

Department of Resources, Energy and Tourism (DRET)

PROPOSED COMMONWEALTH
RADIOACTIVE WASTE MANAGEMENT
FACILITY, NORTHERN TERRITORY

**Meteorological
Analysis Report**

Proposed Commonwealth Radioactive Waste Management Facility, Northern Territory

METEOROLOGICAL ANALYSIS REPORT

13 March 2009

**Department of Resources,
Energy and Tourism (DRET)**



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Contents

	Page number
Executive summary	v
M1. Introduction	1
M2. Data sources	3
M2.1 General	3
M2.2 Mount Everard	4
M2.3 Harts Range	5
M2.4 Fishers Ridge	6
M2.5 Muckaty Station	7
M3. Mount Everard	9
M3.1 Rainfall	9
M3.2 Temperature	11
M3.3 Wind	13
M3.4 Relative humidity	15
M3.5 Extreme weather	15
M3.5.1 Floods	15
M3.5.2 Bushfires	17
M3.5.3 Drought	17
M3.6 Air quality	17
M3.7 Lightning	17
M4. Harts Range	19
M4.1 Rainfall	19
M4.2 Temperature	22
M4.3 Wind	22

Contents (Continued)

	Page number
M4.4 Relative humidity	25
M4.5 Extreme weather	25
M4.5.1 Floods	25
M4.5.2 Bushfires	26
M4.5.3 Drought	26
M4.6 Air quality	27
M4.7 Lightning	27
M5. Fishers Ridge	29
M5.1 Rainfall	29
M5.2 Temperature	31
M5.3 Wind	33
M5.4 Relative humidity	33
M5.5 Extreme weather	36
M5.5.1 Tropical cyclones	36
M5.5.2 Floods	36
M5.5.3 Bushfires	36
M5.6 Air quality	37
M5.7 Lightning	37
M6. Muckaty Station	39
M6.1 Rainfall	39
M6.2 Temperature	42
M6.3 Wind	42
M6.4 Relative humidity	45
M6.5 Extreme weather	46
M6.5.1 Floods	46
M6.5.2 Bushfires	46
M6.5.3 Tropical cyclones	46
M6.6 Air quality	46
M6.7 Lightning	46
M7. Discussion	47
M7.1 Rainfall	47
M7.2 Temperature	47
M7.3 Humidity	48

Contents (Continued)

	Page number
M7.4 Wind	48
M7.5 Extreme events	48
M7.5.1 Bushfires	48
M7.5.2 Tropical cyclones	48
M7.5.3 Lightning	49
M8. References	51
M9. Statement of limitations	53

List of tables

	Page number
Table M2.1 Mount Everard – summary weather station details	4
Table M2.2 Harts Range – summary weather station details	5
Table M2.3 Fishers Ridge – summary weather station details	6
Table M2.4 Muckaty Station – summary weather station details	7
Table M3.1 Mount Everard rainfall ARI values (in mm)	11
Table M4.1 Harts Range rainfall ARI values (mm)	21
Table M5.1 Fishers Ridge rainfall ARI values in (mm)	31
Table M6.1 Muckaty Station rainfall ARI values (in mm)	42
Table M7.1 Selected extreme ARI 1000 rainfall events	47

List of figures

	Page number	
Figure M1.1	Location plan of proposed repository sites	follows Page 2
Figure M2.1	Mount Everard – location of BOM stations	follows Page 4
Figure M2.2	Harts Range – location of BOM stations	follows Page 6
Figure M2.3	Fishers Ridge – location of BOM stations	follows Page 6
Figure M2.4	Muckaty Station – location of BOM stations	follows Page 8
Figure M3.2	Mount Everard highest monthly rainfall	10
Figure M3.3	Alice Springs Airport daily temperature data	12
Figure M3.4	Alice Springs Post Office daily temperature data	12
Figure M3.5	Territory Grape Farm wind speed data	13
Figure M3.6	Alice Springs Airport wind speed data	14
Figure M3.7	Alice Springs Post Office wind speed data	14
Figure M3.8	Alice Springs Airport highest recorded wind gust	15
Figure M3.9	Alice Springs Airport relative humidity data	16
Figure M3.10	Alice Springs Post Office relative humidity data	16
Figure M3.11	Lightning ground flash intensity	18
Figure M4.1	Harts Range average rainfall data for rainfall weather stations	20
Figure M4.2	Harts Range average rainfall data	20
Figure M4.3	Harts Range highest monthly rainfall data	21
Figure M4.4	Territory Grape Farm daily temperature data	22
Figure M4.5	Ringwood daily temperature data	23
Figure M4.6	Territory Grape Farm wind speed data	23
Figure M4.7	Ringwood wind speed data	24
Figure M4.8	Territory Grape Farm highest recorded wind gust	24
Figure M4.9	Territory Grape Farm relative humidity data	25
Figure M4.10	Ringwood relative humidity data	26
Figure M5.1	Fishers Ridge mean monthly rainfall	30
Figure M5.2	Fishers Ridge highest monthly rainfall	30
Figure M5.3	Katherine Council daily temperature data	32
Figure M5.4	Tindal RAAF daily temperature data	32
Figure M5.5	Tindal RAAF wind speed data	33
Figure M5.6	Katherine Council wind speed data	34
Figure M5.7	Tindal RAAF highest recorded wind gusts	34
Figure M5.8	Tindal RAAF relative humidity data	35
Figure M5.9	Katherine Council relative humidity data	35
Figure M6.1	Muckaty Station weather station monthly rainfall data	39
Figure M6.2	Helen Springs weather station monthly rainfall data	40
Figure M6.3	Banka Banka weather station monthly rainfall data	40
Figure M6.4	Tennant Creek Post Office weather station monthly rainfall data	41
Figure M6.5	Tennant Creek Airport weather station monthly rainfall data	41
Figure M6.6	Tennant Creek Post Office daily temperature data	43
Figure M6.7	Tennant Creek Airport daily temperature data	43
Figure M6.8	Tennant Creek Post Office monthly wind speed data	44
Figure M6.9	Tennant Creek Airport monthly wind data	44
Figure M6.10	Tennant Creek Post Office mean daily relative humidity data	45
Figure M6.11	Tennant Creek Airport mean daily relative humidity data	45

Executive summary

Parsons Brinckerhoff Australia Pty Ltd (PB) has been commissioned by the Department of Resources, Energy and Tourism (DRET) to undertake preliminary multi-disciplinary site assessments at four locations in the Northern Territory with regard to their suitability for use as a low to medium level radioactive waste management facility. The facility is to be known as the Commonwealth Radioactive Waste Management Facility (CRWF).

Three Commonwealth owned and Defence-managed sites were selected for the studies which formed part of a larger assessment process involving the collection, collating and provision of site suitability assessments. The studies will provide a basis from which the Commonwealth Government can consider the future project requirements. The three initial sites are listed below:

- Mount Everard – Approximately 25 km north-west of Alice Springs
- Harts Range – Approximately 100 km north-east of Alice Springs
- Fishers Ridge – Approximately 40 km south-east of Katherine.

During the investigations of these three sites, an additional fourth ‘volunteer’ site – Muckaty Station (located approximately 110 km north of Tennant Creek) was nominated by the Traditional Owners (the Ngapa Clan) and added to the scope of the investigations.

Rainfall

Based on average monthly rainfall records at each of the four sites, Fishers Ridge is the wettest site and Harts Range is marginally wetter than Muckaty Station and Mount Everard. These observations are the same when considering highest recorded rainfall with Fishers Ridge recording 704.6 mm, Harts Range recording 550–716 mm, Muckaty Station around 450 mm and Mount Everard recording around 350 mm.

Temperature

In terms of temperature there is little to differentiate the Mount Everard and Harts Range sites. Fishers Ridge has similar maximum temperatures to the southern two sites, however temperatures do not get as low. The extreme temperature range at Harts Range and Mount Everard is the greatest at -5.6°C to 45.8°C and -7°C to 45°C respectively. The extreme range at Fishers Ridge is from 3°C to 46°C and Muckaty Station temperatures range from 2.4°C to 46.1°C . The daily mean temperature ranges are very similar at all three sites. Fishers Ridge daily means range from 13°C to 38°C , Harts Range from 5°C to 38°C , Mount Everard from 4°C to 36°C and Muckaty Station from 12°C to 37°C .

Humidity

As with temperature, there is minimal difference in relative humidity between the southern sites (Harts Range and Mount Everard) and Muckaty Station. They are most humid during their wet season (winter) and the relative humidity ranges from approximately 30–60% at 9 am and from approximately 20–30% at 3 pm. Fishers Ridge has higher humidity with a range from approximately 50–80% at 9 am and from approximately 20–60% at 3 pm. The most humid time at Fishers Ridge is in summer (the wet season).

Wind

Average wind speeds are considered neutral at each site as the facility will need to be designed to appropriate building codes for the region, this will include consideration of average wind effects. However, highest recorded wind gusts at each site are not considered neutral. Fishers Ridge and Harts Range have very similar highest recorded monthly wind gusts ranging from 45 km/hr (July) to 90 km/hr (December) and 50 km/hr (March and June) to 85 km/hr (January, July, November and December) respectively. Wind gusts at Mount Everard are significantly higher ranging from 80 km/hr (April) to 170 km/hr (November). At Muckaty Station the wind gusts speed varies from around 80 km/hr in May to September to 100–120 km/hr in the summer months. In considering the aspect of wind gusts, Mount Everard is the most impacted, Muckaty Station is moderately impacted while Fishers Ridge and Harts Range are both equally less impacted.

Bushfires

At both Mount Everard and Harts Range the annual risk of bushfires is low due to sparse vegetation coverage. However, bushfires do occur in these regions, especially after a high rainfall period followed by a dry period. This risk is minimised at Mount Everard by controlled burn offs when high fuel loads occur (after high rainfall). Muckaty Station has a higher risk of bushfires due to the higher vegetation coverage of the site accompanied by the local practice of lighting fires to control vegetation for grazing. There is a much higher risk of bushfire at Fishers Ridge especially from winter to spring (dry season).

Tropical cyclones

Fishers Ridge is the only site that could be affected directly by a tropical cyclone. Fishers Ridge has in the past experienced high winds and extreme rainfall as a result of a dissipating tropical cyclone. Harts Range, Mount Everard and Muckaty Station are too far south for direct effects, although they could be indirectly affected by the weather system created by a former tropical cyclone.

Lightning

Lightning is much more common at Fishers Ridge during the summer months than at any time at Harts Range, Mount Everard or Muckaty Station. This is a result of Fishers Ridge having a tropical climate and being subject to tropical storms throughout the summer (wet) season.

M1. Introduction

Parsons Brinckerhoff Australia Pty Ltd (PB) has been commissioned by the Department of Resources, Energy and Tourism (DRET) to undertake preliminary multi-disciplinary site assessments at four locations in the Northern Territory with regard to their suitability for use as a low to medium level radioactive waste management facility. The facility is to be known as the Commonwealth Radioactive Waste Management Facility (CRWF).

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- Harts Range – Approximately 100 km north-east of Alice Springs
- Fishers Ridge – Approximately 40 km south-east of Katherine.

