WITTENOOM AIRBORNE ASBESTOS STUDY

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Perth, Western Australia
Technical Series 7 March 1986

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WITTENOOM AIRBORNE ASBESTOS STUDY

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Department of Conservation and Environment
Perth, Western Australia

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1. INTRODUCTION

An intensive study of airborne asbestos fibre concentrations in the Wittenoom area was undertaken by the Department of Conservation and Environment's Pollution Control Division during the period 5 January 1986 to 30 March 1986.

The purpose of the study was to determine fibre concentrations at eight sites; not only in the townsite itself, but also at the proposed 9 km and 43 km sites previously thought to be suitable for town's relocation if deemed necessary (Figure 1). The study was also undertaken in order to extend the length of the Geraldton Building Company's previous three month survey which commenced in April 1985. Fibre concentrations could therefore be determined during differing meteorological conditions.

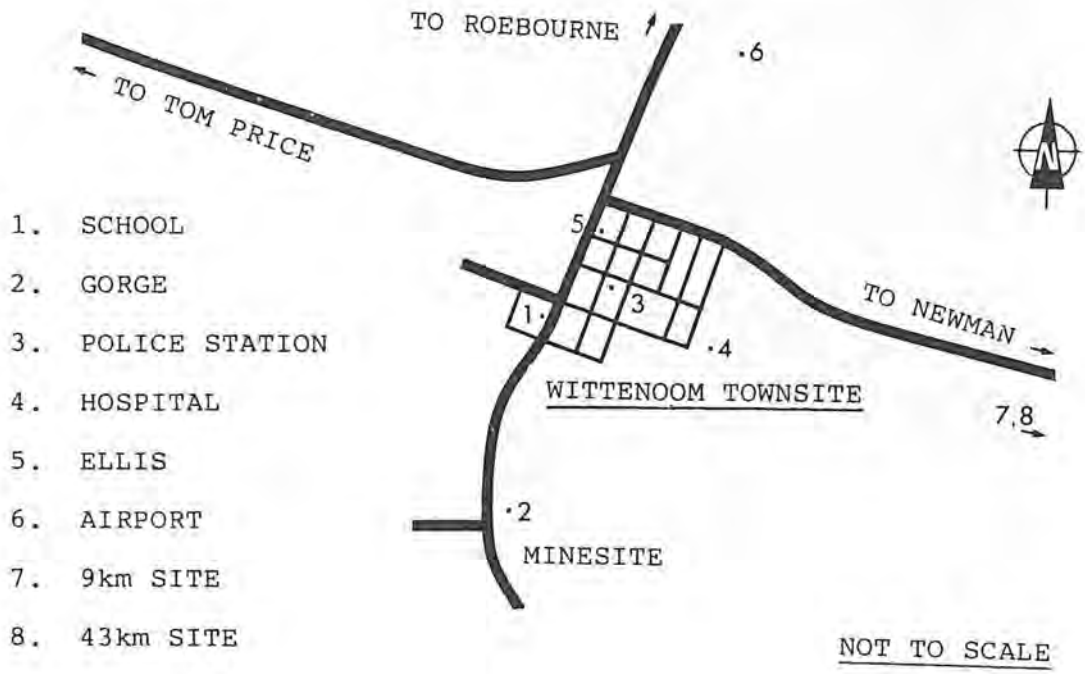


Figure 1. Positions of Monitors

Results from the April survey indicated that fibre levels had decreased dramatically when compared to previous results obtained by the State Health Department from Summer 1980/81 to Summer 1984/85. It is hoped that the following report will indicate to Government if this trend is continuing, or is likely to continue for a sustained period, or more significantly, whether the levels determined can be regarded as "safe" for environmental exposure.

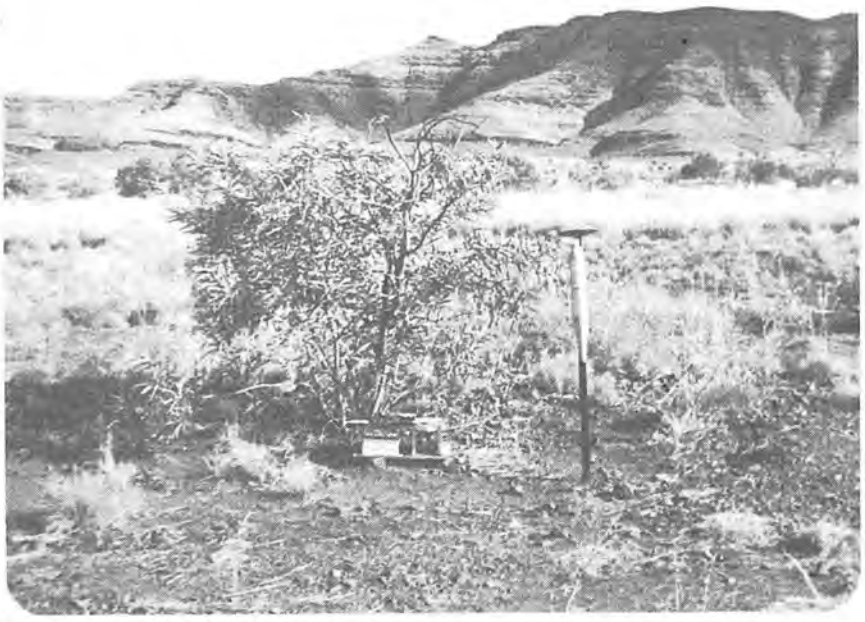
It is not the intention of this report to deal in depth with the mechanics of fibre disturbance and monitoring techniques. This area has been adequately covered in the previous report by the Geraldton Building Company (GBC). The report will simply provide daily fibre levels likely to be experienced under certain meteorological conditions. This after all is the main consideration for Government when determining current health risk to the population of Wittenoom.

2. TECHNIQUES

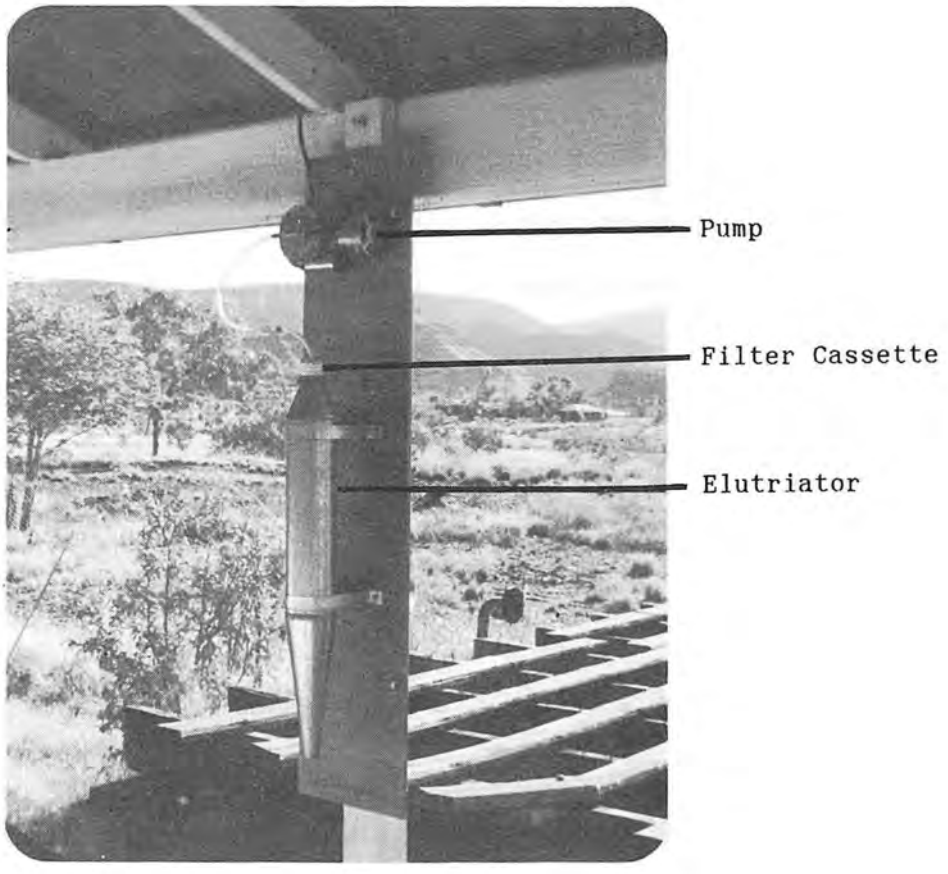
2.1 SAMPLING EQUIPMENT

Sampling equipment identical to what used over five years by the State Health Department at the Wittenoom School, and by the Geraldton Building Company in the April Study was utilised at all sites. Samplers used in remote areas, ie Gorge, 43 km site and 9 km site were powered by two 12V lead acid batteries which were recharged daily by the sampling officer. The sampling officer also changed the filter cassettes daily and determined the air flow rates through the elutriator before and after each 24 hour sampling period. Clean filter cassettes were prepared in the Pollution Control laboratory in order to avoid risk of contamination (Photographs 1, 2, 3 and 4).

Photograph 1. Police Station Monitor



Photograph 2. 9 km Site Monitor



Photograph 3. Hospital Monitor

Photograph 4. Gorge Monitor

2.2 ANALYSIS TECHNIQUES

2.2.1 OPTICAL MICROSCOPY

Concentrations of fibres were determined for each 24 hour sample utilising the National Health and Medical Research Council's (NHMRC) method for Determination of Airborne Asbestos Fibre Concentrations.

Two sets of results are presented from the optical microscopy analysis which can be described as:

1. those fibres whose size corresponds to the definition of "fibre" given in the NHMRC method for airborne asbestos fibre determinations; and

2. fibres conforming to the NHMRC size limitations, but which based on fibre counting experience, are more likely to be asbestiform ie:

    1. possible and probable fibres; and

    2. probable fibres only.

Approximately every third sample was despatched to Pilbara Laboratories for checking purposes. These results are also shown.

Blank filters which were checked for contamination, were despatched with each total daily filter collection, to the Pollution Control Division.

2.2.2 SCANNING ELECTRON MICROSCOPE ANALYSIS

Twelve filter papers used in the survey were selected at random and subsequently analysed by SEM at a magnifications of x800 - x1000 by the Western Australian Institute of Technology's Physics Department.

Spectrums were obtained for a variety of fibre forms in order to obtain an indication of the composition of fibres counted as asbestiform ie conforming to the size limitations as stipulated in the NHMRC method. It was also the intention to use the SEM work to identify thinner fibres which may not have been visible by optical microscopy.

2.2.3 METEOROLOGICAL DATA

Data showing wind direction, wind speed and rainfall was obtained with appreciation from the Wittenoom Meteorological Station at the Wittenoom Post Office. These readings were recorded at 0600, 0900, 1500 and 1800 hours; the mean being taken over a period of ten minutes before each reading. In order to obtain mean wind velocities calculated over full 24 hour periods, DCE also positioned an anemometer at the rear of the Wittenoom Shire Office from 6 February 1986 to 20 March 1986. The wind direction data obtained was used to confirm the meteorological station's data and to give an indication of wind direction between 1800 and 0600 hours (Tables 1-8).

3. RESULTS

Tables 1 to 10 present the data under the following headings.

DCE A (fibres/ml) - Probable crocidolite fibres only.

DCE B (fibres/ml) - Probable and possible crocidolite fibres.

Pilbara Laboratories (fibres/ml) - Check on the same filter using a different segment.

Wind Directions - Averaged over 10 mins prior to 0600, 0900, 1500 and 1800 hours (reading not noted during calm conditions).

Max wind speed - Taken during 10 mins prior to 0600, 0900, 1500 and 1800 hours.

Rainfall - Min. indicates Less than 1 mm.

4. DISCUSSION OF RESULTS

4.1 SCHOOL MONITOR

The mean concentration of probable fibres at this site is low when compared to results previously obtained. The concentration of probable and possible fibres is also slightly reduced when compared to previous and GBC study results. Concentration of probable fibres did not increase in any specific wind direction, and did not reduce during wet conditions (Diagram 1 and Table 1).

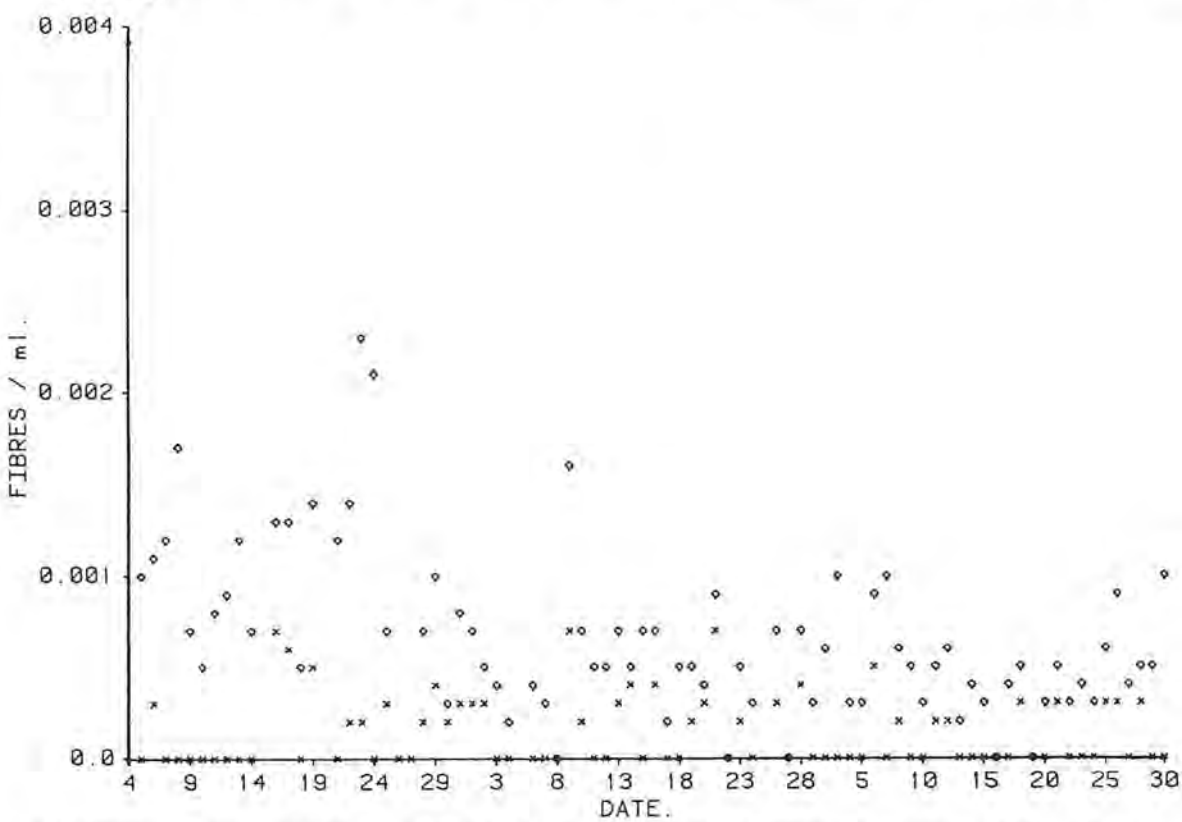


Diagram 1. Wittenoom - School 24 Hour Fibre Concentrations, Jan - Mar 1986. (Limit of detection 0.0002 Fibres/ml)

