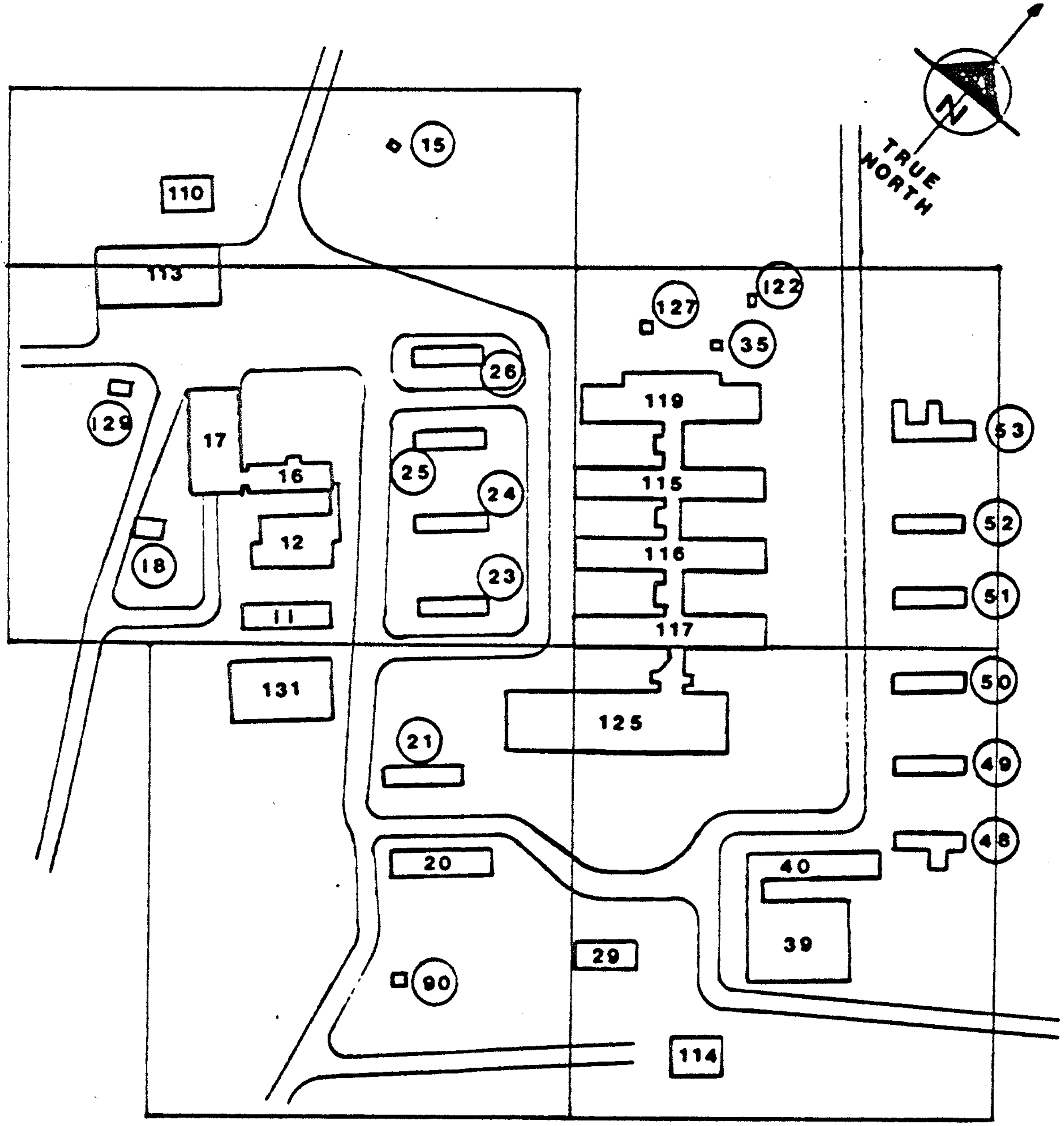
This chapter will look at the construction, testing and initial results of the outdoor model.

4.2 Constructing the 1:120 Scale Model

At a scale of 1:120 the model was approximately 9 m^2. The main drawback with this size of model was that it had to be closely monitored to ensure it was not completely covered with snow, notwithstanding the handling difficulties.

In order to construct the model, the site was first divided into five sections, as shown in Figure 4-1. Each section was built separately in the Faculty of Architecture workshop at the University of Manitoba and then put together in the field.

The sections were built with 1" x 6" and 1" x 8" boards for



LEGEND

11	FIREHALL
12	CE SECTION
15	POL DAY TANKS
16	MSE SUPPLY
17	MSE GARAGE
18	LUMBER STORAGE
20	POWER PLANT 2
21	1CEU DETACHMENT
23	QUARTERS
24	QUARTERS
25	QUARTERS
26	QUARTERS
29	POWER PLANT 1
35	ELECT. SPLICE HUT
39	GYMNASIUM
40	CURLING CLUB
48	ATCO TLRS(QUARTERS)
49	ALL RANKS LOUNGE(ALICES II)
50	QUARTERS
51	QUARTERS(VIP)
52	QUARTERS
53	SENIOR STAFF MESS
90	CE FLAMMABLE STORES
110	KIMONO BLDG
113	VEHICLE STORAGE
114	WATER TREATMENT PLANT
115	B.B.1(CHIMO)
116	B.B.2(LADNER)
117	B.B.3(WHITEHORSE)
119	OPERATIONS
122	HURRICANE SPLICE HUT
125	HAPS BLDG(CHURCHILL HALL)
127	INCINERATOR
129	POL STORAGE
131	SUPPLY WAREHOUSE

Figure 4-1 CFS Alert - Site Divided Into Sections for Model Construction

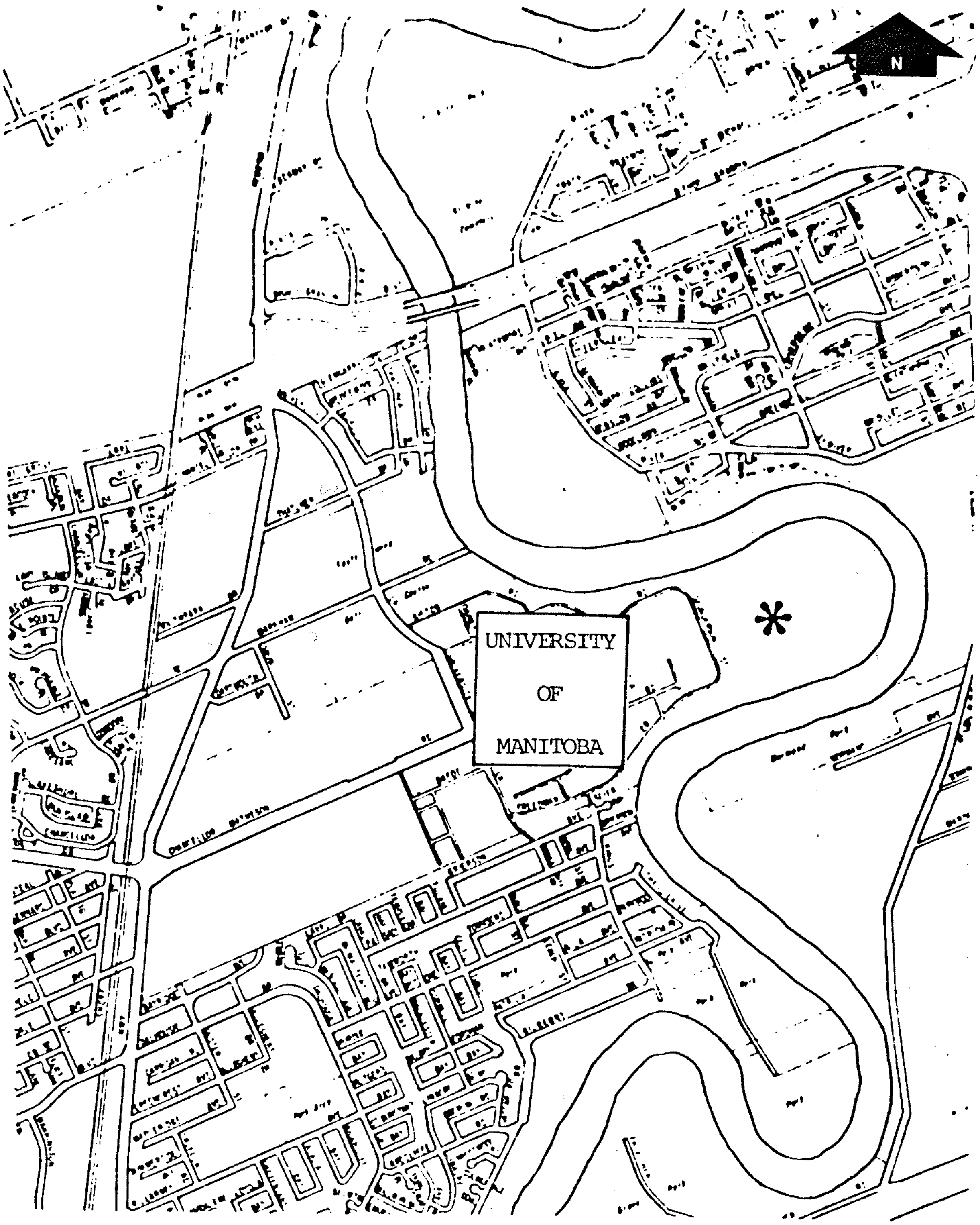
framing and at 16" centres. The depth of these boards were cut in proportion to the contours so that when ¼" aspenite sheeting was nailed to the frame, it would bend to the correct contour. The sections were coated with a primer and then a brown paint to simulate the ground.

All the buildings were then constructed, mostly out of wood, with Buildings No. 11 and 40 constructed using 3" PVC pipe. The buildings were coated with a primer and then orange paint so that they could be seen more clearly in the snow. The buildings were then attached to the sections with tapping screws from undernearth.

The final step, before placing the model outdoors, was to paint on the roads and major parking areas. This was, again, done with grey paint to show up more clearly with the snow.

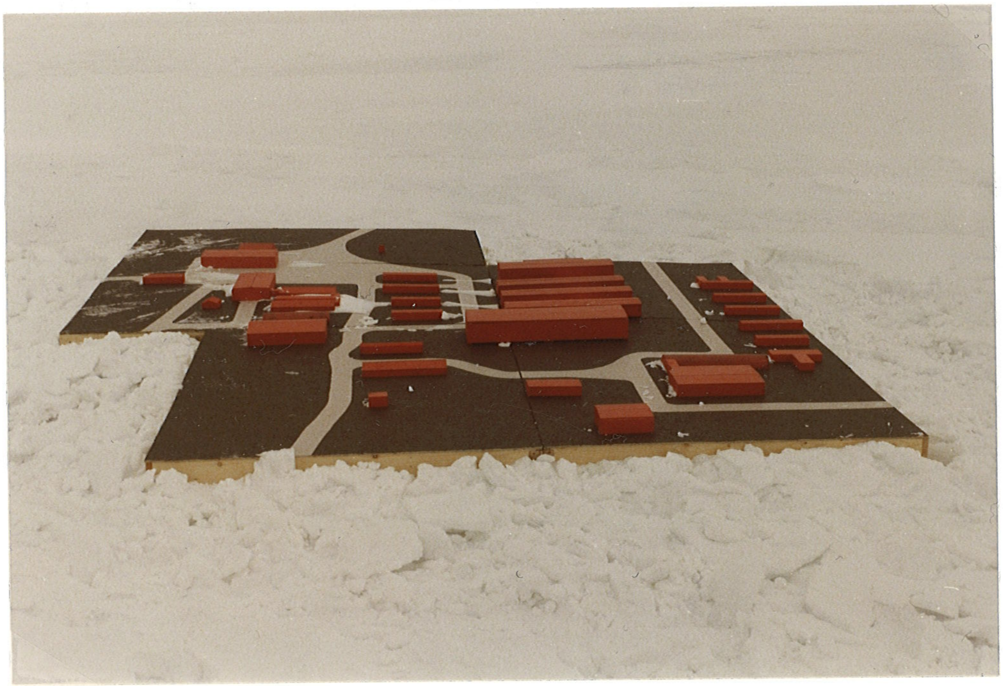
The model was located on the agricultural field at the east side of the University of Manitoba as per Figure 4-2. This site was ideal because there were no obstructions near the model that might interfere with the drifting pattern, and the site was relatively secure with chain link fencing on the southwest and the Red River on the other three sides.

With its five sections, the model was easily transferred from the workshop to the field in a ½-ton truck. Once on site, the model was levelled using snow, and some sections were connected with hinges to ensure a proper fit. Hinges were used because the centre pin could be easily removed to separate the sections later. Figure 4-3 shows the model on site.



* Indicates location of model, on University of Manitoba property, for conducting outside snow drift testing.

Figure 4-2 Location of Outdoor Model



Model set up for testing.

Figure 4-3 CFS Alert - Outdoor Model

4.3 Testing the Outdoor Model

The model was initially tested with the present site plan so that results could be compared with laboratory results using the water flume, and actual site data. The main consideration in positioning the model then was to ensure that it was oriented so that the drifting would come from the southwest.

Table 4-1 provides wind data for Winnipeg International Airport. From this table it can be seen that the predominant wind for each month is from the south. However, winds from the northwest are the next most frequent for the winter months and are also the strongest. It was also learned from the Meteorological School at Canadian Forces Base (CFB) Winnipeg, that drifting usually occurs when winds are from the northwest. Because the direction of wind cannot be controlled as is done in the water flume, it was decided to orient the model so that southwest on the model would actually be pointing northwest.

Once all the sections had been positioned properly and connected with hinges for stability, the edges were then filled with snow to form a gradual rise to the model surface.

4.4 Test Results

The first results using the outdoor model were obtained on 3 February 1986. The weather on the preceding two days was blowing snow from the south with gusts as high as 35 km/hr (see Table 4-2). With respect to the position of the model then, drifting snow was occurring from the east. Since it was hoped that drifting on the

WINNIPEG INT'L A MAN.

PERIOD 1955-80 PERIODE

Lat. 49°54'N Long 097°14 W

Elevation 239 m Altitude

PERCENTAGE FREQUENCY / **FRÉQUENCE EN %**

	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL	
N	7.4	9.6	9.6	10.9	10.1	8.8	7.2	7.6	7.2	8.9	8.5	7.0	8.6	N
NNE	4.6	6.9	6.6	9.9	9.6	7.5	4.9	5.5	4.4	5.0	5.1	5.3	6.3	NNE
NE	2.7	3.3	3.9	6.3	7.5	6.3	4.1	4.6	3.8	3.1	3.0	3.6	4.3	NE
ENE	1.2	1.2	1.5	3.2	3.5	2.9	2.0	2.5	2.2	1.8	1.6	1.9	2.1	ENE
E	1.4	1.7	2.9	4.8	4.9	3.9	2.9	3.3	3.2	2.2	2.0	2.1	2.9	E
ESE	1.8	1.6	3.1	4.0	4.3	3.3	2.6	3.7	3.3	2.3	2.0	2.1	2.8	ESE
SE	3.5	3.0	4.7	5.6	6.3	6.2	4.3	6.5	5.9	4.7	3.6	4.0	4.9	SE
SSE	5.0	5.8	6.5	6.4	7.6	8.3	6.3	7.8	7.5	7.2	6.4	6.6	6.8	SSE
S	15.3	17.1	15.4	12.2	10.7	13.1	13.4	12.9	15.2	15.7	15.1	18.0	14.5	S
SSW	4.9	4.7	4.6	4.0	4.3	4.9	6.0	5.1	5.5	5.5	5.4	4.8	5.0	SSW
SW	3.3	3.0	3.2	3.0	3.8	3.8	4.7	3.6	4.3	3.5	3.6	3.2	3.6	SW
WSW	3.2	2.5	2.4	2.5	2.9	3.5	4.8	3.7	4.5	3.7	3.4	2.9	3.3	WSW
W	10.1	7.8	6.7	4.4	4.6	6.8	9.9	8.1	9.0	8.0	8.8	8.8	7.8	W
WNW	10.1	7.8	7.4	4.9	4.1	5.4	7.2	6.8	6.9	6.8	7.6	8.2	6.9	WNW
NW	15.0	12.1	11.3	8.1	6.6	6.7	9.5	7.8	8.3	10.8	11.9	11.3	10.0	NW
NNW	8.1	8.5	7.5	7.5	6.9	6.0	7.0	6.3	6.4	8.3	8.8	7.4	7.4	NNW
Calm	2.4	3.4	2.7	2.1	2.3	2.6	3.2	4.2	2.4	2.5	3.2	2.8	2.8	Calme

MEAN WIND SPEED IN KILOMETRES PER HOUR
VITESSE MOYENNE DES VENTS EN KILOMÈTRES PAR HEURE

	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL	
N	20.9	20.8	24.3	23.7	22.5	19.5	16.3	17.9	19.8	21.0	22.2	22.4	20.9	N
NNE	18.4	16.8	21.2	23.4	22.2	19.0	15.6	17.0	18.3	18.9	19.1	18.9	19.1	NNE
NE	15.4	13.1	16.0	17.3	18.1	16.6	13.8	14.7	15.5	16.3	16.6	15.6	15.8	NE
ENE	14.5	11.8	15.0	18.3	16.8	15.3	12.8	14.3	15.9	14.7	15.0	14.4	14.9	ENE
E	15.3	14.7	18.0	19.6	18.5	15.7	13.6	14.9	16.9	15.3	15.5	15.7	16.1	E
ESE	17.4	16.6	18.6	21.8	19.3	17.6	15.0	17.0	17.5	17.7	17.2	18.3	17.8	ESE
SE	18.8	17.7	19.4	19.9	18.2	18.5	16.4	16.4	17.8	18.8	16.1	18.2	18.0	SE
SSE	20.1	19.9	21.7	21.2	20.8	20.5	18.2	18.6	20.0	21.7	19.7	20.3	20.2	SSE
S	22.7	23.3	22.7	22.6	22.7	20.8	18.2	18.6	21.3	22.5	22.5	22.9	21.7	S
SSW	14.9	15.7	16.5	19.1	19.6	17.3	15.9	16.5	17.8	18.5	17.0	15.5	17.0	SSW
SW	13.1	11.9	13.3	17.4	17.2	15.2	14.5	13.8	15.5	15.9	13.9	12.1	14.5	SW
WSW	13.3	12.9	13.9	17.2	18.1	16.1	15.2	14.5	16.9	16.2	15.2	12.5	15.2	WSW
W	15.7	14.4	14.4	16.1	18.2	17.2	15.9	16.5	16.7	17.8	16.9	15.0	16.4	W
WNW	16.8	16.4	18.1	19.4	21.0	17.9	16.5	17.7	19.1	19.5	19.5	16.7	18.2	WNW
NW	21.5	20.7	20.7	23.2	23.5	20.7	18.9	18.8	21.5	22.5	23.7	21.7	21.5	NW
NNW	23.2	22.2	21.5	24.6	24.9	20.8	18.0	18.3	21.4	23.3	24.9	22.9	22.2	NNW
All Directions	18.6	18.1	19.3	20.9	20.2	18.1	16.0	16.4	18.5	19.6	19.4	18.6	18.6	Toutes directions
Maximum Hourly Speed	68 SVL	80 SVL	80 N	80 SVL	72 SVL	64 N	89 SE	72 SVL	68 NNW	77 NW	76 WNW	71 S	89 SE	Vitesse horaire maximale
Maximum Gust Speed	98 NW	129 NW	113 N	106 N	109 NW	127 WNW	127 SSW	122 NW	98 SVL	102 NNW	124 WNW	89 NW	129 NW	Vitesse maximale des rafales

Height of anemometer 10.1 m hauteur de l'anémomètre

STATION INFORMATION

Airport is located on the west edge of the city in the broad flat Red River Valley

DONNÉES RELATIVES A LA STATION

L'aéroport se trouve à la limite ouest de la ville, dans la vallée plate et large de la rivire Rouge

Source: Environment Canada, Canadian Climate Normals, Volume 5, Wind, 1951-1980. A publication of the Canadian Climate Program, 1982.

Table 4-1 Winnipeg Wind Data

Date	Precipitation (mm)	Mean Temp. (C)	Prevailing Wind (km/hr)	Prevailing Wind (Direct.)	Peak Wind (km/hr)	Peak Wind (Direct.)
1	1.8	- 6.6	14	S	35	S
2	0	- 6.2	8	S	22	S
3	0	- 3.9	20	S	39	S
6	2.1	- 8.6	6	N	18	N
7	0	-16.4	14	NW	18	N
8	0.5	-20.8	14	NW	22	NW
9	0.4	-23.8	12	NW	18	NW
10	0	-24.5	7	W	11	NW
16	2.2	-13.9	15	E	37	SSE
17	2.7	-15.7	16	NW	31	NW
18	0.4	-22.4	17	N	20	N
19	1.8	-23.0	13	NW	18	NW

Source: Environment Canada, Atmospheric Environmental Service, Winnipeg.

Table 4-2 Climatological Data During Outdoor Testing February 1986 model would occur from the west or southwest with respect to it, these results were only useful in that they showed the type of drifting the model might produce. Figure 4-4 shows the results of this test.

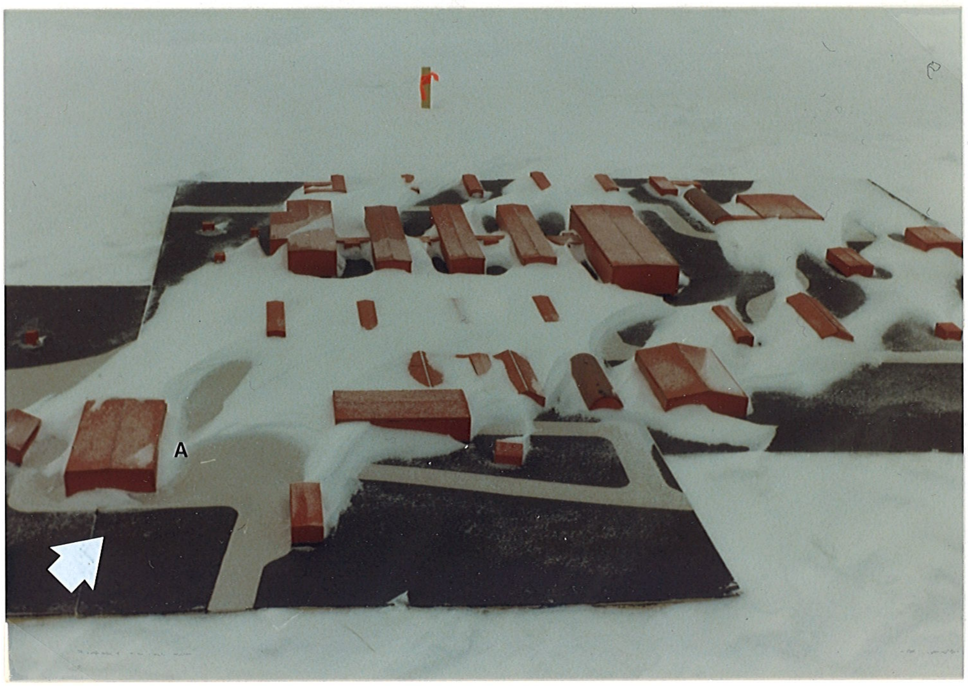
After photographs of the results of the first test were taken, the model was cleaned of all snow. This clearly ensured that any future drifting would not be influenced by any past drifting.

Drifting on the model had occurred from the east (with respect to the model). Although snow drifting from winds in this direction is not considered a problem, the result illustrates the type of drifting which can occur on the model. Arrow indicates wind direction.

Figure 4-4 Outdoor Model - 3 February 1986

Results were next obtained on 7 February, after drifting had occurred from the north (see Table 4-2). This meant that, with respect to the model, drifting was occurring from the west. The results of this test are presented in Figure 4-5. As can be seen by the results, the central part of the station (Buildings 23 through 26) is completely drifted in. Although the drifting appears to be excessive, there are also several similarities with the actual drifting on site, as noted in the Figure.

The model was again cleaned of snow to ensure that the next drifting was not influenced by present drifting.



