

APPENDIX A

**ICE THICKNESS MEASUREMENTS BETWEEN INGRAHM TRAIL AND LOCKHART
LAKE, DECEMBER 7 - 14, 1995**

03-Feb-95 SURTHICK WB1 Page 1

ECHO BAY WINTER ROAD ICE THICKNESS SURVEY			
FOR BHP DIAMONDS - 113418			
INITIAL THICKNESS SURVEY - DECEMBER 7 - 14, 1994			
Location	Ice Thickness		
	(cm)	(in)	
Small Lk. off Highgrade	30	12	
Location	Ice Thickness		
	(cm)	(in)	
Small Lk. off Highgrade	30	12	
Dec 10/95	30	12	
	30	12	
Tibbet Lk.	33	13	
Dec 10/95	33	13	
	38	15	Avg = 35 cm
	43	17	Std. Dev = 4 cm
	36	14	Min. = 30 cm
	33	13	Max. = 43 cm
	33	13	No Obs. = 8
	30	12	

ECHO BAY WINTER ROAD ICE THICKNESS SURVEY FOR BHP DIAMONDS - 113418			
INITIAL THICKNESS SURVEY - DECEMBER 7 - 14, 1994			
Location	Ice Thickness		
	(cm)	(in)	
Small Lk. off Highgrade	30	12	
Lk. 2, N. of Tibbet	33	13	
Dec 10/95	38	15	
	33	13	
	33	13	
	38	15	
	33	13	
	33	13	
	30	12	
Lake 3	41	16	
Dec 10/95	36	14	
	36	14	Avg = 34 cm
	36	14	Std. Dev = 4 cm
	36	14	Min. = 20 cm
	41	16	Max. = 43 cm
Lake 4 - "S" shaped	30	12	No Obs. = 39
Dec 10/95	30	12	
	36	14	
Lake 5	33	13	
Dec 10/95	33	13	
	20	8	
Lake 6	36	14	
Dec 10/95	33	13	
Lake 7	41	16	
Dec 10/95	36	14	
	41	16	
	43	17	
	36	14	
	28	11	
	30	12	
	33	13	
Lake 8	36	14	
Dec 10/95	33	13	
	36	14	
	30	12	
	30	12	
Lake 9	38	15	
Dec 10/95	33	13	
	33	13	
	41	16	

ECHO BAY WINTER ROAD ICE THICKNESS SURVEY FOR BHP DIAMONDS - 113418					
INITIAL THICKNESS SURVEY - DECEMBER 7 - 14, 1994					
Location	Ice Thickness				
	(cm)	(in)			
Small Lk. off Highgrade	30	12			
Ross Lake	36	14			
Dec 10/95	43	17			
	46	18	Avg =	41	cm
	48	19	Std. Dev =	5	cm
	43	17	Min. =	33	cm
	41	16	Max. =	48	cm
	33	13	No Obs. =	8	
	38	15			
Pensive Lake	38	15			
Dec 10/95	41	16			
	38	15	Avg =	37	cm
	41	16	Std. Dev =	2	cm
	36	14	Min. =	33	cm
	38	15	Max. =	41	cm
	36	14	No Obs. =	9	
Dome Lake	33	13			
	36	14			
Waite Lake	46	18			
Dec 10/95	41	16			
	46	18	Avg =	41	cm
	46	18	Std. Dev =	5	cm
	41	16	Min. =	30	cm
	41	16	Max. =	48	cm
	36	14	No Obs. =	15	
	46	18			
	48	19			
	38	15			
	41	16			
	36	14			
	38	15			
	30	12			
	38	15			
Small Lk N. of Waite Lk	43	17			
	41	16			
	30	12			
	30	12	Avg =	40	cm
Lee Lake	36	14	Std. Dev =	6	cm
	48	19	Min. =	30	cm
	38	15	Max. =	48	cm
	38	15	No Obs. =	12	
	41	16			
	46	18			
	41	16			
	48	19			

03-Feb-95 SURTHICK WB1 Page 4

ECHO BAY WINTER ROAD ICE THICKNESS SURVEY FOR BHP DIAMONDS - 113418				
INITIAL THICKNESS SURVEY - DECEMBER 7 - 14, 1994				
Location	Ice Thickness			
	(cm)	(in)		
Small Lk. off Highgrade	30	12		
Gordon Lake	33	13		
	41	16		
	41	16	Avg =	37 cm
	36	14	Std. Dev =	4 cm
	38	15	Min. =	30 cm
	36	14	Max. =	43 cm
	41	16	No Obs. =	12
	30	12		
	38	15		
	43	17		
	38	15		
	30	12		
1st Lk. N. of Gordon Lk	33	13		
2nd Lk. N. of Gordon Lk.	28	11		
(Gravel Pile)	36	14	Avg =	38 cm
	36	14	Std. Dev =	6 cm
	46	18	Min. =	28 cm
	46	18	Max. =	46 cm
	41	16	No Obs. =	13
3rd Lk. N. of Gordon	33	13		
4th Lk. N. of Gordon	36	14		
	36	14		
	46	18		
	46	18		
	41	16		

ECHO BAY WINTER ROAD ICE THICKNESS SURVEY
FOR BHP DIAMONDS - 113418

INITIAL THICKNESS SURVEY - DECEMBER 7 - 14, 1994

Location	Ice Thickness				
	(cm)	(in)			
Small Lk. off Highgrade	30	12			
Beaver Pond	33	13			
Dec 14/95	61	24			
5th Lk. N. of Gordon	33	13	Avg =	45	cm
(Charlie Hill)	61	24	Std. Dev =	9	cm
	36	14	Min. =	33	cm
Brown Lake	51	20	Max. =	61	cm
Dec 14/95	46	18	No Obs. =	34	
	56	22			
	51	20			
	56	22			
Long Lake	36	14			
Dec 14/95	61	24			
	46	18			
	38	15			
	46	18			
	61	24			
Lake at Drybones Hill	36	14			
	38	15			
	46	18			
	51	20			
	36	14			
4th Lk. S. of Drybones Lk.	41	16			
3rd Lk. S. of Drybones Lk.	36	14			
2nd Lk. S. of Drybones Lk.	41	16			
	53	21			
	41	16			
1st Lk. S. of Drybones Lk.	43	17			
	48	19			
	36	14			
	48	19			
	48	19			
	36	14			
	41	16			
	41	16			

ECHO BAY WINTER ROAD ICE THICKNESS SURVEY					
FOR BHP DIAMONDS - 113418					
INITIAL THICKNESS SURVEY - DECEMBER 7 - 14, 1994					
Location	Ice Thickness				
	(cm)	(in)			
Small Lk. off Highgrade	30	12			
Drybones Lake	43	17			
	36	14			
	51	20	Avg =	46	cm
	56	22	Std. Dev =	5	cm
	48	19	Min. =	36	cm
	43	17	Max. =	56	cm
	51	20	No Obs. =	17	
	43	17			
	43	17			
	51	20			
	46	18			
	36	14			
	46	18			
	51	20			
	53	21			
	48	19			
	43	17			

ECHO BAY WINTER ROAD ICE THICKNESS SURVEY FOR BHP DIAMONDS - 113418				
INITIAL THICKNESS SURVEY - DECEMBER 7 - 14, 1994				
Location	Ice Thickness			
	(cm)	(in)		
Small Lk. off Highgrade	30	12		
Small Lks Between	48	19		
Lockhart & Drybones	51	20		
Lockhart Lake	58	23		
	58	23		
	48	19		
	58	23	Avg =	53 cm
	48	19	Std. Dev =	6 cm
	64	25	Min. =	46 cm
	56	22	Max. =	64 cm
	46	18	No Obs. =	12
	46	18		
	51	20		
	48	19		
	51	20		
Average	41	16.0		
Std. Deviation	8	3.1		
Minimum	20	8		
Maximum	64	25		
No. Observations	184			

APPENDIX B

**ICE THICKNESS, FREEBOARD AND SNOW THICKNESS MEASUREMENTS PLUS
OBSERVATIONS, JANUARY 7 - 14, 1995 SURVEY**

FOR BHP DIAMONDS - 113418

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ECHO BAY WINTER ROAD ICE THICKNESS SURVEY

FOR BHP DIAMONDS - 113418

SURVEY CONDUCTED JANUARY 7 - 14, 1995

DATE	LOCATION	ODOMETER READING (km)	STATION (km)	ROAD CENTER LINE				OFF-ROAD IN SNOW			ROAD EDGE			OBSERVATIONS
				ICE DEPTH (cm)	SNOW DEPTH (cm)	FREE- BOARD (cm)	WATER DEPTH (m)	ICE DEPTH (cm)	SNOW DEPTH (cm)	FREE- BOARD (cm)	ICE DEPTH (cm)	SNOW DEPTH (cm)	FREE- BOARD (cm)	
	Lake N. of Brown Lake	52.5		76	0	13	7.9	58	11	4	70	0	8	Plowed snow not very high
	Start Brown Lake	53.5												
			0.5	81	0	8	11.6	76	12	4				
			1.5	87	0	9	14	84	10	7				Snow 7-12 cm deep off road
	Length of Lake (km) =	7.3	2.5	98	0	9	>15	53	14	1	59	0	0	
			3.5	92	0	9	>15	73	15	0				Snow 13-18 cm deep off road
			4.5	80	0	9	8.8	70	8	1.5				Snow 6-9 cm deep off road
			5.5	74	0	9	N.A.	61	20	0	70	0	-1	Fairly extensive plowed snow - feathered
			6.5	74	0	9	11.6	71	16	1	74	0	-2	Snow depth 13-19 cm off road
	End Brown Lake	60.8												
	1st Lk. S. of Brown Lk. & Charlie Hill	62.6		78	0	9	4.3	82	10	1				
	Same location							61	15	0				In Snow on other side of road - may have been running water in fall
09-Jan	Lockhart Camp odometer reading	0.0												
	2nd Lk. S. of Brown Lk. & Charlie Hill	68.4		76	0	7	8.5	55	18	-1				Snow less dense - easy to shovel
	- actually part of 1st													
	3rd Long Lk. S. of Brown (Gravel Lk.)	71.4												
			0.5	64	0	5	8.2							Jan 11 measurement
			1	61	0	6	7.3	49	20	0				Snow less dense
			1.5	69	0	7	9							Jan 11 measurement
			2	64	0	7	N.A.				51	0	0	W. Edge - Near end of lake
	4th long Lk. past Brown	73.8		67	0	6	11.3	53	20	0				Snow loose
	- last N. of Gordon Lk.													
	Start Gordon Lake - 76.3 km	76.3												
	Edge meas. W. of C.L.		0.2	77	0	7	10				70	0	3	Jan 11 meas. - 3 cm fresh snow off C.L.
			0.5	80	0	5	6.2							Jan 11 measurement
			1	75	0	4	6.7	56	15	0				Road only recently plowed/travelled
			2	69	0	4	N.A.							in center - drifted on edges
	Edge meas. at E. of C.L.		2.5	84	3	8	N.A.				80	0	8	3 cm fresh snow at C.L. - Jan.11 measmnt
			3	62	0	6	31.1	61	17	0				
	Edge meas. at E. of C.L.		3	60	10	5	N.A.				75	0	7	Jan 11 meas. - 10 cm fresh snow
			3.5	82	0	6	N.A.							Jan 11 measurement
			4	76	0	6	N.A.							
			4	87	0	7.5	N.A.							Jan 11 meas. - fresh snow on road
			5	78	0	8	N.A.	66	9	0				
	Length (km) =		6	81	0	6	N.A.							
		44.9	7	91	0	9	N.A.	76	12	0.5				
			8	82	0	9	N.A.							
			9	82	0	7	N.A.	62	18	0				
			10	81	0	7	N.A.							
			11	79	0	6	N.A.	55	11	3				
			12	82	0	7	N.A.							
			13	90	0	10	22	71	13	0				Snow 11 -15 cm off road

ECHO BAY WINTER ROAD ICE THICKNESS SURVEY

FOR BHP DIAMONDS - 113418

SURVEY CONDUCTED JANUARY 7 - 14, 1995

DATE	LOCATION	ODOMETER READING (km)	STATION (km)	ROAD CENTER LINE				OFF-ROAD IN SNOW			ROAD EDGE			OBSERVATIONS
				ICE DEPTH (cm)	SNOW DEPTH (cm)	FREE- BOARD (cm)	WATER DEPTH (m)	ICE DEPTH (cm)	SNOW DEPTH (cm)	FREE- BOARD (cm)	ICE DEPTH (cm)	SNOW DEPTH (cm)	FREE- BOARD (cm)	
			14	79	0	4	N.A.							
			15	89	0	7	N.A.	69	15	0				Snow very dense - hard to shovel
			16	84	0	6	N.A.							
			17	86	0	7	26.5	74	12	1				
			18	86	0	6	N.A.							
			19	85	0	7	N.A.	71	12	0.5				
			20	92	0	6	N.A.							
			21	87	0	7	10.4	82	6	5				
			22	87	0	5	N.A.							
			23	87	0	5	N.A.	70	7	1				
			24	91	0	7	N.A.							
			25	89	0	7	29.3	81	10	4				
			26	93	0	9	N.A.							Used track W. of C.L. - hole on C.L.
			27	89	0	9	N.A.	64	16	0				
			28	72	0	9	N.A.							
			29	91	0	7	14.9	71	14	2				
			30	90	0	10	N.A.							
			31	81	0	8	N.A.	86	2	2				
			32	91	0	8	N.A.							
			33	90	0	7	14.9	89	3	7				
			34	91	0	7	N.A.							
			35	90	0	8	31.7	70	12	0				
			36	78	0	8	N.A.							
			37	82	0	9	N.A.	84	6	6				
			38	85	0	9	N.A.							
			39	86	0	7	N.A.							
			40	82	0	8	N.A.							
			41	88	0	9	N.A.							
		118.3	42	81	0	7	3.5							Turned curve at S. tip of lake
10-Jan	S. end Gordon Lk. from Lockhart	118.5												
	- earned on from Jan 9													
	113deg 17' W, 62deg 54' N													
			0.6	92	0	7	3	75	7	2.5				
	Just W. of 1st portage on S. tip	119.6		79	0	7	7.3	56	16	-1				Snow dense
	Just S. of 2nd portage on S. tip	120.1		70	0	7	N.A.							Ice grounded
		120.5	0.4	89	0	8	N.A.							
	Just N. of portage to Lee Lk.	121.2		83	0	7	N.A.							
	Start Lee Lake	121.3												
	Length = 3 km		1	91	0	9	3	68	8	1				
			2	80	0	8	1.8							
	Small Lk. before Waite Lk.	126.9		85	0	8	2.4	53	14	2				
	Start Waite Lake	128												
			1	81	0	7	1.8	54	17	0				

FOR BHP DIAMONDS - 113418

SURVEY CONDUCTED JANUARY 7 - 14, 1995

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ECHO BAY WINTER ROAD ICE THICKNESS SURVEY

FOR BHP DIAMONDS - 113418

SURVEY CONDUCTED JANUARY 7 - 14, 1995

				ROAD CENTER LINE				OFF-ROAD IN SNOW			ROAD EDGE				OBSERVATIONS	
DATE	LOCATION	ODOMETER READING	STATION	ICE DEPTH	SNOW DEPTH	FREE- BOARD	WATER DEPTH	ICE DEPTH	SNOW DEPTH	FREE- BOARD	ICE DEPTH	SNOW DEPTH	FREE- BOARD			
		(km)	(km)	(cm)	(cm)	(cm)	(m)	(cm)	(cm)	(cm)	(cm)	(cm)	(cm)			
	Part B Ingrahm Trail North to Ross Lake															
11-Jan	Heading North from Yellowknife															
	Slough just off Ingrahm Trail	0														
	West of C.L.	0.2		55	3	3	1.2	44	22	0					Snow at C.L. fresh - was snowing	
	Start Tibbit Lake	0.6														
	West of C.L.		1.1	92	0	7	7.3	66	10	2.5					3 cm fresh snow on road	
	West of C.L.		2	81	0	9										
	On C.L.		2	85	0	7	19.5	60	12	0					Fresh snow in the road	
	East of C.L.		2	84	0	7										
				2.5	85	0	8		58	16	3					Fresh snow in the road
	End Tibbit Lake	2.8														
	Start 1st Lake N. of Tibbit	4.2														
				1	82	0	8.5	1.2	50	15	2.5					Snow off road med. dense - former flooding
				1.5	79.5	0	7	1.5	56	14	1					Snow off road loose to med. dense
	2nd lake N. of Tibbit	6.1														
				0.5	77	0	9	1.8	46	23	0					
				1.5	88	0	7	6.4	63	11	3					
	End 2nd lake	8.2														
3rd Lk. N. of Tibbit - small	9.5			78	0	5	2	50	16	0						
4th lake N. of Tibbit	10.9															
			1	85	0	8	1.5	50	17	2					Fresh snow in the road	
5 th lake N. of Tibbit	12.2			74	0	6	1.2	53	14	1						
7th lake N. of Tibbit	13.8															
			0.5	86	0	9.5	1.5	53	17	0					Fresh snow in the road	

ECHO BAY WINTER ROAD ICE THICKNESS SURVEY

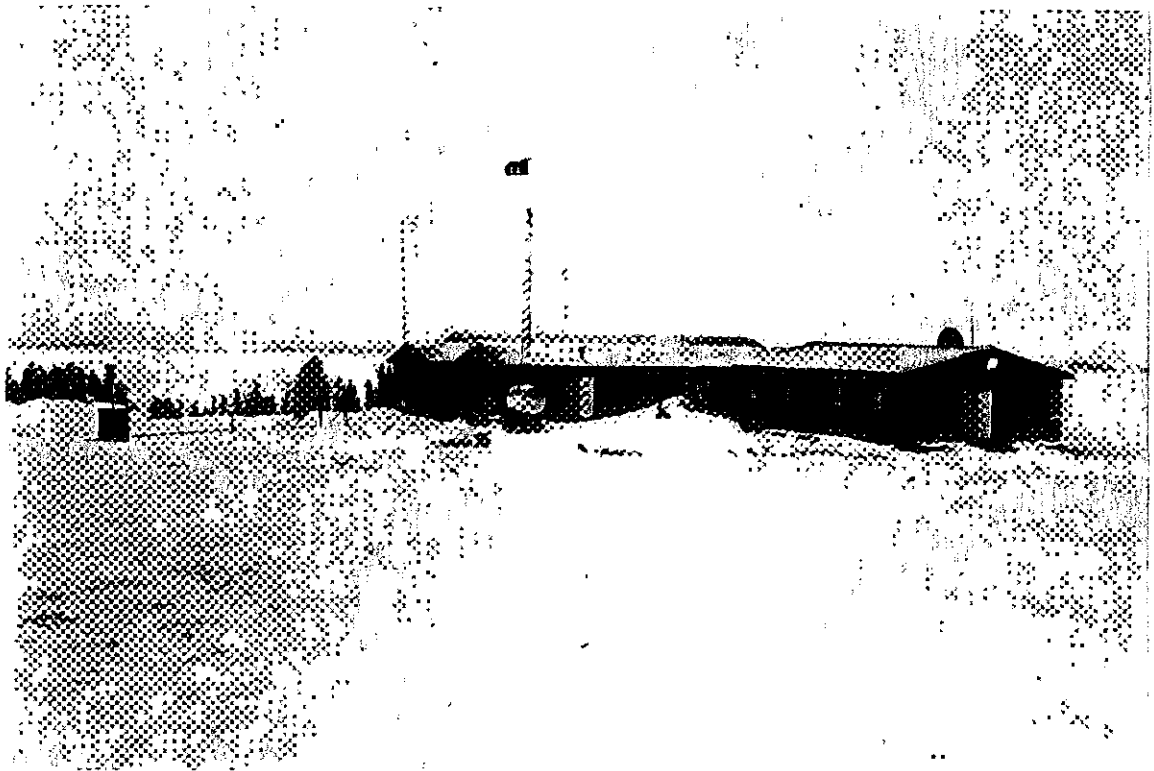
FOR BHP DIAMONDS - 113418

SURVEY CONDUCTED JANUARY 7 - 14, 1995

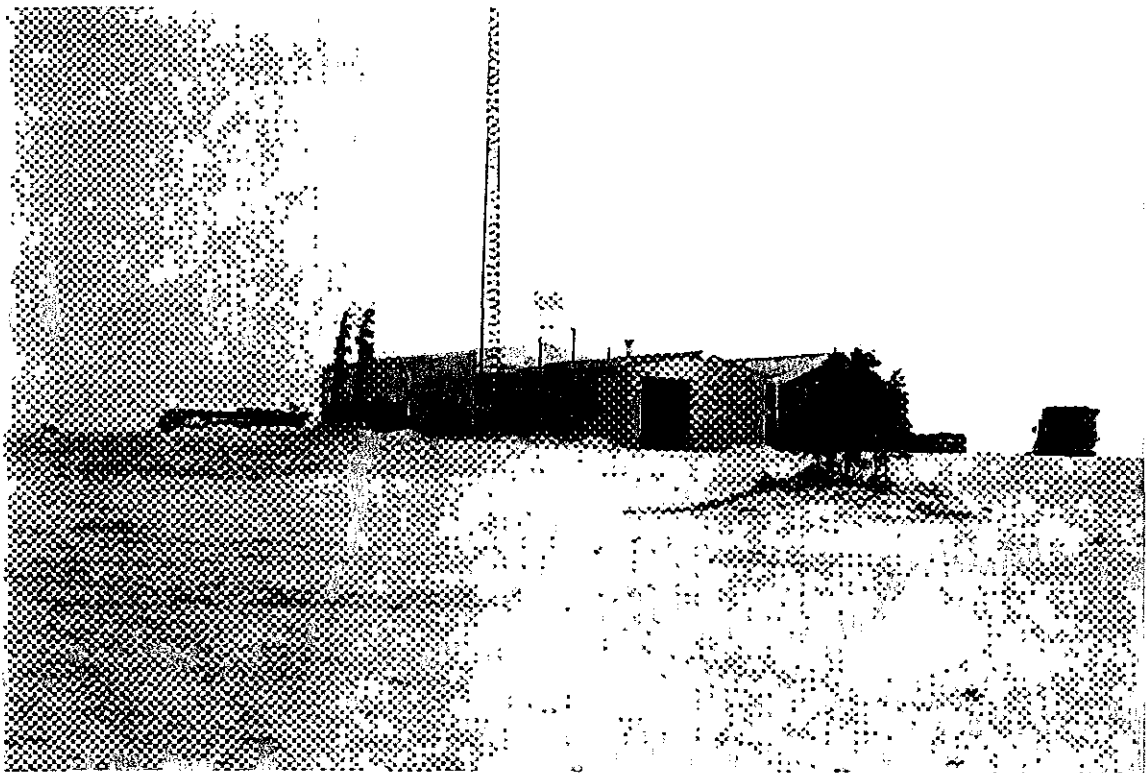
				ROAD CENTER LINE				OFF-ROAD IN SNOW			ROAD EDGE				OBSERVATIONS
DATE	LOCATION	ODOMETER READING (km)	STATION (km)	ICE DEPTH (cm)	SNOW DEPTH (cm)	FREE- BOARD (cm)	WATER DEPTH (m)	ICE DEPTH (cm)	SNOW DEPTH (cm)	FREE- BOARD (cm)	ICE DEPTH (cm)	SNOW DEPTH (cm)	FREE- BOARD (cm)		
	Part C Pressure Ridge on McKay Lake South to Lockhart Camp														
12-Jan	1st Pressure Ridge on McKay Lk.	78.7													
	Odo. Referenced to Lockhart Camp														
	20 m S. of 1st ridge			105	0	8	41.5								
	2nd pressure rdge on McKay Lk.	83.5													
	S. side of 2nd pressure rdge			111	0	7	16.8								
	Starting S. of 1st ridge		5	109	0	7	20.7								Lk. snow cover variable, bare in places, several cm in others
	Portage Bay		10	115	0	9	23.8								
			15	74	0	3	2.3								
	Near end of Portage Bay		14.5	113	0	5	2.6								
	Lake S. of Portage Bay			115	0	7	4.4								
	Same Lake			110	0	7	6								
	Lake before Wharburton			109	0	8	8.5								
	Wharburton Bay														
			4	101	0	8	6.4								
			10	99	0	7	3.8								
			15	117	0	7	4								
			20	96	0	8	11								
			25	106	0	10	2.4								
			30	98	0	10	6.1								
	Past Sandridge		35	86	0	7	3.7								
			40	100	0	7	4								
	Lockhart Lake														
			5	103	0	9	11.3								
	About 100 m from Lockhart camp		10	80	0	6	4.6								

APPENDIX C

PHOTOGRAPHS FROM THE JANUARY 7 - 14, 1995 WINTER ROAD SURVEY



LOCKHART CAMP



LOCKHART SHOPS - JANUARY 1995



ICE ROAD OVER LAKE BETWEEN LOCKHART AND DRYBONES LAKE - JANUARY 1995



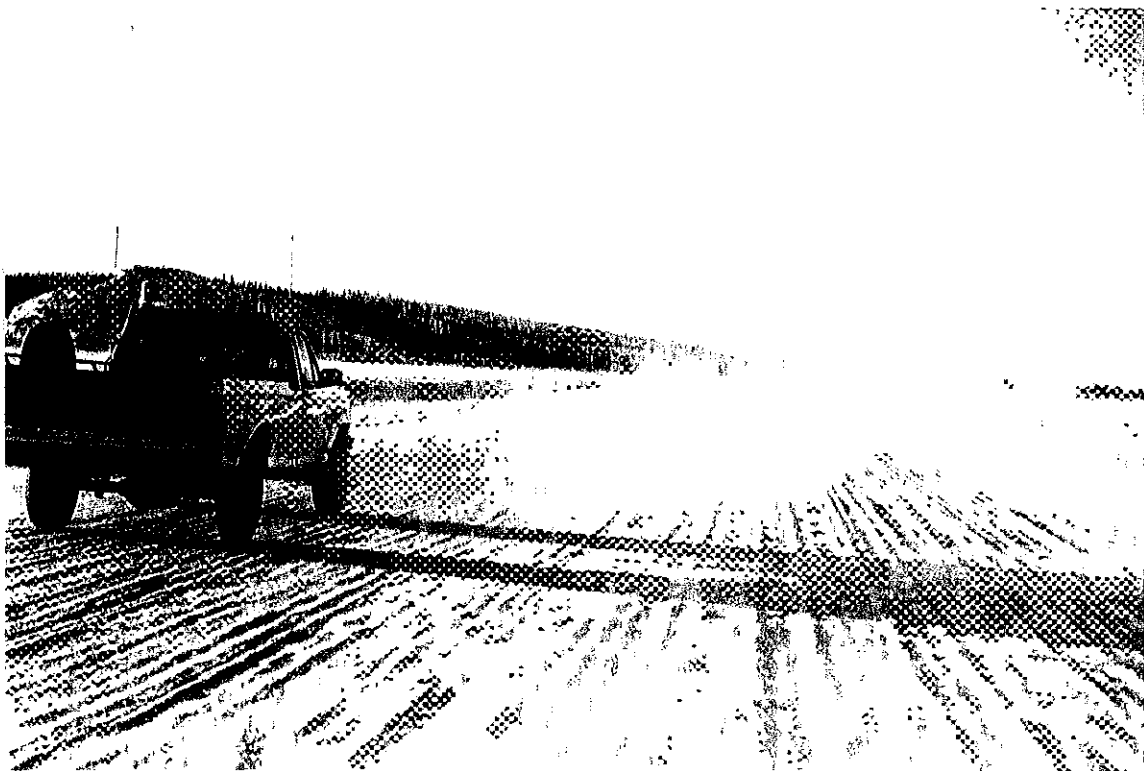
WORK ON PORTAGE AT DRYBONES HILL, NORTH SIDE - JANUARY 1995



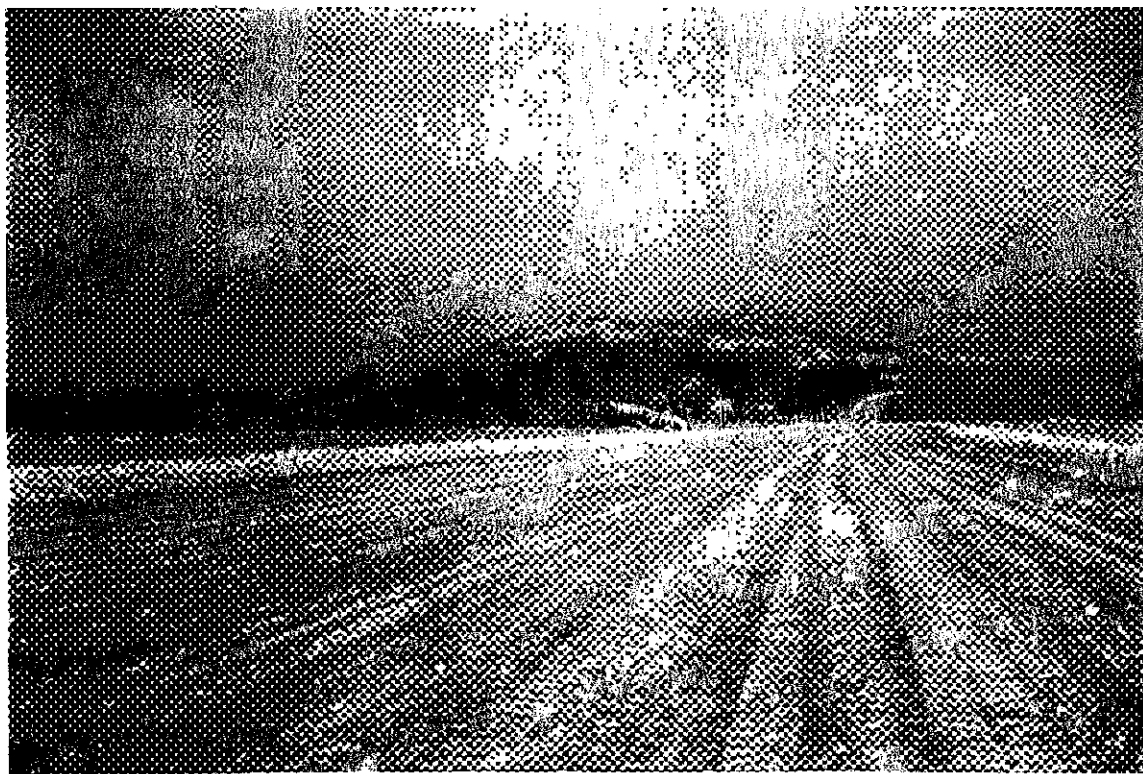
NORTH END OF DRYBONES HILL - JANUARY 1995