Table 1. School Monitor Fibre Results and Meteorological Data

Date	DCE A Fibres/ml	DCE B Fibres/ml	Pilbara Labs Fibres/ml	Max Wind Speed (m/s)	Wind Directions	Rainfall (mm)
5.1.86	<0.0002	0.0010		2.6	E	47
6.1.86	0.0003	0.0011		3.1	N/E	11
7.1.86	<0.0002	0.0012	0.0011	4.1	E/ENE	6
8.1.86	"	0.0017		6.2	SW/NE/E ESE	Min
9.1.86	"	0.0007		3.1	S/SE/S/SW	
10.1.86	"	0.0005	0.0005	2.1	S/SW	
11.1.86	"	0.0008		5.1	E/WSW	
12.1.86	"	0.0009		3.1	W	
13.1.86	"	0.0012	0.0009	3.1	S/NW	
14.1.86	"	0.0007		2.6	NE/NW	
15.1.86	No result electrical fault on pump					11
16.1.86	0.0007	0.0013	0.0011	5.1	E/SE	13
17.1.86	0.0006	0.0013		4.6	E/ESE	
18.1.86	<0.0002	0.0005		1.0	NE	Min
19.1.86	0.0005	0.0013	0.0012	8.2	E/SE	
20.1.86	No result filter damaged					Min
21.1.86	<0.0002	0.0012		12.9	E/ESE	
22.1.86	<0.0002	0.0014	0.0008	14.4	E	
23.1.86	"	0.0023		5.1	E/SE/SSE	
24.1.86	"	0.0021		2.1	E/S	
25.1.86	0.0003	0.0007	0.0003	4.1	E/SSW/SE	
26.1.86	<0.0002	0.0007		6.2	E/ESE	
27.1.86	<0.0002	0.0007		2.6	E	Min
28.1.86	0.0002	0.0007		2.6	E/NE/ENE/N	12
29.1.86	0.0004	0.0010	0.0005	2.6	W/NNE	1
30.1.86	0.0002	0.0003		4.1	SSW/NW/WSW	
31.1.86	0.0003	0.0008		5.1	S/SSE/NNE/SW	2
1.2.86	0.0003	0.0007	0.0003	5.1	SE/SSE	2
2.2.86	0.0003	0.0005		6.2	SSE/ESE/NE/S	Min
3.2.86	<0.0002	0.0004		5.1	SSE/E	1
4.2.86	"	0.0002	0.0003	3.1	E/SW	
5.2.86	Cassette tube disconnected no result					
6.2.86	<0.0002	0.0004		2.6	N/NW	
7.2.86	<0.0002	0.0003	0.0008	2.6	S/WSW	
8.2.86	"	0.0002		4.1	SSE/E/NE/NW	
9.2.86	0.0007	0.0016		5.1	SE/E/NW/SSE	
10.2.86	0.0002	0.0007	0.0004	2.6	S/WNW/NNW/NW	
11.2.86	<0.0002	0.0005		4.1	SSW/SE/W/NW	
12.2.86	<0.0002	0.0005		1.0	NW	
13.2.86	0.0003	0.0007	0.0004	4.1	SSW/WSW/W	
14.2.86	0.0004	0.0005		3.1	WNW	
15.2.86	<0.0002	0.0007		5.1	ENE/NW	
16.2.86	0.0004	0.0007	0.0002	9.3	E/NNE/N	
17.2.86	<0.0002	0.0002		7.7	SE/ESE/E	
18.2.86	<0.0002	0.0005		5.1	E/ENE	4
19.2.86	0.0002	0.0005	0.0002	7.7	ESE/E/NNE	33
20.2.86	0.0003	0.0004		2.6	NE/N	3

Table 1. School Monitor Fibre Results and Meteorological Data (contd)

Date	DCE A Fibres/ml	DCE B Fibres/ml	Pilbara Labs Fibres/ml	Max Wind Speed (m/s)	Wind Directions	Rainfall (mm)
21.2.86	0.0007	0.0009		9.3	NNW	3
22.2.86	<0.0002	0.0002	0.0002	5.1	NNW	
23.2.86	0.0002	0.0005		2.6	NNW	
24.2.86	<0.0002	0.0003		1.0	ESE	
25.2.86	No result	filter damaged				
26.2.86	0.0003	0.0007	0.0003	7.7	SE/E	7
27.2.86	<0.0002	0.0002		10.3	SE/N/E	
28.2.86	0.0004	0.0007	0.0002	2.1	SE/ESE	
1.3.86	<0.0002	0.0003		5.1	N/E	
2.3.86	<0.0002	0.0006		7.7	SSE/SE/N	3
3.3.86	<0.0002	0.0010	0.0006	7.7	N	
4.3.86	<0.0002	0.0003		4.1	SSE/S/E/N	
5.3.86	"	0.0003		4.1	N/NNE/N	Min
6.3.86	0.0005	0.0009	0.0005	5.1	E/NE/N	Min
7.3.86	<0.0002	0.0010		7.7	E/NNE/N	
8.3.86	0.0002	0.0006		5.1	E/NE	
9.3.86	<0.0002	0.0005	0.0005	7.7	ESE/N/NNW	
10.3.86	<0.0002	0.0003		7.7	SSE/NNW/NE	
11.3.86	0.0002	0.0005		7.7	SSE/S	1
12.3.86	0.0002	0.0006	0.0002	9.2	SE/NNE/N	Min
13.3.86	<0.0002	0.0002		7.7	SSE/SE/E	2
14.3.86	"	0.0004		6.2	SSE/ESE/SE	Min
15.3.86	"	0.0003	0.0002	5.1	SSE/ESE/N	8
16.3.86	"	0.0002		5.1	SE/SSE/E/NE	
17.3.86	"	0.0004		5.1	S/SE/ESE/E	
18.3.86	0.0003	0.0005	0.0006	1.0	S/E	
19.3.86	<0.0002	0.0002		1.0	W/NW	
20.3.86	<0.0002	0.0003		5.1	WNW/NW	
21.3.86	0.0003	0.0005	0.0002	2.6	SSE/NNW	1
22.3.86	<0.0002	0.0003		2.6	SE/ESE/ENE	
23.3.86	<0.0002	0.0004		10.2	E	
24.3.86	<0.0002	0.0003	0.0002	7.7	ESE/E	
25.3.86	0.0003	0.0006		2.6	E	
26.3.86	0.0003	0.0009		7.7	ESE/E/NNW	
27.3.86	<0.0002	0.0004	0.0003	2.6	NW	
28.3.86	0.0003	0.0005		7.7	WNW/W/WSW	
29.3.86	<0.0002	0.0005		2.6	E/WSW	
30.3.86	<0.0002	0.0010	0.0004	7.7	E	

4.2 AIRPORT MONITOR

This monitor indicated extremely high levels of probable asbestos fibres in the surrounding atmosphere, with a mean of 0.0020 fibres/ml (probable fibres) over the full study period. A maximum level of 0.1050 fibres/ml of probable fibres was recorded on 6 February 1986 in moderate winds ranging from SW to NW. This high level could be attributed to either vehicular movement in the nearby carpark, aircraft movement or localised wind turbulence.

It can be assumed that the majority of fibres originated from large areas of unsealed land around the monitor, in particular the carpark to the E and SW which is heavily contaminated with tailings (Table 2 and Diagram 2).

Table 2. Airport Monitor Fibre Results and Meteorological Data

Date	DCE A Fibres/ml	DCE B Fibres/ml	Pilbara Labs Fibres/ml	Max Wind Speed (m/s)	Wind Directions	Rainfall (mm)
5.1.86	0.0002	0.0003		2.6	E	47
6.1.86	0.0008	0.0017		3.1	N/E	11
7.1.86	0.0006	0.0016	0.0013	4.1	ENE/E	6
8.1.86	0.0009	0.0026		6.2	ESE/E/NE/SW	Min
9.1.86	0.0002	0.0004		3.1	S/SE/SW	
10.1.86	0.0007	0.0013	0.0011	2.1	S/SW	
11.1.86	0.0004	0.0008		5.1	E	
12.1.86	0.0002	0.0010		3.1	W	
13.1.86	0.0011	0.0033	0.0037	3.1	S/NW	
14.1.86	0.0006	0.0012		2.6	NE/NW	
15.1.86	0.0006	0.0015		7.7	NW/WNW/W	11
16.1.86	0.0008	0.0016	0.0012	5.1	E/SE	13
17.1.86	0.0011	0.0019		4.6	ESE/E	
18.1.86	0.0006	0.0012		1.0	NE	
19.1.86	0.0005	0.0013	0.0010	8.2	SSE/SE/E	Min
20.1.86	0.0006	0.0017		4.1	SE	
21.1.86	0.0010	0.0013		12.9	E/ESE	
22.1.86	<0.0002	0.0015	0.0008	14.4	E	
23.1.86	0.0004	0.0007		5.1	E/SSE/SE	
24.1.86	0.0007	0.0021		2.1	E/S	
25.1.86	0.0011	0.0018	0.0012	4.1	E/SSW/SE	
26.1.86	0.0004	0.0009		6.2	E/ESE	
27.1.86	0.0004	0.0009		2.6	E	Min
28.1.86	<0.0002	0.0005		2.6	E/NE/ENE/N	12
29.1.86	0.0009	0.0010	0.0013	2.6	W/NNE	1
30.1.86	0.0017	0.0020		4.1	SSW/NW/WSW	
31.1.86	0.0015	0.0016		5.1	S/SSE/NNE/SW	2
1.2.86	0.0003	0.0007	0.0008	5.1	SE/SSE	2
2.2.86	0.0009	0.0009		6.2	SSE/ESE/NE/S	Min
3.2.86	0.0009	0.0009		5.1	SSE/E	1
4.2.86	<0.0002	0.0002	0.0003	3.1	E/SW	
5.2.86	0.0012	0.0012	Heavy Fibre	4.1	ESE/E	
6.2.86	0.1050	0.1060	Load	2.6	N/NW	
7.2.86		Monitor Fault		No result		
8.2.86	0.0003	0.0005		4.1	SSE/E/NE/NW	

Table 2. Airport Monitor Fibre Results and Meteorological Data

Date	DCE A Fibres/ml	DCE B Fibres/ml	Pilbara Labs Fibres/ml	Max Wind Speed (m/s)	Wind Directions	Rainfall (mm)
9.2.86	0.0028	0.0035		5.1	SE/E/NW/SSE	
10.2.86	0.0032	0.0035	0.0028	2.6	S/WNW/NNW/NW	
11.2.86	0.0014	0.0019		4.1	SSW/SE/W/NW	
12.2.86	0.0018	0.0023		1.0	NW	
13.2.86	0.0019	0.0025	0.0032	4.1	SSW/WSW/W	
14.2.86	0.0025	0.0028		3.1	WNW	
15.2.86	0.0009	0.0013		5.1	ENE/NW	
16.2.86	0.0002	0.0011	0.0010	1.0	E/NNE/N	
17.2.86	0.0007	0.0012		7.7	SE/ESE/E	
18.2.86	0.0008	0.0011		5.1	E/ENE/E	5
19.2.86	0.0003	0.0003	0.0002	7.7	ESE/E/NNE	33
20.2.86	<0.0002	0.0002		2.6	NE/N	3
21.2.86	0.0003	0.0007		9.3	NNW	3
22.2.86	0.0002	0.0003	0.0003	5.1	NNW	
23.2.86	0.0003	0.0005		2.6	NNW	
24.2.86	0.0008	0.0016		1.0	E/ESE	
25.2.86	0.0005	0.0007	0.0011	10.3	S/ESE/NE	Min
26.2.86	0.0003	0.0010		7.7	SE/E	7
27.2.86	0.0005	0.0010		10.3	SE/N/E	
28.2.86	0.0003	0.0008	0.0004	2.1	SE/ESE	
1.3.86	0.0002	0.0008		5.1	N/E	
2.3.86	<0.0002	0.0006		7.7	SSE/SE/N	3
3.3.86	0.0007	0.0013	0.0009	7.7	N	
4.3.86	0.0004	0.0007		4.1	SSE/S/E/N	
5.3.86	0.0003	0.0004		4.1	N/NNE/N	Min
6.3.86	0.0008	0.0017	0.0013	5.1	E/NE/N	Min
7.3.86	0.0005	0.0018		7.7	E/NNE/N	
8.3.86	0.0004	0.0012		5.1	E/NE	
9.3.86	0.0003	0.0014	0.0008	7.7	ESE/N/NNW	
10.3.86	0.0012	0.0019		7.7	SSE/NNW/NE	
11.3.86	0.0006	0.0010		7.7	SSE/S	
12.3.86	-----No Cassettes Available-----No result----------					
13.3.86	0.0004	0.0005	0.0011	9.2	SSE/SE/E	2
14.3.86	0.0010	0.0016		7.7	SSE/ESE/SE	Min
15.3.86	0.0003	0.0008		6.2	SSE/ESE/N	8
16.3.86	0.0005	0.0007	0.0006	5.1	SE/SSE/E/N	
17.3.86	0.0004	0.0004		5.1	S/SE/ESE/E	
18.3.86	0.0008	0.0010		5.1	S/E	
19.3.86	0.0059	0.0062	0.0011	1.0	W/NW	
20.3.86	--------Monitor Fault no Result----------					
21.3.86	0.0006	0.0006	0.0006	5.1	SSE/NNW	1
22.3.86	0.0003	0.0006		2.6	SE/ESE/ENE	1
23.3.86	0.0002	0.0007		10.2	E	
24.3.86	0.0005	0.0011	0.0005	7.7	ESE/E	
25.3.86	0.0006	0.0010		2.6	E	
26.3.86	0.0005	0.0013		7.7	ESE/E/NNW	Trace
27.3.86	0.0002	0.0008	0.0007	2.6	NW	Min
28.3.86	<0.0002	0.0006		7.7	WNW/W/WSW	
29.3.86	0.0005	0.0007		2.6	E/WSW	
30.3.86	0.0003	0.0012	0.0009	7.7	E	