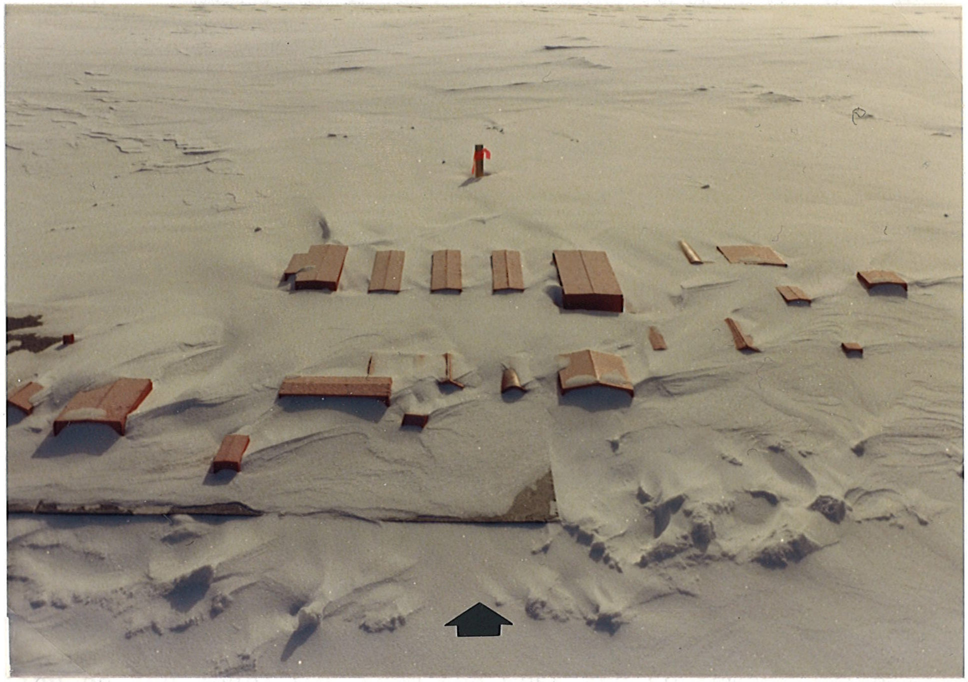
View from the southwest.

Drifting on the model has occurred from the west (with respect to the model). Although drifting is quite extensive, the pattern on the southeast side of Building 113 is similar to laboratory results with the water flume and actual on site data (A). Drifting in other areas is too extensive to make any correlations, however. Arrow indicates wind direction.

Figure 4-5 Outdoor Model - 7 February 1986

The third set of results was obtained on 10 February, after drifting had occurred from the northwest. With respect to the model, this drifting was from the "southwest". As can be seen from the results (Figure 4-6), many of the buildings have been completely covered with drifting snow, making it impossible to determine drifting patterns. Because of the extent of snow coverage, it was not possible to make any correlation with results obtained in the water flume or actual drifting on site.

The model was again cleaned off in preparation for further drifting snow.

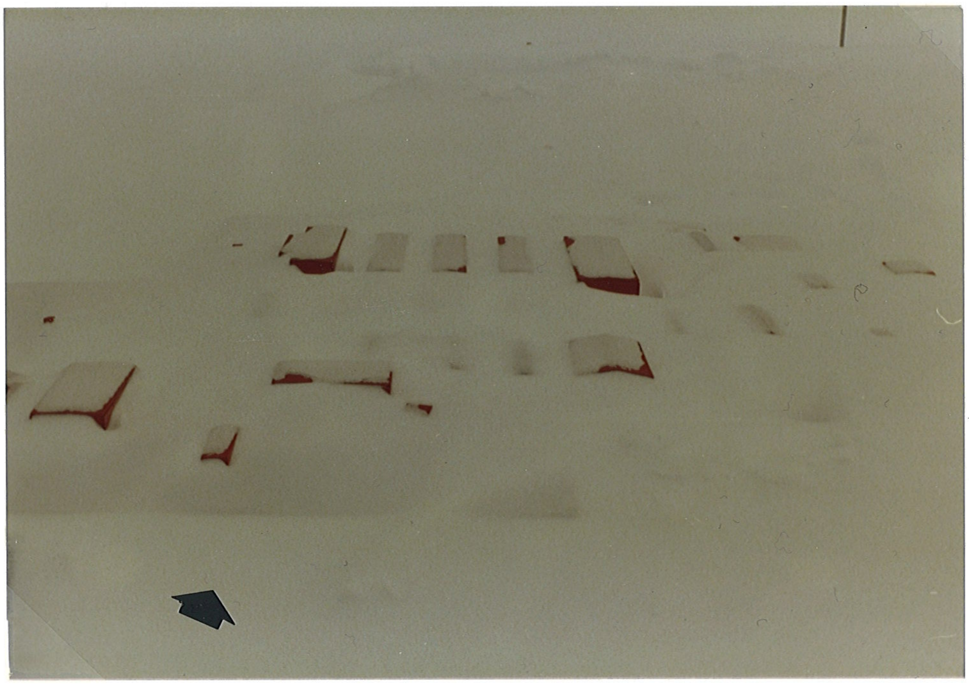


View from the southwest.

Drifting on the model has occurred from the southwest. As can be seen, the drifting has completely covered many of the buildings making any comparison with other data very difficult. Arrow indicates wind direction.

Figure 4-6 Outdoor Model - 10 February 1986

The fourth and final set of results were obtained on 19 February, after drifting had occurred from the north and northwest or west and southwest with respect to the model. These results were similar to the previous in that many of the buildings were again completely covered, making it impossible to make any reasonable correlations (see Figure 4-7.



View from the southwest.

Drifting on the model was from the west and southwest (with respect to the model). The extensive snow covering made it impossible to make any comparison with other testing or actual drifting on site. Arrow indicates wind direction.

Figure 4-7 Outdoor Model - 19 February 1986

4.5 Discussion of Results

The outdoor model did not provide results which were suitable for comparison with the tests conducted in the water flume or actual on site data collection. This was because most of the snow drifting which occurred was too extensive to determine the actual initial drifting patterns.

One illustration the model did make, however, was the large amount of drifting which can occur with very little or no actual precipitation. The snow which had accumulated in this large open field probably contributed to most of the snow drifting which occurred on the model. Since CFS Alert is located in a similar environment, with barren land and nothing to stop the blowing snow, the same type of drifting occurs. Instead of blowing across an open field of 500 metres, which was the case with the model, snow drifts at Alert can be formed from snow that has blown for thousands of kilometres.

In retrospect it can be concluded that an outdoor model does not provide the controlled condition possible in a hydraulic flume simulation. The only validity this model might have is when:

a. it is set up on the actual site, prior to construction, to experience identical meteorological conditions; and

b. it is constantly monitored for the proper amount of precipitation, i.e. proportional to the actual amounts.

The main problems with the outdoor model appeared to be that the high natural wind velocity was too great for the size of the buildings.

CHAPTER 5

WATER FLUME TEST RESULTS

5.1 Introduction

The results obtained from an extended series of tests carried out in the water flume are summarized in this chapter. There is a section which presents and discusses the results of each proposal, as well as a concluding section which compares the overall results.

Four alternative site proposals were tested. These include the present proposal, as per Figure 5-1, as well as three variations to this proposal. The first three development proposals for CFS Alert were tested with two wind directions, namely west and southwest, while the fourth proposal was only tested from the west because of the physical limitations of the model. Table 5-1 summarizes the water velocity and depth during testing of each proposal.

5.2 Proposal A

As a starting point for the study of alternative proposals for development at CFS Alert, the presently existing proposal was tested first (see Figure 5-1). It was felt that by testing the initial proposal, the results would assist identifying other plans that should be looked at. Figure 5-2 shows the basic model revised to show Proposal A which includes the demolition of all buildings identified in Figure 2-5. A more detailed description of the buildings proposed is provided in Annex B.

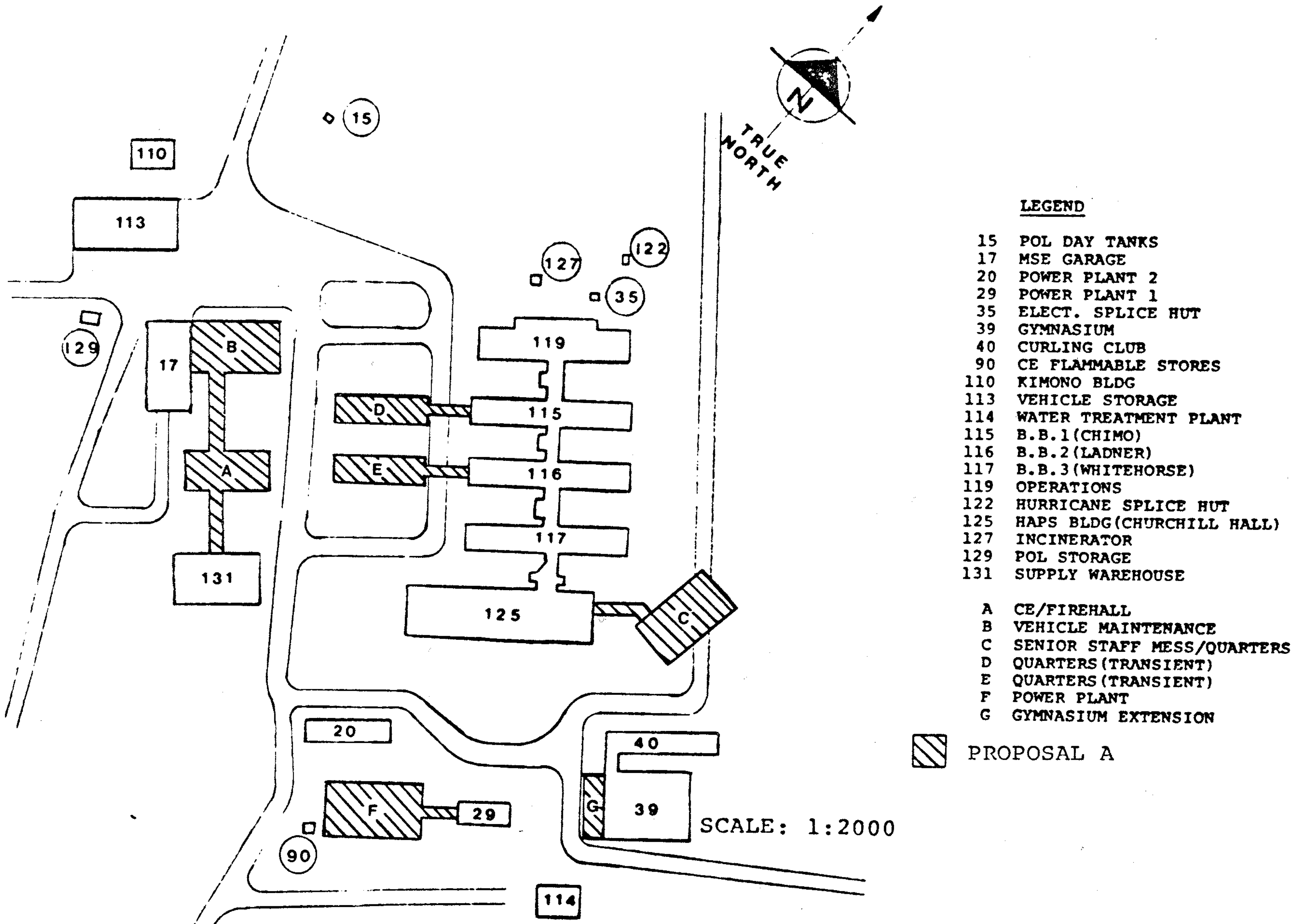
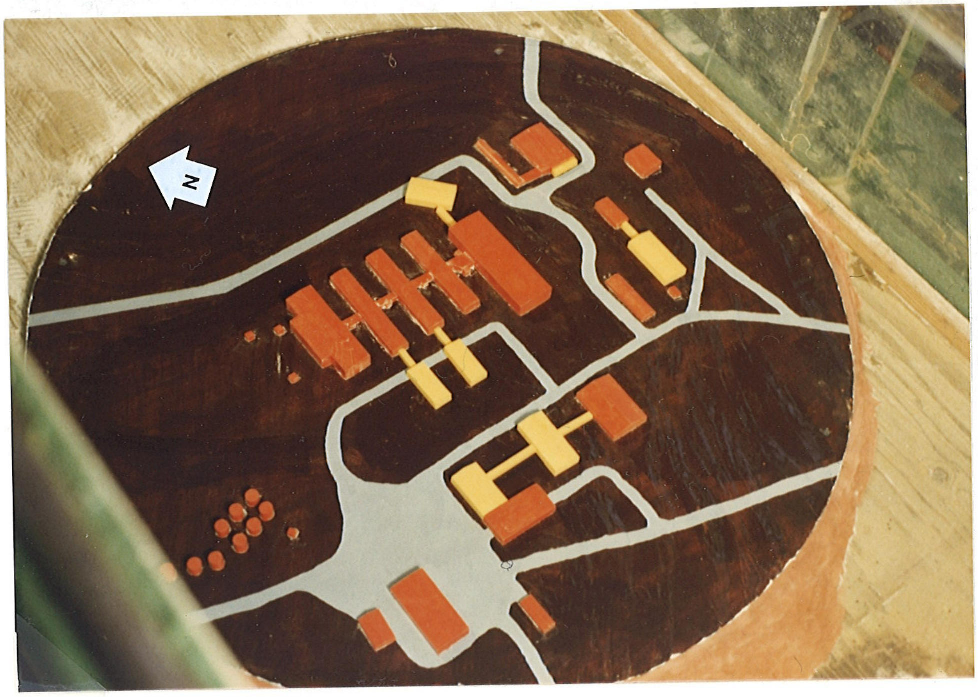


Figure 5-1 March 1985 Development Plan Update - Proposal A

Proposal	Wind Direction	Drifting Quantity	Water Velocity Meter Reading rev/min	Water Velocity m/s	Water Depth mm
Present Site	SW	Light	51	0.24	235
	SW	Heavy	51	0.25	235
A	W	Light	37	0.18	240
	W	Heavy	44	0.21	240
	SW	Light	43	0.21	240
	SW	Heavy	43	0.21	240
B	W	Light	43	0.21	240
	W	Heavy	43	0.21	240
	SW	Light	42	0.20	240
	SW	Heavy	44	0.21	240
C	W	Light	41	0.20	240
	W	Heavy	41	0.20	240
	SW	Light	43	0.21	250
	SW	Heavy	43	0.21	250
D	W	Light	45	0.21	240
	W	Heavy	45	0.21	240
Test Run	W/SW	Heavy	41	0.20	240

Table 5-1 Test Data

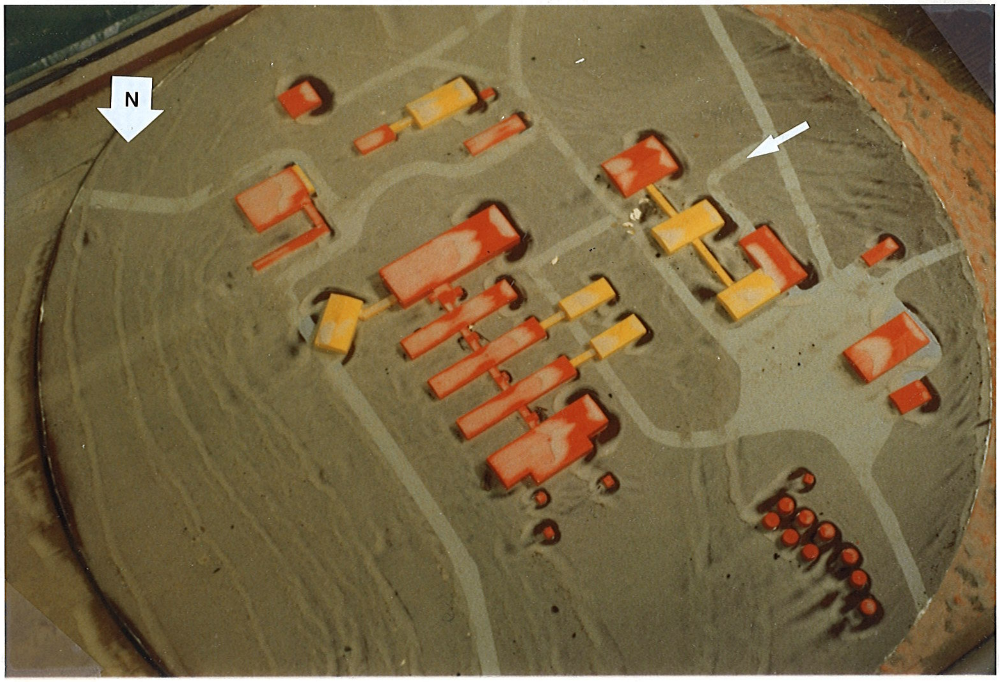


View of proposed site plan from the west. New buildings are yellow, while existing buildings are orange. The road network will also require realignment with the new buildings proposed.

Figure 5-2 Model of Proposal A

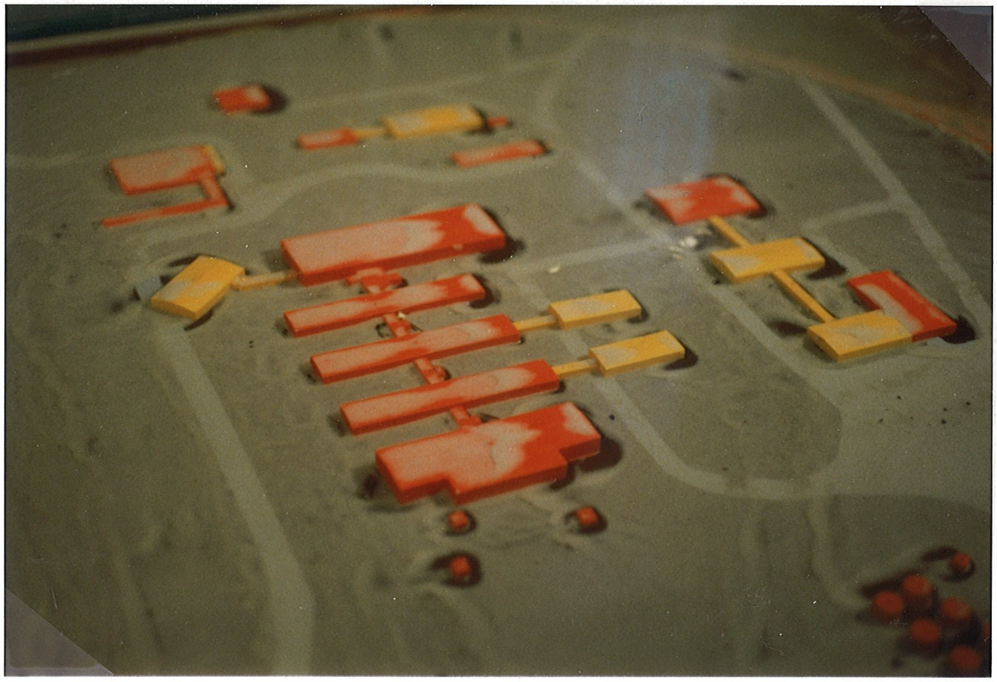
For this test, the model was first oriented so that direction of flow would be from the southwest. As in the previous test, two runs were conducted, the first with a small amount of sand and the latter with a larger amount. Test results from the first and second run are shown in Figures 5-3 and 5-4 respectively.

The model was then rotated so that wind direction would be from the west and two more runs similar to the previous testing, were conducted. The results obtained from these tests are presented in Figures 5-5 and 5-6 respectively.



(a)

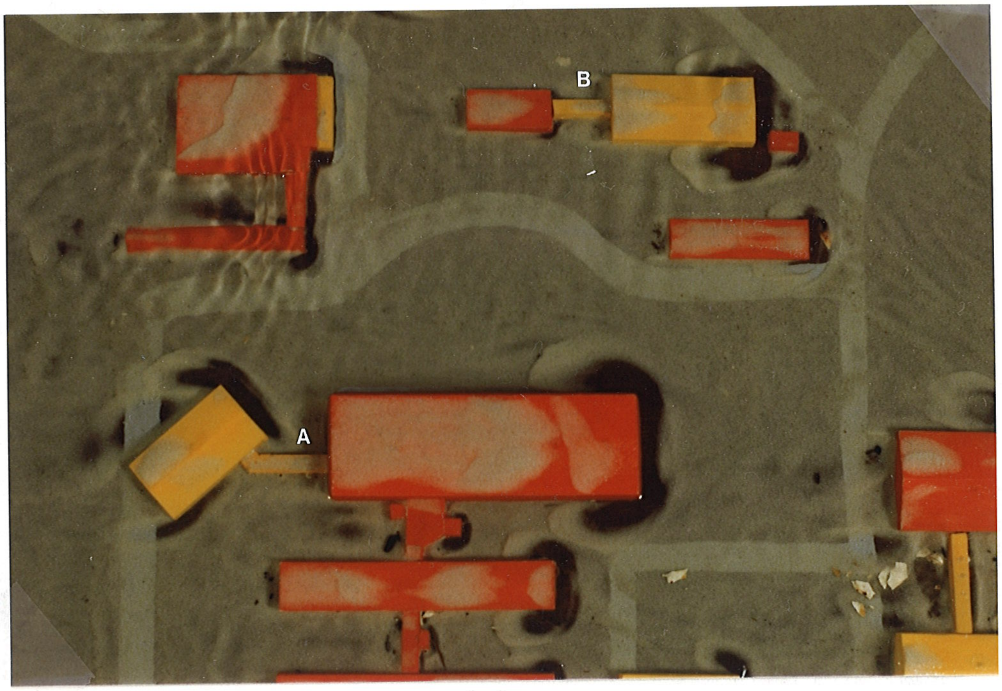
View from the north. Arrow indicates wind direction.



(b)

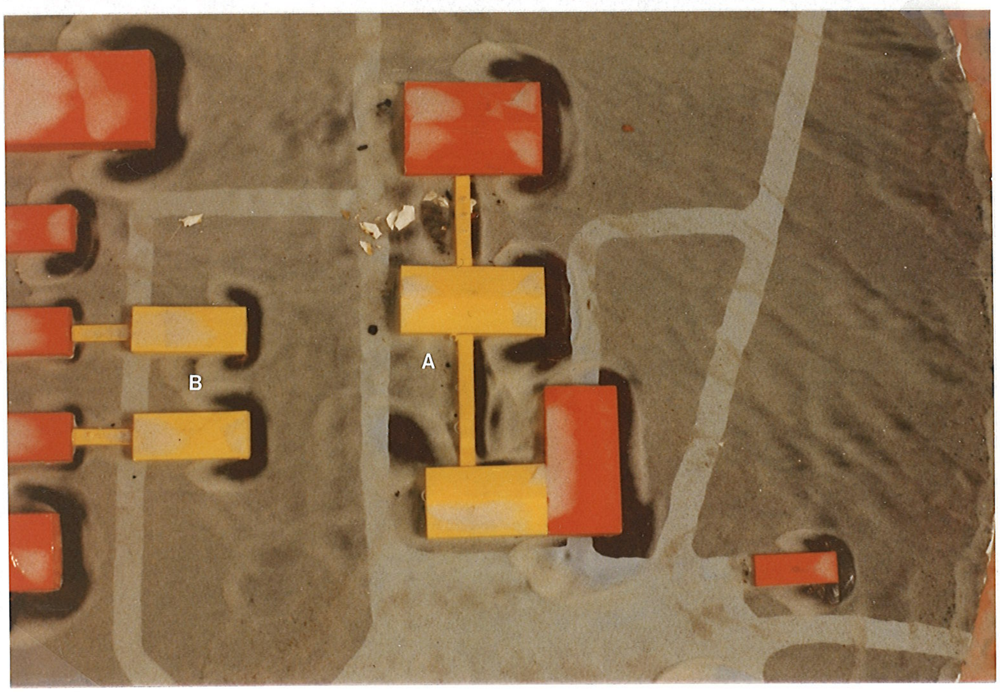
View from the north at a lower angle to the horizon.

Figure 5-3 Proposal A - Light Drifting from the Southwest



(c)

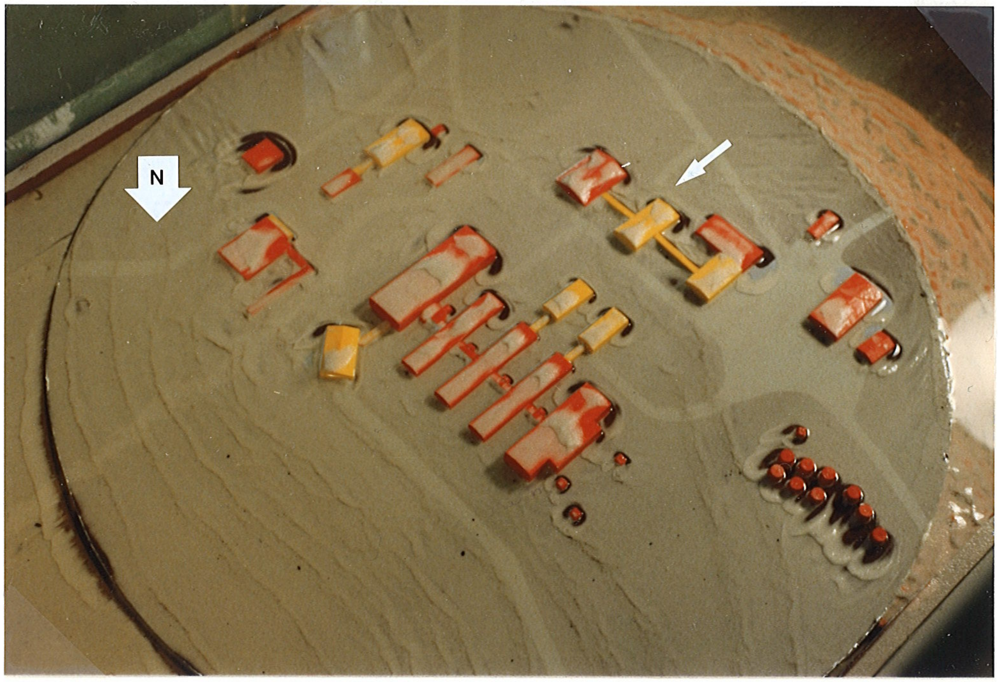
Note the drifting occurring on both sides of the linkway to the Senior Staff Mess and Quarters (A). Drifting is also occurring on the east side of the new power plant (B).