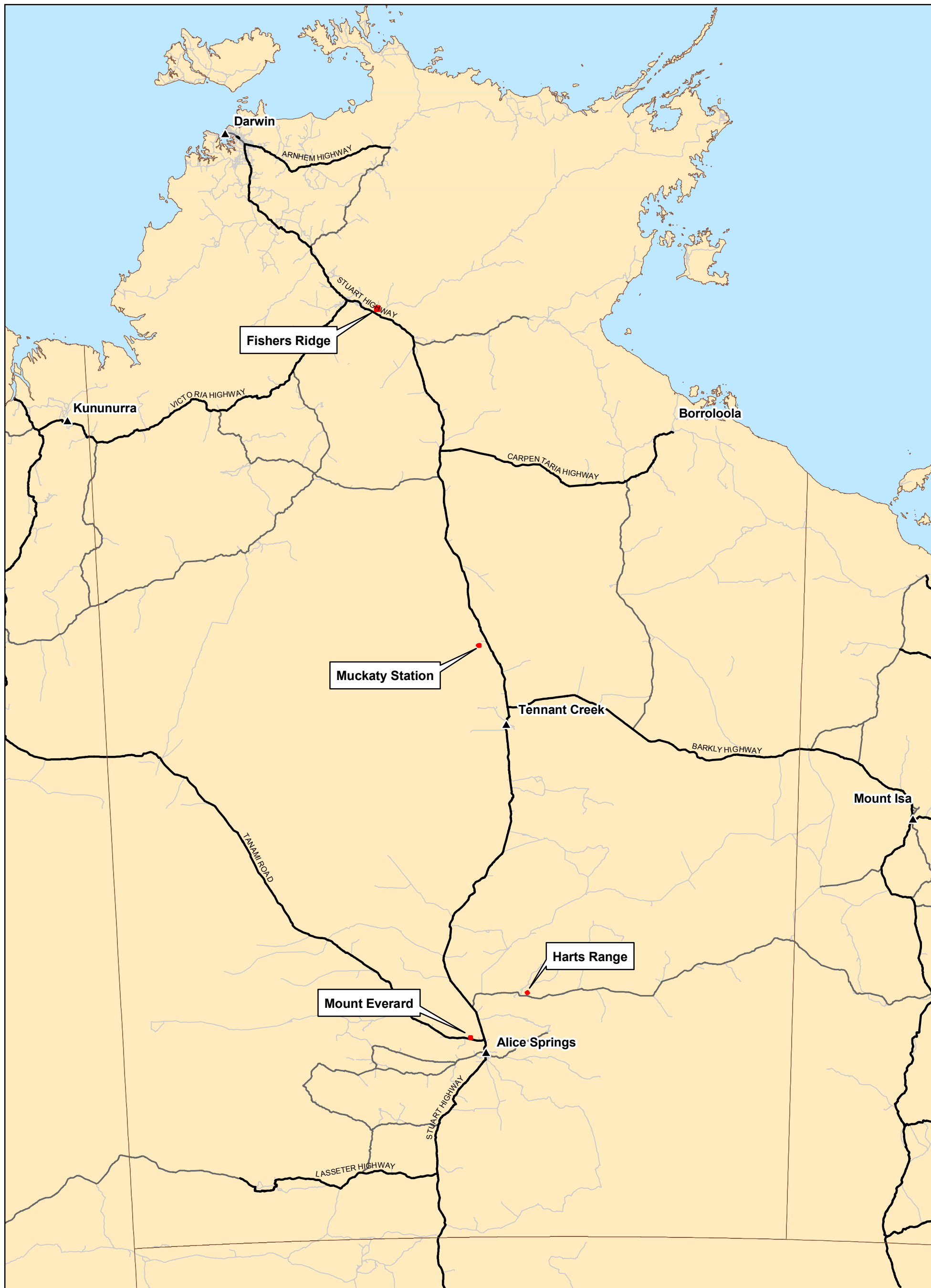
During the investigations of these three sites, an additional fourth ‘volunteer’ site – Muckaty Station (located approximately 110 km north of Tennant Creek) was nominated by the Traditional Owners (the Ngapa Clan) and added to the scope of the investigations.



The four proposed sites are shown in Figure M1.1.

The purpose of this report is to document the meteorological characteristics of the four sites from literature and existing information. No site specific data was collected. This factual report presents a summary of the meteorology of the sites it does not include in-depth analysis of the data nor attempt to rank the sites with respect to their meteorological suitability for a CRWF.

This meteorological report should be read in conjunction with the hydrology report (Parsons Brinckerhoff 2008), which includes a more detailed consideration of flooding associated with high rainfall events.





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			Revision: A Date: 22/07/2008	Drawn By: BHB Checked by: JAG	Client Ref: RADWASTE

M2. Data sources

M2.1 General

All data used in this report was obtained from the Bureau of Meteorology (BOM) Australia. There are two main types of weather station data available from the BOM:

1. Weather station data available online. The data from the online weather stations includes daily temperature data, daily rainfall data and relative humidity data.
2. Weather Station data for purchase from the BOM. These weather stations have not been made freely available online as they either have too short a record (the time period of recording data has not been long enough to produce average results) or they do not measure enough elements (e.g. they may only measure wind speed or rainfall).

All weather stations record daily data and in this report the data has been averaged to give mean records for each month of the year.

M2.2 Mount Everard

Three different weather stations were used to collate climate data for the Mount Everard site. These were:

1. Jindalee weather station
2. Alice Springs Airport weather station
3. Alice Springs Post Office weather station

A summary of these weather stations, their location and the data collected by each is provided in Figure M2.1 and in Table M2.1 below.

Table M2.1 Mount Everard – summary weather station details

Weather Station and BOM Code	Latitude (° S)	Longitude (° E)	Elevation (m above sea level)	Distance from site (km)	Data recording started	Data recording ceased	Data Collected
Jindalee (15671)	23.5232	133.6792	712	On site	2002 (August)	Still recording	Rainfall
Alice Springs Airport (15590)	23.7651	133.8890	546	35 (south-east)	1940	Still recording	Temperature Rainfall Wind speed Wind gust Cloud cover Hours of sunshine Evaporation Dew point Relative humidity
Alice Springs Post Office (15540)	23.7100	133.8683	580	26 (south east)	1873	1987	Temperature Rainfall Wind speed Cloud cover Dew point Relative humidity

M2.3 Harts Range

Seven different weather stations were used to collate climate data for the Harts Range site. These were:

1. Mt Riddock weather station
2. Alcoota weather station
3. Gemtree Park weather station
4. Territory Grape Farm weather station
5. Alice Springs Post Office weather station
6. Ringwood weather station
7. Arltunga.

A summary of these weather stations, their location and the data collected by each is provided in Figure M2.2 and in Table M2.2 below.

Table M2.2 Harts Range – summary weather station details

Weather Station and BOM Code	Latitude (° S)	Longitude (° E)	Elevation (m above sea level)	Distance from site (km)	Data recording started	Data recording ceased	Data Collected
Mt Riddock (15503)	23.0364	134.6801	606	24 (south-east)	1966	Still recording	Rainfall
Alcoota (15593)	22.8211	134.4508	595.5	14 (north)	1950	Still recording	Rainfall
Gemtree Park	22.9689	134.2415	635	19 (west)	1990	Still recording	Rainfall
Territory Grape Farm (15643)	22.4518	133.6377	566	98 (north-west)	1987	Still recording	Temperature Dew Point Relative humidity Wind speed and gust Rainfall Cloud cover Evaporation
Alice Springs Post Office (15540)	23.7100	133.8683	580	98 (south west)	1873	1989	Temperature Dew Point Relative humidity Wind speed Rainfall Cloud cover
Ringwood (15546)	23.8289	134.9555	416	106 (south-east)	1964	Still recording	Temperature Dew Point Relative humidity Wind speed Rainfall Cloud cover
Arltunga (15594)	23.4635	134.6865	663	60 (south-east)	1988	Still recording	Wind speed

M2.4 Fishers Ridge

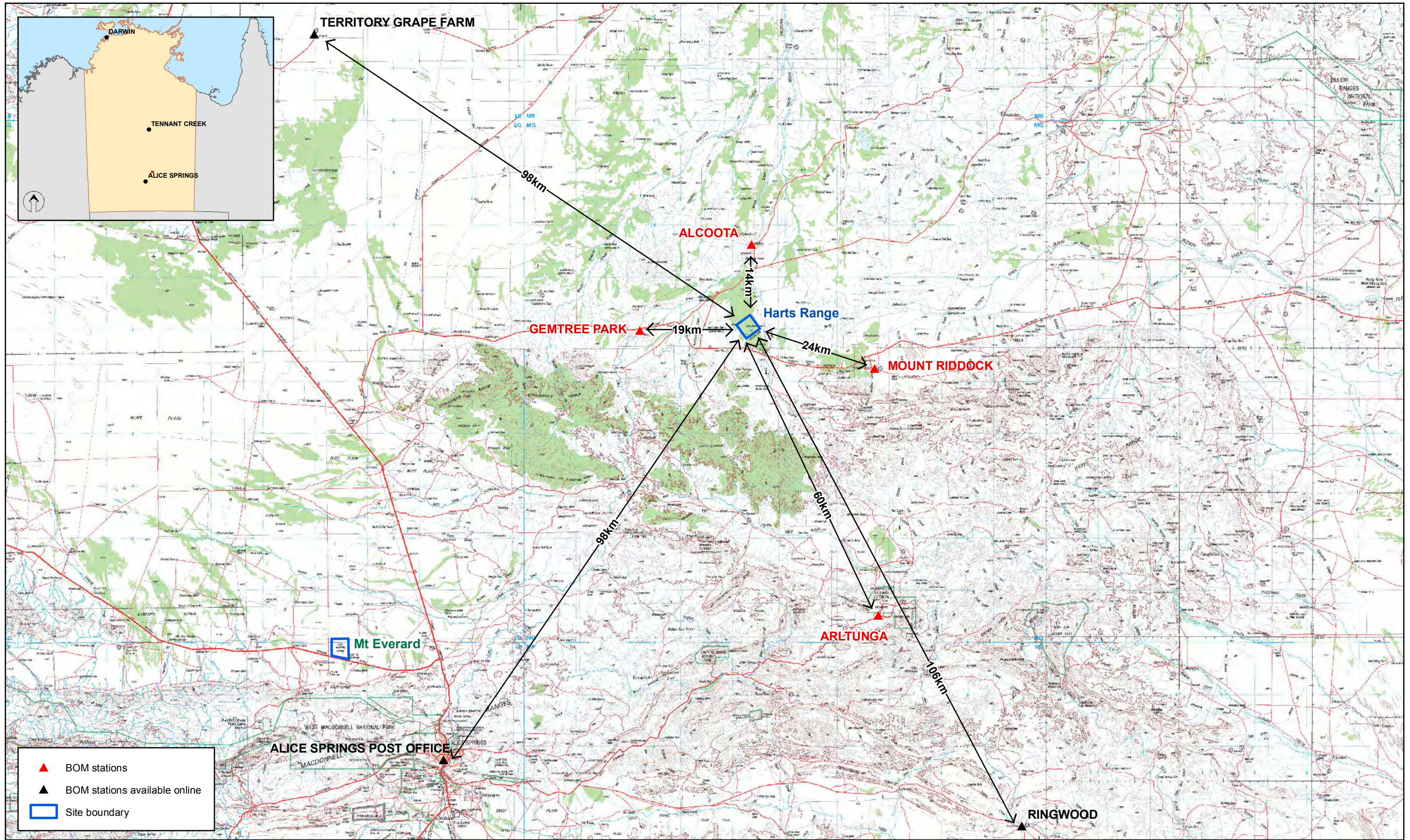
Five different weather stations were used to collate climate data for the Fishers Ridge site. They were:

1. Cutta Cutta weather station
2. Maranboy weather station
3. Tindal RAAF weather station
4. Katherine Council weather station
5. Katherine Aviation Museum weather station.

A summary of these weather stations, their location and the data collected by each is provided in Figure M2.3 and in Table M2.3 below.

Table M2.3 Fishers Ridge – summary weather station details

Weather Station and BOM Code	Latitude (° S)	Longitude (° E)	Elevation (m above sea level)	Distance from site (km)	Data recording started	Data recording ceased	Data Collected
Cutta Cutta (14952)	14.58	132.47	175	15 (west)	1997	Still recording	Rainfall
Maranboy (14919)	14.53	132.79	160	14 (north-east)	1923	2005	Rainfall
Tindal RAAF (14932)	14.52	132.38	133.6	25 (north-west)	1969	Still recording	Temperature Relative Humidity Dew Point Wind speed and gust Rainfall Cloud cover
Katherine Council (14902)	14.46	132.26	107	40 (north-west)	1873	Still recording	Temperature Relative Humidity Dew Point Wind speed Rainfall Cloud cover
Katherine Aviation Museum (14903)	14.44	132.27	108	38 (north-west)	1942	Still recording	Wind speed