ICE ROAD IN DRYBONES AREA - JANUARY 1995



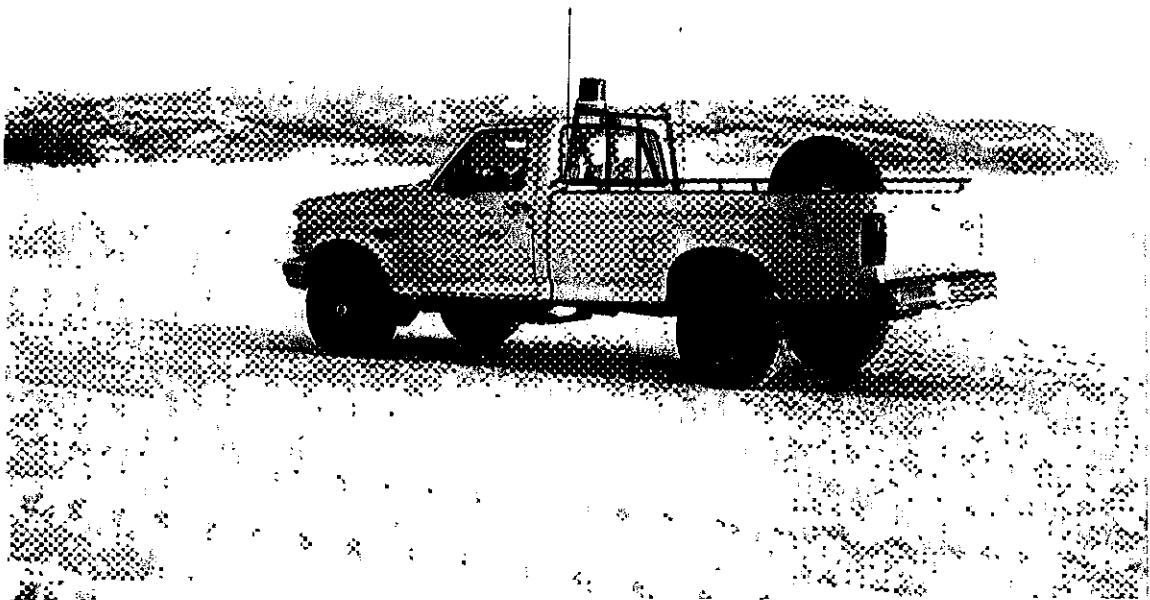
ICE ROAD IN DRYBONES AREA - JANUARY 1995



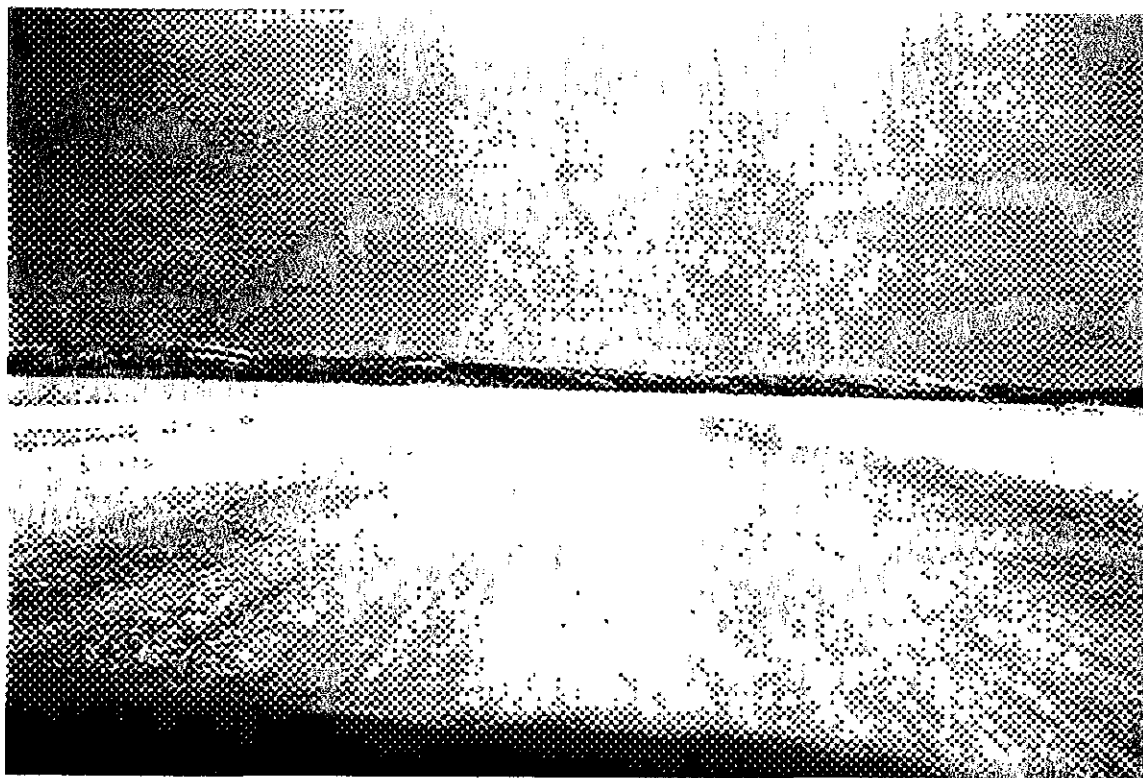
APPROACHING END OF LAKE AND PORTAGE - JANUARY 1995



ICE ROAD ON LONG LAKE - JANUARY 1995



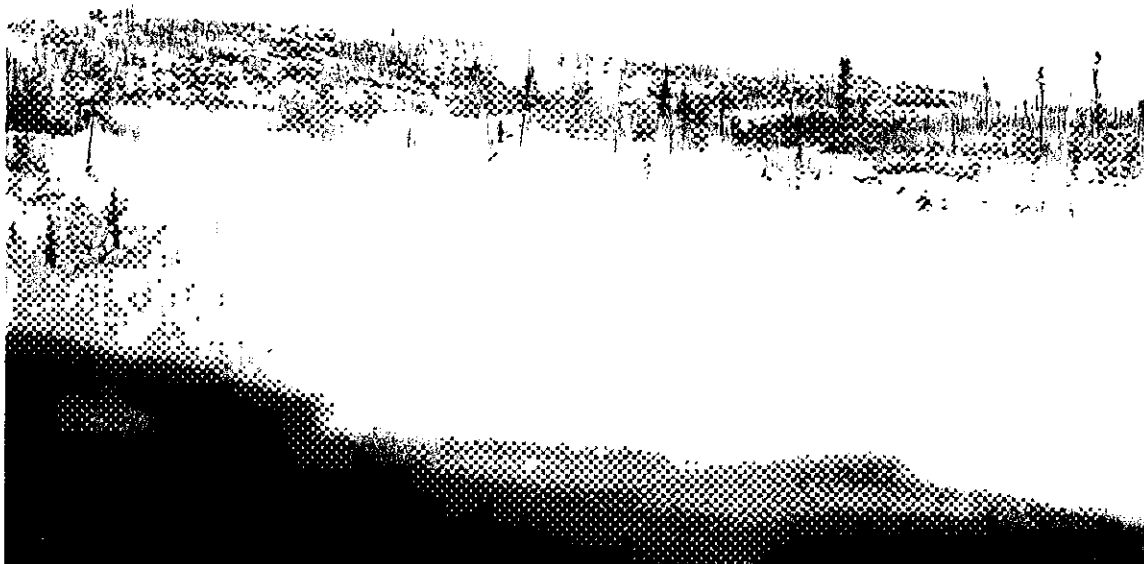
ICE ROAD ON LONG LAKE - JANUARY 1995



ICE ROAD ON DRYBONES LAKE - JANUARY 1995



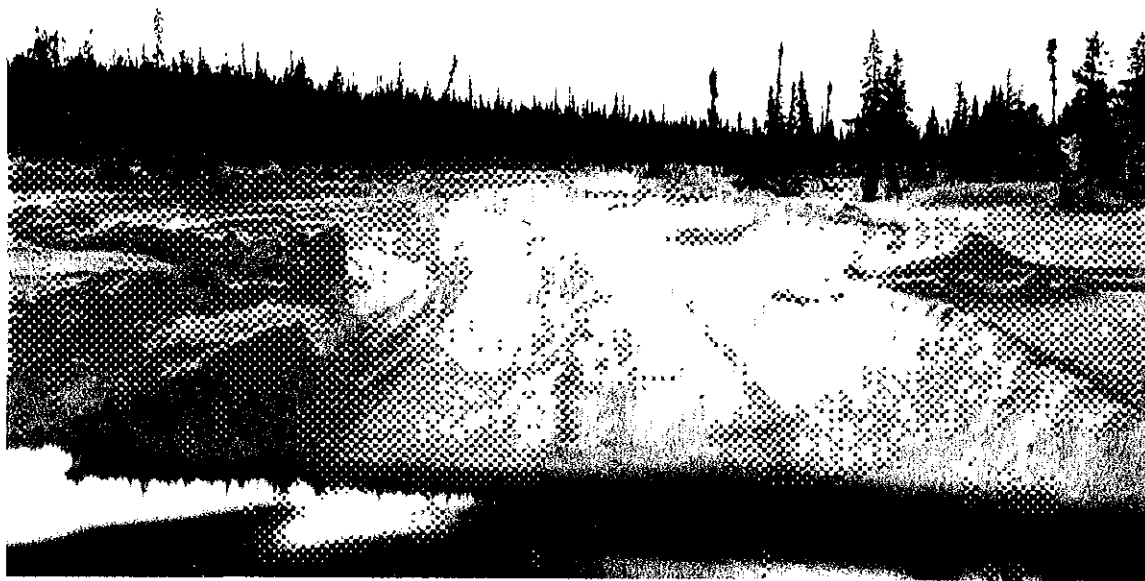
PORTAGE IN AREA OF DRYBONES / BROWN LAKE - JANUARY 1995



PORTAGE IN AREA OF DRYBONES / BROWN LAKE - JANUARY 1995



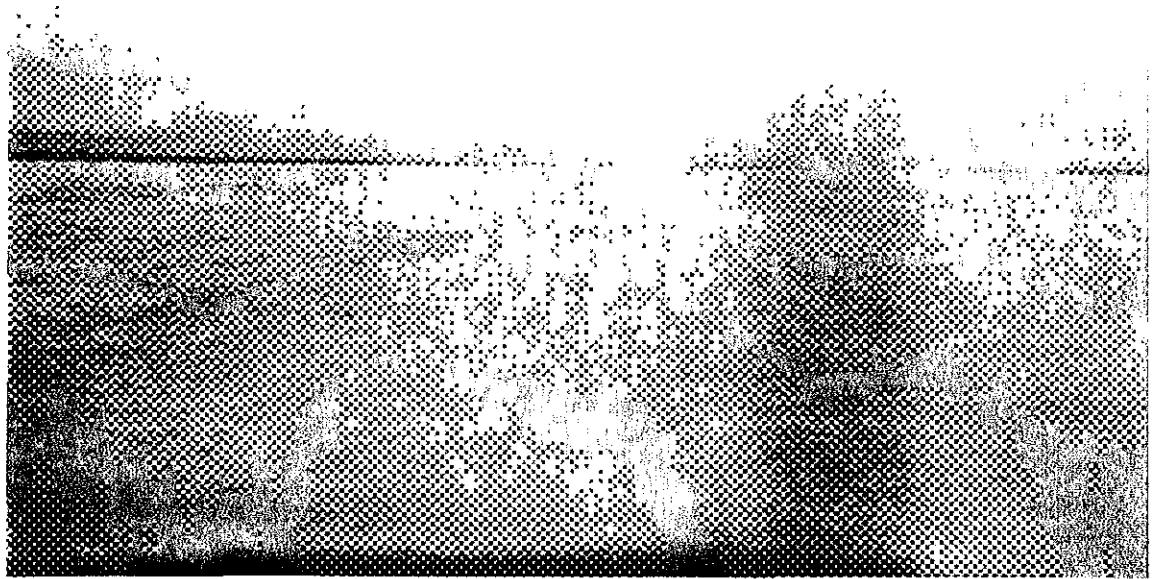
**SHOWING VERTICAL CURVATURE IN PORTAGE, HEADING NORTH IN AFTERNOON
- JANUARY 1995**



PORTAGE SOUTH OF BROWN LAKE ON WAY TO GORDON LAKE



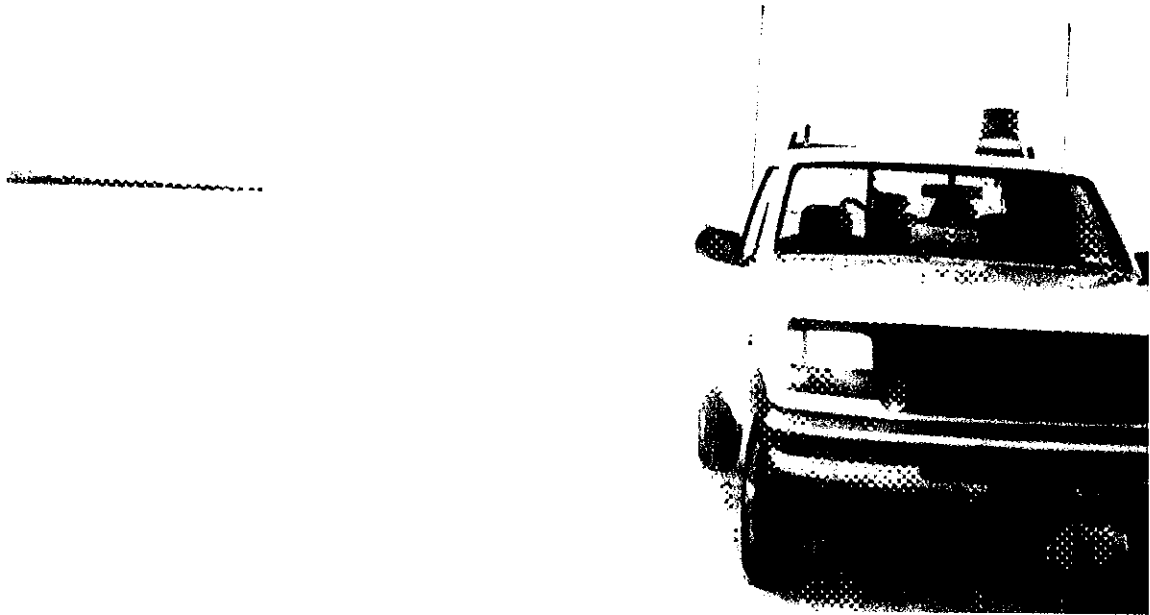
PORTAGE SOUTH OF BROWN LAKE ON WAY TO GORDON LAKE - JANUARY 1995



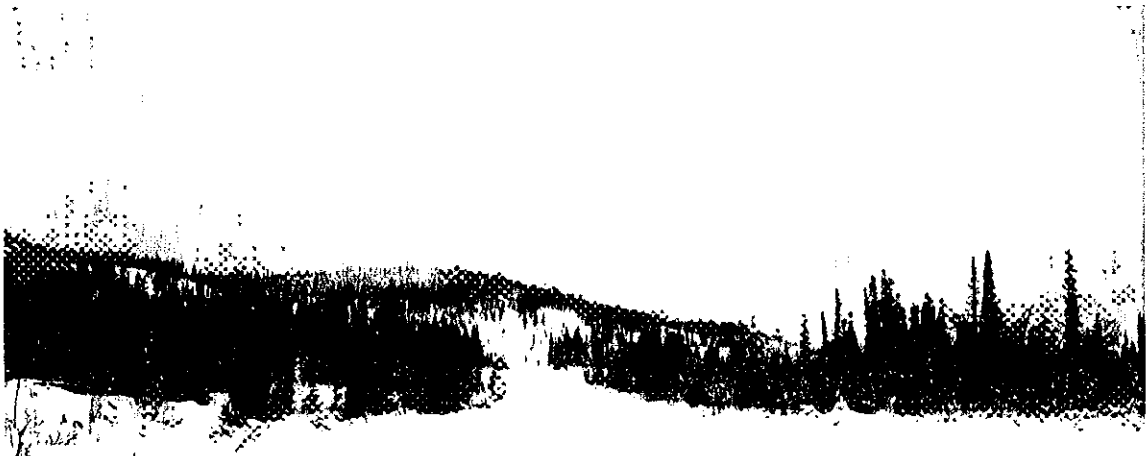
ICE ROAD OVER GORDON LAKE - JANUARY 1995



ICE ROAD OVER GORDON LAKE - JANUARY 1995



ICE ROAD ON GORDON LAKE - JANUARY 1995



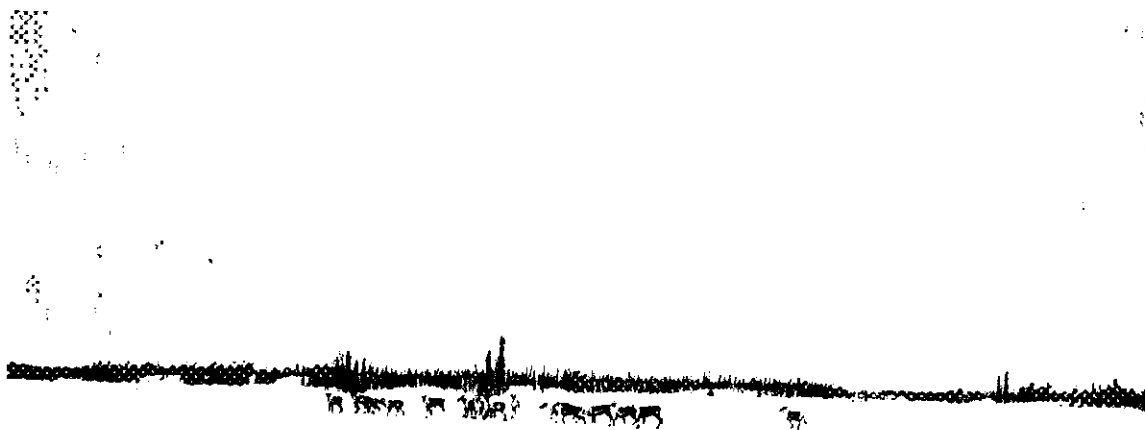
PORTAGE SOUTH OF GORDON LAKE - JANUARY 1995



PORTAGE SOUTH OF GORDON LAKE - JANUARY 1995



CARIBOO HERD ON WAITE LAKE - JANUARY 1995



CARIBOO HERD ON WAITE LAKE - JANUARY 1995



ICE ROAD OVER SOUTHERN LAKE - JANUARY 1995



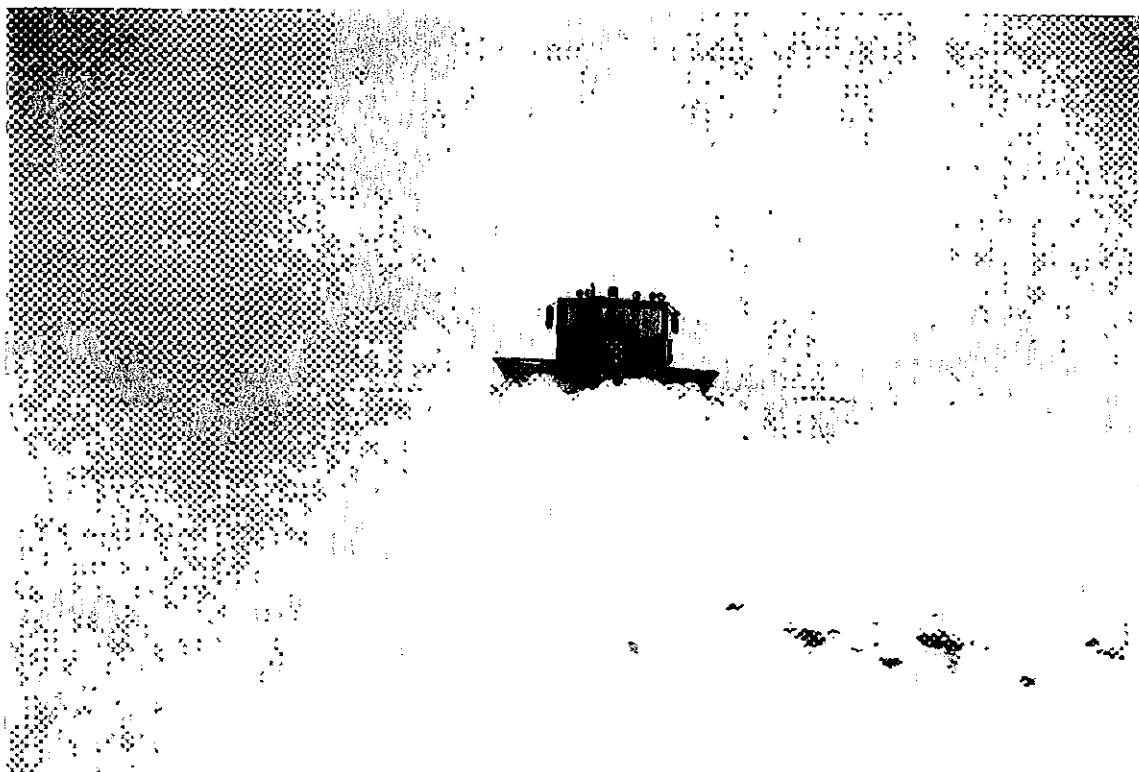
SOUTHERN PORTAGE - JANUARY 1995



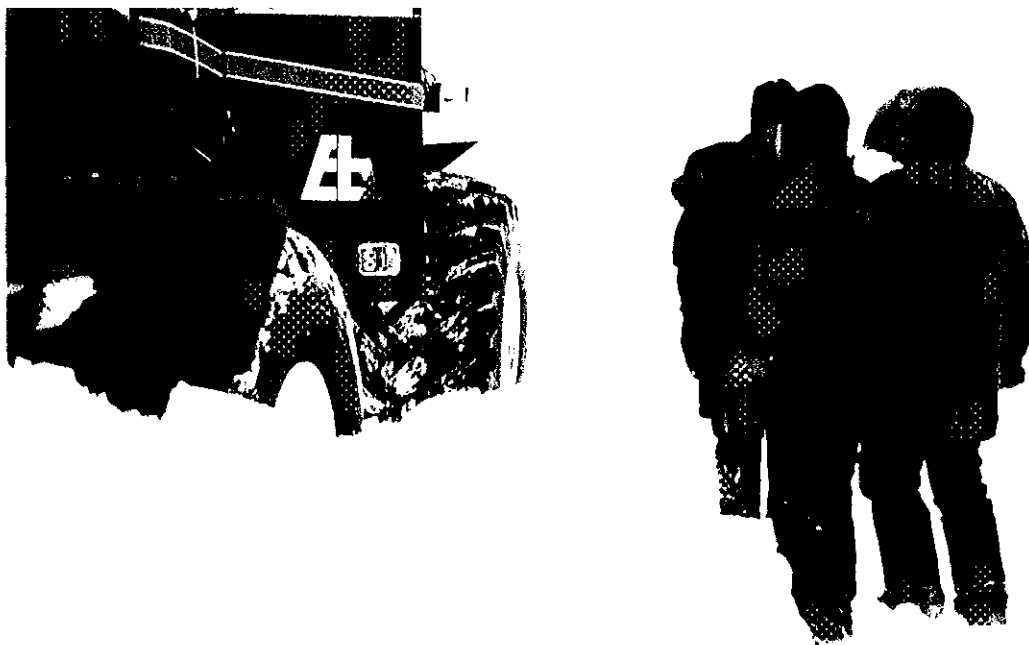
PORTAGE ON WHARBURTON BAY LEADING TO MACKAY LAKE - JANUARY 1995



PORTAGE ON WHARBURTON BAY LEADING TO MACKAY LAKE - JANUARY 1995



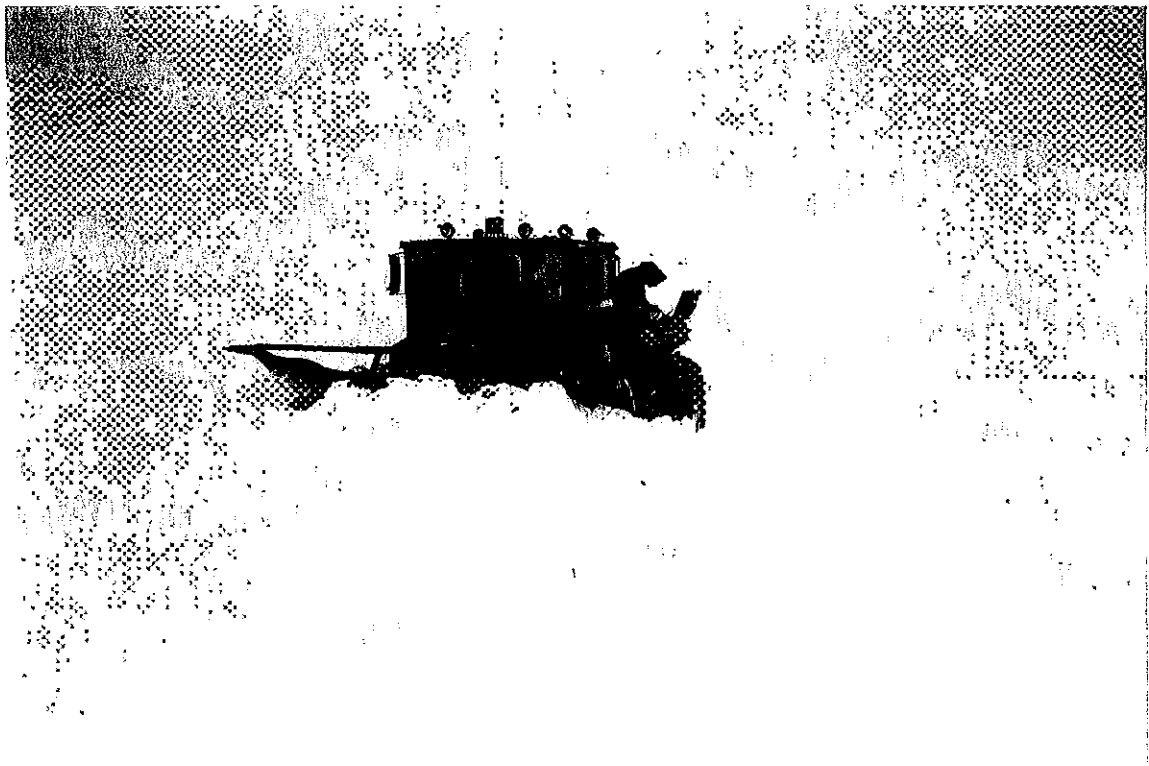
BREAKING THROUGH PRESSURE RIDGE ON MACKAY LAKE - JANUARY 1995



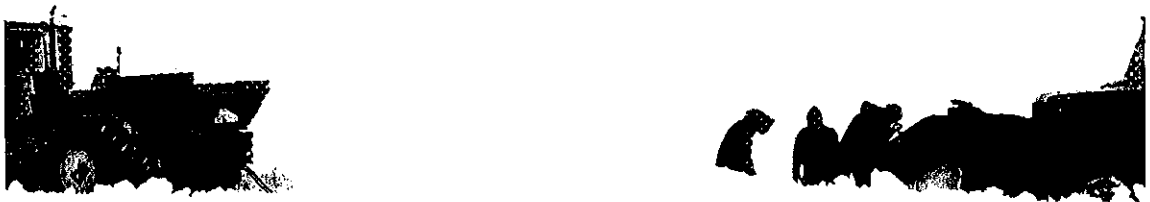
ARDCO STUCK IN PRESSURE RIDGE ON MACKAY LAKE - JANUARY 1995



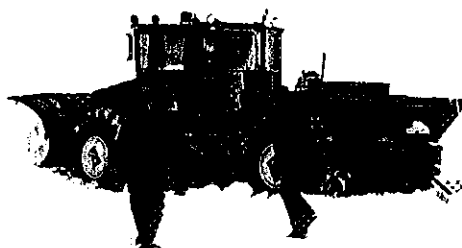
ARDCO STUCK IN PRESSURE RIDGE ON MACKAY - JANUARY 1995



ARDCO STUCK IN PRESSURE RIDGE ON MACKAY LAKE - JANUARY 1995



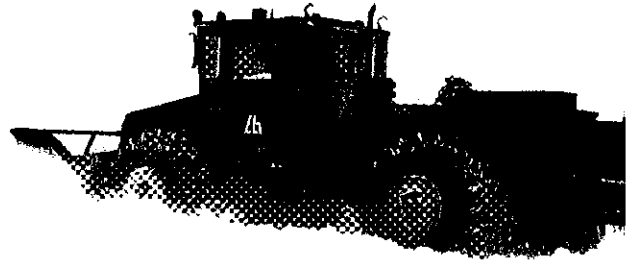
READY TO TOW ARDCO - JANUARY 1995



PUSHING THROUGH PRESSURE RIDGE - JANUARY 1995



PUSHING THROUGH PRESSURE RIDGE - JANUARY 1995

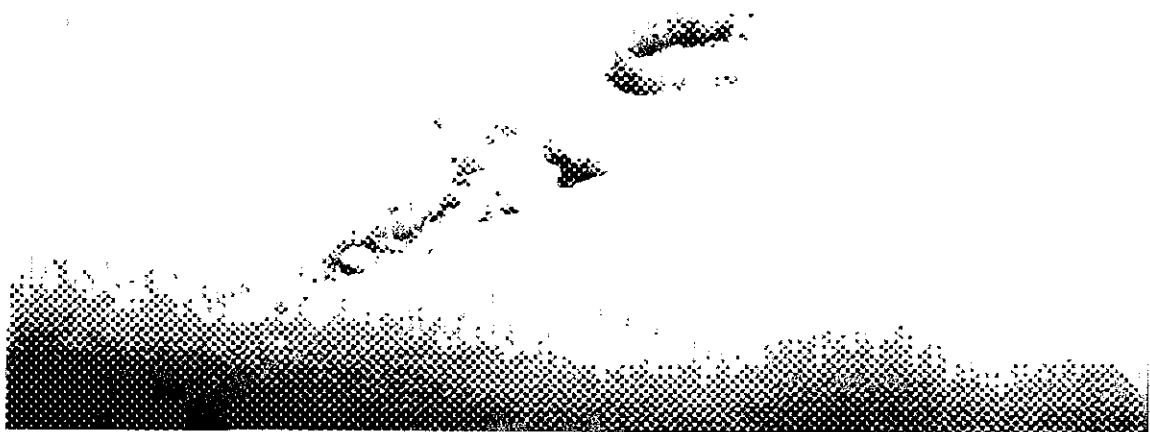


PUSHING THROUGH SECOND PRESSURE RIDGE ON MACKAY LAKE - JANUARY 1995



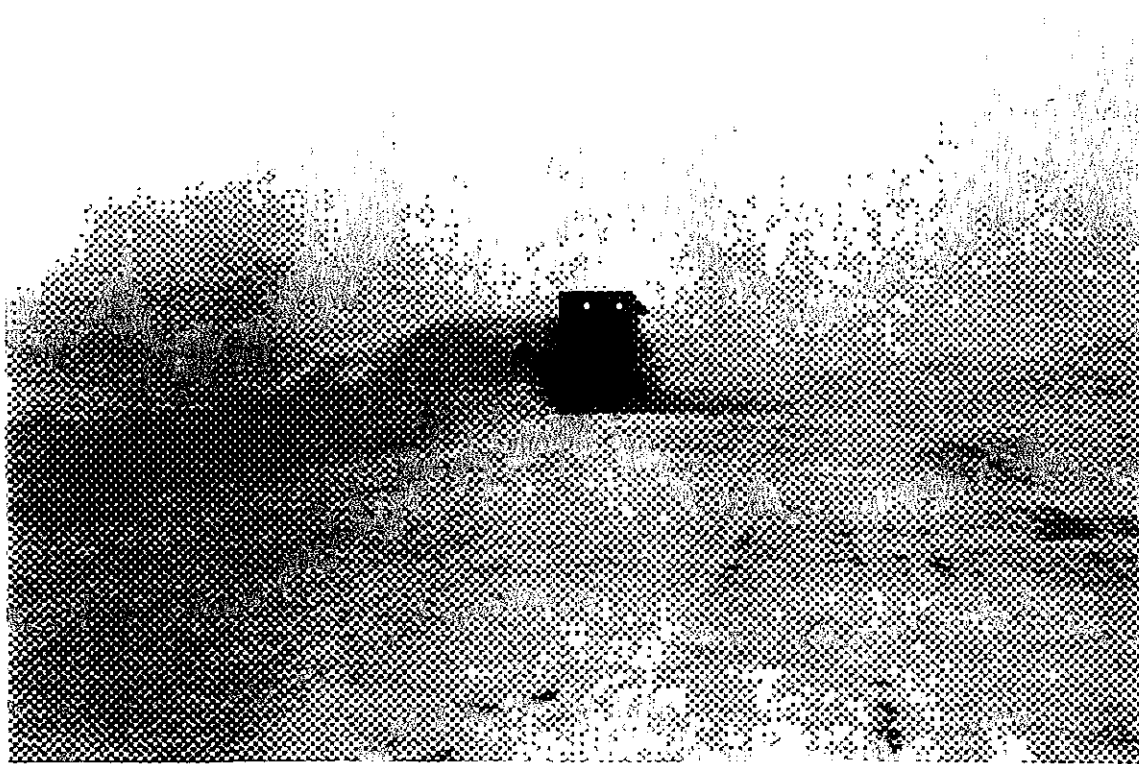
DAN MASTERSON AT FIRST PRESSURE RIDGE ON MACKAY LAKE - JANUARY 1995