(d)

Drifting has started on the northwest side of the new firehall (A). Drifting between the new transient quarters is also developing (B).

Figure 5-3 Proposal A - Light Drifting from the Southwest (Continued)



(a)

View from the north. Arrow indicates wind direction.

(b)

View from the north. Note the large drifts formed on the northeast sides of the new firehall (A) and the supply building (B). Extensive drifting can also be seen on the northeast side of the new power plant (C).

Figure 5-4 Proposal A - Heavy Drifting from the Southwest

(c)

View from the northeast. Extensive drifting has occurred along the linkway to the new Senior Staff Mess and Quarters (A). Extensive drifting can also be seen between the transient quarters (B) and the north corner of the new power plant (C).

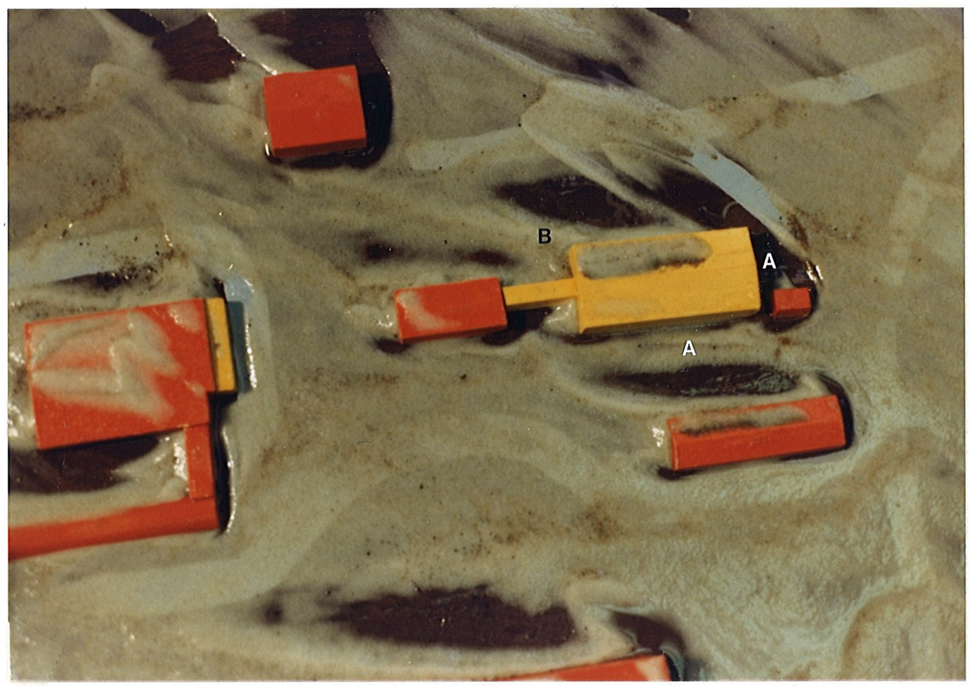
(d)

View from the southeast. Note the large drifts that have formed on the east side of the new Senior Staff Mess and Quarters (A). Drifting can also be seen near the linkways to the new transient quarters (B).

Figure 5-4 Proposal A - Heavy Drifting from the Southwest (Continued)

(a)

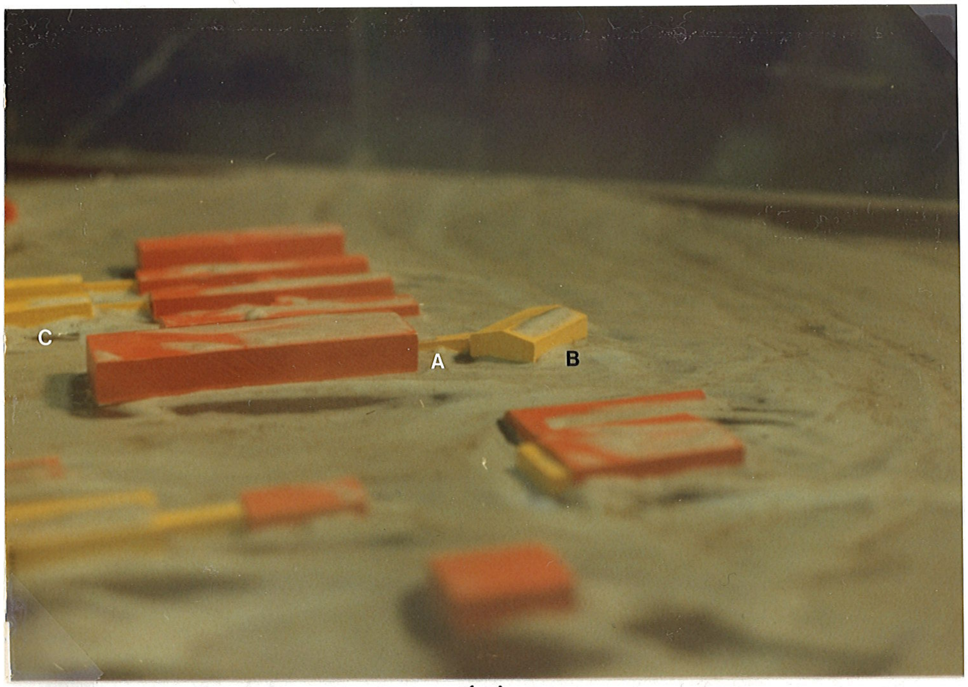
View from the north. Arrow indicates wind direction.



(b)

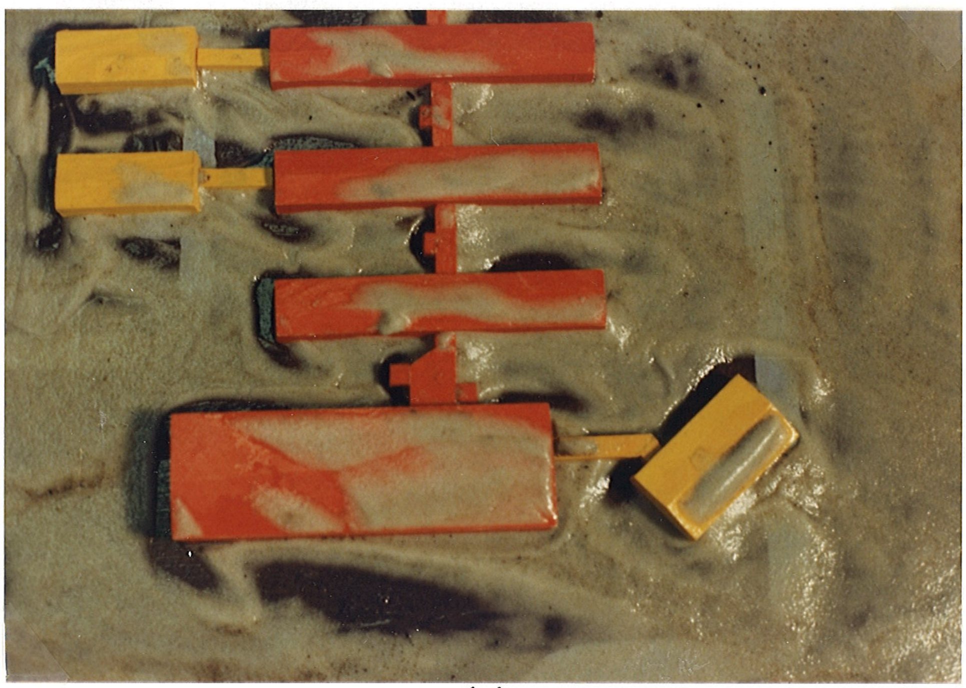
The new power plant is mostly clear of snow to southwest and northwest (A). Drifting, however, has developed on both sides of the linkway and on the southeast side (B).

Figure 5-5 Proposal A - Light Drifting from the West



(c)

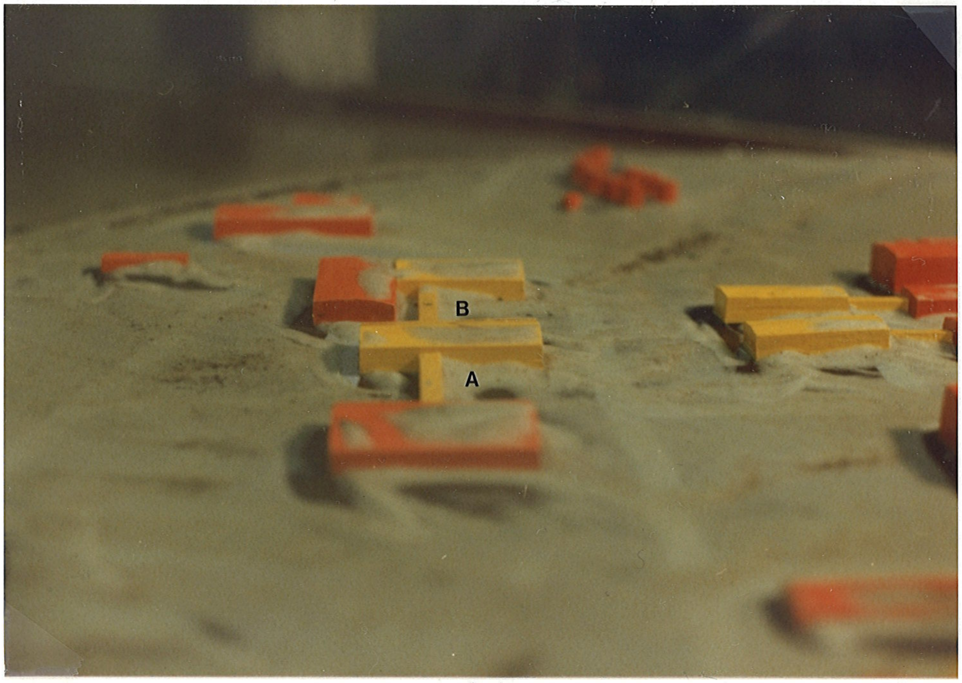
The Senior Staff Mess has drifting along the linkway (A) and on the east side (B). Drifting is also noticeable on the southeast side of the transient quarters (C).



(d)

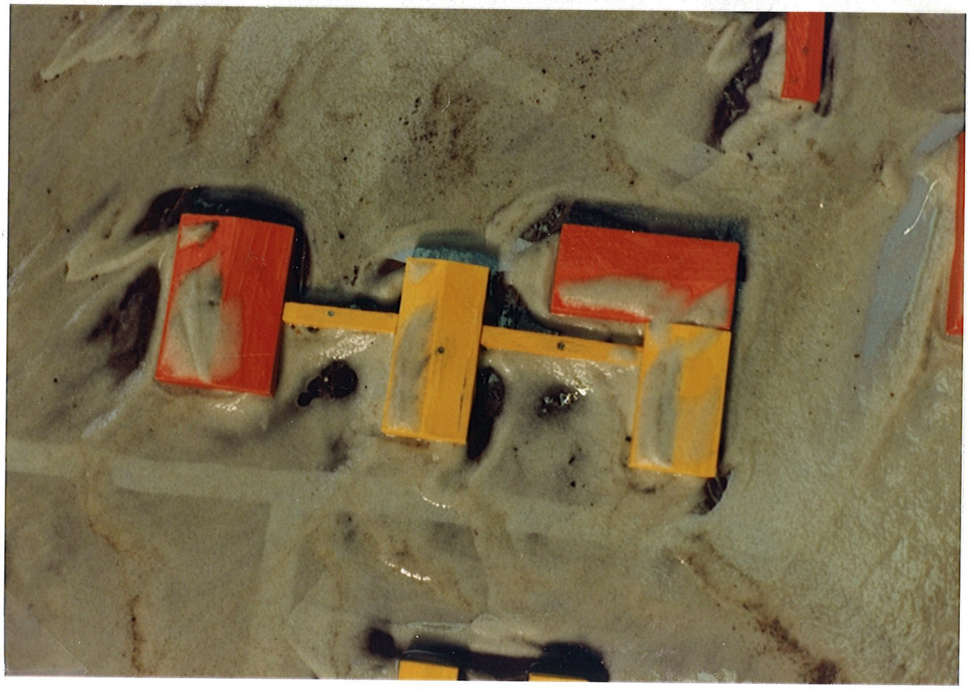
Top view again showing the drifting patterns as mentioned in (c) above.

Figure 5-5 Proposal A - Light Drifting from the West (Continued)



(e)

Drifting is evident northeast of the linkway and adjacent to the firehall (A) and MSE Supply (B).



(f)

Top view again showing the drifting patterns as mentioned in (e) above.

Figure 5-5 Proposal A - Light Drifting from the West (Continued)

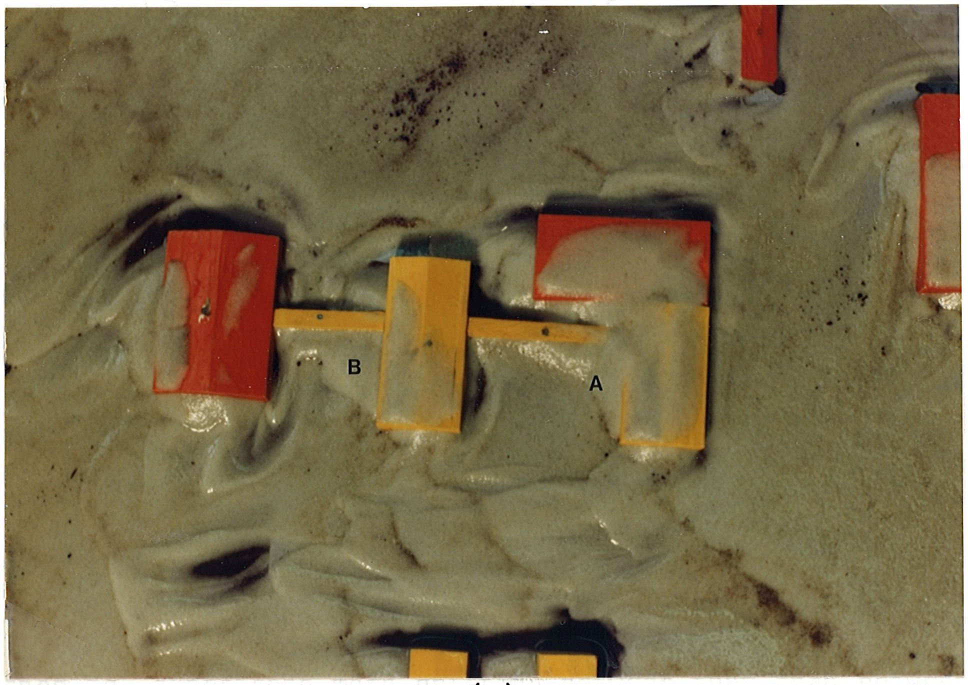
(a)

View from the north. Arrow indicates wind direction.

(b)

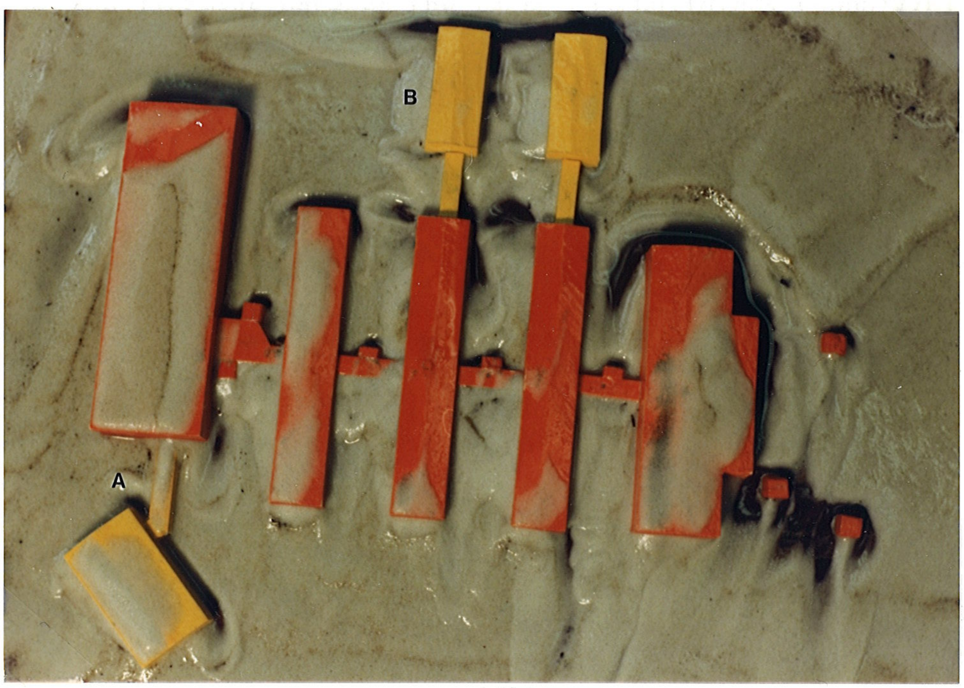
View from the northwest. Extensive drifting can be seen on the southeast sides of the transient quarters (A), the MSE Supply (B) and the firehall (C).

Figure 5-6 Proposal A - Heavy Drifting from the West



(c)

Top view of technical buildings again show the drifting on the southeast sides of MSE Supply (A) and the firehall (B).



(d)

Extensive drifting can be seen on the southeast side of the linkway to the Senior Staff Mess (A) and on the southeast side of the transient quarters (B). Drifting between the barrack blocks is also extensive (C).

Figure 5-6 Proposal A - Heavy Drifting from the West (Continued)

The results indicate more serious drifting around the linkway and Senior Staff Mess when wind direction is from the southwest. While winds from the west keep the west side clear drifting is still evident along the linkway and on the east side of the building.

The linkways to the transient quarters are drifted in when winds are from both the west and southwest. Drifting between the transient quarters is less serious with a westerly wind than a southwest wind, however. The barrack blocks, which the transient quarters are attached to, experience more drifting between them than between other barrack blocks or buildings.

Winds from both the west and southwest cause drifting on northeast side of the linkways between the technical buildings (Supply/Firehall/MSE). Drifting from the west appears less serious, however.

To summarize, in testing Proposal A several snow drifting problem areas were identified, as shown in Figure 5-7. These include:

a. along both sides of the linkways joining the transient quarters to the existing barrack blocks;

b. between the transient quarters;

c. on both sides of the linkway to the Senior Staff Mess; and

d. on the northeast side of the linkways connecting the technical buildings.

The drifting along the linkways are critical because access doors are being proposed on these. Drifting here would not only cause a snow clearing problem, but would also prevent emergency access. Drifting between the transient quarters would also prevent emergency

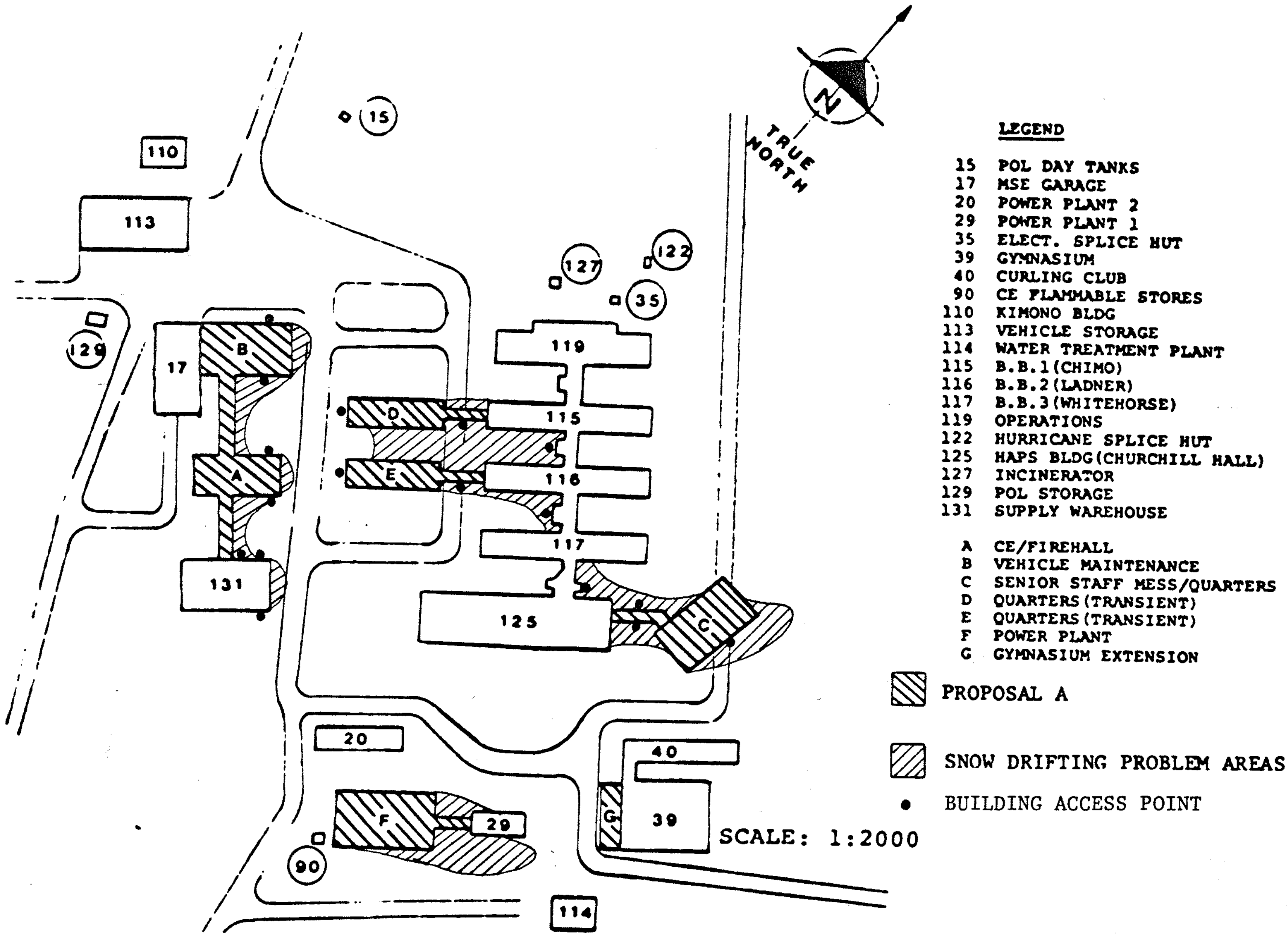


Figure 5-7 CFS Alert - Proposal A Drifting Problem Areas

access between the adjoining barrack blocks.

The drifting which could occur on the northeast side of the linkways connecting the technical buildings would not only cause a snow clearing problem, but would also prevent emergency vehicles from getting out of the new firehall, since overhead doors are located on the northwest and southeast sides of this building.

5.3 Proposal B

On the basis of the results obtained when testing Proposal A, the linkways between the transient quarters and the existing barrack blocks were removed, making them a direct extension to the existing barrack blocks. A second change, although not actually related to the previous results, was the retention of Building No. 16 (MSE Supply) and the construction of a new MSE Building with a linkway to Building No. 17 (MSE Garage). The reasons for this change are as follows:

a. there is presently some uncertainty as to whether Building No. 16 should be demolished because it is believed to be structurally sound; and

b. the requirement for additional MSE storage space has been identified.

The new MSE building would be approximately 325 m^2 and designed to accommodate the increased requirements of MSE.

The CE/Firehall building was not changed because it is scheduled to be constructed in 1986.

Figure 5-8 shows the site plan for Proposal B.