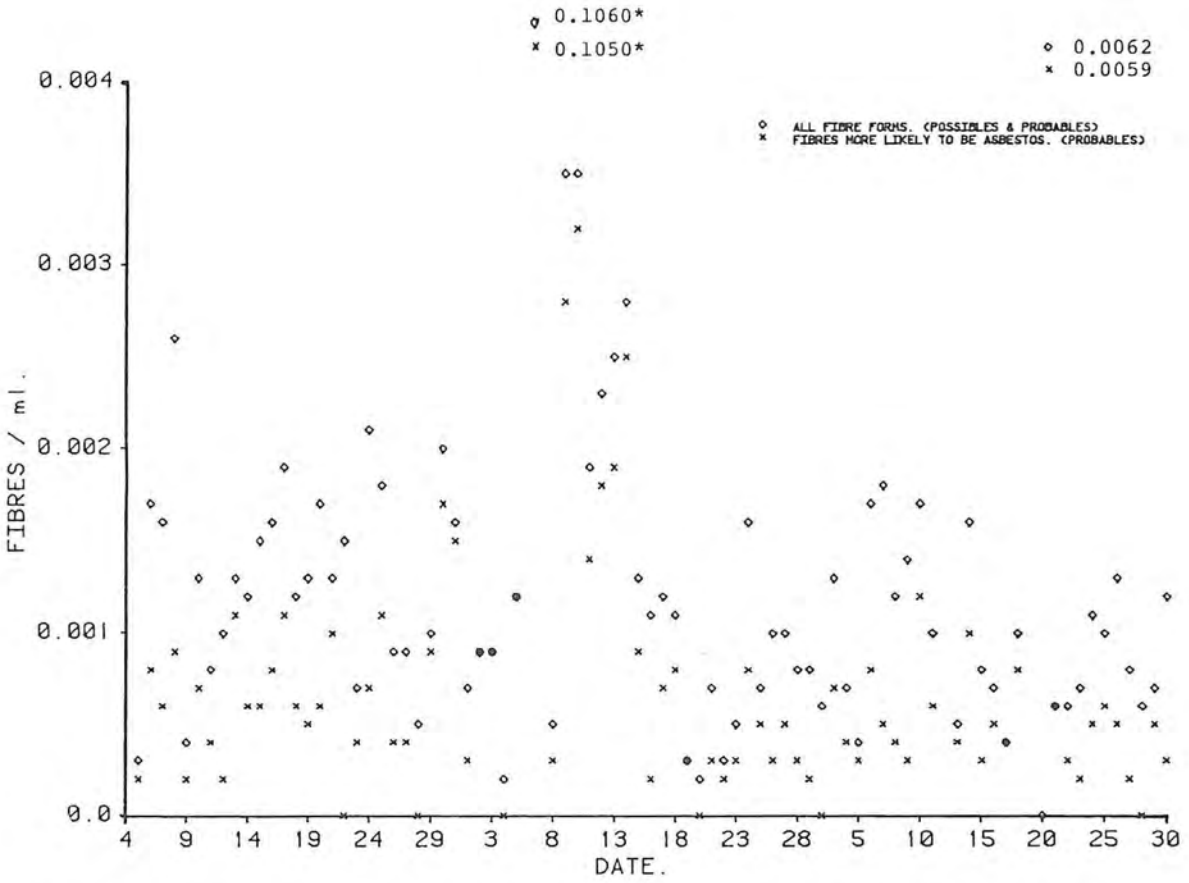
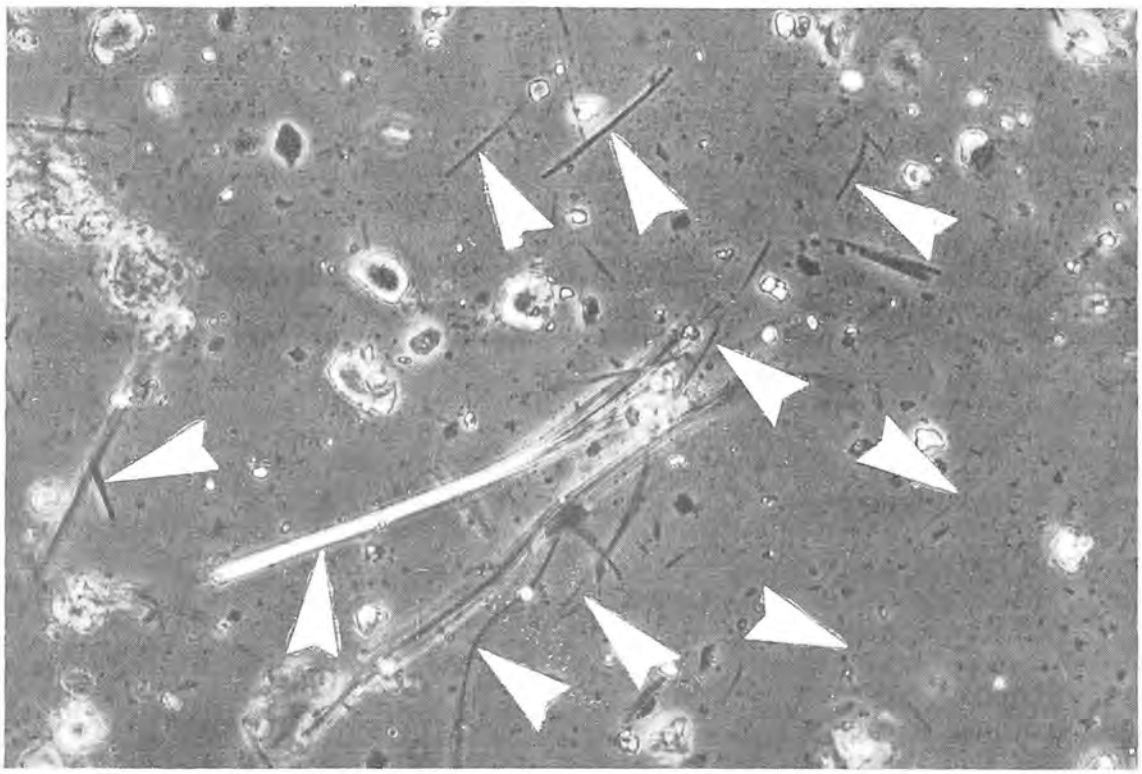
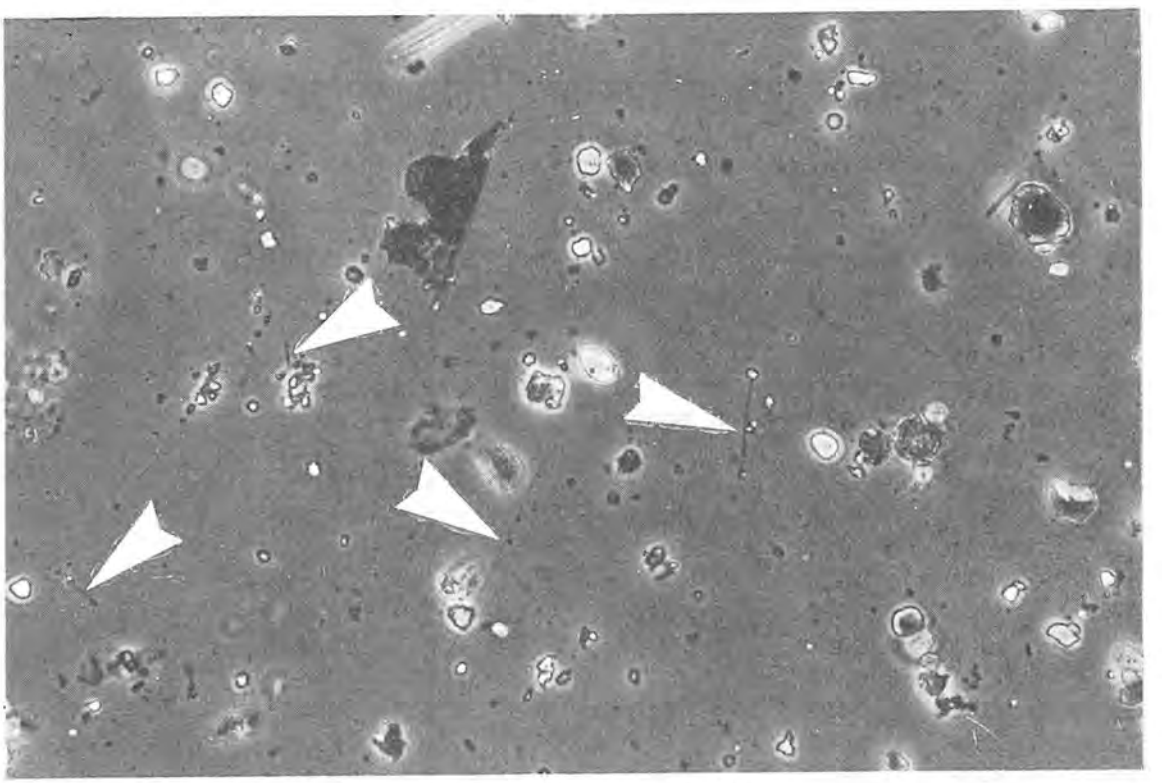


Diagram 2. Wittenoom - Airport 24 Hour Fibre Concentrations, Jan-Mar 1986. (Limit of detection 0.0002 Fibres/ml)



Photograph 5. Crocidolite Fibres, Airport 6/2/86
(Optical Microscopy) x 600 Magnification



Photograph 6. Crocidolite Fibres, Airport 9/2/86
(Optical Microscopy) x 600 Magnification

4.3 ELLIS MONITOR

High fibre levels, which also appeared not to be influenced from day to day by rainfall, wind direction or wind speed, were also recorded at this location. This area is also surrounded by unsealed areas of contaminated land, including a carpark to the north which is heavily contaminated with tailings.

The mean value of 0.0003 fibres/ml stated in the GBC report for all fibreforms at monitoring station 4, which was near the Ellis monitor, is significantly lower than that estimated by DCE (0.0026 fibres/ml). The level of probable fibres also exceeds the level of total fibres recorded by GBC (Table 3 and Diagram 3).

4.4 POLICE MONITOR

The mean level of probable fibres is reduced significantly at this site; however the level of probable and possible fibres again exceeds the previous GBC study results ie increasing from 0.0004 to 0.0008. Although the mean value for the monitor was low, levels of probable fibres were high on various occasions, particularly on 27 March 1986, when a level of 0.0017 fibres/ml (probable) was recorded. The level of total fibres was again twice that recorded by GBC (Diagram 4 and Table 4).

Table 3. Ellis Monitor Fibre Results and Meteorological Data

Date	DCE A Fibres/ml	DCE B Fibres/ml	Pilbara Labs Fibres/ml	Max Wind Speed (m/s)	Wind Direction	Rainfall (mm)
5.1.86	0.0004	0.0009		2.6	E/NNE/E	4F
6.1.86	0.0003	0.0013		3.1	E/N	11
7.1.86	<0.0002	0.0013	0.0009	4.1	ENE/E	6
8.1.86	0.0005	0.0015		6.2	ESE/E/NE/SW	Min
9.1.86	0.0006	0.0019		3.1	S/SE/SW	
10.1.86	0.0003	0.0012	0.0009	2.1	S/SW	
11.1.86	0.0011	0.0026		5.1	E/WSW	
12.1.86	0.0008	0.0015		3.1	W	
13.1.86	0.0015	0.0020	0.0023	3.1	S/NW	
14.1.86	0.0004	0.0016		2.6	NE/NW	
15.1.86	0.0016	0.0024		7.7	NW/WNW	11
16.1.86	0.0006	0.0010	0.0010	5.1	E/SE	13
17.1.86	0.0003	0.0008		4.6	ESE/E	
18.1.86	0.0003	0.0006		1.0	NE	
19.1.86	<0.0002	0.0005	0.0010	8.2	SSE/SE/E	Min
20.1.86	0.0008	0.0018		4.1	SE	
21.1.86	0.0002	0.0007		12.9	E/ESE	
22.1.86	0.0004	0.0017	0.0010	14.4	E	
23.1.86	0.0006	0.0020		5.1	E/SSE/SE	
24.1.86	0.0008	0.0022		2.1	E/S	
25.1.86	0.0015	0.0020	0.0022	4.1	E/SSW/SE	
26.1.86	0.0004	0.0010		6.2	E/ESE	
27.1.86	0.0004	0.0010		2.6	E	Min
28.1.86	0.0006	0.0012		2.6	E/NE/ENE/N	12
29.1.86	0.0006	0.0009	0.0004	2.6	W/NNE	1
30.1.86	0.0007	0.0011		4.1	SSW/NW/WSW	
31.1.86	0.0008	0.0010		5.1	S/SSE/NNE/SW	2
1.2.86	0.0011	0.0014	0.0013	5.1	SE/SSE	2
2.2.86	0.0014	0.0016		6.2	SSE/NE/ESE/S	Min
3.2.86	0.0007	0.0016		5.1	SSE/E	1
4.2.86	0.0007	0.0011	0.0009	3.1	E/SW	
5.2.86	0.0015	0.0021		4.1	ESE/E	
6.2.86	0.0007	0.0010		2.6	N/NW	
7.2.86	0.0016	0.0021	0.0015	2.6	S/WSW	
8.2.86	0.0014	0.0018		4.1	SSE/E/NE/NW	
9.2.86	0.0020	0.0024		5.1	SE/E/NW/SSE	
10.2.86	0.0013	0.0021	0.0019	2.6	S/WNW/NNW/NW	
11.2.86	0.0009	0.0012		4.1	SSW/SE/W/NW	
12.2.86	0.0019	0.0020		1.0	NW	
13.2.86	0.0028	0.0035	0.0026	4.1	SSW/WSW/W	
14.2.86	0.0009	0.0015		3.1	WNW	
15.2.86	0.0009	0.0015		5.1	ENE/NW	
16.2.86	0.0005	0.0010	0.0006	9.3	E/NNE/N	
17.2.86	0.0007	0.0013		7.7	SE/ESE/E	
18.2.86	0.0020	0.0016		5.1	E/ENE	4
19.2.86	0.0006	0.0010	0.0002	7.7	ESE/E/NNE	33
20.2.86	0.0003	0.0004		3.6	NE/N	3

Table 3. Ellis Monitor Fibre Results and Meteorological Data (contd)

Date	DCE A Fibres/ml	DCE B Fibres/ml	Pilbara Labs Fibres/ml	Max Wind Speed (m/s)	Wind Directions	Rainfall (mm)
21.2.86	0.0005	0.0008		9.3	NNW	3
22.2.86	0.0004	0.0011	0.0008	5.1	NNW	
23.2.86	0.0007	0.0007		2.6	NNW	
24.2.86	0.0006	0.0012		1.0	ESE	
25.2.86	0.0006	0.0009	0.0008	10.3	S/ESE/NE	Min
26.2.86	0.0003	0.0013		7.7	SE/E	7
27.2.86	0.0006	0.0013		10.3	SE/N/E	
28.2.86	0.0005	0.0010	0.0007	2.1	SE/ESE	
1.3.86	0.0005	0.0010		5.1	N/E	
2.3.86	0.0002	0.0008		7.7	SSE/SE/N	3
3.3.86	0.0005	0.0009	0.0010	7.7	N	
4.3.86	0.0002	0.0004		4.1	SSE/S/E/N	
5.3.86	0.0005	0.0005		4.1	N/NNE/N	Min
6.3.86	0.0004	0.0010	0.0008	5.1	NE/E/N	Min
7.3.86	0.0004	0.0012		7.7	E/NNE/N	Min
8.3.86	<0.0002	0.0006		5.1	E/NE	
9.3.86	0.0007	0.0015	0.0013	7.7	ESE/N/NNW	
10.3.86	0.0006	0.0008		7.7	SSE/NNW/NE	
11.3.86	0.0004	0.0009		7.7	SSE/S	1
12.3.86	-------NO CASSETTES AVAILABLE			NO RESULT----------		
13.3.86	<0.0002	0.0011	0.0019	7.7	SSE/SE/E	2
14.3.86	0.0006	0.0007		6.2	SSE/ESE/SE	Min
15.3.86	<0.0002	0.0003	0.0002	5.1	SSE/ESE/N	8
16.3.86	0.0004	0.0006		5.1	SE/SSE/E/NE	
17.3.86	0.0006	0.0006		5.1	S/SE/ESE	
18.3.86	0.0006	0.0009	0.0012	1.0	S/E	
19.3.86	0.0002	0.0004		1.0	W/NW	
20.3.86	0.0017	0.0022		5.1	WNW/NW	
21.3.86	0.0006	0.0010	0.0011	2.6	SSE/NNW	1
22.3.86	0.0004	0.0008		2.6	SE/ESE/ENE	
23.3.86	0.0003	0.0006		10.2	E	
24.3.86	0.0007	0.0011	0.0008	7.7	ESE/E	
25.3.86	0.0006	0.0014		2.6	E	
26.3.86	0.0005	0.0012		7.7	ESE/E/NNW	Min
27.3.86	0.0005	0.0012	0.0010	2.6	NW	
28.3.86	0.0007	0.0016		7.7	WNW/W/WSW	
29.3.86	------HEAVY DUST LOADING		NO RESULT--------			
30.3.86	0.0002	0.0006	0.0012	7.7	E	