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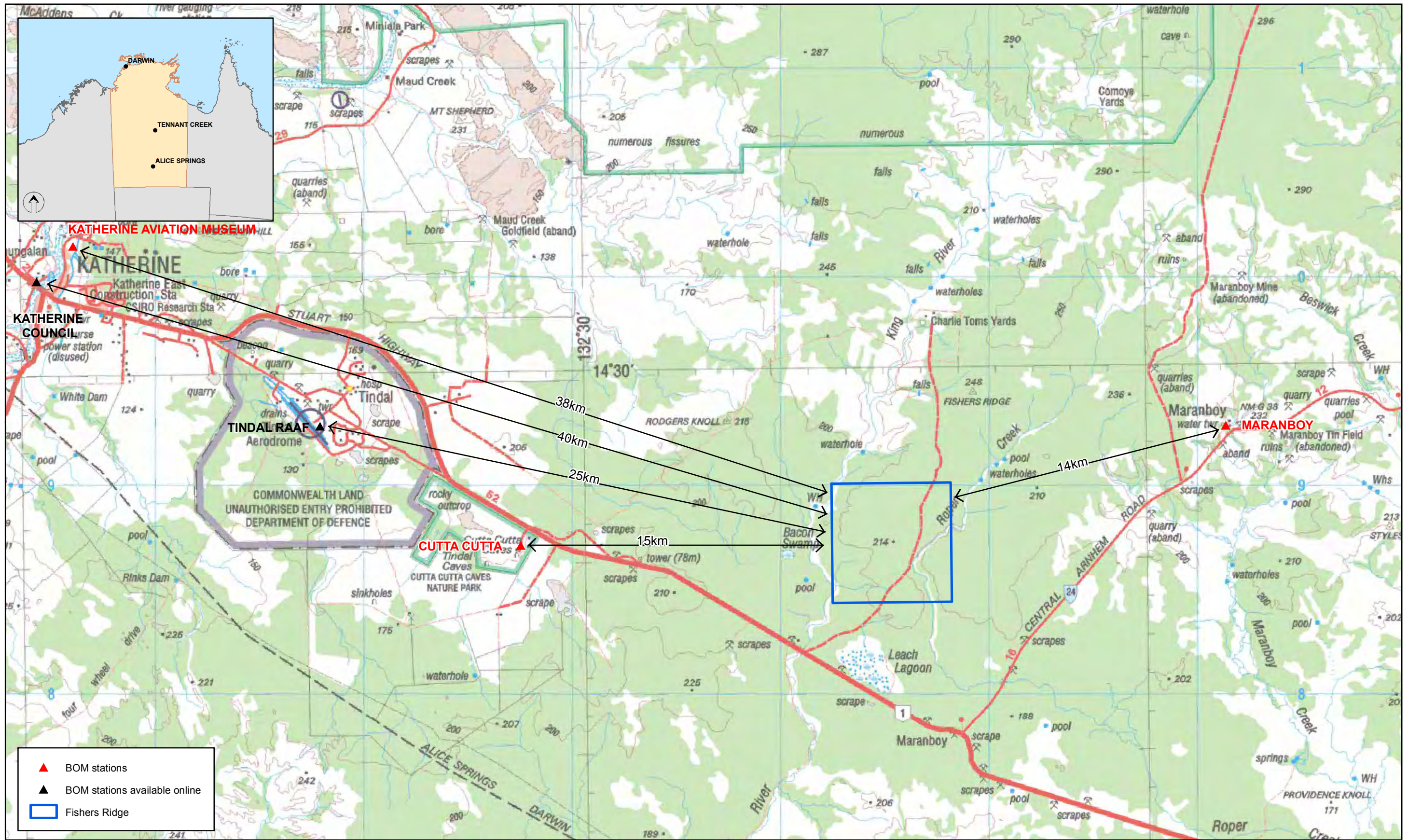
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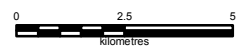
**Commonwealth Radioactive Waste Management Facility
Site Characterisation
Harts Range - location of BOM stations
Figure M2.2**



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**Commonwealth Radioactive Waste Management Facility
Site Characterisation
Fishers Ridge - location of BOM stations
Figure M2.3**

M2.5 Muckaty Station

Seven different weather stations were used to collate climate data for the Muckaty Station site. They were:

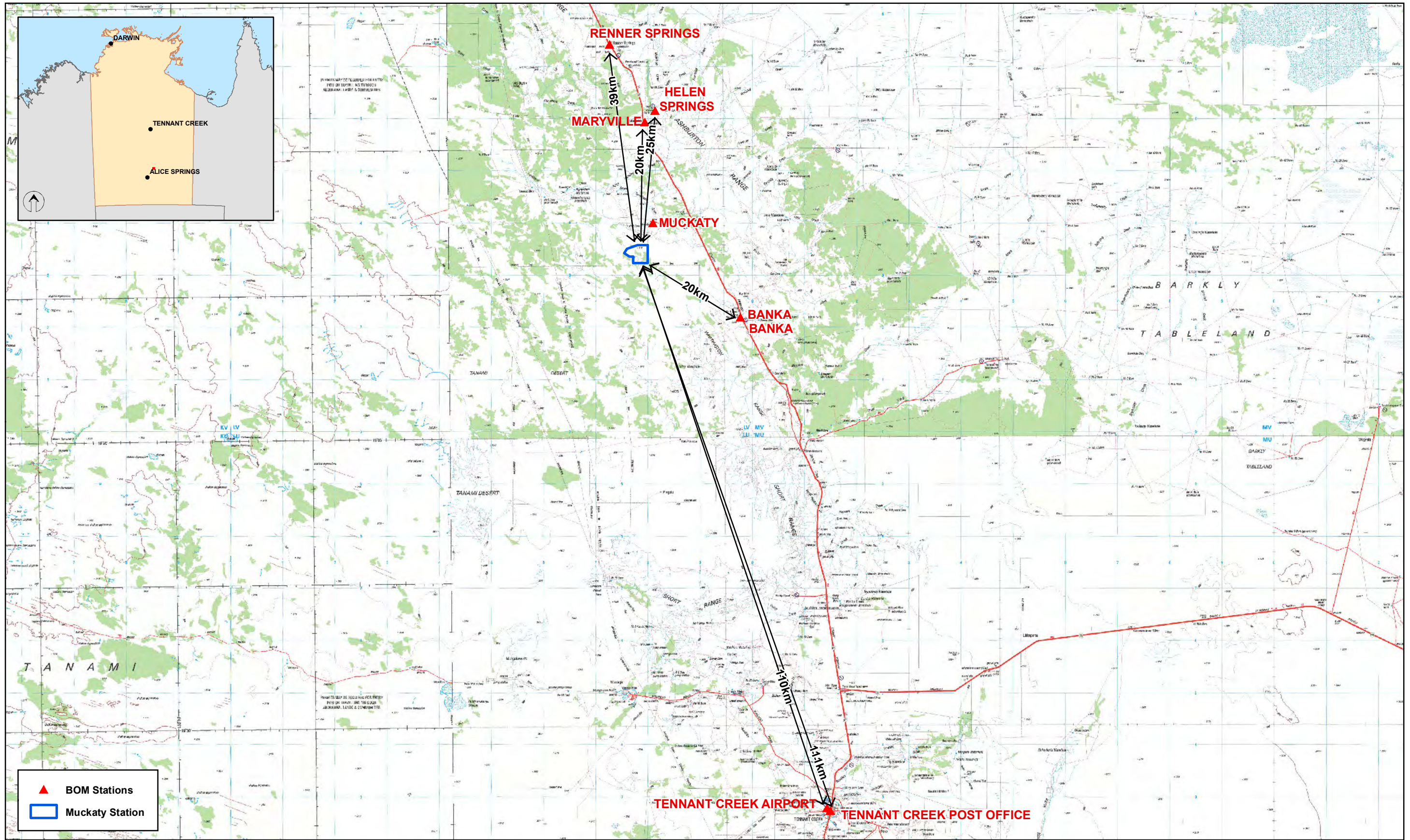
1. Tennant Creek Post Office weather station
2. Tennant Creek Airport weather station
3. Muckaty weather station
4. Maryville weather station
5. Helen Springs weather station
6. Banka Banka weather station
7. Renner Springs weather station

A summary of these weather stations, their location and the data collected by each is provided in Figure M2.4 and Table M2.4 below.

Table M2.4 Muckaty Station – summary weather station details

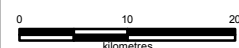
Weather Station and BOM Code	Latitude (° S)	Longitude (° E)	Elevation (m above sea level)	Distance from site (km)	Data recording started	Data recording ceased	Data Collected
Tennant Creek Post Office (015087)	-19.65	134.19	377	111 (south-east)	1874	2000	Temperature Rainfall Wind speed Wind gust Cloud cover Dew point Relative humidity
Tennant Creek Airport (015135)	-19.64	134.18	376	110 (south-east)	1969	Still recording	Temperature Rainfall Wind speed Wind gust Cloud cover Dew point Relative humidity
Muckaty Station (015108)	-18.6278	133.8716	280	Located on Muckaty Station	1943	Still recording	Rainfall
Maryville (015136)	-18.4533	133.8583	295	20 (north)	1970	1975	Rainfall
Helen Springs (015015)	-18.4333	133.8771	288	25 (north)	1945	Still recording	Rainfall
Banka Banka (015067)	-18.7920	134.0297	299	20 (south-east)	1946	Still recording	Rainfall
Renner Springs (015082)	-18.3184	133.7951	262.4	39 (north)	1953	Still recording	Rainfall





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Commonwealth Radioactive Waste Management Facility Site Characterisation

Muckaty Station - location of BOM stations
Figure M2.4

M3. Mount Everard

The Mount Everard site is situated approximately 25 kilometres north-west of Alice Springs. The site was purchased by the Department of Defence in 1973 and is currently operated by BAE Systems under contract to the OTHRSPO.

The site was originally used as a cattle station from early 1880's until 1973. When Department of Defence purchased the site it was originally established as a high frequency radar receiving station, although this facility was replaced by the larger, present day facility in 1980. Today it operates as a receiver station for the over-the-horizon high frequency radar.

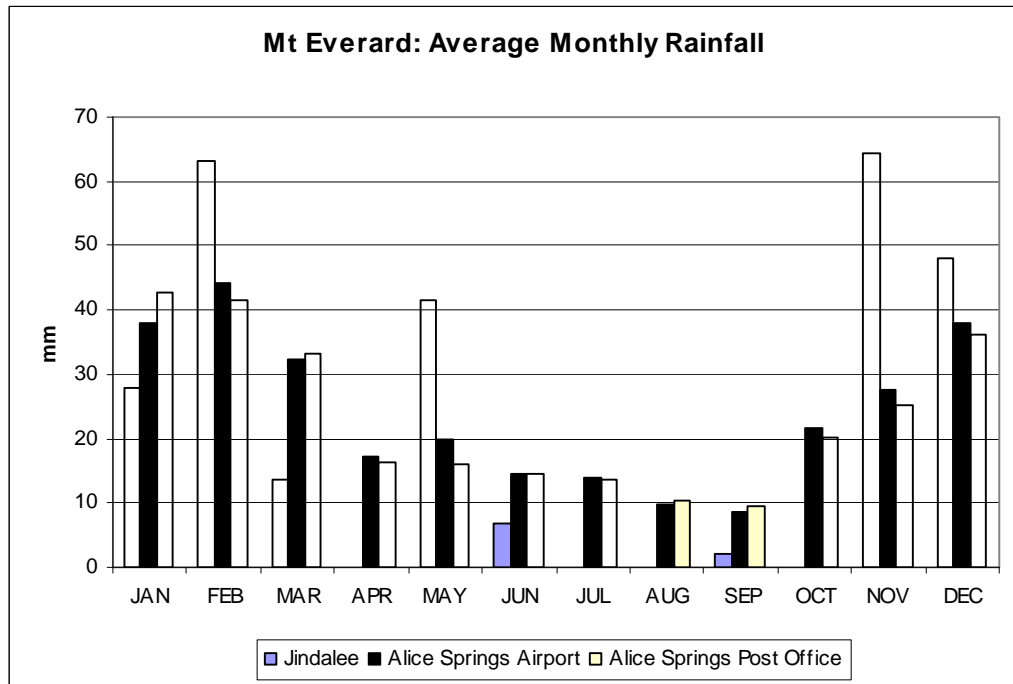
Mount Everard is in the same region as Harts Range and, therefore, has a desert climate. The region has predominantly dry conditions and clear skies from April to September with some rainfall in the hottest months (October to March). The average annual rainfall for the region ranges from 275–300 mm. Temperatures in summer can sit in the low 40's°C while winter evenings can reach -7°C with cold mornings to follow.

M3.1 Rainfall

Figure M3.1 shows average monthly rainfall measured at the three Mount Everard weather stations. The Jindalee weather station (located within the Mount Everard site boundary) shows rainfall measurements quite different from the two Alice Springs weather stations. This could be due to the fact that Jindalee has only be operational from 2002, while Alice Springs Airport weather station has been in operation since 1940 and Alice Springs Post Office since 1873. The two Alice Springs stations have been measuring rainfall long enough to gain an average record for the region. Jindalee's measurements, however, could be easily skewed by one peak rainfall year or drought year as it has not been operating long enough to observe a regional average.

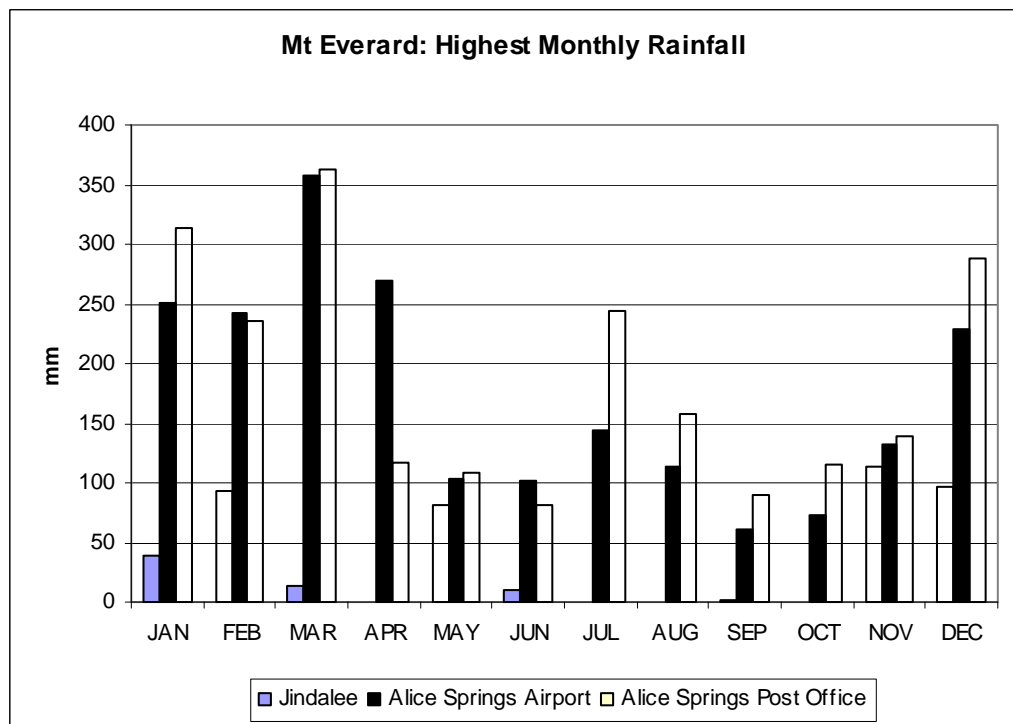
Rainfall throughout the year is low at Mount Everard, with the peak rainfall months (December to March) measuring approximately 30–40 mm. The driest months on average are the winter months (April to September) with September measuring less than 10 mm.