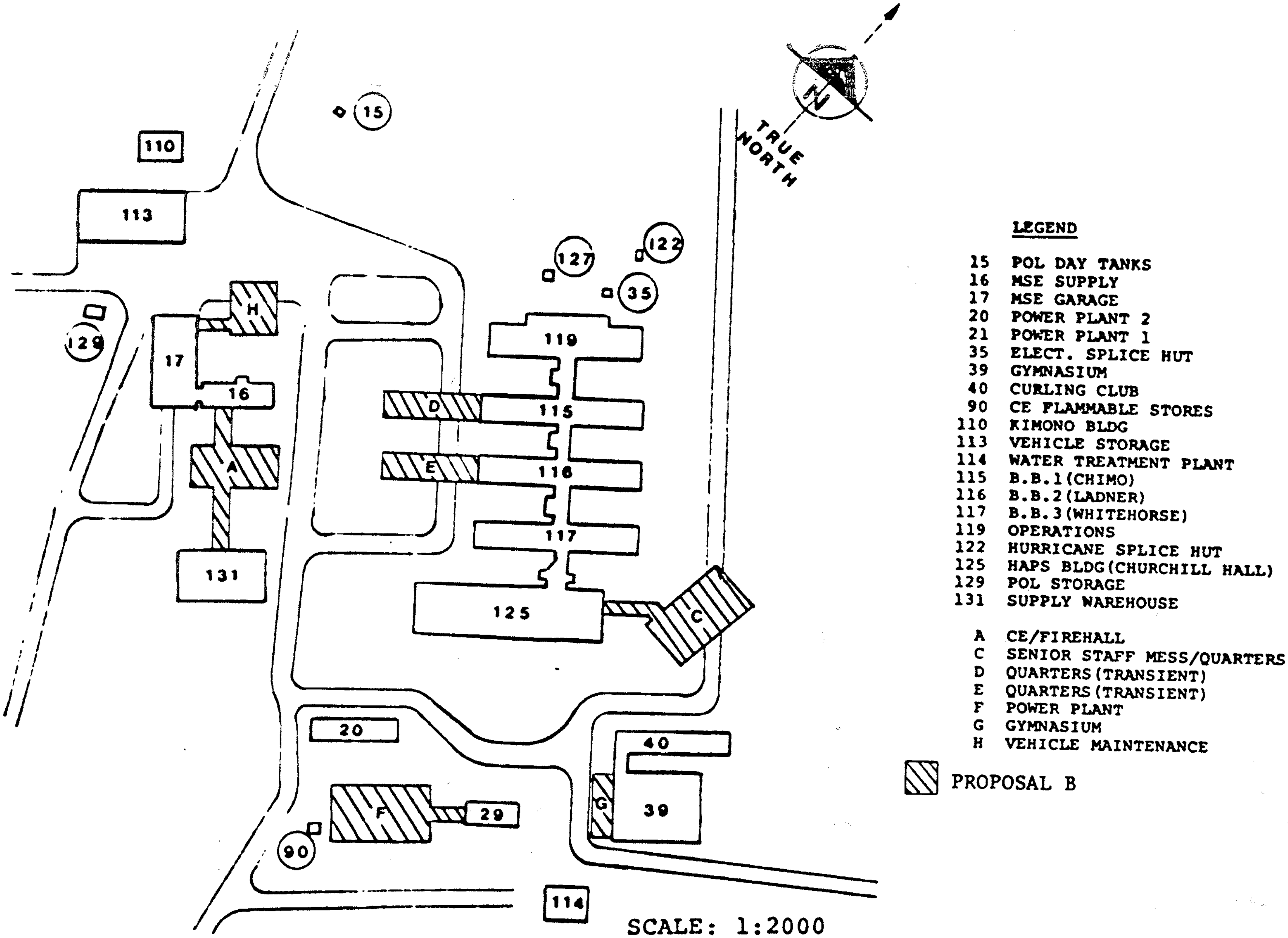
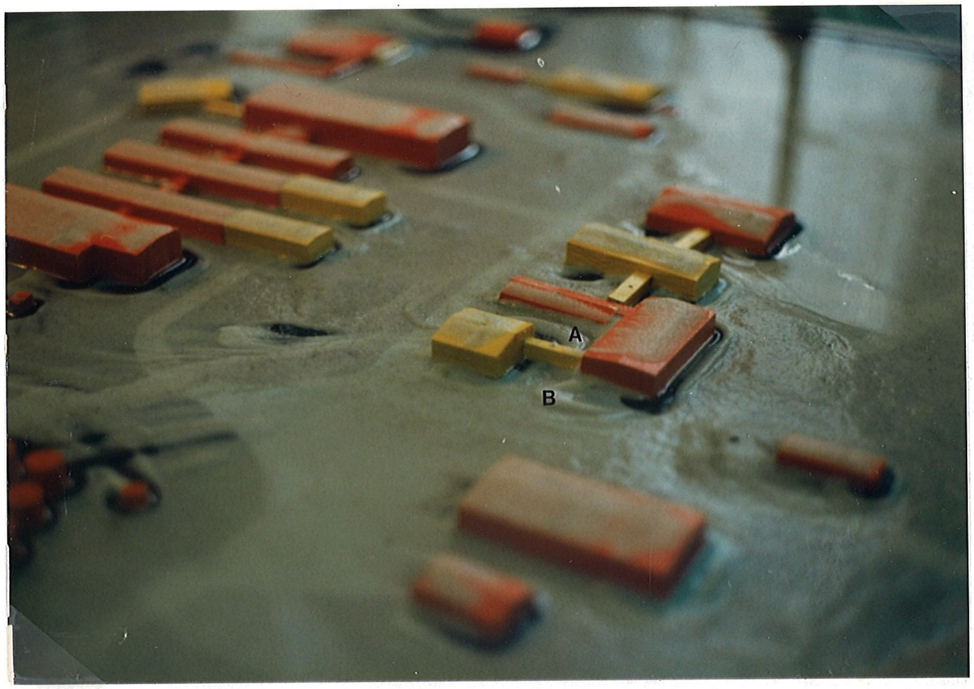


Figure 5-8 CFS Alert - Proposal B

Similarly to the previous proposal, Proposal B was tested from both the west and southwest, with both light and heavy drifting for each direction. The results for drifting from the southwest, with light and heavy drifting, are shown in Figure 5-9 to 5-10 respectively, while Figures 5-11 and 5-12 respectively contain the results for light and heavy drifting from the west.

(a)

View from the north. Arrow indicates wind direction.



(b)

View from the west. Extensive drifting is occurring between the new MSE Building and Building No. 16 (A) and on the northwest side of the linkway and in front of Building No. 17 (B).

Figure 5-9 Proposal B - Light Drifting from the Southwest

(c)

Top view of technical buildings. Large drifting is evident between Building No. 16 and the new MSE Building (A) and in front of the MSE Garage (B).

(d)

Drifting is event around the linkway to the Senior Staff Mess (A), however, no serious drifting is occurring around the transient quarters.

Figure 5-9 Proposal B - Light Drifting from the Southwest (Continued)

(a)

View from the north. Arrow indicates wind direction.

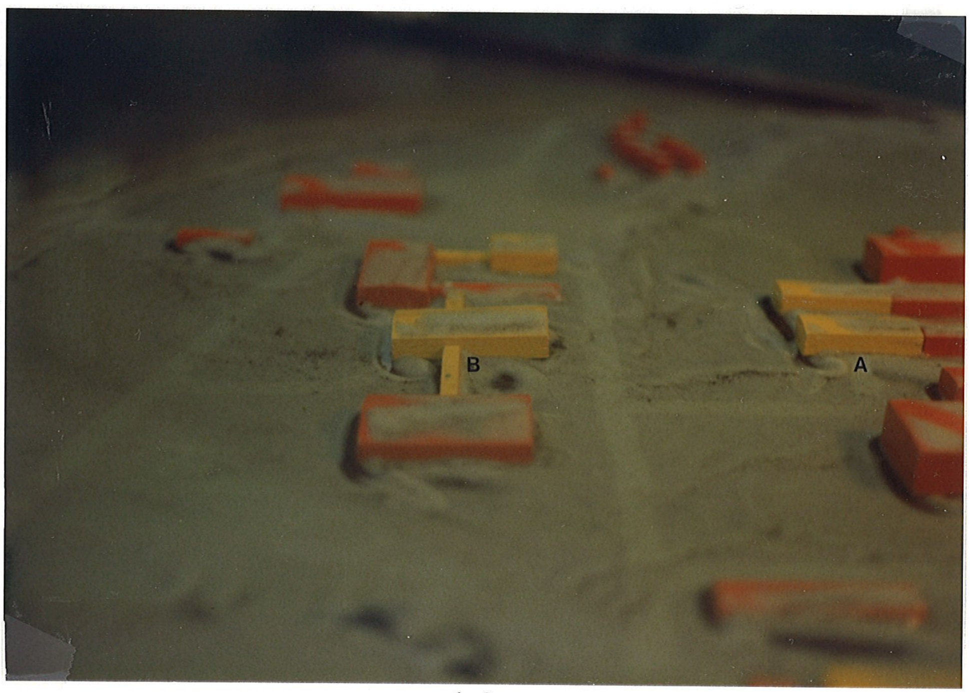
(b)

Extensive drifting has occurred on the northeast side of the linkways joining the technical buildings (A) with Building No. 16 almost buried (B). Drifting is also heavy along the linkway to the Senior Staff Mess (C).

Figure 5-10 Proposal B - Heavy Drifting from the Southwest

(a)

View from the northeast. Arrow indicates wind direction.



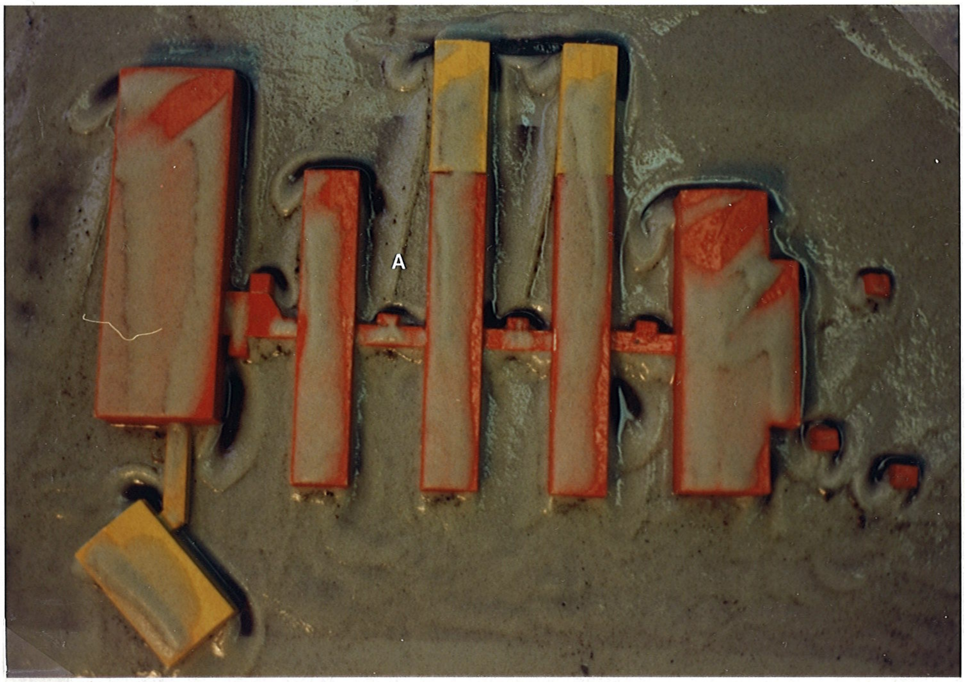
(b)

View from the southeast. Drifting is developing on the southeast side of the transient quarters (A) and the firehall (B).

Figure 5-11 Proposal B - Light Drifting from the West

(c)

Top view of the technical buildings. A large drift has formed between Building No. 16 and the new MSE Building (A).



(d)

Large long drifts on the southeast sides of barrack blocks No. 115 and 116 have formed as a result of the new transient quarters (A).

Figure 5-11 Proposal B - Light Drifting from the West (Continued)

(a)

View from the northeast. Arrow indicates wind direction.

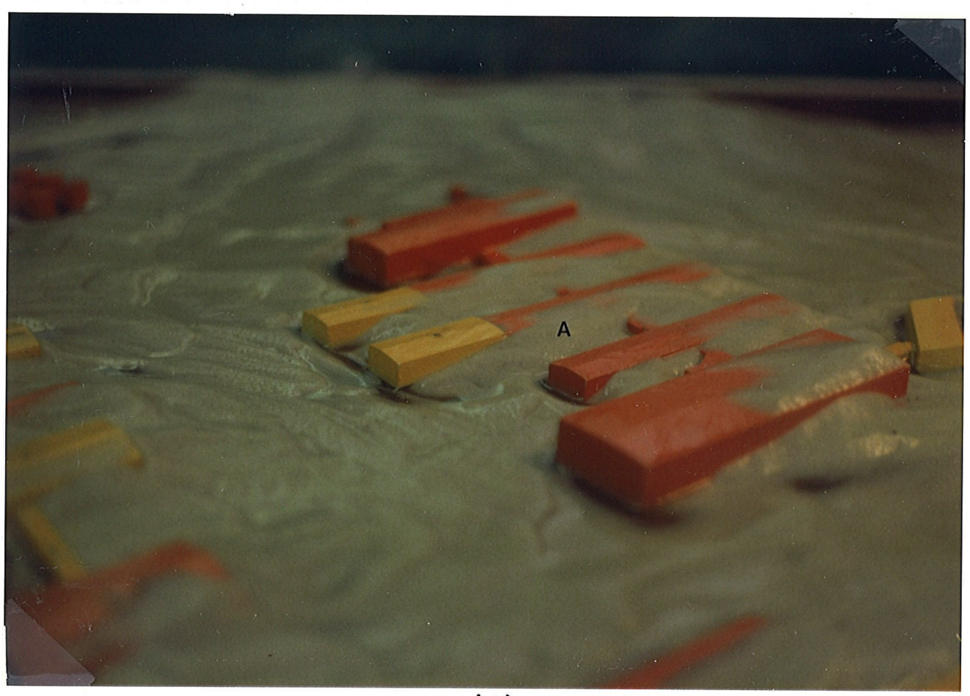
(b)

View from the north. Extensive drifting has occurred around the technical buildings with Building No. 16 almost buried (A).

Figure 5-12 Proposal B - Heavy Drifting from the West

(c)

View from the northeast. The northwest sides of the transient quarters are almost clear of drifting (A). Heavy drifting has occurred on the east side of the Senior Staff Mess (B).



(d)

The southeast side of barrack blocks Nos. 115 and 116 have extensive drifting as a result of the transient quarters (A).

Figure 5-12 Proposal B - Heavy Drifting from the West (Continued)

The tests showed that in Proposal B the drifting has worsened between barrack block Nos. 115 and 116, and between Nos. 116 and 117 when drifting occurred from the west. This was because of the new siting for the transient quarters. Buildings No. 16 and the new MSE Building experienced serious drifting problems when winds were from both the west and southwest. Drifting around both the technical buildings and the transient quarters appeared to be more extensive than in Proposal A.

As was evident from the results obtained when testing Proposal B serious drifting was identified in several areas as shown in Figure 5-13. These included:

a. between the transient quarters;

b. between the barrack blocks;

c. between Building No. 16 and the new MSE Building;

d. in front of the overhead door to Building No. 17 (MSE Garage);

e. northeast of the linkway connecting the technical buildings; and

f. on both sides of the linkway to the Senior Staff Mess.

5.4 Proposal C

To avoid the problem areas identified when testing Proposal B the following changes were made:

a. location of the transient quarters and the Senior Staff Mess in a new line northeast of the barrack blocks and connected by linkways; and

b. removal of Building No. 16 and the addition of a new MSE Building as originally proposed in Proposal A.

The site layout for this proposal is presented in Figure 5-14.

The model, with the modifications for Proposal C, is shown in Figure 5-15. Test results with light and heavy drifting from the southwest are shown in Figures 5-16 and 5-17 respectively, while light and heavy drifting from the west are shown in Figures 5-18 and 5-19 respectively.

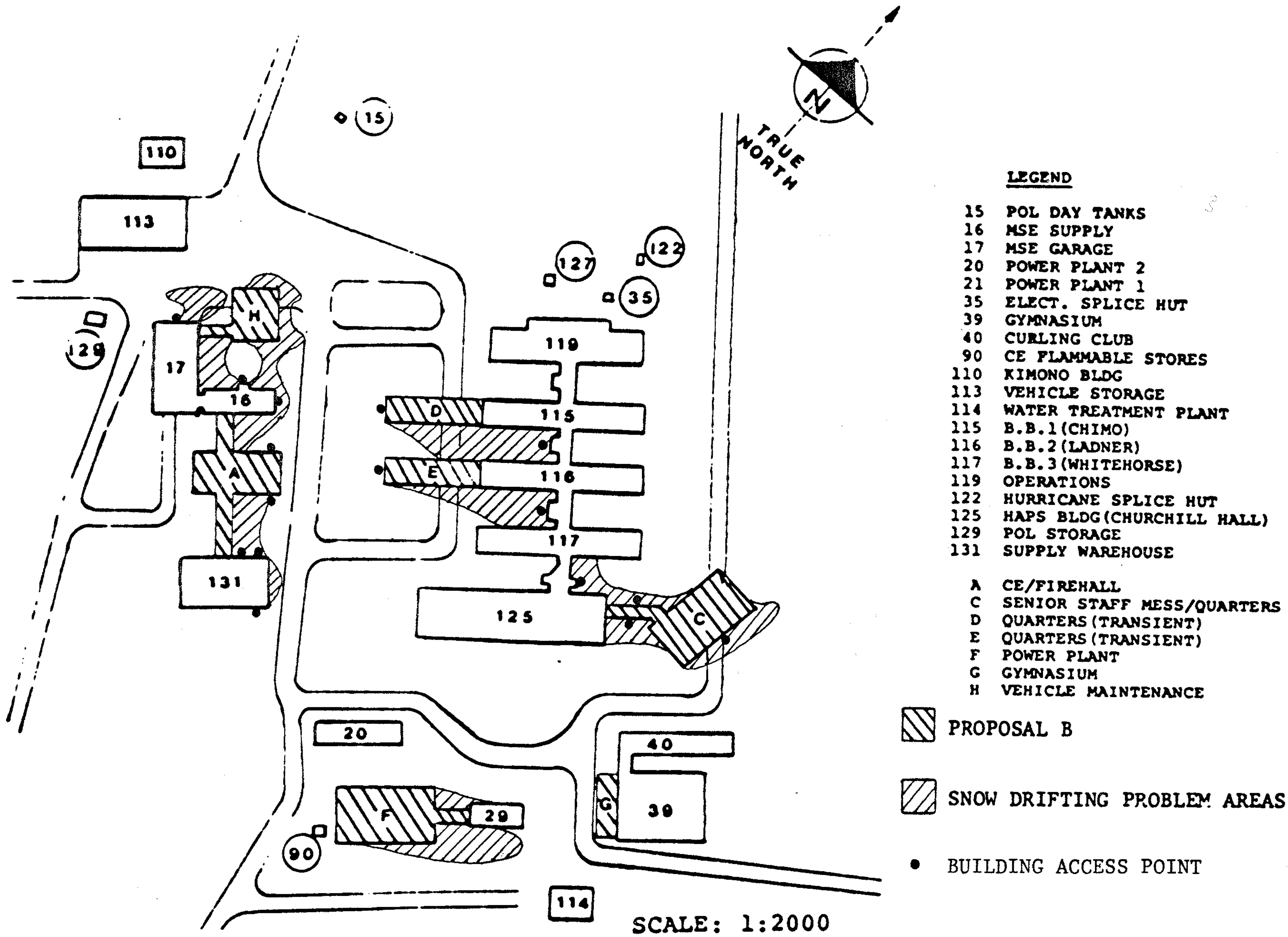
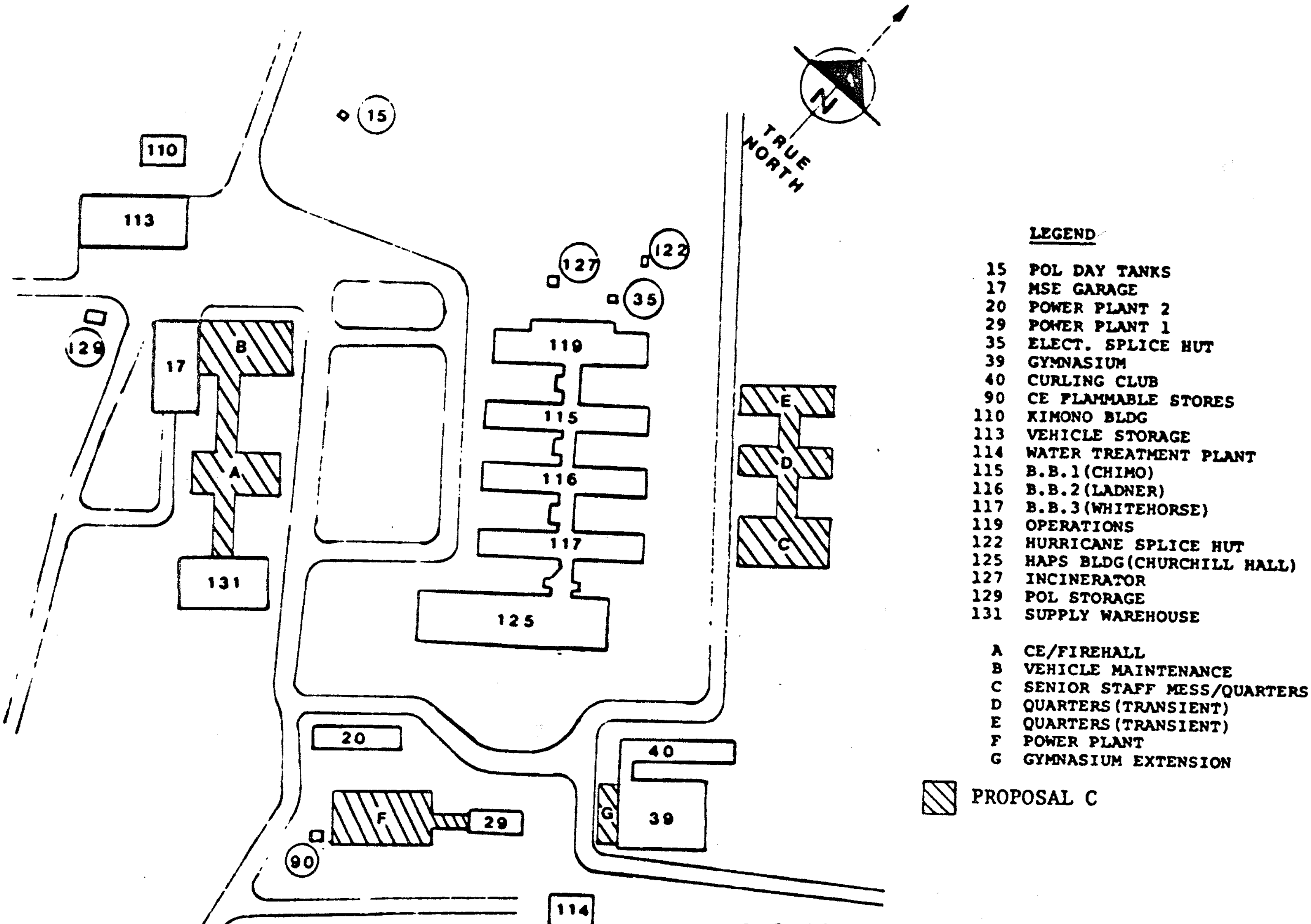
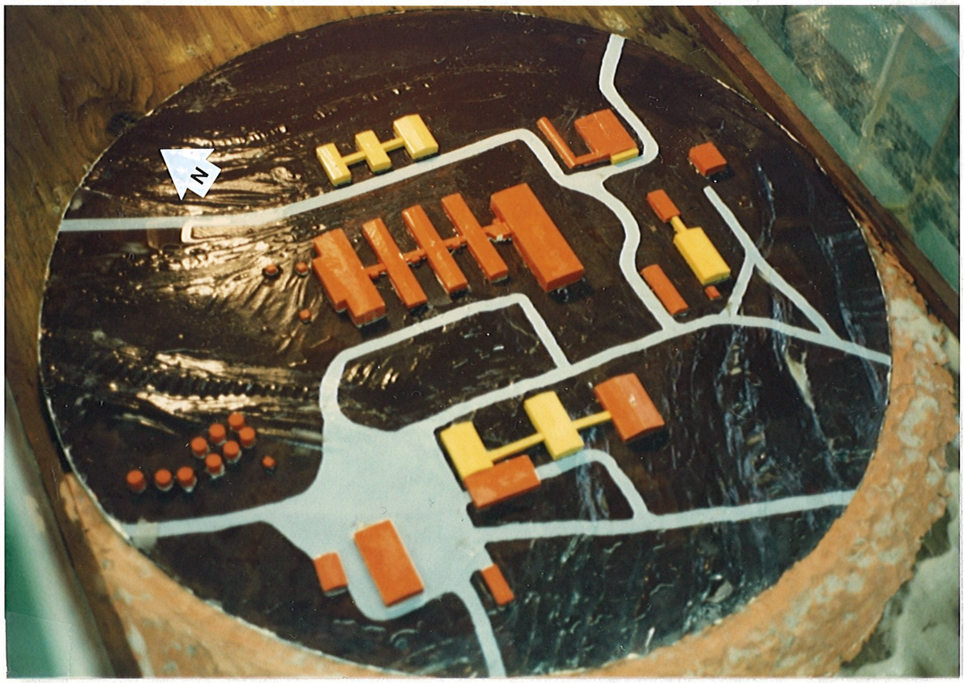