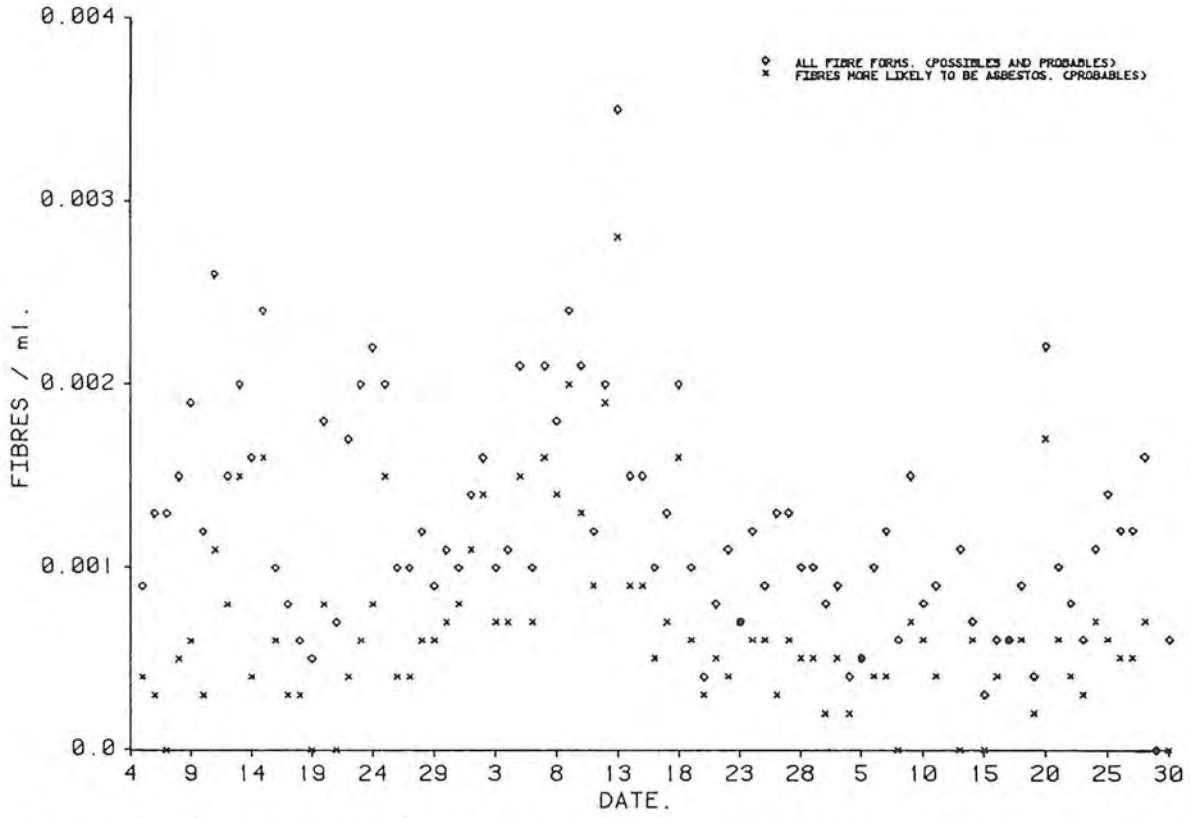
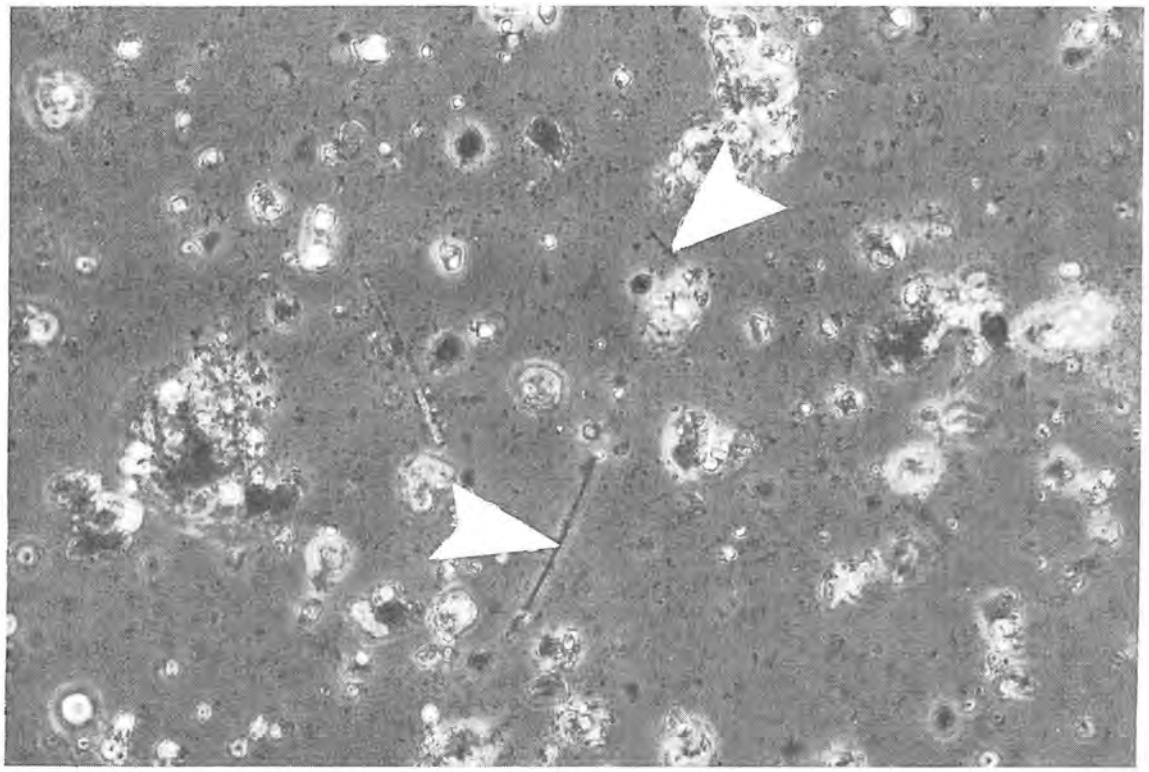


Diagram 3. Wittenoom - Ellis 24 Hour Fibre Concentrations, Jan - Mar 1986.
(Limit of detection 0.0002 Fibres/ml)



Photograph 7. Crocidolite Fibres, Ellis 15/1/86
(Optical Microscopy) x 600 Magnification

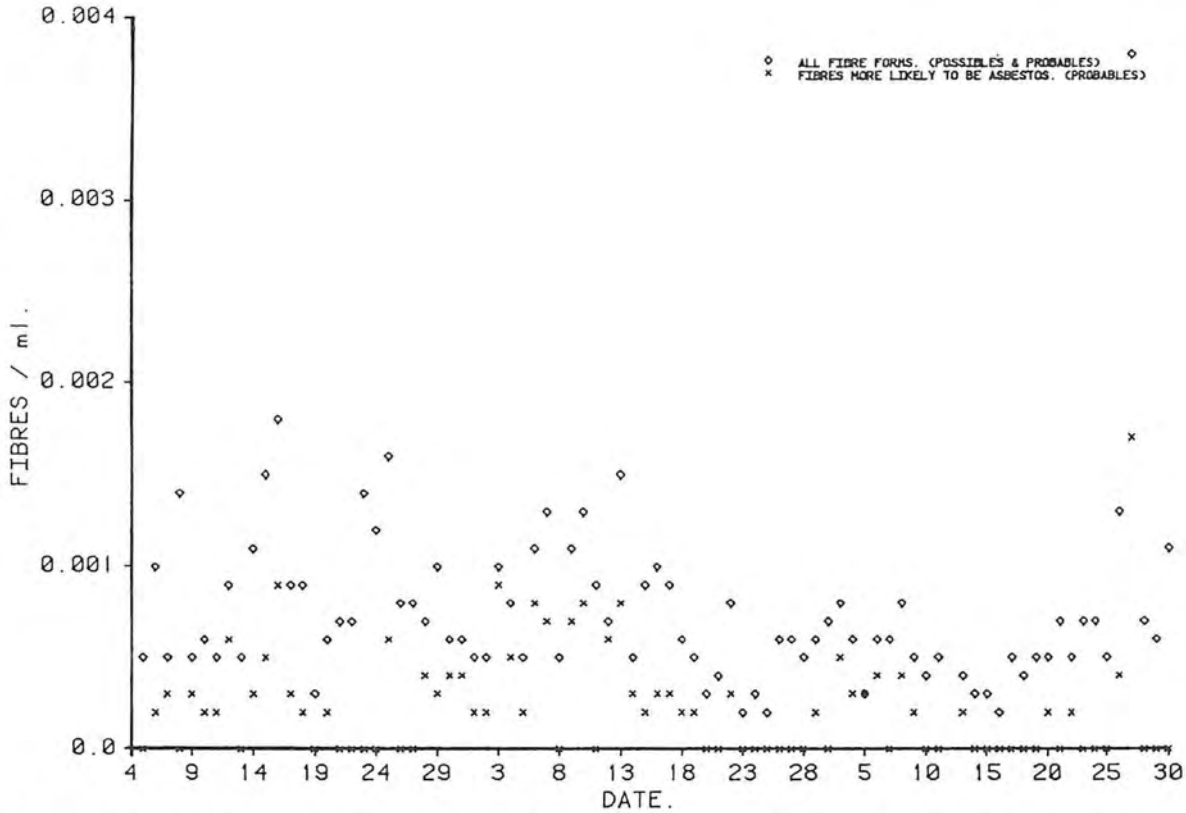
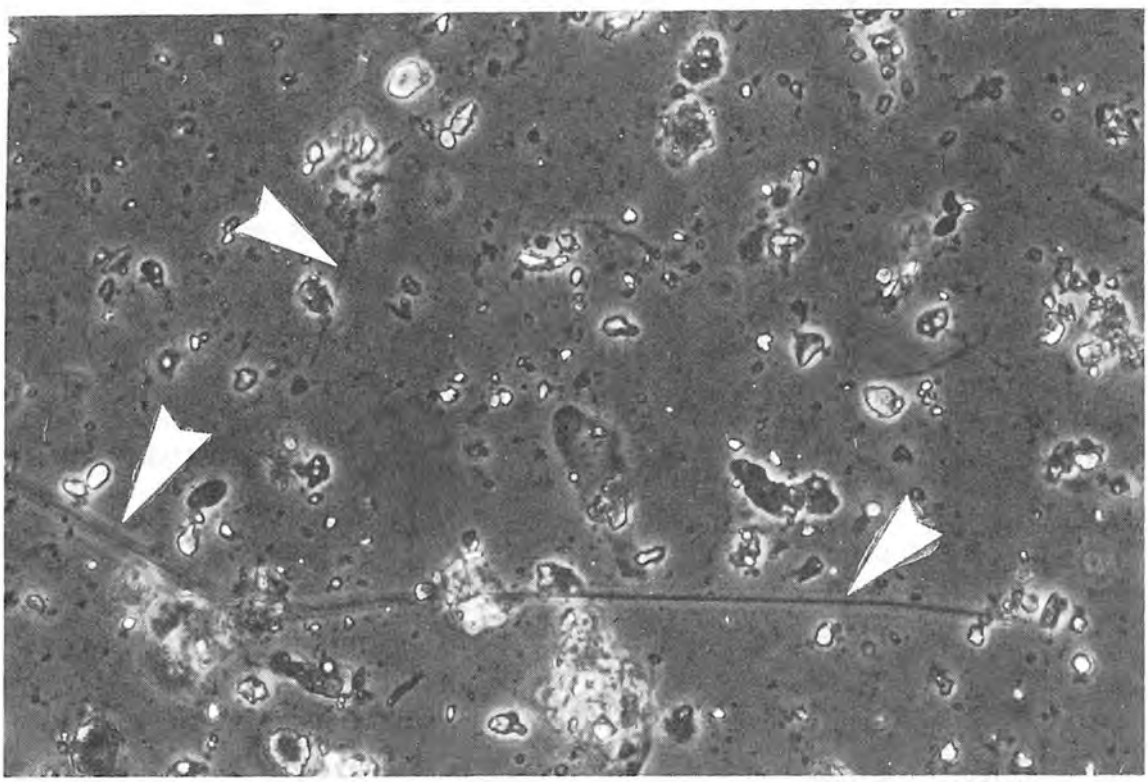


Diagram 4. Wittenoom - Police Station 24 Hour Fibre Concentrations, Jan - Mar 1986. (Limit of detection 0.002 Fibres/ml)



Photograph 8. Crocidolite Fibres Police Station 27/3/86 (Optical Microscopy) x 600 Magnification

Table 4. Police Monitor Fibre Results and Meteorological Data

Date	DCE A Fibres/ml	DCE B Fibres/ml	Pilbara Labs Fibres/ml	Max Wind Speed (m/s)	Wind Directions	Rainfall (mm)
5.1.86	<0.0002	0.0005		2.6	E/NNE/E	47
6.1.86	0.0002	0.0010		3.1	E/N	11
7.1.86	0.0003	0.0005	0.0004	4.1	ENE/N	6
8.1.86	<0.0002	0.0014		6.2	ESE/E/NE/SW	Min
9.1.86	0.0003	0.0005		3.1	S/SE/SW	
10.1.86	0.0002	0.0006		2.1	S/SW	
11.1.86	0.0002	0.0005		5.1	E/WSW	
12.1.86	0.0006	0.0009		3.1	W	
13.1.86	<0.0002	0.0005	0.0005	3.1	S/NW	
14.1.86	0.0003	0.0011		2.6	NE/NW	
15.1.86	0.0005	0.0015		7.7	NW/WNW	11
16.1.86	0.0009	0.0018	0.0012	5.1	E/SE	13
17.1.86	0.0003	0.0009		4.6	ESE/E	
18.1.86	0.0002	0.0009		1.0	NE	
19.1.86	<0.0002	0.0003	0.0004	8.2	SSE/SE/E	Min
20.1.86	0.0002	0.0006		4.1	SE	
21.1.86	<0.0002	0.0007		12.9	E/ESE	
22.1.86	<0.0002	0.0007	0.0003	14.4	E	
23.1.86	<0.0002	0.0014		5.1	E/SSE/SE	
24.1.86	<0.0002	0.0012		2.1	E/S	
25.1.86	0.0006	0.0016	0.0009	4.1	E/SSW/SE	
26.1.86	<0.0002	0.0008		6.2	E/ESE	
27.1.86	<0.0002	0.0008		2.6	E	
28.1.86	0.0004	0.0007		2.6	E/NE/EWE/N	12
29.1.86	0.0003	0.0010	0.0012	2.6	W/NNE	1
30.1.86	0.0004	0.0006		4.1	SSW/NW/WSW	
31.1.86	0.0004	0.0006		5.1	S/SSE/NNE/SW	2
1.2.86	0.0002	0.0005	0.0012	5.1	SE/SSE	2
2.2.86	0.0002	0.0005		6.2	SSE/NE/ESE/S	Min
3.2.86	0.0009	0.0010		5.1	SSE/E	1
4.2.86	0.0005	0.0008	0.0005	3.1	E/SW	
5.2.86	0.0002	0.0005		4.1	ESE/E	
6.2.86	0.0008	0.0011		2.6	N/NW	
7.2.86	0.0007	0.0013	0.0005	2.6	S/WSW	
8.2.86	<0.0002	0.0005		4.1	SSE/E/NE/NW	
9.2.86	0.0007	0.0011		5.1	SE/E/NW/SSE	
10.2.86	0.0008	0.0013	0.0007	2.6	S/WNW/NNW/NW	
11.2.86	<0.0002	0.0009		4.1	SSW/SE/W/NW	
12.2.86	0.0006	0.0007		1.0	NW	
13.2.86	0.0008	0.0015	0.0007	4.1	SSW/WSW/W	
14.2.86	0.0003	0.0005		3.1	WNW	
15.2.86	0.0002	0.0009		5.1	ENE/NW	
16.2.86	0.0003	0.0010	0.0005	9.3	E/NNE/N	
17.2.86	0.0003	0.0009		7.7	SE/ESE/E	
18.2.86	0.0002	0.0006		5.1	E/ENE	4
19.2.86	0.0002	0.0005	0.0004	7.7	ESE/E/NNE	33
20.2.86	<0.0002	0.0003		3.6	NE/N	3

Table 4. Police Monitor Fibre Results and Meteorological Data (contd)

Date	DCE A Fibres/ml	DCE B Fibres/ml	Pilbara Labs Fibres/ml	Max Wind Speed (m/s)	Wind Directions	Rainfall (mm)
21.2.86	<0.0002	0.0004		9.3	NNW	3
22.2.86	<0.0003	0.0008	0.0006	5.1	NNW	
23.2.86	<0.0002	0.0002		2.6	NNW	
24.2.86	<0.0002	0.0003		1.0	E/ESE	
25.2.86	<0.0002	0.0002	0.0002	10.3	S/ESE/NE	Min
26.2.86	<0.0002	0.0006		7.7	SE/E	7
27.2.86	<0.0002	0.0006		10.3	SE/N/E	
28.2.86	<0.0002	0.0003	0.0004	2.1	SE/ESE	
1.3.86	0.0002	0.0006		5.1	N/E	
2.3.86	<0.0002	0.0007		7.7	SSE/SE/N	3
3.3.86	0.0005	0.0008	0.0005	7.7	N	
4.3.86	0.0003	0.0006		4.1	SSE/S/E/N	
5.3.86	0.0003	0.0003		4.1	N/NNE/N	Min
6.3.86	0.0004	0.0006	0.0008	5.1	E/NE/N	Min
7.3.86	<0.0002	0.0006		7.7	E/NNE/N	Min
8.3.86	<0.0004	0.0008		5.1	E/NE	
9.3.86	0.0002	0.0005	0.0006	7.7	ESE/N/NNW	
10.3.86	<0.0002	0.0004		7.7	SSE/WNW/NE	
11.3.86	<0.0002	0.0005		7.7	SSE/S	1
12.3.86	--------NO CASSETTES AVAILABLE			NO RESULT----------		
13.3.86	0.0002	0.0004	0.0007	7.7	SSE/SE/E	2
14.3.86	<0.0002	0.0003		6.2	SSE/ESE/SE	Min
15.3.86	<0.0002	0.0003	0.0002	5.1	SSE/ESE/N	8
16.3.86	<0.0002	0.0002		5.1	SE/SSE/E/NE	
17.3.86	<0.0002	0.0005		5.1	S/SE/ESE	
18.3.86	<0.0002	0.0004	0.0002	1.0	S/E	
19.3.86	<0.0002	0.0005		1.0	W/NW	
20.3.86	0.0002	0.0005		5.1	WNW/NW	
21.3.86	<0.0002	0.0007	0.0005	2.6	SSE/NNW	1
22.3.86	0.0002	0.0005		2.6	SE/ESE/ENE	
23.3.86	<0.0002	0.0007		10.2	E	
24.3.86	<0.0002	0.0007	0.0003	7.7	ESE/E	
25.3.86	<0.0002	0.0005		2.6	E	
26.3.86	0.0004	0.0013		7.7	ESE/E/NNW	Min
27.3.86	0.0017	0.0038	0.0015	2.6	NW	
28.3.86	0.0002	0.0007		7.7	WNW/W/WSW	
29.3.86	<0.0002	0.0006		2.6	E/WSW	
30.3.86	<0.0002	0.0011	0.0004	7.7	E	

4.5 HOSPITAL MONITOR

Recorded levels of total fibres were again increased when compared to the GBC mean ie 0.0002 fibres/ml increased to 0.0008 fibres/ml. Probable fibres recorded a mean of 0.0002 fibres/ml; however, levels up to 0.0011 fibres/ml were recorded on various occasions. Once more, fibre levels were not increased or decreased in any specific wind direction, speed or rainfall (Diagram 5 and Table 5).