FIRST PRESSURE RIDGE IN WHITEOUT ON MACKAY LAKE

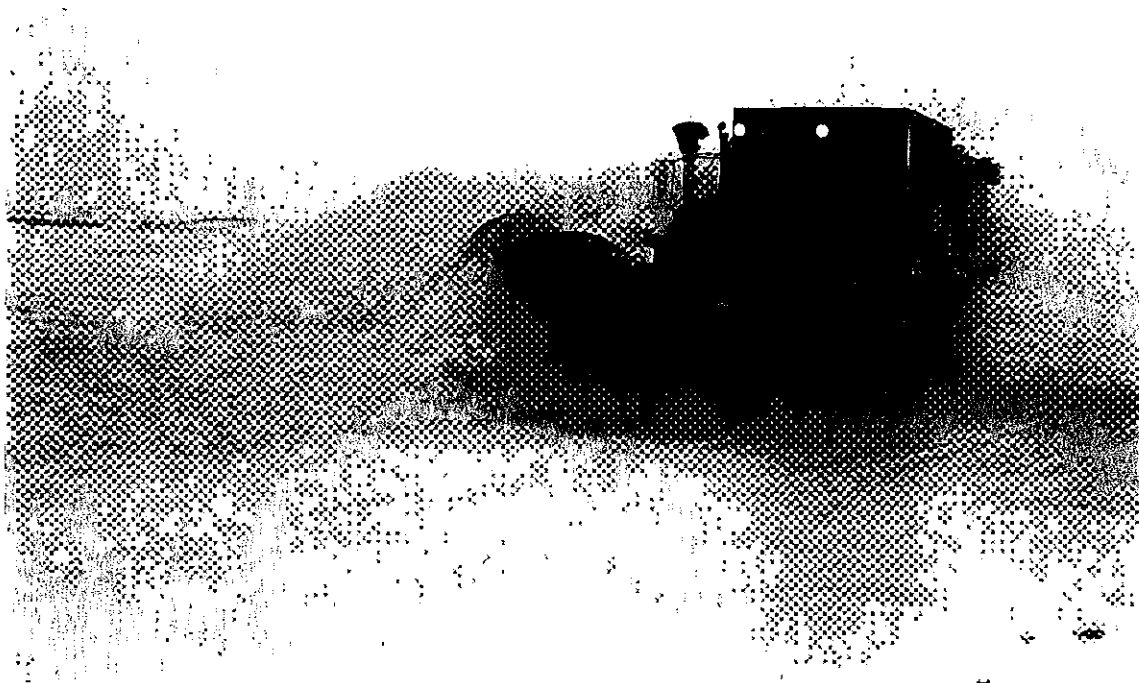


"STUCK HOLE" IN FIRST PRESSURE RIDGE ON MACKAY LAKE - JANUARY 1995

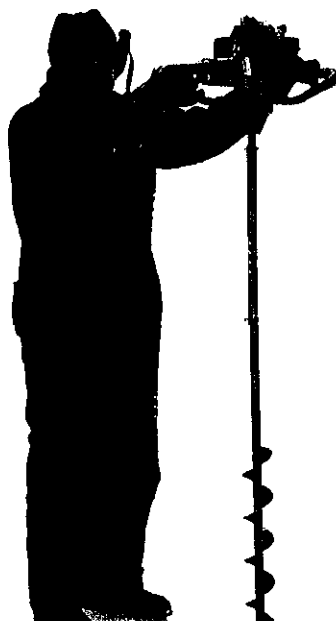
VIEW ALONG TOP OF FIRST PRESSURE RIDGE ON MACKAY LAKE IN WHITEOUT



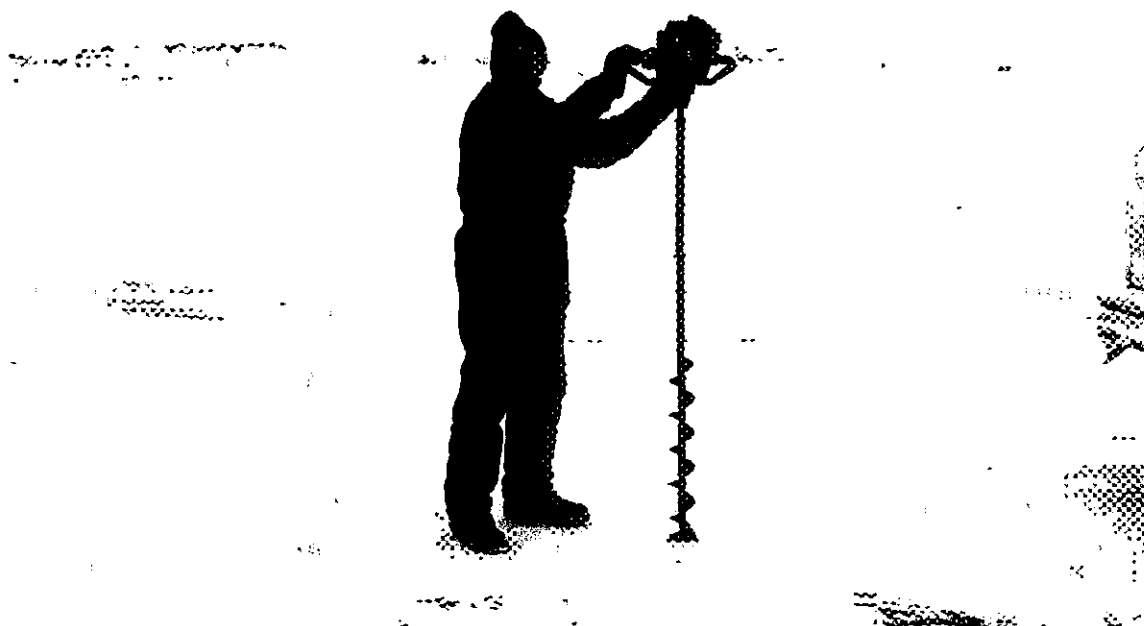
SNOW PLOW ON WHARBURTON BAY - JANUARY 1995



SNOW PLOW ON WHARBURTON BAY - JANUARY 1995



WILF CALLIHOO AND AUGER ON WHARBURTON BAY - JANUARY 1995



DAN MASTERSON AND AUGER ON WHARBURTON BAY - JANUARY 1995

APPENDIX D

MODELLING OF ICE GROWTH

D-1.0 Ice Growth and Ice Thickness

The growth of ice in a lake or water body is governed by a number of factors. These are the amount of heat loss into the air, the characteristics of any snow layer and the water temperature immediately below the growing ice layer. The heat loss is in turn controlled by the ambient air temperature, wind velocities, incident solar and long wave radiation and the albedo and emissivity of the upper surface. Data on all of these parameters will not usually be available throughout the winter season and along the whole length of the roadway. For ice growth, the important aspects are air temperature and wind speed. These parameters are available from meteorological stations within a few hundred kilometers of the roadway. The snow layer depth and thermal conductivity should be explicitly included in the ice growth equations. The last major factor is the water temperature below the ice sheet. The models used here assume that the water temperature is 0°C just below the ice layer. The maximum density of water occurs at $+4^{\circ}\text{C}$ and so the presence of mixing, caused by streams or springs in the lake, could cause warmer water to be near the surface. This would then have an effect on the ice growth resulting in lower thickness.

The model used here is based on one-dimensional heat flow through the ice and snow layer and explicitly assumes a 0°C water body temperature. Because of the variation and uncertainty in input parameters and environmental parameters, the data for this comparison was obtained from the Environment Canada network of ice thickness measuring stations and data obtained along this winter road. The main reason for the model is that the roadway is snow covered for a variable amount of time. The effect of snow cover on the growth of the ice thereby needs to be included.

The model used for predicting the ice growth [Prinsenberg, 1992] allows for a snow layer as well

as the ice layer and is given by

$$\begin{aligned}
 h_i &= \sqrt{C_1 \text{ FDD} + (0.5 C_2)^2} - 0.5 C_2 \\
 C_1 &= \frac{2 k_i}{\rho_i L (1 + \beta \phi)} \times 10^4 \times 3600 \times 24 \\
 C_2 &= \frac{2 \alpha \phi}{(1 + \beta \phi)} \\
 \phi &= \frac{k_i}{k_s}
 \end{aligned}
 \tag{D-1}$$

$$h_s = \alpha + \beta h_i \tag{D-2}$$

Where	h_i	=	Ice thickness (cm)
	k_i	=	Thermal conductivity of ice (W/mk)
	k_s	=	Thermal conductivity of snow (W/mk)
	ρ_i	=	Density of ice (kg/m ³)
	ρ_s	=	Density of snow (kg/m ³)
	L	=	Latent heat of fusion (J/kg)
	h_s	=	Snow thickness (cm)
	FDD	=	Freezing degree days relative to 0° C

The numerical multiplying constant in C_1 is to convert freezing degree days to freezing degree seconds and to convert m to cm

In this model the snow thickness is represented as a linear function of ice thickness in Equation D-2. Expressing the snow thickness in this way allowed for a closed form solution to the ice growth problem. If the snow layer were allowed to vary randomly throughout the season, a different algorithm would have to be used

The thermal conductivity of the snow can be related to the snow density (Gray and Male, 1981)

$$k_s = 2.9 \times 10^{-6} \rho_s^2 \text{ (W/mK)} \quad \text{D-3}$$

Note however that the thermal conductivity of snow is also a function of temperature, moisture content and crystallographic structure and Equation D-3 only predicts the conductivity to within about ± 50 percent

The range of snow densities observed in nature is given in Table D-1 [data from Gray and Male, 1981] The observed snow densities given in Section 5 indicate that higher snow densities can be found.

In a model based on the same physics, but for sea ice, Brown and Cote [1992], found that a snow density of 338 kg/m³ at Alert and 412 kg/m³ at Resolute were required The required snow density was found to increase with increasing mean wind velocity.

Data from the Yellowknife Atmospheric Environment Services ice station were used to calibrate the model At this station, measurement of ice and snow thickness were provided on a weekly basis over 28 seasons. Average and extreme values were also provided. The data for freezing degree days, FDD were obtained from AES climate normals. Figure D-1 illustrates the observed mean ice and snow thickness along with a predicted ice growth assuming a snow density of 300 kg/m³. The values of the parameters α and β were chosen to reflect the observed snow depths Comparison at Baker Lake and Alert are given in Figures D-2 and D-3 respectively using the observed FDD for these stations Note that for the Alert data, a snow density of 325 kg/m³ was used as it provided for a better agreement. Also the Alert ice thickness station used was on a freshwater lake The model adequately represents the observed mean ice thickness.

D-1.1 Data From Ice Road: December 1994 - January 1995

Data on ice and snow thickness were collected during January 7 - 14, 1995 by Sandwell and on ice thickness during December 7 - 14, 1994 by Echo Bay. The December survey was conducted

as part of the road opening investigation and only ice thickness were recorded. Data from these surveys are summarized in Table D-2 and D-3. In these tables, the error bars in thickness represent one standard deviation of the population.

Also contained within Table D-3 are estimates of the snow density calculated from the freeboard measurements made in the January survey, tabulated in Appendix B, and the assumption of isostatic equilibrium in the overall ice sheet. The road center line freeboard measurements provide reliable values of the ice density since the density in the southern portion of the road is also in accord with the qualitative observations (Appendix B) obtained during the field survey.

D-1.2 Data From Ice Road: March 1995

The collected data are presented in detail in Section 5. The data suggests that for modelling purpose, the road should be considered as two segments, South of Lockhart Camp and North of Lockhart Camp. The range representative of ice thickness values identified are in Table D-4. As Lockhart Camp is situated at the tree line, the ice data suggest that one thermal region is south of the tree line and another in the open areas to the north.

D-1.3 Ice Growth on Access Road

For the purpose of modelling the ice growth in the southern section of the road, the following assumptions were made:

- 1) The temperature data at Yellowknife will be used
- 2) The snow density will be fixed at 300 kg/m^3 .
- 3) The underlying water body will be at 0° C

The model results based on the above parameters and using the actual temperature record for 1994-95 in Yellowknife is given in Figure D4. In Figure D4 are also the observed ice thickness ranges for the three measurement periods. The snow thickness assumed was chosen to reflect that the road was not opened until early December and thus the road route would be snow covered.

The second aspect was to allow for some snow cover on the road due to periodic snowfall and subsequent removal by the snowplow. As may be seen, there is good agreement between the model and observations, indicating that the model is adequate and that the climate data at Yellowknife can be used to predict ice thickness south of Lockhart Camp.

As part of the electronic survey conducted during March 1995, measurements were taken on the Fish Camp access road (MacKay Lake). As the road had only been open for a few days, the ice thickness profile along the road reflected the natural variation. These were assumed to reflect the effect of snow drifts. The model was also used to predict the ice thickness on March 31 as a function of snow depth. In Figure D-5 the snow layer was assumed to grow uniformly during the winter. The results are given in Figure D5 along with the observed snow depth and ice thickness data obtained along the Fish Camp access road. Also superimposed are manually determined data obtained on Gordon Lake. There is good agreement between the model and the Fish Camp access road data supporting the proposed interpretation of ice thickness variation. The Gordon Lake data do not match the theoretical prediction because for these data, except for the 20 cm and 30 cm data points, the snow layer had not been growing uniformly throughout the season. The measurement at zero snow thickness were below the theoretical level because the road had not been open for the whole season and the data points at 67 cm and 100 cm snow thickness are from the snow banks at the sides of the road. These snow banks had not been uniformly growing during the season and were the result of storms later in the winter.

In Figure D6 are shown the predicted minimum ice thickness on the centerline of the road south of Lockhart Camp. The curves are based on the modelling described and reflect the expected ice thickness in a cold year, a normal year and a warm year. Because the calibration was performed using the 94 - 95 season, there is also the implicit assumption that activity to open the road will be occurring in December. The definition of warm and cold years are based on the variation in freezing degree days at Yellowknife from year to year. The cold year is the mean plus one standard deviation in freezing degree days and the warm year is mean minus one standard deviation. For a normal distribution the weather would be warmer than mean plus 1 standard deviation approximately 1 out of 6 years.

Also, superimposed on Figure D-6 are the required ice thickness for a loaded B-Train and a partially loaded B-Train. The intersection with the ice growth curves give estimates of the date

when such loads could be transported based on ice thickness rather than operational conditions. The opening dates are listed in Table D-9.

In Figure D7 are shown the result of the ice thickness model using actual temperature data from the Lupin Mine site during 1994-95. Because of the large variation in the ice thickness due to snow cover, two lines have been indicated. The low thickness snow case is a likely upper bound to the ice thickness and the high thickness snow can likely lower bound. As may be seen, the agreement is good between observed and predicted, again supporting the use of the model. It also emphasizes the role of snow cover in the minimum ice thickness on the road. Because the northern segment of the road was opened later than the southern portion and that the road alignment was changed during operation, the effect of natural snow cover on ice growth is more significant than in the southern portion of the road. The low shallow snow drift case represents a uniform buildup of snow during the winter reaching 14.4 cm by March 31. The deep snow drift corresponds to 35.3 cm by March 31.

The minimum expected ice thickness for the centerline of the road north of Lockhart Camp are given in Figure D8. Plotted are predictions for a normal, a warm and a cold year. The warm and cold years are the ± 1 standard deviation of the temperature records at Lupin Mine site. Also superimposed are the required thicknesses for a fully loaded and partially loaded B-Train. The anticipated opening dates are given in Table D-11. From a comparison of Tables D-9 and D-11, the opening date for the whole road is governed by the opening date of the section south of Lockhart Camp.

On a normal year the ice would be thick enough to allow reduced loads by January 08 (see Table D-9). From Table D-13 the mean opening date excluding 1983 because it was the first year of operation was January 28. Thus from an ice thickness perspective and ignoring operational considerations, the start-up date could be 20 days earlier than the historical start-up. This would allow for a significant increase in the number of loads without increasing the traffic frequencies on the road.

Subsidiary data plots on the temperature and ice data are presented in Figure D-9 to D-15. The 1994-95 winter season approximately corresponds to a "warm" year as identified in Figures D6 and D-8.

As indicated in Section 1.0 one reason for conducting the ice thickness survey was to evaluate the likelihood of achieving the required ice thickness for 85 tonne payloads. The calculated required ice thickness for such a load on a standard trailer configuration is 1.70 (m). The minimum observed ice thickness over the road is the parameter relevant to the situation. As may be seen from Figures D-6 and D-8, current practice, even during a normal year would not likely provide 1.70 (m) by April 01. Note however that the maximum ice thickness observed during the 1994 - 95 season were up to 1.58 (m) south of Lockhart Camp and 1.8 (m) north of Lockhart Camp. The 1994 - 95 was a warm year and during a normal year greater maximum ice thickness are predicted. The maximum values indicate what is potentially achievable if snow layers are kept minimum throughout the season and the road is open early in the winter. To achieve this would require more aggressive action on the part of the road construction and maintenance procedures. This is not likely to be achieved without additional machinery, eg snow blowers and snow plows and possibly additional personnel. Even with this increased level of effort, in order to achieve 1.7 (m) during a normal year may still require local sections to be thickened by using flooding techniques.

TABLE D-1 SNOW DENSITY RANGES

New Snow	50 → 300 kg/m ³
Wind Hardened Snow	150 → 360 kg/m ³

TABLE D-2 ICE SURVEY, DECEMBER 7 - 14, 1994

LOCATION	ICE THICKNESS (cm)
Tibbet Lake	35 ± 4
Lake 2 to 9 North of Tibbet	34 ± 4
Ross Lake	41 ± 5
Pensive Lake	37 ± 2
Waite Lake	41 ± 5
Lee Lake	40 ± 6
Gordon Lake	37 ± 4
Lakes between Gordon and Drybones	45 ± 9
Drybones Lake	46 ± 5
Lockhart Lake	53 ± 6
Tibbet to Lockhart (overall)	41 ± 8

TABLE D-3a ICE SURVEY, JANUARY 7 - 14, 1995 - CENTERLINE

LOCATION	CENTERLINE ICE THICKNESS (cm)	SNOW THICKNESS (cm)	FREEBOARD (cm)	CALCULATED ICE DENSITY (KG/M ³)
Lockhart to Ingrahm	81 9 ± 8.2	0	7 5 ± 1.5	908 ± 2
Ingrahm Trail to Ross Lake	80 8 ± 8.5	0	7 2 ± 1.7	911 ± 6

TABLE D-3b ICE SURVEY, JANUARY 7 - 14, 1995 - OFF-ROAD

LOCATION	OFF ROAD ICE THICKNESS (cm)	SNOW THICKNESS (cm)	FREEBOARD (cm)	CALCULATED SNOW DENSITY (kg/m ³)
Lockhart to Ingrahm	65 6 ± 11 4	13.3 ± 5.1	1 3 ± 2.0	356 ± 21
Ingrahm Trail to Ross	54 1 ± 6 4	15 6 ± 3 8	1 3 ± 1 2	225 ± 40

TABLE D-4 ICE THICKNESS REPRESENTATIVE RANGES - MARCH 31, 1995

LOCATION	MINIMUM (m)	MEAN (m)	MAXIMUM (m)
South of Lockhart Camp	1 30	1 45	1.58
North of Lockhart Camp	1 25	1 60	1.80

**TABLE D-5 FREEZING DEGREE DAYS*, OCTOBER 01 TO APRIL 30
MEAN VALUES SELECTED LOCATIONS**

Yellowknife Airport	3665	C days
Hay River Airport	2971	C days
Fort Simpson Airport	3360	C.days
Contwoyto Lake	4927	C days
Wrigley Airport	3581	C.days
Norman Wells Airport	3950	C.days
Baker Lake Airport	5064	C.days
Fort Smith Airport	3056	C days
Fort Reliance Airport	3885	C.days
Alert	6360	C days

*Relative to 0° C

**TABLE D-6 DEVIATIONS FROM LONG TERM MONTHLY MEAN TEMPERATURES
(°C) YELLOWKNIFE AIRPORT**

MONTH	1984	1985	1986	1987	1988	1989
October	-2.6	-2.2	0.7	1.7	-0.1	0.6
November	-2.9	-4.9	-4.8	1.3	-2.8	-6.1
December	-7.3	2.7	5.6	9.7	1	-2.1
January	1.1	5.7	3.5	10.2	1.4	-0.3
February	5.3	-6.1	2.9	7.7	-1.0	6.5
March	1.9	3.0	1.0	1.3	6.0	-4.0
April	6.5	-0.5	-1.7	3.8	2.1	0.5

TABLE D-7 CUMULATIVE FREEZING DEGREE* DATA LUPIN MINE

MONTH	94 - 95 ACTUALS	84 - 95 MEAN	84 - 95 STANDARD DEVIATION
October	180.6	309.2	44.9
November	783.6	1017.9	117.6
December	1803.5	1929.1	153.9
January	2626.5	2916.9	202.0
February	3464.4	3791.0	245.3
March	4324.7	4624.3	258.2
April	4845.9	5169.5	275.9

* Relative to 0° C

TABLE D-8 SOUTH OF LOCKHART CAMP, ICE THICKNESS PREDICTION (FIGURE D-6)

DATE	ICE THICKNESS WARM YEAR (cm)	ICE THICKNESS NORMAL YEAR (cm)	ICE THICKNESS COLD YEAR (cm)
November 1	4.9	6.7	8.3
December 1	29.5	35.3	40.7
January 1	61.0	71.7	79.8
February 1	94.9	105.2	114.9
March 1	117.3	128.1	138.3
April 1	134.4	145.3	155.7
May 1	140.9	151.3	161.3

TABLE D-9 ESTIMATED OPENING DATES SOUTH OF LOCKHART CAMP

	WARM YEAR	NORMAL YEAR	COLD YEAR
Start load B-Train	16 January	08 January	1 January
Full Load B-Train	6 February	26 January	18 January

**TABLE D-10 NORTH OF LOCKHART CAMP, ICE THICKNESS PREDICTION
(FIGURE D-8)**

DATE	ICE THICKNESS WARM YEAR (cm)	ICE THICKNESS NORMAL YEAR (cm)	ICE THICKNESS COLD YEAR (cm)
November 1	31.1	33.7	36.0
December 1	57.5	61.1	64.6
January 1	80.7	84.1	87.4
February 1	99.8	103.5	107.0
March 1	114.1	118.0	121.7
April 1	126.6	130.3	133.7
May 1	134.0	137.7	141.4

TABLE D-11 ESTIMATED OPENING DATES NORTH OF LOCKHART CAMP

	WARM YEAR	NORMAL YEAR	COLD YEAR
Start Load B-Train	December 30	December 25	December 21
Full Load B-Train	February 1	January 25	January 20

TABLE D-12 MODEL PARAMETERS USED

FIGURE	α cm	B	ρ_s (kg/m ³)
D-1	2.5	0.1833	300
D-2	1.5	0.014	300
D-3	0.0	0.168	325
D-4	8.0	-0.015	300
D-5	0	Variable	300
D-6	8.0	-0.015	300
D-7 (Shallow)	0.0	0.08	300
D-7 (Deep)	0.0	0.28	300
D-8	0.0	0.28	300

Other Parameters Used:

k_i 2.24 W/mK
 ρ_i 917 kg/m³
L 333 kJ/kg

TABLE D-13 FIRST AND LAST TRUCKS AT LUPIN MINE

YEAR	FIRST TRUCK	LAST TRUCK
1995	25 January	
1994	18 January	03 April
1993	03 February	01 April
1992	28 January	22 March
1991	23 January	13 March
1990	01 February	22 March
1989	14 February	07 April
1988	12 February	09 April
1987	No Date	No Data
1986	14 January	01 April
1985	27 January	07 April
1984	30 January	08 April
1983	17 February	14 April

FIGURE D-1 : ICE THICKNESS PREDICTION
YELLOWKNIFE

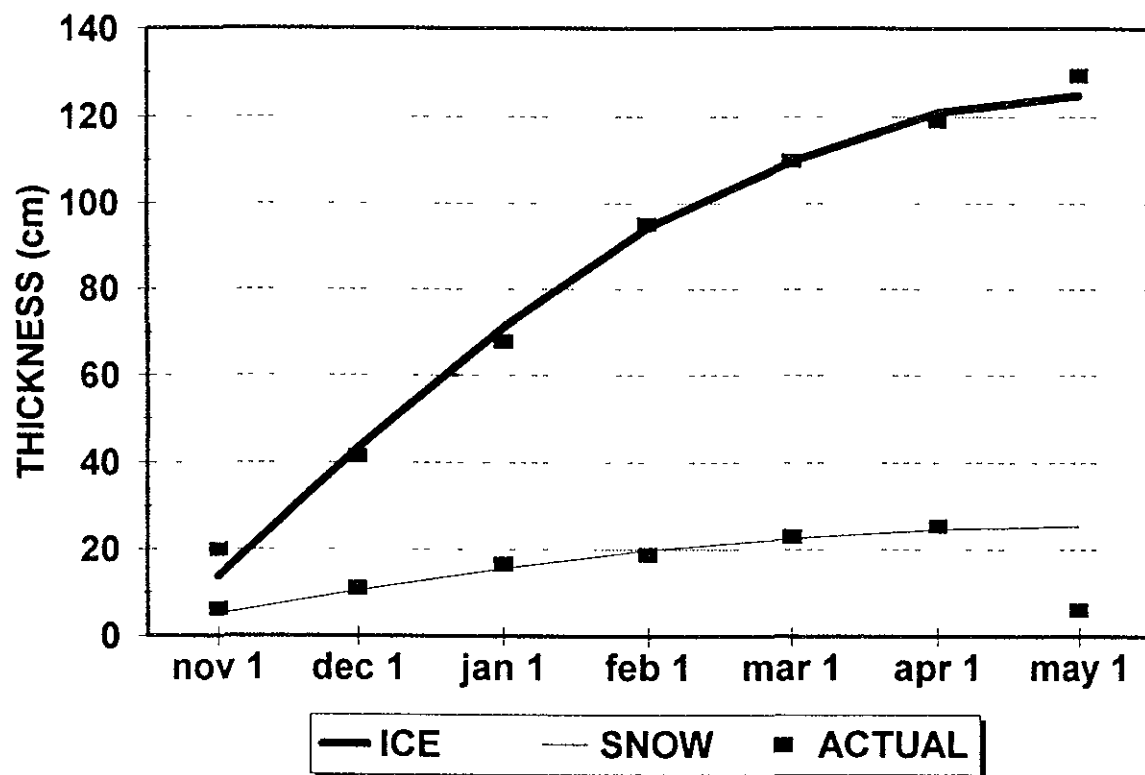
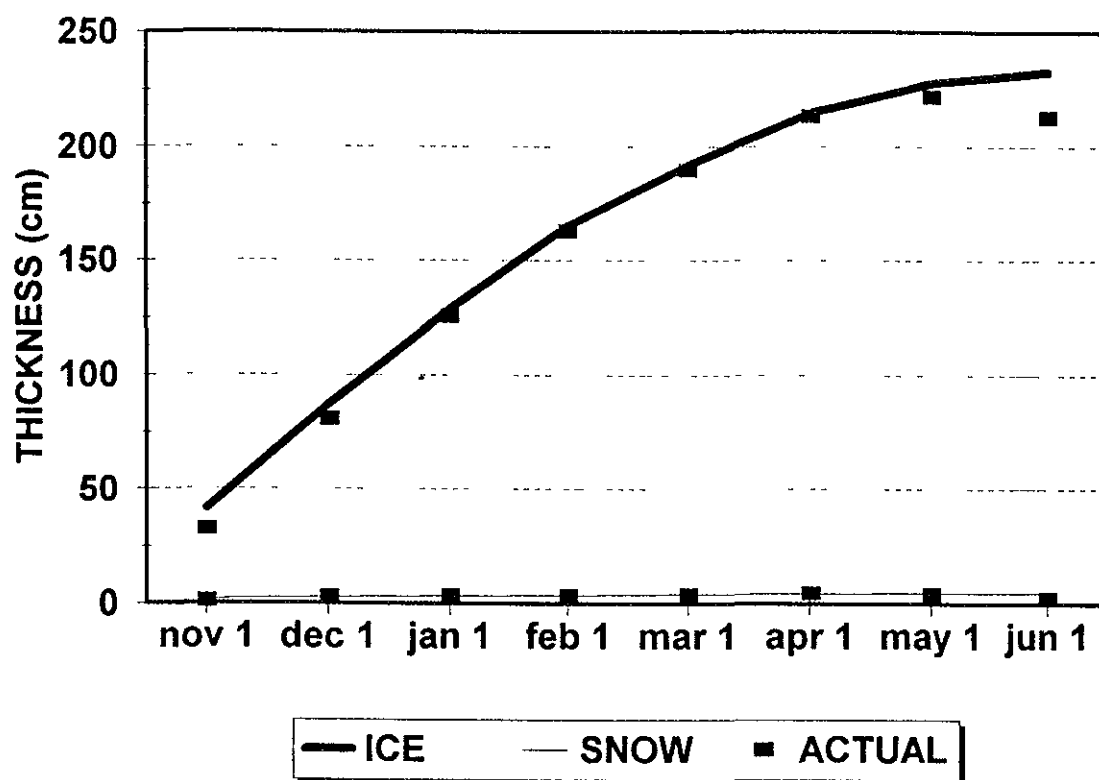
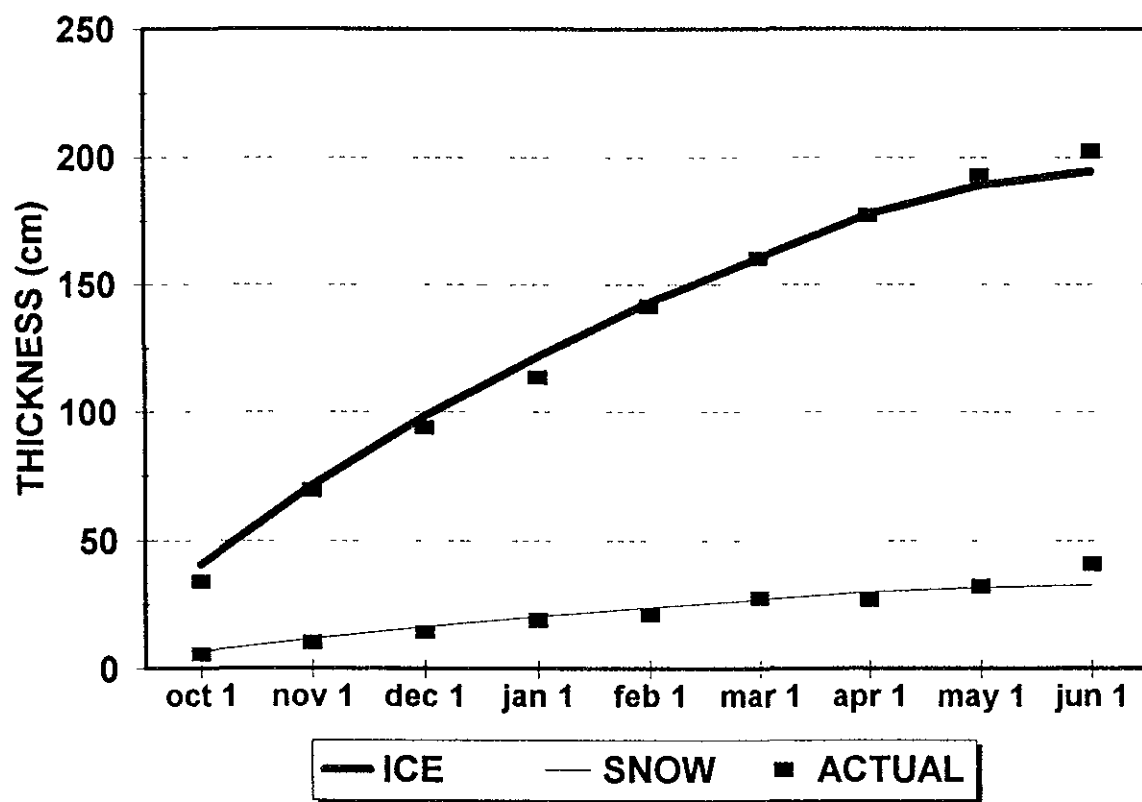