The most extreme rainfall events in the Mount Everard region predominantly occurred in the higher rainfall months of December to March (Figure M3.2). The highest recorded rainfall for the region was in March with over 350 mm measured at both Alice Springs weather stations. Events in January, February, March, April, July and December of more than 200 mm were recorded at either one of the Alice Springs stations.



Source: BOM (2006a, 2006b, 2006i)

FIGURE M3.1
Mount Everard average monthly rainfall



Source: BOM (2006a, 2006b, 2006i)

FIGURE M3.2
Mount Everard highest monthly rainfall

Predicted rainfall events were calculated using the *Australian Rainfall and Runoff Guide* (AR&R) (The Australian Institute of Engineers, 1997) and *Bulletin 17B of the Interagency Advisory Committee on Water Data* (Interagency Advisory Committee on Water Data, 1992) (to supplement the AR&R and determine the 1:1000 year rainfall event, i.e. an event that has a 1:1000 chance of occurring or being exceeded in a given year). Results were given as a range of rainfall intensities for a variety of duration and average recurrence intervals (ARIs). ARIs from 1:10 to 1:1000 years were considered. For various storm durations, the intensity was then multiplied by the time to obtain the depth of rainfall (in mm) for the corresponding rainfall event. Table M3.1 below shows the results of ARI values calculated for Mount Everard. ARI 1000 results range from 26.2 mm for a 5 minute duration and 480.7 mm for a 72 hr duration. As expected from the site's location the values are lower than Fishers Ridge and similar to Harts Range. For more discussion on this issue please refer to the hydrology report (Parsons Brinckerhoff 2008).

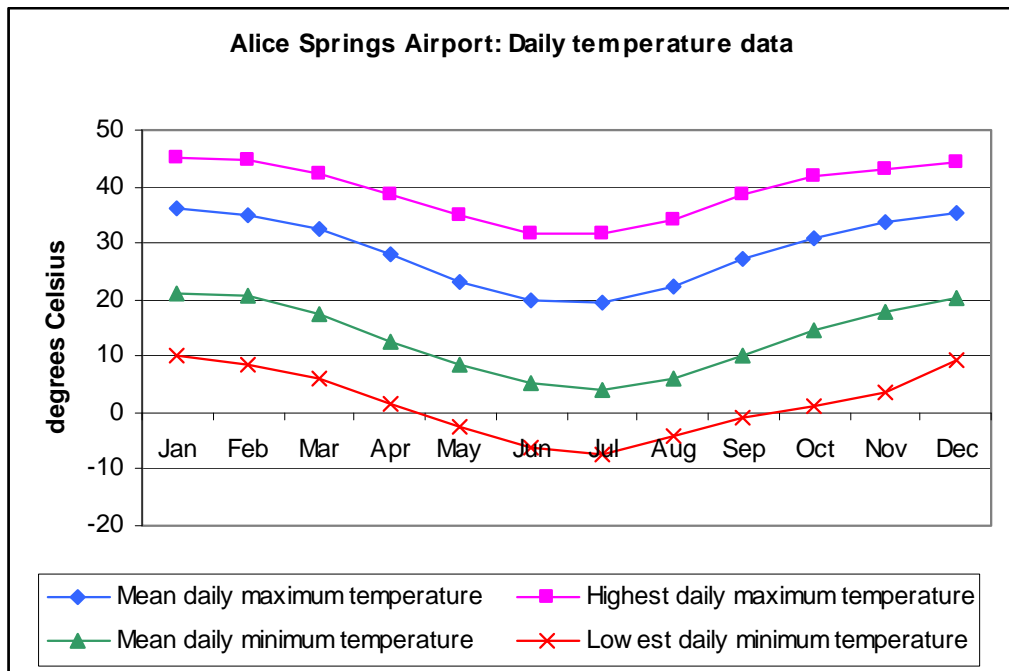
Table M3.1 Mount Everard rainfall ARI values (in mm)

Duration	ARI10	ARI20	ARI50	ARI100	ARI200	ARI500	ARI1000
5 mins	9.8	12.0	14.9	17.3	19.8	23.4	26.2
10 mins	15.6	19.1	23.9	27.8	31.9	37.8	42.5
15 mins	20.0	24.5	30.9	36.0	41.4	49.0	55.2
30 mins	29.7	36.5	46.2	54.1	62.4	74.3	83.9
1 hr	42.5	52.6	67.0	78.7	91.2	109.0	123.6
3 hr	61.7	76.7	98.0	115.4	134.0	160.6	182.3
6 hr	77.5	96.5	123.5	145.6	169.3	203.3	231.1
12 hr	97.4	121.6	156.0	184.2	214.5	257.9	293.4
72 hr	155.8	195.3	252.0	298.6	348.9	421.2	480.7

All durations of the ARI 1000 figures should be considered, as a 1 in 1000 year rainfall event which is only 5 minutes in duration and will have a higher intensity than a 1 in 1000 event that lasts for 72 hours (even though overall the 72 hr event will result in a greater volume of water). Therefore, all events need to be considered for drainage purpose. For more discussion on this issue please refer to the hydrology report (PB 2008).

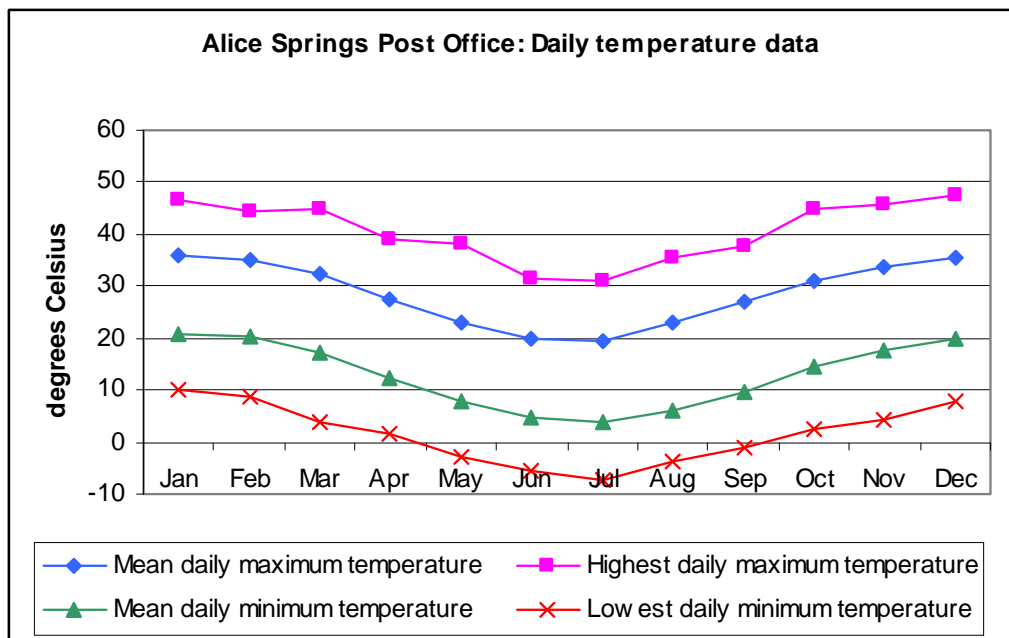
M3.2 Temperature

Figures M3.3 and M3.4 below show the daily temperature data for the Mount Everard region (as measured at Alice Springs Airport and Post Office weather stations). The highest recorded daily maximum temperature at each weather station is 45.2°C in January and 47.5°C in December. Mean daily maximum temperatures range from 20°C in July to 36°C in January. The mean daily minimum temperatures range from 4°C in July to 21°C in January. The lowest recorded temperature in the region is just below -7°C which occurred in July (the coldest month of the year for the Mount Everard region).



Source: BOM (2006a)

FIGURE M3.3
Alice Springs Airport daily temperature data

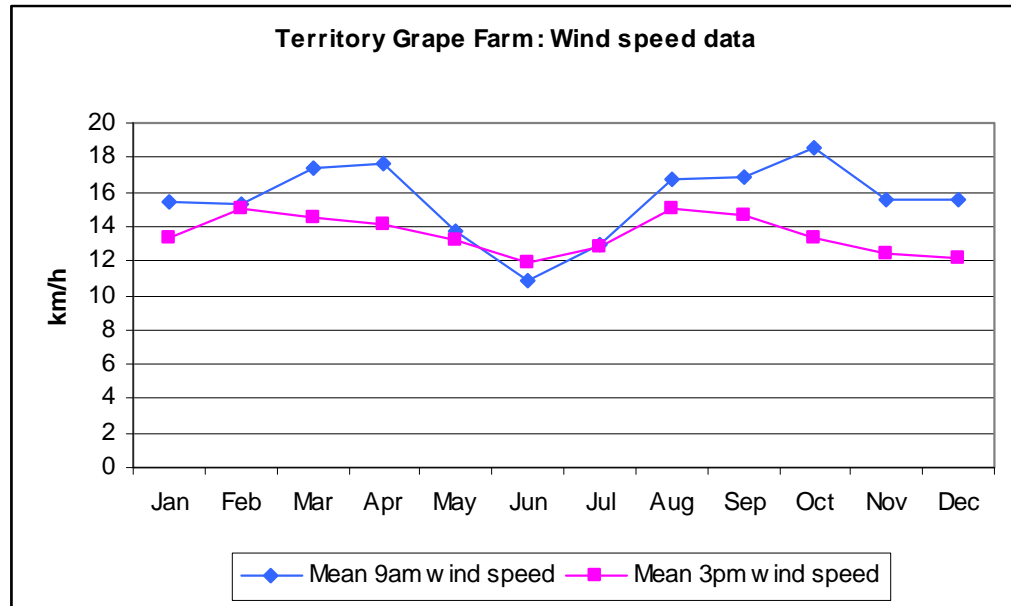


Source: BOM (2006b)

FIGURE M3.4
Alice Springs Post Office daily temperature data

M3.3 Wind

Wind speeds in the region fluctuate with stronger winds during the summer months and weaker winds during winter (refer to Figures M3.5 to M3.7). The range of average wind data for the region collected at 9 am is from 4 km/hr in June to 19 km/hr in October. In Alice Springs, in general, the 9 am wind speeds are a lot less than the 3 pm averages, while at the Territory Grape Farm the 9 am wind speeds are generally stronger than at 3 pm. The range of average 3 pm wind data ranges from 10 km/hr in June to 16 km/hr recorded in February and October.