4.6 GORGE MONITOR

Fibre levels at this location were not increased when the wind direction originated from the minesite and tailings dump. The total surrounding area is contaminated with asbestos tailings which can be readily identified surrounding the rock pools and the roads leading to the rock pools. Again, high probable fibre concentrations were recorded on various occasions with a peak of 0.0013 fibre/ml being reached on 9 February 1986, a day with a mean wind speed of 2.2 m/s and max velocity of 5.1 m/s (Diagram 6 and Table 6).

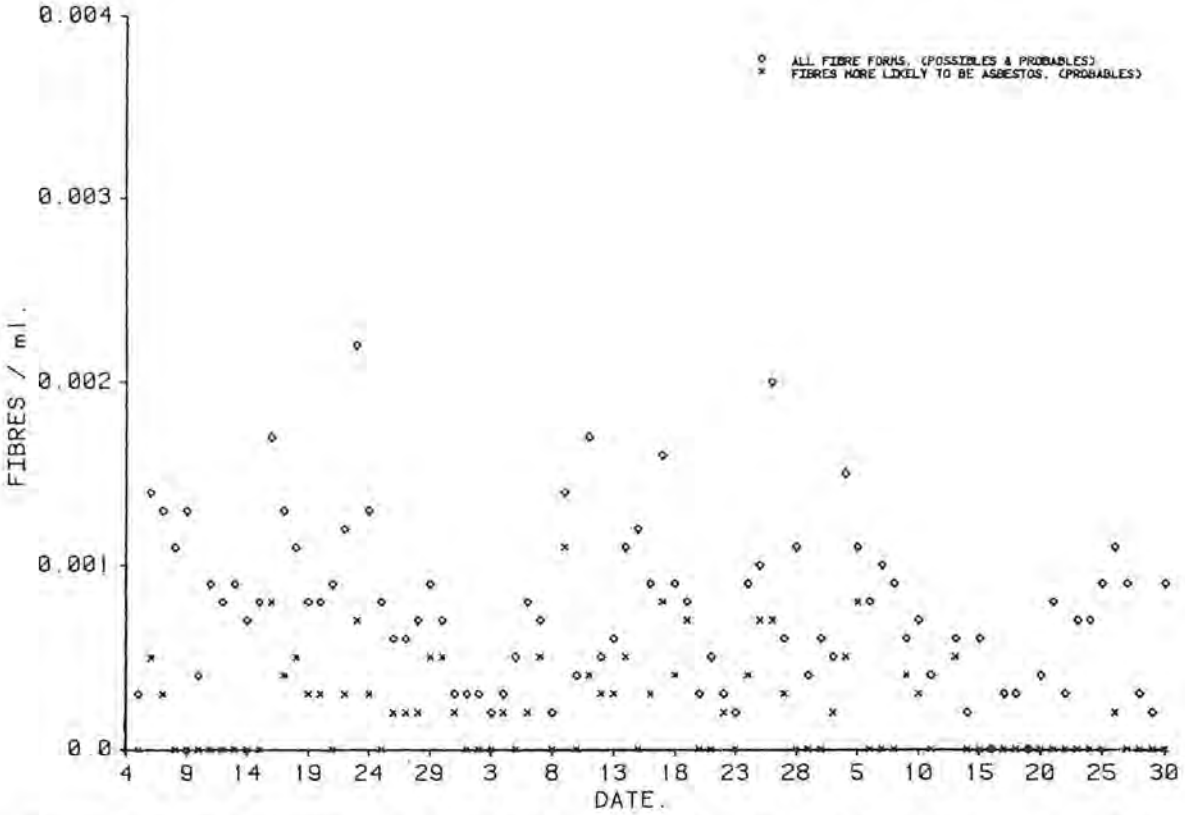


Diagram 5. Wittenoom - Hospital 24 Hour Fibre Concentrations, Jan - Mar 1986. (Limit of detection 0.0002 Fibres/ml)

Table 5. Hospital Monitor Fibre Results and Meteorological Data

Date	DCE A Fibres/ml	DCE B Fibres/ml	Pilbara Labs Fibres/ml	Max Wind Speed (m/s)	Wind Directions	Rainfall (mm)
5.1.86	<0.0002	0.0003		2.6	E/NWE/E	47
6.1.86	0.0005	0.0014		3.1	E/N	11
7.1.86	0.0003	0.0013	0.0011	4.1	ENE/N	6
8.1.86	<0.0002	0.0011		6.2	ESE/E/NE/SW	Min
9.1.86	<0.0002	0.0013		3.1	S/SE/SW	
10.1.86	<0.0002	0.0004	0.0005	2.1	S/SW	
11.1.86	<0.0002	0.0009		5.1	E/WSW	
12.1.86	<0.0002	0.0008		3.1	W	
13.1.86	<0.0002	0.0009	0.0008	3.1	S/NW	
14.1.86	<0.0002	0.0007		2.6	NE/NW	
15.1.86	<0.0002	0.0008		7.7	NW/WNW	11
16.1.86	0.0008	0.0017	0.0019	5.1	E/SE	13
17.1.86	0.0004	0.0013		4.6	ESE/E	
18.1.86	0.0005	0.0011		1.0	NE	
19.1.86	0.0003	0.0008	0.0009	8.2	SSE/SE/E	Min
20.1.86	0.0003	0.0008		4.1	SE	
21.1.86	<0.0002	0.0009		12.9	E/ESE	
22.1.86	0.0003	0.0012	0.0012	14.4	E	
23.1.86	0.0007	0.0022		5.1	E/SSE/SE	
24.1.86	0.0003	0.0013		2.1	E/S	
25.1.86	<0.0002	0.0008	0.0008	4.1	E/SSW/SE	
26.1.86	0.0002	0.0006		6.2	E/ESE	
27.1.86	0.0002	0.0006		2.6	E	
28.1.86	0.0002	0.0007		2.6	E/NE/ENE/N	12
29.1.86	0.0005	0.0009	0.0008	2.6	W/NNE	1
30.1.86	0.0005	0.0007		4.1	SSW/NW/WSW	
31.1.86	0.0002	0.0003		5.1	S/SSE/NNE/SW	2
1.2.86	<0.0002	0.0003	0.0004	5.1	SE/SSE	2
2.2.86	<0.0002	0.0003		6.2	SSE/NE/ESE/S	Min
3.2.86	<0.0002	0.0002		5.1	SSE/E	1
4.2.86	0.0002	0.0003	0.0005	3.1	E/SW	
5.2.86	<0.0002	0.0005		4.1	ESE/E	
6.2.86	0.0002	0.0008		2.6	N/NW	
7.2.86	0.0005	0.0007	0.0005	2.6	S/WSW	
8.2.86	<0.0002	0.0002		4.1	SSE/E/NE/NW	
9.2.86	0.0011	0.0014		5.1	SE/E/NW/SSE	
10.2.86	<0.0002	0.0004	0.0003	2.6	S/WNW/NNW/NW	
11.2.86	0.0004	0.0017		4.1	SSW/SE/W/SW	
12.2.86	0.0003	0.0005		1.0	NW	
13.2.86	0.0003	0.0006	0.0006	4.1	SSW/WSW/W	
14.2.86	0.0005	0.0011		3.1	WNW	
15.2.86	<0.0002	0.0012		5.1	ENE/NW	
16.2.86	0.0003	0.0009	0.0007	9.3	E/NNE/N	
17.2.86	0.0008	0.0016		7.7	SE/ESE/N	
18.2.86	0.0004	0.0009		5.1	E/ENE	4
19.2.86	0.0007	0.0008	0.0008	7.7	ESE/E/NNE	33
20.2.86	<0.0002	0.0003		3.6	NE/N	3

Table 5. Hospital Monitor Fibre Results and Meteorological Data (contd)

Date	DCE A Fibres/ml	DCE B Fibres/ml	Pilbara Labs Fibres/ml	Max Wind Speed (m/s)	Wind Directions	Rainfall (mm)
21.2.86	<0.0002	0.0005		9.3	NNW	3
22.2.86	<0.0002	0.0003	0.0005	5.1	NNW	
23.2.86	<0.0002	<0.0002		2.6	NNW	
24.2.86	0.0004	0.0009		1.0	E/ESE	
25.2.86	0.0007	0.0010	0.0008	10.3	E/ESE/NE	Min
26.2.86	0.0007	0.0020		7.7	SE/E	7
27.2.86	0.0003	0.0006		10.3	SE/N/E	
28.2.86	<0.0002	0.0011	0.0010	2.1	SE/ESE	
1.3.86	<0.0002	0.0004		5.1	N/E	
2.3.86	<0.0002	0.0006		7.7	SSE/SE/N	3
3.3.86	0.0002	0.0005	0.0005	7.7	N	
4.3.86	0.0005	0.0015		4.1	SSE/S/E/N	
5.3.86	0.0008	0.0011		4.1	N/NNE/N	Min
6.3.86	<0.0002	0.0008	0.0004	5.1	NE/E/N	Min
7.3.86	<0.0002	0.0010		7.7	E/NNE/N	Min
8.3.86	<0.0002	0.0009		5.1	E/NE	
9.3.86	0.0004	0.0006	0.0005	7.7	ESE/N/NNW	
10.3.86	0.0003	0.0007		7.7	SSE/WNW/NE	
11.3.86	<0.0002	0.0004		7.7	SSE/S	1
12.3.86	---------- NO CASSETTES AVAILABLE ----------					
13.3.86	0.0005	0.0006	0.0017	7.7	SSE/SE/E	2
14.3.86	<0.0002	0.0002		6.2	SSE/ESE/SE	Min
15.3.86	<0.0002	0.0006	0.0003	5.1	SSE/ESE/N	8
16.3.86	<0.0002	<0.0002		5.1	SE/SSE/E/NE	
17.3.86	<0.0002	0.0003		5.1	S/SE/ESE	
18.3.86	<0.0002	0.0003	0.0002	1.0	S/E	
19.3.86	<0.0002	<0.0002		1.0	W/NW	
20.3.86	<0.0002	0.0004		5.1	WNW/NW	
21.3.86	<0.0002	0.0008	0.0005	2.6	SSE/NNW	1
22.3.86	<0.0002	0.0003		2.6	SE/ESE/ENE	
23.3.86	<0.0002	0.0007		10.2	E	
24.3.86	<0.0002	0.0007	0.0006	7.7	ESE/E	
25.3.86	<0.0002	0.0009		2.6	E	
26.3.86	0.0002	0.0011		7.7	ESE/E/NNW	Min
27.3.86	<0.0002	0.0009	0.0006	2.6	NW	
28.3.86	<0.0002	0.0003		7.7	WNW/W/WSW	
29.3.86	<0.0002	0.0002		2.6	E/WSW	
30.3.86	<0.0002	0.0009	0.0008	7.7	E	

Table 6. Gorge Monitor Fibre Results and Meteorological Data

Date	DCE A Fibres/ml	DCE B Fibres/ml	Pilbara Labs Fibres/ml	Max Wind Speed (m/s)	Wind Directions	Rainfall (mm)
5.1.86	BATTERY FAILURE - NO RESULT					
6.1.86	"					
7.1.86	"					
8.1.86	"					
9.1.86	"					
10.1.86	"					
11.1.86	0.0002	0.0011		5.1	E/WSW	
12.1.86	BATTERY FAILURE - NO RESULT					
13.1.86	0.0007	0.0018	0.0027	3.1	S/NW	
14.1.86	0.0002	0.0010		2.6	NE/NW	
15.1.86	0.0003	0.0008		7.7	NW/WNW/W	11
16.1.86	0.0004	0.0009	0.0006	5.1	E/SE	13
17.1.86	0.0010	0.0019		4.6	ESE/E	
18.1.86	0.0003	0.0005		1.0	NE	Min
19.1.86	0.0003	0.0008	0.0006	8.2	SSE/SE/E	Min
20.1.86	0.0002	0.0009		4.1	SE	
21.1.86	CASSETTE DISCONNECTED - NO RESULT					
22.1.86	0.0002	0.0013	0.0009	14.4	E	
23.1.86	0.0003	0.0012		5.1	E/SSE/SE	
24.1.86	0.0006	0.0023	0.0011	2.1	E/S	
25.1.86	RIPPED FILTER - NO RESULT					
26.1.86	HIGH VARIATION IN FLOW RATES - NO RESULT					
27.1.86	"					
28.1.86	"					
29.1.86	0.0002	0.0010	0.0010	2.6	W/NNE	1
30.1.86	0.0006	0.0007		4.1	SSW/NW/WSW	
31.1.86	0.0003	0.0005		4.1	S/SSE/NNE/SW	2
1.2.86	0.0002	0.0002	0.0006	5.1	SE/SSE	2
2.2.86	<0.0003	0.0006		6.2	SSE/ESE/NE/S	Min
3.2.86	BATTERY FAILURE - NO RESULT					
4.2.86	0.0006	0.0008	0.0003	3.1	E/SW	
5.2.86	0.0002	0.0004		4.1	ESE/E	
6.2.86	0.0002	0.0004		2.6	N/NW	
7.2.86	0.0005	0.0008	0.0003	2.6	S/WSW	
8.2.86	0.0002	0.0005		4.1	SSE/E/EN/NW	
9.2.86	0.0013	0.0021		5.1	SE/E/NW/SSE	
10.2.86	0.0002	0.0005	0.0003	2.6	S/WNW/NNW/NW	
11.2.86	0.0003	0.0008		4.1	SSW/SE/W/NW	
12.2.86	0.0003	0.0009		1.0	NW	
13.2.86	0.0004	0.0010	0.0006	4.1	SSW/WSW/W	
14.2.86	0.0005	0.0007		3.1	WNW	
15.2.86	BATTERY FAILURE - NO RESULT					
16.2.86	0.0006	0.0011	0.0005	9.3	E/NNE/N	
17.2.86	0.0002	0.0006		7.7	SE/ESE/E/E	
18.2.86	0.0002	0.0003		5.1	E/ENE/E	4
19.2.86	0.0002	0.0004	0.0002	7.7	ESE/E/NNE	33
20.2.86	PUMP FAULT - NO RESULT					

Table 6. Gorge Monitor Fibre Results and Meteorological Data (contd)

