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Feasibility of establishing a snow/ice runway in the 60°E–120°E sector of the Antarctic coast

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FEASIBILITY OF ESTABLISHING A SNOW/ICE RUNWAY IN THE 60°E—120°E SECTOR OF THE ANTARCTIC COAST

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ABSTRACT

A feasibility study on establishing a snow/ice runway in Antarctica for intercontinental flights by wheeled aircraft, has been undertaken in accordance with an agreement between the Australian Antarctic Division and the Russian Antarctic Expedition.

In January–February 1996, a field reconnaissance was made to find a snow/ice runway site in the East Antarctic coastal zone between 60°E and 120°E longitude. Historical meteorological data have been analysed. The temperature range, and wind speed and direction were examined to evaluate the frequency of unfavourable weather conditions at four Antarctic stations: Casey, Zhong Shan, Davis and Mawson. The natural conditions at the four prospective sites near Casey, the Larsemann Hills, Druzhnaya IV and Mawson were investigated to identify the most favourable site in relation to both construction and air operation requirements.

Four main criteria were applied to determine the best location for snow/ice runway establishment: (1) the absence of crevassing, (2) the potential for aligning the runway parallel with the prevailing wind with no limiting obstacles in the climb path, (3) the suitability of natural surface gradients, and (4) the suitability of snow stratigraphy and the relation of snow accumulation to melting. The information produced demonstrates that the Casey area is the best place for construction and operation of a compacted snow runway. Another prospective site is on the Amery Ice Shelf near Druzhnaya IV. The equipment and logistic facilities required for compacted snow runway construction are summarised.

1. INTRODUCTION

The concept of operating conventional aircraft on a well distributed Antarctic air network has been discussed over the last 25 years. International collaboration in creating links between stations and bases would avoid unproductive duplication of facilities, improve safety and limit environmental impact. A jointly used air network including airstrips and fuel depots could maximise research productivity by shifting expeditioners and equipment into the field and reduce travel time for highly qualified professionals.

The concept of the East Antarctica Air Network (EAAN) was presented at the last Standing Committee on Antarctic Logistics and Operations (SCALOP) Symposium in Rome (Klokov and Lukin 1995). In the late 1960s, there had been discussion of the Cooperative Air Transport System Antarctica (CATSA) (see Fowler in COMNAP/SCALOP 1995). A high density of stations and bases in the East Antarctic coastal zone would attract Antarctic Treaty countries to more active collaboration in the area. The EAAN idea attracted interest from several national Antarctic programs, including those of Australia, China, Russia and Japan.

An important component of EAAN is the establishment of a snow/ice runway in Antarctica which would be used for intercontinental flight. As previous practice showed, snow/ice runways can be developed, and used successfully, by conventional aircraft at very low cost and with minimal environmental disturbance.

The first compacted snow runway was built near the Russian Molodezhnaya Station in the 1970s. During the 1980s and early 1990s, regular intercontinental flights have been carried out from Maputo (Mozambique) and Cape Town (South Africa) to Molodezhnaya using two types of aircraft—Ilyushin Il-76 TD and Ilyushin 18 D. An ice runway located 15 km to the south of Novolazarevskaya Station was operated as the alternate runway in the same period. The last time the runways at Molodezhnaya and Novolazarevskaya were prepared for operation was in November 1994.

In the 1989–90 summer season, a 3 km long compacted snow runway was constructed near Casey station. Although the site has not been used for aircraft landing, the comprehensive testing program and a proof rolling showed that the runway pavement was strong enough to support C-130 wheeled aircraft.

In January–February 1996, in accordance with an agreement between the Australian Antarctic Division and the Russian Antarctic Expedition, a field reconnaissance to find a snow/ice runway site was made in the East Antarctic coastal zone from 60°E to 120°E (Figure 1). The conditions of the four prospective sites were investigated to identify the most favourable site in relation to both construction and air operation requirements.

The study was conducted as part of the 49th Australian National Antarctic Research Expeditions (ANARE) and the 41st Russian Antarctic Expedition (RAE).

2. METEOROLOGICAL CONDITIONS AT STATIONS

2.1 HISTORICAL DATA

Complete summary sets of the standard meteorological data have been prepared for the main Australian stations by the Climate and Constancy Section of the Tasmania and Antarctica Regional Office of the Australian Bureau of Meteorology at request for this study (Appendix A). Summaries of the meteorological parameters for Mawson are based on observations from 1954 to 1995, and for Davis from 1957 to 1995. The data set for Casey has been created as a composite synopsis of meteorological records from the old observation site from 1969 to 1989, and data collected on the current site from 1989 to 1995.

Surface meteorological data for Zhong Shan Station (69°22'S, 76°22'E), published by the Chinese Academy of Meteorological Sciences, have been used to characterise the general features of the meteorological regime in the Larsemann Hills area (*CHINARE Data Report Number 7*, 1994). Limited data are available for Zhong Shan from 1989 to 1992.

Only data from October to March were analysed because all major air operations are conducted during this period and it is a suitable time for snow/ice runway construction and maintenance.

2.2 TEMPERATURE

The temperature conditions have a dominant influence on snow/ice runway construction and maintenance procedures. The optimal temperature of snow for effective compression is in the range -5° - 0°C, as was recognised during actual compacted snow runway construction (Klokov 1979). On the other hand, gross melting can result in disaggregation inside the compacted pavement of a snow runway and form melt pools on an ice runway. Therefore, historical temperature records (see Appendix A) have been examined to determine the mean, mean daily maximum, and maximum air temperature for each month during the operating season. These data are shown in Table 1.

It should be noted that in the summer months (from December to February) temperature conditions are similar at all observation stations, but Mawson has a slightly lower mean temperature. All four stations show a tendency for rapid seasonal changes and in particular an abrupt decrease in temperature in March. In general, the temperature cycle at Casey is less extreme than at other stations and certainly preferable for snow/ice runway construction.

2.3 WIND SPEED AND DIRECTION

The wind regime is also one of the most important factors both for runway construction and for aviation operations. A knowledge of the range of directions of strong winds is needed to align the runway along the strongest wind direction or as close as possible to it. The wind records can also reveal how often sudden strong winds occur that can cause problems when aircraft are parked or moored for a relatively long time.

Table 1. Climatological summaries of air temperature (°C) for meteorological stations. (Upper figure—mean 9 am air temperature. Middle figure—mean daily maximum air temperature. Lower figure—highest temperature.)

	Casey 1989-1995	Davis 1957-1995	Zhong Shan 1989-1992	Mawson 1954-1995
October	-10.7 -7.8 0.8	-12.1 -9.1 0.6	-11.3 -4.0 -3.2	-13.7 -9.8 0.0
November	-5.3 -2.9 4.8	-5.1 -2.7 8.0	-5.7 -2.5 3.3	-6.3 -2.7 6.1
December	0.1 1.8 7.1	0.1 2.3 11.0	-0.7 3.2 6.9	-0.9 2.2 9.3
January	0.6 2.5 9.2	0.9 3.1 13.0	0.5 3.3 6.7	-0.5 2.7 10.6
February	-1.6 0.5 6.6	-2.6 -0.4 10.0	-2.2 0.1 4.7	-5.4 -1.3 8.0
March	-6.6 -3.9 2.8	-8.8 -5.9 4.1	-8.3 -5.6 -0.1	-11.3 -7.2 4.0

Comprehensive data on wind speed and direction have been provided at our request by the National Climate Centre of the Bureau of Meteorology (Appendix B). Analysis of the data reveals that eastern sector winds dominate at all four stations. The direction of prevailing winds changes gradually from the E–ENE at Casey to the ESE–SE at Mawson. As can be seen from Table 2, very strong wind events (>40 m/s) occur throughout the period of interest at Australian stations. The speeds of strong winds at Zhong Shan are generally lower, and maximum recorded wind gusts are less than 32 m/s.

The frequency of wind speeds and the directions into sixteen compass sectors have been analysed for Casey, Davis and Mawson (Barnes-Keoghan *et al.* 1993). Figure 2 presents the frequencies of wind events that have been broken down into 5-knot groups up to 50 knots. A grid of the speed and direction categories has been made, and each cell in that grid assigned a shading depending on frequency of wind events. A separate cell for calms is shown in the left bottom corner of each plot.

On the icesheet plateau, wind directions are very much affected by mesoscale fluctuations of local topography. Therefore, wind observations will be required at the particular outstation runway site to adjust the long-term wind database collected at the station.

2.4 FREQUENCY OF UNFAVOURABLE WEATHER CONDITIONS

The information on frequency of restricted horizontal visibility and low cloud is presented in Tables 3 and 4. The percentage of these unfavourable weather events for Australian stations has been

Table 2. Climatological summaries of wind direction and wind speed (m/s) foqpmeteorological stations. (Upper figure—most frequent wind direction. Middle figure—daily mean wind speed. Lower figure—maximum wind gust.)

	Casey 1969-1990	Davis 1957-1992	Zhong Shan 1989-1992	Mawson 1954-1992
October	ENE 7.8 64	NE 5.0 49	E 7.3 31.9	ESE 10.8 54
November	ENE 6.6 56	NE 5.7 47	E 6.6 29.1	ESE 10.8 57
December	ENE 5.3 57	NE 5.4 47	E 6.0 31.8	ESE 9.2 53
January	ENE 4.9 51	N 4.9 45	E 5.3 27.2	ESE 8.8 41
February	E 5.1 46	NE 5.2 52	E 7.1 26.0	ESE 11.0 53
March	E 6.3 49	NE 5.0 45	E 7.3 30.3	SE 12.0 52

Table 3. Percentage frequency of restricted horizontal visibility. (Upper figure—for visibility 8000 m or less; 'alternate' minimum realised. Lower figure—similar, but for 5000 m; 'circling' minimum realised.)

	Casey	Davis	Zhong Shan	Mawson
October	18.9 17.0	11.6 9.5	9.3 7.7	11.8 10.5
November	12.0 10.2	5.3 3.7	8.3 5.4	9.3 8.7
December	8.4 6.9	4.0 2.7	4.6 3.8	3.4 2.9
January	8.7 6.6	3.4 2.5	7.3 4.0	3.4 2.7
February	9.7 7.7	6.8 5.0	20.7 18.5	7.5 6.8
March	16.0 12.9	14.0 10.8	24.7 20.7	8.1 7.2

Table 4. Percentage frequency of extensive low cloud. (Upper figure—5 or more oktas of cloud with base at or below 1500 feet; 'alternate' minimum realised. Lower figure—similar, but for 1000 feet; 'circling' minimum realised.)

	Casey	Davis	Mawson
October	5.4 1.6	1.7 0.4	0.2 0.1
November	5.9 2.2	1.4 0.5	0.2 0.1
December	8.0 3.1	1.8 0.9	0.9 0.7
January	7.1 2.8	1.3 0.9	1.2 0.5
February	7.1 3.4	2.0 0.9	0.6 0.4
March	10.4 4.6	2.6 1.1	0.4 0.3

* feet are used by international aviation convention

obtained from the preliminary report issued by the Tasmania and Antarctica Regional Office Bureau of Meteorology (Barnes-Keoghan *et al.* 1993). In addition, the frequency of poor visual conditions at Zhong Shan has been calculated using meteorological data published by the Chinese Academy of Meteorological Sciences (*CHINARE Data Report Number 7*, 1994).

The comparison of the frequency of such conditions at the four stations shows that restricted horizontal visibility at Casey occurs roughly twice as often as at other stations during the spring and summer. In February and March, the worst visual conditions are at Zhong Shan when the horizontal visibility below the minima prescribed for aircraft landing occurs in around 20% of operational time.

The historical data for Davis and Mawson show a dominance of favourable operational conditions at both sites where cloud height allows landing 97–99% of the time from October to March. In general, substantially worse cloud conditions exist in the Casey area, though the frequency of extensive low cloud (below 1500 feet) does not exceed 10.4% at this time of year. Regrettably, no data on the height of low cloud are available for Zhong Shan.

3. FIELD INVESTIGATION DATA

3.1 SITE REQUIREMENTS

To make the best choice of location for a runway, the four prospective sites were investigated simultaneously. Four major criteria were applied to each site to determine the suitability for runway construction and air operations.

A. Crevassing-free

Crevassing is a typical feature of the Antarctic icesheet, particularly in the coastal zone. To investigate the existence or absence of crevassing at the potential runway site, observations were performed both by air reconnaissance from low-flying aircraft, and by surface surveying. The best time to detect crevassing in the coastal zone is in February. At this time of the year the last winter snow has been destroyed by summer melting and the new snow cover has not yet appeared.

In three of the four areas investigated, an S-76 helicopter was used to make a visual reconnaissance by air. Obtaining appropriate information from different altitudes was a major factor in making judgments of the suitability of the inspected sites. The surface survey was conducted to detect small, invisible crevasses along the potential runways' centrelines, probing the snow surface at 1 m intervals using a heavy ice chisel.

B. Potential for aligning the runway parallel with the prevailing wind with no limiting obstacles in the climb path.

One major requirement is to align the runway in the direction of the strongest winds. In practice this is not an easy task. Although the actual length of a runway handling heavy aircraft is around 3000 m, the total airfield area subject to safety regulations and operating standards includes the approach and climb-out path—up to 25 km in length and 9 km in width.

The standard climb-out slope for most heavy aircraft operating in Antarctica has to be less than 1/60 (0.0167). Large areas of the Antarctic Coast have icesheet relief limitations or local peculiarities, such as high mountains or nunataks, that restrict the possibility of aligning the runway parallel to the prevailing wind. The choice of runway alignment normally involves a compromise between heading away from a high obstacle and heading into the prevailing wind. To make a decision on the runway alignment, map analyses (both 1:200 000 or 1:250 000) and air reconnaissance were used.

C. Suitability of natural surface gradients

Generally, the runway site should be reasonably level and surface gradients should be appropriate to airfield standards. Required surface gradients need to be within the specified limits that are 0.02 for longitudinal slope and 0.02 for transverse slope.

The required information on natural relief was gathered partly by using large scale, 1:50 000 and 1:100 000, topographic maps issued for the permanent station areas. Useful data were obtained by analysing the results of previous surveys which were made in 1987–88 south of the Larsemann Hills, in 1987 at the north-east corner of the Amery Ice Shelf by Russian surveyors, and in 1990 south of Mawson station by Australian surveyors.

During reconnaissance in the Mawson area, surface gradients were measured on a large blue-ice field using GPS equipment.

D. Snow stratigraphy and relationship between snow accumulation and melting

A SIPRE corer was used to study the snow structure at the investigated sites (Figure 3). A stratigraphic study of the layering of snow, firn and ice lenses permits recognition of past glaciological events (Figures 4, 5). It is important to define the rate of snow accumulation at the site. If snow accumulation is extremely high, or very low, then the efforts needed to build and to maintain the compacted snow runway will be unreasonably complex. An acceptable range of snow accumulation is 30–60 cm/yr. The degree of summer melting has a dominant influence on the usefulness of the snow/ice runway and its ease of maintenance in the summer months. The acceptable limit of melt is about 20% of the annual volume of snow accumulation.

Another source of information is direct monitoring of snow accumulation by either or both of two proper methods. The standard method in meteorological observations is to collect falling snow in precipitation gauges. Another traditional method of accumulation/ablation measurement is to monitor the snow surface position using stakes and canes. In Antarctica, both of these methods experience problems connected with the difficulty of separating falling snow from drifting snow. However, all available data gathered by both methods are used in this report.

In addition, during field work all runway centrelines were marked using bamboo canes about 2.5 m in height, with black flags. The canes were labelled '1996,41 RAE—49 ANARE' (Figure 6). The height of the canes was marked, so that in the future these readings can be used to get accumulation rates along the runway centrelines.

3.2 CASEY STATION AREA

Casey station (66°17'S, 110°32'E) is located in the Windmill Islands area (Figure 7). The site inland from Casey is one of the most comprehensively investigated locations for establishing a compacted snow runway. Trial programs were undertaken there in 1983–84 and 1989–90 to assess the practicability of constructing a compacted snow pavement that would support heavy, wheeled aircraft loads. The results of these trial programs prove that a competent pavement can be constructed at the Casey location (Russell-Head and Budd 1989, Russell-Head and Budd 1991). The task for this study was to review the data collected during the construction experiments as well as to make an overview of glaciological conditions at the site to define the most favourable location in the area.

A. An aerial inspection was not possible at the time of the visit to Casey but there were no indications of any cracks on the surface in this area during land reconnaissance. Also, there are no records, from pilots or ground vehicle operators experienced in the area, of crevassing between S1 and Lanyon Junction. Therefore the conclusion is that the area is completely free of crevassing.

B. Although the Windmill Islands region, with its associated coastal rock outcrops where the station is located, is one of the most extensive rock exposures in this sector of East Antarctica, there are no conspicuously high mountains in the region that would qualify as obstacles for air approaches. The ice topography of Law Dome, located to the south-east of Casey, is quite smooth and allows for the runway to be sited at any place inland of the station at elevations above 400 m, and to be aligned with the prevailing strong east winds.

C. There is no evidence that this prospective runway zone has been surveyed by standard methods, though there is little indication that finding a possible runway site in this area with optimal grades would be problem. Of all locations visited, the area of the old USA skiway (see Figure 7), based on the total visual impression obtained during ground traverses to the location, offers the best general snow surface. The slope gradients at this site, lying above 350 m, certainly meet the standard necessary for normal airfield requirements.

D. The stratigraphy of the in situ snow was investigated during two short missions covering the lower part of Law Dome from S1 up to the automatic weather station (AWS) located 12 km east of Casey. Seven cores to 180 cm depth were taken for stratigraphic analysis at different distances from S1. The position of the sampling points is shown in Figure 7:

No.1—1.5 km east of S1 (natural conditions)
No.2—2.0 km east of S1 (natural conditions)
No.3—2.0 km east of S1 (old 1989–90 trial runway spot)
No.4—3.3 km east of S1 (old 1989–90 trial runway spot)
No.5—5.4 km north-east of S1 (natural conditions)
No.6—6.2 km north-east of S1 (natural conditions)
No.7—6.5 km east of S1 (natural conditions near the AWS)

The stratification of snow, firn and ice lenses revealed in the cores is illustrated in Figure 8. At lower altitudes, up to 6 km inland of S1, the total thickness of firn layers alternating with ice lenses is in the 40–120 cm range. Blue ice formed by refrozen meltwater lies below the firn within this zone. At higher altitudes (above 370–380 m), there are multiple firn layers containing annual ice lensing. No underlying blue ice was evident there. The relation between the volume of ice lenses and annual snow accumulation varies substantially from place to place, with a general trend of the relation decreasing upslope, from 100% by S1 down to 20% at an altitude of 400 m.