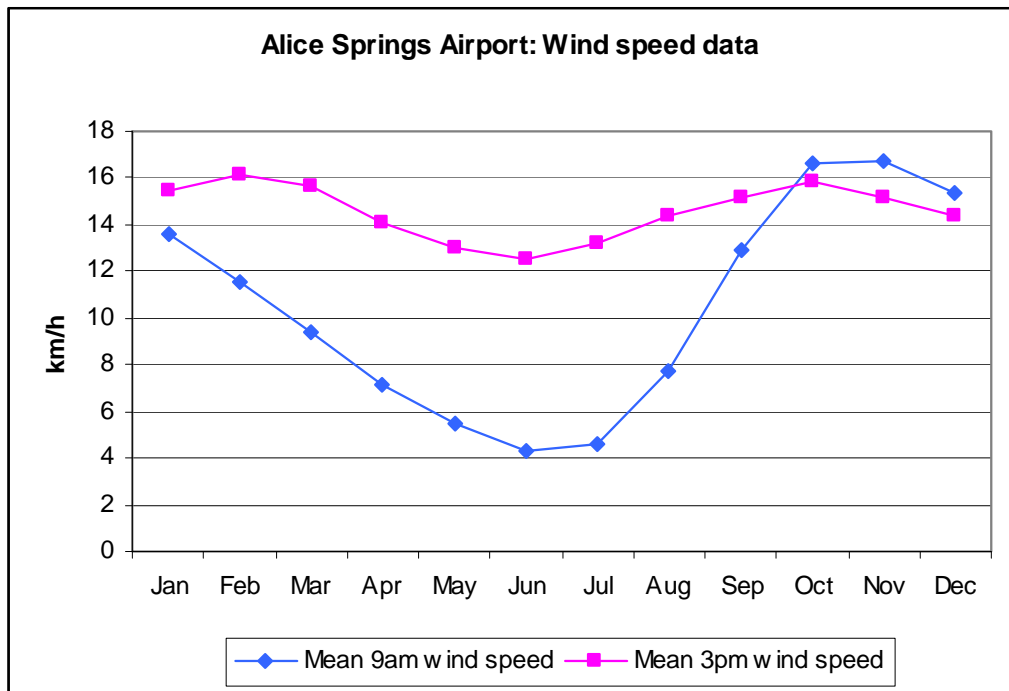


Source: BOM (2006g)

FIGURE M3.5
Territory Grape Farm wind speed data

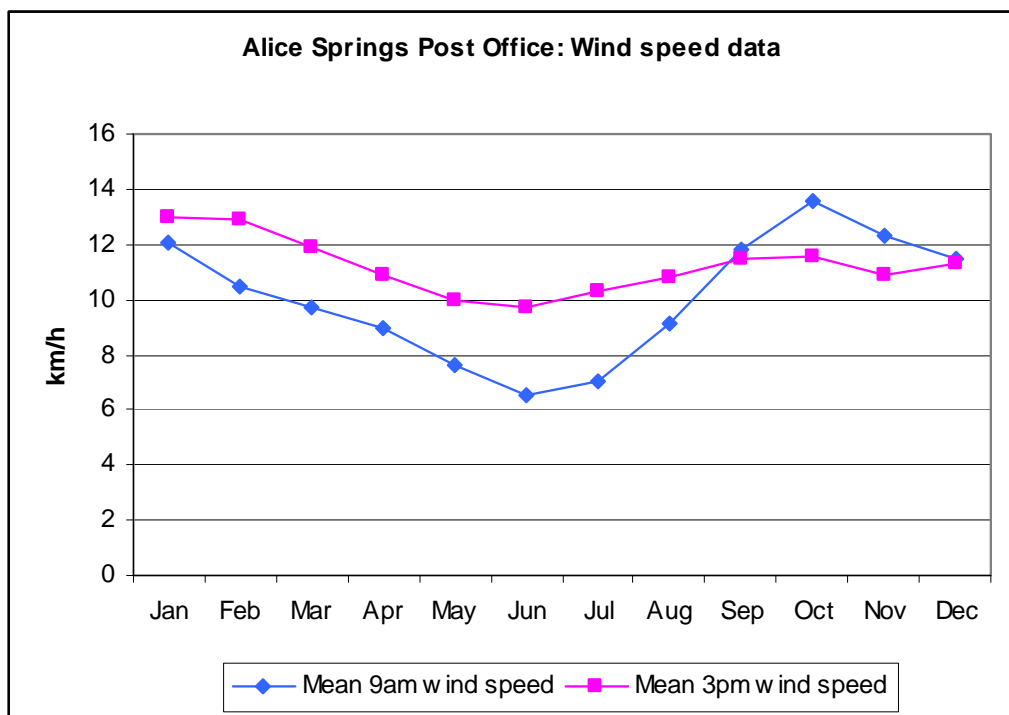
The only weather station in the region that measures wind gust is the Alice Springs Airport. Figure M3.8 displays the measured results of wind gust at this weather station. The highest recorded wind gust is 174 km/hr which occurred in November. Generally, throughout the year the highest recorded wind gusts range from 90–120 km/hr.

The nearest stations to Mount Everard that measure data for wind roses are Alice Springs Post Office and Alice Springs Airport weather stations. All year round the post office weather station measures a strong south-easterly wind with calmer mornings (9 am) from May through August. All year round the airport weather station measures a strong easterly wind with a slight south-easterly at the 9 am recording which changes to a strong south-easterly with a slight easterly wind at the 3 pm recording. The airport also records calmer mornings (9 am) from March to September.



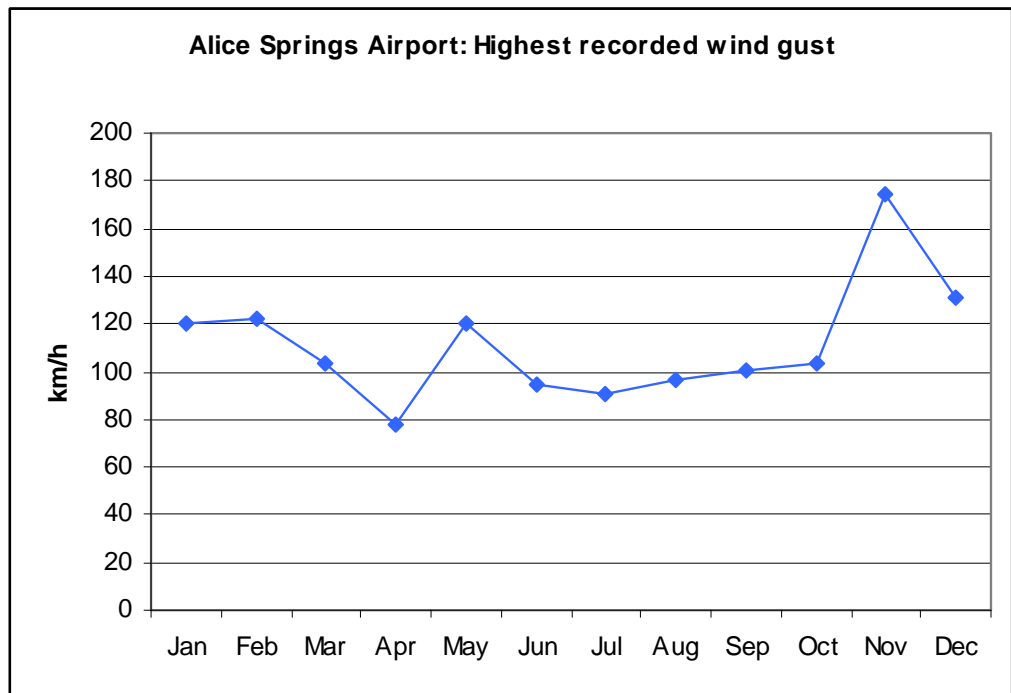
Source: BOM (2006a)

FIGURE M3.6
Alice Springs Airport wind speed data



Source: BOM (2006b)

FIGURE M3.7
Alice Springs Post Office wind speed data



Source: BOM (2006a)

FIGURE M3.8
Alice Springs Airport highest recorded wind gust

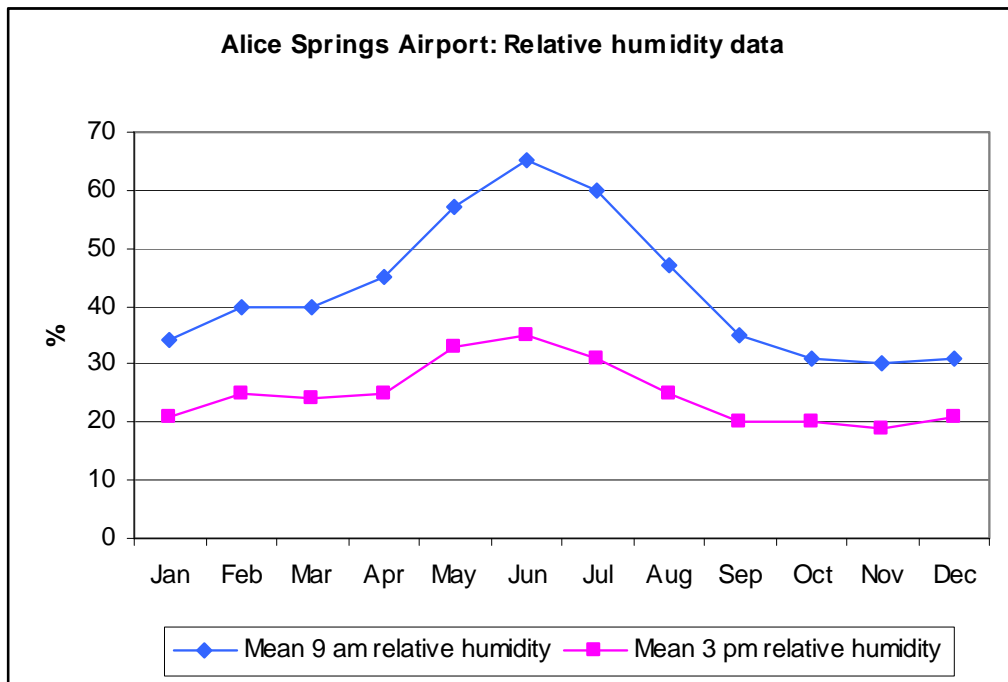
M3.4 Relative humidity

The average relative humidity within the Mount Everard region is seen below in Figures M3.9 and M3.10. The general trend shows humidity rising during the winter months, peaking in June and decreases through the summer months with lowest relative humidity in December and January. Highest humidity levels are between 55–65% and lowest are between 10–20%. Humidity is also higher during the morning as apposed to the afternoon.

M3.5 Extreme weather

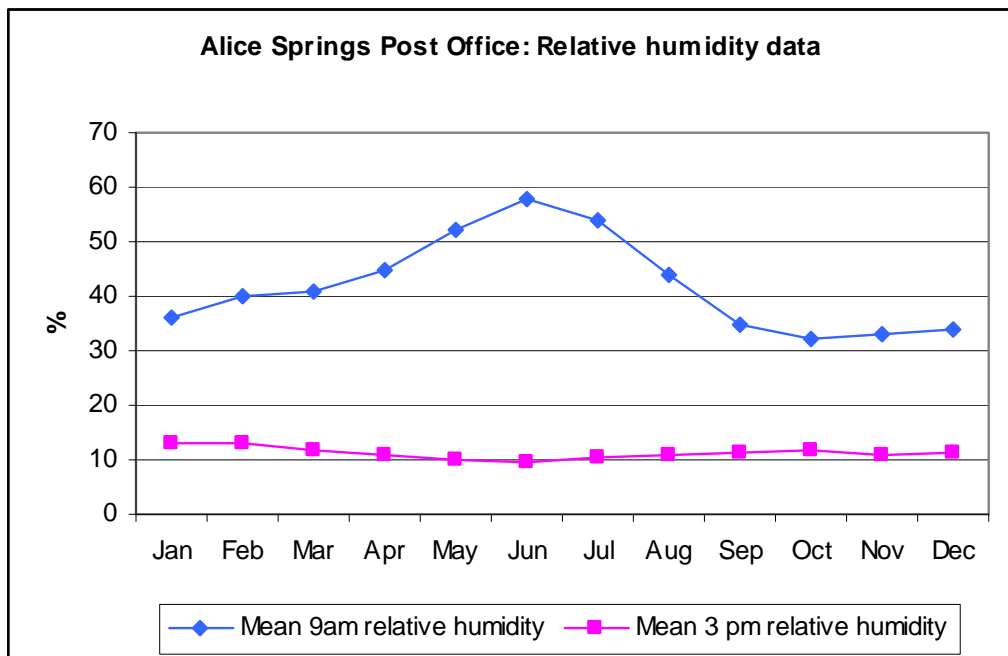
M3.5.1 Floods

Surface water hydrology including a consideration of flooding is discussed in the hydrology report (Parsons Brinckerhoff 2008) and is not considered in detail here. At Mount Everard, local experience is that year to year flooding does not occur, but local flooding may occur in periods of extreme rainfall, with water cover on the ground usually drying out within 24 hours of the rain event (G. Parker 2007, pers. comm.).



Source: BOM (2006a)

FIGURE M3.9
Alice Springs Airport relative humidity data



Source: BOM (2006b)

FIGURE M3.10
Alice Springs Post Office relative humidity data

M3.5.2 Bushfires

Mount Everard is protected under a Northern Territory fire protection zone due to its proximity to Alice Springs. The area has an all year long fire ban and a permit is required before the lighting of any fires in the region. The Mount Everard fire season is in the very dry months through spring and summer. Due to the very dry conditions and high temperatures throughout these months bushfires do occur within the region.

In an average year in the Mount Everard region, rainfall is low and vegetation is generally sparse and the intensity of any fires that do occur is low. However, in years of unusually high rainfall, the growth of fire fuel is increased increasing the risk of severe bushfires in the region.

At Mount Everard, Defence conduct controlled burn-offs on a requirement basis to minimise the risk of bushfire to the site (G. Parker 2007, pers. comm.).

M3.5.3 Drought

Mount Everard is in a desert region and is, therefore, prone to droughts. Due to the low rainfall the vegetation that does occur in the region has adapted to low rainfall and can survive through drought conditions. However, in drought periods vegetation is very sparse.