Date	DCE A Fibres/ml	DCE B Fibres/ml	Pilbara Labs Fibres/ml	Max Wind Speed (m/s)	Wind Directions	Rainfall (mm)
21.2.86	0.0002	0.0008		9.3	NNW	3
22.2.86	0.0002	0.0004	0.0003	5.1	NNW	
23.2.86	0.0002	0.0002		2.6	NNW	
24.2.86	0.0002	0.0004		1.0	ESE/E	
25.2.86	0.0002	0.0006	0.0005	10.3	S/ESE/NE	Min
26.2.86	0.0002	0.0002		7.7	SE/E	7
27.2.86	0.0002	0.0004		10.3	SE/N/E	
28.2.86	0.0002	0.0005	0.0005	2.1	SE/ESE	
1.3.86	0.0004	0.0009		5.1	E/N	
2.3.86	0.0002	0.0003		7.7	SSE/SE/N	3
3.3.86	0.0006	0.0007	0.0008	7.7	N	
4.3.86	0.0002	0.0002		4.1	SSE/S/E/N	
5.3.86	0.0002	0.0004		4.1	N/NNE	Min
6.3.86	0.0002	0.0011	0.0005	5.1	E/NE/N	Min
7.3.86	0.0002	0.0020		7.7	E/NNE/N	
8.3.86	POWER FAILURE AT SCHOOL - BATTERY NOT CHARGED - NO RESULT					
9.3.86	0.0002	0.0003	0.0006	7.7	ESE/N/NNW	
10.3.86	0.0003	0.0008		7.7	SSE/NNW/NE	
11.3.86	0.0002	0.0010		7.7	SSE/S	1
12.3.86	---------- NO CASSETTES AVAILABLE ----------					Min
13.3.86	0.0002	0.0002	0.0005	7.7	SSE/SE/E	2
14.3.86	0.0002	0.0006		6.2	SSE/ESE/SE	Min
15.3.86	0.0002	0.0004	0.0003	5.1	SSE/ESE/N	8
16.3.86	CLEAN FILTER - NO RESULT					
17.3.86	CLEAN FILTER - NO RESULT					
18.3.86	0.0002	0.0005	0.0003	1.0	S/E	
19.3.86	0.0002	0.0003		1.0	W/NW	
20.3.86	0.0002	0.0007		5.1	WNW/NW	
21.3.86	0.0002	0.0004	0.0004	2.6	SSE/NNW	1
22.3.86	0.0002	0.0009		2.6	SE/ESE/ENE	
23.3.86	0.0003	0.0007		10.2	E	
24.3.86	0.0005	0.0012	0.0008	7.7	ESE/E	
25.3.86	0.0009	0.0020		2.6	E	
26.3.86	0.0004	0.0016		7.7	ESE/E/NNW	Trace
27.3.86	0.0002	0.0010	0.0007	2.6	NW	Min
28.3.86	0.0009	0.0017		7.7	WNW/W/WSW	
29.3.86	0.0002	0.0004		2.6	E/WSW	
30.3.86	0.0005	0.0015	0.0013	7.7	E	

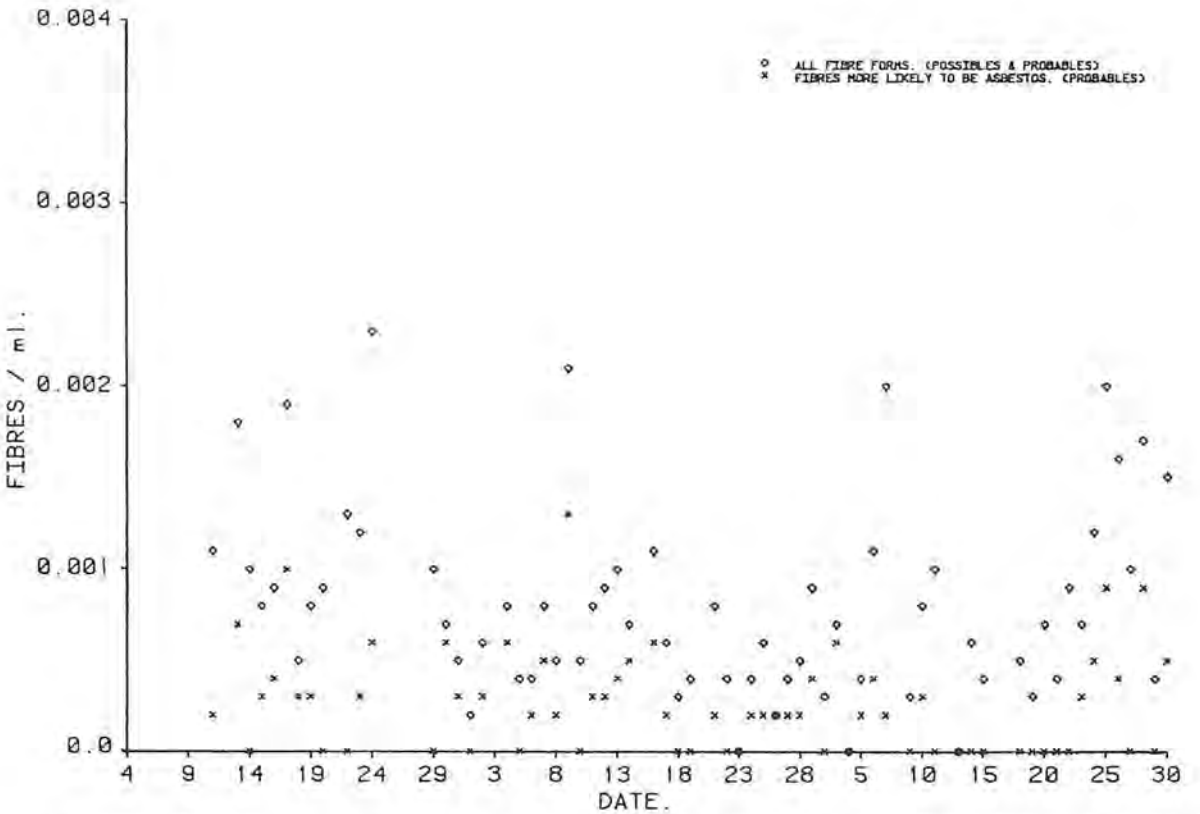


Diagram 6. Wittenoom - Gorge 24 Hour Fibre Concentrations, Jan - Mar 1986. (Limit of detection 0.0002 Fibres/ml)

4.7 9 KM AND 3 KM SITES MONITORS

The significance of the results obtained from these monitors is that on occasions, total fibre concentration were similar to those recorded within the Wittenoom townsite. The difference between the two results was that noticeably more probable fibres were observed on the filters from the townsite. It is interesting to note that probable fibres were also observed on occasions at these sites, although their occurrence was not on a regular basis as was the case with the townsite series. Maximum values of probable fibres achieved did not exceed 0.0002 fibres/ml (Diagrams 7a and 7b, Tables 7a and 7b).

4.8 METEOROLOGICAL DATA

The GBC report stated that the wind direction was between the E and S quadrant for 60% of the study period. Results obtained from the DCE continuous anemometer showed that for the period 3 February 1986 to 10 March 1986, the wind originated from the SW quadrant for 20% of the time, from the NW quadrant for 18% and from the NE quadrant for 16% ie the wind originated from other than the SE quadrant for a total of 58% of the time period. This high variation in wind pattern is also confirmed by information obtained from the meteorological station at Wittenoom Post Office; which, as previously stated by GBC, would appear to be 30^{o} off true N towards E.

Rainfall recorded throughout the sampling period did not appear to have any long-lasting stabilishing-effect on airborne asbestos fibre concentrations, which demonstrates the ease at which fibres can lose moisture to the atmosphere.

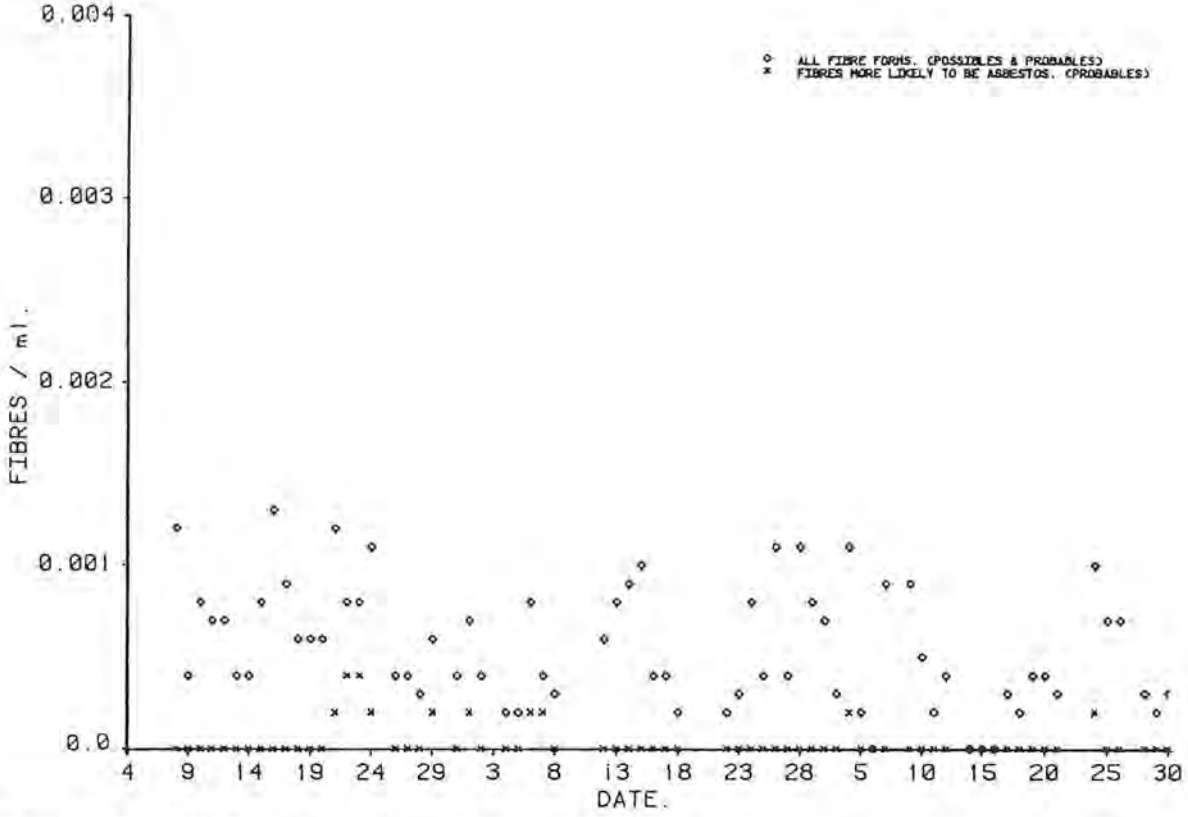


Diagram 7a. Wittenoom - 9 km Site 24 Hour Fibre Concentrations, Jan - Mar 1986. (Limit of detection 0.002 Fibres/ml)

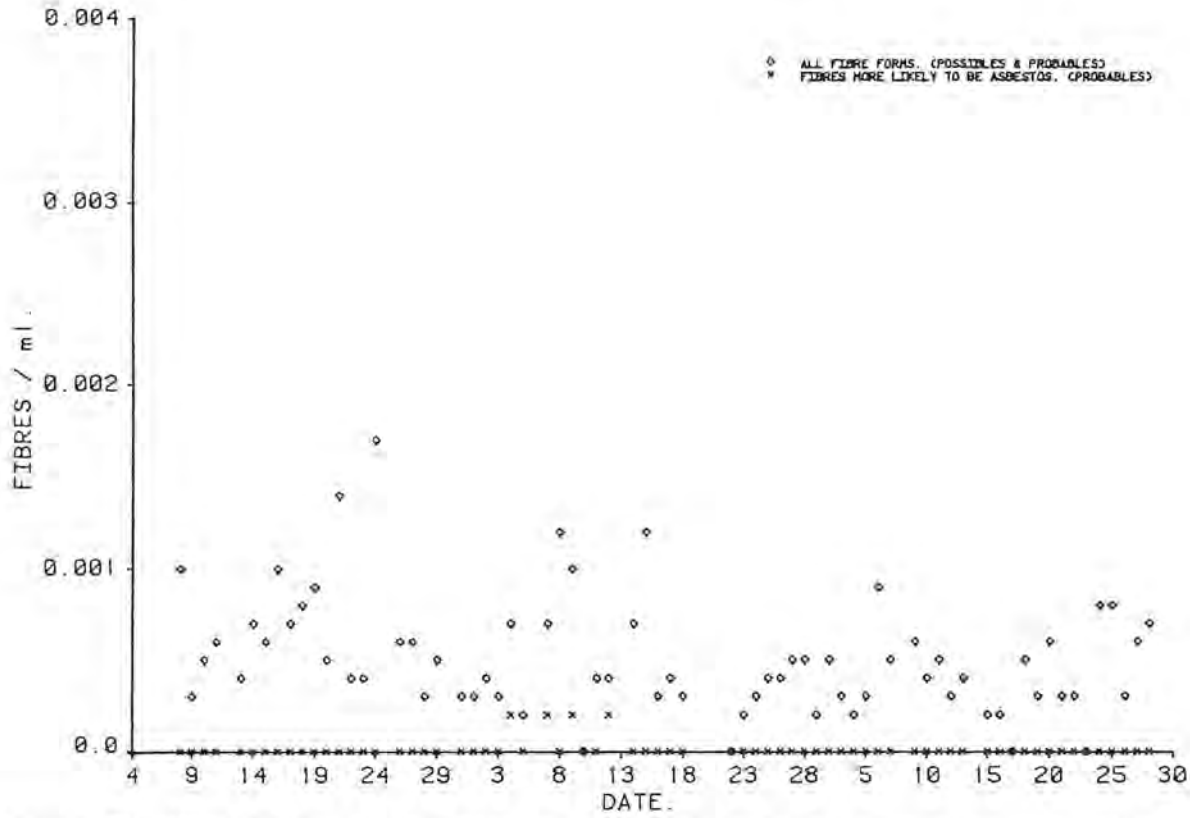


Diagram 7b. Wittenoom - 43 km Site 24 Hour Fibre Concentrations, Jan - Mar 1986. (Limit of detection 0.0002 Fibres/ml)

Table 7a. 9 km Monitor Fibre Results and Meteorological Data

Date	DCE A Fibres/ml	DCE B Fibres/ml	Pilbara Labs Fibres/ml	Max Wind Speed (m/s)	Wind Directions	Rainfall (mm)
5.1.86	---------- BATTERY FAILURE - NO RESULT ----------					
6.1.86			"			
7.1.86			"			
8.1.86	<0.0002	0.0010	0.0009	6.2	ESE/E/WE/SW	Min
9.1.86	"	0.0003		3.1	S/SE/SW	
10.1.86	"	0.0005		2.1	S/SW	
11.1.86	"	0.0006		5.1	E/WSW	
12.1.86	---------- FILTER RIPPED - NO RESULT ----------					
13.1.86	<0.0002	0.0004		3.1	S/NW	
14.1.86	"	0.0007	0.0006	2.6	NE/NW	11
15.1.86	"	0.0006		7.7	NW/WNW	13
16.1.86	"	0.0010		5.1	SE/E	
17.1.86	"	0.0007	0.0006	4.6	ESE/E	
18.1.86	"	0.0008		1.0	NE	
19.1.86	"	0.0009		8.2	SSE/SE/E	Min
20.1.86	"	0.0005	0.0003	4.1	SE	
21.1.86	"	0.0014		12.9	E/ESE	
22.1.86	"	0.0004	0.0003	14.4	E	
23.1.86	"	0.0004		5.1	E/SSE/SE	
24.1.86	"	0.0017		2.1	E/S	
25.1.86	---------- FILTER RIPPED - NO RESULT ----------					
26.1.86	"	0.0006		2.6	E	
27.1.86	---------- 48HR SAMPLE FOR 26/27 ----------					
28.1.86	"	0.0003		2.6	E/NE/ENE/N	12
29.1.86	"	0.0005		2.6	W/NNE	1
30.1.86	---------- FILTER RIPPED - NO RESULT ----------					
31.1.86	"	0.0003	0.0002	5.1	S/SSE/NNE/SW	20
1.2.86	"	0.0003		5.1	SE/SSE	2
2.2.86	"	0.0004	0.0004	6.2	SSE/NE/ESE/S	Min
3.2.86	"	0.0003		5.1	SSE/E	1
4.2.86	"	0.0007		3.1	E/SW	
5.2.86	"	0.0002	0.0003	4.1	ESE/E	
6.2.86	---------- NO DEPOSIT - FAULT? ----------					
7.2.86	0.0002	0.0007		2.6	S/WSW	
8.2.86	<0.0002	0.0012	0.0009	4.1	SSE/E/NE/NW	
9.2.86	0.0002	0.0010		5.1	SE/E/NW/SSE	
10.2.86	<0.0002	<0.0002		2.6	S/WNW/NNW/NW	
11.2.86	0.0002	0.0004		1.1	NW	
12.2.86	0.0002	0.0004		1.0	NW	
13.2.86	---------- LOOSE PUMP CONNECTION - NO RESULT ----------					
14.2.86	<0.0002	0.0007		3.1	WNW	
15.2.86	<0.0002	0.0012	0.0007	5.1	ENE/NW	
16.2.86	"	0.0003		9.3	E/NNE/N	
17.2.86	"	0.0004	0.0002	7.7	SE/ESE/E	
18.2.86	"	0.0003		5.1	E/ENE	4
19.2.86	---------- ROADS CLOSED ----------					
20.2.86	---------- ROADS CLOSED ----------					