The remains of the old (1989–90) trial runway pavement were encountered in cores 3 and 4 at depths of 120 cm and 80 cm respectively (Figure 9). From an assumed average density of the firn/ice material of the cores of about 0.5 Mg/m^3, the rate of snow accumulation can be calculated. The average annual accumulation from 1990 to 1996 at the trial runway site was around 0.08 Mg/m^2. For an average density of winter snow of 0.4 Mg/m^3, this corresponds to an accumulation rate of 0.2 m/yr.

A detailed program of accumulation measurements was undertaken in the Wilkes/Casey area in 1957–62. A summary of monthly and annual totals of the precipitation, falling snow without contamination by drifting snow, is given in Table 5 (Budd 1966). The mean annual precipitation at Wilkes/Casey is about 0.3 m of water. According to Budd's (1966) conclusions, the effective annual depth of fallen snow is about three times more than the mean water-equivalent precipitation because of snowdrift loss. This means that about 0.9 m of snow falls and only 0.3 m of snow accumulates in the coastal area of Law Dome between S1 and Lanyon Junction.

In general, the above results of the 1996 field examination confirm the conclusions of previous investigators (Russell-Head and Budd 1991) that a compacted snow runway can be constructed fairly close to Casey at altitudes near 400 m. There are no obvious environmental obstructions to this possibility.

Table 5. Monthly and annual precipitation values, in mm of water equivalent, for Wilkes station from 1957 to 1962 (from Budd 1966).

Month	1957	1958	1959	1960	1961	1962	Mean	SD
January	8	6	20	10	2	2	8	8
February	8	20	10	5	2	5	8	7
March	122	0	80	30	40	20	49	45
April	48	9	11	20	30	55	29	19
May	50	61	27	10	10	16	29	22
June	24	18	41	20	50	6	27	16
July	50	78	13	30	40	8	27	26
August	45	17	27	10	1	30	22	16
September	23	9	5	10	100	28	29	36
October	31	19	29	10	2	48	23	16
November	42	22	16	10	10	20	20	12
December	6	5	19	0	4	20	9	8
Yearly Total	457	264	298	165	291	258	280	

3.3 LARSEMANN HILLS AREA

The Larsemann Hills are 85 km south-west of Davis. The area includes a few rock outcrops separated by small sea bays. They extend 8 km along the Ingrid Christensen Coast (Figure 10). Three facilities lie in the eastern part of the Hills: Zhong Shan Station (People's Republic of China); Progress Station (Russia), abandoned in 1993; and Law Base (Australia), used as a seasonal field base. There is a gradual slope of the icesheet inland of the Larsemann Hills, mostly covered with snow year-round; it can be easily accessed by ground transport. A safe route for inland traverse was established up to 200 km from the coast by a Russian traverse group in 1991. In the late 1980s a preliminary effort to develop a snow/ice runway for wheeled aircraft was undertaken south of the Larsemann Hills by Russia.

A. The area south of the Larsemann Hills is characterised by the existence of gross crevassing associated with the Dalk Glacier. The runway site is located about 3 km west of the glacier flow centreline. It appears that the ice at the runway site tends to drift toward the Dalk Glacier valley and this could potentially result in crevassing although aerial inspections have not revealed any signs of crevasses at the runway location.

A rigorous surface examination is needed in this kind of active ice area. The results of the search for invisible crevasses at the site are given in Table 6. A heavy ice chisel was used to probe the snow at 1 m intervals. A number of insignificant crevasses was found. In general, they appear as 1–2 cm cracks on the surface, increasing to 30–60 cm wide and tens of metres long at 1 m depth (Figure 11).

Table 6. Surface gradients along the 1987 airstrip alignment south of Larsemann Hills (Progress Station, Zhong Shan, Law base).

Station (m)	Elevation ASL (m)	Longitudinal gradient	Transverse gradient
Chainage 00 (SW end of the runway)	275.3		0.016
Chainage 250	273.3	0.008	
Chainage 500	268.6	0.019	
Chainage 750	262.0	0.026	0.025
Chainage 1000	255.1	0.028	
Chainage 1250	250.2	0.019	
Chainage 1500	246.3	0.015	0.021
Chainage 1750	243.0	0.013	
Chainage 2000	240.9	0.008	
Chainage 2250	240.3	0.002	0.017
Chainage 2500	239.6	0.003	
Chainage 2750	236.7	0.011	
Chainage 3000 (NE end of the runway)	231.8	0.019	0.015

B/C. In January 1987, a topographical survey was made at the site 4–6 km south-west of Progress Station. The results of the survey show that there is sufficient room to site a 3 km long runway in this area, and that the runway could be aligned with the prevailing winds (SE). The gradient values measured along the 1987 runway alignment are given in Table 6. Some of these exceed the 0.02 limit.

In the 1988–89 summer the conditions of the runway approaches at the prospective runway site were examined and assessed as appropriate for air operation standards. There are no up-wind mountains or other high obstacles.

These initial investigations indicated that a runway can be sited at a relatively low elevation, about 250 m, and aligned with the prevailing winds by orienting the runway 53°/232°. In 1989 a construction program at the site was suspended because a few small crevasses were found at the eastern end of the runway. One of the major tasks of this mission to the Larsemann Hills area in early February 1996 was to make an overview of conditions and to try to realign the runway to avoid the area of crevassing. Aerial inspection carried out on 4 February 1996 suggested that this could be done. The runway orientation was changed to 50°/230°, rotating it about the centrepoint (Figure 10). The new alignment of the runway has been marked by five bamboo canes with black flags.

D. Five cores up to 180 cm depth were taken on the runway, one near each 1996 bamboo cane. Positions of stratigraphy sampling points are given in Table 7. The results on snow stratigraphy at the site are shown in Figure 12. Two types of structure exist along the runway. One type is a glaciological condition when all accumulated snow is transformed into ice within one year. This type occurs from the NE end of the runway to the 0.3 km point. On February 5 the thickness of this rough firn/snow ranged from 5 cm to 20 cm. Obviously these last remains of the winter's snow will melt or be blown away by strong winds before the next snow accumulation.

The second type of structure found in the upper layers appears over the rest of the runway and can be characterised as multiple annual melt zones alternating with firn snow. Analysis of the cores taken in this part of the runway allows the assumption that annual snow accumulation here varies in the 30–40 cm range. The relation between volume of ice lenses and annual snow accumulation is about 30%. Rather thick layers of the rough disaggregated firn were obtained at depths ranging from 90 cm to 110 cm. Usually their occurrence is associated with melt water infiltration, so their depth can be interpreted as depth of annual melt penetration.

Generally, this site does not appear to be favourable for building a compacted snow runway because of excessive surface gradients and the numerous underground small crevasses. It is possible that a more suitable spot could be found further south near altitudes around 450–500 m.

Table 7. Positions of stratigraphic sampling points and crevasses along the 1996 airstrip alignment south of Larsemann Hills (Progress Station, Zhong Shan, Law base).

Figure in map of Larsemann Hills area.	Distance from the point 1 (km)	Position	Crevasses present
1 (NE end of the 1996 airstrip alignment)	0	69°25'.8S; 76°20'.5E	9 crevasses between point 1 and point 2
2	0.5		
3	1.0		none
4	1.5		none
5 (SW end of the 1996 airstrip alignment)	2.5	69°26'6S; 76°17'.3E	1 crevasse within 400 m of point 4

3.4 DRUZHNAYA IV (SANSOM ISLAND) AREA

A vast and level area occurs in the south-east corner of the Amery Ice Shelf edge. This part of the Amery Ice Shelf has a rather stable outline. There are a few locations where the height of the ice barrier is 5–8 m. All these natural conditions make this area very attractive as a handy entry point to the Prince Charles Mountains region. The Russian seasonal base Druzhnaya IV (69°45'S, 73°43'E) is situated on the Landing Bluff, the largest rock outcrop in the area. Sansom Island is 2 km north of Landing Bluff, and is a rocky island that is used as a fuel depot by ANARE (Figure 13).

A. Most of the area has a flat snow-covered surface; however there are a couple of blue ice exposures about 10 km inland of Druzhnaya IV, near Collins Nunatak. On 7 February 1996 an aerial reconnaissance of these blue ice fields found that the whole bare ice surface appears severely crevassed.

At the same time, aerial inspection located and outlined a large area of snow covered surface on the ice shelf itself, without any visual indication of crevassing. The centre of this area is 3 km due west of Landing Bluff. Surface examination of the prospective runway spot was undertaken using the technique described above and which is needed in such active ice areas. Probing showed the spot to be free of crevassing.

B. The proposed runway area is free of any substantial elevated terrain from the south-west to the east-north-east centred on the runway's centrepoint (see Figure 13). A gradual slope of the icesheet joins the flat ice shelf from the south and from the south-east at a 6–7 km distance from Landing Bluff. As the survey shows, the climb-out profile heading into the prevailing winds (ESE–SE) would be less than 1/60 if the runway centrepoint lay roughly 2 km west of Landing Bluff, so

Table 8. Surface gradients along the 1987 runway alignment survey at the south-east corner of the Amery Ice Shelf (Druzhnaya IV Base, Sansom Island).

Station (m)	Elevation ASL (m)	Longitudinal gradient	Transverse gradient
Chainage 00 (NW end of the 1987 runway alignment)	32.54		
Chainage 400	32.74	0.00050	0.0047
Chainage 600	32.35	0.00195	
Chainage 800	32.51	0.00080	0.0037
Chainage 1000	32.01	0.00250	
Chainage 1200	32.24	0.00115	0.0041
Chainage 1400	31.93	0.00155	
Chainage 1600	32.42	0.00245	0.0039
Chainage 1800	32.34	0.00040	
Chainage 2000	32.58	0.00120	0.0053
Chainage 2200	32.44	0.00070	
Chainage 2400	32.39	0.00025	0.0069
Chainage 2600	31.86	0.00265	
Chainage 2800	31.71	0.00075	0.0085
Chainage 3000	30.92	0.00395	
Chainage 3200	30.49	0.00215	0.0110
Chainage 3400	29.86	0.00315	
Chainage 3500 (SE end of the 1987 runway alignment)	30.00	0.00140	0.0160

a 3 km runway can be oriented in the direction of the prevailing winds (SE). 122° was designated as the optimal orientation for the runway.

C. In the 1987 summer a topographical survey was made on the Amery Ice Shelf west of Landing Bluff. Preliminary data on the general character of the natural relief was obtained by levelling at 1 km grid-spacing in a 6 x 6 km area. Detailed information about the surface gradients was gathered along the proposed runway alignment. Table 8 gives the values of the longitudinal and transverse slopes in the 1987 runway alignment.

Table 9. Snow accumulation at the prospective airfield site nearby Druzhnaya IV Station.

Height of canes (cm)		Accumulation (cm snow)	Snow density (kg/m^3)
18 March, 1988	6 January, 1990		
311	188	123	0.48
301	182	119	
320	191	129	
318	199	119	
296	175	121	
293	158	135	0.47
305	187	118	
282	163	119	
280	167	113	
302	201	101	
285	164	121	0.48
362	242	140	0.47
305	175	130	
302	177	125	
273	159	114	
244	126	118	
299	179	120	
312	192	120	
311	184	127	
325	217	108	
314	194	120	0.51
Average		121	0.48

During the 1996 surface inspection at the runway site a new reading was made of the runway's centrepoint position using GPS. Its new position is 69°45'S, 73°37'E. The runway centreline was marked again, installing five new bamboo canes with black flags. To avoid confusion, this installation is called the 1996 runway alignment.

D. Five cores to 180 cm were taken on the runway, one near each 1996 bamboo cane. The results of the stratigraphic analyses are shown in Figure 14. There is considerable similarity of structure in the upper layers in all cores taken on the runway. Typical strata are fine-grained firn zones separated by thin ice lenses. Though the average altitude of the runway is only 32 m, there is no convincing stratigraphical evidence of extensive summer melting. The relation between volume of ice lenses and annual snow accumulation is about 15%.

Table 9 presents the data of the 1988–90 measurements of snow accumulation at the runway site. The average snow accumulation in the two years was 60 cm. A rather similar value of the snow accumulation rate (50–70 cm/yr) has been obtained by analysing the ice core stratigraphy diagrams.

In general, the investigated site demonstrates very suitable natural conditions for compacted snow runway construction. There is a little concern that the rather high snow accumulation would require processing during the time of construction.

3.5 MAWSON AREA

A vast zone with remarkably extensive blue ice fields exists on the icesheet slope close to Mawson. There are two related factors that have formed numerous bare ice exposures here: the steepness of the local ice slope and very strong katabatic winds blowing the whole year. In early December 1961, a wind storm destroyed a DC-3 aircraft near Mawson. In the late 1970s, a parked Russian aircraft was destroyed by a sudden blizzard. Even so, the location still seems attractive for use by large aircraft as a natural airstrip almost ready for landing.

A. Considering the area as a potential air operation region, the blue ice here is much less affected by crevassing than similar areas elsewhere. An aerial reconnaissance was conducted inland of Mawson using an S-76 helicopter. Local occurrences of crevassing were outlined and sketched. Another source of information was the chart of crevassing drawn by B. Marmo during his surface inspections in the 1995–96 summer season. Both of these surveys indicated that there is an area downwind of the North Masson Range and north-east of Mt Parsons which is crevassing-free; however there are numerous 'healed' cracks a few metres long and about 0.1 m across. These seem to be completely filled with solid ice which has a slightly different colour from ordinary blue ice. A few 1 m long cores were taken at such 'healed' cracks using the SIPRE corer. All cores appear to be of solid pure ice, although, at the bottom of one hole, a small (2 cm) open crack was obvious.

B. Previous investigators, during a runway surface reconnaissance at the site, found a location that satisfied the length and approach requirements. It is halfway between the north end of the Masson Range and the north end of the David Range (Murphy 1990).

A surface inspection at the above site was conducted on 10 February 1996. Data from this inspection showed that the climb-out path would meet aircraft take-off standards if the runway were headed close to the prevailing wind (ESE) and oriented 155°/335° (Figure 15). The significant negative feature of this runway alignment is the high degree of risk of turbulence that can occur to the leeward of the Masson Range and which would badly affect aircraft climb angle.

C. With the assistance of Bob Twilly (Australian Surveying & Land Information Group—AUSLIG), levelling along the 1996 runway alignment was performed on 10 February, using GPS. The centrepoint position of the runway was estimated to be 67°45'S; 62°41'E. Table 10 gives the information on the longitudinal gradients. Although a crossfall is not a problem, the longitudinal grades are mostly above the 0.02 limit.

D. According to conclusions of past observations, the firn-line starts at about 700 m elevation in the Mawson area. There is no permanent snow cover at lower elevations. The investigated runway site is between 450 m and 520 m. The ablation rate at this elevation is in the range of 20–30 cm of ice per year.

The runway area was completely snow-free in early February 1996. Bare glacier ice had a typical cuspate surface, with regularly spaced pits about the size of a saucer. Such an ice appearance occurs if there is no melting and ablation occurs directly by sublimation. However on the runway site a number of isolated sharp lumps 0.1–0.2 m high with a diameter of about 1 m were found. These appear to result from melting and refreezing of small snow drift patches.

In general, there is serious concern over the nearby high mountain ridges in the runway climb-out area. Also, protected parking of aircraft may be a problem because an ordinary tie-down arrangement will not be enough if a strong blizzard occurs.

Table 10. Surface gradients along the 1996 runway alignment south of Mawson station.

Station (m)	Elevation ASL (m)	Longitudinal gradient
Chainage 00 (SE end of the runway)	518.731	
Chainage 500	504.935	0.0276
Chainage 1000	486.110	0.0377
Chainage 1500	476.057	0.0201
Chainage 2000	471.869	0.0084
Chainage 2500	462.218	0.0193
Chainage 3000 (NE end of the runway)	450.311	0.0238

4. GENERAL CONCLUSIONS REGARDING INVESTIGATED RUNWAY SITES

The site investigation program undertaken at four sites along the East Antarctic coast in the sector from 60°E to 120°E provides information on the natural conditions of the most favourable areas for a snow/ice runway construction. The general characteristics of the sites investigated are given in Table 11. This information allows a general comparison of the relative merits of potential runway sites near permanent stations.

It is remarkable that all four investigated runway sites are located in a rather narrow latitude range, from 66.3°S to 69.8°S. This means that daylight available for air operations is almost the same at all these locations. Although the narrow latitudinal range of the sites suggests similar melting conditions, in fact, this is not the case, since the runways' elevations varied from 32 m in the Druzhnaya IV area up to 475 m near Mawson. Also, local topographical and meteorological peculiarities have a substantial influence on the relation between snow accumulation and melting. Therefore the stratigraphy of the upper glacier layers is very different at the various sites.

The simplest and most low cost type of runway—a blue-ice runway—can be built only in the Mawson area. The environment surrounding Casey, Larsemann Hills and Druzhnaya IV permits only a compacted snow runway. There are no alternatives near these three locations. In terms of compacted-snow runway construction, the area inland from Casey has the best glaciological conditions.

There are two very important aspects involved in the general consideration of runway requirements in Antarctica which have not been mentioned before:

- proximity to a functional station with a proper logistic infrastructure
- distance from airports outside Antarctica to the potential runway location in Antarctica

Both the level of logistic support and the magnitude of the initial construction effort are strongly influenced by these two factors. From this point of view, the Casey area has a substantial advantage over the others (see Table 11).

Major natural factors and important practical considerations have been drawn together to assess the feasibility and practicability of runway construction in the investigated areas. Ten criteria were used to evaluate the relative merits of each of the four investigated runway sites. The results of this assessment are presented in Table 12. The positive sign is given if the criterion is realised in the area and the negative sign if it is not.

The Casey area provides the best opportunity (9/1) for construction and operation of a compacted snow runway. Unfavourable weather conditions (compared with the other alternatives) is the single negative factor for the Casey area. The recent development in the local observational network and the establishment of the AWS on the proposed runway site will lead to significant improvements in operational forecasting for the area.

Another prospective site (7/3) is on Amery Ice Shelf near Druzhnaya IV. Two negative factors for this site are associated with the absence of an adequate logistics infrastructure near the runway site.

Both the Larsemann Hills area and the Mawson area are much less suitable for use as sites for intercontinental air operations.

Table 11. General characteristics of the investigated runway sites.