Figure 5-13 CFS Alert - Proposal B Drifting Problem Areas



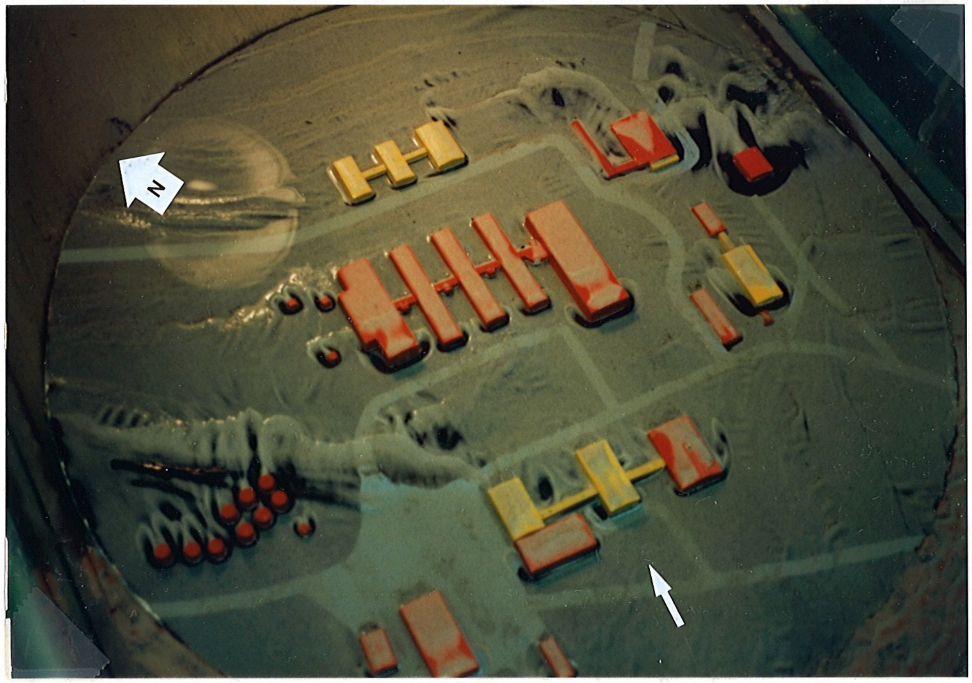
SCALE: 1:2000

Figure 5-14 CFS Alert - Proposal C



Orange is existing buildings, while
yellow represents new buildings

Figure 5-15 Proposal C - Site Layout



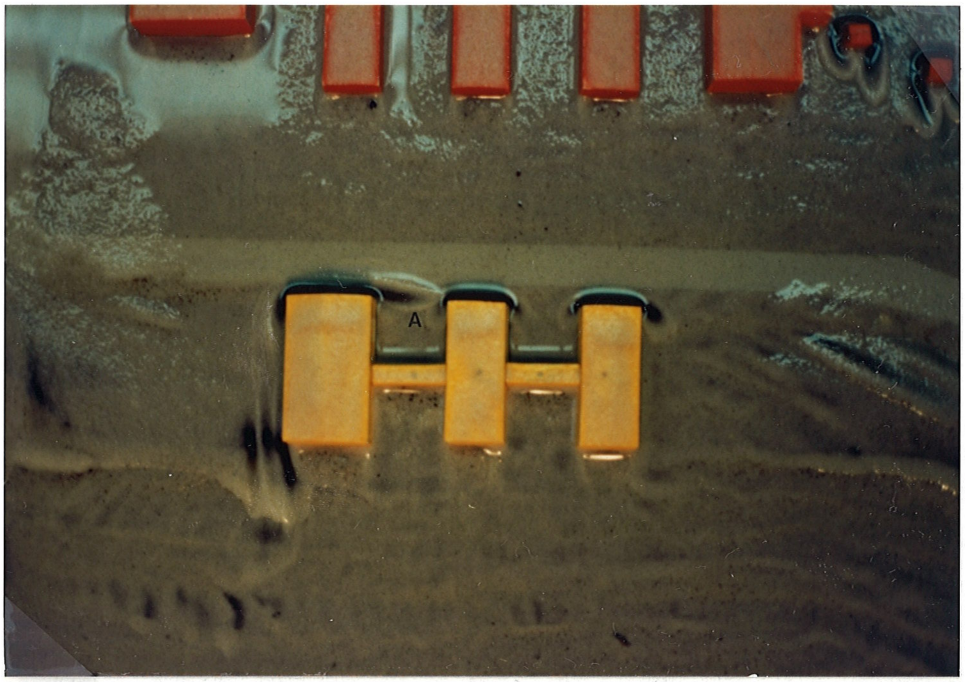
(a)

View from the west. Arrow indicates wind direction.

(b)

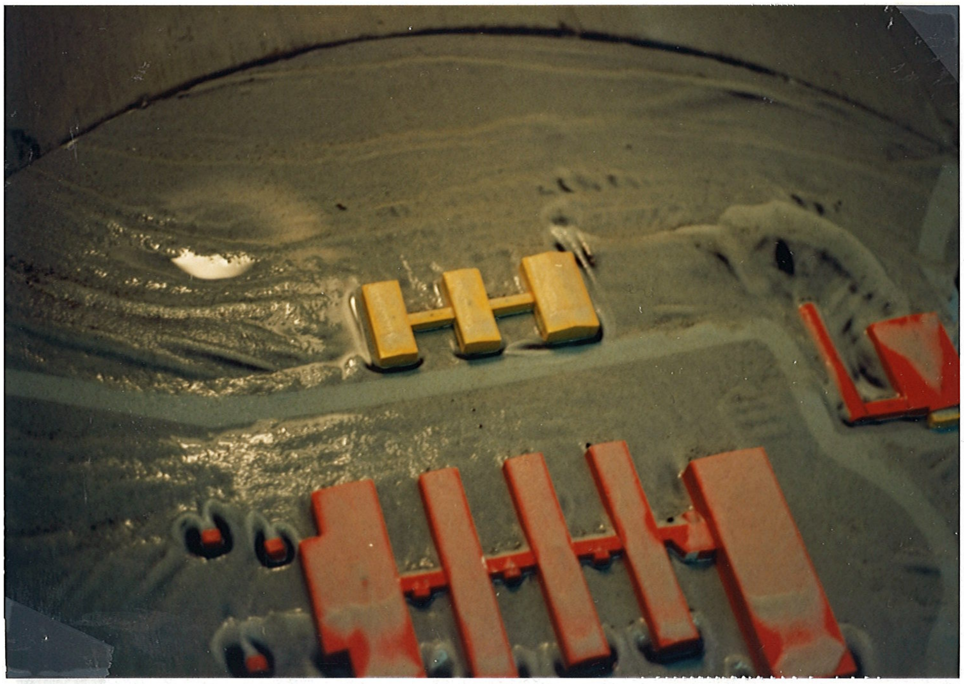
View from the north. Drifting is starting to occur on the northeast side of the linkways between the technical buildings (A).

Figure 5-16 Proposal C - Light Drifting from the Southwest



(c)

A small drift has formed between the Senior Staff Mess and the first transient quarters (A).



(d)

View from the southwest. Very little drifting is evident around the Senior Staff Mess and transient quarters.

Figure 5-16 Proposal C - Light Drifting from the Southwest (Continued)

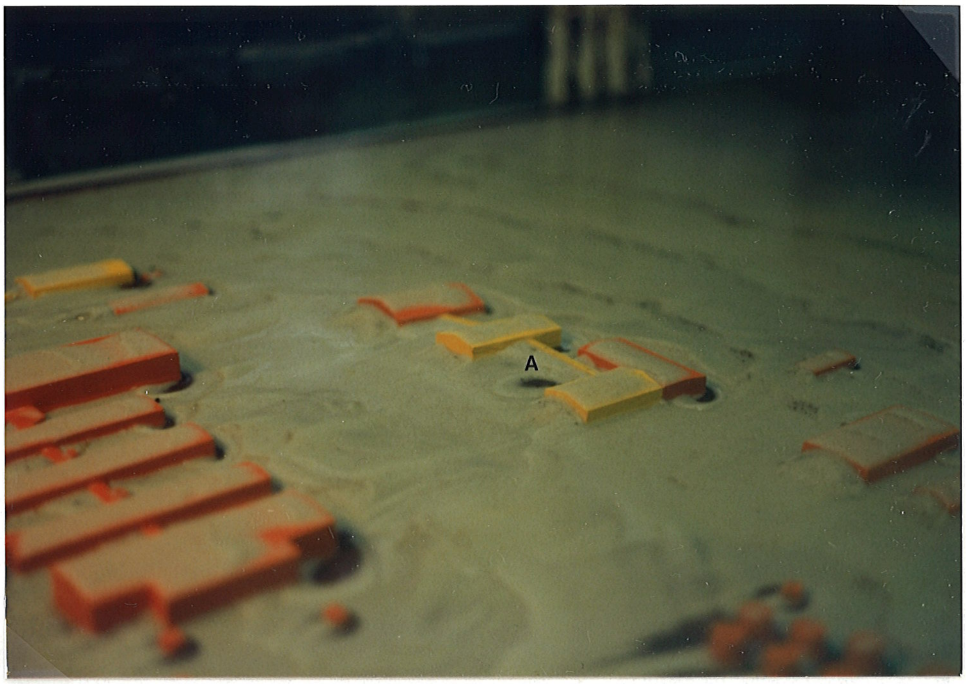
(a)

View from the west. Arrow indicates wind direction.

(b)

Drifting is very light around the Senior Staff Mess and transient quarters.

Figure 5-17 Proposal C - Heavy Drifting from the Southwest



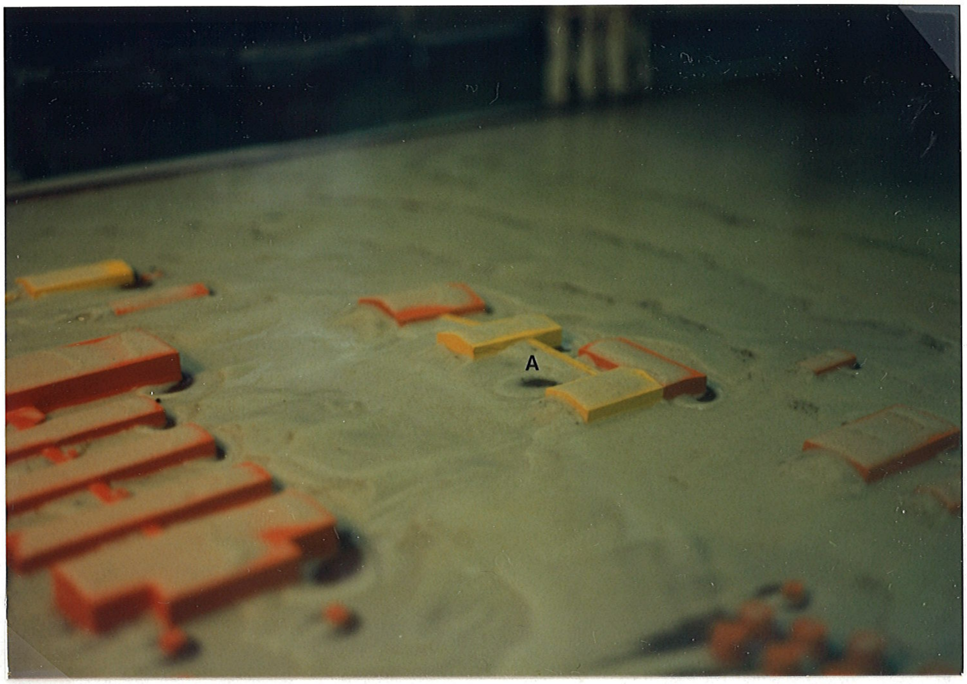
(c)

Drifting is extensive northeast of the linkways joining the technical buildings (A).

(d)

Top view of technical buildings showing drifting northeast of linkways (A).

Figure 5-17 Proposal C - Heavy Drifting from the Southwest (Continued)



(c)

Drifting is extensive northeast of the linkways joining the technical buildings (A).

(d)

Top view of technical buildings showing drifting northeast of linkways (A).

Figure 5-17 Proposal C - Heavy Drifting from the Southwest (Continued)

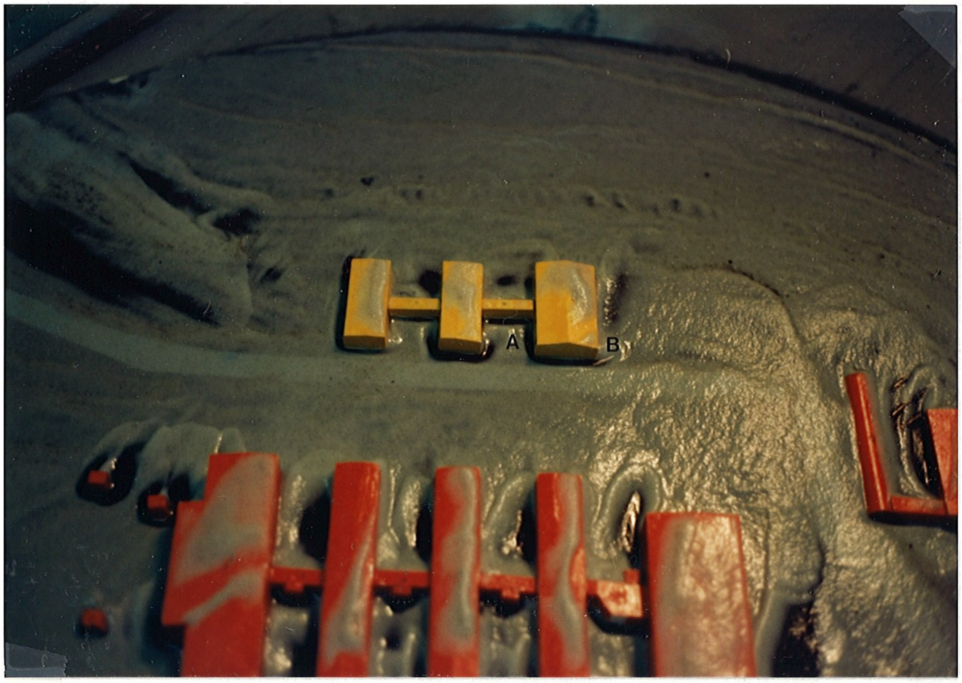
(a)

View from the northeast. Arrow indicates wind direction.

(b)

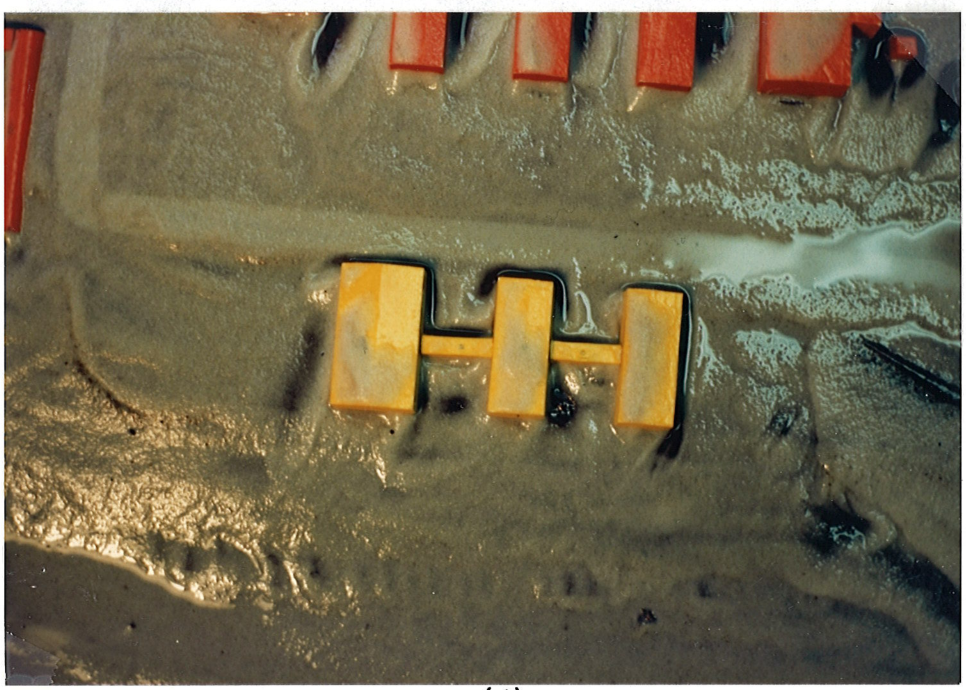
Drifting around the technical buildings is more extensive on the southeast sides (A) than the northwest side.

Figure 5-18 Proposal C - Light Drifting from the West



(c)

View from the southwest. Drifting is occurring between the new buildings (A) and on the southeast side of the Senior Staff Mess (B).



(d)

View from the northeast. Drifting pattern is shown around buildings and linkways.

Figure 5-18 Proposal C - Light Drifting from the West (Continued)

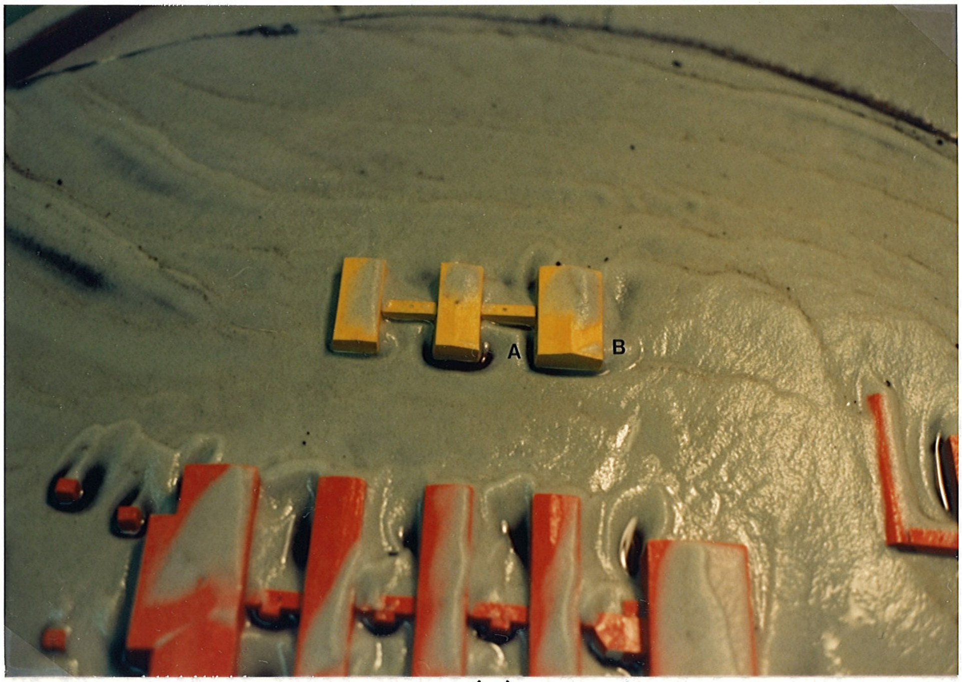
(a)

View from the north. Arrow indicates wind direction.

(b)

Extensive drifting has occurred on the southeast side of the new MSE Building (A) and between the Supply and Firehall Buildings (B).

Figure 5-19 Proposal C - Heavy Drifting from the West



(c)

View from the southwest. Drifting can be seen between the buildings (A) and on the southeast side of the Senior Staff Mess (B).

(d)

View from the north. Drifting on the northeast side of the linkways is extensive (A).

Figure 5-19 Proposal C - Heavy Drifting from the West (Continued)

From the tests it was observed that the Senior Staff Mess and transient quarters have caused a minimal amount of drifting in comparison with the other proposals. The worst drifting for this site layout appears to occur from westerly winds. The technical buildings have extensive drifting on the southeast side, especially with a west wind. The extent of this drifting is further illustrated in Figure 5-20.

5.5 Proposal D

On the basis of these results it was decided to further attempt to improve on Proposal C by:

a. rearranging the Senior Staff Mess and transient quarters so that the Senior Staff Mess was at the northwest end of the row;

b. move the linkways between the transient quarters and Senior Staff Mess so that they connect at the southwest ends of the buildings; and

c. install a skywalk connecting the middle building (transient quarters) to Building No. 125.

1 CEU was also interested in the siting of a new thermal power plant southeast of the proposed power plant. The new thermal power plant was, therefore, also added along with a linkway to the proposed power plant. A more detailed description of the new thermal power plant is shown in Figure 5-21. Because the new power plant was constructed on a large berm, it was also necessary to make a road connection to the building. In the model this was done using

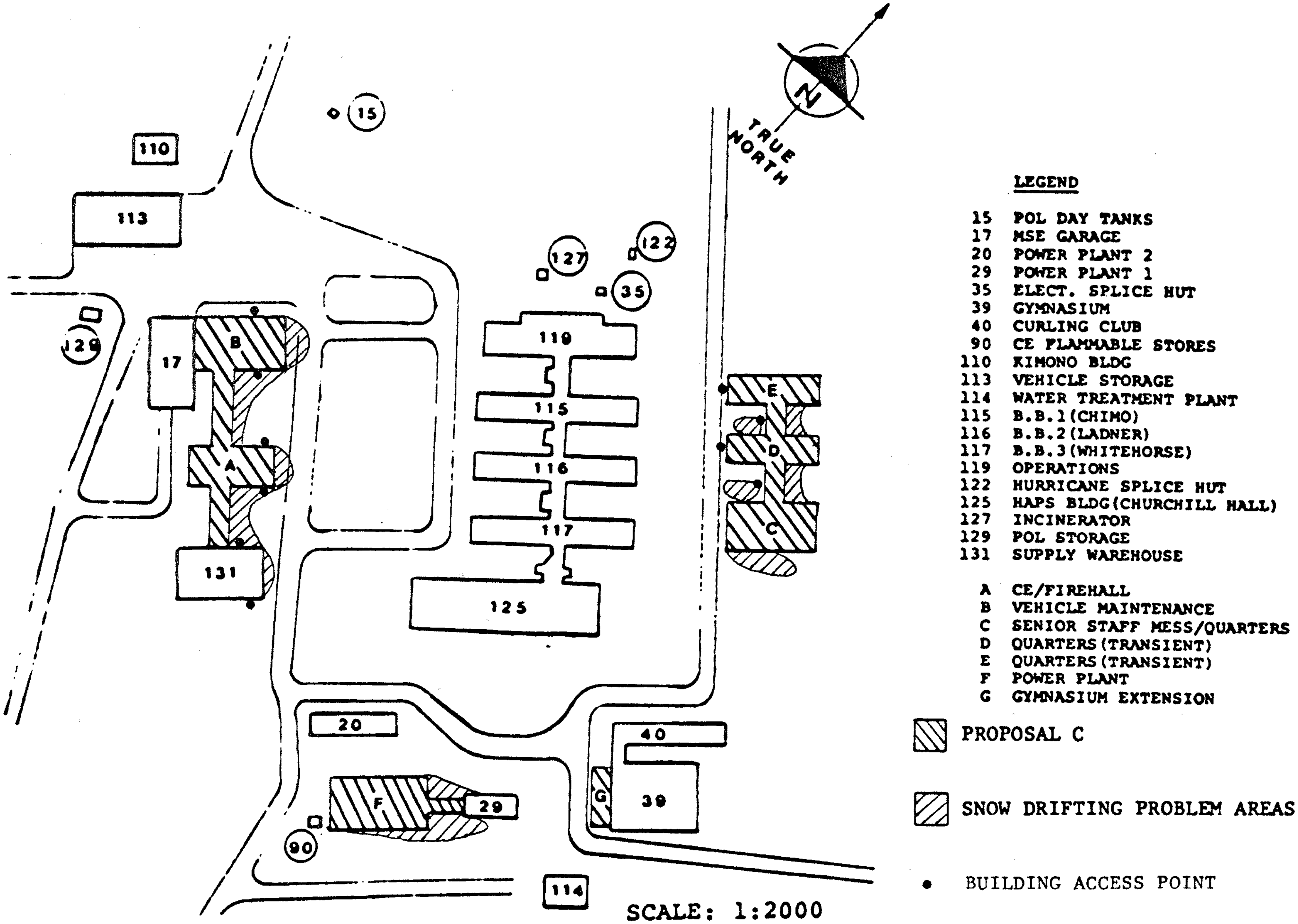
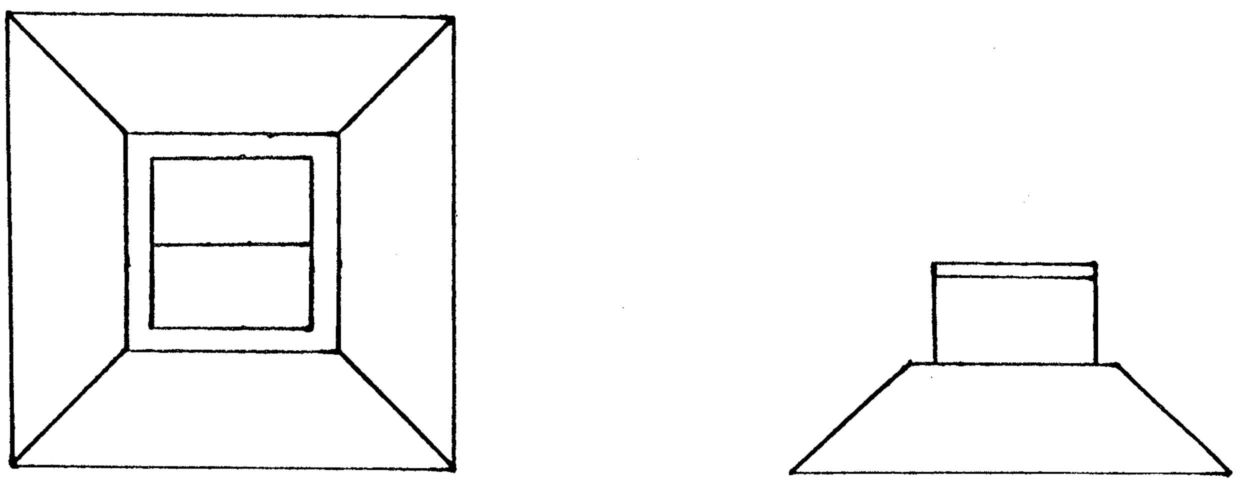