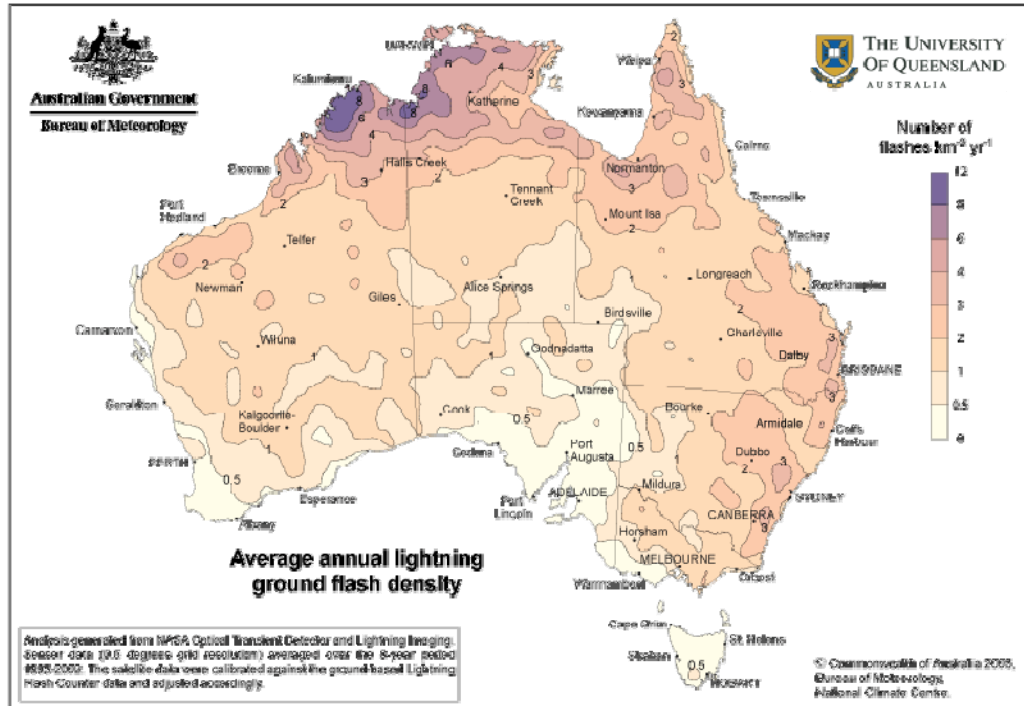
M3.6 Air quality

There is no baseline National Pollutant Inventory (NPI) data as part of the National Environment Protection Measures (NEPM) for the region. The only NPI monitoring stations are in the far north of the Northern Territory and in Alice Springs. Although Alice Springs is quite close to Mount Everard the NPI data has not been used as the Alice Springs data is not considered indicative of the Mount Everard region. This is because the Alice Springs data is from an urbanised industrial area, while Mount Everard is remote and therefore, its air quality is not a result of any human impact but rather its natural climate. The general air quality of the Harts Range region is expected to be high. This estimate is based on:

- the isolated and remote location of the region
- the main surrounding land use is agricultural, not urban residential or industrial
- there being no nearby point sources of pollution.

M3.7 Lightning

Lightning at Mount Everard is not very common. Figure M3.11 below shows the density of lightning strikes over Australia with Mount Everard having 1 flash/km²/yr.



Source: (BOM, 2007d)

FIGURE M3.11
Lightning ground flash intensity

M4. Harts Range

The Harts Range site is situated approximately 100 km north-east of Alice Springs. The site is on Commonwealth owned land owned by the Department of Defence. Site activities are undertaken by British Aerospace Systems (BAE Systems) on a contract basis.

The site itself is used as a transmitter station for the Over the Horizon Radar Systems Program Office (OTHRSPPO).

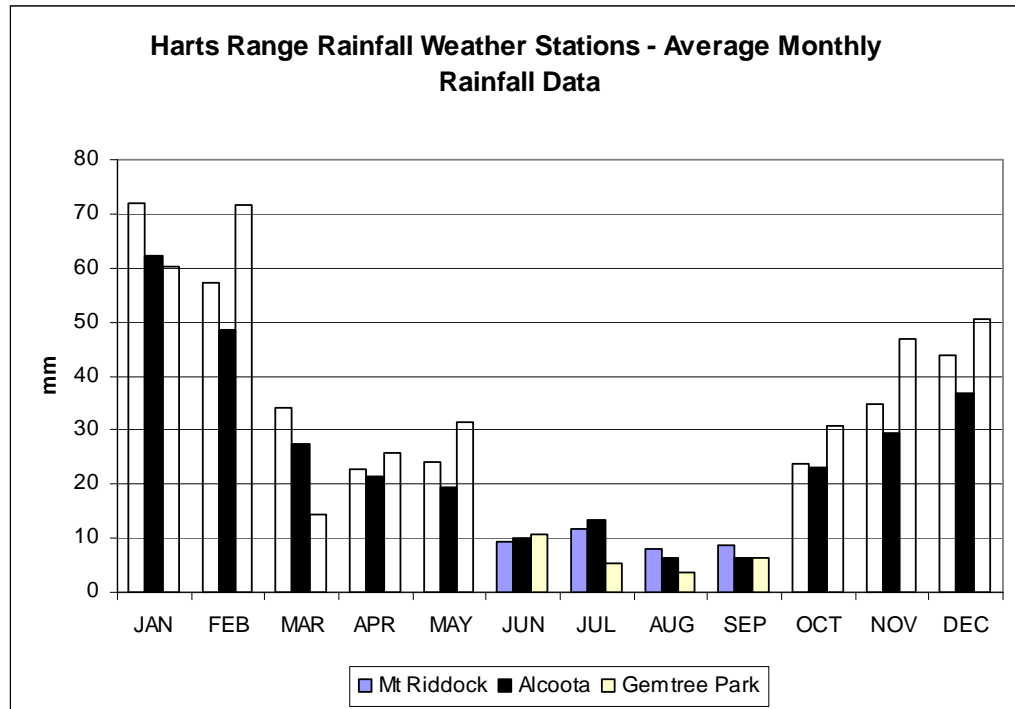
The adjoining land is under perpetual pastoral leases with a Land Use Agreement 4 km west and 5 km south of the site (refer to Figure M2.2).

The Harts Range region is a desert environment with predominantly dry conditions and clear skies from April to September with some rainfall in the hottest months (October to March). The average annual rainfall for the region ranges from 275–300 mm. Temperatures in summer can sit in the low 40s°C while winter evenings can reach –7°C with cold mornings to follow.

M4.1 Rainfall

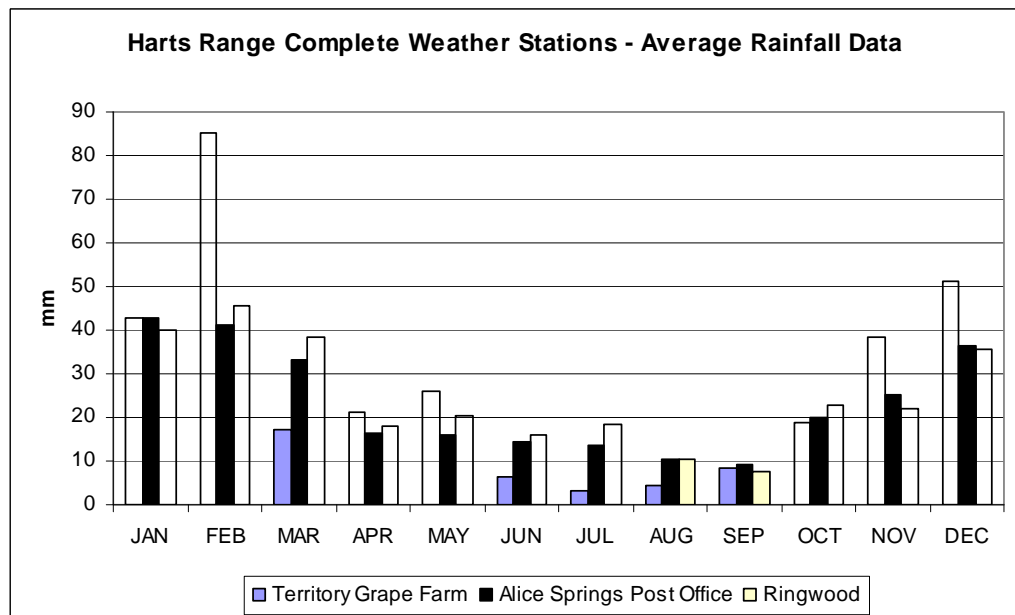
Of the seven weather stations surrounding Harts Range, three record only rainfall: Mt Riddock, Alcoota and Gemtree Park weather stations. The average monthly rainfall recorded at these stations is seen in Figure M4.1. The data shows the highest rainfall months to be November through to February with an average monthly rainfall of 50–70 mm. The lowest rainfall months (June – September) have an average monthly rainfall of <10 mm and receive no rain at all in some years. Overall, rainfall in the region is low all year round.

Figure M4.2 below shows average monthly rainfall recorded at the weather stations that record rainfall and other elements. While Figure M4.2 does not show as much summer rainfall as Figure M4.1, it does show the general trend of very low rainfall in winter and higher rainfall in summer. Figure M4.2 also shows very low rainfall all year round with the average monthly rainfall during the wet season ranging from 30–40 mm.



Source: BOM (2006i)

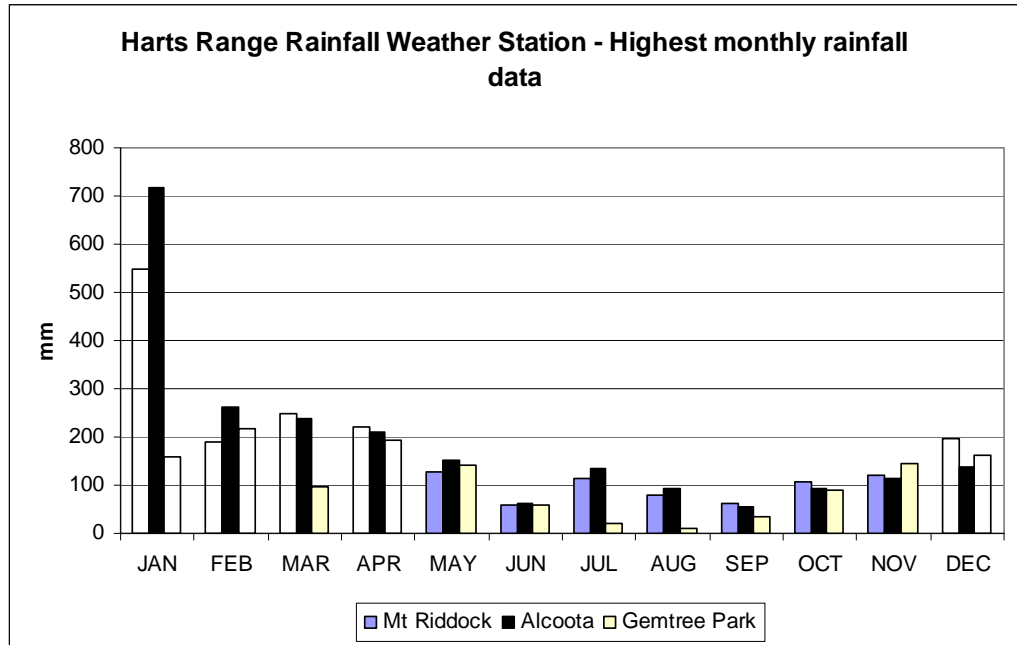
FIGURE M4.1
Harts Range average rainfall data for rainfall weather stations



Source: BOM (2006b, 2006f, 2006g)

FIGURE M4.2
Harts Range average rainfall data

Figure M4.3 below shows highest monthly rainfall data at the three closest weather stations to Harts Range, Mt Riddock, Alcoota and Gemtree Park. With the exception of January the highest recorded rainfall in each month falls within 50–250 mm. Mt Riddock and Alcoota weather stations recorded 550 mm and respectively in the month of January. These readings are considered extreme as they are comparable to the Fishers Ridge site which is in a tropical climate and is occasionally affected by Tropical Cyclones.



Source: BOM (2006i)

FIGURE M4.3
Harts Range highest monthly rainfall data

Table M4.1 below shows the results of ARI values calculated as described for Mount Everard (Section M3.1). ARI 1000 results range from 24.7 mm for a 5 minute duration and 553.2 mm for a 72 hr duration. As expected from the site’s location the values are slightly higher than Mount Everard and lower than Fishers Ridge. For more discussion on this issue please refer to the hydrology report (Parsons Brinckerhoff 2008).