Site characteristics	Casey	Progress, Zhong Shan, Law	Druzhnaya IV, Sansom Island fuel depot	Mawson
Position of the runway centrepoint	66°17'S 110°47'E	69°26'S 76°19'E	69°45'S 73°37'E	67°45'S 62°41'E
Elevation (m)	400	245	32	475
Airfield site location	slope of the ice sheet	slope of the ice sheet	ice shelf	blue ice field
Runway type	compacted snow runway	compacted snow runway	compacted snow runway	ice airstrip
Weather condition	moderate	good	good	moderate
Runway orientation	90	53	122	155
Strong winds direction	E	ENE	SE	ESE
Snow accumulation (cm)	30	30-40	60	0
Melting	low	moderate	low	high
Surface gradients	appropriate	inappropriate 0.002-0.028	appropriate 0.005-0.016	inappropriate 0.019-0.038
Crevassing	no	exist	no	exist
Existence of high mountains upwind of the runway	no	no	no	Masson Range
Distance from logistics base (km)	11	4	4	18
Distance from airports outside Antarctica (km):				
Hobart	3431	4888	4956	5463
Albany	3515	4583	4642	4992
Capetown	6699	5278	5253	4693
Sum of distance (km): Aus-Ant-Afr	10130	9861	9895	9685

Table 12. Evaluation of the relative merits of the potential runway sites within the 60°E–120°E sector of the East Antarctic Coast.

Criterion	Casey	Progress, Zhong Shan, Law	Druzhnaya IV Sansom Islland fuel depot	Mawson
Closeness to exit airports (Hobart, Perth, Cape Town)	+	-	-	+
Proximity to the multi functional logistics infrastructure	+	-	-	+
Easiness of refuelling procedure	+	-	-	-
Free of crevassing	+	-	+	-
Free of high mountains upwind of the runway	+	+	+	-
Suitability of natural surface gradients	+	-	+	-
Possibility to align runway into prevailing wind	+	+	+	+
Adequate accumulation/ melting	+	-	+	-
Frequency of favourable weather conditions	-	+	+	+
Safety weather factor (in case of long term parking of aircraft)	+	-	+	-
Total sum (+)/(-)	9/1	3/7	7/3	4/6

5. CONSTRUCTION REQUIREMENTS FOR SNOW/ICE RUNWAYS

Any runway, whether on ice or on snow, designed for wheeled aircraft use has to be:

- hard enough to resist wheel ruts formed by the aircraft
- strong enough to support the maximum take off weight of the aircraft

The major input parameters to design an adequate pavement for a snow/ice runway are the aircraft wheel tyre pressure and the maximum take off weight. Table 13 summarises the general characteristics of aircraft types that are of practical interest for use in Antarctica. A pavement of adequate thickness and strength has to be designed using the specifications of the particular aircraft to be used. The value of the required thickness and strength for different types of aircraft are given in Table 14.

The method for designing a two-layer compacted snow runway pavement has been developed by Australian investigators during the constructing of the trial compacted snow runway in the Casey area (Russell-Head and Budd 1989). The major principles of three-layer compacted snow pavement

Table 13. Characteristics of aircraft with potential for Antarctic use.

Type	Ski/ Wheeled	Wing Span (m)	Length (m)	Height (m)	Maximum Take Off (kg)	Maximum Payload (kg)	Range Max PL (km)	Ferry Range (km)
Lockheed LC-130R	wheeled	40.4	29.8	11.6	70310	19685	2435	7871
Lockheed C-130J	wheeled	40.4	29.8	11.6	70308	20181	2978	8654
Ilyushin 76TD	wheeled	50.5	46.6	14.8	190000	50000	3650	10580
Dornier 228 Polar	ski/ wheeled	17.0	16.6	4.9	6400	2201	870	2440
DH Twin Otter	ski/ wheeled	19.8	15.8	5.7	5670	2350	690	2030

Table 14. Required parameters of snow pavements for wheeled aircraft use in Antarctica.

Aircraft	Maximum Take Off Gross Weight (kg)	Tyre Pressure (kg/cm^2)	Pavement Thickness (m)	Upper Layer Hardness (MPa)
C-130H	79400	7	0.5	0.8
Ilyushin Il-76TD	210000	5-7	0.7	0.8
Dornier 228-100	5700	3-5	0.25	0.5
DHC-6 Twin Otter	5670	3-5	0.25	0.5

construction were published after the construction of the compacted snow runway in the Molodezhnaya area (Aver'yanov, Klokov *et al.* 1985). Both these design approaches produce the desired result because they are based on firm practical experience in Antarctica.

Establishing a hard surface runway on deep snow seems to be a difficult task taking into consideration that a strong pavement has to be created over a thick and weak snow/firn basement. However, a fairly simple procedure has been developed. The construction technique that was used both by Russians at Molodezhnaya in 1970s and Australians at Casey in the 1980s includes three main methods of snow processing: disaggregating the snow with disk harrows, levelling with a grader, and compacting with a multiple-tyre roller. The maintenance procedure includes the same methods of snow processing, although it is less labour-intensive.

Basically, it is easier to build a conventional runway on blue-ice than in areas of net snow accumulation. Even without substantial treatment, snow-free glacier ice can be used by wheeled aircraft for air operations throughout the year except at the time of melting. To operate from a blue-ice runway in summer, a protective snow cover should be created on the ice surface before melting. Such a snow cover will protect the runway from melting and also improve the friction parameters of the runway surface. Both the initial and annual procedures of runway preparation include planing the ice, using a heavy grader or rotary ice chipper, and periodic compaction of the snow if a protective snow cover is needed. A typical procedure for ice runway construction was described earlier (Klokov and Diemand 1995).

The required equipment and logistic facilities for establishing a snow/ice runway are listed in Table 15. The infrastructure requirements in the table assume the runway site is located far away from a permanent station. If the snow/ice runway is close to the station, the support for the runway construction can be mostly based on existing infrastructure. In any case, temporary field camp facilities should be established at the runway site during the operating period.

Table 15. Required infrastructure for establishing a snow/ice runway.

	Compacted-snow airfield		Airfield on snow-free ice	
Major items	heavy wheeled aircraft	small (light) wheeled aircraft	heavy wheeled aircraft	small (light) wheeled aircraft
Personnel (full time)	6-8	3-4	3-4	2-3
Camp modules (accommodation, workshop, power unit, store)	4-5	2-3	3-4	1-2
Fuel tanks (L) and refuelling equipment	70000	5000	70000	5000
Machinery				
Tractor	3-4	2-3	2-3	2
Multi-tyred roller	2-3	1	1	
Snow miller (multi-disk harrow)	1-2	1	-	-
Grader on ski	1-2	1	-	-
Drag-planer	1	-	-	-
Snow-blower	1-2	1	1-2	1
Radio/nav aids	HF, VHF, UHF, Beacon, GPS, Satcom			
Medical and fire care	+	+	+	+

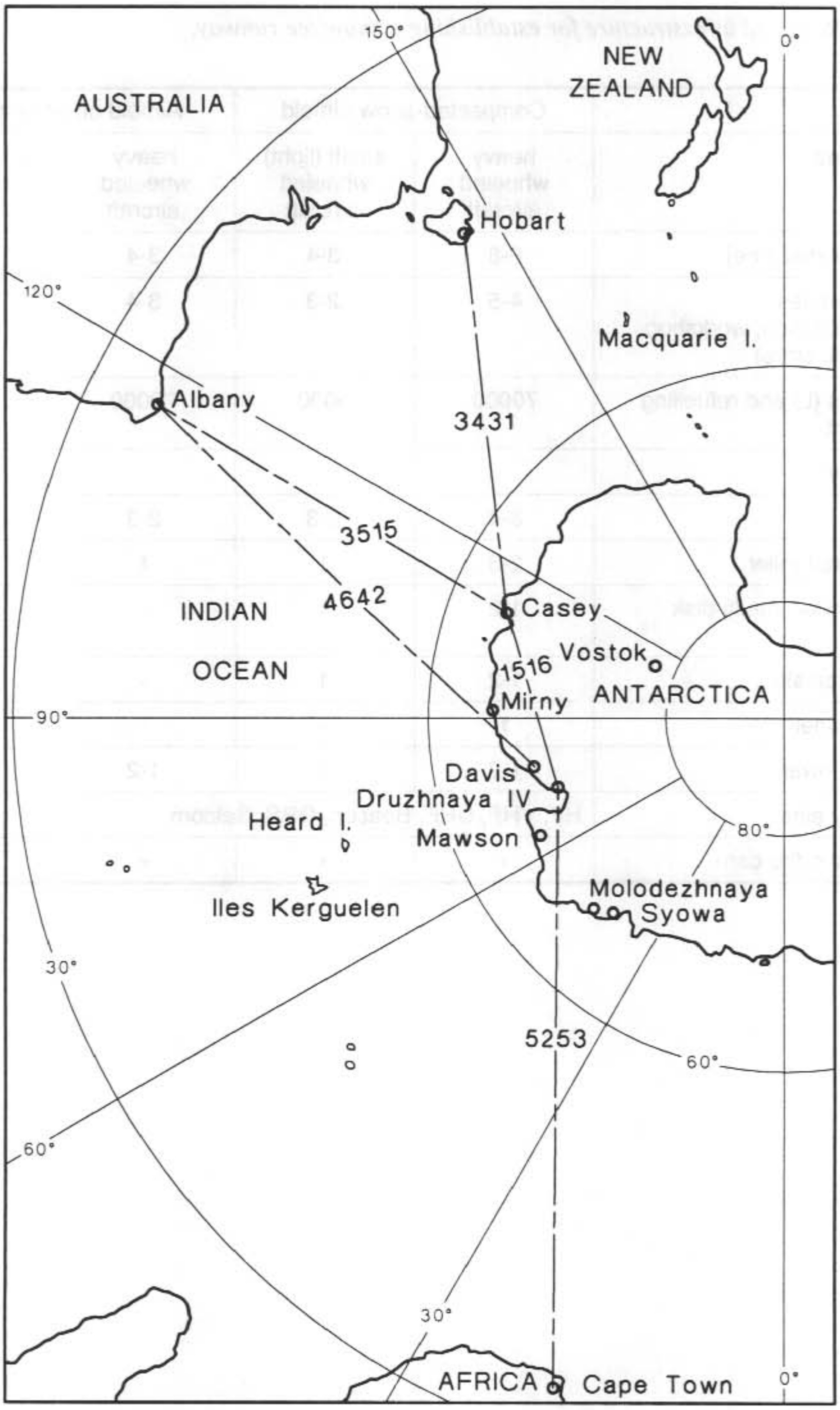

Figure 1. Distance in kilometres from entry points in Australia and Africa to potential runway sites in East Antarctica.

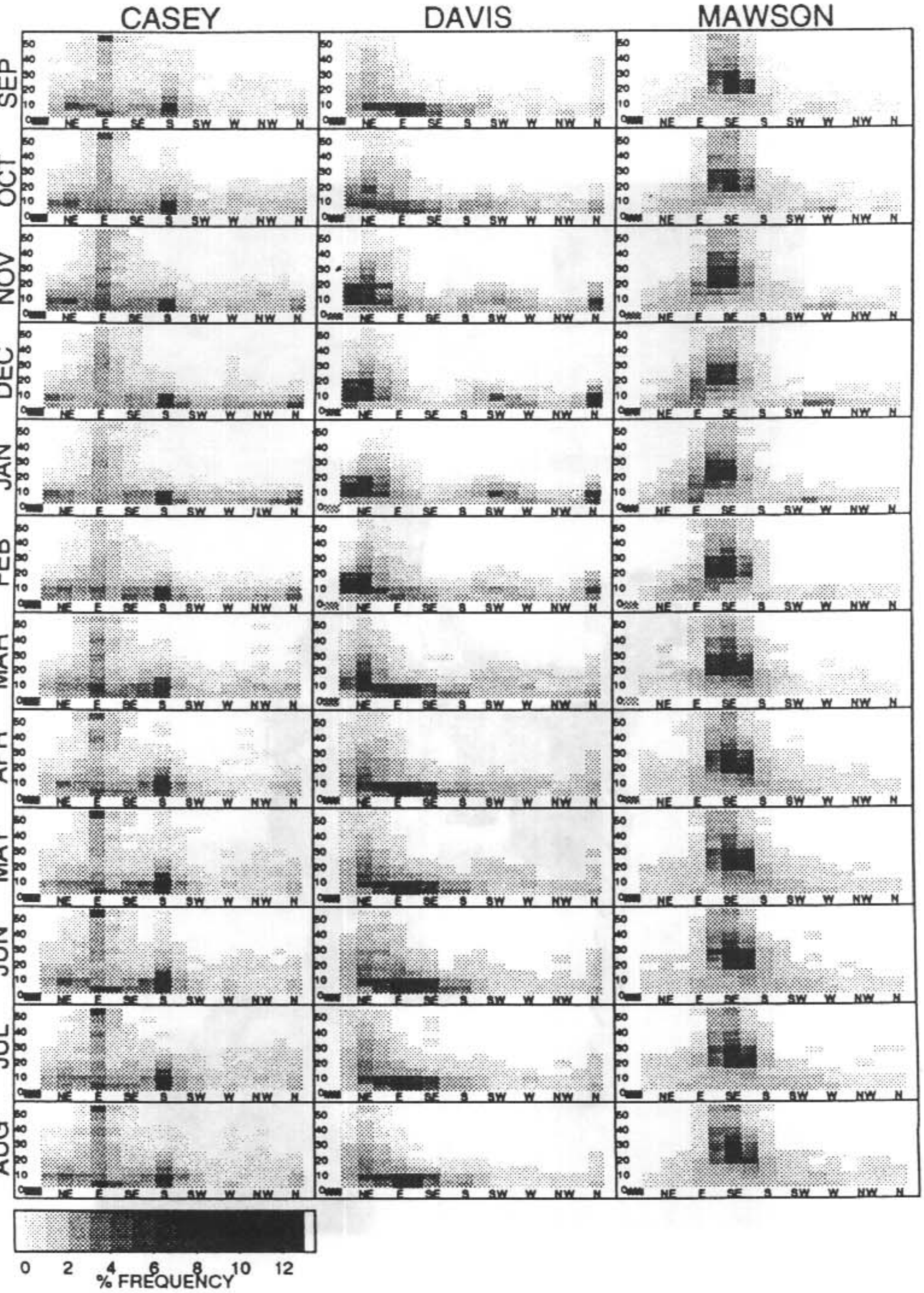

Figure 2. Wind frequency analyses (Ian Barnes-Keoghan, Doug Shepherd and Hugh Hutchinson 1993). Wind speeds have been divided into %-knot groups (1 to 5 knots, 6 to 10 knots ... 45 to 50 knots). Wind direction is one of sixteen compass points.

Figure 3. Ice coring with an electromechanical drill.

Figure 4. Stratigraphy analysis of an ice core in situ.

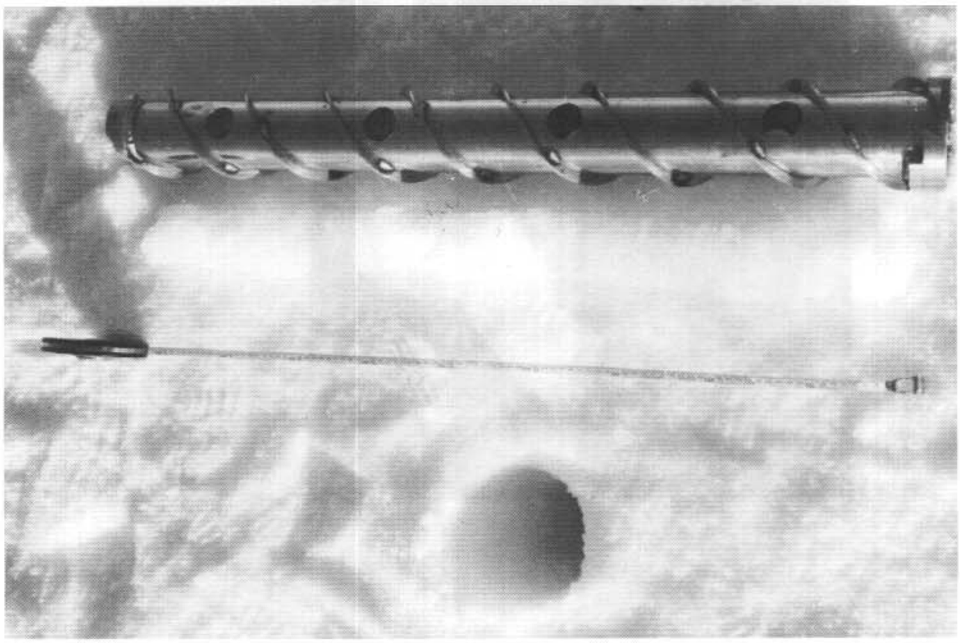

Figure 5. Ice core and drill leg.

Figure 6. Marking of a cane installed on the prospect runway site.