Figure 5-20 CFS Alert - Proposal C Drifting Problem Areas

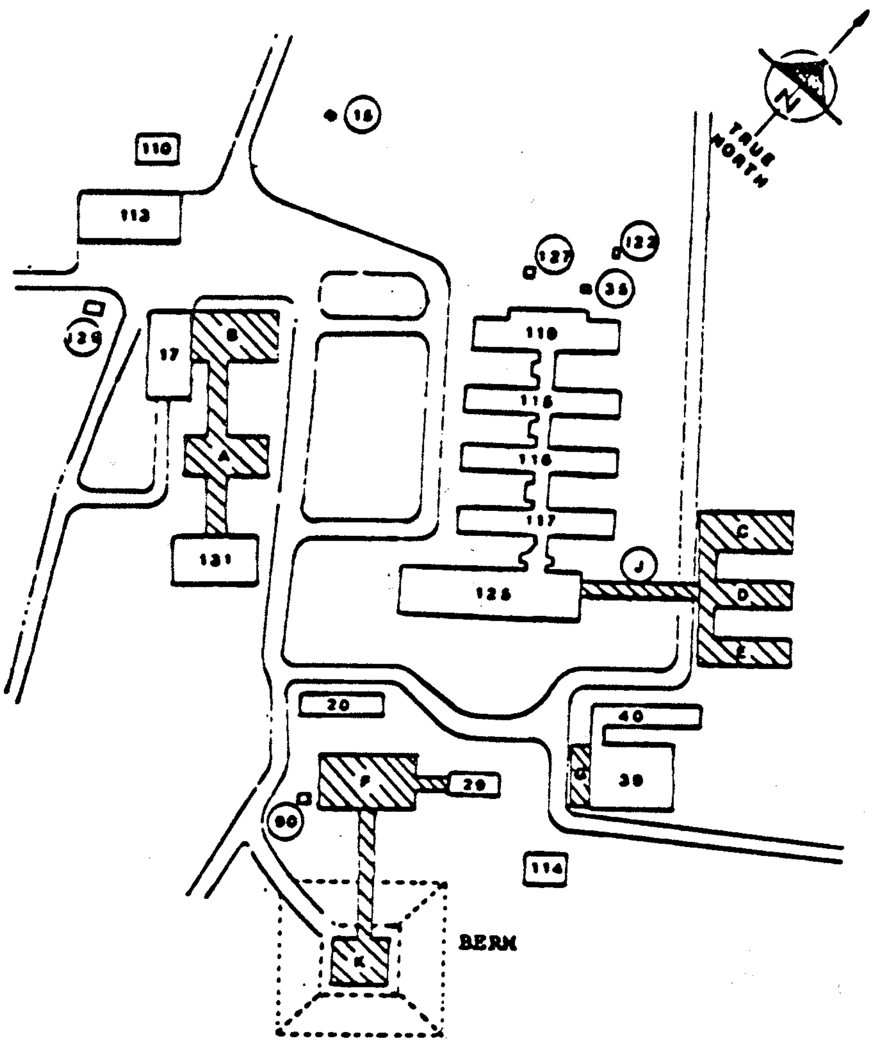


Top View Side View

Scale 1:1000

Figure 5-21 Proposed Thermal Power Plant plasticine and a 10% slope was created. The site layout for Proposal D is shown in Figure 5-22, while the model revised for this proposal is shown in Figure 5-23.

Since the new power plant was on the edge of the model, it was only meaningful to test it from one direction, namely the west. If the model had been tested from the southwest, the new power plant would have been directly against the side of the water flume, thus giving very poor results because of the slower velocity of the water near the sides. However, experience gained with other tests provide a reasonable assumption as to the probable results. Test results for light and heavy drifting from the west are shown in Figures 5-24 and 5-25 respectively.



LEGEND

15 POL DAY TANKS
17 MSE GARAGE
20 POWER PLANT 2
29 POWER PLANT 1
35 ELECT. SPLICE HUT
39 GYMNASIUM
40 CURLING CLUB
90 CE FLAMMABLE STORES
110 KIMONO BLDG
113 VEHICLE STORAGE
114 WATER TREATMENT PLANT
115 B.B.1(CHIMO)
116 B.B.2(LADNER)
117 B.B.3(WHITEHORSE)
119 OPERATIONS
122 HURRICANE SPLICE HUT
125 HAPS BLDG(CHURCHILL HALL)
127 INCINERATOR
129 POL STORAGE
131 SUPPLY WAREHOUSE

A CE/FIREHALL
B VEHICLE MAINTENANCE
C SENIOR STAFF MESS/QUARTERS
D QUARTERS(TRANSIENT)
E QUARTERS(TRANSIENT)
F POWER PLANT
G GYMNASIUM EXTENSION
J SKYWALK
K THERMAL POWER PLANT

PROPOSAL D

Figure 5-22 CFS Alert - Proposal D

Site layout showing new buildings in yellow and existing buildings in orange for Proposal D.

Figure 5-23 Proposal D - Site Layout

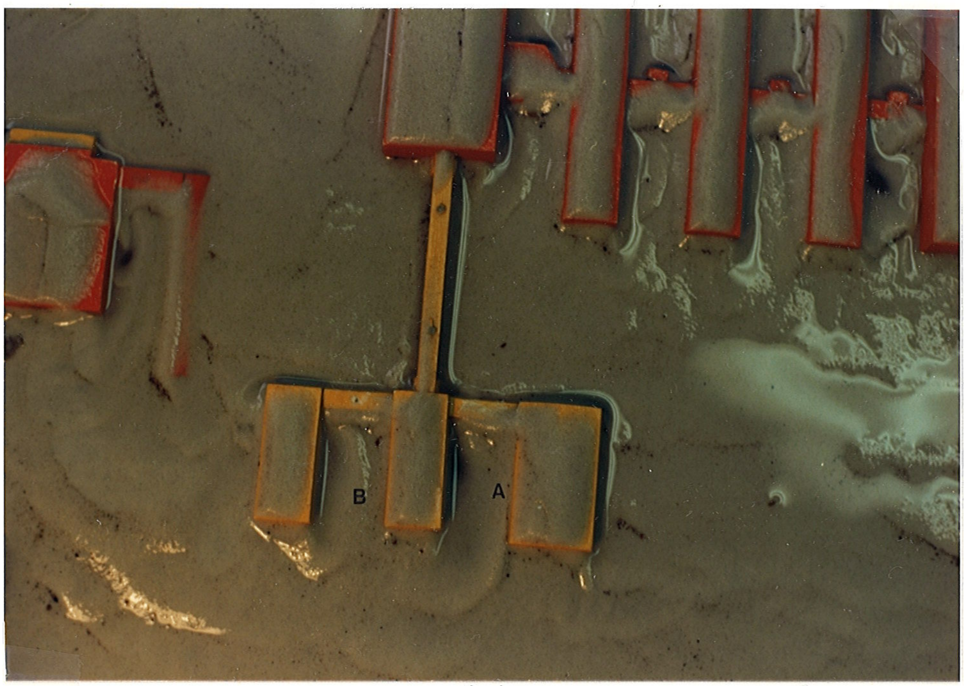
(a)

View from the north. Arrow indicates wind direction.

(b)

View from the south. Drifting is minimal on the southwest side of the Senior Staff Mess and transient quarters (A). The skywalk is also clean of drifting (B).

Figure 5-24 Proposal D - Light Drifting from the West



(a)

A large drift has formed on the southeast side of the Senior Staff Mess (A). Drifting appears to be also extensive between the transient quarters (B).

(b)

Drifting around the new thermal power plant is extensive between the road and the linkway (A) with large drifting southeast of the new power plant (B).

Figure 5-25 Proposal D - Light Drifting from the West

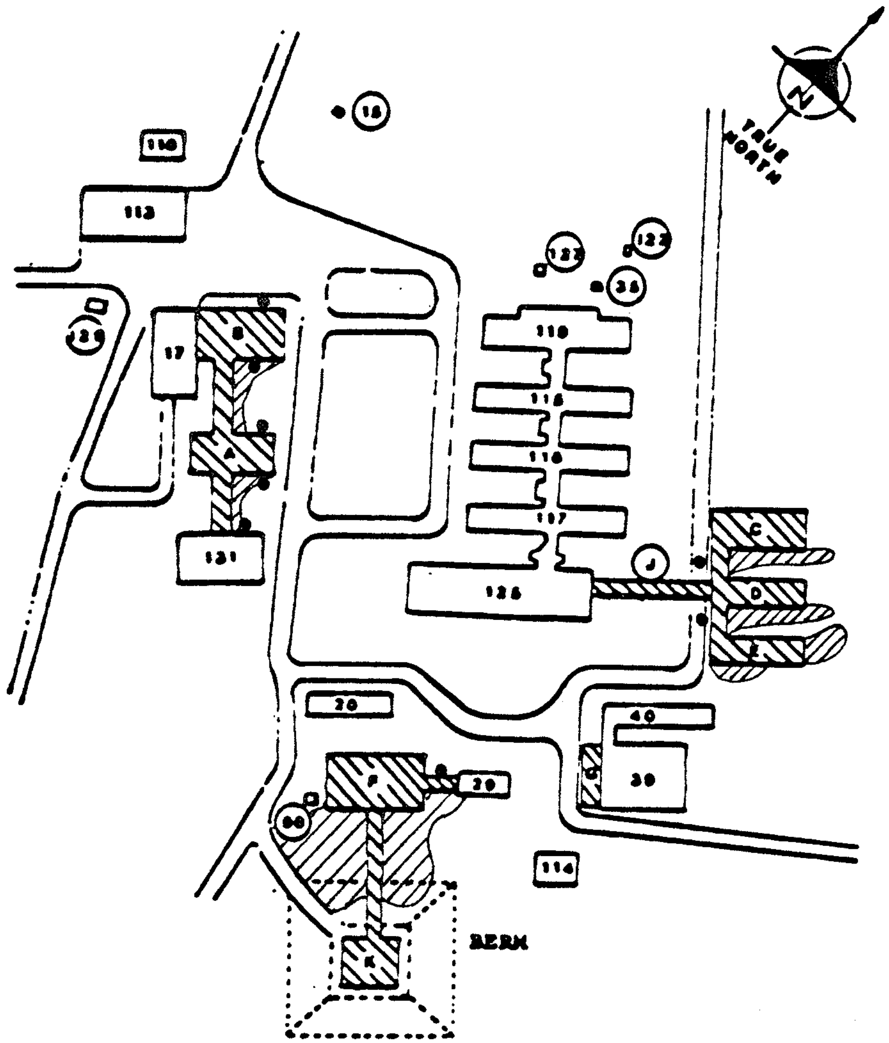
In Proposal D, drifting appears to be more extensive around the Senior Staff Mess and transient quarters than in Proposal C as shown in Figure 5-26. The skywalk, however, appeared to cause very little drifting.

Drifting around the new thermal power plant was extensive between the new road and the linkway. The structure, however, appeared to have little effect on drifting around other nearby buildings.

5.6 Summary of Results

The preceding sections have provided the results of 14 tests in the water flume. These tests were conducted at an almost uniform water velocity and depth in order to obtain comparative results. From these results it was shown that Proposal C appeared to cause the minimum snow drifting problem. Drifting around the Senior Staff Mess and transient quarters was small compared with the other alternatives, while drifting around the technical building, although being extensive, did not appear to be as severe as in Proposal B. Although there was extensive drifting in many areas, it was only considered significant if it occupied a position of a doorway, path or road.

The skywalk which was tested in Proposal D also had satisfactory results and may be another option which can be added to Proposal C. The thermal power plant tested in Proposal D also appeared to cause minimal drifting problems with nearby buildings and could be considered as a reasonable option for the future.



LEGEND

15 POL DAY TANKS
17 MSE GARAGE
20 POWER PLANT 2
29 POWER PLANT 1
35 ELECT. SPLICE HUT
39 GYMNASIUM
40 CURLING CLUB
90 CE FLAMMABLE STORES
110 KIMONO BLDG
113 VEHICLE STORAGE
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115 B.B.1(CHIMO)
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117 B.B.3(WHITEHORSE)
119 OPERATIONS
122 HURRICANE SPLICE HUT
125 HAPS BLDG(CHURCHILL HALL)
127 INCINERATOR
129 POL STORAGE
131 SUPPLY WAREHOUSE

A CE/FIREHALL
B VEHICLE MAINTENANCE
C SENIOR STAFF MESS/QUARTERS
D QUARTERS(TRANSIENT)
E QUARTERS(TRANSIENT)
F POWER PLANT
G GYMNASIUM EXTENSION
J SKYWALK
K THERMAL POWER PLANT

PROPOSAL D

SNOW DRIFTING PROBLEM AREAS

• BUILDING ACCESS POINT

Figure 5-26 CFS Alert - Proposal D Drifting Problem Areas

CHAPTER 6

FINDINGS AND RECOMMENDATIONS

6.1 Introduction

In conducting this study there were many findings, both related to specific buildings and to the site as a whole. This chapter will summarize the significant findings and make recommendations based on these.

6.2 Findings

From both testing in the flume and the site visit, it was found that drifting near buildings which were raised was greatly reduced. The scouring effect of the wind around the raised buildings kept drifts away from the sides of the buildings, thus reducing their magnitude. This was especially evident where it was more open such as near Building No. 119, Operations.

In contrast, buildings built on grade had large drifts forming on the leeward side. Tests in the water flume as well as the site visit showed that the more extensive drifting occurred on the southeast of these buildings..

Another significant finding was the tunnel effect between the barrack blocks and the Operations and HAPS buildings. Drifts which formed between these buildings were larger the closer one was to the linkway joining them. Although this was observed during the site visit, it was amplified in the laboratory when the new transient quarters were connected to the existing barrack blocks. Drifting was much more extensive between the ajoining barrack blocks because the wind was channelled over a longer distance.

The linkway between the proposed technical buildings was found to cause extensive drifting on the northeast side, however, drifting on the side of the technical buildings was reduced the further distance from the linkway.

The skywalk tested in Proposal D had almost no impact on snow drifting. In comparison, the ground level linkway connecting the Senior Staff Mess in Proposals A and B had extensive drifting.

From the testing and site visit, spacing of buildings did not appear to contribute to the drifting. The 50-foot spacing which is presently followed for fire protection, therefore, appears to be adequate.

From the site visit, it was also found that snow clearing, in some cases, contributed to the snow drifting problem. This was especially evident at the southwest end of Building No. 113 where snow is regularly pushed away from the overhead doors and piled as shown in Figure 6-1.

Another finding, during the site visit, was that snow accumulation was heavy on the road from Building Nos. 20 to 53 as shown in Figure 6-2, while areas to the northwest and southeast had very little accumulation.

Figure 6-1 Snow Piled at Southwest End of Building No. 113

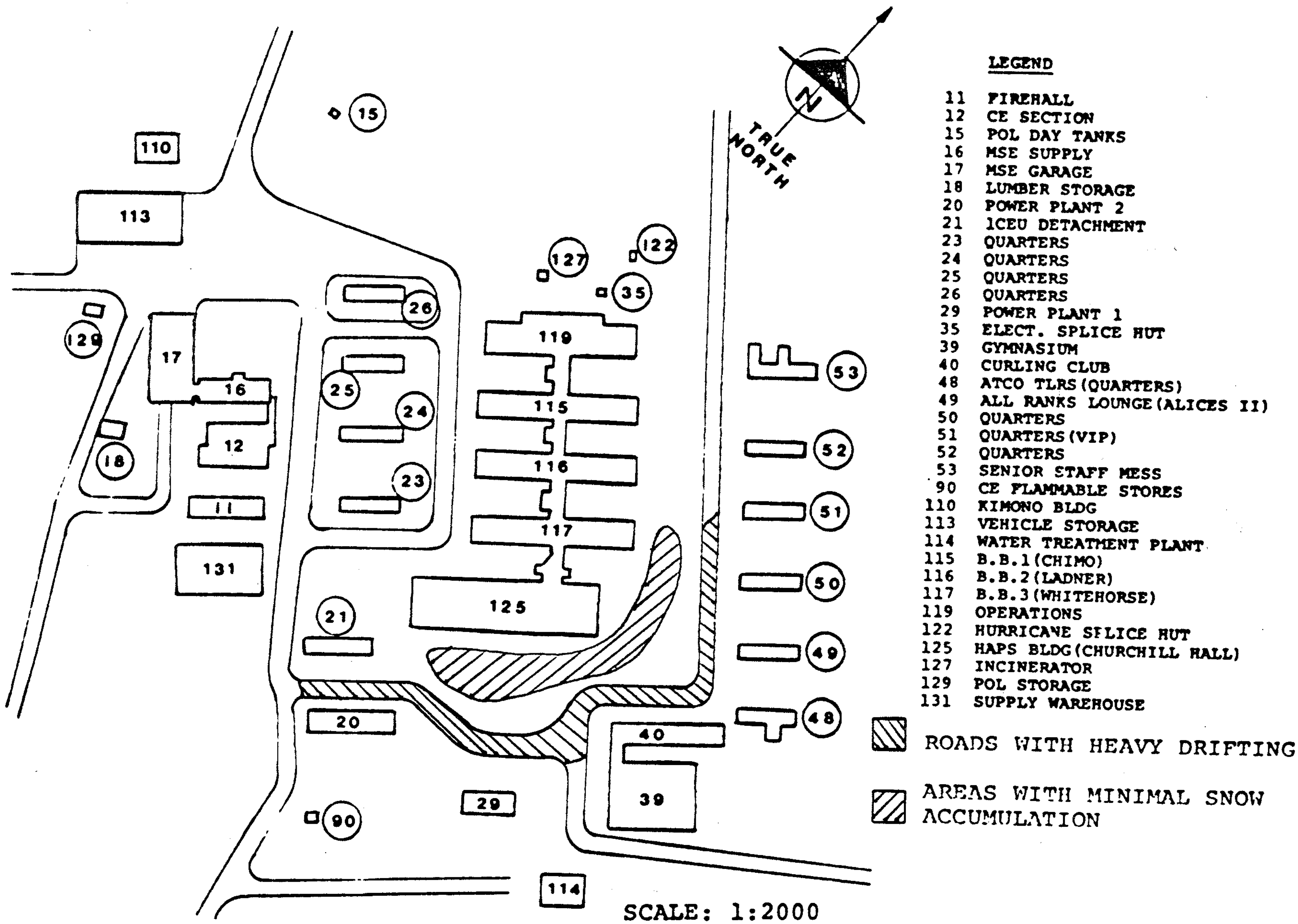

Figure 6-2 CFS Alert - Snow Accumulation on Roads

6.3 Recommendations

On the basis of testing results and the above findings it is recommended that the site plan as shown in Figure 6-3 be followed for future development at CFS Alert. This plan incorporates the satisfactory results from both Proposal C and Proposal D.

In relation to new buildings proposed at CFS Alert it is further recommended that:

a. buildings should be raised approximately 1 metre, where possible, to reduce snow accumulation;

b. no further additions should be made to the ends of the barrack blocks, or the Operations or HAPS buildings because it would increase snow accumulation near the linkways connecting these buildings;

c. access doors to buildings should be located on the northwest side where possible;

d. access doors on the proposed CE/Firehall and MSE Building should be as far away from the linkway as possible; and

e. where possible, all linkways should be above ground a minimum of 1 metre.

Based on the findings related to the existing site, it is also recommended that:

a. snow should not be piled to the west or southwest of roads, parking areas or building access points to minimize drifting;

b. roads should be relocated to minimize the requirements for snow clearing;

c. equipment or material should not be stored outside where they

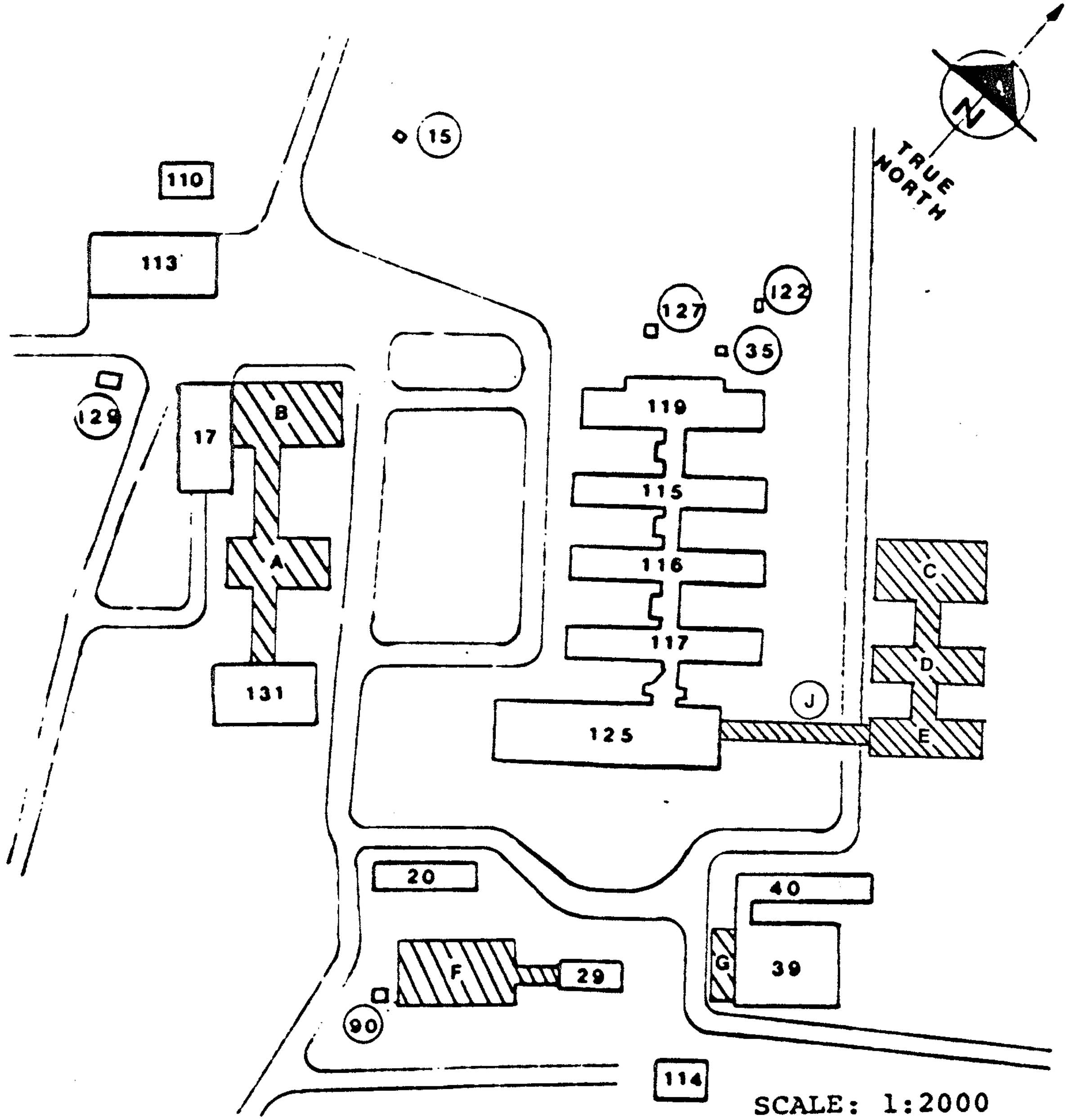

Figure 6-3 Recommended Site Plan

LEGEND

15 POL DAY TANKS
17 MSE GARAGE
20 POWER PLANT 2
29 POWER PLANT 1
35 ELECT. SPLICE HUT
39 GYMNASIUM
40 CURLING CLUB
90 CE FLAMMABLE STORES
110 KIMONO BLDG
113 VEHICLE STORAGE
114 WATER TREATMENT PLANT
115 B.B.1(CHIMO)
116 B.B.2(LADNER)
117 B.B.3(WHITEHORSE)
119 OPERATIONS
122 HURRICANE SPLICE HUT
125 HAPS BLDG(CHURCHILL HALL)
127 INCINERATOR
129 POL STORAGE
131 SUPPLY WAREHOUSE

A CE/FIREHALL
B VEHICLE MAINTENANCE
C SENIOR STAFF MESS/QUARTERS
D QUARTERS(TRANSIENT)
E QUARTERS(TRANSIENT)
F POWER PLANT
G GYMNASIUM EXTENSION
J SKYWALK

RECOMMENDED SITE PLAN

might increase snow drifting; and

d. access points to buildings should be relocated, where possible, to minimize the requirement for snow clearing.