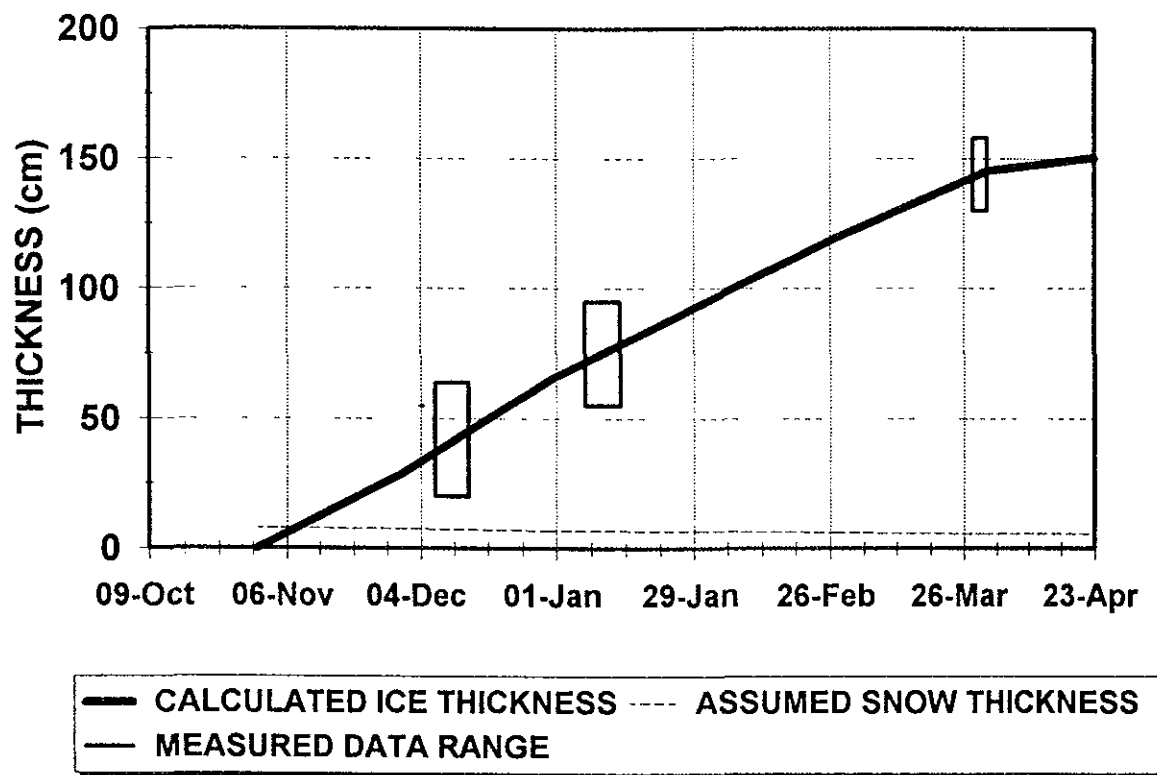
FIGURE D-2 : ICE THICKNESS PREDICTION
BAKER LAKE



**FIGURE D-3 : ICE THICKNESS PREDICTION
ALERT UPPER DUMBELL LAKE**



**FIG D-4 : ICE THICKNESS MODEL & ACTUAL
On Road Ingrahm to Lockhart 1994-95**



**FIG D-5 : EFFECT OF SNOW ON ICE GROWTH
THEORY & OBSERVATIONS**

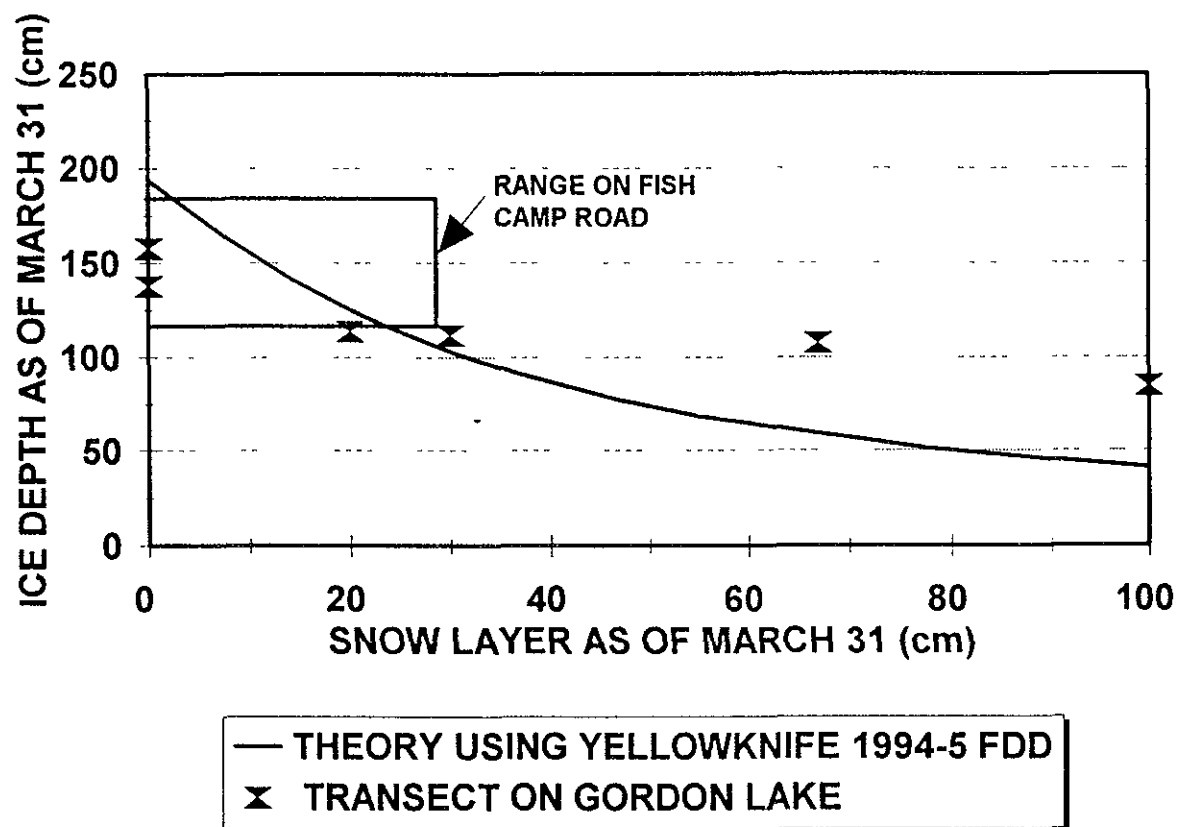
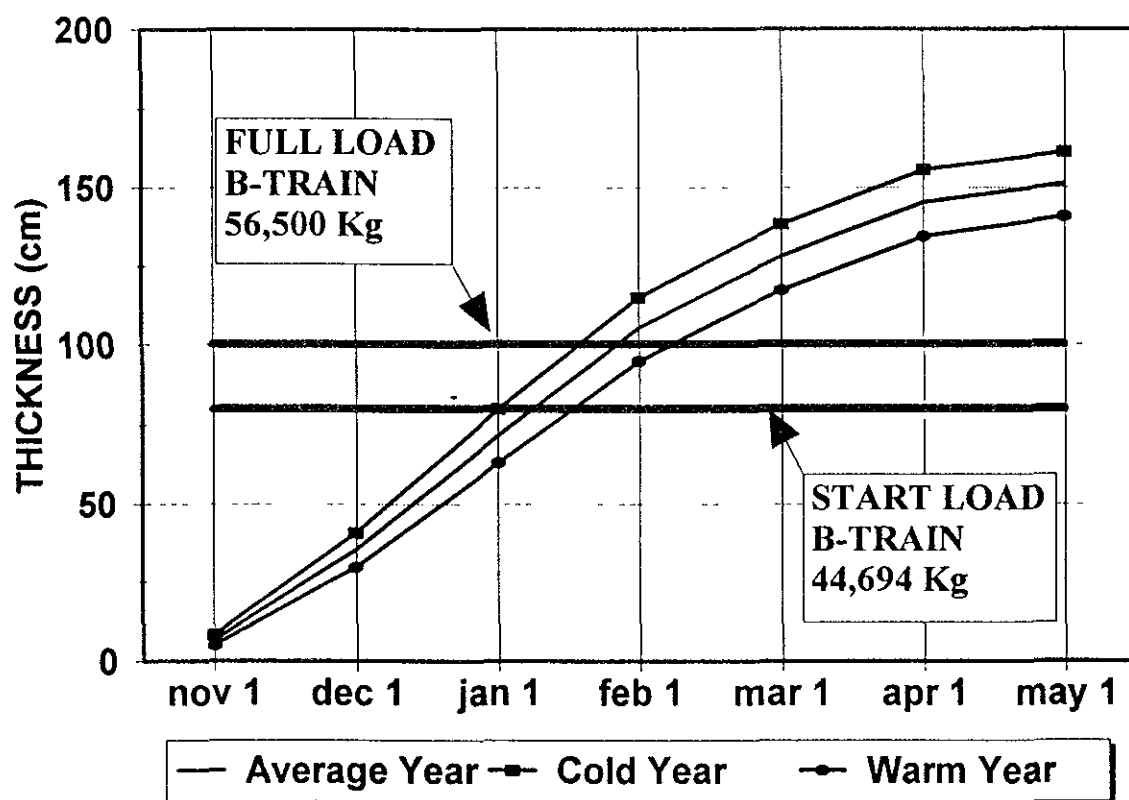
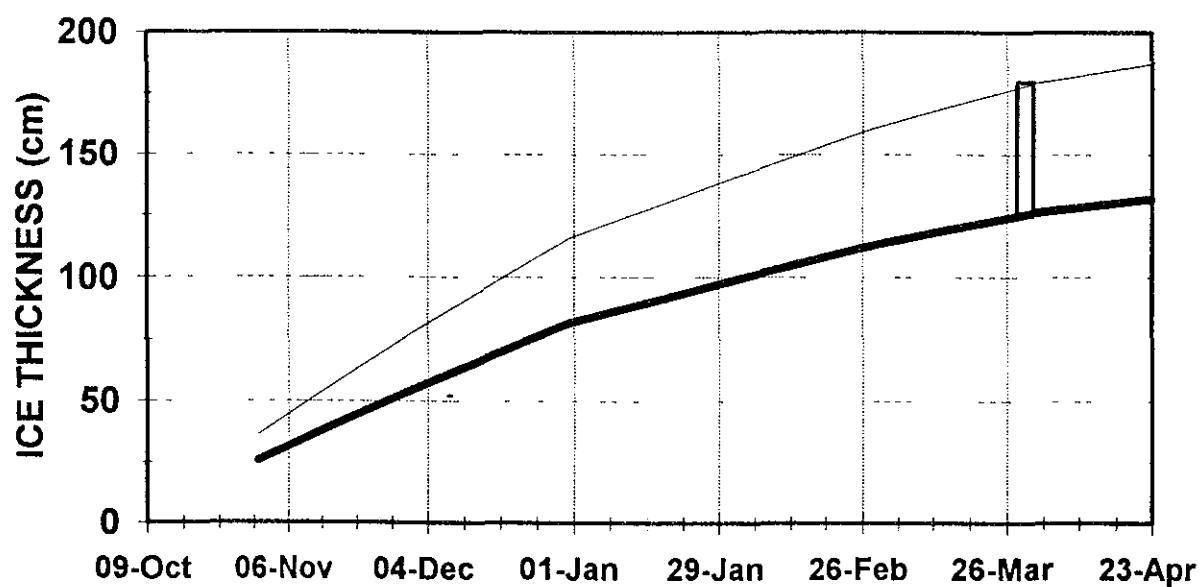


FIG D-6 : MINIMUM ICE THICKNESS
Ingrahm Trail to Lockhart Camp

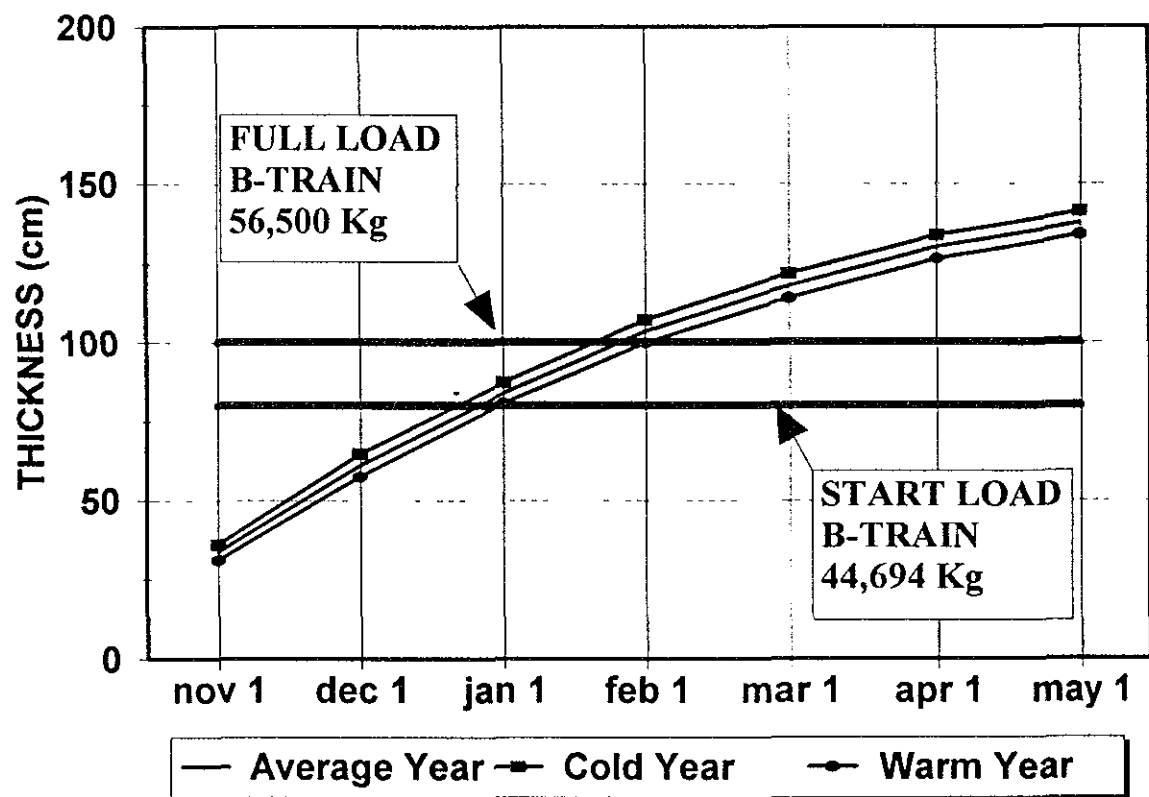


**FIG D-7 : ICE THICKNESS MODEL & ACTUAL
North of Lockhart Camp**

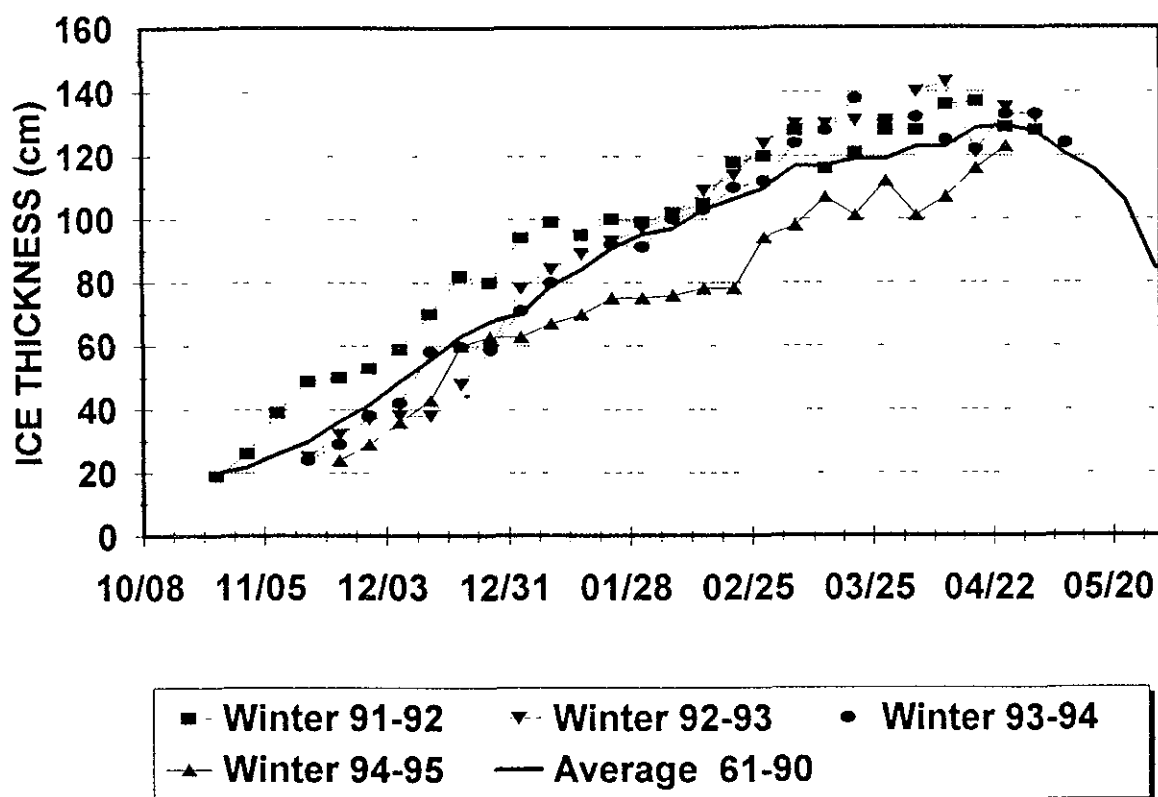


— SHALLOW SNOWDRIFT	— DEEP SNOWDRIFT
— MEASURED DATA RANGE	

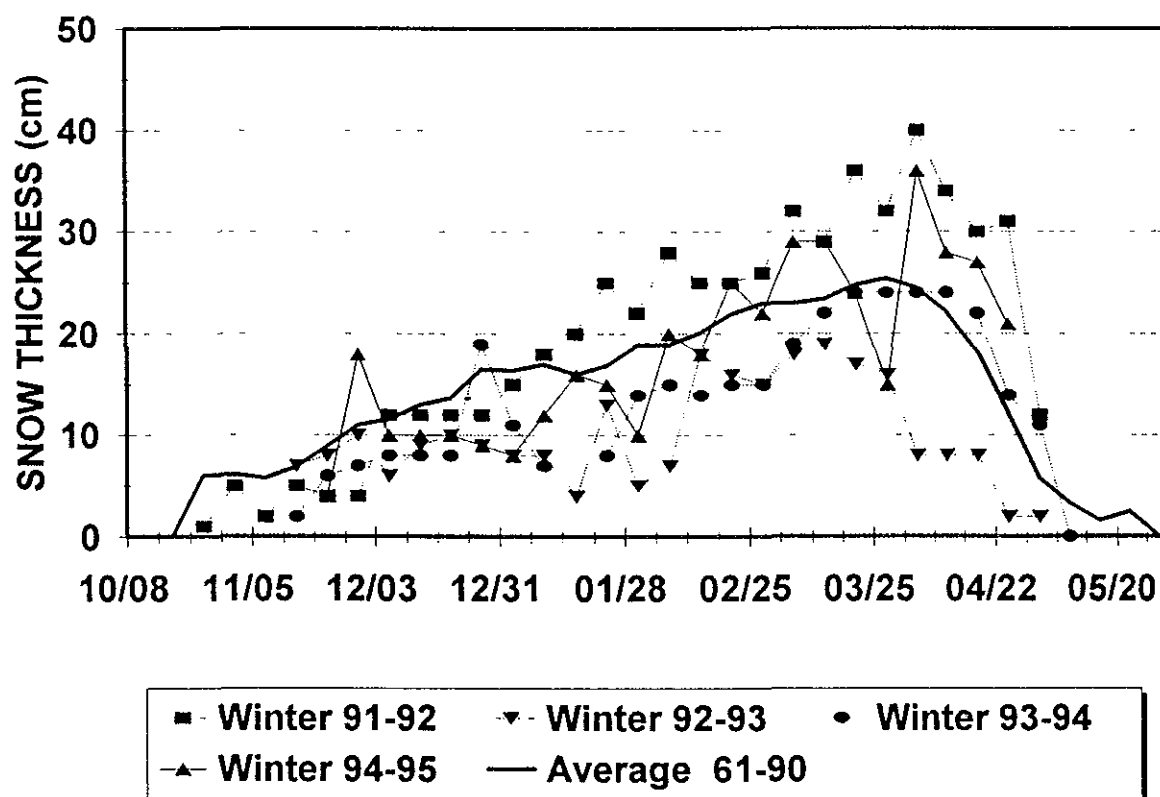
**FIG D-8 : MINIMUM ICE THICKNESS
North of Lockhart Camp**



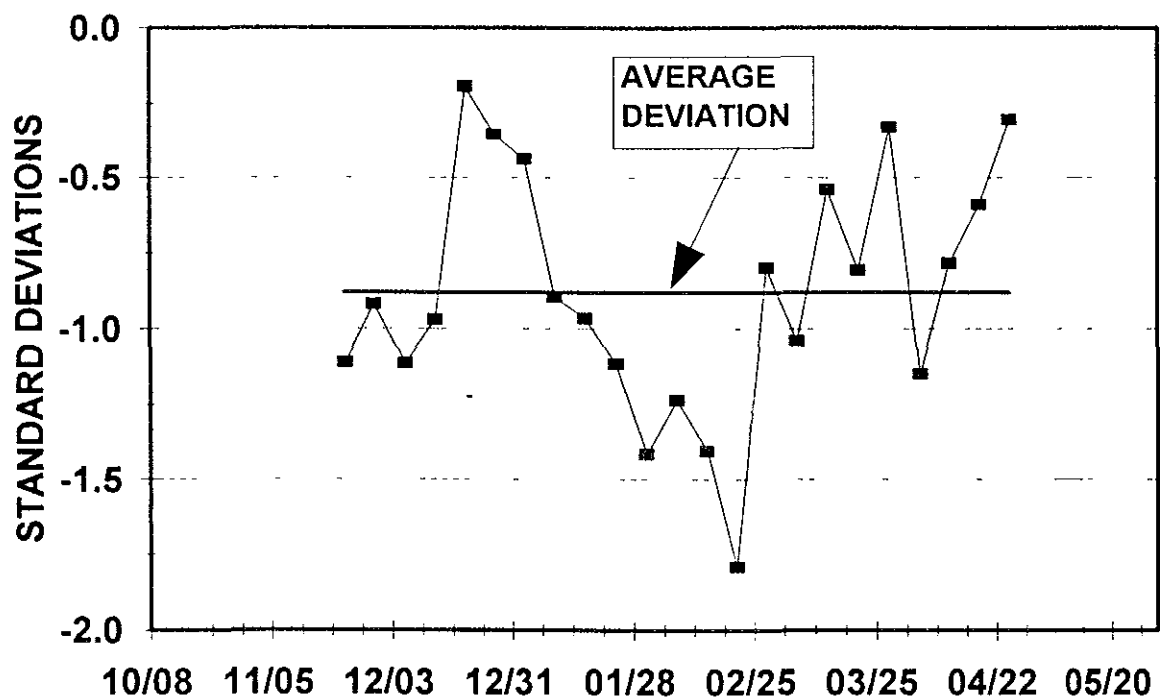
**FIG D-9 : ICE THICKNESS DATA
BACK BAY YELLOWKNIFE**



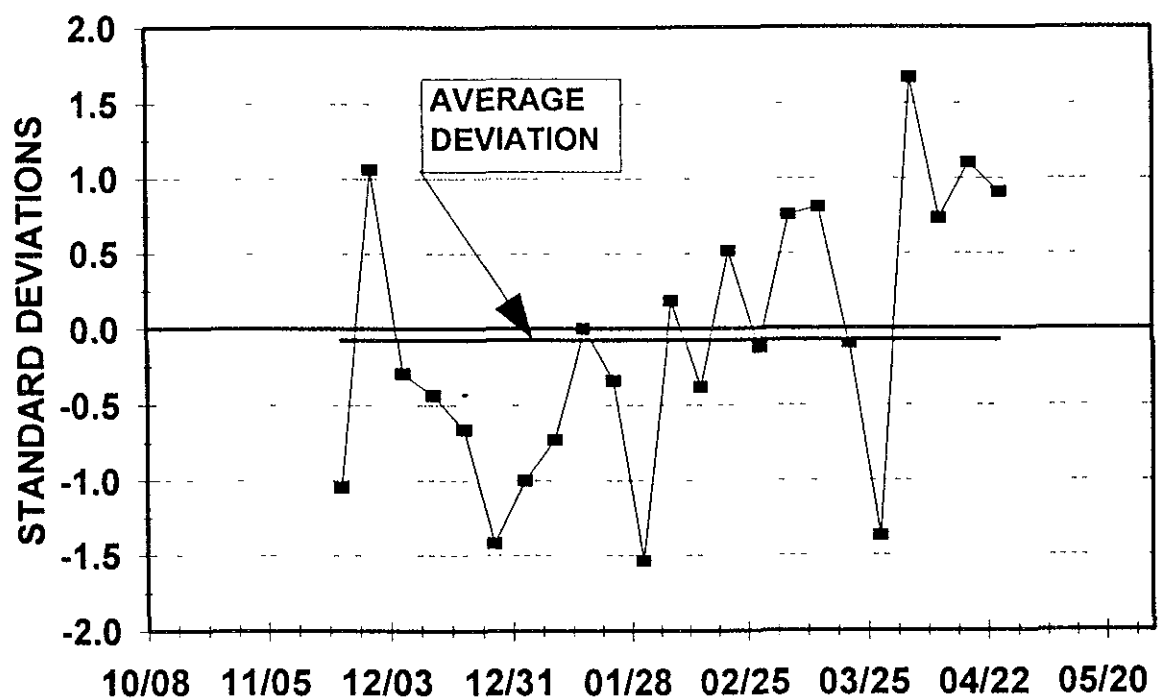
**FIG D-10 : SNOW THICKNESS DATA
BACK BAY YELLOWKNIFE**