Table 7a. 9 km Monitor Fibre Results and Meteorological Data (contd)

Date	DCE A Fibres/ml	DCE B Fibres/ml	Pilbara Labs Fibres/ml	Max Wind Speed (m/s)	Wind Directions	Rainfall (mm)
21.2.86	----------	ROADS CLOSED	----------			
22.2.86	<0.0002	<0.0002	0.0004	5.1	NNW	
23.2.86	"	0.0002	0.0003	2.6	NNW	
24.2.86	"	0.0003		1.0	E/ESE	
25.2.86	"	0.0004		10.3	S/ESE/NE	Min
26.2.86	"	0.0004	0.0003	7.7	SE/E	7
27.2.86	"	0.0005		10.3	SE/N/E	
28.2.86	"	0.0005		2.1	SE/ESE	
1.3.86	"	0.0002	0.0003	5.1	N/E	
2.3.86	"	0.0005		7.7	SSE/SE/N	3
3.3.86	"	0.0003		7.7	N	
4.3.86	"	0.0002	0.0003	4.1	SSE/S/E/N	
5.3.86	"	0.0003		4.1	N/NNE/N	Min
6.3.86	"	0.0009		5.1	NE/E/N	Min
7.3.86	"	0.0005	Heavy Dust	7.7	E/NNE/N	Min
8.2.86	--------	POWER OUT UNABLE TO RECHARGE BATTERIES	---------			
9.3.86	<0.0002	0.0006		7.7	ESE/N/NNW	
10.3.86	"	0.0004	0.0003	7.7	SSE/WNW/NE	
11.3.86	"	0.0003		7.7	SSE/S	1
12.3.86	"	0.0003		9.2	SE/N E/N	Min
13.3.86	0.0002	0.0004	0.0003	7.7	SSE/SE/E	2
14.3.86	----------	PUMP FAULT - NO RESULT	----------			
15.3.86	<0.0002	<0.0002	0.0003	5.1	SSE/ESE/N	8
16.3.86	"	<0.0002		5.1	SE/SSE/E/NE	
17.3.86	"	<0.0002	<0.0002	5.1	S/SE/ESE	
18.3.86	"	0.0005		1.0	S/E	
19.3.86	"	0.0003		1.0	W/NW	
20.3.86	"	0.0006	0.0004	5.1	WNW/NW	
21.3.86	"	0.0003		2.6	SSE/NNW	1
22.3.86	"	0.0003		2.6	SE/ESE/ENE	
23.3.86	"	0.0004	<0.0002	10.2	E	
24.3.86	"	0.0008		7.7	ESE/E	
25.3.86	"	0.0008		2.6	E	
26.3.86	"	0.0003	0.0002	7.7	ESE/E/NNW	Min
27.3.86	"	0.0006		2.6	NW	
28.3.86	"	0.0007		7.7	WNW/W/WSW	
29.3.86	----------	PUMP FAULT - NO RESULT	----------			
30.0.86	----------	PUMP FAULT - NO RESULT	----------			

Table 7b. 43 km Monitor Fibre Results and Meteorological Data

Date	DCE A Fibres/ml	DCE B Fibres/ml	Pilbara Labs Fibres/ml	Max Wind Speed (m/m)	Wind Directions	Rainfall (mm)
5.1.86	---------- BATTERY FAILURE - NO RESULT ----------					
6.1.86			"			
7.1.86			"			
8.1.86	<0.0002	0.0012	0.0007	6.2	ESE/E/NE/SW	Min
9.1.86	"	0.0004		3.1	S/SE/SW	
10.1.86	"	0.0008		2.1	S/SW	
11.1.86	"	0.0007	0.0006	5.1	E/WSW	
12.1.86	"	0.0007		3.1	W	
13.1.86	"	0.0004		3.1	S/NW	
14.1.86	"	0.0004	0.0004	2.6	NE/NW	
15.1.86	"	0.0008		7.7	NW/WNW	11
16.1.86	"	0.0013		5.1	E/SE	13
17.1.86	"	0.0009	0.0007	4.6	ESE/E	
18.1.86	"	0.0006		1.0	NE	
19.1.86	"	0.0006		8.2	SSE/SE/E	Min
20.1.86	"	0.0006	0.0004	4.1	SE	
21.1.86	"	0.0012		12.9	E/ESE	
22.1.86	"	0.0004	0.0004	14.4	E	
23.1.86	"	0.0004		5.1	E/SSE/SE	
24.1.86	0.0002	0.0011		2.1	E/S	
25.1.86	---------- FILTER RIPPED - NO RESULT ----------					
26.1.86	<0.0002	0.0004	0.0002	6.2	E/ESE	
27.1.86	"	0.0004		2.6	E	
28.1.86	0.0002	0.0003		2.6	E/NE/ENE/N	12
29.1.86	<0.0002	0.0006		2.6	W/W/NNE	
30.1.86	---------- FILTER RIPPED - NO RESULT ----------					
31.1.86	<0.0002	0.0004	0.0006	5.1	S/SSE/NNE/SW	2
1.2.86	0.0002	0.0007		5.1	SE/SSE	2
2.2.86	<0.0002	0.0004	0.0005	6.2	SSE/NE/ESE/S	Min
1.2.86	---------- CLEAN FILTER? - NO RESULT ----------					
4.2.86	<0.0002	0.0002		3.1	E/SW	
5.2.86	"	0.0002	0.0004	4.1	ESE/E	
6.2.86	0.0002	0.0008		2.6	N/NW	
7.2.86	0.0002	0.0004		2.6	S/WSW	
8.2.86	0.0002	0.0003	0.0004	4.1	SSE/E/NE/NW	
9.2.86	---------- PUMP OUT - NO RESULT ----------					
10.2.86	---------- PUMP OUT - NO RESULT ----------					
11.2.86	---------- PUMP OUT - NO RESULT ----------					
12.2.86	<0.0002	0.0006	0.0008	1.0	NW	
13.2.86	<0.0002	0.0008		4.1	SSW/WSW/W	
14.2.86	<0.0002	0.0009		3.1	WNW	
15.2.86	<0.0002	0.0010	0.0006	5.1	ENE/NW	
16.2.86	"	0.0004		9.3	E/NNE/N	
17.2.86	"	0.0004	0.0002	7.7	SE/ESE/E	
18.2.86	0.0002	0.0002	0.0002	5.1	E/ENE	4
19.2.86	---------- ROADS CLOSED ----------					
20.2.86	---------- ROADS CLOSED ----------					

Table 7b. 43 km Monitor Fibre Results and Meteorological Data (contd)

Date	DCE A Fibres/ml	DCE B Fibres/ml	Pilbara Labs Fibres/ml	Max Wind Speed (m/s)	Wind Directions	Rainfall (mm)
21.2.86	----------	ROADS CLOSED	----------			
22.2.86	<0.0002	<0.0002	0.0003	5.1	NNW	
23.2.86	<0.0002	0.0003	0.0003	2.6	NNW	
24.2.86	"	0.0008		1.0	E/ESE	
25.2.86	"	0.0004		10.3	S/ESE/NE	Min
26.2.86	"	0.0011	0.0006	7.7	SE/E	7
27.2.86	"	0.0004		10.3	SE/N/E	
28.2.86	"	0.0011		2.1	SE/ESE	
1.3.86	"	0.0008	0.0006	5.1	N/E	
2.3.86	"	0.0007		7.7	SSE/SE/N	3
3.3.86	"	0.0003		7.7	N	
4.3.86	0.0002	0.0011	0.0002	4.1	SSE/S/N	
5.3.86	<0.0002	0.0002		4.1	N/NNE/N	Min
6.3.86	<0.0002	0.0002		5.1	NE/E/N	Min
7.3.86	<0.0002	0.0009	Heavy Dust Load	7.7	E/NNE/N	Min
8.3.86	-------	ELECTRICAL FAILURE - BATTERY NOT CHARGED	--------			
9.3.86	"	0.0009		7.7	ESE/N/NNW	
10.3.86	"	0.0005	0.0006	7.7	SSE/WNW/NE	
11.3.86	"	0.0002		7.7	SSE/S	
12.3.86	"	0.0004		9.2	SE/NNE/N	Min
13.3.86	----------	FAULTY PUMP CONNECTION - NO RESULT	----------			
14.3.86	<0.0002	0.0002	0.0003	6.2	SSE/ESE/SE	Min
15.3.86	"	"		5.1	SSE/ESE/N	8
16.3.86	"	"		5.1	SE/SSE/E/NE	
17.3.86	"	0.0003	0.0003	5.1	S/SE/ESE	
18.3.86	"	0.0002		1.0	S/E	
19.3.86	"	0.0004		1.0	W/NW	
20.3.86	"	0.0004	0.0004	5.1	WNW/NW	
21.3.86	"	0.0003		2.6	SSE/NNW	1
22.3.86	----------	PUMP FAULT - NO RESULT	----------			
23.3.86	----------	PUMP FAULT - NO RESULT	----------			
24.3.86	0.0002	0.0010	0.0010	7.7	ESE/E	
25.3.86	<0.0002	0.0007		2.6	E	
26.3.86	<0.0002	0.0007	0.0007	7.7	ESE/E/NNW	Min
27.3.86	--------	CASSETTE CONNECTION LOOSE - NO RESULT	----------			
28.3.86	<0.0002	0.0003		7.7	WNW/W/WSW	
29.3.86	"	0.0002		2.6	E/WSW	
30.3.86	"	0.0003		7.7	E	

Table 8. Statistics For All Sites

SITE		MEAN FIBRE CONCENTRATION (FIBRES/ml)	MIN VALUE	MAX VALUE	STANDARD DEVIATION
SCHOOL	(A)	<0.0002	<0.0002	0.0007	0.0002
	(B)	0.0007	<0.0002	0.0023	0.0004
ELLIS	(A)	0.0007	<0.0002	0.0028	0.0005
	(B)	0.0012	<0.0002	0.0035	0.0006
AIRPORT	(A)	0.0020	<0.0002	0.1050	0.0115
	(B)	0.0025	<0.0002	0.1060	0.0115
GORGE	(A)	0.0003	<0.0002	0.0013	0.0003
	(B)	0.0008	<0.0002	0.0023	0.0005
POLICE	(A)	0.0002	<0.0002	0.0017	0.0003
	(B)	0.0008	<0.0002	0.0038	0.0005
HOSPITAL	(A)	0.0002	<0.0002	0.0011	0.0003
	(B)	0.0008	<0.0002	0.0022	0.0004
9 Km SITE	(A)	<0.0002	<0.0002	0.0002	0.0005
	(B)	0.0005	<0.0002	0.0017	0.0003
43 Km SITE	(A)	<0.0002	<0.0002	<0.0002	0.0002
	(B)	0.0006	<0.0002	0.0013	0.0003

A = PROBABLE ASBESTOS FIBRES

B = PROBABLE AND POSSIBLE ASBESTOS FIBRES

Table 9. Mean Wind Speeds from DCE Anemometer 6/2/86 - 10/3/86

DATE	MEAN WIND SPEED m/s	DATE	MEAN WIND SPEED m/s
6/2	2.1	23/2	1.0
7/2	1.8	24/2	2.0
8/2	1.6	25/2	3.6 *
9/2	2.2	26/2	3.8 *
11/2	2.9	28/2	2.7
12/2	0.9	1/3	2.4
13/2	0.8	2/3	3.1 *
14/2	0.7	3/3	-
15/2	1.1	4/3	2.8
16/2	1.0	5/3	1.8
17/2	4.7 *	6/3	1.6
18/2	4.4 *	7/3	3.2 *
19/2	3.4 *	8/3	2.7
20/2	1.9	9/3	2.3
21/2	1.2	10/3	3.4 *
22/2	0.9		

* Exceeds Assumed Pick Up Speed of 3 m/s. ie GBC assumed minimum wind speed at which crocidolite fibres are disturbed sufficiently to enter the surrounding atmosphere

Table 10. Mean Results Showing Variation in DCE and GBC Results

	DCE Fibres/ml POSSIBLES & PROBABLES	GBC * POSSIBLES & PROBABLES
AIRPORT	0.0025	0.0007 (Site 9)
ELLIS	0.0012	0.0004 (Site 4)
POLICE	0.0008	0.0004 (Site 17)
HOSPITAL	0.0008	0.0002 (Site 16)
GORGE	0.0003	0.0004 (Site 12)
SCHOOL	0.0002	0.0003 (Site 19)

* Results from nearest GBC monitor

High wind speed did not appear to cause higher concentrations of fibres in the atmosphere. There were no significant differences in the fibre counts when the wind speed was above the GBC suggested pick up velocity of 3-4 m/s for crocidolite fibres.

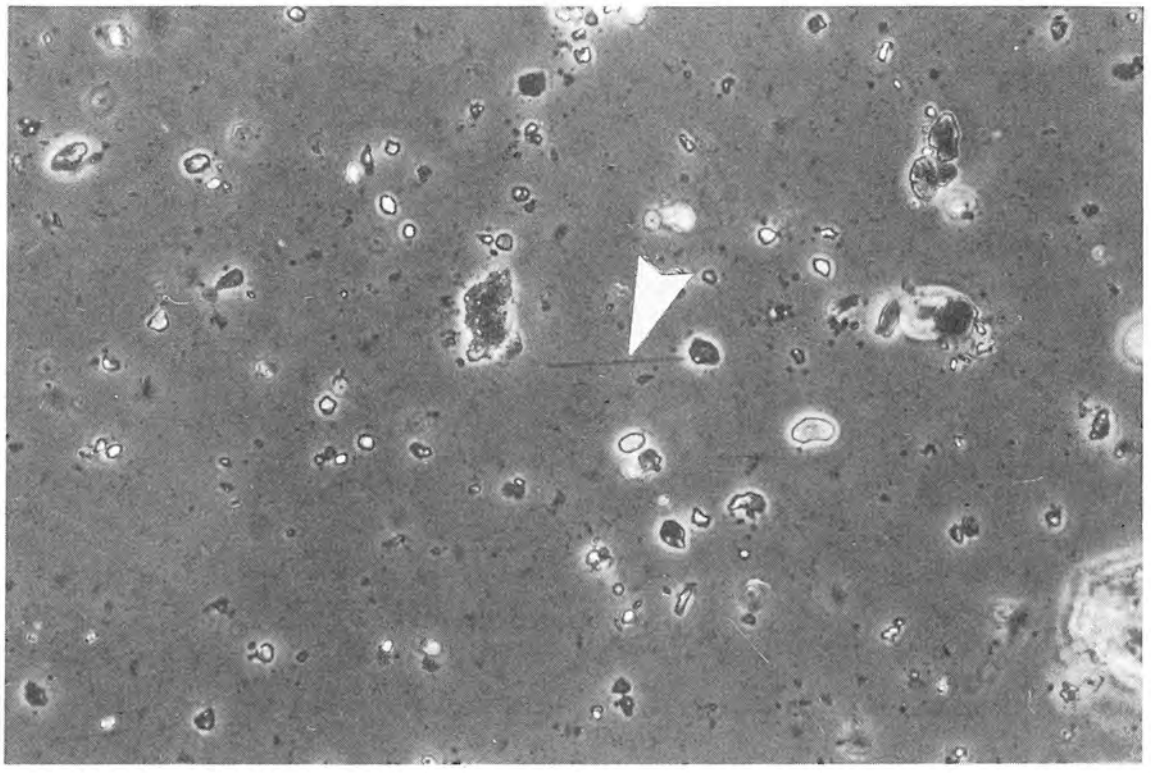
4.9 SCANNING ELECTRON MICROSCOPY

Identification of thinner fibres not visible by optical microscopy was not possible by this method. This was due to the fact that the membrane filters used were of a relatively high pore size (0.8 μm), and many fibres were obscured by filter material when viewed at high magnification. The SEM analysis, however, did support the theory that many fibres conforming to the NHMRC definition of fibre were not in fact crocidolite, but in the majority of cases were silica material. Those fibres deemed to be probable fibres, however, were crocidolite in the majority of cases, showing definite spectrum peaks of Mg, Fe and Si on analysis (Photographs 11, 12 and 13).