CHAPTER 7

CONCLUSION

7.1 Introduction

The use of a water flume, to simulate drifting patterns for future development at CFS Alert, has been very successful in this study. Less than satisfactory results were obtained, however, from the outdoor model. This chapter will summarize the findings from both the outdoor model and the water flume model as to the actual results. Technical problems encountered while doing the testing are summarized in Annex D. This chapter will conclude with recommendations for further study.

7.2 The Outdoor Model

The outdoor model was unsuccessful in providing useful results on snow drifting patterns at CFS Alert because when the wind was blowing from the proper direction it would cause excessive drifting. As a result many of the buildings were completely buried with snow, making it impossible to identify the drifting patterns.

The main drawback with the outdoor model was that wind direction, velocity and snow precipitation could not be controlled. Achieving results required a considerable measure of luck since the model could only be positioned in one direction.

7.3 The Water Flume Model

The results in the water flume were satisfactory in that it was possible to reproduce the existing drifting patterns at CFS Alert on a model. The four proposals which were examined, therefore, are believed to provide a reliable indication of the expected snow drifting patterns with new buildings at CFS Alert.

7.4 Recommendations

The findings of this study illustrate the value of conducting a snow drift study when new development is proposed in areas susceptible to serious drifting. However, snow drifting is only one of many factors, including function and cost, which must be considered when selecting sites for facilities. It often becomes the case, therefore, when some other criteria governs the site selection, the consideration of snow drifting is left to be dealt with after the facilities have been constructed.

Although it is recommended that a composite with the inclusion of a skywalk be selected as the future site for new facilities at CFS Alert, other restrictions may lead to the selection of an alternative site plan. If this is the case, it is recommended that the site proposal selected be subjected to a study to determine snow drifting areas and changes to building design, such as the addition of wind deflectors, to reduce and control the drifting.

The cleared areas around the fuel storage tanks also indicated that cylindrical buildings have much reduced snow drifting. Further studies should, therefore, be conducted to determine the optimal design and form of buildings to further reduce such effects.

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ANNEX A

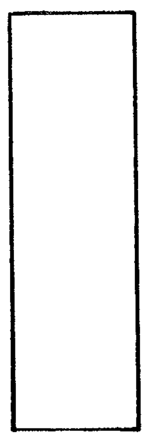
CFS ALERT - SURVEY OF EXISTING BUILDINGS

This annex provides a summary of the existing buildings at the main site of CFS Alert. The information provided was obtained from the 1978 development plan, the March 1985 development plan update and 1 CEU drawings.

The buildings covered in this annex are as follows:

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 11 Use: Firehall



Top View End View

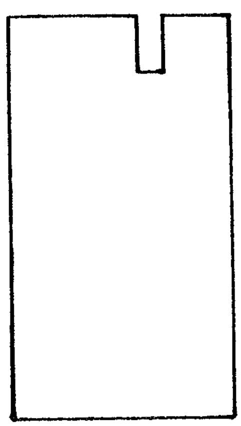
Scale: 1:600

Date Constructed: 1961
Gross Area: 321 m^2
General Condition: Poor
Estimated Life Expectancy: Less than 2 years
Recommendations: Demolition
Reference: 1978 Development Plan

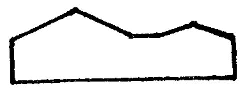
BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 12

Use: CE Section



Top View



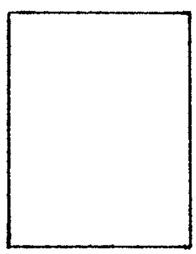
End View

Scale: 1:600

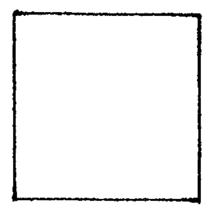
Date Constructed: 1960
Gross Area: 442 m^2
General Condition: Poor
Estimated Life Expectancy: Less than 2 years
Recommendations: Demolition
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 15 Use: Fuel Oil Pumphouse



Top View



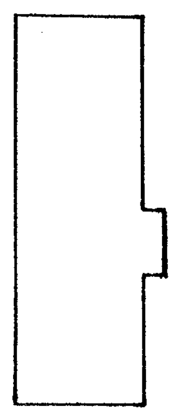
End View

Scale: 1:100

Date Constructed: 1969
Gross Area: 13.4 m^2
General Condition: Good
Estimated Life Expectancy: 10-20 years
Recommendations: Retain for present use
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 16 Use: MSE Supply



Top View

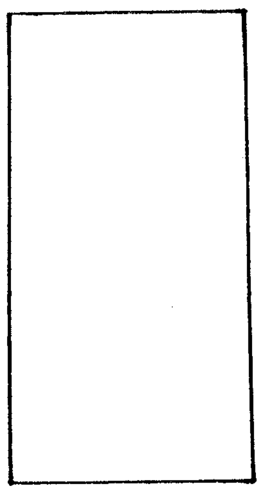
End View

Scale: 1:600

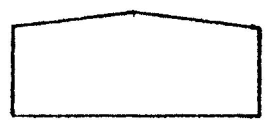
Date Constructed: 1969
Gross Area: 287 m^2
General Condition: Fair (has exposed asbestos insulation)
Estimated Life Expectancy: 10-20 years
Recommendations: Demolition
Reference: March 1985 Development Plan Update

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 17 | Use: MSE Garage



Top View



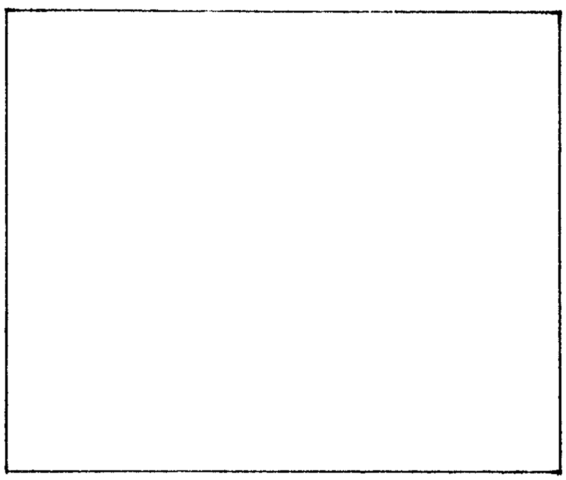
End View

Scale: 1:600

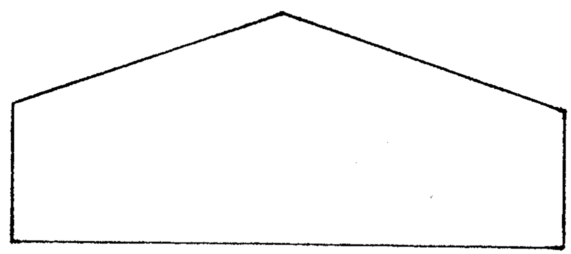
Date Constructed: 1969
Gross Area: 716 m^2
General Condition: Good
Estimated Life Expectancy: Greater than 20 years
Recommendations: Retain for present use
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 18 Use: Lumber Storage



Top View



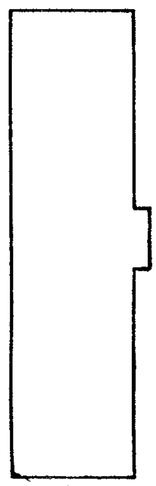
End View

Scale: 1:100

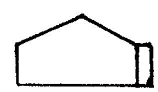
Date Constructed: Unknown
Gross Area: 46.5 m^2
General Condition: Poor
Estimated Life Expectancy: Less than 2 years
Recommendations: Demolition
Reference: March 1985 Development Plan Update

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 20 Use: Power Plant



Top View



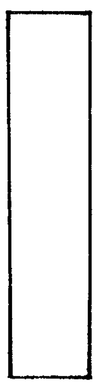
End View

Scale: 1:600

Date Constructed: 1965
Gross Area: 357 m^2
General Condition: Good
Estimated Life Expectancy: Greater than 20 years
Recommendations: Retain for present use
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 21 | Use: 1 CEU Detachment



Top View

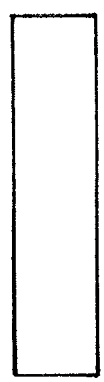
End View

Scale: 1:600

Date Constructed: 1960
Gross Area: 150 m^2
General Condition: Poor
Estimated Life Expectancy: Less than 5 years
Recommendations: Demolition
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 23 Use: Quarters



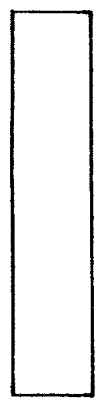
Top View End View

Scale: 1:600

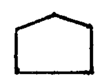
Date Constructed: 1959
Gross Area: 156 m^2
General Condition: Poor
Estimated Life Expectancy: Less than 5 years
Recommendations: Demolition
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 24 Use: Quarters



Top View



End View

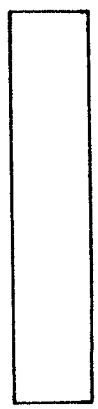
Scale: 1:600

Date Constructed: 1959
Gross Area: 156 m^2
General Condition: Poor
Estimated Life Expectancy: Less than 5 years
Recommendations: Demolition
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 25

Use: Quarters



Top View

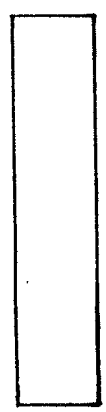
End View

Scale: 1:600

Date Constructed: 1959
Gross Area: 195 m^2
General Condition: Poor
Estimated Life Expectancy: Less than 5 years
Recommendations: Demolition
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 26 Use: Quarters



Top View

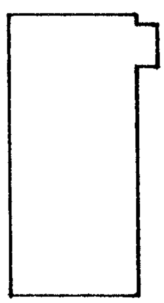
End View

Scale: 1:600

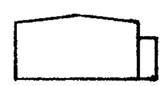
Date Constructed: 1959
Gross Area: 195 m^2
General Condition: Poor
Estimated Life Expectancy: Less than 5 years
Recommendations: Demolition
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 29 Use: Power Plant



Top View



End View

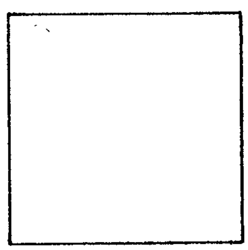
Scale: 1:600

Date Constructed: 1966
Gross Area: 219 m^2
General Condition: Good
Estimated Life Expectancy: Greater than 20 years
Recommendations: Retain for present use
Reference: 1978 Development Plan

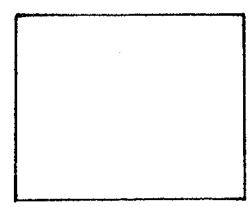
BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 35

Use: Electrical Splice Hut



Top View



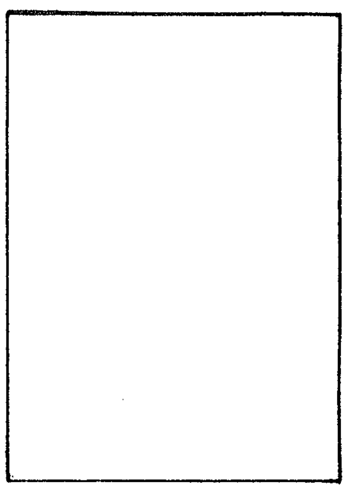
End View

Scale: 1:100

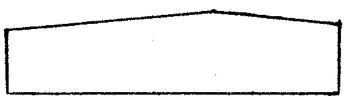
Date Constructed: Unknown
Gross Area: 9.0 m^2
General Condition: Good
Estimated Life Expectancy: Greater than 20 years
Recommendations: Retain for present use
Reference: March 1985 Development Plan Update

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 39 Use: Gymnasium



Top View



End View

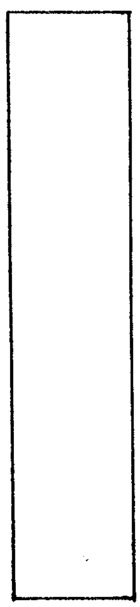
Scale: 1:600

Date Constructed: 1967
Gross Area: 1,172 m^2
General Condition: Good
Estimated Life Expectancy: Greater than 20 years
Recommendations: Retain for present use
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 40

Use: Curling Club



Top View

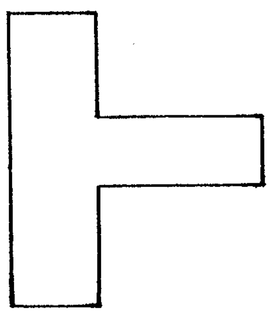
End View

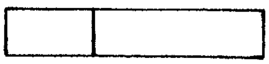
Scale: 1:600

Date Constructed: 1962
Gross Area: 464 m^2
General Condition: Good
Estimated Life Expectancy: Greater than 10 years
Recommendations: Retain for present use
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 48 Use: Quarters





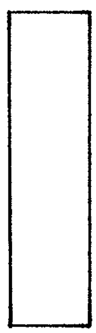
Top View End View

Scale: 1:600

Date Constructed: 1961
Gross Area: 295 m^2
General Condition: Poor
Estimated Life Expectancy: Less than 5 years
Recommendations: Demolition
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 49 Use: All Ranks Lounge



Top View

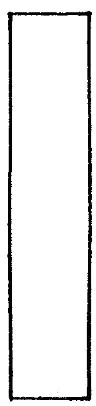
End View

Scale: 1:600

Date Constructed: 1967
Gross Area: 163 m^2
General Condition: Poor
Estimated Life Expectancy: Less than 5 years
Recommendations: Demolition
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 50 Use: Quarters



Top View

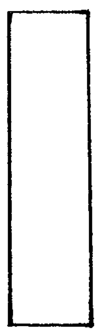
End View

Scale: 1:600

Date Constructed: 1967
Gross Area: 194 m^2
General Condition: Poor
Estimated Life Expectancy: Less than 5 years
Recommendations: Demolition
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 51 Use: Quarters (VIP)



Top View

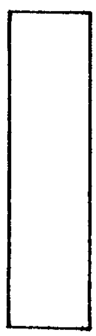
End View

Scale: 1:600

Date Constructed: 1964
Gross Area: 156 m^2
General Condition: Poor
Estimated Life Expectancy: Less than 5 years
Recommendations: Demolition
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 52 Use: Quarters



Top View

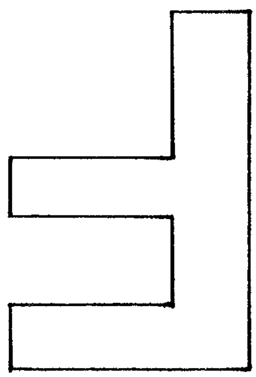
End View

Scale: 1:600

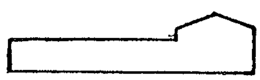
Date Constructed: 1967
Gross Area: 156 m^2
General Condition: Poor
Estimated Life Expectancy: Less than 5 years
Recommendations: Demolition
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 53 Use: Senior Staff Mess/Quarters



Top View



End View

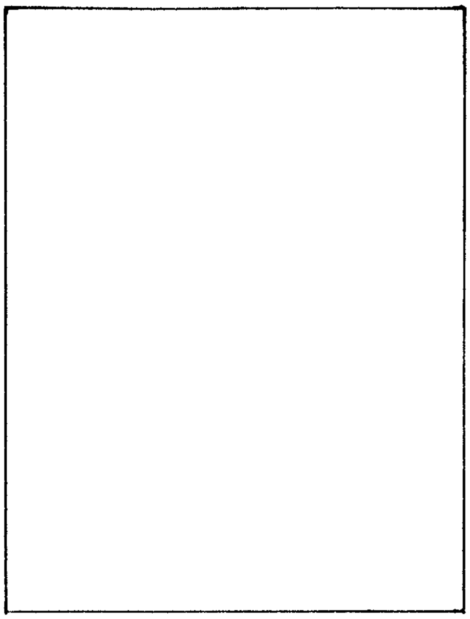
Scale: 1:600

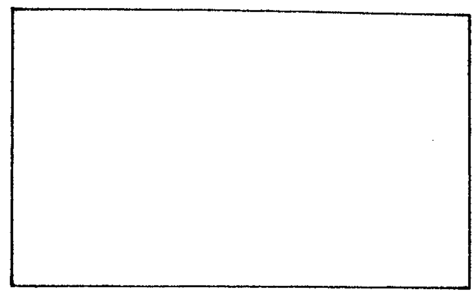
Date Constructed: 1967
Gross Area: 399 m^2
General Condition: Poor
Estimated Life Expectancy: Less than 5 years
Recommendations: Demolition
Reference: March 1985 Development Plan Update

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 90

Use: CE Flammable Stores





Top View

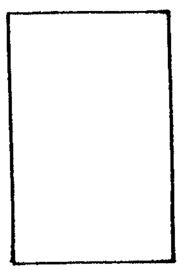
End View

Scale: 1:100

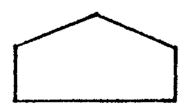
Date Constructed: 1969
Gross Area: 46.8 m^2
General Condition: Good
Estimated Life Expectancy: Greater than 20 years
Recommendations: Retain for present use
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 110 Use: Storage



Top View



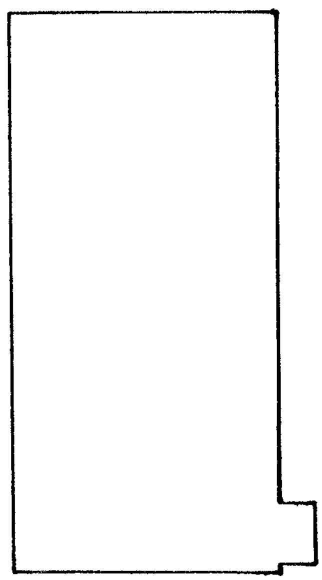
End View

Scale: 1:600

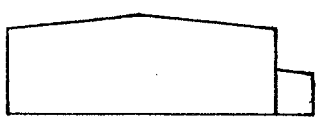
Date Constructed: 1973
Gross Area: 234 m^2
General Condition: Fair
Estimated Life Expectancy: Greater than 10 years
Recommendations: Retain for present use
Reference: March 1985 Development Plan Update

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 113 Use: Vehicle Storage



Top View



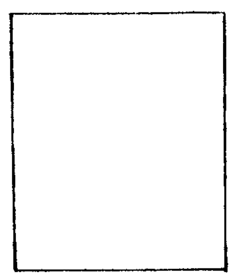
End View

Scale: 1:600

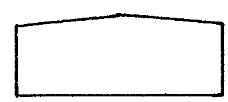
Date Constructed: 1977
Gross Area: 923 m^2
General Condition: Good
Estimated Life Expectancy: Greater than 20 years
Recommendations: Retain for present use
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 114 Use: Water Treatment Plant



Top View



End View

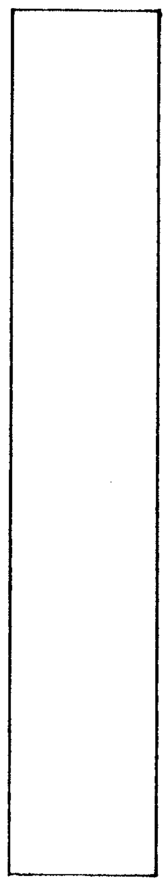
Scale: 1:600

Date Constructed: 1979
Gross Area: 379 m^2
General Condition: Good
Estimated Life Expectancy: Greater than 20 years
Recommendations: Retain for present use
Reference: March 1985 Development Plan Update

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 115

Use: Barrack Block



Top View

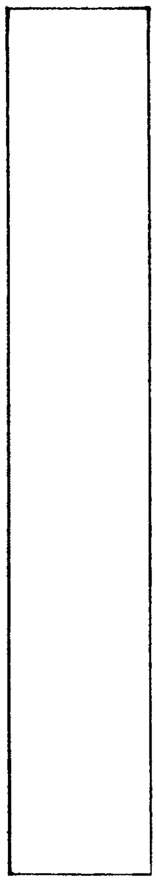
End View

Scale: 1:600

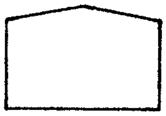
Date Constructed: 1975
Gross Area: 1,627 m^2
General Condition: Good
Estimated Life Expectancy: Greater than 20 years
Recommendations: Retain for present use
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 116 Use: Barrack Block



Top View



End View

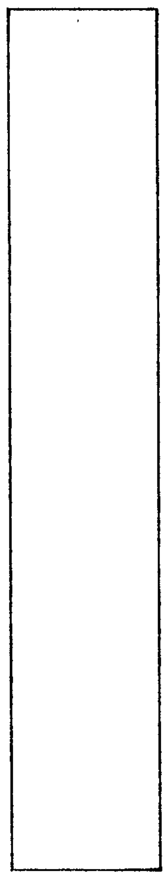
Scale: 1:600

Date Constructed: 1976
Gross Area: 1,499 m^2
General Condition: Good
Estimated Life Expectancy: Greater than 20 years
Recommendations: Retain for present use
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 117

Use: Barrack Block



Top View

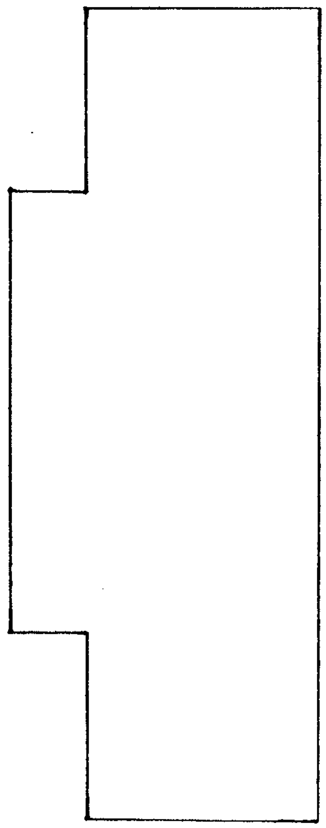
End View

Scale: 1:600

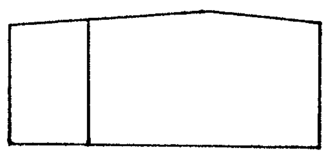
Date Constructed: 1979
Gross Area: 1,499 m^2
General Condition: Good
Estimated Life Expectancy: Greater than 20 years
Recommendations: Retain for present use
Reference: 1978 Development Plan

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 119 Use: Operations



Top View



End View

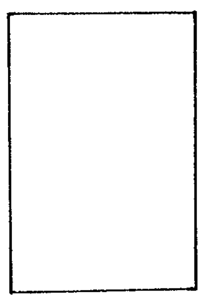
Scale: 1:600

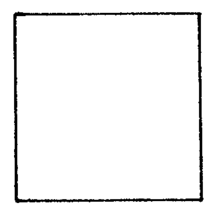
Date Constructed: 1980
Gross Area: 2,793 m^2
General Condition: Good
Estimated Life Expectancy: Greater than 20 years
Recommendations: Retain for present use
Reference: March 1985 Development Plan Update