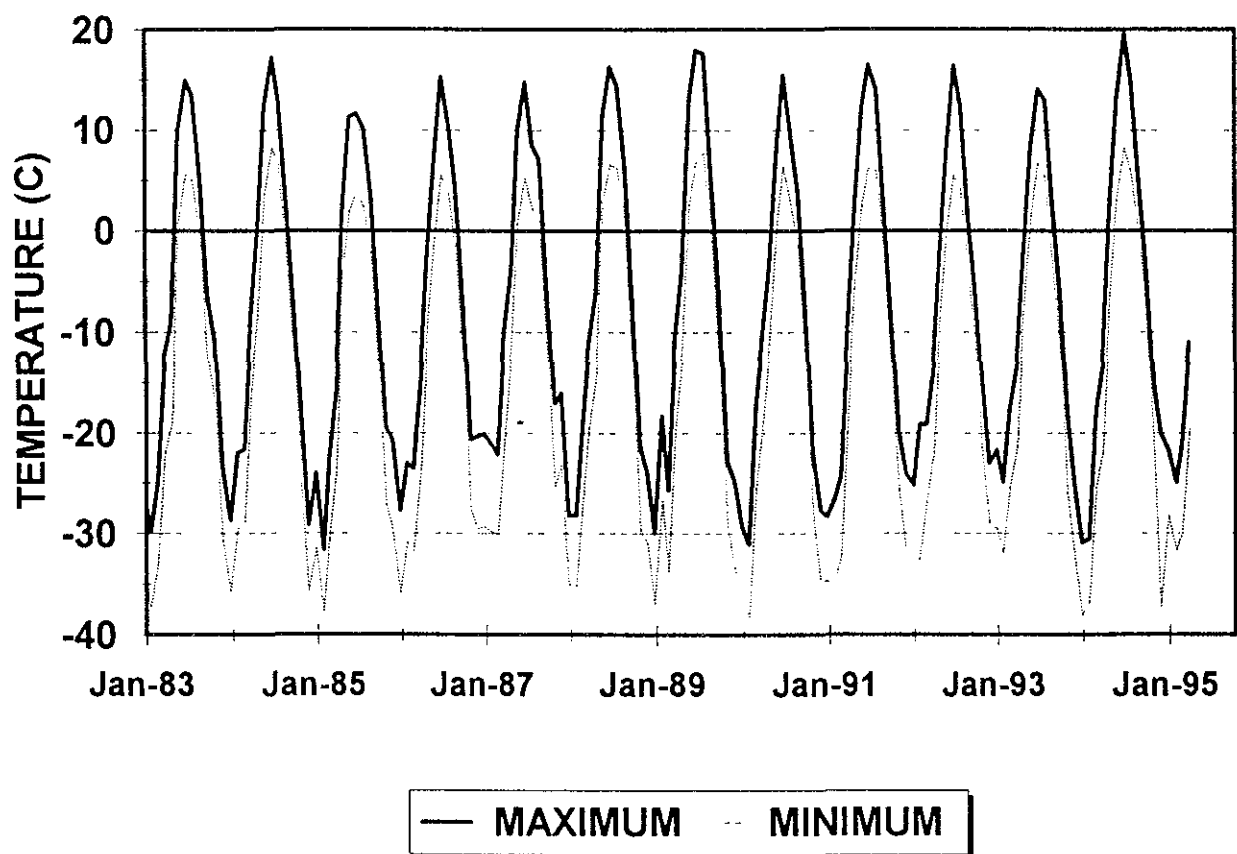
**FIG D-11 : ICE DATA YELLOWKNIFE 94-5
STANDARD DEVIATIONS FROM MEAN**



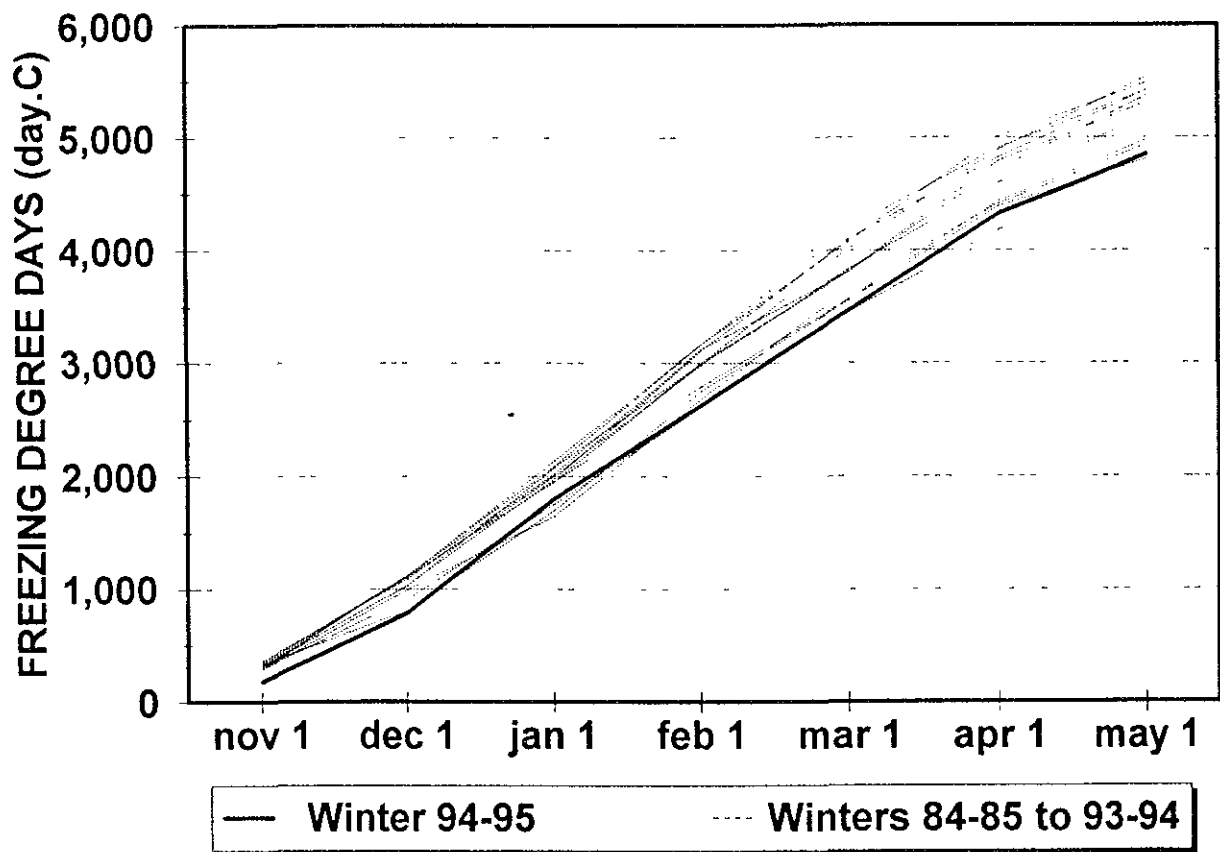
**FIG D-12 : SNOW DATA YELLOWKNIFE 94-5
STANDARD DEVIATIONS FROM MEAN**



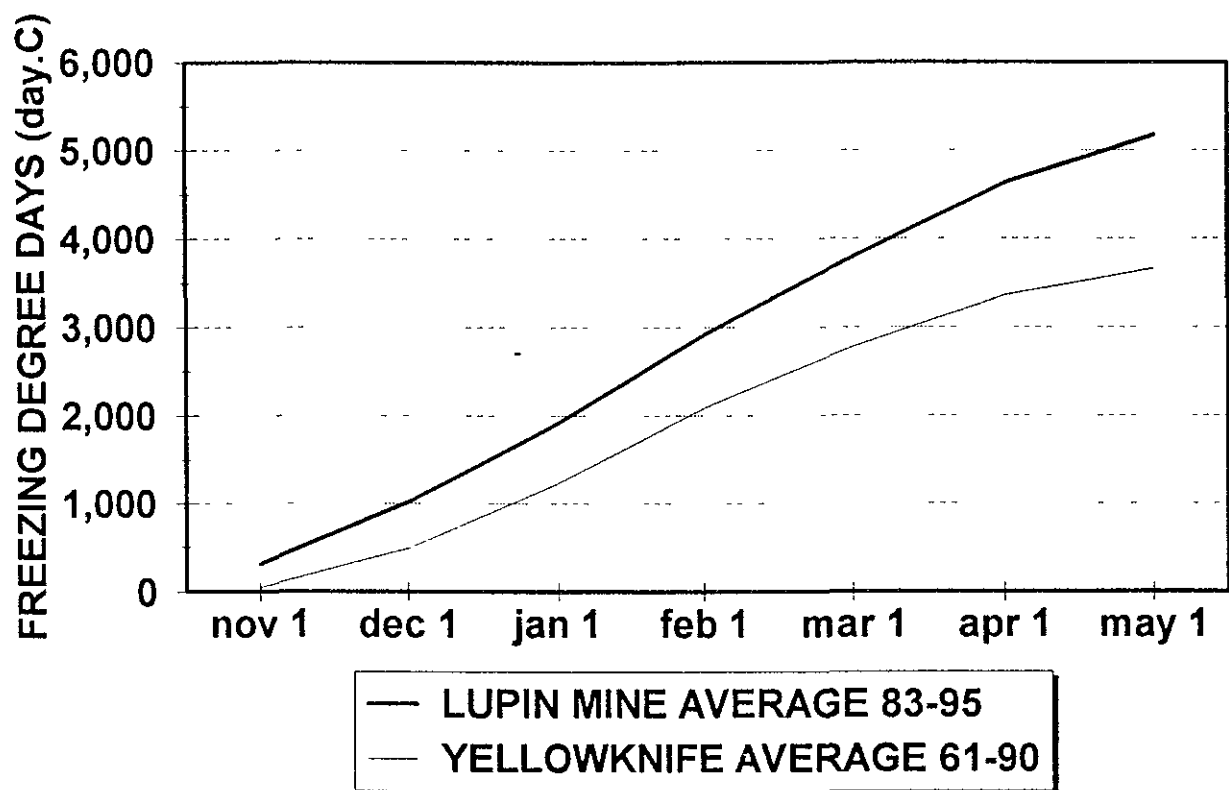
**FIG D-13 : LUPIN MINE TEMPERATURES
AVERAGE MONTHLY MAXIMUM & MINIMUM**



**FIG D-14 : LUPIN MINE TEMPERATURES
CUMULATIVE FREEZING DEGREE DAYS**

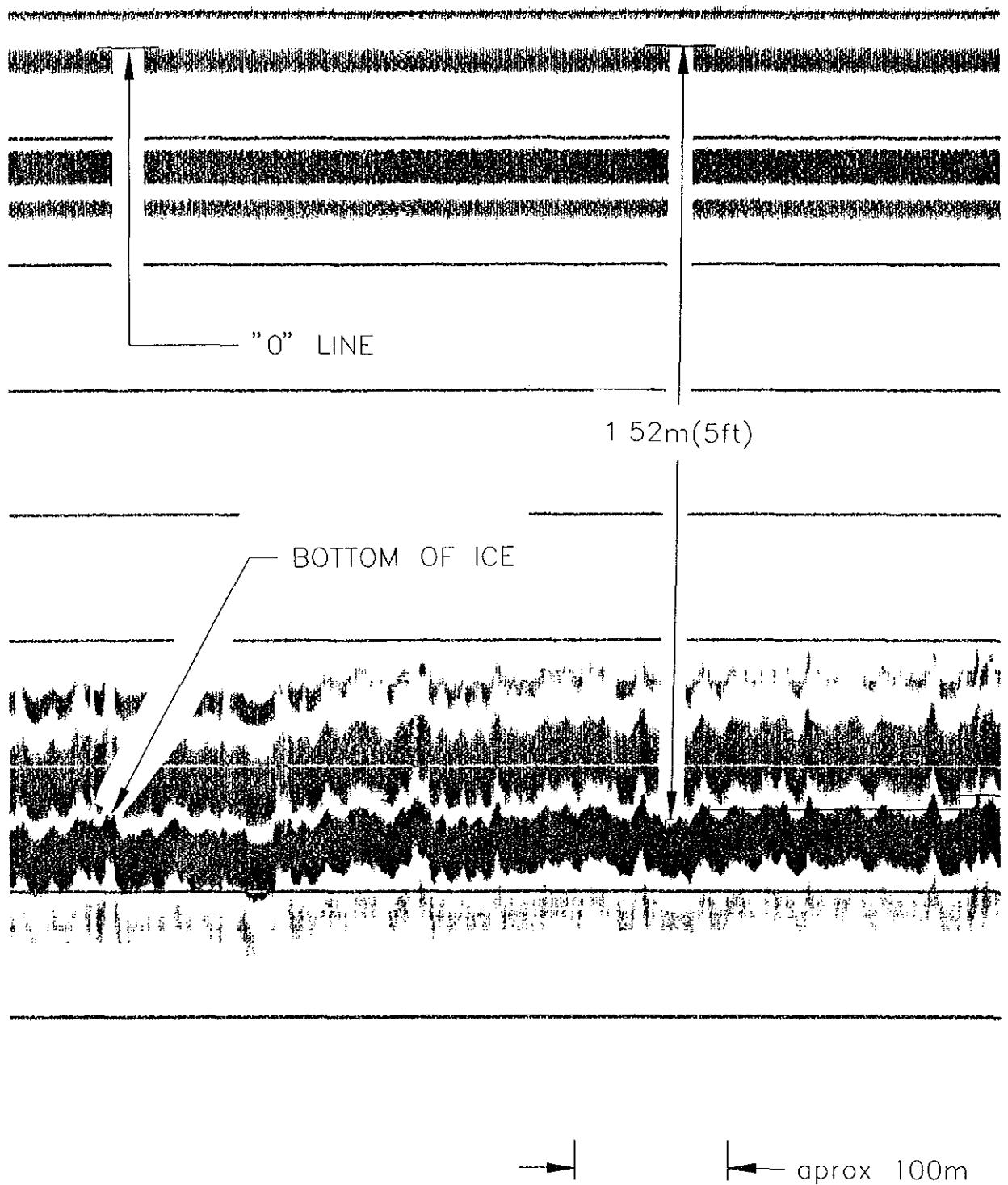


**FIG D-15 : TEMPERATURE DATA
CUMULATIVE FREEZING DEGREE DAYS**



APPENDIX E

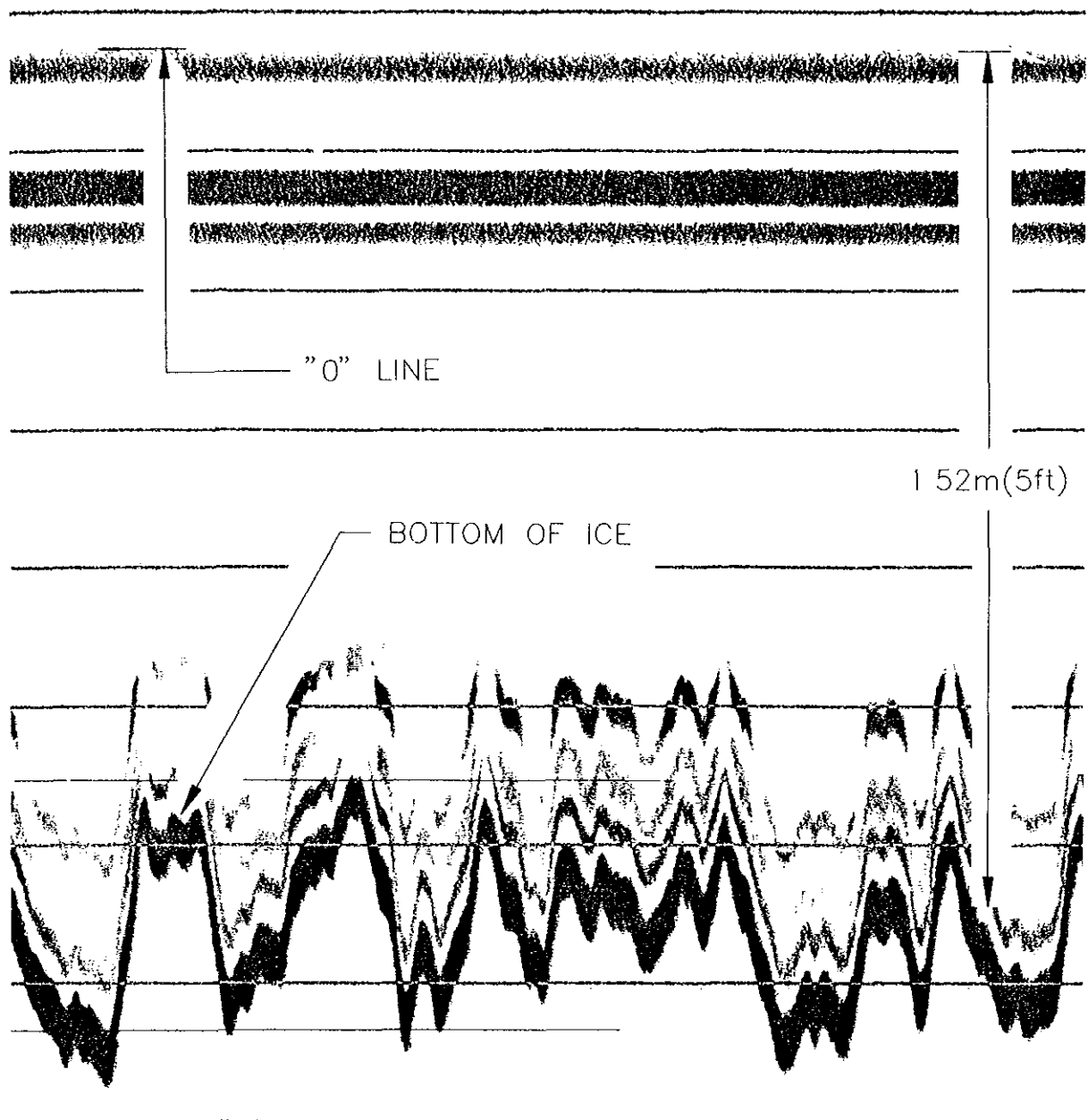
ELECTRONIC ICE PROFILE DATA, March 28 - March 31, 1995



LAKE CLEARED IN DECEMBER
LESS INFLUENCE OF SNOWDRIFTS ON THE ICE THICKNESS

GSSI PROFILE ON GORDON LAKE

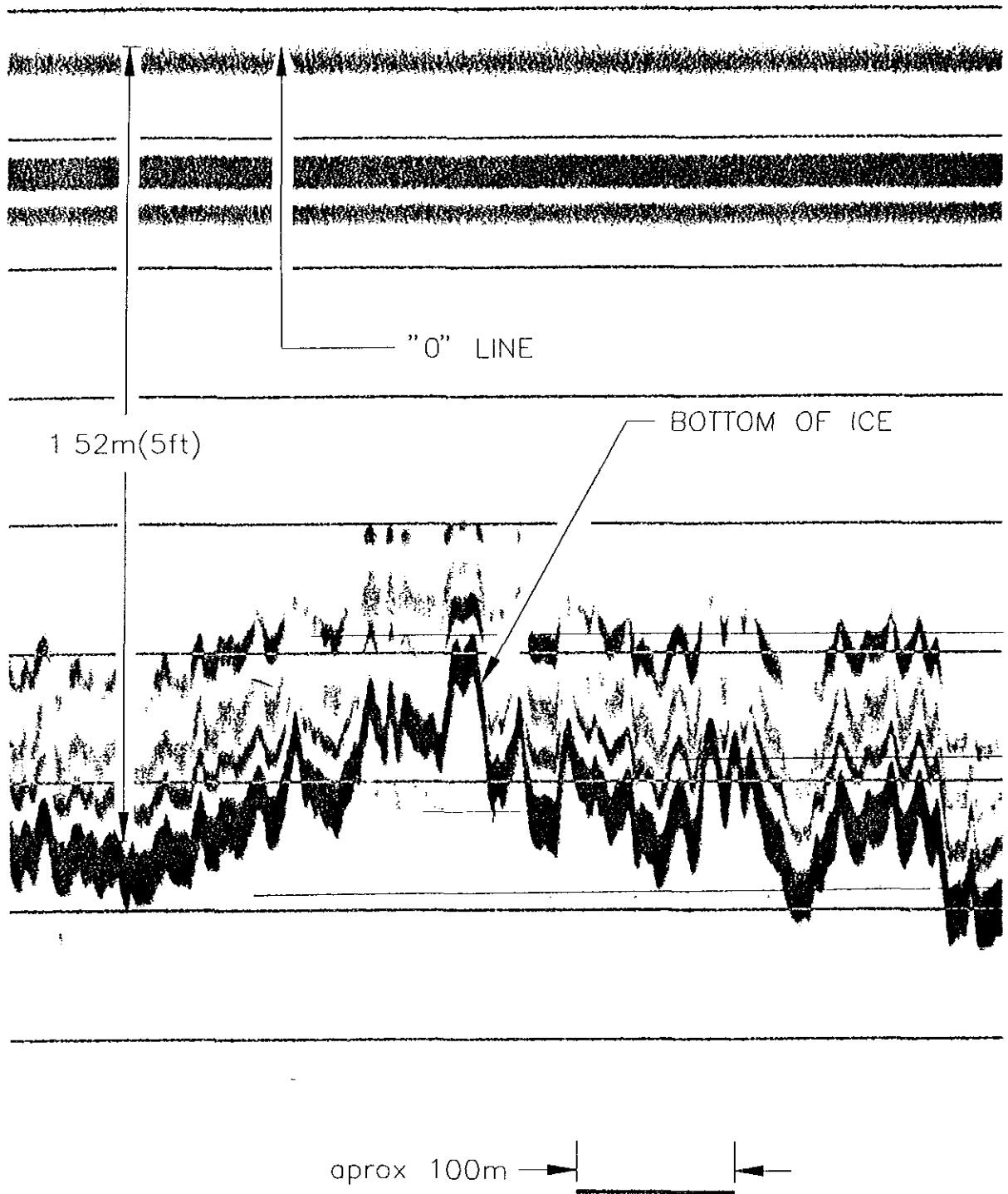
FIGURE 3618C001



LAKE CLEARED IN MID MARCH
THE SNOWDRIFTS INFLUENCE THE ICE GROWTH

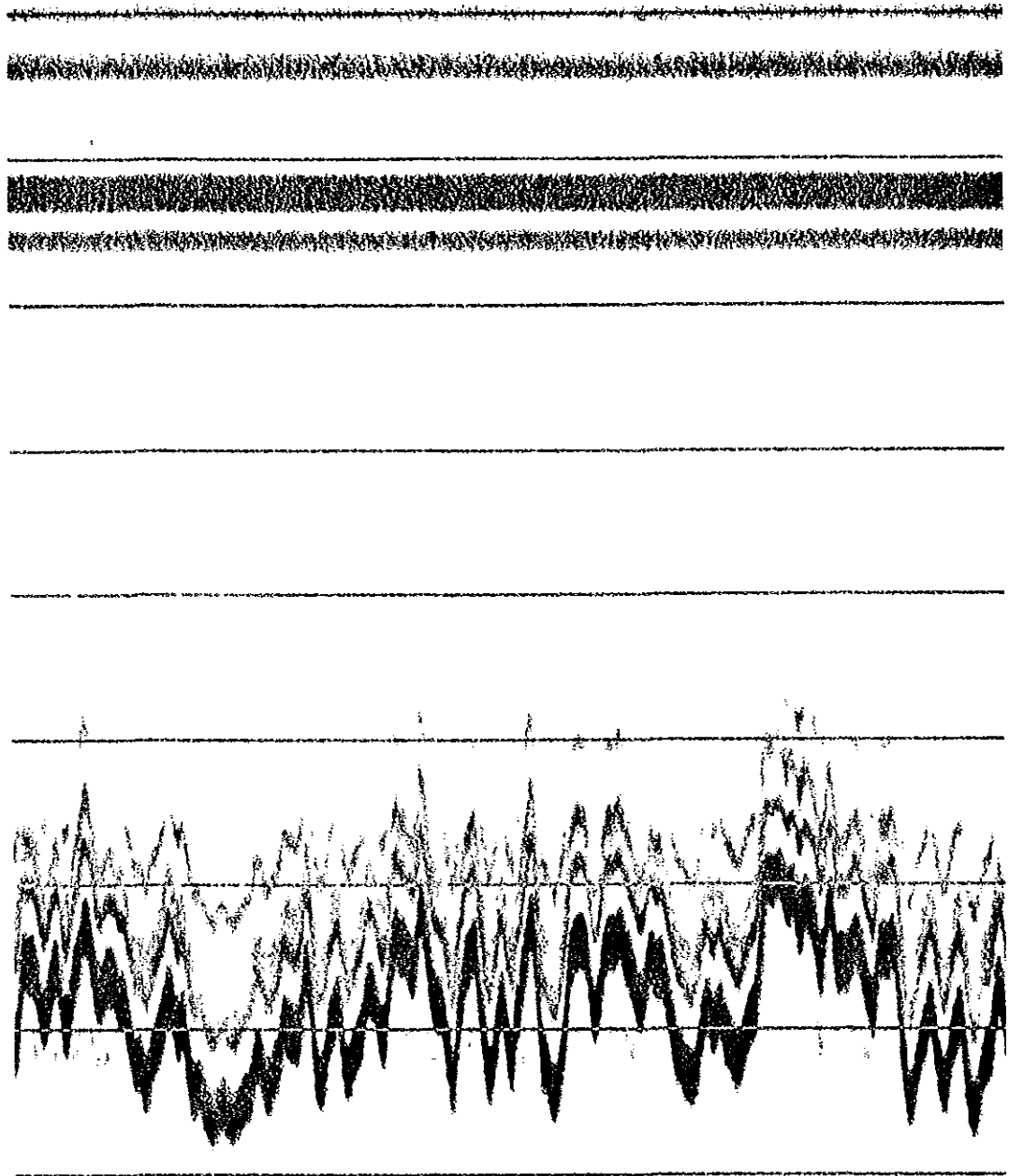
GSSI PROFILE ON MacKAY LAKE

FIGURE 3618C002



**GSSI PROFILE ON MacKAY LAKE
AT LOCATION OF BOIL**

FIGURE 3618C003

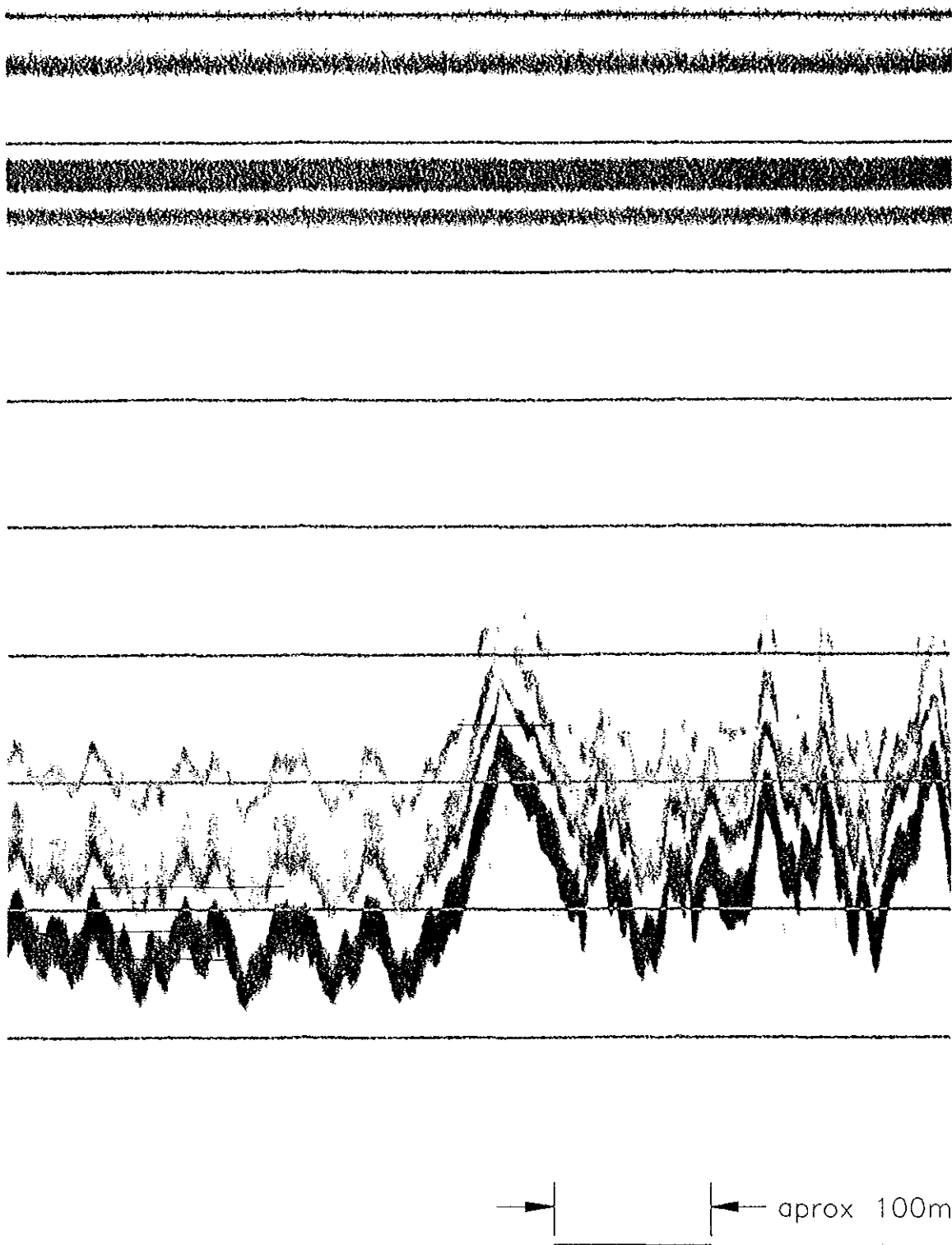


1ft(0.30m)