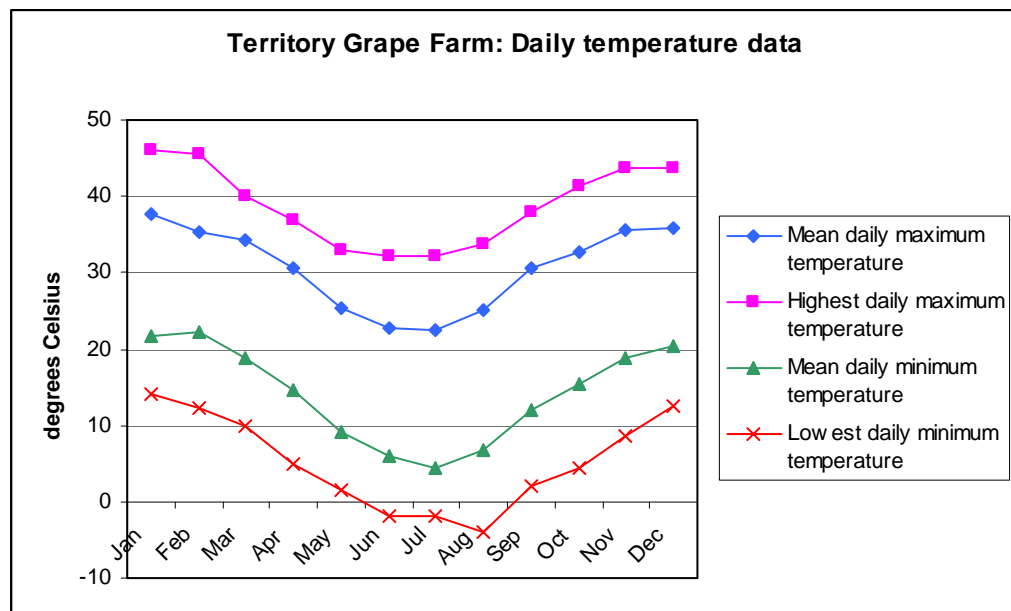
Table M4.1 Harts Range rainfall ARI values (mm)

Duration	ARI10	ARI20	ARI50	ARI100	ARI200	ARI500	ARI1000
5 mins	10.0	12.0	14.8	16.9	19.1	22.3	24.7
10 mins	16.0	19.2	23.5	27.0	30.6	35.7	39.7
15 mins	20.5	24.6	30.3	34.8	39.5	46.1	51.3
30 mins	30.3	36.5	45.1	51.9	59.1	69.0	77.0
1 hr	43.4	52.5	65.0	75.0	85.4	100.1	111.9
3 hr	64.5	79.1	99.5	116.0	133.5	158.2	178.2
6 hr	82.1	101.6	129.2	151.6	175.5	209.5	237.3
12 hr	104.8	130.9	168.0	198.4	231.1	278.0	316.5
72 hr	177.1	222.6	288.0	341.9	400.1	484.0	553.2

All durations of the ARI 1000 figures should be considered, as a 1 in 1000 year rainfall event which is only 5 minutes in duration and will have a higher intensity than a 1 in 1000 event that lasts for 72 hours (even though overall the 72 hr event will result in a greater volume of water). Therefore, all events need to be considered for drainage purpose. For more discussion on this issue please refer to the hydrology report (PB 2008).

M4.2 Temperature

The mean daily maximum temperatures in the Harts Range region range from low 20°Cs in June and July to high 30°Cs in November to February (refer to Figures M4.4 and M4.5). The mean daily minimum temperatures range from 5°C in July to low 20°Cs in December to February. The highest temperature recorded at Territory Grape Farm (Figure M4.4) and Ringwood weather station (Figure M4.5) is 45.8°C in December and the lowest is -5.6°C in July.

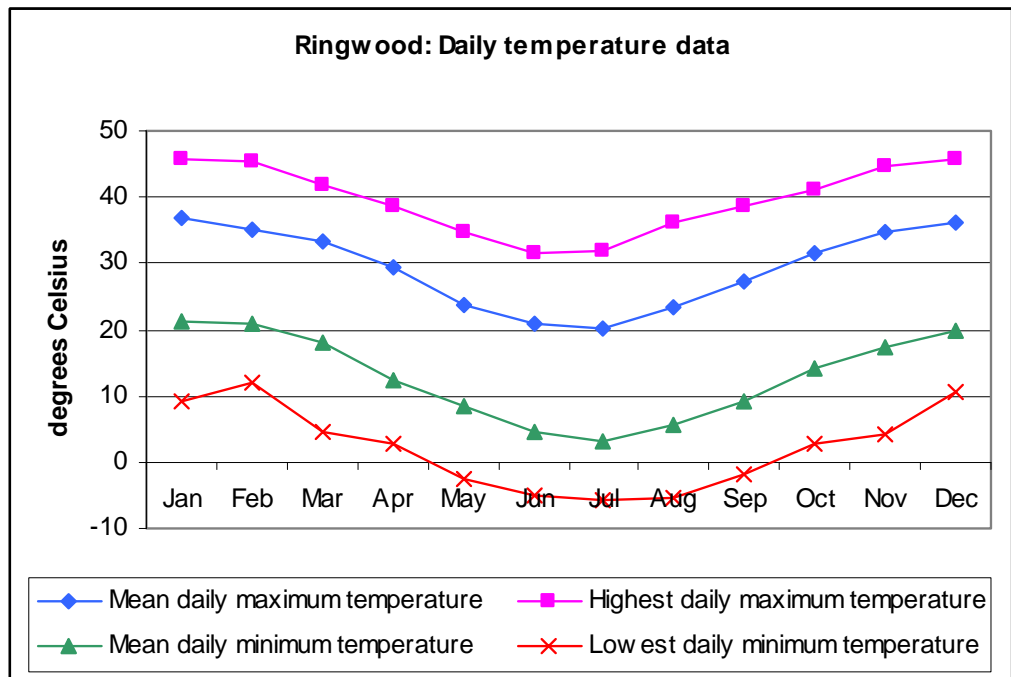


Source: BOM (2006g)

FIGURE M4.4
Territory Grape Farm daily temperature data

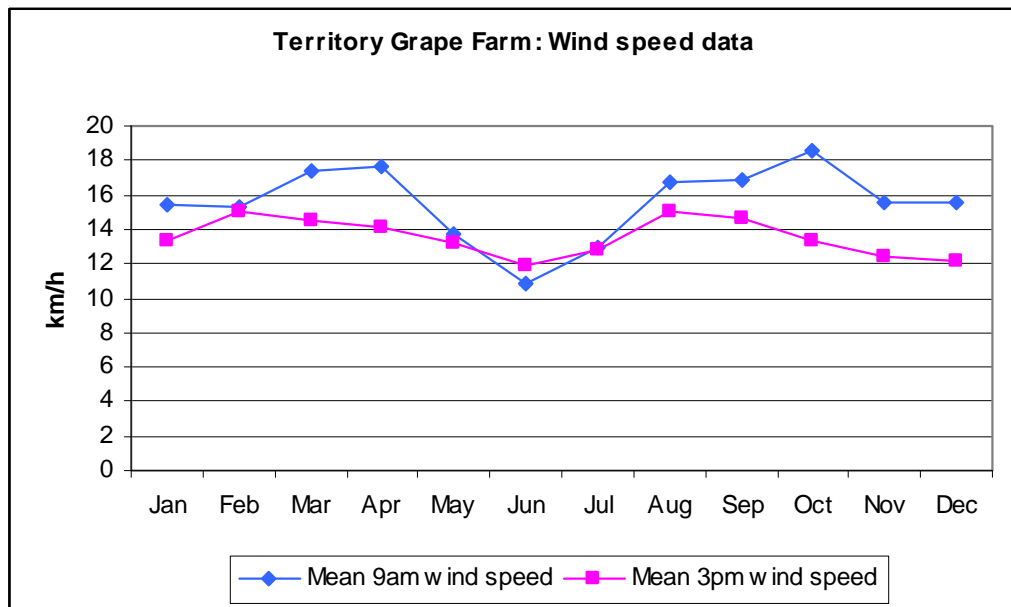
M4.3 Wind

Wind speeds in the region fluctuate throughout the year from 6–18 km/hr. During the warmer months the Territory Grape Farm station has recorded stronger winds in the morning (9 am) compared to the afternoon (3 pm) (Figures M4.6 and M4.7) and there is a distinct drop in morning wind May through July. The Ringwood station, however, has measured stronger afternoon winds in every month except November. Throughout the year afternoon (3 pm) wind speeds remain quite constant with lightest winds in June and December.



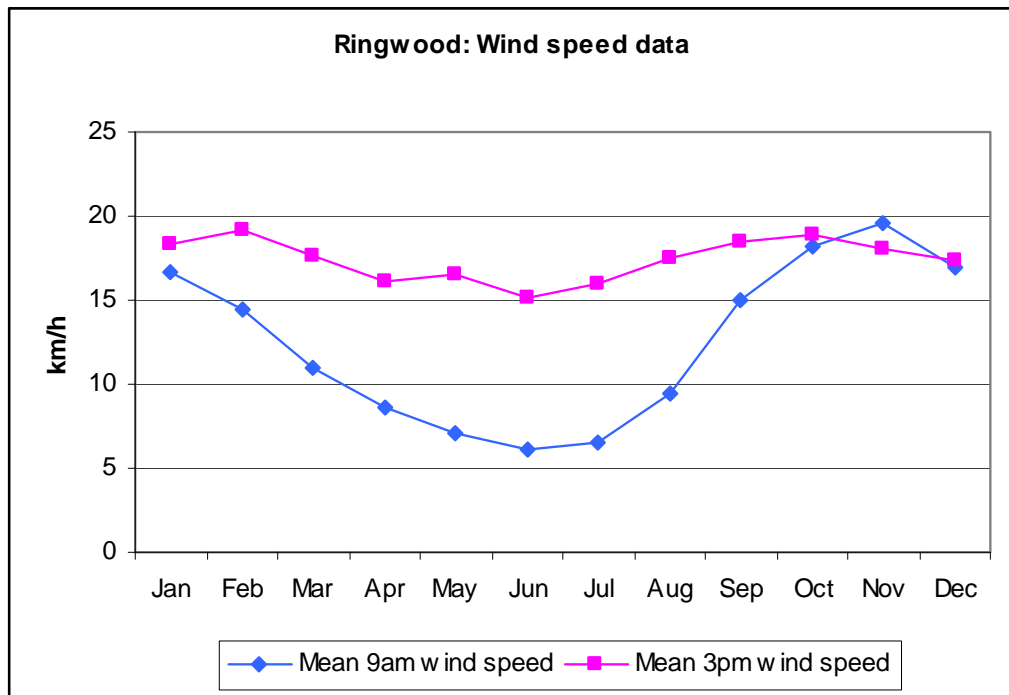
Source: BOM (2006f)

FIGURE M4.5
 Ringwood daily temperature data



Source: BOM (2006g)

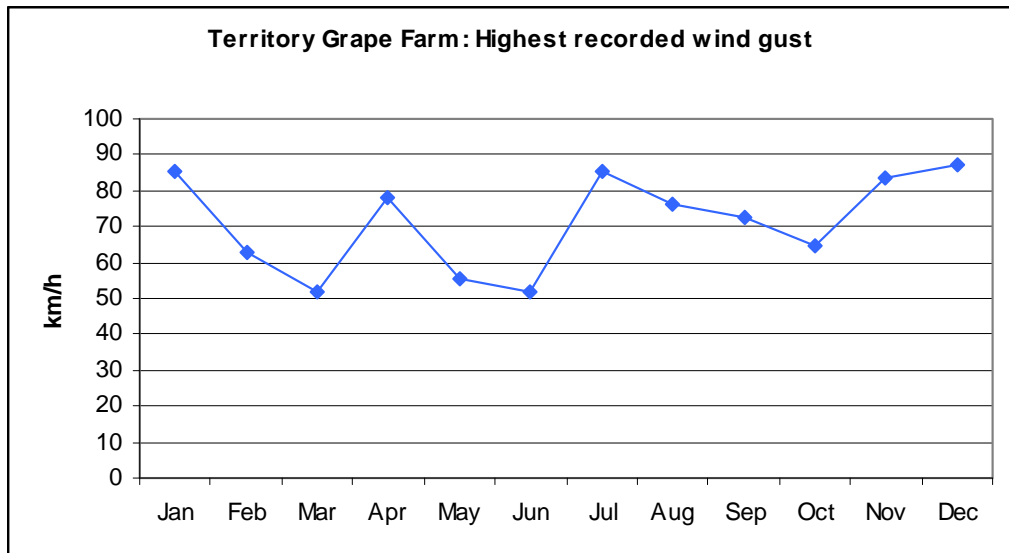
FIGURE M4.6
 Territory Grape Farm wind speed data



Source: BOM (2006f)

FIGURE M4.7
Ringwood wind speed data

Highest recorded wind gusts in the region fluctuate all year. The highest recorded gust is 87.1 km/hr in December. The fluctuation can be seen in Figure M4.8 below.