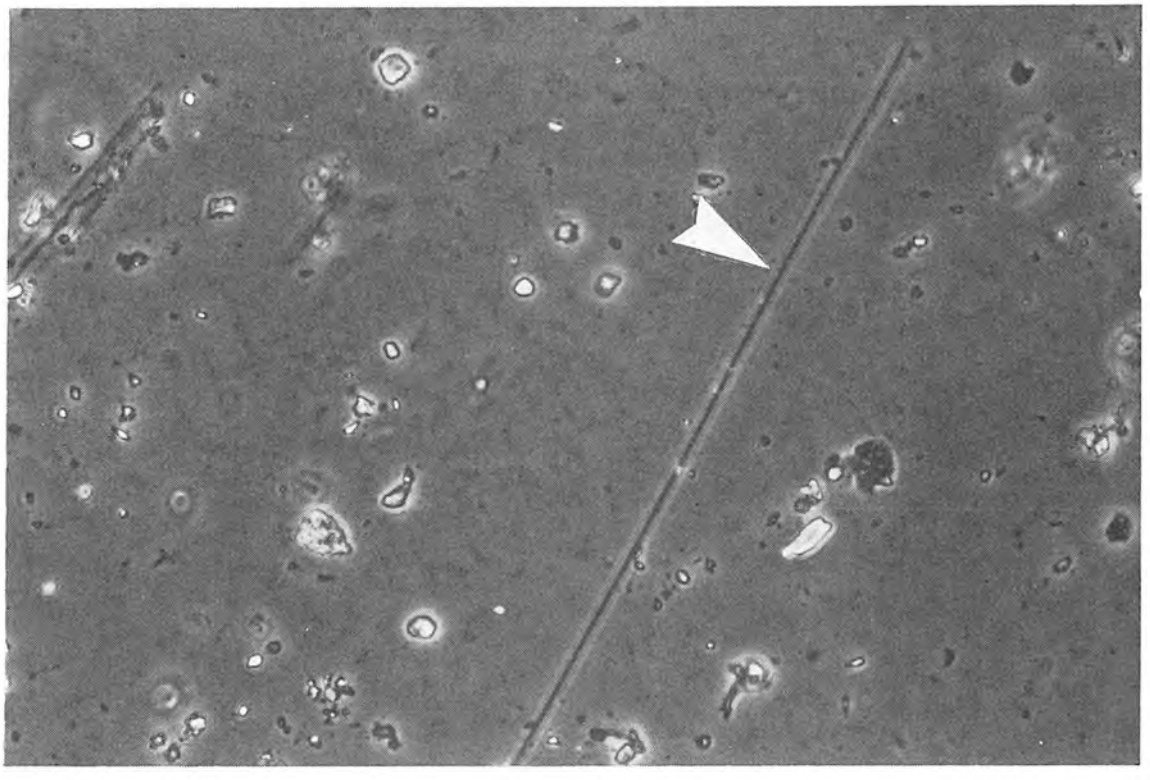
It should also be stated that it is possible that many fibres are lost through the pores of the filter, particularly those making contact with the filter in a vertical alignment.

4.10 COMPARISON OF RESULTS WITH PILBARA LABORATORIES

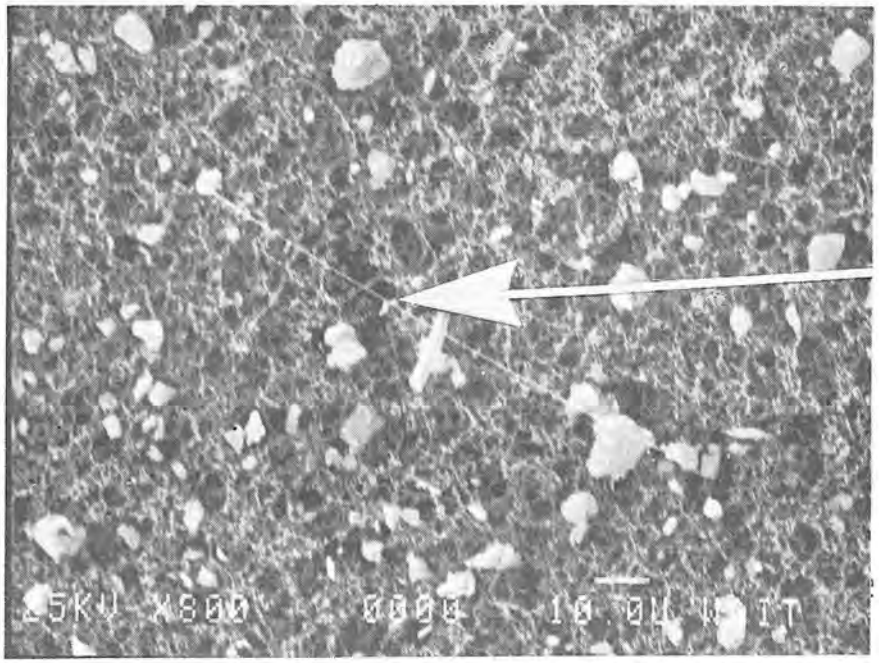
Excellent correlation of results was achieved when filters were analysed by Pilbara Laboratories; therefore, the results indicate an excellent uniform distribution over the whole filter paper area. It is necessary to be totally familiar with the NHMRC method to understand the error which can be introduced into this method. It is therefore reassuring to see such good correlation of results.



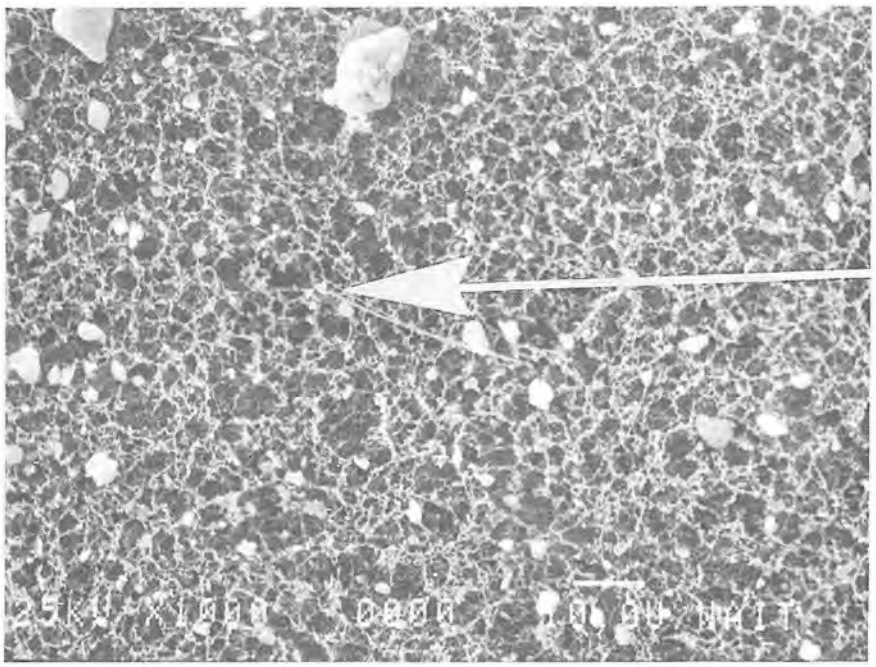
Photograph 9. Crocidolite Fibre, Gorge 17/1/86
(Optical Microscopy) x 600 Magnification



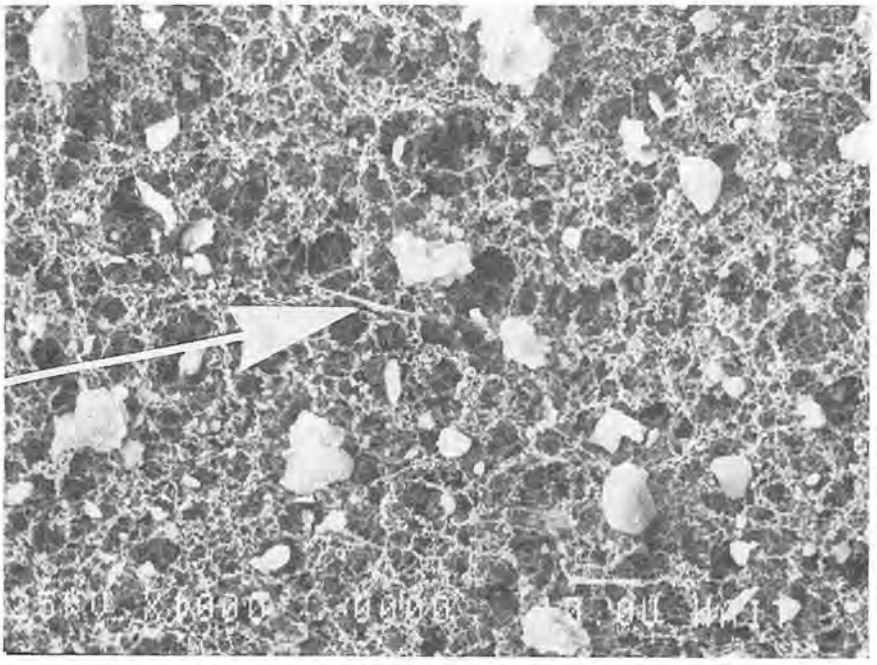
Photograph 10. Large Crocidolite Fibre Showing Thinner Fibril Ready to Break Away from Main Fibre
(Optical Microscope x 600 Magnification)



Photograph 11. Crocidolite Fibres
(Scanning Electron Microscope) x 800 Magnification



Photograph 12. Crocidolite Fibre and Fibril (*)
(Scanning Electron Microscope) x 1000 Magnification



Photograph 13. Crocidolite Fibre
(Scanning Electron Microscope) x 1000 Magnification

5. CONCLUSIONS

The results show an increase in total fibres when compared to the previous GBC report. If a comparison of the two studies is to be made, it should be understood that figures quoted for total fibre forms ie probable and possible, were used for concentration determinations in the GBC report (Figure 2).

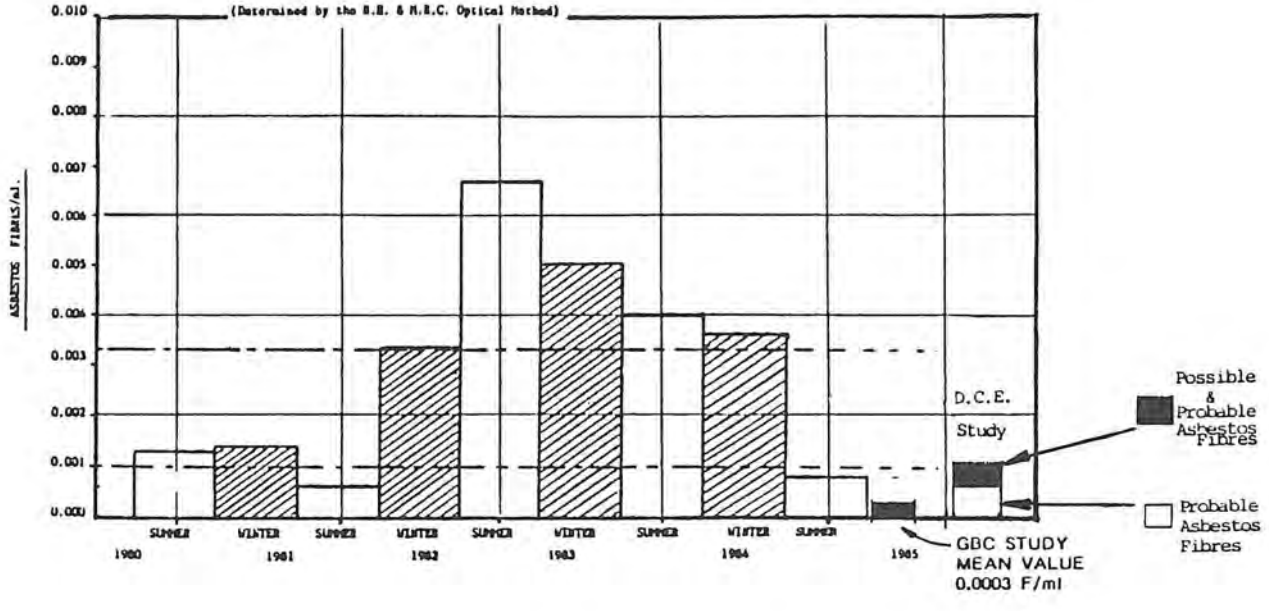


Figure 2. Seasonal Trends - Wittenoom Asbestos Fibre Monitoring Results

It can be assumed from results obtained by Scanning Electron Microscopy that a large percentage of "possible" fibre forms are not crocidolite. However, it can also be assumed that a high percentage of fibre forms listed as "probable fibres" are crocidolite; these being fibres which based on fibre counting experience and SEM analysis appear to be crocidolite.

It is clear from the study that wind direction or wind speed does not have a significant effect on atmospheric fibre levels, therefore, casting some doubt as to the accuracy of the 3-4 m/s pick up velocity for fibres quoted in the GBC report. The absence of correlation between high fibre levels and wind direction would also indicate that contamination in the townsite is widespread and that contamination does not only originate from the minesite area. It can be seen from the meteorological data obtained during the study that wind directions during the study varied significantly and were not predominantly in a SE direction as quoted in the GBC report: the predominant winds being from the SW (in early mornings therefore not shown in the meteorological data) and Northerly directions. The SW winds from the minesite and tailings dump areas are directed towards the townsite. The level of airborne contamination from the minesite and dumps would not appear to be significant in the townsite area, although it must contribute to a certain extent. It has become obvious from the results of the study, and from previous work undertaken by the Pollution Control Division that rainfall does not have a significant stabilising effect on crocidolite fibres. The ability of crocidolite to rapidly lose moisture to the surrounding atmosphere has been demonstrated in the past, and it would require constant rainfall to reduce atmosphere contamination to an acceptable level.

The tailings in the townsite area are widespread and it is therefore not possible to state that they have been sufficiently consolidated to reduce atmospheric crocidolite to a minimum. Large areas of land, particularly surrounding the airport and caravan park, are heavily contaminated with loose clumps of fibres and are constantly adding fibrils of crocidolite to the surrounding environment.

Although the results quoted (probable fibres) are below the figure of 0.001 fibres/ml, which is quoted in the GBC report as the possible environmentally "safe" level equalling one hundredth of the Threshold Limit Value (TLV) for occupational exposure, the practice of using TLVs as a basis for setting safe exposure levels is not one which is fail safe. TLVs are to be used as a guide only and not as a strict level of safety. In many cases where carcinogenity is suspected, the TLV has been cancelled and a warning isued that nil exposure is the only level acceptable. It is always good practice to reduce exposure to carcinogens to the absolute minimum level able to be achieved. There is no doubt that the level of "probable" fibres determined in the townsite exceeds minimum levels. When a comparison is made between the 9 and 43 km sites and the townsite results, this becomes even more evident. Crocidolite fibres were observed in all samples taken at the townsite; this was not the case with the 43 km and 9 km sites, although fibres were observed on occasions at these sites.

There is sufficient doubt regarding the health risks associated with crocidolite fibre exposure to regard the current levels as unacceptable. The levels of atmospheric crocidolite fibre contamination are unique to Wittenoom, and this level of contamination would not be found in other populated areas of Western Australia.

6. REFERENCES

GERALDTON BUILDING COMPANY. (1985) Wittenoom Environmental Engineering Study. Geraldton Building Company, July 1985.

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