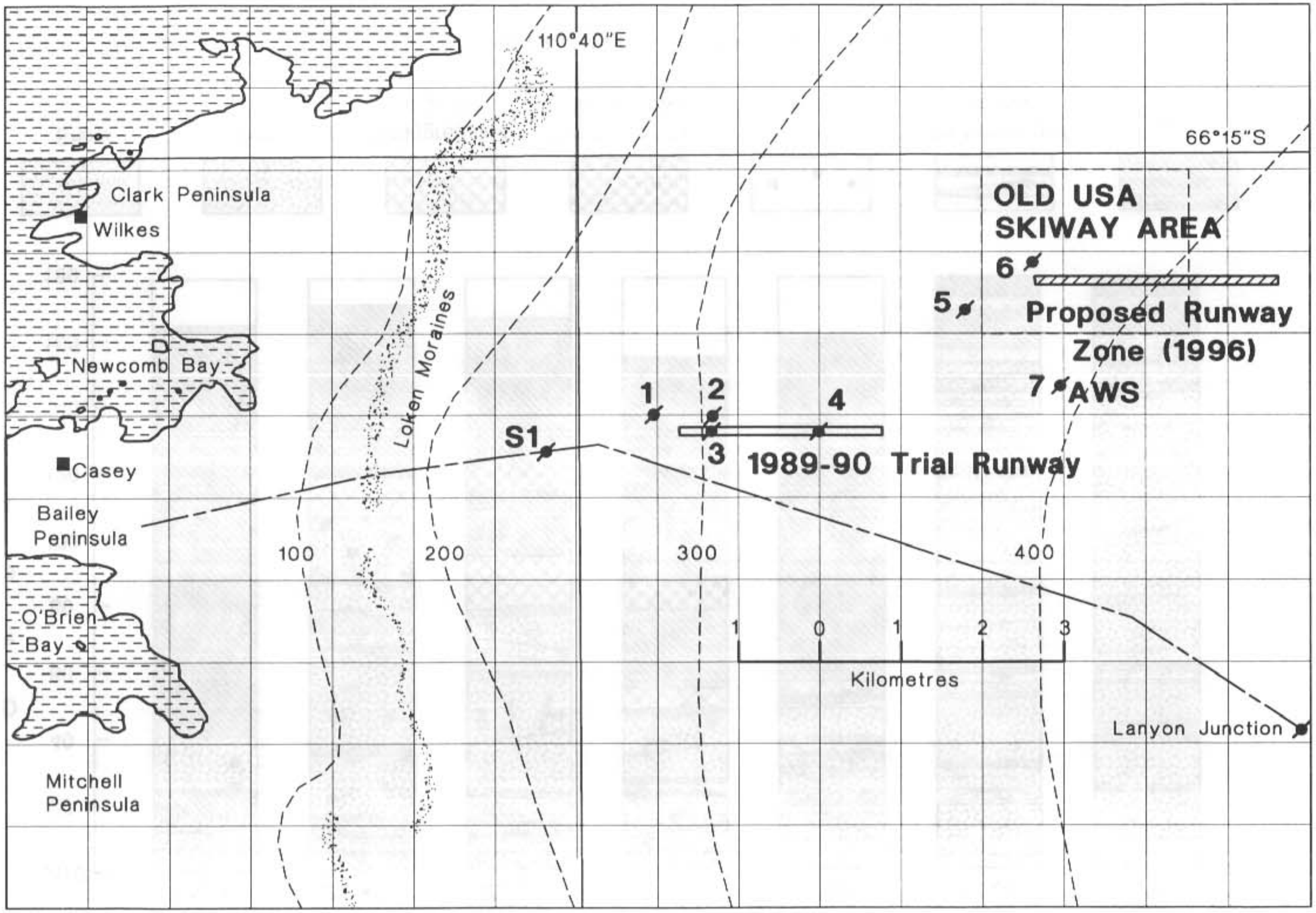

Figure 7. Casey area and proposed runway site.

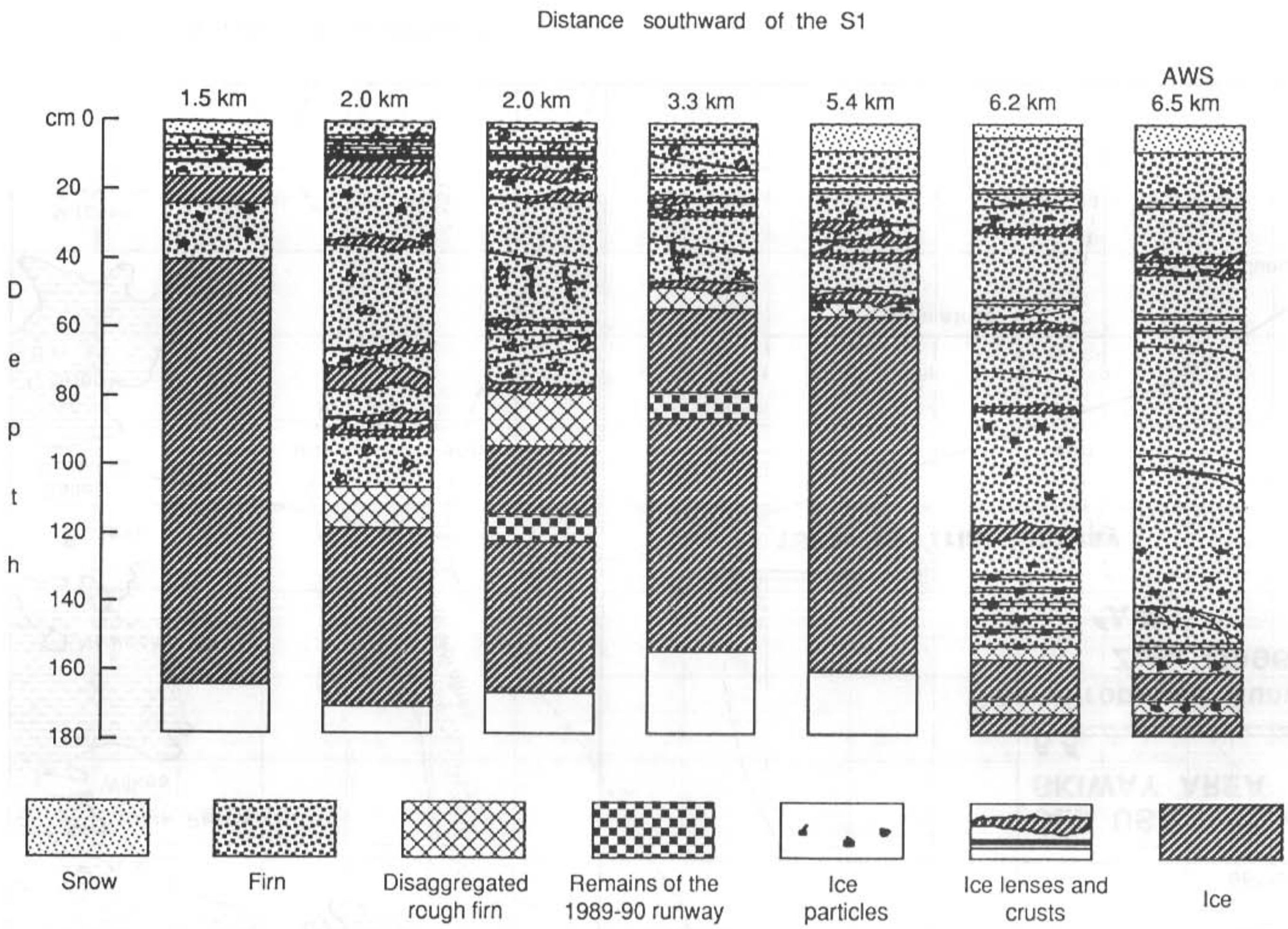

Figure 8. Stratigraphy of the upper layers inland of Casey station. Cores were taken on 27 January and on 26 February 1996.

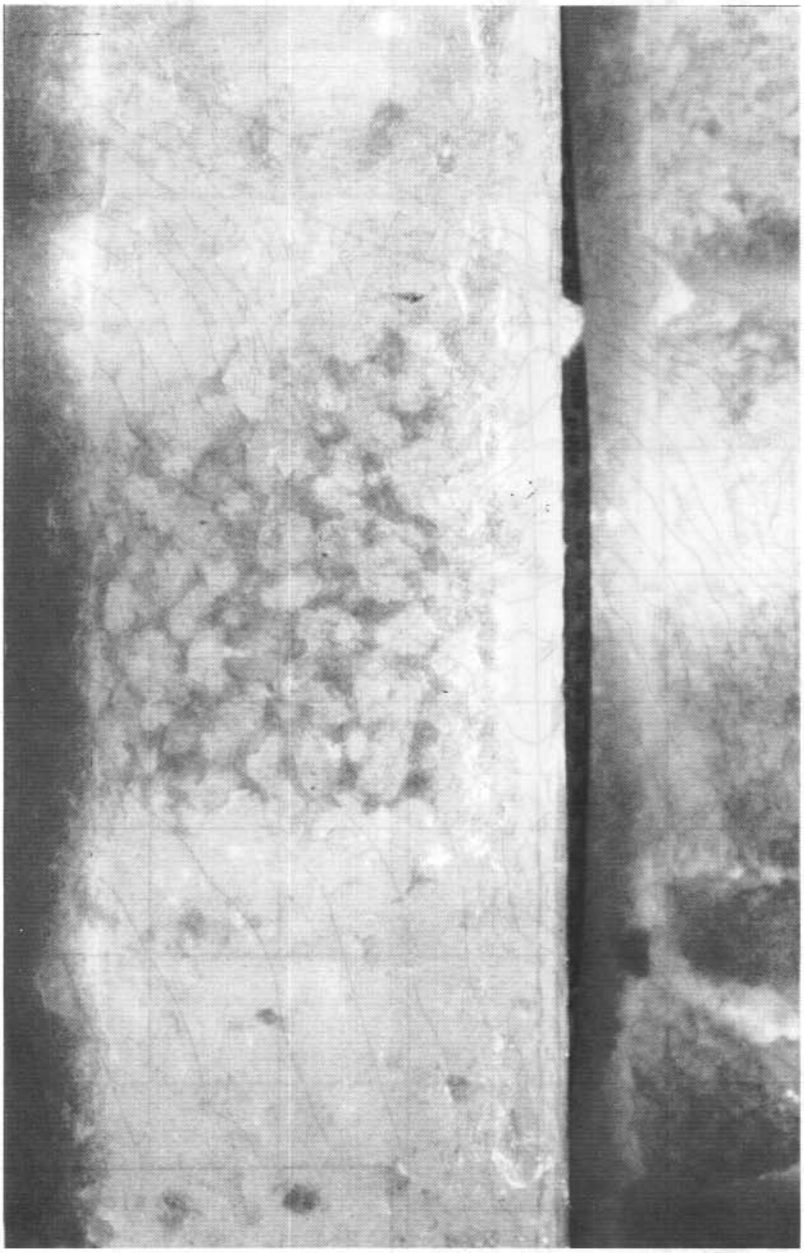

Figure 9. Remains of the old (1989–90) runway pavement east of Casey.

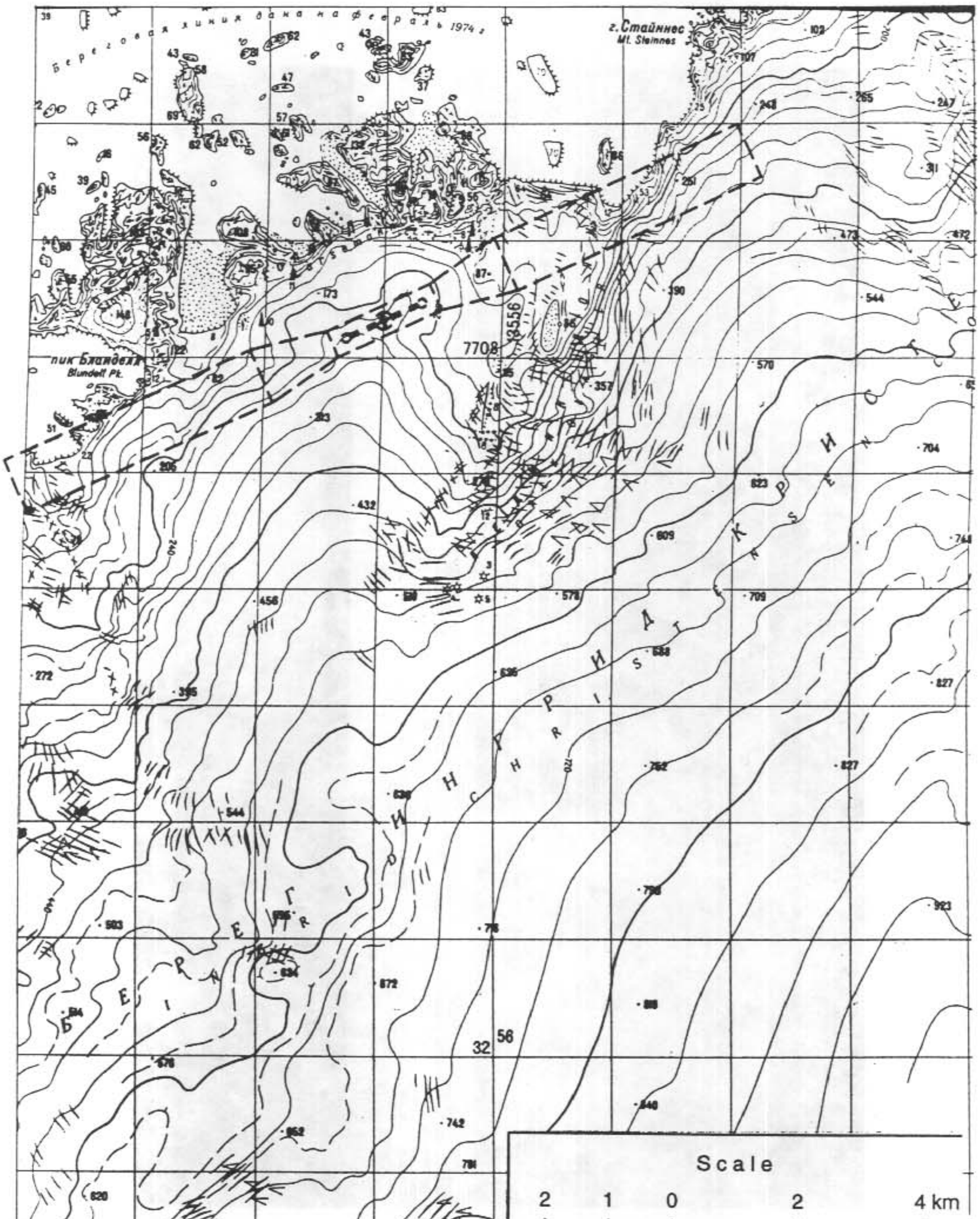

Figure 10. Larsemann Hills area and investigated runway site. (The runway centrepoint position: 69°26'S, 76°19'E.)

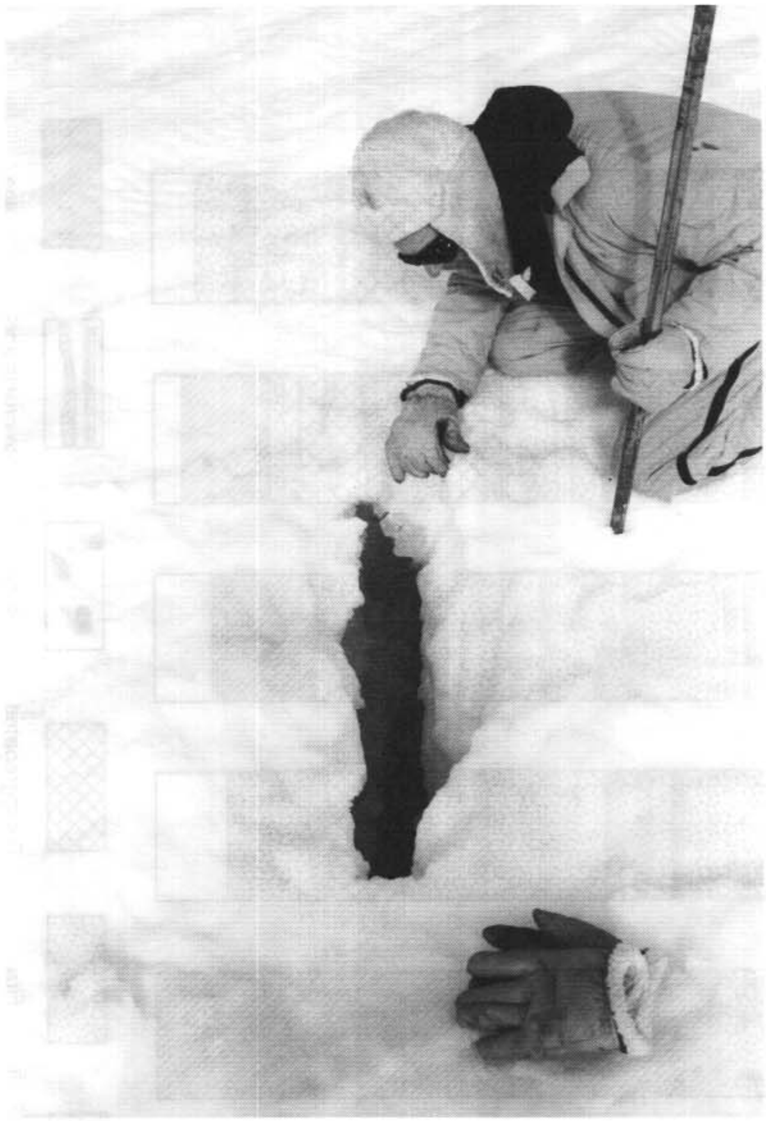

Figure 11. Crevassing at NE part of the runway south of the Larsemann Hills.

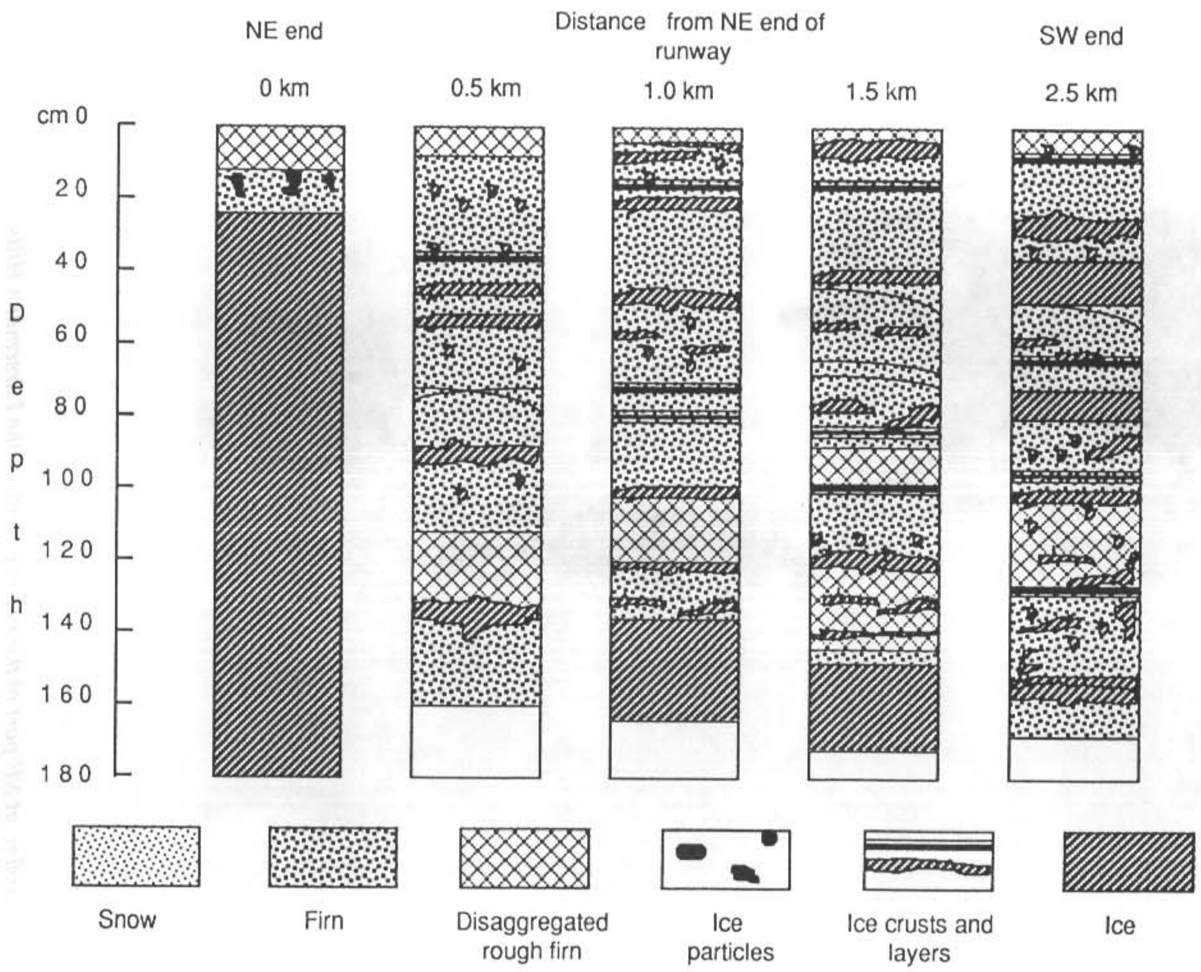

Figure 12. Stratigraphy of the upper layers southward of Larsemann Hills. All cores were taken on 5 February 1996.