aprox 100m

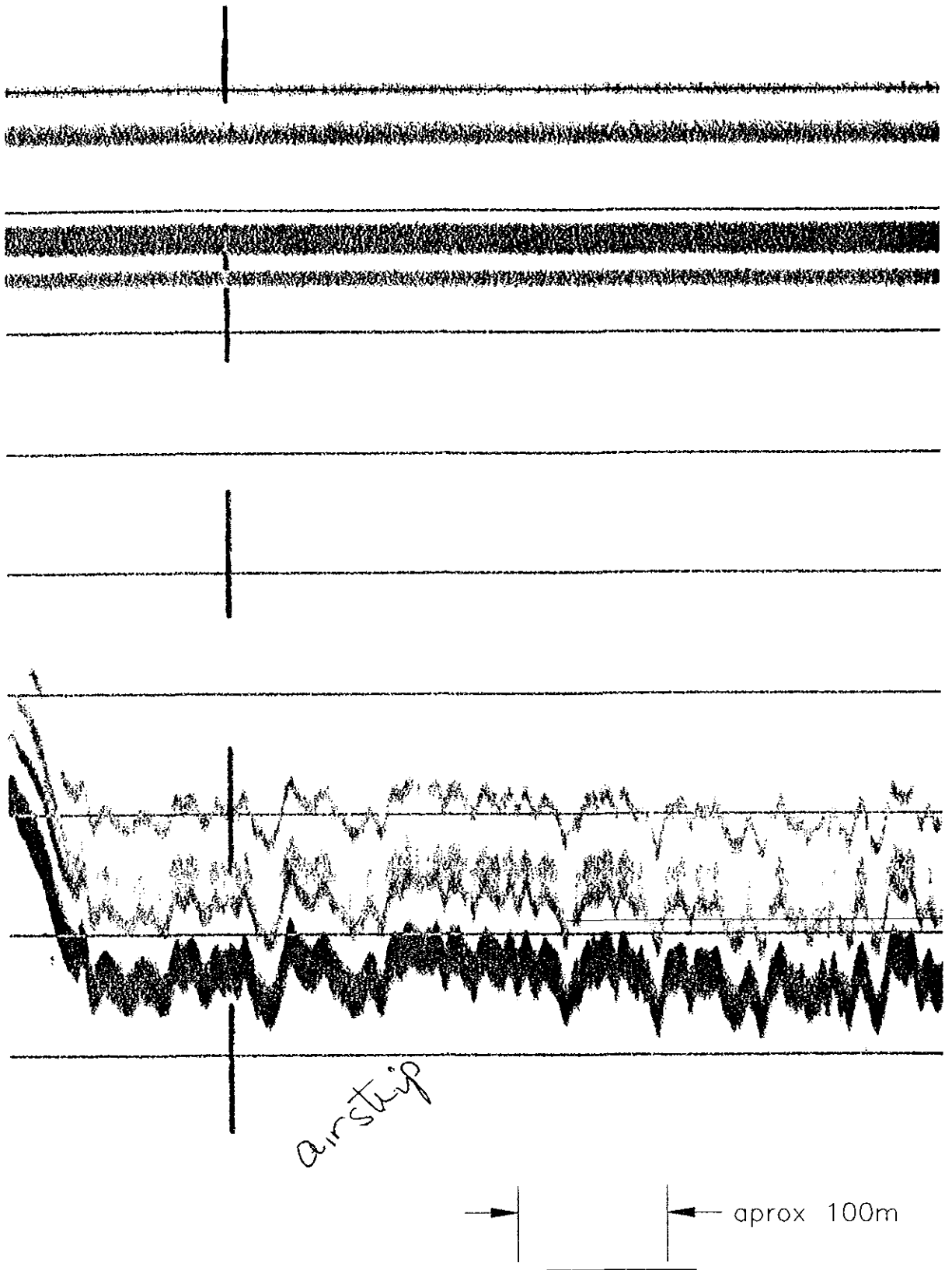
GSSI PROFILE ON LAC DE GRAS

FIGURE 3618C004



**GSSI PROFILE ON LAC DE GRAS
SHOWING THIN ICE NEAR KOALA TURNOFF**

FIGURE 3618C005



**GSSI PROFILE ON LAC DE GRAS
ALONG THE AIR STRIP AT REDPATH CAMP**

FIGURE 3618C006

Lake Name or identifier	From Tibbitt (km)	On Ice (km)	Center of Road			Side of Road			Comments
			Max (m)	Min (m)	Ave (m)	Max (m)	Min (m)	Ave (m)	
Tibbitt Lk.	0.0	2.0	1.62	1.49	1.52				Started 16.45 March 28
#2	3.6	1.5							Grounded Sections @ 1.43 m
#3	5.4	2.0	1.55	1.28	1.34				
4(S)	8.0	0.3	1.58	1.49	1.54				
4(N)	8.6	0.4	1.40	1.31	1.37				Possibly Grounded
5	9.5	0.1	1.55	1.52	1.54				
6	10.1	1.1	1.52	1.37	1.46				Drilled @ 1.52 m
7	11.2	0.3	1.43	1.37	1.40				
8	11.9	0.9							Grounded Sections @ 1.22 m
9	13.0	1.2							Grounded in thin areas @ 1.22 m
Ross Lk.	14.2	7.0							Drilled on return @ 1.19 m
--"	15.2								Probably grounded @ 1.37 m
--"	16.2		1.43	1.37	1.40				
--"	17.2		1.52	1.37	1.46				Drilled @ 1.4 m, water > 18 m
--"	18.2		1.46	1.40	1.43				
--"	19.2		1.58	1.40	1.46				
--"	20.2		1.55	1.46	1.49				
Pensive Lk.	22.1	5.0							Grounded at South end
--"	23.1		1.52	1.40	1.46				
--"	24.1		1.55	1.46	1.49				
--"	25.1		1.49	1.43	1.46				
--"	26.1		1.46	1.40	1.43		1.31		Traversing across road
Dome Lk	29.0	3.2	1.58	1.43	1.52				On to Dome for 1 km and back
29-03-95									Arrived 19.03, @ Grader Camp, Depart. 7.40
Dome Lk.	30.4	1.8	1.58	1.43	1.52				Air Temp. -24 C
#1	35.9	3.4			1.28				
Waite Lk.	38.6	6.7			1.37				
--"	39.6		1.49	1.37	1.46				
--"	40.6		1.52	1.37	1.46				
--"	41.6		1.37	1.31	1.34				
--"	42.6		1.37	1.31	1.34				
--"	43.6		1.37	1.31	1.34				Drilled @ 1.38m F.B. 12cm
--"	44.6								
N of Waite	45.6	1.0	1.52	1.43	1.48				Grounded
Lee Lk.	49.4	1.7	1.37	1.31	1.34				Air Temp. -22 C
Gordon Lk.	52.1	45.4	1.46	1.34	1.40				
--"	53.1		1.37	1.28	1.34				
--"	54.1		1.43	1.40	1.40				Intermittent probs. with GSSI
--"	55.1		1.46	1.31	1.43				
--"	56.1				1.45				Drilled @ 1.45 m, F.B. 4.8 cm
--"	57.1				1.58			1.37	Test Holes Greer changes zero ref
--"	58.1		1.55	1.46	1.52				Air Temp -21 C
--"	59.1					1.49	1.40	1.46	On left side of Road
--"	60.1		1.55	1.46	1.49	1.46	1.37	1.40	On Right side of Road
--"	61.1		1.55	1.46	1.49				
--"	62.1		1.58	1.49	1.49				
--"	63.1		1.52	1.46	1.49				
--"	64.1		1.55	1.49	1.52				
--"	65.1		1.55	1.46	1.51				
--"	66.1		1.52	1.49	1.51				
--"	67.1		1.58	1.49	1.55				
--"	68.1		1.55	1.49	1.52				
--"	69.1		1.55	1.49	1.52				
--"	70.1		1.58	1.49	1.55				
--"	71.1		1.58	1.46	1.55				Transect & crack survey on return

Lake	Name or identifier	From Tibbitt (km)	On Ice (km)	Center of Road			Side of Road			Comments
				Max (m)	Min (m)	Ave (m)	Max (m)	Min (m)	Ave (m)	
--"		72.1		1.55	1.49	1.52				
--"		73.1		1.58	1.55	1.52				
--"		74.1		1.55	1.52	1.55				
--"		75.1		1.58	1.49	1.55				
--"		76.1		1.58	1.49	1.55				
--"		77.1		1.58	1.49	1.55				
--"		78.1		1.58	1.49	1.55	1.52	1.37	1.46	On Right side of Road
--"		79.1		1.58	1.46	1.55				
--"		80.1		1.55	1.49	1.52				
--"		81.1		1.55	1.49	1.52				
--"		82.1		1.58	1.46	1.55				
--"		83.1		1.58	1.46	1.55				Air Temp. -17 C
--"		84.1		1.52	1.46	1.49				
--"		85.1		1.52	1.40	1.49				
--"		86.1		1.46	1.43	1.46				
--"		87.1		1.43	1.40	1.43				
--"		88.1		1.52	1.46	1.49				
--"		89.1		1.55	1.49	1.52				
--"		90.1		1.58	1.49	1.52				
--"		91.1		1.55	1.46	1.52				
--"		92.1		1.55	1.46	1.52				
--"		93.1		1.52	1.37	1.46				
--"		94.1		1.49	1.37	1.43	1.43	1.34	1.39	On Right Side of Road
--"		95.1		1.49	1.37	1.43	1.40	1.34	1.37	On Right Side of Road
--"		96.1					1.43	1.37	1.40	On Right Side of Road
--"		97.1					1.46	1.37	1.42	On Right Side of Road, 12.00 @ end of Gordon
Lake #2		99.5	0.9	1.55	1.52	1.54	1.46	1.40	1.43	On Right Side of Road
Gravel Pit Lk.		100.8	1.5				1.43	1.40	1.42	On Right Side of Road
#4		104.3	1.7	1.52	1.43	1.48				Blowout ice 1.34 - 1.40 m, water 2.1 - 2.2m
?		109.2	0.3							Possibly Grounded @ 1.31 - 1.34 m
#5		110.1	1.6	1.55	1.43	1.49				Boil on lake, drilled found rock
A		112.3								Grounded
Brown Lk.		113.1	7.3				1.40			Drilled @ 1.4 m, F.B. 8.9 cm, Time 13.15
--"		114.1					1.46	1.34	1.40	On left side of Road
--"		115.1		1.52	1.43	1.48				Few large cracks
--"		116.1					1.52	1.43	1.48	Natural snow 0.25 m, banks 7.0m by 0.75 m
--"		117.1		1.55	1.46	1.51	1.49	1.40	1.45	Air Temp. -11 C
--"		118.1					1.55	1.37	1.46	Time 13.38
--"		119.1		1.58	1.52	1.49	1.49	1.40	1.45	Large blowout
B		120.6	1.5	1.52	1.46	1.49				
C		122.3	0.6	1.46	1.40	1.45				
?		123.4	0.3	1.43	1.40	1.42				Grounded
Long Lk.		124.0	6.9	1.49	1.43	1.46				
--"		125.0					1.52	1.43	1.46	
--"		126.0		1.52	1.46	1.49	1.49	1.40	1.45	
--"		127.0		1.55	1.46	1.49				
--"		128.0		1.52	1.40	1.49				
--"		129.0		1.46	1.37	1.42				32 m road, banks 1.2m, narrow crack on centerline
--"		130.0								Changed cable on GSSI, Time 14.55
--"		131.0								
D		131.9	0.5	1.52	1.46	1.49				
E		134.2	0.9	1.52	1.46	1.49				
5		139.2	1.0	1.55	1.49	1.52				
4		140.9	1.1	1.40	1.34	1.40				
3B		142.5	0.3	1.46	1.40	1.43				

Lake	Name or identifier	From Tibbitt (km)	On Ice (km)	Center of Road			Side of Road			Comments
				Max (m)	Min (m)	Ave (m)	Max (m)	Min (m)	Ave (m)	
3		143.7	0.8	1.55	1.46	1.49				
2		144.9	0.7	1.46	1.40	1.43				
	Drybones Lk.	146.6	11.7	1.58	1.46	1.52				
	--"	147.6					1.49	1.37	1.43	On Left Side of Road
	--"	148.6		1.62	1.49	1.55				
	--"	149.6		1.52	1.34	1.43				
	--"	150.6		1.52	1.43	1.49				
	--"	151.6		1.58	1.43	1.49				
	--"	152.6		1.52	1.34	1.46				
	--"	153.6		1.55	1.43	1.49				Large cracks
	--"	154.6		1.62	1.49	1.52				
	--"	155.6		1.49	1.37	1.43				
	--"	156.6		1.55	1.40	1.49				
	--"	157.6		1.52	1.43	1.49				
F		160.8	0.4							Grounded @ 1.34 m
G		161.5	0.2							Grounded @ 1.31 m
H		161.9	1.1	1.43	1.31	1.37				
I		163.3	1.1							Grounded @ 1.45 m
	Lockhart Lk.	168.4	18.9	1.52	1.43	1.46				
	--"	169.4		1.52	1.46	1.49				
	--"	170.4		1.52	1.43	1.46				
	--"	171.4		1.55	1.46	1.49				
	--"	172.4		1.58	1.46	1.49				
	--"	173.4		1.55	1.46	1.49				Air temp. -21 C
	--"	174.4					1.52	1.37	1.49	North of camp before returning
30-03-95										Overnight @ Lockhart Camp, Depart 7.20
	Lockhart Lk.	177.1					1.58	1.46	1.52	Repeat of km 174.4, Air Temp. -29 C
	--"	178.1		1.65	1.52	1.58				Drilled @ 1.52 m, 1.57 m, F.B. 8.9 cm
	--"	179.1					1.55	1.46	1.52	
	--"	180.1		1.65	1.55	1.58				
	--"	181.1		1.65	1.52	1.58				
	--"	182.1		1.71	1.52	1.58				
	--"	183.1		1.68	1.55	1.62				
	--"	184.1		1.68	1.52	1.62				
	--"	185.1		1.68	1.52	1.58				
	--"	186.1		1.74	1.55	1.65				
	Warburton Arm	188.8	10.0							Air Temp -30 C, Time 8.14
	--"	189.8		1.65	1.25	1.58				
	--"	190.8		1.65	1.55	1.58				
	--"	191.8		1.65	1.58	1.58				Not many cracks
	--"	192.8		1.68	1.52	1.62				
	--"	193.8		1.65	1.52	1.62				
	--"	194.8		1.71	1.55	1.65				
	--"	195.8		1.65	1.46	1.62				3-4 s sway cycle of antennae
	--"	196.8		1.65	1.55	1.58				
	--"	197.8					1.55	1.46	1.52	
	--"	198.8					1.55	1.46	1.49	
	Warburton Bay	198.9	32.2	1.65	1.58	1.62				Time 8.43
	--"	199.9		1.68	1.58	1.65				
	--"	200.9		1.71	1.55	1.65				
	--"	201.9		1.74	1.55	1.62				
	--"	202.9		1.71	1.55	1.65				
	--"	203.9		1.71	1.52	1.62				
	--"	204.9		1.71	1.55	1.62				
	--"	205.9		1.71	1.55	1.62				

Lake	Name or Identifier	From Tibbitt (km)	On Ice (km)	Center of Road			Side of Road			Comments
				Max (m)	Min (m)	Ave (m)	Max (m)	Min (m)	Ave (m)	
--"		206.9		1.74	1.58	1.65				
--"		207.9					1.52	1.31	1.42	
--"		208.9		1.71	1.55	1.65				
--"		209.9		1.71	1.55	1.62				
--"		210.9		1.71	1.55	1.65				
--"		211.9		1.71	1.55	1.62				
--"		212.9		1.71	1.55	1.65				
--"		213.9		1.74	1.55	1.65				
--"		214.9		1.74	1.52	1.65				17.5 m wide road, 0.1 m wide crack along centerline
--"		215.9		1.74	1.58	1.68				
--"		216.9		1.74	1.55	1.65				
--"		217.9		1.77	1.55	1.65				
--"		218.9		1.74	1.55	1.65				
--"		219.9		1.71	1.52	1.62				
--"		220.9		1.71	1.52	1.62				
--"		221.9		1.68	1.49	1.58				
--"		222.9		1.77	1.52	1.68				
--"		223.9		1.77	1.65	1.71				
--"		224.9					1.68	1.49	1.62	
--"		225.9		1.77	1.58	1.68				
--"		226.9		1.77	1.55	1.68				
--"		227.9		1.80	1.58	1.71				
--"		228.9		1.80	1.62	1.71				
--"		229.9		1.74	1.55	1.65				
--"		230.9		1.71	1.55	1.65				
--"		231.9		1.77	1.55	1.68				Time 11.22
W1		231.2		1.74	1.52	1.65				32 m wide road, small crack on centerline
W2		237.1	3.2	1.74	1.58	1.65				
--"		238.1		1.74	1.58	1.65				Drilled @ 1.73m center, 1.60m on right
--"		238.1		1.74	1.58	1.65				Air Temp -24 C, Time 12.20
--"		239.1		1.74	1.62	1.68				
--"		240.1				1.71				
MacKay Lk.		240.4	95.8	1.77	1.55	1.68			1.58	Time 12.28
--"		241.4		1.77	1.55	1.68				
--"		242.4		1.74	1.55	1.65				
--"		243.4		1.74	1.52	1.65				
--"		244.4		1.77	1.58	1.68				
--"		245.4		1.55	1.37	1.43				New section of Road
--"		246.4		1.71	1.37	1.52				
--"		247.4		1.77	1.31	1.62				
--"		248.4		1.77	1.37	1.52				
--"		248.4		1.74	1.40	1.55				
--"		249.4		1.74	1.40	1.55				
--"		250.4		1.71	1.40	1.62				
--"		251.4		1.74	1.37	1.52	1.74	1.37	1.55	
--"		252.4			1.52					
--"		253.4		1.74	1.55	1.65				
--"		254.4		1.74	1.46	1.65				
--"		255.4		1.74	1.58	1.65				
--"		256.4		1.74	1.55	1.65				Pressure Ridge with bridge
--"		257.4		1.77	1.58	1.68				
--"		258.4		1.71	1.52	1.62				
--"		259.4		1.71	1.52	1.62				
--"		260.4		1.74	1.58	1.71		1.37		Minimum in 1 place
--"		261.4		1.74	1.40	1.55				

Lake	Name or identifier	From Tibbitt (km)	On Ice (km)	Center of Road			Side of Road			Comments
				Max (m)	Min (m)	Ave (m)	Max (m)	Min (m)	Ave (m)	
--"		262.4		1.71	1.31	1.52				
--"		263.4		1.74	1.37	1.62	1.68	1.37	1.52	
--"		264.4					1.58	1.37	1.49	
--"		265.4		1.74	1.37	1.62				
--"		266.4		1.77	1.34	1.62				
--"		267.4		1.74	1.34	1.62				
--"		268.4		1.77	1.37	1.58	1.74	1.37	1.65	
--"		269.4					1.77	1.31	1.55	
--"		270.4					1.74	1.31	1.55	
--"		271.4					1.74	1.40	1.55	
--"		272.4		1.65	1.49	1.58				
--"		273.4		1.71	1.49	1.65				
--"		274.4		1.62	1.16	1.52		0.99		Boil in Road
--"		275.4		1.65	1.34	1.49				Tied tree log to antennae for stability
--"		276.4		1.74	1.40	1.58				
--"		277.4		1.77	1.40	1.58				
--"		278.4		1.74	1.40	1.62				
--"		278.6		1.77	1.40	1.58				Old Road Area
--"		279.4		1.77	1.28	1.52				Road To Fish Camp
--"		280.4		1.74	1.28	1.62				Road To Fish Camp
--"		281.4		1.77	1.25	1.51				Road To Fish Camp
--"		282.1		1.68	1.37	1.52				Back on Road to Lac De Gras
--"		283.1		1.77	1.43	1.62				
--"		284.1		1.77	1.37	1.52				
--"		285.1		1.77	1.43	1.62				
--"		286.1		1.77	1.43	1.62				
--"		287.1		1.77	1.40	1.58				
--"		288.1		1.74	1.40	1.55				
--"		289.1		1.74	1.34	1.55				
--"		290.1		1.77	1.37	1.58				
--"		291.1		1.74	1.37	1.58				
--"		292.1		1.68	1.37	1.58				
--"		293.1		1.71	1.37	1.58				
--"		294.1		1.80	1.43	1.65				
--"		295.1		1.77	1.49	1.65	1.77	1.49	1.62	
--"		296.1					1.74	1.40	1.62	
--"		297.1					1.77	1.40	1.62	
--"		298.1					1.80	1.37	1.65	
--"		299.1					1.80	1.40	1.55	
--"		300.1					1.77	1.43	1.58	
--"		301.1					1.77	1.43	1.62	
--"		302.1					1.80	1.40	1.68	
--"		303.1					1.77	1.37	1.58	
--"		304.1		1.74	1.40	1.55				
--"		305.1		1.74	1.40	1.55				
--"		306.1		1.77	1.40	1.58				
--"		307.1		1.77	1.40	1.58				
--"		308.1		1.77	1.37	1.55				
--"		309.1		1.77	1.37	1.55				
--"		310.1		1.77	1.37	1.58				
--"		311.1		1.77	1.37	1.65				
--"		312.1		1.80	1.43	1.65				30m wide road
--"		313.1		1.80	1.46	1.65				1.5 m banks, natural snow thickness recorded
--"		314.1		1.71	1.46	1.62				
--"		315.1		1.68	1.40	1.58				

Ice Thickness Data from electronic survey March 28- April 4, 1995 : Tibbitt Lake to Koala Camp

Lake	Name or Identifier	From Tibbitt (km)	On Ice (km)	Center of Road			Side of Road			Comments
				Max (m)	Min (m)	Ave (m)	Max (m)	Min (m)	Ave (m)	
--"		316.1		1.68	1.40	1.58				
--"		317.1		1.68	1.46	1.58				
--"		318.1		1.68	1.46	1.62				
--"		319.1		1.77	1.40	1.65				
--"		320.1		1.74	1.40	1.65				
--"		321.1		1.71	1.37	1.58				
--"		322.1		1.74	1.40	1.58				
--"		323.1		1.77	1.43	1.62				
--"		324.1		1.74	1.37	1.58				
--"		325.1		1.80	1.43	1.58				
--"		326.1		1.71	1.31	1.55				
--"		327.1		1.65	1.40	1.55				
--"		328.1		1.71	1.31	1.55				
--"		329.1		1.65	1.37	1.52				
--"		330.1		1.77	1.28	1.55				
--"		331.1		1.77	1.31	1.58				
--"		332.1		1.77	1.25	1.58				
--"		333.1		1.77	1.37	1.58				
--"		334.1		1.74	1.34	1.62				
--"		335.1		1.77	1.37	1.58				
--"		336.1		1.74	1.37	1.58				
Lk #1		337.5	1.2							Grounded
Lk #2		339.4								Grounded
Lk #3		340.4	0.6	1.80	1.62	1.71				
Lk #4		342.1	0.3	1.74	1.68	1.71				Possibly Grounded
Lk #5		342.8	3.8	1.80	1.65	1.74				
--"		343.8		1.80	1.62	1.71				
--"		344.8		1.77	1.65	1.71				
--"		345.8		1.77	1.62	1.71				
Lk #6		347.9	5.5	1.83	1.68	1.77				
--"		348.9		1.80	1.62	1.71				
--"		349.9		1.77	1.65	1.71				
--"		350.9		1.77	1.62	1.71				
--"		351.9		1.77	1.62	1.71				
--"		352.9		1.83	1.65	1.74				
Lk #7		357.4	2.3	1.77	1.62	1.71				Changed cable on GSSI, wear from portages
01-04-95										Overnight @ Lac De Gras Camp, Depart 7.36
?		360.3	1.3	1.77	1.62	1.68				
Lac De Gras		362.6	29.8	1.80	1.34	1.57				Air Temp -28 C
--"		363.6		1.77	1.37	1.57				
--"		364.6		1.77	1.31	1.54				
--"		365.6		1.71	1.34	1.52				
--"		366.6		1.68	1.37	1.52				
--"		367.6		1.71	1.34	1.52				
--"		368.6		1.65	1.31	1.48				
--"		369.6		1.80	1.46	1.63				Old Road 1.65 - 1.83 m
--"		370.6		1.77	1.34	1.62				
--"		371.6		1.71	1.34	1.62				
--"		372.6		1.77	1.16	1.65				Possibly grounded
--"		373.6		1.77	1.34	1.65				
--"		374.6		1.77	1.37	1.57				Road to Redpath
--"		375.6		1.80	1.65	1.74				Airstrip
--"		376.6		1.80	1.46	1.74				Road North of airstrip, Gas up vehicle
--"		377.6								Not profiling
--"		378.6								Not profiling

Lake	Name or identifier	From Tibbitt (km)	On Ice (km)	Center of Road			Side of Road			Comments
				Max (m)	Min (m)	Ave (m)	Max (m)	Min (m)	Ave (m)	
--"		379.6								Not profiling
--"		380.6		1.74	1.46	1.65				Back on main road, Time 8.52
--"		381.6		1.74	1.46	1.58				
--"		382.6		1.74	1.37	1.58				
--"		383.6		1.65	1.46	1.58				
--"		384.6		1.74	1.40	1.62				
--"		385.6		1.68	1.43	1.58				
--"		386.6					1.62	1.37	1.52	
--"		387.6							1.49	Drilled @ 1.46, 1.55, 1.52, 1.46 m
--"		388.6					1.71	1.40	1.55	38 m wide road
--"		389.6					1.77	1.40	1.52	
--"		390.6		1.77	1.43	1.62	1.77	1.43	1.58	
--"		391.6		1.77	1.58	1.71				
Lac Du Savage		393.1	21.0	1.83	1.68	1.77				
--"		394.1		1.83	1.55	1.77				
--"		395.1		1.80	1.65	1.74				
--"		396.1		1.83	1.65	1.71				
--"		397.1		1.83	1.62	1.74				
--"		398.1		1.80	1.62	1.74				
--"		399.1		1.77	1.62	1.71				
--"		400.1		1.77	1.31	1.65				Profile Changes looks like new road
--"		401.1		1.80	1.34	1.71				
--"		402.1		1.80	1.37	1.71				
--"		403.1		1.80	1.37	1.71				
--"		404.1		1.80	1.34	1.68				Air Temp -26 C, Time 10.22
--"		405.1		1.71	1.34	1.58				Koala Junction. Now on road to Koala Camp
--"		406.1		1.77	1.37	1.68				
--"		407.1		1.77	1.43	1.68				
--"		408.1		1.77	1.43	1.68				Narrow road, high banks, not much cracking
--"		409.1		1.80	1.40	1.68				
--"		410.1		1.74	1.37	1.68				
--"		411.1		1.77	1.43	1.65				
--"		412.1		1.80	1.43	1.65				14.5 m wide road
--"		413.1		1.83	1.43	1.68				
Paul Lk.		417.1	10.2							Grounded
--"		418.1								Grounded
--"		419.1		1.74	1.55	1.65				
--"		420.1		1.68	1.52	1.65				
--"		421.1								Grounded
--"		422.1								Grounded
--"		423.1		1.71	1.49	1.65				
--"		424.1		1.74	1.49	1.68				
--"		425.1		1.74	1.46	1.65				
--"		426.1		1.74	1.43	1.49				
--"		427.1		1.68	1.40	1.62				Time 11.28
Lac De Gras		427.5	2.1							
--"		428.5		1.80	1.55	1.68				Road approx 12 m wide
--"		429.5		1.74	1.46	1.65				Time 11.34
#1		430.1	0.7	1.71	1.62	1.68				Time 11.40
#2		431.1	1.2	1.74	1.65	1.71				Grounded @ S end
#3		432.7	0.9	1.74	1.58	1.68				Time 11.47
Koala Camp		439.5								Arrived @ 12.15
Total			368.4	314	315	319	45	47	47	For the whole trip
Average				1.67	1.46	1.57	1.61	1.38	1.51	For the whole trip

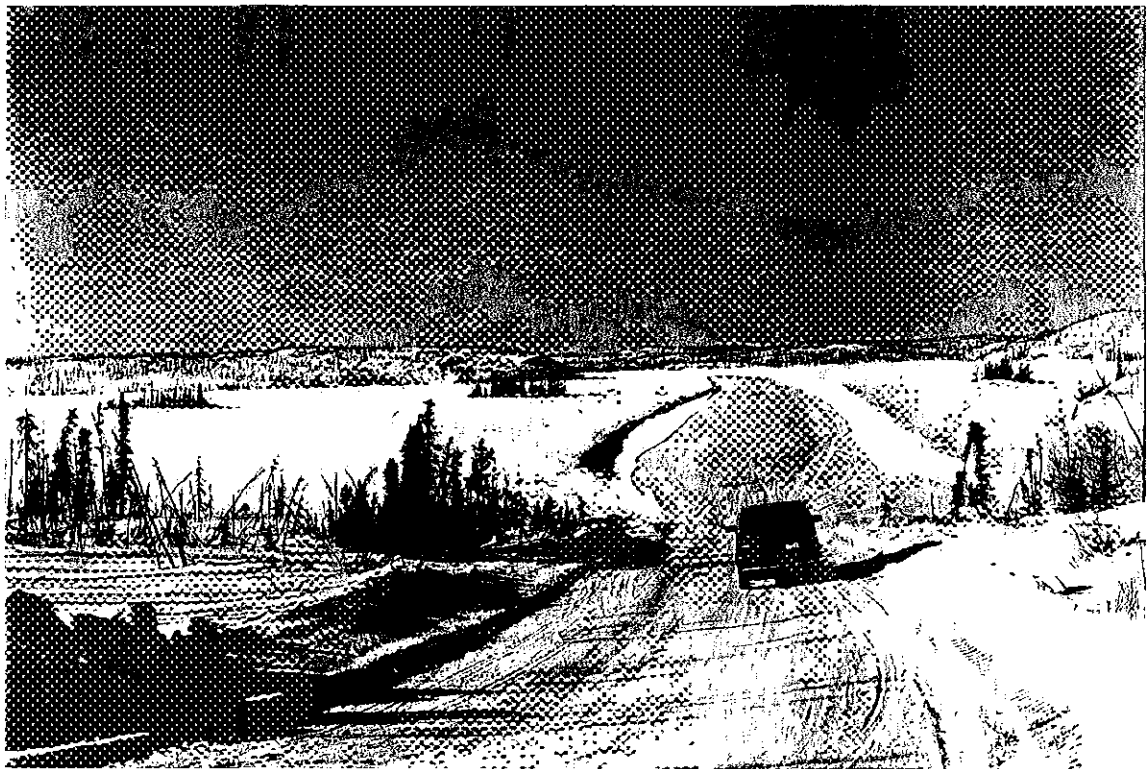
Sandwell

Ice Thickness Data from electronic survey March 28- April 4, 1995 : Tibbitt Lake to Koala Camp

Lake	Name or identifier	From Tibbitt (km)	On Ice (km)	Center of Road			Side of Road			Comments
				Max (m)	Min (m)	Ave (m)	Max (m)	Min (m)	Ave (m)	
	Standard Deviation			0.11	0.10	0.09	0.13	0.07	0.08	For the whole trip
	Total		146.3	105	105	109	19	19	19	South of Lockhart Camp
	Average			1.525	1.433	1.478	1.477	1.38	1.432	South of Lockhart Camp
	Standard Deviation			0.059	0.061	0.06	0.042	0.031	0.035	South of Lockhart Camp
	Total		222.1	209	210	210	26	28	28	North of Lockhart Camp
	Average			1.738	1.469	1.625	1.702	1.387	1.563	North of Lockhart Camp
	Standard Deviation			0.047	0.109	0.06	0.088	0.091	0.056	North of Lockhart Camp

APPENDIX F

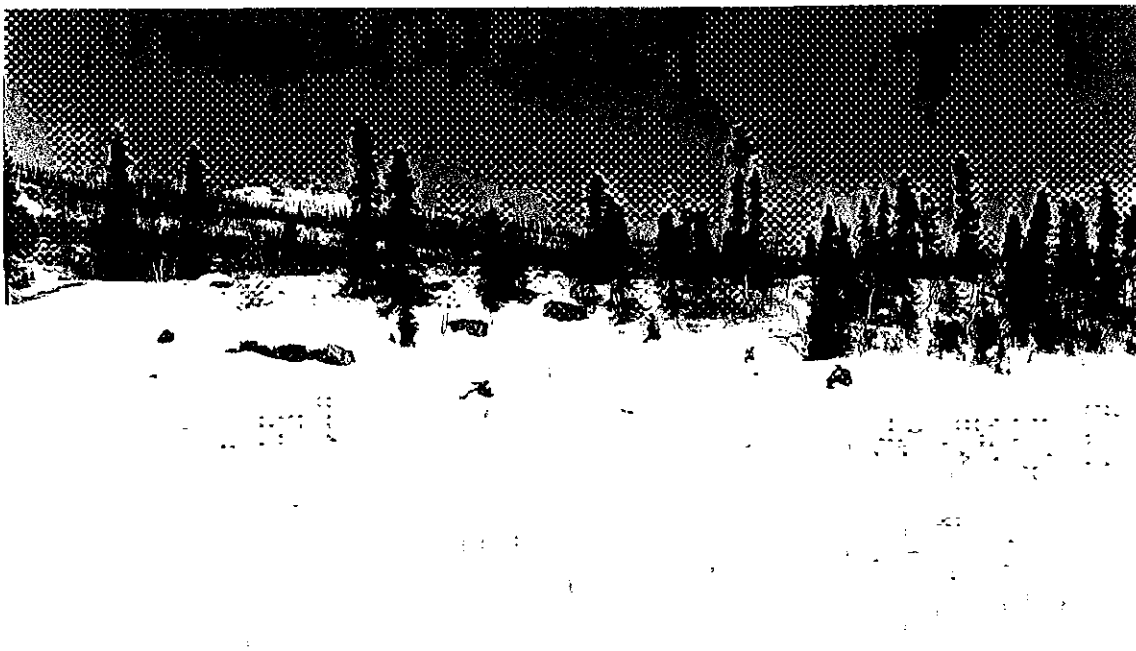
PHOTOGRAPHS FROM THE MARCH/APRIL 1995 SURVEY