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 122

Use: Hurricane Splice Hut





Top View

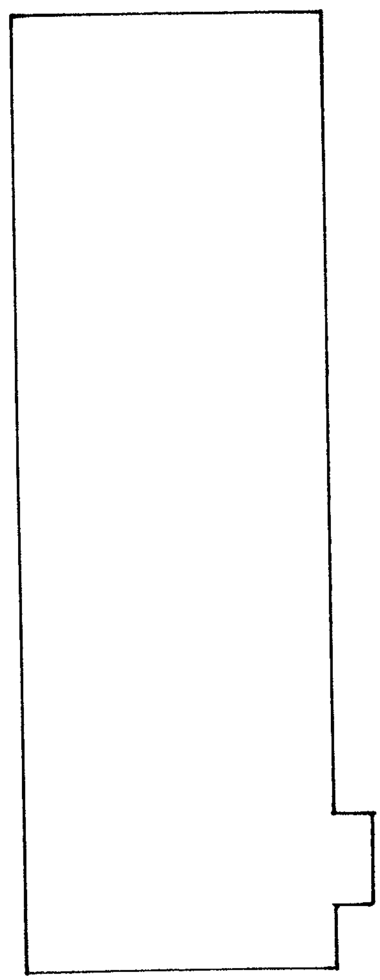
End View

Scale: 1:100

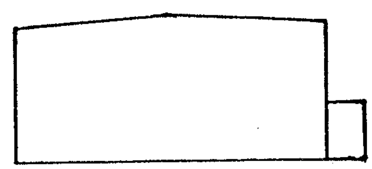
Date Constructed: 1981
Gross Area: 9.3 m^2
General Condition: Good
Estimated Life Expectancy: Greater than 20 years
Recommendations: Retain for present use
Reference: March 1985 Development Plan Update

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 125 Use: Multi-Purpose Bldg (HAPS)



Top View



End View

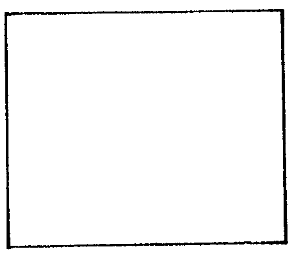
Scale: 1:600

Date Constructed: 1984
Gross Area: 3,626 m^2
General Condition: Good
Estimated Life Expectancy: Greater than 20 years
Recommendations: Retain for present use
Reference: March 1985 Development Plan Update

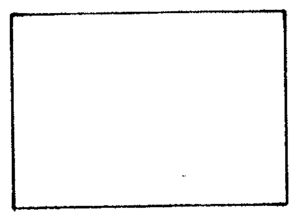
BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 127

Use: Incincerator



Top View



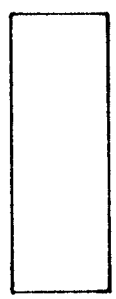
End View

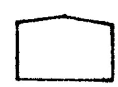
Scale: 1:100

Date Constructed: 1982
Gross Area: 13 m^2
General Condition: Good
Estimated Life Expectancy: Greater than 20 years
Recommendations: Retain for present use
Reference: March 1985 Development Plan Update

BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 129 Use: POL Storage





Top View End View

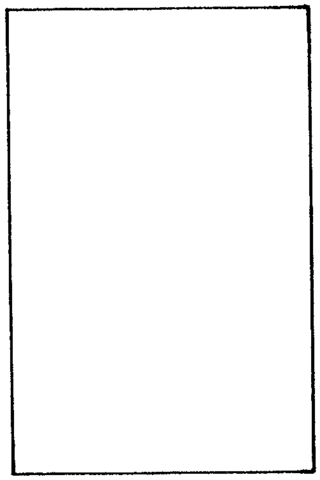
Scale: 1:600

Date Constructed: 1985 (Rebuilt)
Gross Area: 161 m^2
General Condition: Good
Estimated Life Expectancy: Greater than 20 years
Recommendations: Retain for present use
Reference: March 1985 Development Plan Update

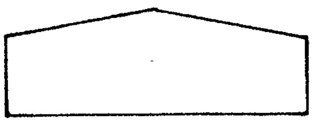
BUILDING SURVEY - PRESENT BUILDINGS

Building No.: 131

Use: Supply Warehouse



Top View



End View

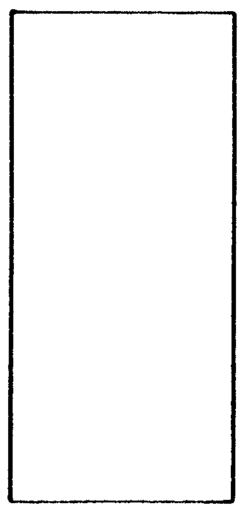
Scale: 1:600

Date Constructed: 1985
Gross Area: 905 m^2
General Condition: Good
Estimated Life Expectancy: Greater than 20 years
Recommendations: Retain for present use
Reference: March 1985 Development Plan Update

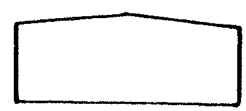
ANNEX B

BUILDING SURVEY OF PROPOSED BUILDINGS

This annex provides a summary of the buildings presently proposed for construction at CFS Alert. The buildings are listed as follows:



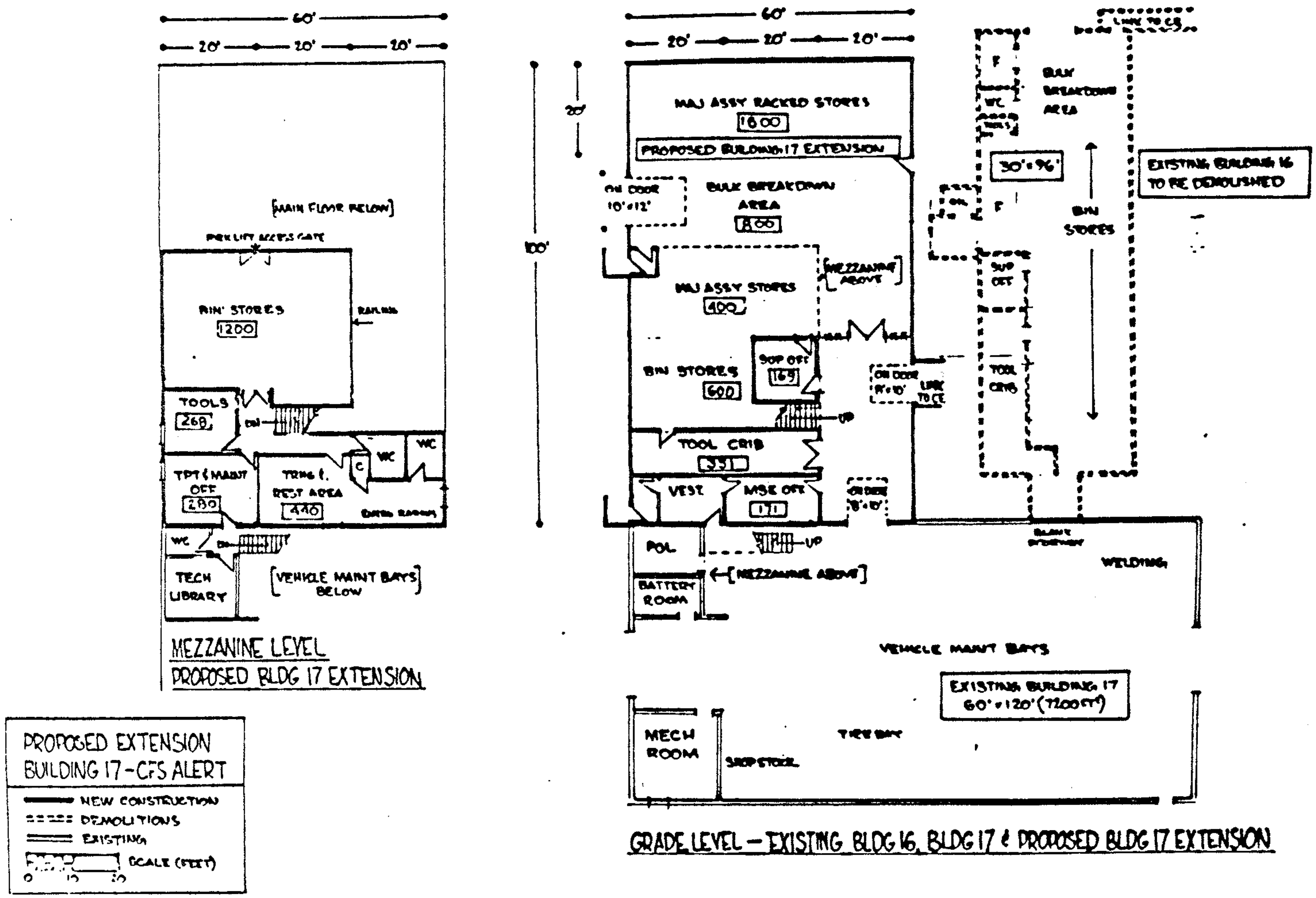
Top View



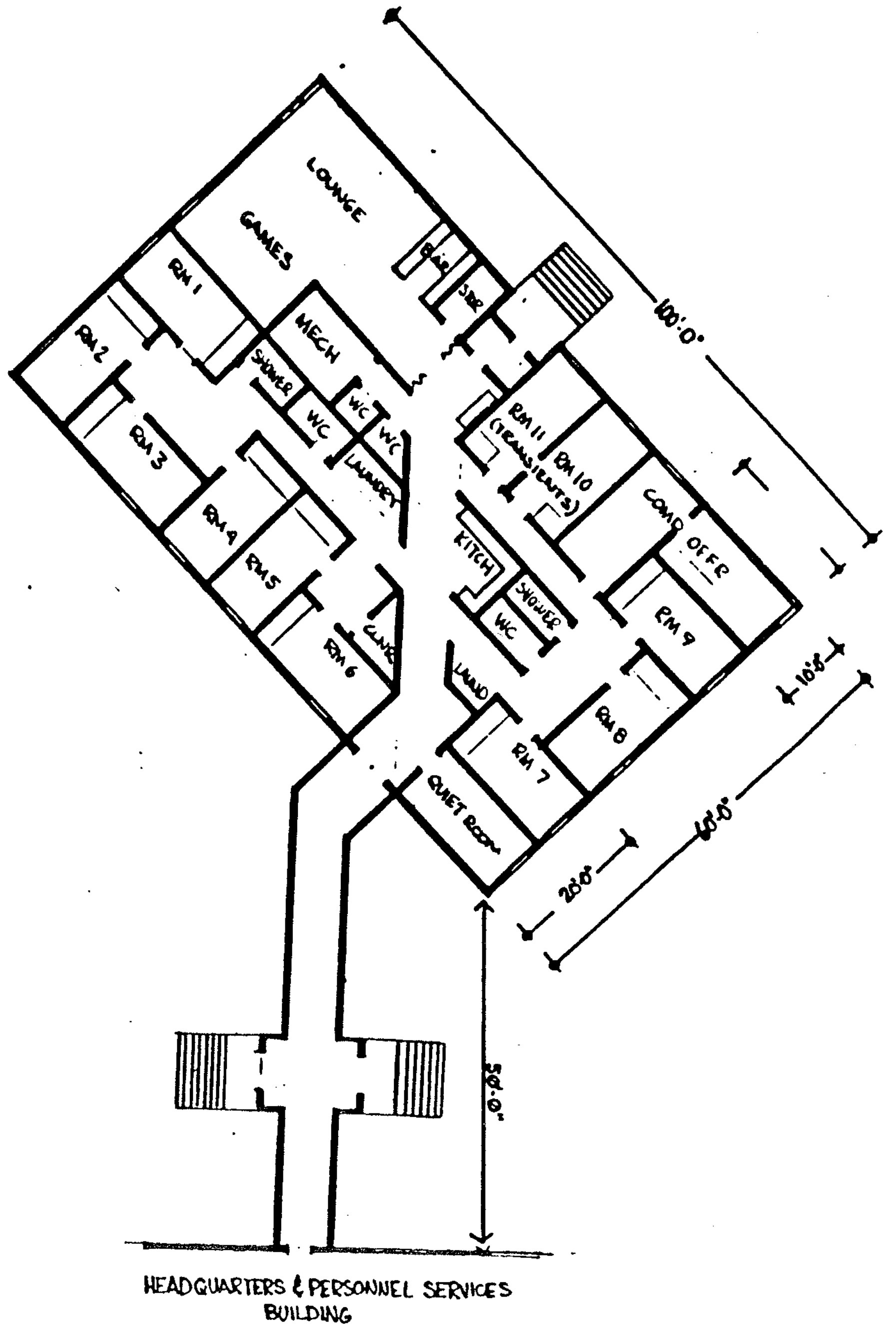
End View

Scale 1:600

Reference: 1 CFU Drawings

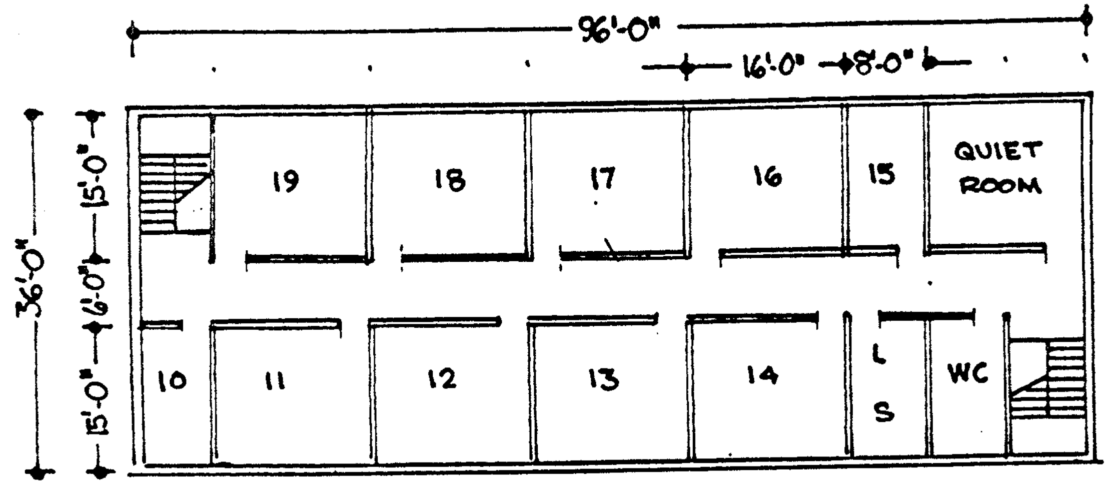


Reference: Military Letter 7625-0208 (SSO CE) dated 29 March 1985

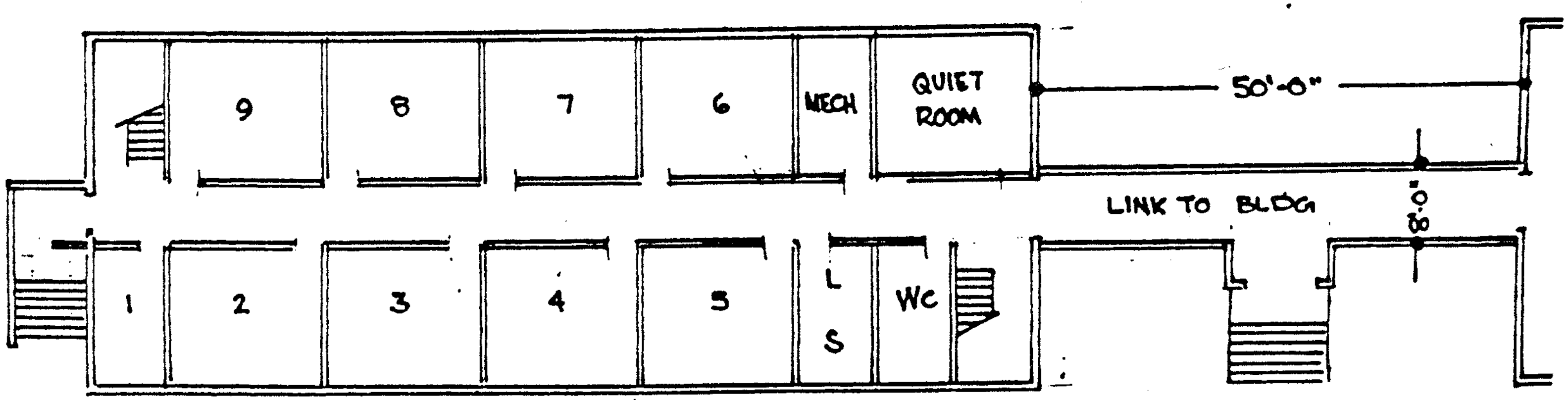


Reference: Authorization for Project 68603

Senior Staff Mess/Quarters



SECOND FLOOR

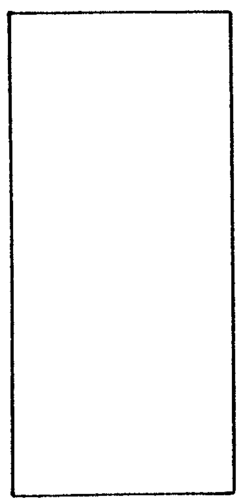


FIRST FLOOR

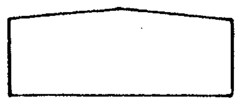
Reference: Authorization for Project 68701

CONCEPT PROPOSAL
TRANSIENT QUARTERS
CFS ALERT

0 8 16 SCALE [FEET]



Top View

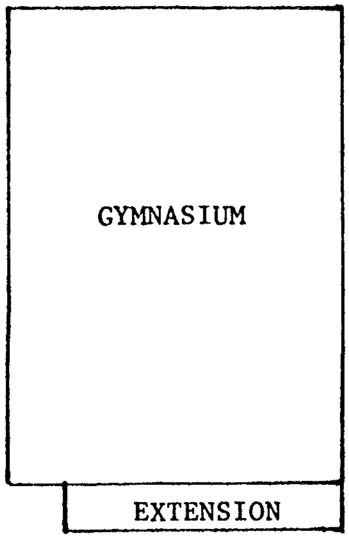


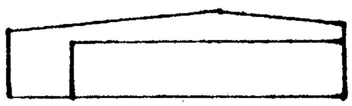
End View

Scale 1:600

Reference: 1 CEU Drawings

Power Plant





Top View

End View

Scale 1:600

Reference: 1978 Development Plan (Estimated)

Gymnasium Extension

ANNEX C

BLOWING SNOW SUMMARY

ALERT, N.W.T.

JANUARY 1983-FEBRUARY 1986

Blowing Snow Summary January 1983 - February 1986

ALERT N.W.T.

Notes

1. Data is presented in the following format.

Date - DD/MM Day/Month

Accumulated Snow - centimetres and tenths of snowfall since last period of blowing snow. tr = trace = less than 0.2 centimetres of accumulated snowfall.
In some special cases only recent snowfall amounts were used (eg. first period of blowing snow after summer, after a period of melting.)

Wind Direction/Speed - direction is degrees true north. Speed is in knots the greatest wind speed recoreded for the day in question.

Mean Wind Speed - Mean wind speed is defined as a period of two minutes or more where the wind meets or exceeds the threshold values of 28 knots and 34 knots used as benchmark values.(denoted by "x")

Blowing Snow - A period of blowing snow is defined as a period where prevailing visibility is reduced at eye level to six miles or less due to the effect of snow being blown up by the wind.

All data has been extracted from official weather records as observed at Alert Weather Station for the time period specified above.

Data compiled by,

Ted Gresiuk

Ted Gresiuk
Atmospheric Environment Service
Alert Weather Station N.W.T.

DATE	ACCUMULATED SNOW	WIND DIRECTION/SPEED	MEAN WIND SPEED 28 kts.	34 kts.
1983				
01/01	0.6	mmm/25	x	
02/01	1.4	320/23	x	
03/01	1.4	350/35	x	
17/01	0.6	230/37		x
18/01	0.0	220/46		x
19/01	0.0	210/50		x
23/01	2.0	330/46		x
08/02	5.1	230/62		x
09/02	0.0	230/73		x
10/02	tr	250/32		x
11/02	0.4	230/50		x
17/02	0.6	220/34		x
18/02	0.0	220/52		x
19/02	0.0	230/50		x
21/02	tr	220/36		x
22/02	tr	220/36		x
26/02	0.2	220/29	x	
27/02	tr	330/27		
28/02	0.6	330/27		
01/03	0.0	210/39		x
03/03	8.0	210/53		x
04/03	0.0	210/58		x
05/03	0.0	210/59		x
18/03	4.2	330/31	x	
19/03	1.8	330/31	x	
26/03	1.0	210/51		x

DATE	ACCUMULATED SNOW	WIND DIRECTION/SPEED	MEAN WIND SPEED 28 kts.	34 kts.
27/03	0.0	190/33	x	
28/03	0.0	220/39		x
29/03	0.0	230/45		x
30/03	0.0	240/45		x
09/04	4.6	230/43		x
10/04	0.0	210/35		x
11/04	0.0	220/37		x
13/04	0.0	240/47		x
19/05	2.0	210/45		x
04/06	10.2	320/23		
05/06	0.2	320/26		
09/10	5.1	230/23		
21/10	6.8	210/43		x
23/10	0.6	230/33		
15/11	4.6	200/50		x
21/11	2.4	240/33	x	
29/11	3.4	360/22		
30/11	tr	330/35	x	
01/12	tr	320/29		
02/12	tr	210/32	x	
20/12	4.0	220/51		x
21/12	1.4	240/61		x
22/12	tr	220/32	x	
23/12	tr	230/37	x	
31/12	2.7	200/47		x

DATE	ACCUMULATED SNOW	WIND DIRECTION/SPEED	MEAN WIND SPEED 28 kts.	34 kts.
1984				
23/01	9.4	220/41		x
24/01	tr	230/44		x
18/03	8.5	220/45		x
19/03	0.0	220/51		x
23/03	tr	210/52		x
05/09	15.6	320/28		
15/09	15.0	330/31		
08/10	7.2	220/53		x
09/10	0.0	210/55		x
12/10	0.4	230/44		x
13/10	0.0	220/60		x
14/10	6.8	240/42		x
16/10	7.2	240/53		x
17/10	5.0	310/36		x
21/10	12.2	330/29		
04/11	2.6	210/40		x
05/11	0.0	230/54		x
15/12	5.4	360/30		
16/12	2.4	200/43		x
17/12	0.2	220/40	x	
28/12	6.6	340/22		
30/12	tr	200/41		x
1985				
02/01	tr	200/79		x
07/01	tr	240/60		x

4

DATE	ACCUMULATED SNOW	WIND DIRECTION/SPEED	MEAN WIND SPEED 28 kts.	34 kts.
17/02	3.0	210/60		x
22/04	2.2	240/32	x	
19/08	1.8	320/35		x
20/08	tr	330/37		x
04/11	1.4	350/19		
05/11	3.6	350/24		
10/11	2.2	340/22		
11/11	0.4	350/26		
16/11	0.6	350/26		
26/11	2.8	240/43		x
28/11	6.0	340/36	x	
29/11	0.4	330/36	x	
01/12	tr	200/43		x
04/12	0.0	230/40		x
17/12	4.2	340/18		
25/12	0.2	210/30		
1986				
17/01	3.0	340/21		
01/02	1.8	320/29		
04/02	0.4	240/44		x
11/02	3.4	340/19		
12/02	0.2	350/23		
13/02	0.4	350/22		
19/02	0.4	200/54		x
22/02	1.6	190/51		x
23/02	tr	200/62		x
28/02	0.4	240/36	X	

ANNEX D

TECHNICAL PROBLEMS RELATED TO MODEL TEST

This Annex will summarize some of the problem areas related to both the outdoor model and the water flume model.

The main problem with the outdoor model appeared to be its size. The construction of a larger scaled model may have provided better results, however, one still had to rely on chance to get the correct wind a precipitation. The increased time and money required to construct a larger model also weighed against it.

A modification to the outdoor model, which would increase the possibility of viable results, would be to put it on a rotating base. Then, when weather forecasts are made, the model could be rotated to the expected wind direction. Depending on the actual size of the outside model, however, this may not be a feasible alternative.

Another proposal for the outdoor model would be to locate it at the actual site. This would ensure correct meteorological conditions for testing.

Although extensive testing was done in the water flume, it was not without its problems. One of the main problems was water scouring the drifting pattern as it was being drained off the model after testing. Since this scouring usually took place on the lower part of the model (the southeast), however, it had little affect on the results. This problem could have been eliminated if a release valve was located in front of the model. With the existing setup, water above the model must flow over it in order to be drained from the water flume. The only other alternative was to drain the water flume very slowly.

The other major problem was with the actual model. After the first test, the model was left in the water flume for two days. When the model was removed, it was noticed that several of the carboard layers had come apart around the edges. These layers required regluing and clamping and most of the surface required more varnish to seal cracks which had developed. In order to ensure that the edge would not separate again, this was coated with silicone. Also, after all subsequent testing, the model was immediately removed from the water flume to reduce to a minimum any future water damage.

Subsequent to this, the model was closely examined after each test and any additional cracks that had formed were filled and revarnished before testing again took place.

The velocity with which the water entered the flume also created problems because it lifted loose materials off the sides of the flume. These particles would settle over the model disrupting the drifting pattern. With proper maintenance to the flume, this problem could have been avoided.