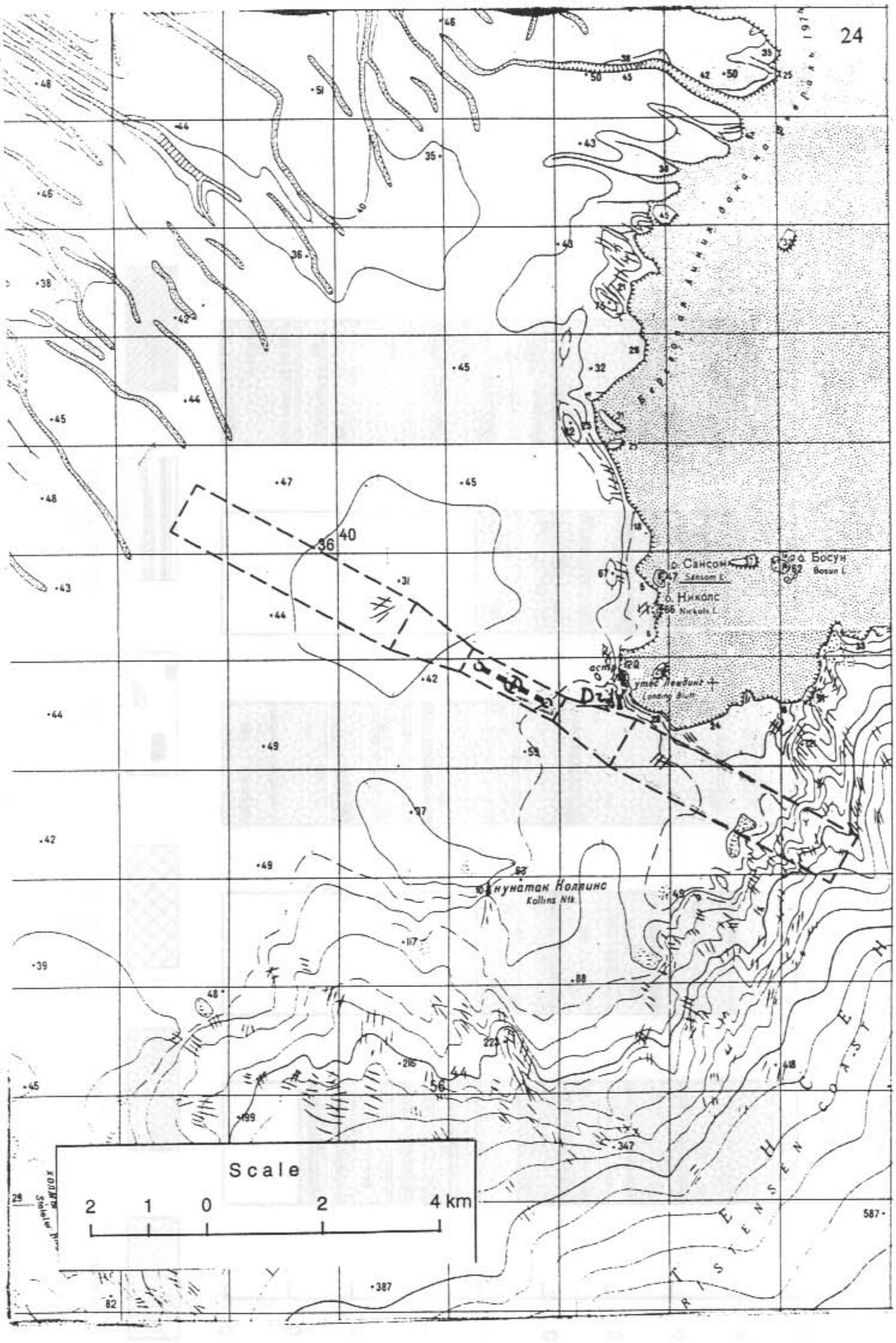

Figure 13. Druzyhnaya IV area and proposed runway site. (The runway centrepoint position: 69°45'S, 73°37'E.)

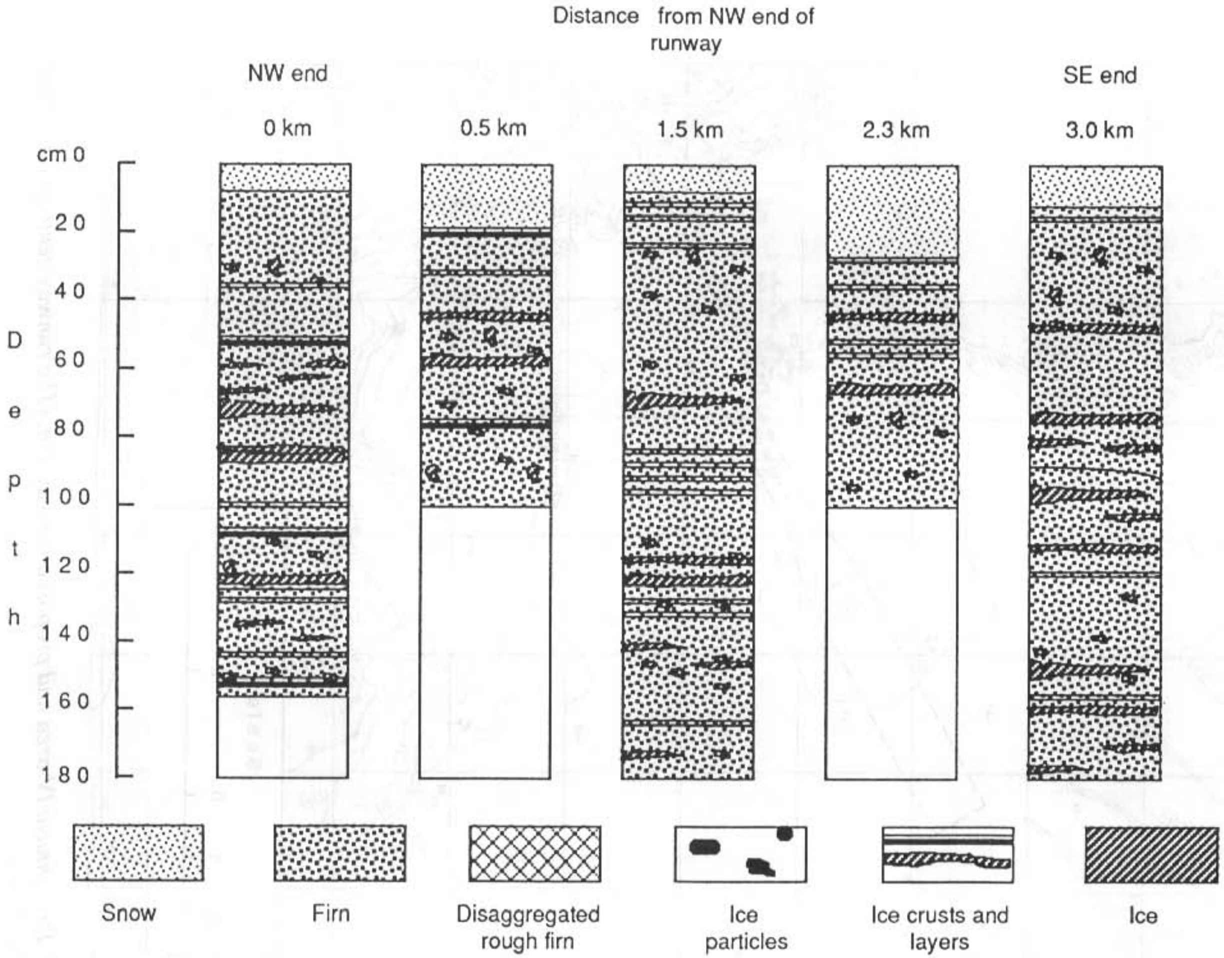

Figure 14. Stratigraphy of the upper layers of the Amery Ice Shelf nearby Druzhnaya IV station. Cores were taken on 7 February 1996.

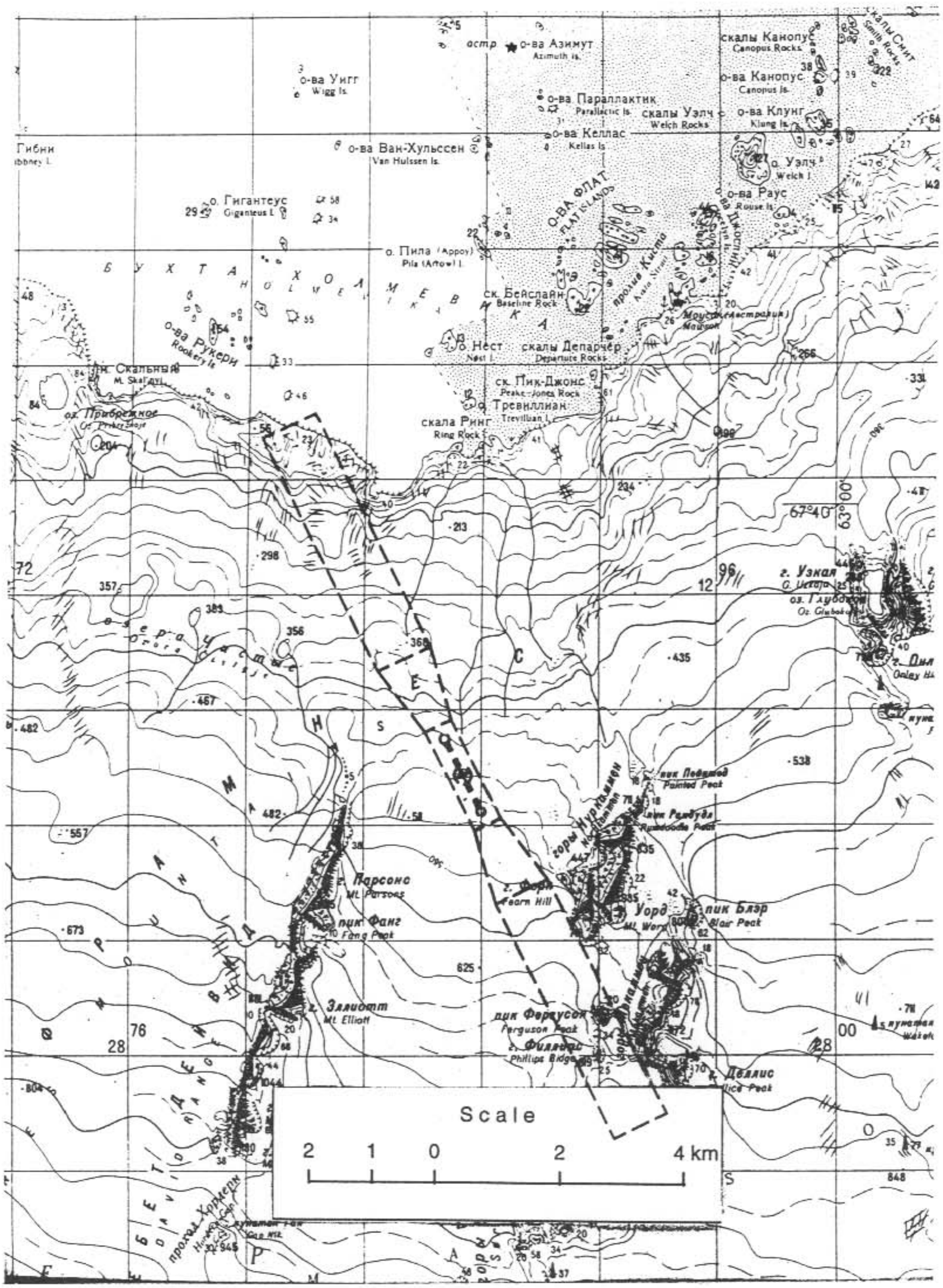

Figure 15. Mawson area and investigated runway site. (The runway centrepoint position: 67°45'S, 62°41'E.)

APPENDIX A.
CLIMATOLOGICAL SUMMARIES FOR CASEY, DAVIS AND MAWSON

Climatological Summary for CASEY

Site Number 300006 Latitude 66°17'00"S Longitude 110°32'00"E Elevation 12 metres Opened Jan 1969 Closed Dec 1989 All available data have been used

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years of Record
Mean Daily Maximum Temp (°C)	2.9	0.3	-3.7	-7.8	-9.2	-9.8	-10.6	-11.3	-10.6	-6.9	-2.1	2.1	-5.6	21
Highest Temperature (°C)	9.2	7.5	4.3	2.7	2.0	4.4	3.5	3.0	3.0	4.0	6.0	7.7	9.2	21
Lowest Maximum Temperature (°C)	-2.0	-6.9	-21.0	-21.0	-23.7	-25.0	-32.4	-30.1	-25.6	-20.3	-10.6	-4.0	-32.4	21
Mean Number of days over 30°C	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	21
Mean Number of days over 35°C	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	21
Mean Daily Minimum Temp (°C)	-1.9	-4.5	-9.3	-14.5	-16.4	-17.4	-18.3	-19.1	-18.3	-14.5	-9.1	-3.1	-12.2	21
Lowest Temperature (°C)	-9.6	-14.8	-26.1	-27.7	-32.7	-33.0	-41.0	-38.4	-34.1	-31.0	-21.9	-13.0	-41.0	21
Highest Minimum Temperature (°C)	3.3	2.2	-0.2	-2.0	-1.0	-1.7	-2.0	-3.0	-2.2	-3.0	0.0	2.0	3.3	21
Mean Number of Days below 2.2°C	30.5	28.2	31.0	29.9	30.9	29.8	30.9	30.9	29.7	31.0	30.0	30.9	363.5	21
Mean Number of Days below 0°C	26.6	27.3	31.0	29.9	30.9	29.8	30.9	30.9	29.7	31.0	30.0	28.7	356.5	21
Mean Daily Terrestrial Minimum (°C)														0
Lowest Daily Terrestrial Minimum (°C)														0
Number of Days Terrestrial below -0.9°C														0
Mean 9am Temperature (°C)	1.0	-1.7	-6.2	-11.0	-12.7	-13.6	-14.4	-15.0	-14.1	-10.0	-4.6	0.2	-8.5	21
Mean 3pm Temperature (°C)	1.5	-1.0	-5.7	-10.9	-12.8	-13.6	-14.6	-15.0	-13.7	-9.4	-3.9	0.5	-8.2	21
Mean 9am Relative Humidity (%)			56	58			70			65	62		62.2	1
Mean 3pm Relative Humidity (%)			59	58			65			63	62		61.3	1
Mean 9am Cloud Cover (oktas)	6.0	6.2	6.2	6.1	6.2	6.0	6.2	6.0	5.9	6.0	5.3	5.8	5.9	21
Mean 3pm Cloud Cover (oktas)	5.7	6.0	6.0	6.0	6.0	5.6	5.9	5.8	5.9	6.0	5.6	5.9	6.0	21
Maximum Wind Gust (km/h)	185	167	176	210	256	221	217	230	291	231	202	204	291	21
Mean Daily Wind Run (km)	423	441	542	529	573	570	722	747	726	675	574	459	582	6
Mean Number of Days of Strong Wind	9.9	7.9	12.0	11.3	12.6	13.7	15.2	15.1	13.0	11.9	11.5	10.0	144.0	21
Mean Number of Days of Gales	6.5	4.7	7.6	7.3	9.4	9.7	11.7	11.2	9.1	8.5	7.3	6.0	98.8	21
Mean Daily Pan Evaporation (mm)														0
Mean Daily Sunshine (hours)	6.5	5.0	3.1	2.0	1.0	0.4	0.5	1.2	3.3	4.9	6.3	5.2	3.3	5
Mean Number of Days with Hail	0.3	0.2	nil	0.2	0.1	0.1	0.1	nil	nil	0.2	0.1	0.1	1.7	21
Mean Number of Days with Snow	12.6	14.5	17.2	16.0	17.4	15.5	16.4	15.3	14.2	15.1	12.0	12.9	179.2	21
Mean Number of Days with Frost	nil	0.1	0.2	0.1	0.5	1.0	1.3	0.3	0.7	nil	nil	nil	4.5	21
Mean Number of Days with Fog	1.1	0.3	0.2	0.2	0.4	0.5	0.8	0.6	0.6	0.3	0.2	0.4	5.9	21
Mean Number of Days with Thunder	nil	nil	nil	0.1	nil	nil	nil	nil	nil	nil	nil	nil	0.1	20
Mean Number of Clear Days	2.4	1.8	1.7	2.0	1.8	2.1	1.9	2.7	2.8	2.0	3.0	2.1	26.3	22
Mean Number of Cloudy Days	16.6	15.6	16.5	13.8	14.8	13.4	13.9	13.7	14.3	14.7	11.7	14.8	173.8	22
Mean Monthly Rainfall (mm)	3.6	11.6	18.2	11.3	14.8	25.4	25.3	4.8	27.0	15.6	16.5	49.2	223.3	1
Highest Monthly Rainfall (mm)	3.6	11.6	18.2	11.3	14.8	25.4	25.3	4.8	27.0	15.6	16.5	49.2		1
Lowest Monthly Rainfall (mm)	3.6	11.6	18.2	11.3	14.8	25.4	25.3	4.8	27.0	15.6	16.5	49.2		1
Mean number of Rain days	2.0	6.0	8.0	9.0	11.0	12.0	7.0	6.0	10.0	8.0	6.0	14.0	99.0	1
Highest number of Rain days	2	6	8	9	11	12	7	6	10	8	6	14		1
Lowest number of Rain days	2	6	8	9	11	12	7	6	10	8	6	14		1