LOOKING SOUTH FROM CHARLIE HILL



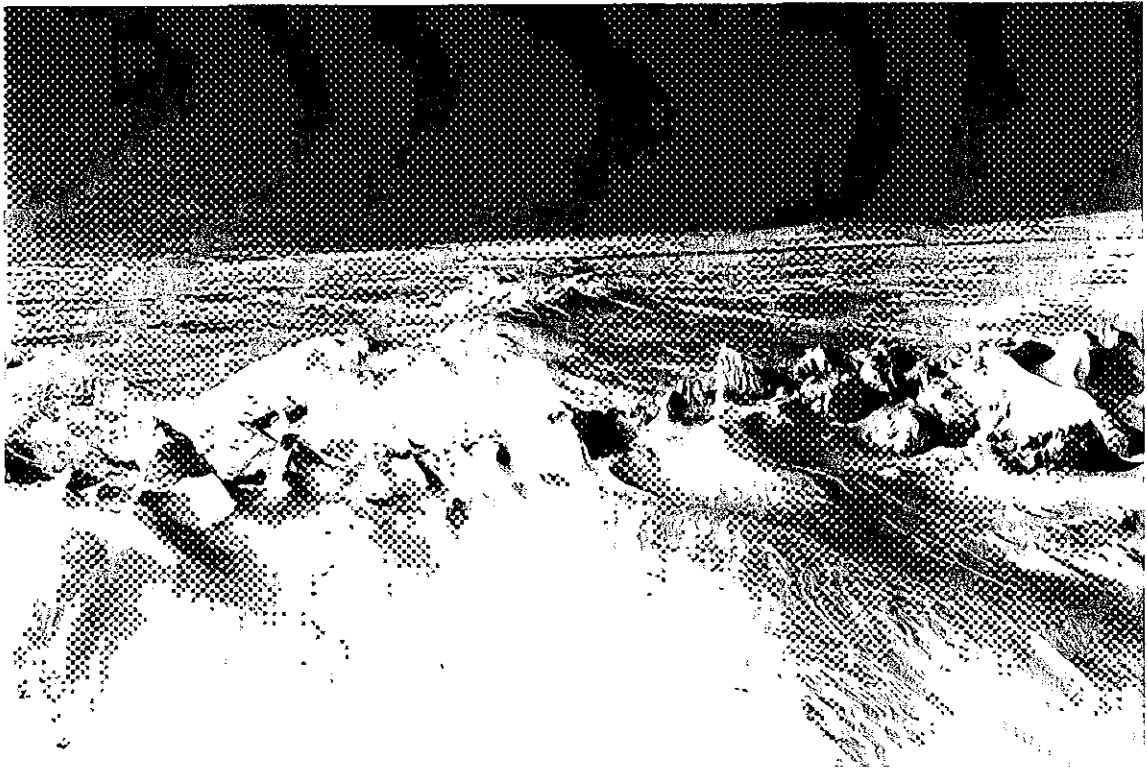
LOOKING NORTH AT CHARLIE HILL



BLOWOUT BESIDE ROAD ON LONG LAKE



PROFILING ON LOCKHART LAKE



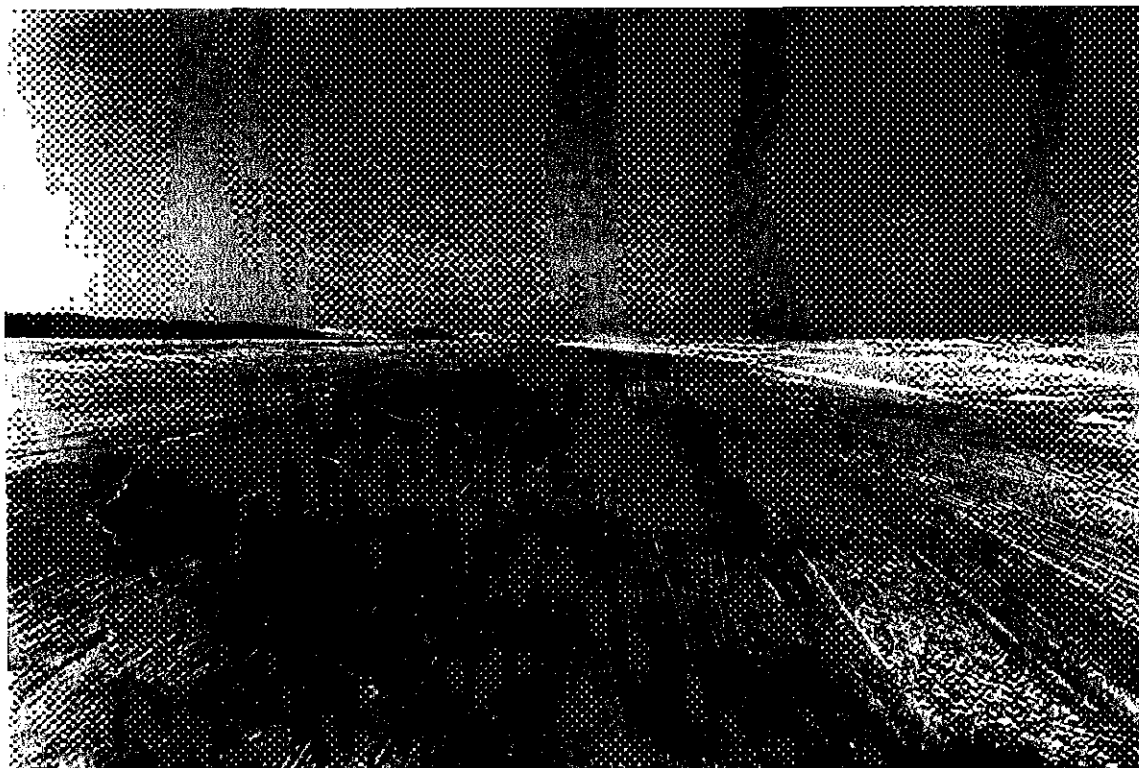
ICE RIDGE ON MACKAY LAKE



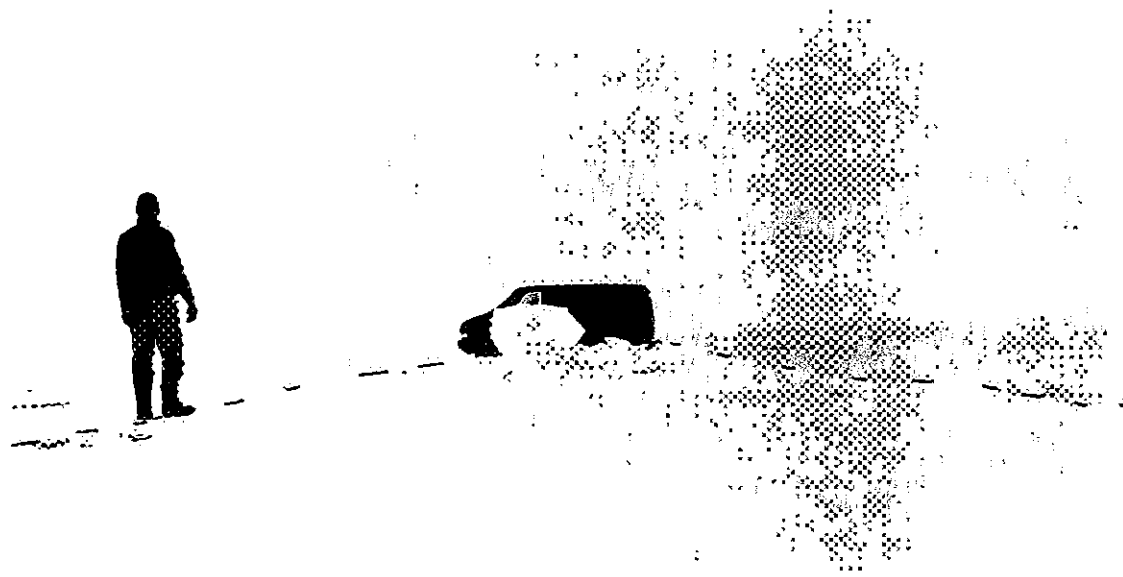
CROSSING BRIDGE OVER ICE RIDGE



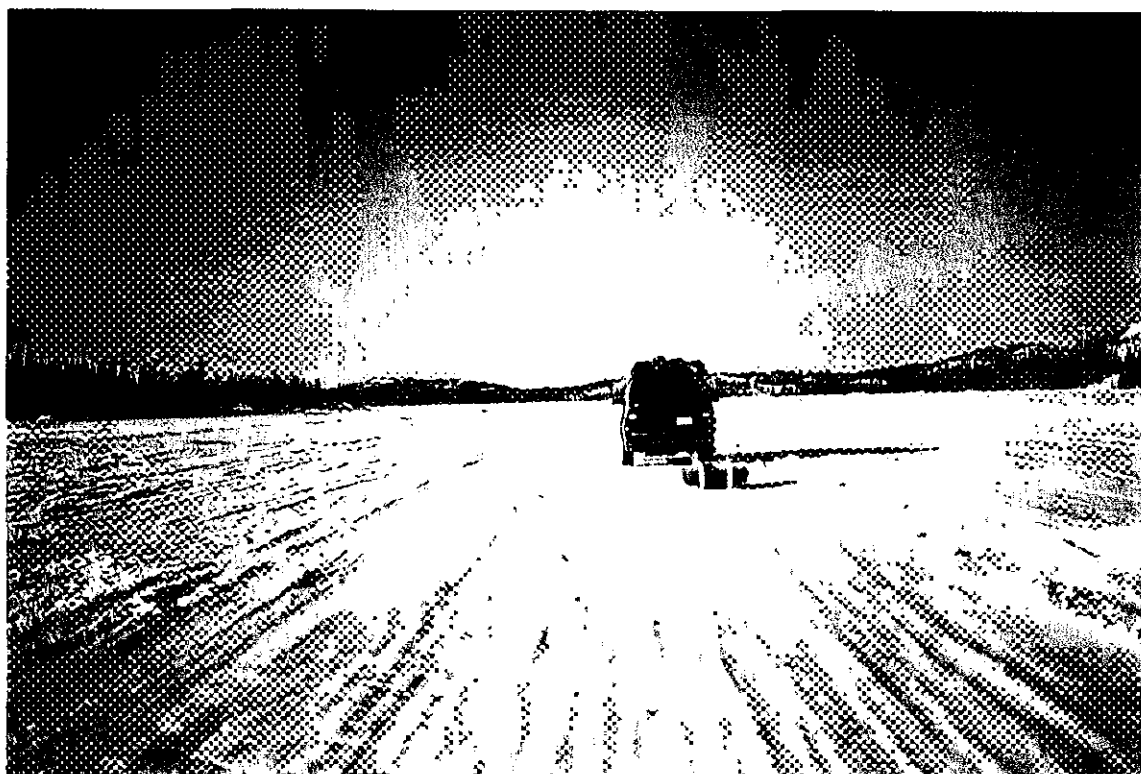
WIDE CLEAR ROAD WITH FEW CRACKS ON LAC DE GRAS



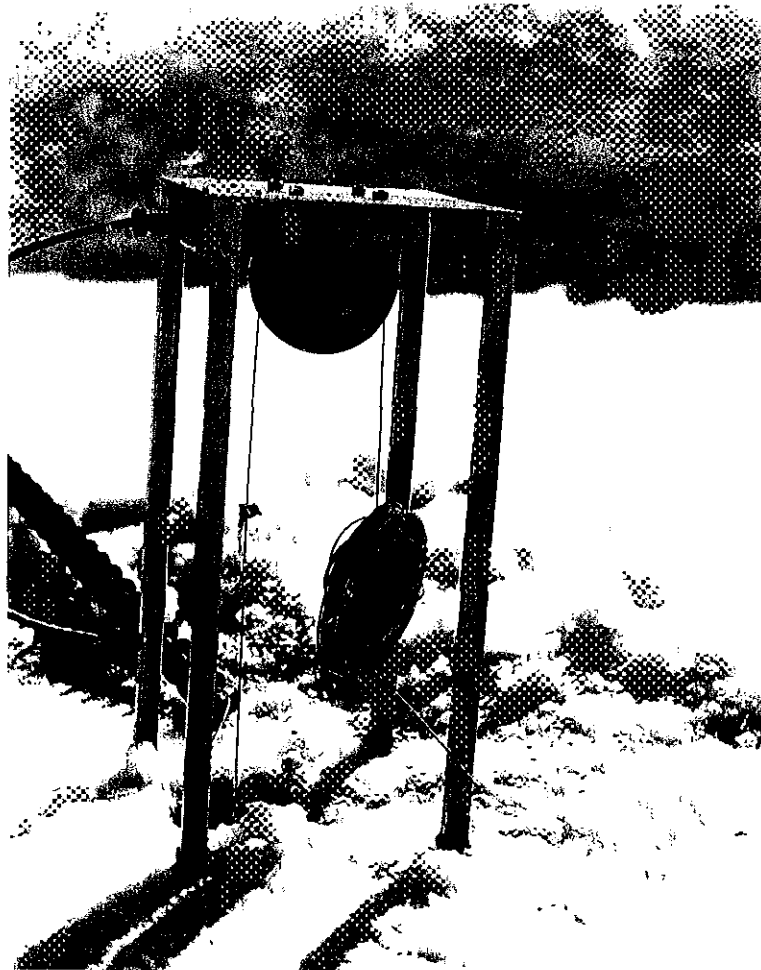
CRACKS ON LAC DE GRAS



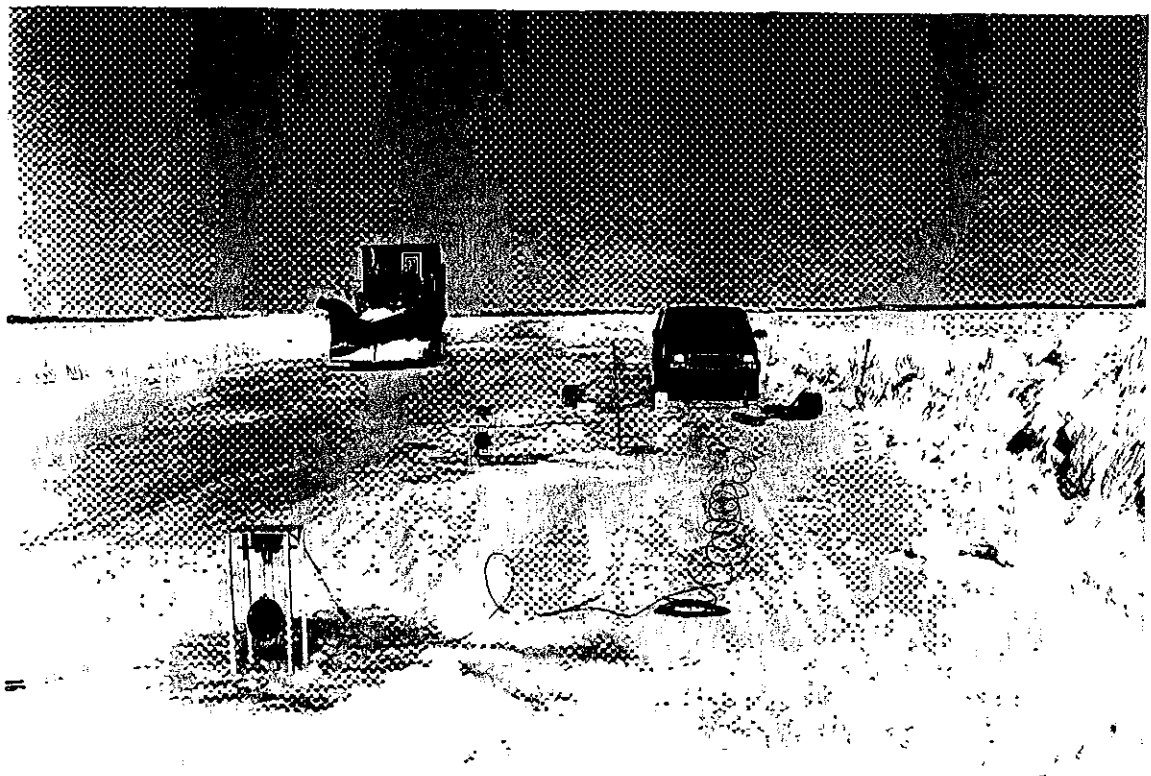
BOIL ON MACKAY LAKE



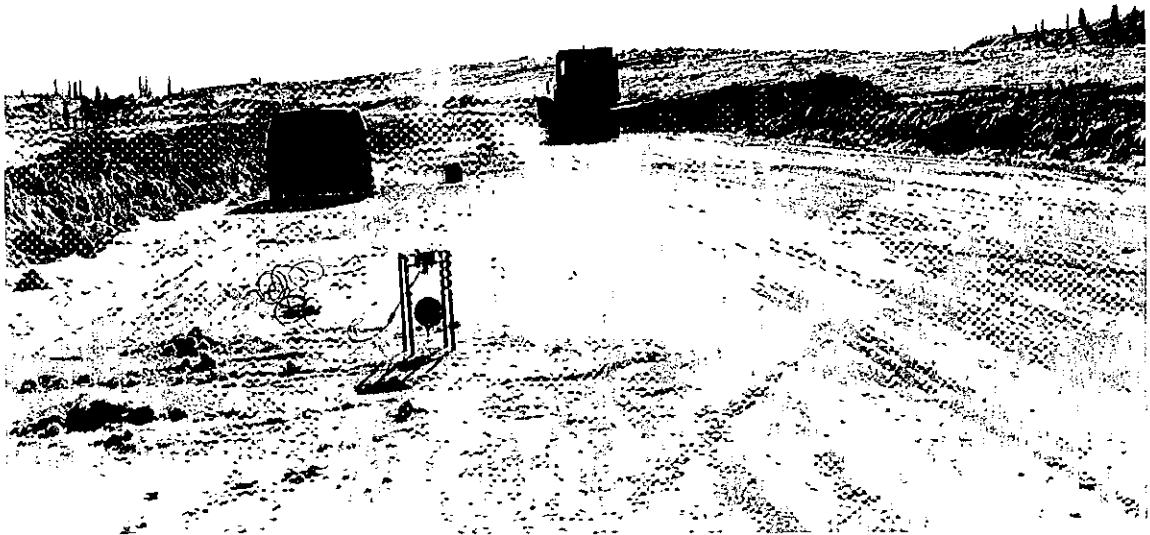
PROFILING ON SOUTH END OF GORDON LAKE



**DEFLECTION
APPARATUS**



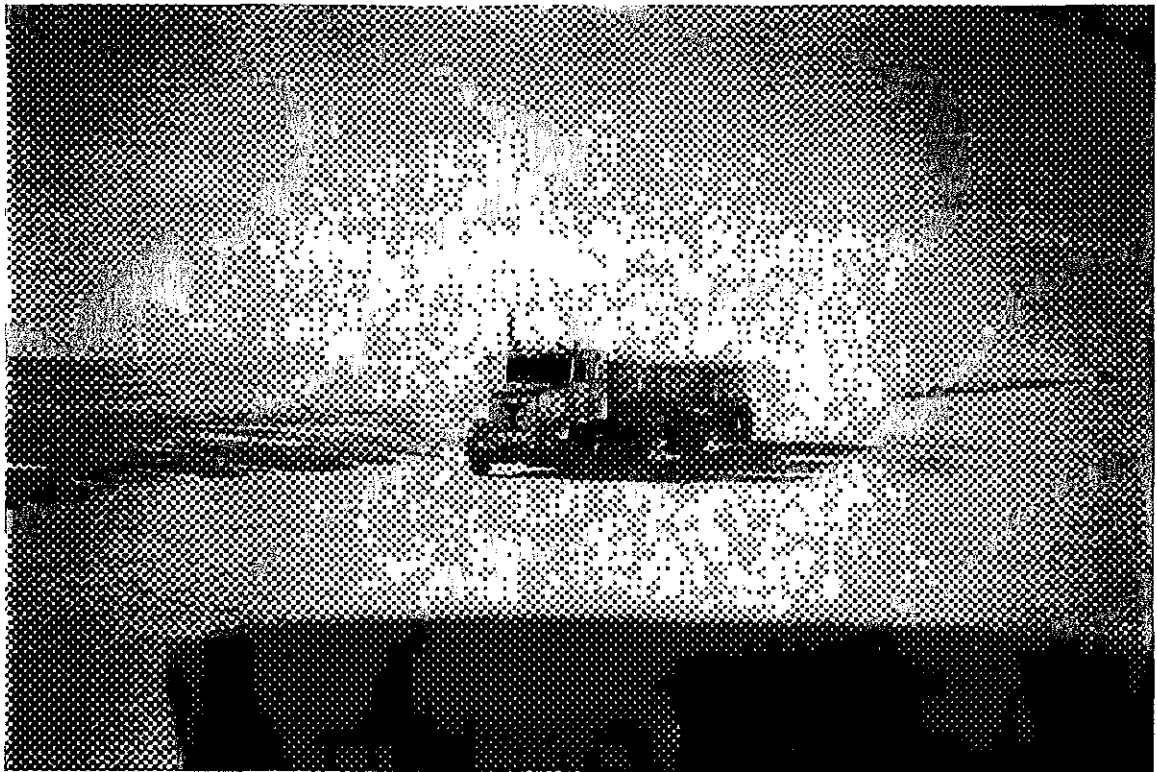
DEFLECTION TEST SET-UP NEAR LOCKHART CAMP



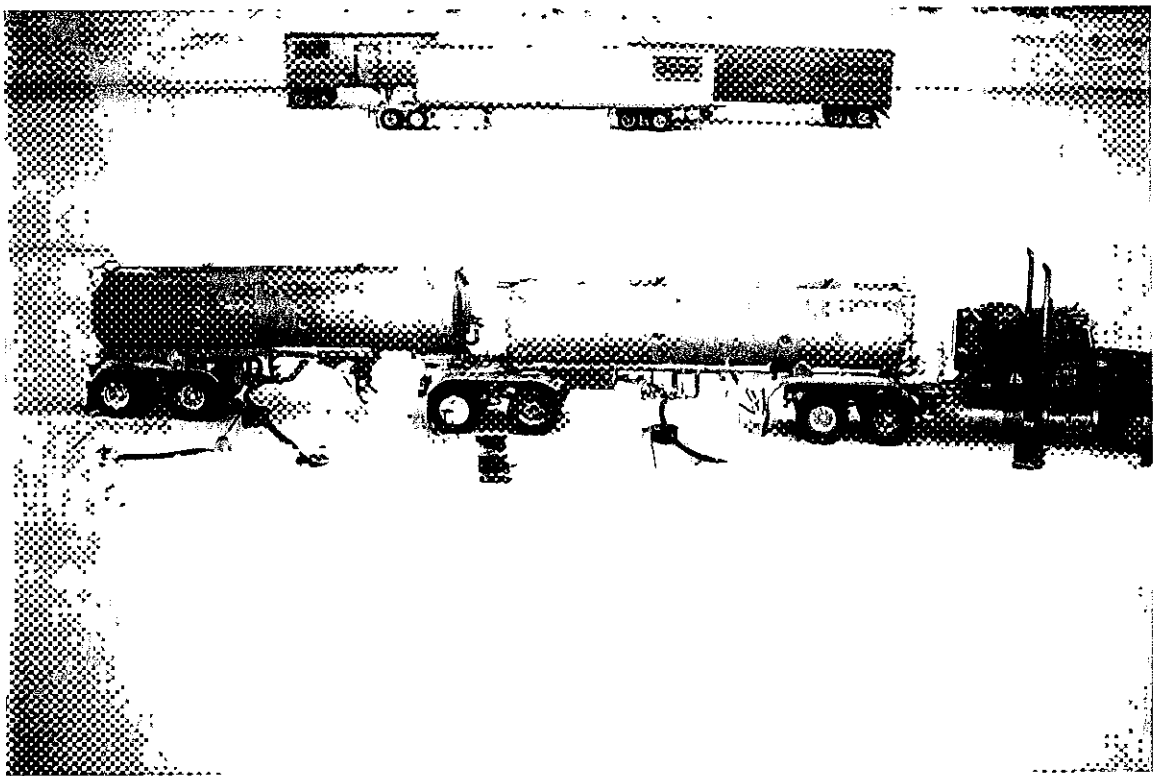
TRUCK APPROACHING SHORE - DEFLECTION TEST



BLOWOUT ALONG ROAD SOUTH OF LOCKHART



TRUCK LOADED WITH CEMENT



FUEL TRUCK

SAFETY REMINDERS FOR SAFE TRAFFIC MOVEMENT IN THE FIELD

1. Always drive defensively, planning your route through congested areas. By doing so, you will not put yourself in a dangerous position, or needlessly interrupt production. Bear in mind, the consequences of a collision with a haul truck.
2. Always allow a following distance of 200 feet between yourself and a haul truck.
3. Do not allow a haul truck to tailgate you. Stay at least 50 feet in front, while it may be wise to increase this distance, if the road is wet and slippery.
4. Do not attempt to overtake a haul truck, if any of these dangerous conditions exist:
 - (a) you are approaching a curve, intersection, or crest of a hill
 - (b) if there are oncoming vehicles or equipment
 - (c) there is spill rock on the road ahead
 - (d) the road is extremely slippery
5. Do not park in drivers blind area:
 - (a) 25 feet to the left side
 - (b) 50 feet to the front or rear
 - (c) 100 feet to the right side
6. Do not pass by parked haul trucks without:
 - (a) make radio contact with driver and/or
 - (b) make eye contact with the driver if possible
 - (c) leave as much margin of safety as possible
 - (d) watch the haul truck for telltail signs of moving,
i.e. exhaust smoke
7. Never board a haul truck or any other piece of heavy equipment without getting the operators permission.

8. Always get operators attention and permission before entering an active loading area with the intention of boarding.
9. It is advisable to wait until any loading area is clear of trucks before approaching.
10. Make eye contact with the operator before boarding any equipment.
11. By observing these reminders any by always thinking of the safety of others we can have a truly safe working environment.

GENERAL EQUIPMENT RULES

The majority of accidents involving equipment operation are caused by the operator failing to observe basic safety rules or precautions. Most accidents can be avoided by the operator recognizing potentially hazardous situations and avoiding them.

1. Equipment operators are responsible for the safe operation of their piece of equipment and are to follow established operating procedures when working. If there is any doubt as to the safety of the job, or the piece of equipment you operate, stop and report the situation to your supervisor.
2. Study the Operators Manual and read all machine mounted safety signs before operating any piece of equipment.
3. Only authorized personnel are permitted to board, ride in, or operate equipment.
4. Before starting and when parking any piece of equipment:
lower all raised attachments, place the control levers in neutral and set the parking brakes.

5. All vehicles and equipment shall be operated at a safe speed with due regard for weather, traffic, road conditions, visibility, traffic signs, and any other existing conditions.
6. All equipment operators shall complete a through pre-start inspection of their piece of equipment, prior to putting it into operation.
7. Use of all the steps and grabrails provided when mounting or dismounting equipment -NEVER JUMP-. Use both hands, and face the machine.
8. Do not start or move any piece of equipment until a check has been made of the immediate area to ensure all personnel are clear.
9. If working near operating equipment, be sure the operator is aware of your presence and notify him when leaving.
10. Any person wishing to board another piece of equipment is responsible for establishing "Eye-to-Eye" contact with the operator before boarding. Never attempt to climb on to, or off of, any moving piece of equipment.
11. Do not oil, grease, adjust, or repair any moving machinery. Keep hands and clothing away from moving parts.
12. All equipment operators are responsible for completing a production and condition report form for each piece of equipment they operate during a shift.
13. Do not tamper with or attempt any unauthorized repair to any piece of equipment.
14. Reading on the job, without supervisory authorization, is not permitted.
15. Sleeping on the job is not permitted.

BASIC SAFETY AND OPERATING RULES

The following Safety and Operating Rules have been set, to prevent personal injury or equipment damage and to ensure the continuity and efficiency of the mining operation. If there is any doubt concerning correct job procedures and/or safety rules that apply to your job or work area, check with your supervisor for instructions.

GENERAL

1. All Operation employees are required to read, understand and comply with all of the Safety and Operating Rules.
2. All accidents and injuries shall be reported to your supervisor as soon as possible.
3. No unauthorized person is permitted to board, ride in, or operate any vehicle or piece of equipment.
4. Horseplay, or any other careless behavior which may cause personal injury or property damage, is not permitted.
5. All unsafe conditions or unsafe acts shall be reported to your supervisor as soon as possible.
6. No person shall operate any vehicle or piece of equipment if their ability or alertness is impaired because of fatigue, illness or any other reason.
7. No person under the influence of intoxicating liquor or drugs is permitted on the job. No person shall possess, or use, any intoxicating liquor or drugs on the job.
8. Do not leave your job or working area without first obtaining authorization from your supervisor.

PERSONAL WEAR AND PROTECTIVE EQUIPMENT

All employees are responsible to ensure they are equipped with, and wearing, the proper safety apparel for their jobs. Special protective equipment, such as life jackets, goggles, respirators, safety belts, etc., are available and can be obtained from your supervisor.

1. Hard hats and safety boots shall be worn at all times.
2. The body shall be fully clothed (shirt and pants) at all times.
3. Do not wear loose clothing or jewellery around moving machinery or equipment. Long hair shall be kept contained in hair nets or by other means.
4. Approved hearing protection shall be worn in all designated areas, and when operating equipment.
5. Goggles and/or respirators shall be worn when working in windy or dusty conditions.
6. Life jackets shall be worn when working on or near the water.
7. Gloves shall be worn when handling materials with sharp or jagged edges, (e.g. wire, rope or lumber).
8. Seat belts shall be worn at all times when operating equipment.

REPORTING ACCIDENTS AND INJURIES

Reporting accidents and injuries allows investigations to be carried out to determine the cause. These investigations often lead to new rules or procedures designed to prevent recurrences. This creates a safer working environment for all employees.