Prepared by Climate and Consultancy Section in the Tasmania and Antartica Regional Office of the Bureau of Meteorology on 15 March 1996

Climatological Summary for CASEY

Site Number 300017 Latitude 66°16'45"S Longitude 110°32'08"E Elevation 40 metres Opened Jan 1989 Still Open All available data have been used

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years of Record
Mean Daily Maximum Temp (°C)	2.5	0.5	-3.9	-6.9	-11.9	-10.9	-10.1	-10.6	-10.1	-7.8	-2.9	1.8	-5.9	6
Highest Temperature (°C)	9.2	6.6	2.8	3.0	3.4	4.2	7.5	1.3	3.9	0.8	4.8	7.1	9.2	6
Lowest Maximum Temperature (°C)	-1.8	-6.0	-15.3	-19.7	-28.2	-26.8	-27.4	-26.1	-24.1	-21.9	-10.4	-4.0	-28.2	6
Mean Number of days over 30°C	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	6
Mean Number of days over 35°C	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	6
Mean Daily Minimum Temp (°C)	-2.4	-4.4	-9.6	-14.0	-19.5	-18.7	-18.4	-18.2	-17.5	-14.3	-9.5	-3.5	-12.5	6
Lowest Temperature (°C)	-8.4	-15.8	-20.7	-26.4	-34.4	-33.8	-33.2	-32.5	-30.1	-31.2	-21.0	-13.0	-34.4	6
Highest Minimum Temperature (°C)	1.6	2.5	-2.9	-1.8	-3.2	0.0	-4.1	-4.5	-3.4	-4.0	-1.5	1.3	2.5	6
Mean Number of Days below 2.2°C	28.2	27.2	30.5	30.0	31.0	30.0	31.0	31.0	29.8	31.0	30.0	31.0	360.7	6
Mean Number of Days below 0°C	24.8	26.7	30.5	30.0	31.0	30.0	31.0	31.0	29.8	31.0	30.0	28.8	354.6	6
Mean Daily Terrestrial Minimum (°C)														0
Lowest Daily Terrestrial Minimum (°C)														0
Number of Days Terrestrial below -0.9°C	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	1
Mean 9am Temperature (°C)	0.6	-1.6	-6.6	-9.6	-15.1	-15.4	-14.3	-13.5	-13.9	-10.7	-5.3	0.1	-8.8	5
Mean 3pm Temperature (°C)	1.2	-1.1	-5.9	-9.3	-15.2	-15.6	-14.0	-13.4	-13.3	-9.8	-4.4	0.5	-8.4	5
Mean 9am Relative Humidity (%)		71	71	74			64						70.0	0
Mean 3pm Relative Humidity (%)		70	59			46	72						61.8	0
Mean 9am Cloud Cover (oktas)	6.0	6.0	6.2	6.4	5.8	5.6	5.6	5.4	5.6	5.8	4.4	5.4	5.7	5
Mean 3pm Cloud Cover (oktas)	6.0	6.2	6.2	6.0	5.8	5.2	5.8	5.8	5.6	6.0	4.4	5.4	5.7	5
Maximum Wind Gust (km/h)	150	171	241	222	215	217	241	204	228	213	181	161	241	5
Mean Daily Wind Run (km)	496	523	547	620	571	649	716	742	792	731	494	482	614	6
Mean Number of Days of Strong Wind	9.4	11.0	12.5	14.8	12.8	14.3	16.3	17.3	16.7	13.5	11.3	11.8	161.9	6
Mean Number of Days of Gales	7.2	6.2	6.8	10.0	9.0	10.5	11.5	12.5	11.8	10.0	5.3	5.8	106.7	6
Mean Daily Pan Evaporation (mm)														0
Mean Daily Sunshine (hours)	5.5	3.8	3.0	1.9	0.5	0.1	0.2	1.3	3.0	4.2	8.3	6.4	3.2	6
Mean Number of Days with Hail	0.7	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	0.7	3
Mean Number of Days with Snow	13.4	15.7	16.8	17.2	17.0	17.0	17.7	17.7	15.3	17.3	11.2	12.0	188.2	6
Mean Number of Days with Frost	nil	nil	nil	nil	0.5	nil	0.5	0.8	0.3	nil	nil	nil	2.0	4
Mean Number of Days with Fog	0.2	0.2	0.2	0.3	nil	0.3	0.8	0.3	0.2	0.3	nil	0.3	3.2	6
Mean Number of Days with Thunder	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	1
Mean Number of Clear Days	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	6
Mean Number of Cloudy Days	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	6
Mean Monthly Rainfall (mm)	3.2	16.4	15.4	6.2	81.0	34.8	16.4	23.8	5.4	26.6	1.4	30.6	261.2	1
Highest Monthly Rainfall (mm)	3.2	16.4	15.4	6.2	81.0	34.8	16.4	23.8	5.4	26.6	1.4	30.6		1
Lowest Monthly Rainfall (mm)	3.2	16.4	15.4	6.2	81.0	34.8	16.4	23.8	5.4	26.6	1.4	30.6		1
Mean number of Rain days	5.0	11.0	7.0	3.0	9.0	18.0	13.0	10.0	9.0	15.0	3.0	10.0	113.0	1
Highest number of Rain days	5	11	7	3	9	18	13	10	9	15	3	10		1
Lowest number of Rain days	5	11	7	3	9	18	13	10	9	15	3	10		1

Prepared by Climate and Consultancy Section in the Tasmania and Antartica Regional Office of the Bureau of Meteorology on 15 March 1996

Climatological Summary for DAVIS

Site Number 300000 Latitude 68°34'38"S Longitude 77°58'21"E Elevation 16 metres Opened Jan 1957 Still Open All available data have been used

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years of Record
Mean Daily Maximum Temp (°C)	3.1	-0.4	-5.9	-10.2	-12.7	-12.5	-14.6	-14.4	-13.3	-9.1	-2.7	2.3	-7.5	34
Highest Temperature (°C)	13.0	10.0	4.1	4.2	2.0	2.0	0.8	1.0	0.3	0.6	8.0	11.0	13.0	34
Lowest Maximum Temperature (°C)	-3.9	-9.2	-20.0	-28.9	-33.3	-32.1	-31.1	-34.4	-33.2	-21.0	-13.8	-5.5	-34.4	34
Mean Number of days over 30°C	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	34
Mean Number of days over 35°C	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	34
Mean Daily Minimum Temp (°C)	-1.1	-4.6	-11.1	-15.8	-18.8	-18.7	-20.7	-20.8	-20.2	-15.3	-7.8	-2.2	-13.1	34
Lowest Temperature (°C)	-8.3	-15.0	-26.7	-40.0	-38.3	-40.1	-39.0	-38.4	-36.2	-31.0	-19.8	-10.0	-40.1	34
Highest Minimum Temperature (°C)	4.0	3.6	1.0	0.6	-2.3	-0.9	-3.9	-3.9	-4.0	-3.9	1.8	4.0	4.0	34
Mean Number of Days below 2.2°C	30.0	27.8	31.0	30.0	30.9	29.9	31.0	31.0	30.0	30.9	30.0	30.5	363.2	34
Mean Number of Days below 0°C	23.9	27.2	31.0	30.0	30.9	29.9	31.0	31.0	30.0	30.9	29.9	26.6	352.3	34
Mean Daily Terrestrial Minimum (°C)														0
Lowest Daily Terrestrial Minimum (°C)														0
Number of Days Terrestrial below -0.9°C	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	1
Mean 9am Temperature (°C)	0.9	-2.6	-8.8	-13.3	-15.7	-15.6	-17.5	-17.7	-17.2	-12.1	-5.1	0.1	-10.4	33
Mean 3pm Temperature (°C)	1.8	-1.3	-6.9	-11.9	-15.4	-15.6	-17.6	-16.7	-14.9	-10.3	-3.7	1.0	-9.3	33
Mean 9am Relative Humidity (%)	49	46	51	48	72	56	59	76	62	56	43	52	55.8	4
Mean 3pm Relative Humidity (%)	53	50	52	59	69	69	60	57	51	62	50	56	57.3	4
Mean 9am Cloud Cover (oktas)	5.2	5.6	6.1	5.8	5.3	4.9	4.9	5.4	5.3	5.7	5.3	5.1	5.4	33
Mean 3pm Cloud Cover (oktas)	5.1	5.5	5.9	5.9	5.6	5.5	5.3	5.6	5.3	5.4	5.2	5.1	5.4	33
Maximum Wind Gust (km/h)	163	189	163	206	187	185	195	198	176	178	168	168	206	32
Mean Daily Wind Run (km)	426	449	438	393	390	426	418	410	386	433	490	463	427	33
Mean Number of Days of Strong Wind	4.9	5.3	6.2	6.1	6.0	7.1	6.7	6.6	5.7	7.5	8.5	6.8	77.2	34
Mean Number of Days of Gales	1.0	1.2	1.9	2.6	2.7	3.1	3.1	3.1	3.1	2.8	2.8	1.7	29.0	34
Mean Daily Pan Evaporation (mm)														0
Mean Daily Sunshine (hours)	8.9	5.8	3.2	2.2	0.7	0.0	0.2	1.9	4.1	5.3	7.6	9.6	4.1	30
Mean Number of Days with Hail	0.1	nil	nil	0.1	nil	0.2	nil	nil	0.1	0.1	0.1	0.1	0.9	34
Mean Number of Days with Snow	6.9	9.2	12.6	10.9	11.1	9.1	9.2	9.9	8.4	9.1	7.4	7.4	111.1	34
Mean Number of Days with Frost	0.1	0.1	0.3	0.2	0.4	0.1	0.3	0.1	0.1	0.1	nil	nil	1.7	34
Mean Number of Days with Fog	0.1	nil	0.1	0.1	0.4	0.4	0.2	0.3	0.2	0.1	nil	0.1	2.0	34
Mean Number of Days with Thunder	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	34
Mean Number of Clear Days	4.9	3.6	3.4	4.0	6.0	6.0	6.5	5.3	5.8	4.5	5.4	6.0	61.3	34
Mean Number of Cloudy Days	14.5	14.9	18.8	17.5	16.6	14.7	14.4	15.3	14.4	17.3	15.5	15.3	189.0	34
Mean Monthly Rainfall (mm)														
Highest Monthly Rainfall (mm)														
Lowest Monthly Rainfall (mm)														
Mean number of Rain days														
Highest number of Rain days														
Lowest number of Rain days														

Prepared by Climate and Consultancy Section in the Tasmania and Antartica Regional Office of the Bureau of Meteorology on 15 March 1996

Climatological Summary for MAWSON

Site Number 300001 Latitude 67°36'05"S Longitude 62°52'23"E Elevation 8 metres Opened Jan 1954 Still Open All available data have been used

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years of Record
Mean Daily Maximum Temp (°C)	2.7	-1.3	-7.2	-11.7	-13.5	-13.8	-15.2	-15.7	-14.5	-9.8	-2.7	2.2	-8.4	41
Highest Temperature (°C)	10.6	8.0	4.0	0.0	-1.8	-0.5	5.0	6.7	-0.1	0.0	6.1	9.3	10.6	41
Lowest Maximum Temperature (°C)	-3.0	-10.6	-18.9	-24.0	-30.0	-31.0	-31.8	-32.1	-30.0	-21.0	-12.2	-4.7	-32.1	41
Mean Number of days over 30°C	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	41
Mean Number of days over 35°C	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	41
Mean Daily Minimum Temp (°C)	-2.4	-7.3	-13.3	-17.2	-19.0	-19.6	-20.9	-21.7	-20.7	-16.3	-8.9	-3.1	-14.2	41
Lowest Temperature (°C)	-10.0	-17.3	-25.0	-29.0	-34.4	-34.0	-36.0	-35.9	-35.8	-29.0	-20.0	-10.5	-36.0	41
Highest Minimum Temperature (°C)	3.9	1.0	-2.0	-2.6	-5.8	-5.0	-6.0	-5.3	-6.1	-5.0	0.0	4.0	4.0	41
Mean Number of Days below 2.2°C	30.8	28.2	30.9	29.9	30.8	29.9	31.0	31.0	30.0	30.9	30.0	30.9	364.0	41
Mean Number of Days below 0°C	27.0	28.0	30.9	29.9	30.8	29.9	31.0	31.0	30.0	30.9	30.0	29.1	358.3	41
Mean Daily Terrestrial Minimum (°C)	-3.4	-9.1	-16.0	-17.3	-19.0	-18.9	-21.1	-21.6	-22.3	-15.8	-8.6	-3.0	-14.7	4
Lowest Daily Terrestrial Minimum (°C)	-11.7	-16.1	-26.1	-25.0	-30.6	-28.3	-32.2	-35.0	-32.2	-26.7	-20.6	-11.7	-35.0	4
Number of Days Terrestrial below -0.9°C	20.6	22.6	23.3	21.8	24.8	23.8	24.0	24.8	23.8	24.8	23.8	20.8	278.8	5
Mean 9am Temperature (°C)	-0.5	-5.4	-11.3	-14.9	-16.5	-16.8	-18.1	-19.0	-18.3	-13.7	-6.3	-0.9	-11.8	41
Mean 3pm Temperature (°C)	1.9	-2.0	-8.3	-13.3	-16.1	-16.8	-18.1	-18.0	-15.8	-10.8	-3.5	1.3	-10.0	40
Mean 9am Relative Humidity (%)	54	50	51	36	48	57	42	50	51	50	52	53	49.4	6
Mean 3pm Relative Humidity (%)	57	52	44	44	55	61	46	57	50	51	51	55	51.8	5
Mean 9am Cloud Cover (oktas)	5.2	4.8	4.7	4.5	3.9	3.6	3.9	4.2	4.5	4.6	4.9	5.0	4.8	41
Mean 3pm Cloud Cover (oktas)	5.1	4.9	4.9	4.7	4.6	4.7	4.9	4.7	4.8	4.8	5.0	5.1	4.5	40
Maximum Wind Gust (km/h)	198	191	185	234	206	221	217	248	222	204	204	191	248	40
Mean Daily Wind Run (km)	761	926	982	959	961	993	962	983	962	931	946	776	928	40
Mean Number of Days of Strong Wind	24.1	25.7	28.4	26.4	27.1	26.3	27.1	27.9	26.8	27.5	27.1	23.7	318.1	39
Mean Number of Days of Gales	7.7	9.5	12.8	12.0	13.7	14.7	14.7	14.8	13.9	12.8	11.9	8.1	146.5	39
Mean Daily Pan Evaporation (mm)														0
Mean Daily Sunshine (hours)	8.3	7.8	5.3	3.8	1.6	0.0	0.6	2.9	5.0	7.4	8.7	9.0	5.0	40
Mean Number of Days with Hail	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	0.1	0.1	41
Mean Number of Days with Snow	7.4	4.5	4.2	4.5	4.5	4.5	4.8	5.2	5.0	5.0	5.2	7.0	62.0	41
Mean Number of Days with Frost	nil	nil	nil	nil	nil	0.1	nil	nil	nil	nil	nil	nil	0.4	41
Mean Number of Days with Fog	0.2	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	0.2	0.4	41
Mean Number of Days with Thunder	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	41
Mean Number of Clear Days	4.4	5.1	6.0	7.4	9.1	8.5	7.8	7.7	6.9	6.9	6.0	5.2	81.1	41
Mean Number of Cloudy Days	14.4	10.8	11.2	9.6	8.9	8.9	9.8	9.7	9.9	12.0	13.3	13.6	132.0	41
Mean Monthly Rainfall (mm)														
Highest Monthly Rainfall (mm)														
Lowest Monthly Rainfall (mm)														
Mean number of Rain days														
Highest number of Rain days														
Lowest number of Rain days														

Prepared by Climate and Consultancy Section in the Tasmania and Antartica Regional Office of the Bureau of Meteorology on 15 March 1996

APPENDIX B.
PERCENTAGE OCCURRENCE OF WIND SPEED AND DIRECTION FOR CASEY, DAVIS AND MAWSON

BUREAU OF METEORGLOGY

National Climate Centre
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BUREAU OF METEOROLOGY - SURFACE WIND ANALYSIS

PERCENTAGE OCCURRENCE OF SPEED VERSUS DIRECTION BASED ON 22 YEARS OF RECORDS

FIRST YEAR : 1969 LAST YEAR : 1990 NUMBER OF MISSING OBSERVATIONS (AS PERCENTAGE OF MAXIMUM POSSIBLE) : 6.74 %

STATION : 300006 CASEY 66 17 S. 110 32 E 12.0 M ELEV

JANUARY 0900 HOURS LST — SPEED (KM/HR) — CALM 9

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	3	5	6	1				15
NE	1	2	4	2	*	1	1	10
E	1	1	2	2	1	3	8	18
SE	1	2	2	1	*	1	2	8
S	2	6	8	2	*	*	*	19
SW	1	3	2	*				7
W	2	3	2	*				6
NW	3	3	1	*				9
ALL	15	25	27	8	2	4	10	

NO. OF OBS. 647

FEBRUARY 0900 HOURS LST — SPEED (KM/HR) — CALM 7

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	4	4	1	*			11
NE	1	3	5	3	1	*	*	13
E	1	1	4	2	2	2	6	19
SE	1	2	4	1	*	*	1	10
S	2	7	11	2		*	*	22
SW	1	2	2	*				5
W	*	1	2					3
NW	2	3	3	*				9
ALL	11	23	36	8	4	3	8	

NO. OF OBS. 563

MARCH 0900 HOURS LST — SPEED (KM/HR) — CALM 6

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	3	1				6
NE	1	2	5	3	*	1	1	13
E	1	3	5	3	2	2	10	26
SE	1	2	3	3	*		2	11
S	2	5	14	5	*	1	*	27
SW	1	1	2	*		*		4
W	1	1	1	*				3
NW	*	1	2	1	*			4
ALL	7	16	35	15	3	4	13	

NO. OF OBS. 620

APRIL 0900 HOURS LST — SPEED (KM/HR) — CALM 10

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	1	1	*	*		4
NE	*	2	5	1	*	1	*	10
E	1	3	4	3	2	2	10	24
SE	1	2	5	2	1	1	2	13
S	1	4	17	6	2	1	*	32
SW	*	1	2	1	*			5
W	*	*	1	*	*		*	2
NW	*	*	1				*	1
ALL	6	14	36	13	5	4	12	