1. All injuries, no matter how slight, shall be reported to your supervisor and to the First Aid Station as soon as possible.

2. Any injuries where the skin is broken must be treated carefully to avoid infection.
3. In case of serious injury:
 - (a) Protect the injured person from further injury but do not expose yourself to serious risk of injury to do so.
 - (b) Do not move a seriously injured person unless there is a risk of further injury - send for the First Aid Attendant.
 - (c) Make the injured person comfortable - keep warm and dry if possible.
 - (d) Do not permit the injured person to walk around or travel to the First Aid Station alone.
4. All accidents, or near accidents, shall be reported to your supervisor as soon as possible.
5. In the event of a serious accident, do not disturb the scene unless there is a risk of further damage or a damage to personnel.

TRAFFIC CONTROL

1. All personnel, not normally assigned to the Operations Department, will be required to take the Koala Travellers' Course before operating a vehicle in the pit area.
2. All traffic, within the open pit area of the mine, shall follow a right hand drive traffic pattern.
3. The maximum speed in the Pit area is 40 K.P.H under ideal conditions. Driving speeds shall also be governed by road conditions, weather, traffic, visibility, etc.
4. The maximum speed in the Camp area is 8 K.P.H.

5. A general order of right of way priority given to each vehicle or piece of equipment is:
 - (a) Emergency Vehicles (Ambulances, Fire Truck and Rescue Truck).
 - (b) Crew Buses (at shift end).
 - (c) Road Maintenance Equipment (when maintaining roads).
 - (d) Explosive Trucks
 - (e) Loaded Haul Trucks
 - (f) Empty Haul Trucks
 - (g) Auxiliary Equipment
 - (h) Pick-ups and other light vehicles.

NOTE: **An order of right of way priorities provides guidelines for all personnel to follow, but individual judgement must be used within any given set of circumstances. Remember that the right of way can only be yielded, it should never be taken.**

6. In the event of an accident, all traffic along the route of travel of emergency vehicles shall stop unless otherwise notified.
7. Traffic signs and signals shall be observed by all personnel.
8. Merging traffic shall yield to through traffic unless otherwise notified.

9. The drivers of all units of a one ton capacity or greater are required to use the following horn signals:

- (a) Sound horn twice before moving forward.
- (b) Sound horn three times before reversing.

NOTE: These signals must be given before moving releasing the brakes.

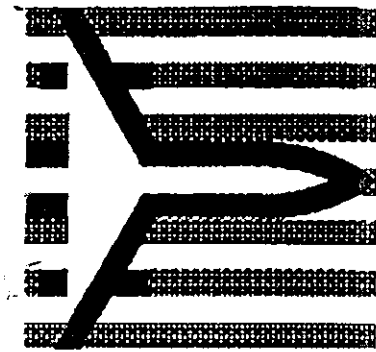
- 10. Extra caution must be used when driving or operating in congested traffic areas (i.e. loading areas, dump areas, etc.)
- 11. All heavy equipment (i.e. haul trucks, dozers, graders shovels, etc.) have large blind areas around them. Within these areas the operators have limited or no visibility. All heavy equipment must be approached with extreme caution.
- 12. A minimum distance of 200 feet must be maintained when following haul trucks or other equipment. This is especially important on ramps.
- 13. Do not park behind or on the blind (right) side of haul trucks.
- 14. Park well clear of traffic patterns in active loading or dump areas.
- 15. Do not leave any vehicle unattended unless it is fully braked and/or chocked.



Transport
Canada

Transports
Canada

Western Region
12th Floor, Canada Place
1100 - 9700 Jasper Ave
Edmonton, AB
T5J 4E8



①

☐ CANADA AIR PILOT/GPH 200☒

COMPANY PROCEDURE

②

☒ New☐ Revised

Effective Date -

③

Procedure - Identification

④

GPS RWY 023T

Aerodrome Name

⑤

KOALA

Field Elevation -

⑦

1540

Community Name

⑥

BHP MINESITE

TDZE Runway -

⑧

1540

Aerodrome Geographical Coordinates



⑨

N 64 41 58 W 110 36 52 (NAD83)

ATIS

CLEARANCE

DEL

GROUND

TOWER

ARRIVAL

DEPARTURE

RADIO

MF

ATF

UNICOM

RADAR

⑩

⑪

Notes

Blasting aprx 1 NM
northwest of arpt.

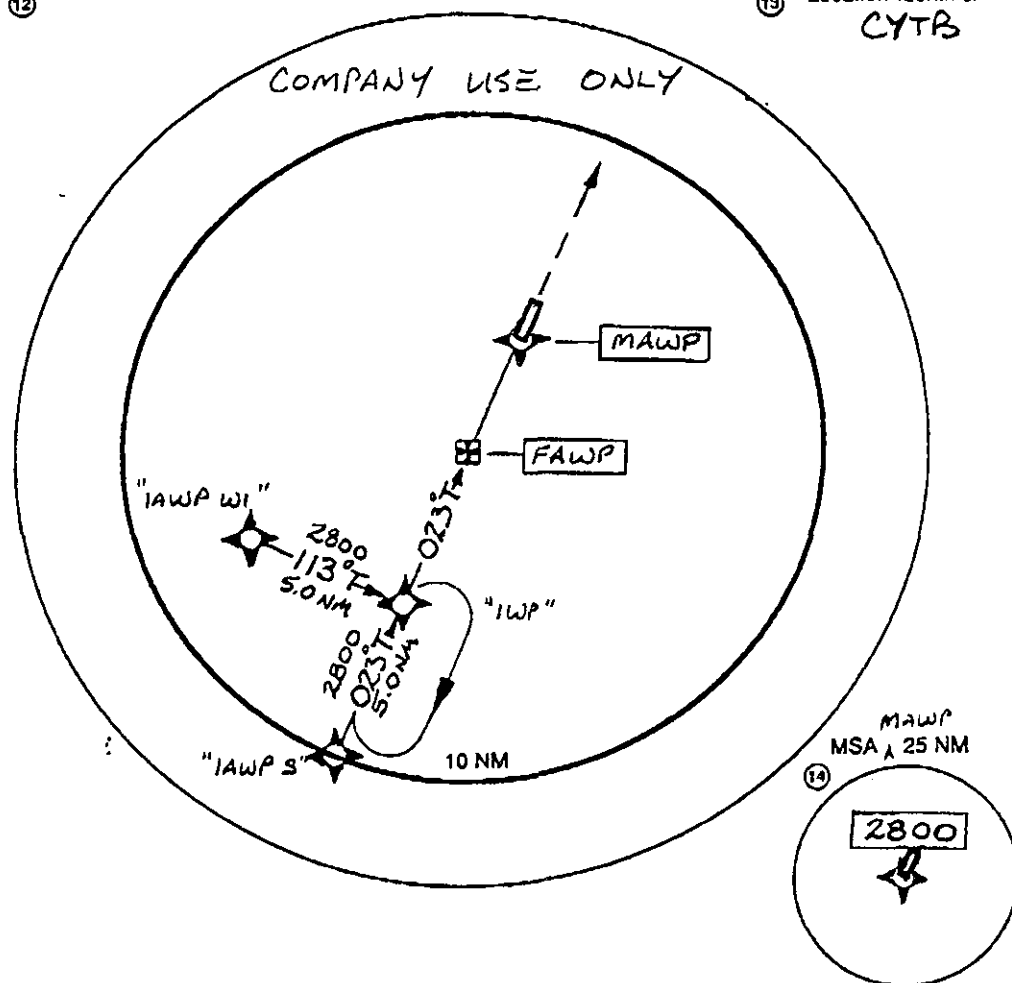
Verify runway
unobstructed when
A/G advisory not
avbl.

⑫

⑬

Location Identifier

CYTB



Safe Altitude 100 NM

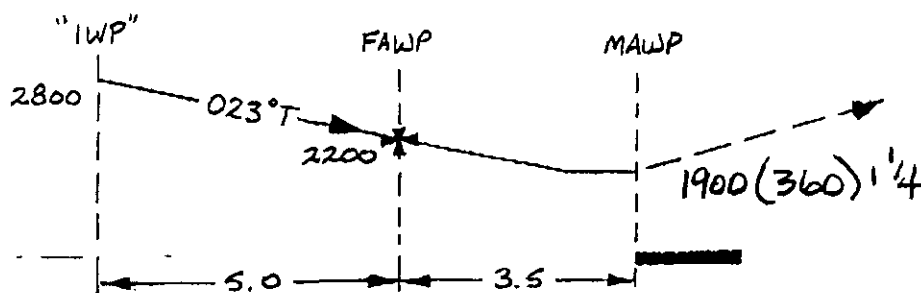


⑮

3200

Profile sketch

⑯



Aerodrome sketch notes

⑰

①

☐ CANADA AIR PILOT/GPH 200

COMPANY PROCEDURE

②

☒ New

Revised

Effective Date -

③

Procedure - Identification

④

GPS RWY 203T

Aerodrome Name

⑤

KOALA

Field Elevation -

⑦

1540

Community Name

⑥

BHP MINESITE

TDZE Runway -

⑧

1522

Aerodrome Geographical Coordinates



⑨ N 64 41 58 W 110 36 52 (NAD 83)

ATIS

CLEARANCE
DEL

GROUND

TOWER

ARRIVAL

DEPARTURE

RADIO

MF

ATF

UNICOM

RADAR

⑩

⑪

Notes

Blasting aprx 1 NM
northwest of arpt.

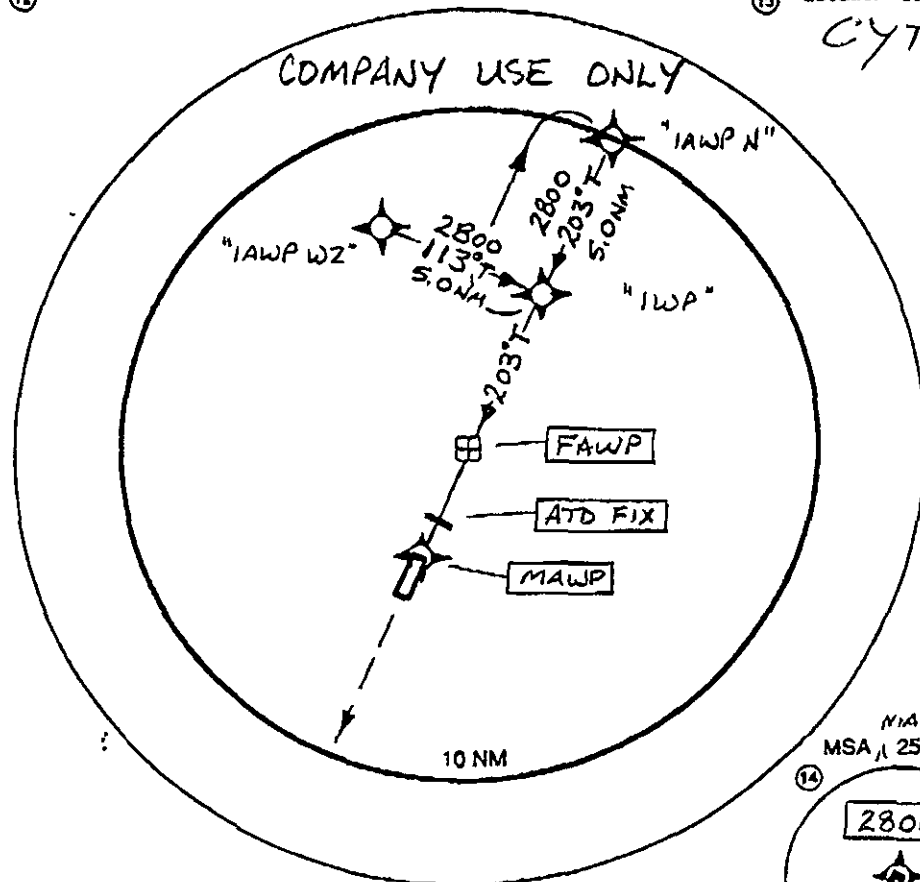
Verify runway
unobstructed when
A/G advisory not
avbl.

⑫

⑬ Location Identifier

CYTB

COMPANY USE ONLY

MAWP
MSA 25 NM

⑭

2800



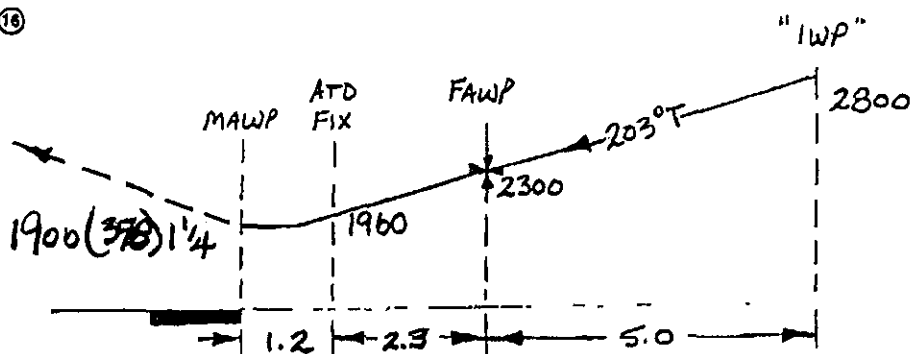
Safe Altitude 100 NM



⑮

Profile sketch

⑯



Aerodrome sketch notes

⑰



CANADA AIR PILOT/GPH 200



COMPANY PROCEDURE



New



Revised

Effective Date -

Procedure - Identification

NDB RWY 023T

Aerodrome Name

KOALA

Field Elevation -

1540

Community Name

BHP MINESITE

TDZE Runway -

1540

Aerodrome Geographical Coordinates

N 64 41 58 W 110 36 52 (NAD 83)

ATIS

CLEARANCE
DEL

GROUND

TOWER

ARRIVAL

DEPARTURE

RADIO

MF

ATF

UNICOM

RADAR

Notes

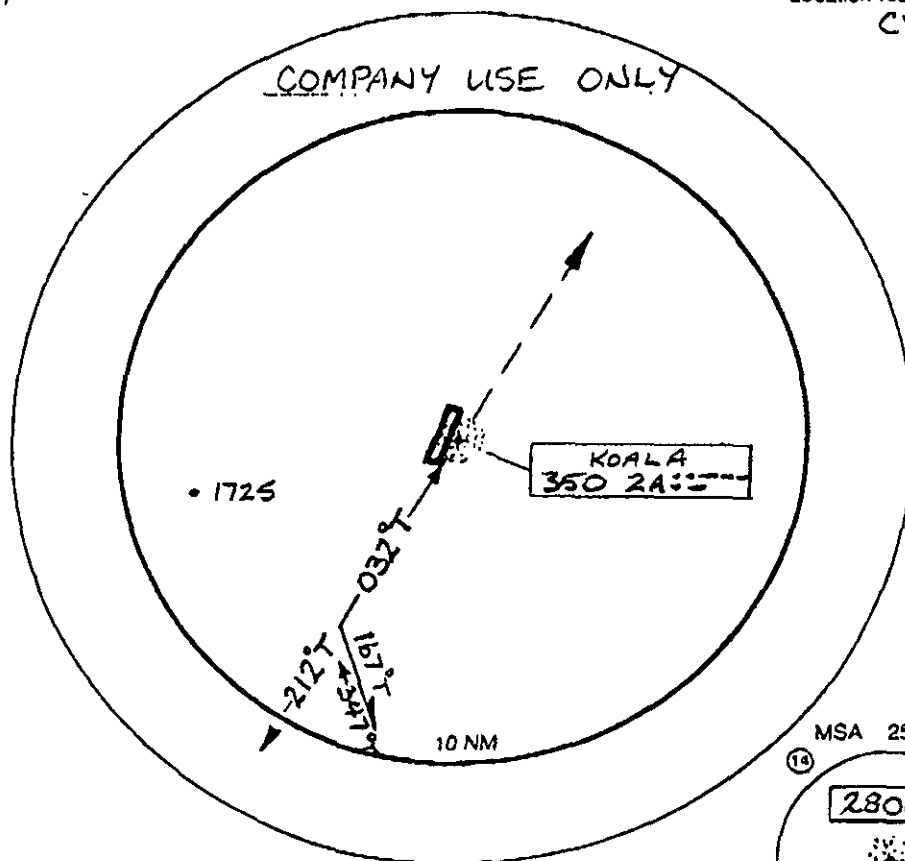
Blasting aprx 1 NM
northwest of arpt.

Verify runway
unobstructed when
A/G advisory not
avbl.

Location Identifier

CYTB

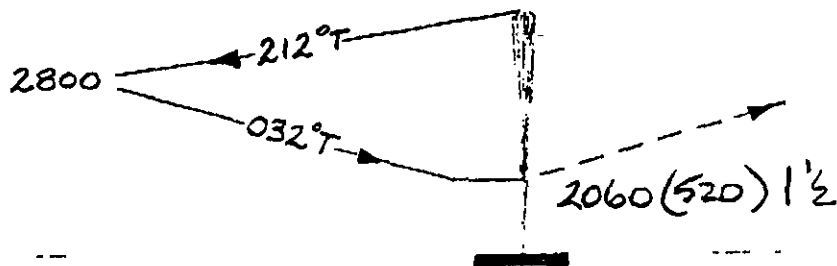
COMPANY USE ONLY



Safe Altitude 100 NM

3200

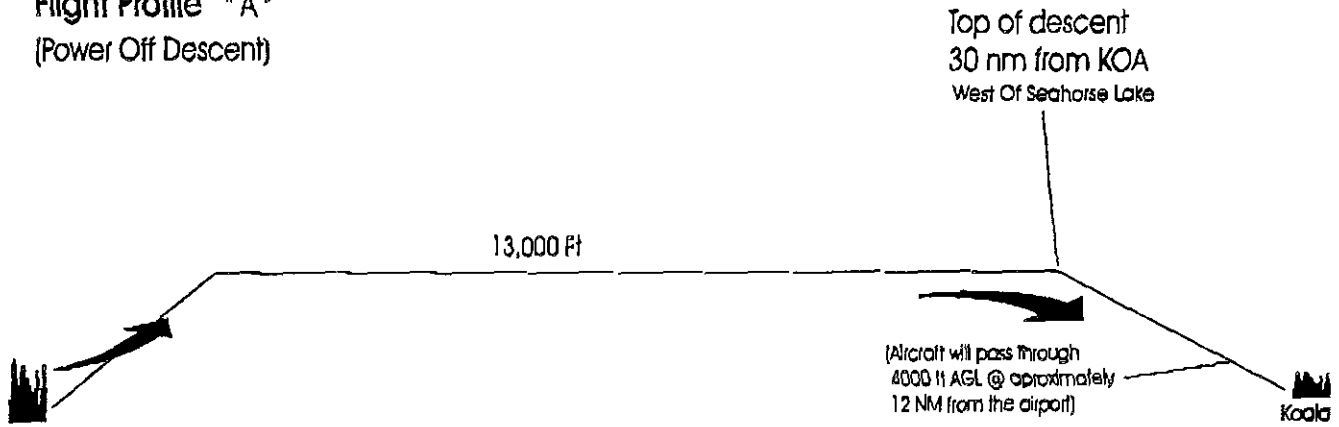
Profile sketch



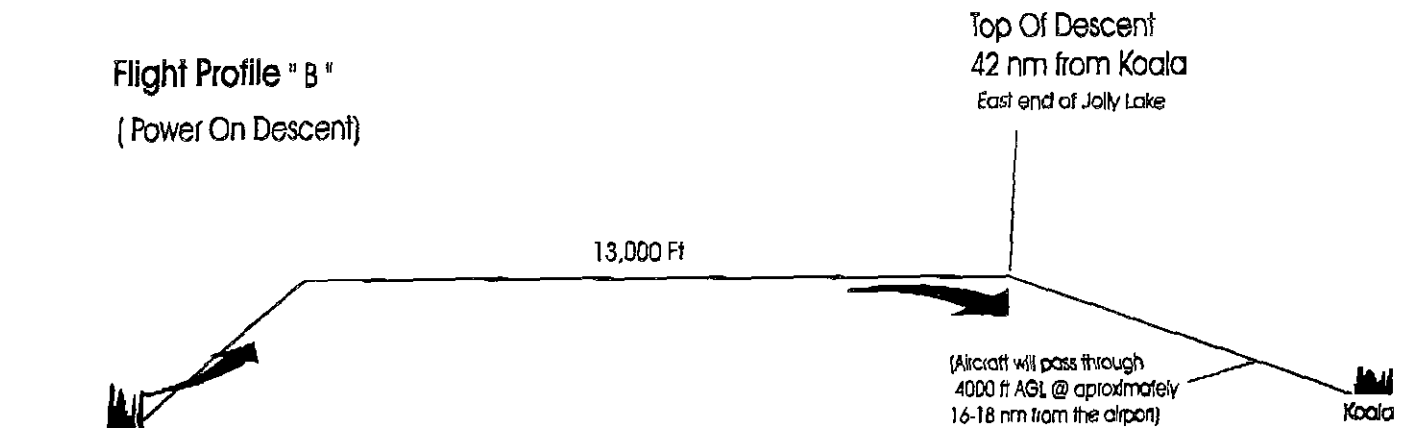
Aerodrome sketch notes

ENROUTE

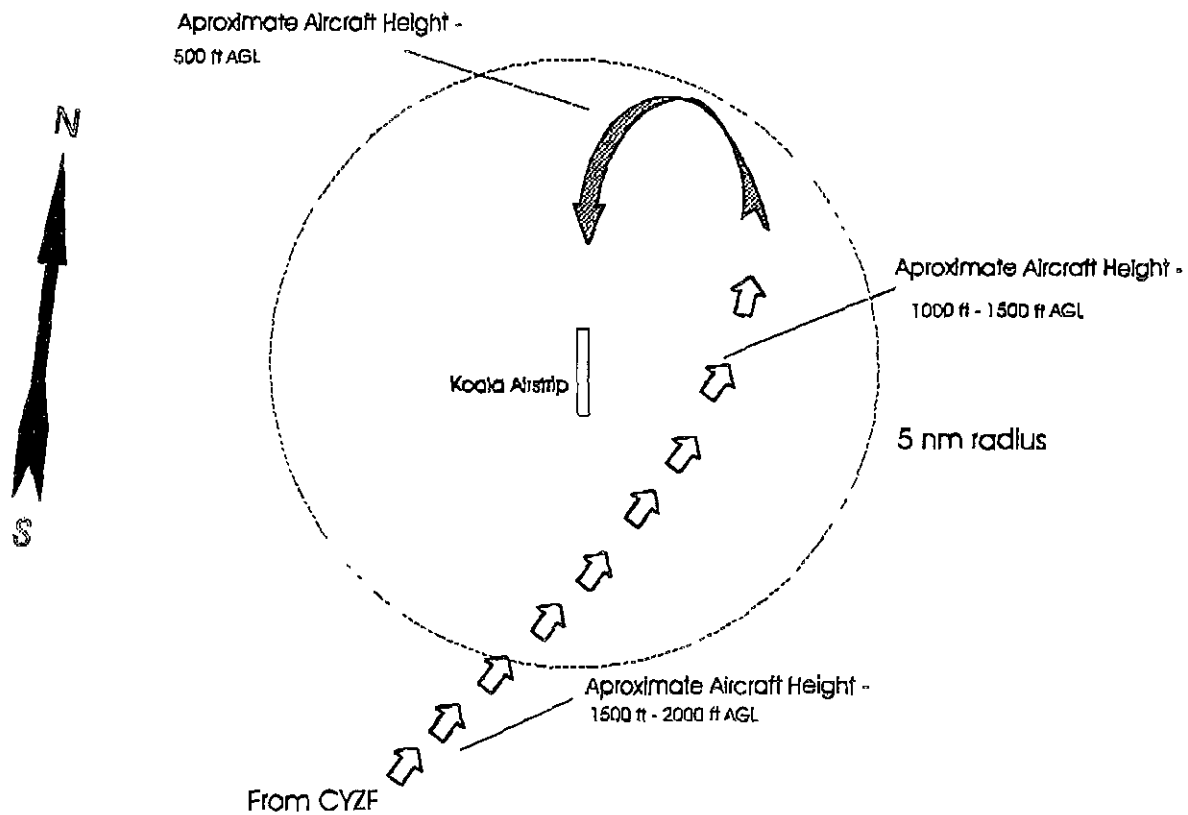
Flight Profile "A" (Power Off Descent)



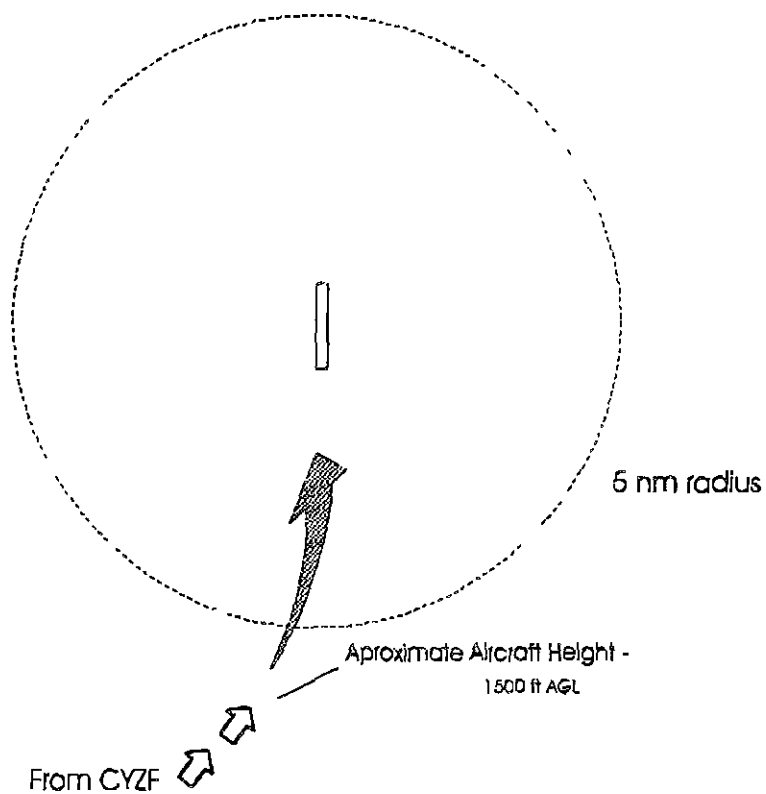
Flight Profile "B" (Power On Descent)



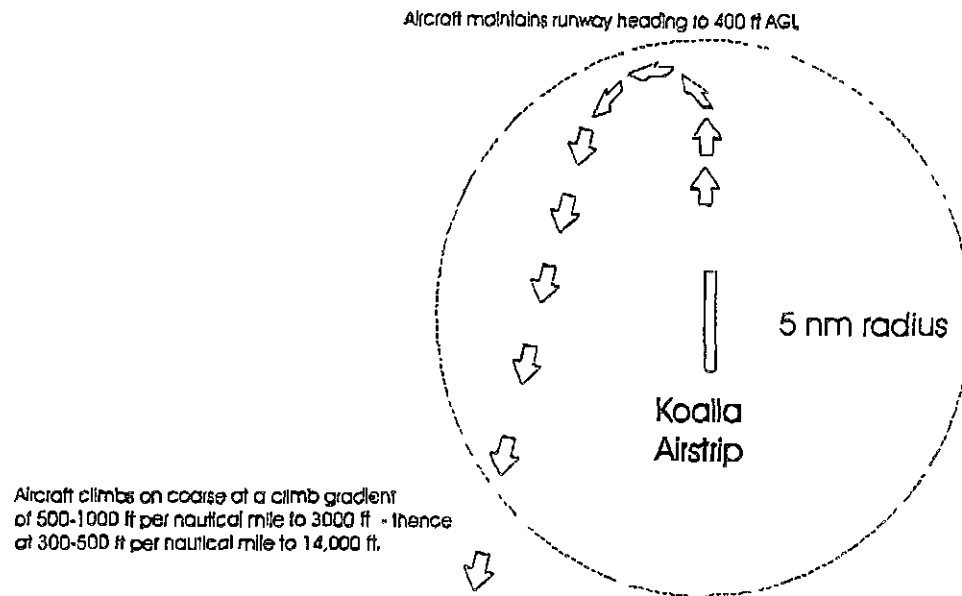
Landing Runway 17



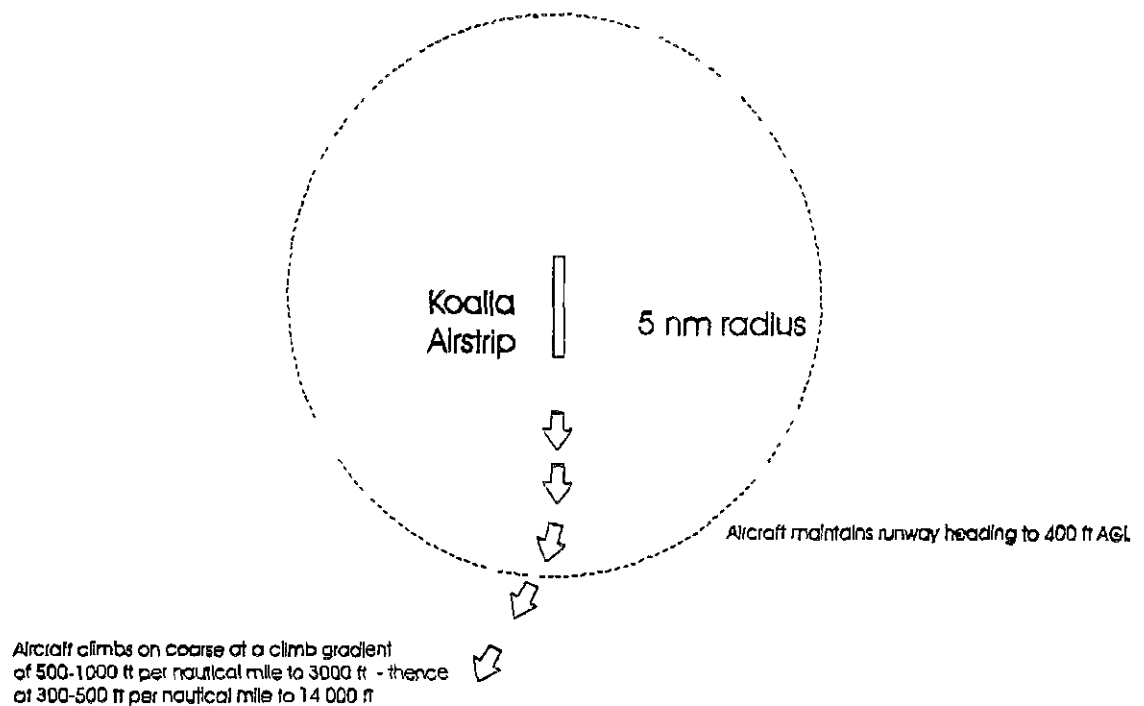
Landing Runway 35



Departure Runway 35



Departure Runway 17



Departure and Enroute Profile
(Distance and altitude will Vary with
temperature and aircraft Weight)