NO. OF OBS. 628

JANUARY 1500 HOURS LST — SPEED (KM/HR) — CALM 6

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	3	7	6	1	*			17
NE	1	2	5	2	1	*	*	11
E	1	1	2	1	2	2	7	16
SE	1	2	4	1	*	*	1	9
S	2	5	5	1	*			13
SW	1	3	2	*				6
W	2	5	3	*				10
NW	3	6	3	*				12
ALL	14	29	30	6	3	3	9	

NO. OF OBS. 647

FEBRUARY 1500 HOURS LST — SPEED (KM/HR) — CALM 8

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	6	6	1	*			15
NE	1	3	6	2	1	*	*	12
E	1	1	2	2	2	2	5	15
SE	2	3	4	1	1	1	1	11
S	2	5	7	1		*	*	15
SW	2	2	1	*	*			5
W	2	3	2	*	*			7
NW	3	5	3	*				11
ALL	14	27	31	7	3	3	7	

NO. OF OBS. 565

MARCH 1500 HOURS LST — SPEED (KM/HR) — CALM 8

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	2	4	1	*			8
NE	1	2	5	2	*	1	1	11
E	2	2	6	3	1	3	10	26
SE	2	4	4	1	1	*	2	13
S	2	6	9	2	1	1		21
SW	1	1	2	*	*	*		4
W	1	1	1	1				3
NW	1	1	2	*			*	5
ALL	9	18	34	10	4	5	12	

NO. OF OBS. 620

APRIL 1500 HOURS LST — SPEED (KM/HR) — CALM 10

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	1	1	*			3
NE	1	3	5	2	*	*	*	12
E	2	4	5	2	1	2	9	24
SE	2	3	5	2	1	1	1	15
S	2	6	13	6	2	1		29
SW	*	1	2	*	*	*		5
W	*	*	1			*		1
NW	*	*	*	*		*		1
ALL	9	18	33	12	4	4	11	

NO. OF OBS. 629

* OCCURRED BUT LESS THAN 0.5 PERCENT

PRODUCED BY M.I.S.S. 30/ 3/94

B 3

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National Climate Centre
TEL: (03) 669 4082 FAX: (03) 6694515

BUREAU OF METEOROLOGY - SURFACE WIND ANALYSIS

PERCENTAGE OCCURRENCE OF SPEED VERSUS DIRECTION BASED ON 22 YEARS OF RECORDS

FIRST YEAR : 1969 LAST YEAR : 1990 NUMBER OF MISSING OBSERVATIONS (AS PERCENTAGE OF MAXIMUM POSSIBLE) : 6.74 %

STATION : 300006 CASEY 66 17 S. 110 32 E 12.0 M ELEV

MAY 0900 HOURS LST — CALM 11 — SPEED (KM/HR)

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	1	1	*			3
NE	1	2	6	2	1	*	1	13
E	3	3	4	2	1	2	13	27
SE	2	2	4	1	*	*	1	10
S	1	5	15	5	1	1	1	29
SW	*	1	1	*	*			3
W	*	*	1	*			*	2
NW	*	*	*	*				1
ALL	8	15	33	12	3	3	15	

NO. OF OBS. 647

JUNE 0900 HOURS LST — CALM 14 — SPEED (KM/HR)

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	2	1	*	*	*	4
NE	1	1	5	2	1	1	1	11
E	2	3	3	2	2	2	12	27
SE	2	2	4	1	*	*	2	11
S	2	4	13	3	2	1	*	23
SW	1	1	2	*	*			5
W	1	1	1	*	*		*	3
NW	*	*	1	*	*		*	2
ALL	8	13	30	9	6	4	17	

NO. OF OBS. 628

JULY 0900 HOURS LST — CALM 10 — SPEED (KM/HR)

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	2	1	*	*		4
NE	1	2	4	2	1	1	*	11
E	2	2	4	2	1	2	17	30
SE	2	4	4	2	1	*	2	15
S	2	4	12	4	1	1	*	24
SW	*	1	2	*				3
W	*	*	1	*				2
NW	*	*	*	1		*		2
ALL	8	14	28	12	4	4	19	

NO. OF OBS. 650

AUGUST 0900 HOURS LST — CALM 13 — SPEED (KM/HR)

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	1	1	1		*		4
NE	1	2	5	1	*	1	1	11
E	3	2	4	2	2	1	16	31
SE	2	2	3	2	1	1	1	11
S	1	4	10	3	2	1	1	22
SW	*	1	2	*	*			3
W	*	*	1	*	*		*	2
NW	1	*	1	1				2
ALL	9	12	26	11	5	4	20	

NO. OF OBS. 651

MAY 1500 HOURS LST — CALM 12 — SPEED (KM/HR)

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	2	*				4
NE	1	2	4	1	*	*	*	9
E	2	2	6	2	2	2	13	30
SE	2	3	3	2	*	*	2	13
S	1	5	12	4	1	1	*	26
SW	*	1	2	*	*			4
W	*	*	*		*			1
NW	*	*	1	*				2
ALL	8	15	31	10	4	3	16	

NO. OF OBS. 649

JUNE 1500 HOURS LST — CALM 13 — SPEED (KM/HR)

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	1	2	1	*	*		5
NE	1	2	6	2	*	1	1	13
E	2	2	4	3	1	2	14	27
SE	2	4	3	2	1	*	2	14
S	1	4	9	5	1	*	*	21
SW	1	1	1	*				3
W	*	1	1	*				2
NW	*	*	1	*	*			2
ALL	8	15	27	12	4	4	17	

NO. OF OBS. 626

JULY 1500 HOURS LST — CALM 10 — SPEED (KM/HR)

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	1	1	*		*	3
NE	1	3	4	2	*	*	1	11
E	3	3	4	2	2	2	18	33
SE	2	3	3	2	1	*	2	13
S	2	5	10	4	1	*		22
SW	1	1	1	*	*	*		4
W	*	*	1	*				2
NW	*	*	1	1	*	*	*	2
ALL	9	15	26	12	4	3	21	

NO. OF OBS. 649

AUGUST 1500 HOURS LST — CALM 13 — SPEED (KM/HR)

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	1	1	1	*	*		3
NE	1	2	5	1	1	*	1	12
E	2	4	4	2	1	2	15	32
SE	2	2	5	2	1	*	2	14
S	2	3	10	3	1	1		19
SW	*	1	2	*	*			4
W		1	1	*	*	*		2
NW		*	1	*	*	*		1
ALL	7	15	28	10	5	4	18	

NO. OF OBS. 650

* OCCURRED BUT LESS THAN 0.5 PERCENT

PRODUCED BY M.I.S.S. 30/ 3/94

BUREAU OF METEOROLOGY

National Climate Centre
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BUREAU OF METEOROLOGY - SURFACE WIND ANALYSIS

PERCENTAGE OCCURRENCE OF SPEED VERSUS DIRECTION BASED ON 22 YEARS OF RECORDS

FIRST YEAR : 1969 LAST YEAR : 1990 NUMBER OF MISSING OBSERVATIONS (AS PERCENTAGE OF MAXIMUM POSSIBLE) : 6.74 %

STATION : 300006 CASEY 66 17 S. 110 32 E 12.0 M ELEV

SEPTEMBER 0900 HOURS LST — SPEED (KM/HR) — CALM 14

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	1	2	1	*			5
NE	1	2	7	3	1	*	1	15
E	1	2	4	2	1	1	12	23
SE	1	2	3	1	*	*	2	9
S	1	5	12	3	2	1	1	25
SW	1	3	2	1	*	*		6
W	*	1	*	*	*	*		2
NW	*		1	1	*	*		2
ALL	6	16	31	11	4	3	15	

NO. OF OBS. 624

OCTOBER 0900 HOURS LST — SPEED (KM/HR) — CALM 12

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	2	4	1	*			8
NE	2	3	6	3	*	1	1	15
E	1	2	3	2	2	1	12	22
SE	1	2	2	1	*	*	1	8
S	2	7	13	3	*	*	*	26
SW	*	1	2	*	*		*	4
W	*	1	1	*		*		3
NW		1	1	*				2
ALL	6	19	32	11	3	3	14	

NO. OF OBS. 618

NOVEMBER 0900 HOURS LST — SPEED (KM/HR) — CALM 8

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	5	4	1				11
NE	1	4	7	4	1	*	*	17
E	1	2	3	3	2	2	11	22
SE	1	1	3	1	1	1	2	8
S	3	5	7	2	1	*		18
SW	1	2	1	*				5
W	1	1	1	*	*	*		4
NW	1	2	3	1	*	*		6
ALL	12	21	29	11	4	3	13	

NO. OF OBS. 598

DECEMBER 0900 HOURS LST — SPEED (KM/HR) — CALM 7

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	5	5	1				13
NE	1	2	3	2	1	*	*	10
E	1	1	2	1	2	2	10	20
SE	1	2	2	1	1	*	2	8
S	2	5	7	1	*			16
SW	2	3	3	1				8
W	2	3	2	*	*			7
NW	3	6	2		*			11
ALL	13	28	26	7	4	3	11	

NO. OF OBS. 619

SEPTEMBER 1500 HOURS LST — SPEED (KM/HR) — CALM 14

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	3	1	*	*		6
NE	1	2	8	3	1	1	1	16
E	3	3	5	2	1	2	12	27
SE	2	3	4	1	1	*	2	13
S	1	4	6	3	2	1	1	18
SW	*	1	1	*	*			2
W	*	*	1	*	*	*		3
NW		1	*	*	*			1
ALL	7	16	28	11	5	3	15	

NO. OF OBS. 623

OCTOBER 1500 HOURS LST — SPEED (KM/HR) — CALM 13

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	2	5	1	*	*		9
NE	2	4	8	3	*	*	1	19
E	2	3	3	2	1	2	11	23
SE	2	3	3	1	*	*	2	10
S	1	6	5	2	*	*	*	15
SW	*	2	2	*	*			4
W	*	*	2	1	*	*		3
NW	*	1	2	*	*	*		4
ALL	9	21	28	10	2	4	13	

NO. OF OBS. 619

NOVEMBER 1500 HOURS LST — SPEED (KM/HR) — CALM 10

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	3	5	5	1				14
NE	1	4	7	4	1	*	*	17
E	2	2	2	2	2	1	10	21
SE	*	2	2	1	1	1	2	9
S	1	3	5	1	1	*	*	11
SW	1	2	1	*				4
W	2	2	2	1	*			7
NW	2	2	3	1	*	*		8
ALL	12	22	27	11	5	2	13	

NO. OF OBS. 600

DECEMBER 1500 HOURS LST — SPEED (KM/HR) — CALM 6

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	3	8	8	1	*	*		21
NE	*	2	4	2	1	*	*	9
E	*	*	1	1	1	1	9	15
SE	*	2	2	1	*	*	1	6
S	2	4	6	1	*			13
SW	1	3	3					6
W	2	4	3	*				10
NW	3	6	3	*				12
ALL	13	30	31	6	2	2	11	

NO. OF OBS. 617

* OCCURRED BUT LESS THAN 0.5 PERCENT

PRODUCED BY M.I.S.S. 30/ 3/94

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BUREAU OF METEOROLOGY - SURFACE WIND ANALYSIS

PERCENTAGE OCCURRENCE OF SPEED VERSUS DIRECTION BASED ON 32 YEARS OF RECORDS

FIRST YEAR : 1957 LAST YEAR : 1992 NUMBER OF MISSING OBSERVATIONS (AS PERCENTAGE OF MAXIMUM POSSIBLE) : 15.45 %

STATION : 300000 DAVIS 68 35 S. 77 58 E 12.2 M ELEV

JANUARY 0900 HOURS LST

SPEED (KM/HR) — CALM 2

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	6	16	7	1	*		31
NE	*	1	12	17	8	4	2	44
E		*	3	3	2	1	1	11
SE	*	*	*	*	*			1
S	*	*	*	*				1
SW	*	1	2	*				4
W	1	2	1	*				4
NW	1	1	*					2
ALL	4	12	35	27	11	5	2	

NO. OF OBS. 929

FEBRUARY 0900 HOURS LST

SPEED (KM/HR) — CALM 2

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	2	5	4	1	1	*	15
NE	1	4	15	16	8	4	3	51
E	1	5	5	3	2	1	1	18
SE	1	3	2	*	*			7
S	1	2	1	*				3
SW	1	*	*	*	*			2
W	1	*	1					2
NW	*	*	*					1
ALL	6	18	30	24	11	6	4	

NO. OF OBS. 817

MARCH 0900 HOURS LST

SPEED (KM/HR) — CALM 4

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	2	1	1	1	*	5
NE	1	3	11	8	5	4	4	35
E	3	8	13	2	1	1	1	29
SE	2	6	8	1	*		*	17
S	1	2	2	*				4
SW	*	*	1	1	*			3
W		1	1	*				2
NW		*	*	*				1
ALL	6	21	38	14	7	6	4	

NO. OF OBS. 928

APRIL 0900 HOURS LST

SPEED (KM/HR) — CALM 6

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	1	1	1	*	1	*	5
NE	1	3	7	5	3	2	4	25
E	3	10	14	2	1	1	1	33
SE	1	8	10	1		*		20
S	1	2	2	*				6
SW	*	1	1	1	*			3
W	*	*	1	*				2
NW	*	1	*	*				1
ALL	8	25	37	10	5	4	5	

NO. OF OBS. 926

JANUARY 1500 HOURS LST

SPEED (KM/HR) — CALM 1

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	5	21	10	3	*	*	39
NE		*	5	9	7	4	2	27
E	*	*	*	1	1	1	1	3
SE		*	*					*
S		*	*	*				1
SW	*	1	8	3	*			12
W	1	5	4	1	*			11
NW	1	3	2					6
ALL	2	15	41	23	11	5	2	

NO. OF OBS. 926

FEBRUARY 1500 HOURS LST

SPEED (KM/HR) — CALM 1

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	4	14	9	4	1		32
NE	*	1	7	12	8	6	3	37
E	*	*	*	1	1	*	1	4
SE	*	*	*					*
S	*	1	1	*				3
SW	1	2	6	1	*			9
W	2	4	3	*	*			9
NW	*	3	1	*				5
ALL	4	15	33	23	13	7	3	

NO. OF OBS. 818

MARCH 1500 HOURS LST

SPEED (KM/HR) — CALM 5

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	4	6	4	2	1	1	18
NE	1	3	10	9	7	5	4	39
E	1	2	4	*	*	*	*	8
SE	2	3	2	*	*			7
S	2	3	3	1				8
SW	1	2	3	1				6
W	1	2	2	*				5
NW	*	1	1	*				3
ALL	8	20	29	16	9	7	5	

NO. OF OBS. 927

APRIL 1500 HOURS LST

SPEED (KM/HR) — CALM 9

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	2	2	1	1	1	*	9
NE	1	3	7	5	4	3	3	27
E	3	6	7	2	1	1	2	22
SE	3	7	6	*	*	*		16
S	2	4	4	*		*		10
SW	*	1	2	*		*		5
W	*	*	1	*				2
NW	*	*	*					1
ALL	10	25	30	10	6	5	5	

NO. OF OBS. 928

* OCCURRED BUT LESS THAN 0.5 PERCENT

PRODUCED BY M.I.S.S. 30/ 3/94

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BUREAU OF METEOROLOGY - SURFACE WIND ANALYSIS

PERCENTAGE OCCURRENCE OF SPEED VERSUS DIRECTION BASED ON 32 YEARS OF RECORDS

FIRST YEAR : 1957 LAST YEAR : 1992 NUMBER OF MISSING OBSERVATIONS (AS PERCENTAGE OF MAXIMUM POSSIBLE) : 15.46 %

STATION : 300000 DAVIS 68 35 S. 77 58 E 12.2 M ELEV

MAY 0900 HOURS LST

CALM 9

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	1	1	*	*	*	3
NE	1	3	6	4	3	3	4	24
E	3	10	14	3	1	1	1	33
SE	3	6	10	1	*			20
S	1	2	3	*	*		*	6
SW	*	1	1	1	*		*	3
W	*	1	1	*				2
NW	*	*	*					*
ALL	9	23	36	10	5	4	6	

NO. OF OBS. 958

JUNE 0900 HOURS LST

CALM 7

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	1	1	*	*	*	3
NE	1	3	6	3	2	4	6	25
E	2	9	15	3	1	1	2	34
SE	2	6	11	1	*	*		20
S	2	2	3	*	*			7
SW	*	*	1	*	*			2
W	*	*	1	*				1
NW		*	*	*				1
ALL	8	21	36	9	4	6	7	

NO OF OBS. 924

JULY 0900 HOURS LST

CALM 10

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	1	1	*	1	*	4
NE	1	3	7	4	3	3	5	27
E	2	8	16	3	1	1	1	33
SE	2	5	10	1	*	*		18
S	1	2	3	*				6
SW	*	1	1	*				2
W	*	*	*	*				1
NW	*	*	*					*
ALL	6	20	37	11	4	5	7	

NO. OF OBS. 960

AUGUST 0900 HOURS LST

CALM 7

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	2	1	*	*	1	4
NE	1	3	7	4	2	2	6	25
E	2	10	19	3	1	1	1	38
SE	1	6	10	1	*			18
S	1	2	2	*				5
SW	*	*	1	*				2
W	*	*	*	*				1
NW			*					*
ALL	6	21	41	9	4	3	8	

NO. OF OBS. 960

MAY 1500 HOURS LST

CALM 9

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	1	1	1	*	*	*	4
NE	1	2	7	5	2	3	4	24
E	2	9	14	2	2	1	1	31
SE	2	7	10	1	*			20
S	1	2	3	*	*	*	*	3
SW	1	*	1	1	*	*		3
W	*	*	1	*	*			2
NW	*	*	*	*				1
ALL	8	22	36	10	5	5	5	

NO. OF OBS. 960

JUNE 1500 HOURS LST

CALM 6

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	1	*	*	1	*	3
NE	1	2	5	4	3	3	6	24
E	3	10	13	3	2	2	2	34
SE	3	6	10	1	*	*		20
S	2	2	3	*	*			7
SW	*	*	1	*	*			2
W	*	*	*	*				1
NW	*	*	*	*				1
ALL	9	22	33	9	6	5	8	

NO. OF OBS. 927

JULY 1500 HOURS LST

CALM 8

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	1	*	*	*	*	4
NE	1	3	6	3	3	3	5	25
E	2	9	16	3	1	1	1	34
SE	1	6	10	1	*	*		19
S	1	3	3	*	*			8
SW	*	1	1	*	*			2
W	*	*	*	*				*
NW	*	*						*
ALL	7	22	38	8	6	5	7	

NO. OF OBS. 959

AUGUST 1500 HOURS LST

CALM 11

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	1	1	1	1	1	*	5
NE	1	4	7	4	3	3	6	29
E	3	9	11	3	1	1	1	30
SE	2	7	5	1	*	*		15
S	1	3	2	*	*			7
SW	*	1	1	*	*			2
W	*	*	1	*				1
NW	*	*	*					*
ALL	8	25	29	10	5	5	8	

NO OF OBS. 957

* OCCURRED BUT LESS THAN 0.5 PERCENT

PRODUCED BY M.I.S.S. 30/ 3/94

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PERCENTAGE OCCURRENCE OF SPEED VERSUS DIRECTION BASED ON 32 YEARS OF RECORDS

FIRST YEAR : 1957 LAST YEAR : 1992 NUMBER OF MISSING OBSERVATIONS (AS PERCENTAGE OF MAXIMUM POSSIBLE) : 15.46 %

STATION : 300000 DAVIS 68 35 S. 77 58 E 12.2 M ELEV

SEPTEMBER 0900 HOURS LST

CALM 11

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	1	1	*	1	1	4
NE	1	3	7	3	2	3	5	24
E	2	10	15	2	1	1	1	33
SE	1	6	9	1	*	*	*	18
S	1	2	2	*				5
SW	*	*	1	*				2
W	*	*	1		*			1
NW		*	*					*
ALL	7	23	36	7	5	5	6	

NO. OF OBS. 928

OCTOBER 0900 HOURS LST

CALM 12

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	2	4	2	1	*	*	11
NE	1	3	10	7	5	4	6	36
E	2	6	6	2	2	1	1	21
SE	2	6	3	*				11
S	1	2	2	*	*			4
SW	*	1	1	*	*			2
W	*	1	1	*				2
NW	*	1	*					1
ALL	8	21	27	11	7	6	8	

NO. OF OBS. 958

NOVEMBER 0900 HOURS LST

CALM 6

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	3	11	5	2	1	*	25
NE	*	2	10	12	9	7	6	46
E	*	1	2	2	2	2	1	11
SE		1	*	*	*			2
S	*	1	1	*				2
SW	1	1	1	*				3
W	1	1	1	*				3
NW	1	1	*					2
ALL	5	12	26	20	14	10	8	

NO. OF OBS. 900

DECEMBER 0900 HOURS LST

CALM 2

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	7	17	6	2	*	*	33
NE	*	1	9	14	10	7	4	44
E	*	*	2	3	2	2	1	10
SE	*	*	*	*				1
S	*	*	1					1
SW	*	1	1	*				3
W	1	2	1					3
NW	1	1	*					3
ALL	4	13	31	23	14	9	5	

NO. OF OBS. 927

SEPTEMBER 1500 HOURS LST

CALM 16

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	2	3	2	*	1	1	10
NE	1	3	10	5	2	2	5	29
E	2	3	5	2	1	1	1	15
SE	2	3	2	*	*			8
S	2	3	4	1				10
SW	1	2	2	*				6
W	1	1	1	*				3
NW	1	*	*					2
ALL	11	19	28	10	4	4	7	

NO. OF OBS. 926

OCTOBER 1500 HOURS LST

CALM 6

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	6	9	4	2	1	*	24
NE	1	1	6	6	5	5	5	29
E	*	*	1	1	1	1	1	7
SE	1	1	1	*	*			2
S	1	1	5	1				8
SW	1	3	7	1				12
W	2	3	2	*				7
NW	2	2	1					5
ALL	9	17	32	13	8	7	7	

NO. OF OBS. 961

NOVEMBER 1500 HOURS LST

CALM 1

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	4	13	10	3	2	1	33
NE		1	3	10	7	7	7	34
E		*	*	1	1	*	1	4
SE		*		*				*
S		*	1	*		*		1
SW	1	2	7	2	*			12
W	1	5	4	*	*			11
NW	1	2	1					5
ALL	4	14	30	24	10	9	8	

NO. OF OBS. 899

DECEMBER 1500 HOURS LST

CALM 1

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	5	20	7	2	1	*	36
NE		*	4	8	7	6	4	28
E			*	*	1	1	1	3
SE			*					*
S		*	*	*				1
SW	*	2	7	2		*		12
W	1	5	6	*				13
NW	1	3	2	*				6
ALL	2	15	41	18	10	8	5	

NO. OF OBS. 930

* OCCURRED BUT LESS THAN 0.5 PERCENT

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PERCENTAGE OCCURRENCE OF SPEED VERSUS DIRECTION BASED ON 39 YEARS OF RECORDS

FIRST YEAR : 1954 LAST YEAR : 1992 NUMBER OF MISSING OBSERVATIONS (AS PERCENTAGE OF MAXIMUM POSSIBLE) : 4.07 %

STATION : 300001 MAWSON 67 36 S. 62 52 E 8.2 M ELEV

JANUARY 0900 HOURS LST — SPEED (KM/HR) — CALM 3

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	*	*				*
NE	*	*	*	*	*			1
E	1	1	2	3	4	7	6	23
SE	*	*	2	10	15	22	18	67
S	*	*	*	1	1	1	1	5
SW	*	*	*					1
W	*	*						1
NW	*	*						*
ALL	2	2	5	14	20	30	25	

NO. OF OBS. 1178

FEBRUARY 0900 HOURS LST — SPEED (KM/HR) — CALM *

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N								
NE		*		*				*
E		*	*	1	2	4	5	12
SE			2	7	15	23	28	75
S		*	1	3	3	4	2	12
SW		*	*					*
W		*						*
NW					*			*
ALL		1	3	11	20	30	35	

NO. OF OBS. 1079

MARCH 0900 HOURS LST — SPEED (KM/HR) — CALM 1

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*		*	*				*
NE	*	*	*	*				*
E	*	*	1	1	1	3	4	10
SE	*	*	2	6	11	19	28	67
S	*	*	2	3	4	5	5	20
SW	*	*	*			*		*
W	*	*	*			*		*
NW		*	*					*
ALL	1	1	6	10	17	27	38	

NO. OF OBS. 1176

APRIL 0900 HOURS LST — SPEED (KM/HR) — CALM 4

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*		*	*			*
NE	*	*	1	*	*			1
E	*	1	2	2	1	3	6	14
SE	*	1	3	7	11	14	24	61
S	*	1	3	4	3	3	3	18
SW	*	*	1	*		*		2
W	*	*	*	*	*			1
NW		*	*	*				*
ALL	1	4	9	13	16	21	32	

NO. OF OBS. 1138

JANUARY 1500 HOURS LST — SPEED (KM/HR) — CALM 5

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	1					2
NE	1	3	6	1	*			11
E	3	3	8	9	6	5	6	40
SE	1	*	1	3	6	6	9	26
S	*	*	*	*	*	*	*	1
SW	1	2	1					4
W	3	3	1	*				7
NW	1	2	1					3
ALL	9	15	20	13	12	11	15	

NO. OF OBS. 1146

FEBRUARY 1500 HOURS LST — SPEED (KM/HR) — CALM 2

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	1					1
NE	*	2	3	1	*			6
E	1	2	8	10	6	4	5	36
SE	*	1	4	8	10	9	14	47
S	*	*	1	1	*	*	*	2
SW	1	*	*	*				1
W	*	1	1	*				3
NW	*	1	*					1
ALL	3	8	19	19	17	13	19	

NO. OF OBS. 1045

MARCH 1500 HOURS LST — SPEED (KM/HR) — CALM 3

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	*	*				1
NE	*	*	1	*	*	*		2
E	1	1	4	4	4	3	5	22
SE	1	1	5	10	14	11	19	61
S	1	1	2	2	1	1	1	8
SW	*	*	*		*			1
W	*	*	1	*				2
NW	*	*	*	*	*			1
ALL	3	5	13	16	19	16	25	

NO. OF OBS. 1147

APRIL 1500 HOURS LST — SPEED (KM/HR) — CALM 5

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	*			*		*
NE	*	*	*	1		*	*	2
E	*	1	2	4	3	3	5	18
SE	*	1	3	9	11	14	18	57
S	*	2	3	2	3	2	1	14
SW	*	1	1	*	*			2
W	*	1	*	*				1
NW	*	*		*				*
ALL	2	6	9	16	17	20	25	

NO. OF OBS. 1106

* OCCURRED BUT LESS THAN 0.5 PERCENT

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D 2

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STATION : 300001 MAWSON 67 36 S, 62 52 E 8.2 M ELEV

MAY — 0900 HOURS LST (CALM 7)

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	*	*				*
NE	*	*	1	*				1
E	*	1	1	1	2	2	6	13
SE	*	*	3	6	9	16	25	59
S	*	1	3	2	3	3	4	17
SW	*	1	1	*	*			2
W	*	*	*	*				1
NW	*	*	*					*
ALL	2	4	8	9	14	21	36	

NO. OF OBS. 1173

JUNE — 0900 HOURS LST (CALM 7)

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	*			*		1
NE	*	*	*	*	*	*		1
E	*	1	1	1	2	3	6	14
SE	*	1	2	4	8	15	26	57
S	1	1	2	1	3	3	3	15
SW	*	1	1	*	*			3
W	*	*	*	*				1
NW		*	*					*
ALL	3	4	8	7	13	22	35	

NO. OF OBS. 1138

JULY — 0900 HOURS LST (CALM 8)

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	*		*	*		1
NE	*	*	*	*	*	*		1
E	*	1	1	1	2	3	6	14
SE	*	*	2	4	9	15	25	56
S	1	1	2	2	2	4	3	15
SW	1	1	1		*		*	3
W	*	1	*	*			*	1
NW	*	*	*	*				1
ALL	3	4	7	8	14	22	35	

NO. OF OBS. 1175

AUGUST — 0900 HOURS LST (CALM 8)

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N			*	*	*			*
NE	*		1	*	*	*		1
E	*	*	1	1	2	3	7	14
SE	*	1	3	5	9	14	27	59
S	*	1	2	2	2	3	4	14
SW	*	1	1					2
W	*	1	1					2
NW	*		*		*			*
ALL	1	4	9	8	13	20	38	

NO. OF OBS. 1173

MAY — 1500 HOURS LST (CALM 7)

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N		*	*	*				*
NE	*	*	*	*	*			1
E	*	1	1	1	2	3	6	14
SE	*	1	3	5	11	15	24	59
S	*	1	2	2	3	4	3	15
SW	1	1	1	*	*			3
W	*	*	*	*	*			1
NW	*	*	*					*
ALL	3	5	7	10	15	21	32	

NO. OF OBS. 1137

JUNE — 1500 HOURS LST (CALM 7)

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	*	*				1
NE	*	*	*	*		*		1
E	1	*	1	1	2	3	6	14
SE	*	1	1	5	10	16	26	59
S	*	1	1	2	3	3	4	13
SW	*	1	1	*		*	*	3
W	*	1	*	*			*	2
NW	*	*	*	*				1
ALL	3	4	6	8	14	22	36	

NO. OF OBS. 1103

JULY — 1500 HOURS LST (CALM 9)

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	*	*				1
NE	*	*	*	*	*		*	1
E	1	1	1	1	2	3	7	15
SE	1	1	2	4	9	16	23	56
S	*	1	2	2	2	3	3	14
SW	*	1	1	*	*			3
W	*	1	*	*				2
NW		*	*					*
ALL	2	5	8	8	14	21	32	

NO. OF OBS. 1144

AUGUST — 1500 HOURS LST (CALM 9)

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	*	*				1
NE	*	*	1	*	*			2
E	*	1	1	2	2	3	7	16
SE	1	1	2	6	9	14	24	56
S	*	1	1	2	2	2	3	12
SW	*	1	1	*	*	*		2
W	*	1	*	*	*	*		2
NW	*	*	*	*				*
ALL	3	5	7	11	14	19	33	

NO. OF OBS. 1146

* OCCURRED BUT LESS THAN 0.5 PERCENT

PRODUCED BY M.I.S.S. 30/ 3/94

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SEPTEMBER 0900 HOURS LST — CALM 7

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	*	*		*		1
NE	*	*	1	*				1
E	1	1	1	1	2	3	7	14
SE	*	1	2	5	10	15	26	60
S	*	1	1	2	4	3	2	13
SW	*	1	1	*	*		*	2
W	*	*	*	*	*			1
NW	*	*	*	*	*	*		1
ALL	2	3	7	9	16	21	35	

NO. OF OBS. 1138

OCTOBER 0900 HOURS LST — CALM 5

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	*	*				1
NE	*	*	*			*		1
E	*	*	1	1	2	3	7	14
SE	*	*	2	6	11	18	26	64
S	*	*	1	2	2	3	2	12
SW	*	*	*	*	*			1
W	*	1	*		*			2
NW	*	*	*	*				1
ALL	2	3	6	9	15	24	35	

NO. OF OBS. 1172

NOVEMBER 0900 HOURS LST — CALM 2

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*		*				*
NE	*	*	*	*		*		1
E	*	*	1	1	3	6	8	21
SE		1	1	6	13	20	27	67
S	*	*	*	2	2	1	2	7
SW	*	*	*	*		*		1
W	*	*	*	*	*			1
NW					*			*
ALL	1	2	4	9	It	∠8	36	

NO. OF OBS. 1138

DECEMBER 0900 HOURS LST — CALM 3

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	*	*				1
NE	*	*	1	*	*	*		1
E	1	1	3	4	5	7	7	27
SE	*	1	3	8	14	18	18	60
S	*	*	1	1	1	1	1	4
SW	*	*			*			*
W	1	*			*			1
NW	1	*	*					1
ALL	3	3	8	13	20	25	25	

NO. OF OBS. 1176

SEPTEMBER 1500 HOURS LST — CALM 9

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	*					1
NE	1	1	1	*				3
E	1	1	2	3	3	4	7	21
SE	*	*	3	7	9	11	20	50
S	1	*	1	1	1	1	1	6
SW	1	2	2	*		*		4
W	1	3	2	*				6
NW	*	*	*	*				1
ALL	4	8	10	13	13	16	28	

NO. OF OBS. 1106

OCTOBER 1500 HOURS LST — CALM 7

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	2	*					2
NE	*	2	2	1	*			5
E	*	2	5	7	5	5	7	31
SE	*	*	2	5	6	6	16	35
S	*	*	*	*	1	*	*	2
SW	1	2	1	*				4
W	3	5	3	*	*			11
NW	*	1	1	*	*			3
ALL	5	14	15	14	12	11	23	

NO. OF OBS. 1143

NOVEMBER 1500 HOURS LST — CALM 4

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	1	1	*				3
NE	*	3	5	2	*			10
E	1	1	5	9	7	7	8	38
SE		*	1	4	4	7	14	32
S			*	*	*	*	*	1
SW	*	1	*	*				2
W	2	3	2					8
NW	1	2	1					3
ALL	6	11	16	15	12	14	23	

NO. OF OBS. 1109

DECEMBER 1500 HOURS LST — CALM 8

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	1		*			2
NE	1	3	5	1	1	*		11
E	2	3	7	9	7	6	6	40
SE	*	*	1	2	3	5	10	22
S	*	1	*	*		*	*	2
SW	*	2	1					3
W	1	4	2					8
NW	1	2	1					4
ALL	7	16	19	12	11	11	17	

NO. OF OBS. 1145

APPENDIX C.
POSITION OF MAJOR POINTS AT INVESTIGATED POTENTIAL RUNWAY SITES

(GPS reading, 1996)

Point	Station (Location)	Comment	Geographical Coordinate WGS84		Mercator Coordinate WGS84		
			Latitude	Longitude	Easting	Northing	Zone
1	**Casey**	stratigraphy sampling point, 1996	66°16.7'S	110°41.25'E	485971.5	2649030.5	49
2	(The Baley Peninsula)	stratigraphy sampling point, 1996	66°16.7'S	110°42.2'E	486682.3	2649034.0	49
3		stratigraphy sampling point, 1996 (1989-90 trial airstrip)	66°16.8'S	110°42.25'E	486720.6	2648848.4	49
4		stratigraphy sampling point, 1996 (1989-90 trial airstrip)	66°16.8'S	110°43.9'E	487955.0	2648854.0	49
5		stratigraphy sampling point, 1996	66°16.0'S	110°46.4'E	489819.9	2650347.6	49
6		stratigraphy sampling point, 1996 (US skiway area)	66°15.7'S	110°47.4'E	490566.6	2650907.5	49
7		stratigraphy sampling point, 1996 (AWS)	66°16.5'S	110°47.9'E	490945.7	2649422.5	49
8	**Progress** (The Larsemann Hills)	centrepoint of the 1987 airstrip alignment	69°26.3'S	76°19.2'E	551736.1	2296202.4	43
9		NE end of the 1996 airsprip alignment	69°25.8'S	76°20.5'E	552605.6	2297113.0	43
10		SW end of the 1996 airsprip alignment	69°26.6'S	76°17.3'E	550483.4	2295671.5	43
11	**Druzhnaya IV** (The Amery Ice Shelf,	centrepoint of the 1987 airstrip alignment	69°43.8'S	73°35.6'E	443615.9	2263609.8	43
12	Sansom Island area)	NW end of the 1996 airstrip alignment	69°44.2'S	73°34.6'E	444988.9	2262851.6	43
13		SE end of the 1996 airstrip alignment	69°45.0'S	73°38.5'E	447533.9	2261422.3	43
14	**Mawson** (The Framnes Mountains area)	SE end of the 1990 airstrip alignment	67°45.8'S	110°42.5'E	487700	2483500	41
15		NW end of the 1990 airstrip alignment	67°44.4'S	110°40.55'E	486300	2486100	41
16		SE end of the 1996 airstrip alignment	67°45'36.2"	62°42'27.2"	487647.6	2483858.4	41
17		500 m to NW (330°)	67°45'20.9"	62°42'3.7"	487370.3	2484330.8	41
18		1000 m to NW (330°)	67°45'6.2"	62°41'41.0"	487100.8	2484783.1	41
19		1500 m to NW (330°)	67°44'50.7"	62°41'16.3"	486808.6	2485261.9	41
20		2000 m to NW (330°)	67°44'34.9"	62°40'52.0"	486520.7	2485750.3	41
21		2500 m to NW (330°)	67°44'18.0"	62°40'26.2"	486216.1	2486272.9	41
22		3000 m to NW (330°) (NW end of the 1996 airstrip alignment)	67°44'02.2"	62°40'1.3"	485920.8	2486761.5	41

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