Source: BOM (2006g)

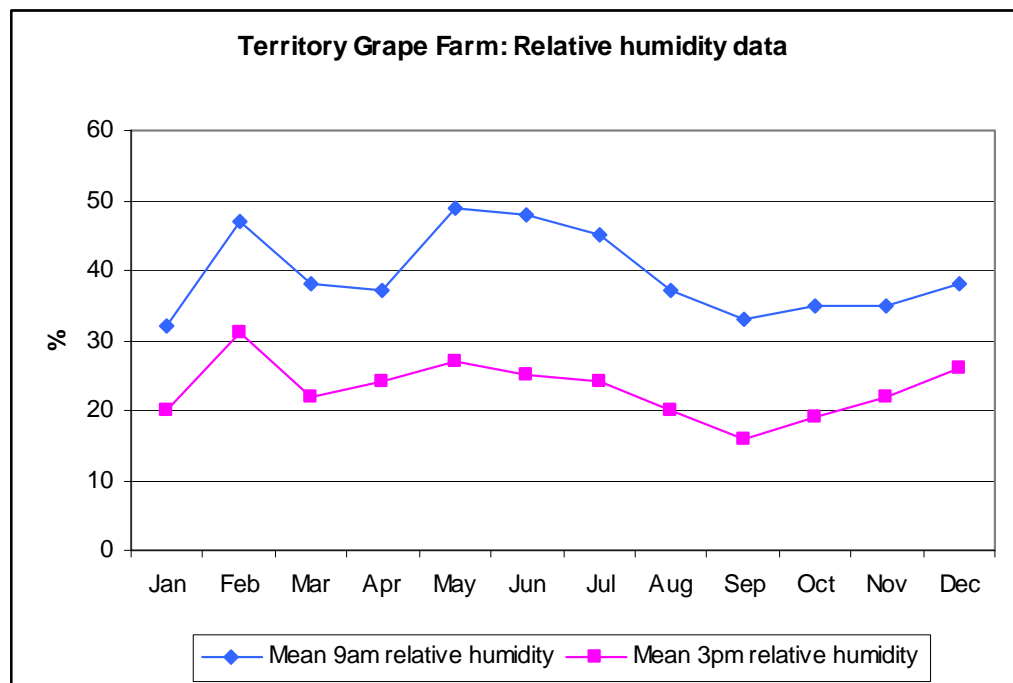
FIGURE M4.8
Territory Grape Farm highest recorded wind gust

The wind rose data for the Harts Range site was reviewed from Arltunga, Alice Springs Airport and Alice Springs Post Office Weather Stations. The wind data for each station throughout the year were similar. From January through to August the

wind was blowing from the east at 9 am and changed around to the south and south-east at the 3 pm recordings. September through to December wind blew from the east and the north in the morning (9 am) and from the east and south in the afternoon (3 pm). These were the general wind directions for all three weather stations except Alice Springs Post Office which measured strong south-easterlies all year round.

M4.4 Relative humidity

As Figures M4.9 and M4.10 below show, the relative humidity in the region is highest through the beginning of winter (May to July) and lowest September through January. The highest humidity levels are approximately 50–65% with the lowest ranging from 15–20%. At the Territory Grape Farm weather station there is a small peak of humidity in February (Figure M4.9). This is also seen to a much lesser extent at Ringwood weather station (Figure M4.10).



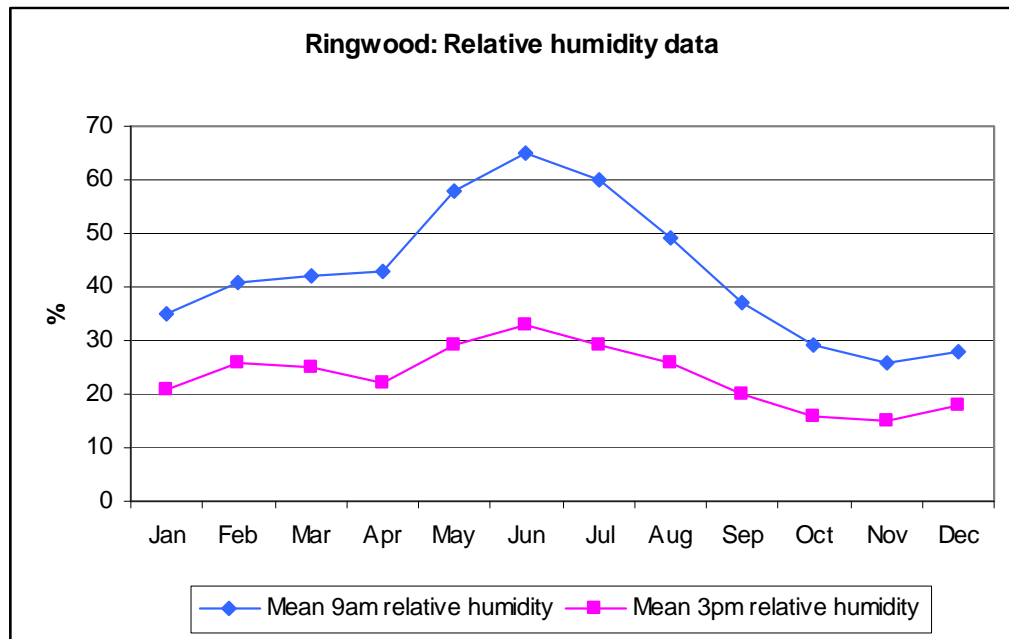
Source: BOM (2006g)

FIGURE M4.9
Territory Grape Farm relative humidity data

M4.5 Extreme weather

M4.5.1 Floods

Surface water hydrology including a consideration of flooding is discussed in the hydrology report (Parsons Brinckerhoff 2008) and is not considered in detail here. Flooding may occur in periods of high rainfall. Gordon Parker (Security Officer at Harts Range/Mount Everard – 1RSU DET B) has stated that in periods of high rainfall, water cover on the ground may last for up to a week before it dries out (G. Parker 2007, pers. comm.).



Source: BOM (2006f)

FIGURE M4.10
Ringwood relative humidity data

M4.5.2 Bushfires

Harts Range is not protected under a Northern Territory fire protection zone. Due to its remoteness the only risk of bushfire is from the natural elements (lightning strikes are a major cause of wildfires in Northern Australia, BOM, 2003). The Harts Range fire season is in the very dry months through spring and summer. The very dry conditions through these months and the extreme temperatures mean bushfires do occur within the region.

In an average year in the Harts Range region, rainfall is low and any vegetation is sparse. This means the intensity of any fires that do occur is usually low. However, in years of unusually high rainfall, the growth of fire fuel is increased, therefore, increasing the risk of severe bushfires in the region.

An example of large bushfire events was in summer 1974/75. Very high summer rainfall in 1973/74 and more rain through winter and early spring resulted in a large growth in vegetation, which then dried out as conditions returned to normal. Thunderstorms (accompanied by no or little rain) set alight the large amounts of dry fuel creating bushfires that burned for months through to 1975.

Defence do not conduct controlled burn-offs at Harts Range (G. Parker 2007, pers. comm.).

M4.5.3 Drought

Harts Range is in a desert region and is, therefore, prone to droughts. Due to the low rainfall the vegetation that does occur in the region is adapted to low rainfall and can

survive through drought conditions. However, in drought periods vegetation is very sparse.

M4.6 Air quality

There is no baseline National Pollutant Inventory (NPI) data as part of the National Environment Protection Measures (NEPM) for the region. The only NPI monitoring stations are in the far north of the Northern Territory and in Alice Springs (100 km south-west of the Harts Range site). Despite this the general air quality of the Harts Range region is expected to be high. This estimate is based on:

- the isolated and remote location of the region
- the main surrounding land use is agricultural, not urban residential or industrial
- there being no nearby point sources of pollution.

M4.7 Lightning

Lightning at Harts Range is not very common. Figure M3.11 shows the density of lightning strikes over Australia with Harts Range having 1 flash/km²/yr.



M5. Fishers Ridge

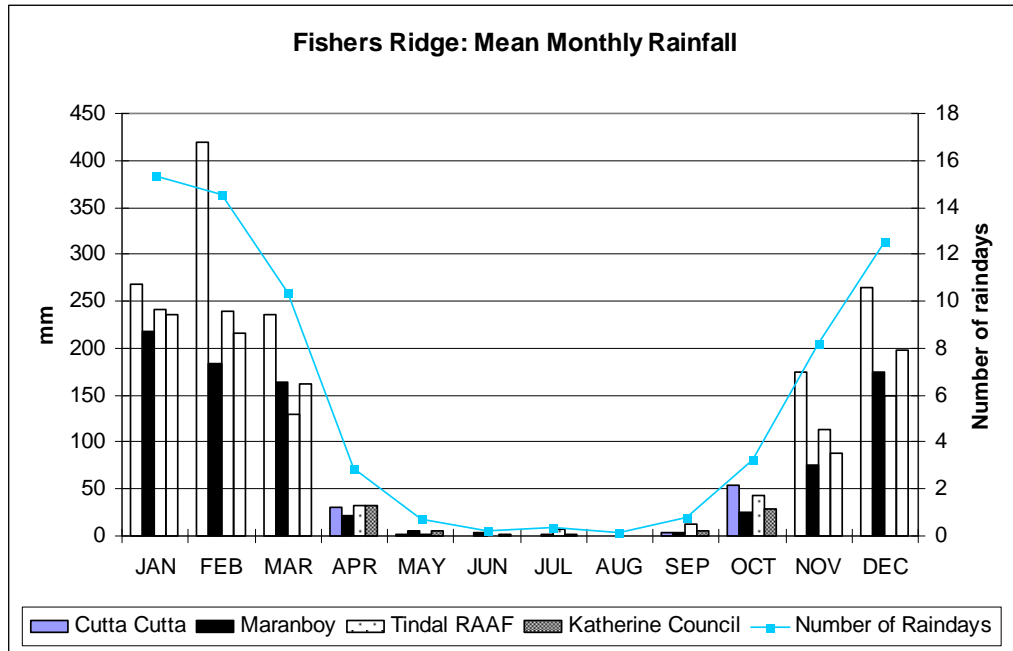
The Fishers Ridge is located approximately 40 km south-east of Katherine on Commonwealth owned Defence land. The site is surrounded by perpetual pastoral leases, freehold land, crown land leased for development purposes and vacant crown land.

The Fishers Ridge region has a sub-tropical climate with a distinct wet and dry season. The wet season is from January to early March with an average of 74 rain days/year in Katherine. Average temperatures for the region range from 25–35°C with extreme humid temperatures exceeding 40°C during November and December. In the dry season the temperature regularly drops down to 10°C overnight (Katherine Town Council, 2003).

M5.1 Rainfall

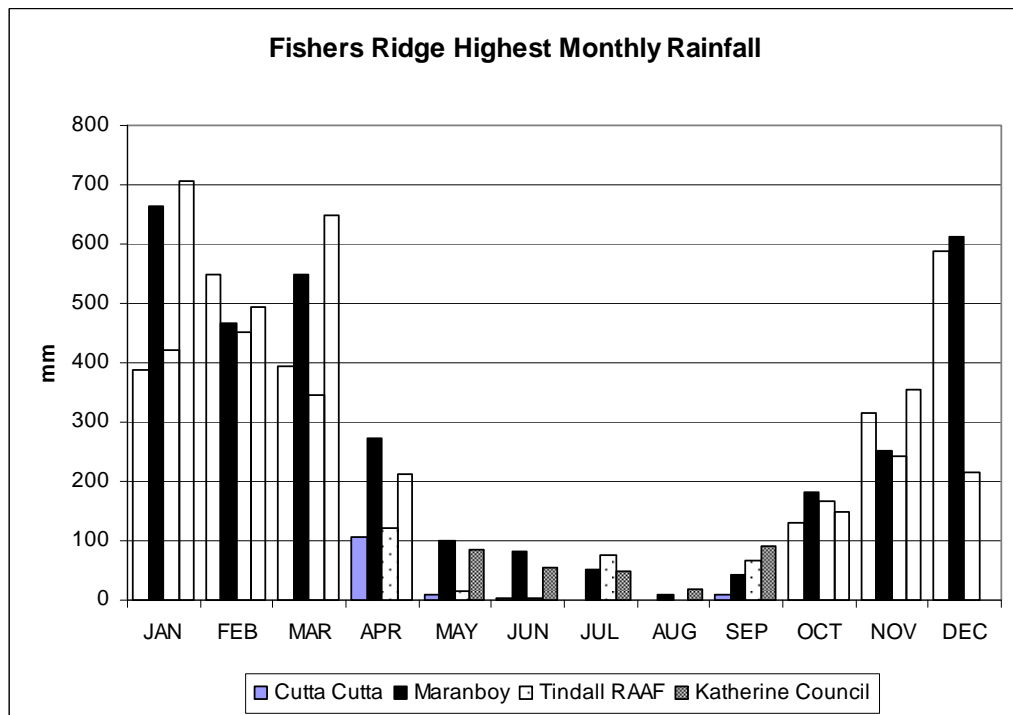
Figure M5.1 below clearly shows the distinct wet and dry seasons (wet season from December to March and dry season from April to October) typical of the northern part of the Northern Territory. Cutta Cutta weather station has measured the most annual rainfall of all the weather stations and is also the closest to the Fishers Ridge site (refer to Figure M2.3). On average in the wet season, the region experiences between 200–250 mm rainfall per month and in the dry season it experiences less than 10 mm. Likewise, on average the wet season experiences over 10 rain days per month while in the dry season it experiences less than one rain day per month. There is a stark contrast in rainfall between the wet and dry seasons within the Fishers Ridge region.

The extreme weather events for the Fishers Ridge region are shown below in Figure M5.2. The three highest rainfall months occurred at Katherine Council in January (year unknown) when 704.6 mm of rain was recorded, Maranboy in January 1998 when 664.8 mm of rain was recorded, and again at Maranboy in January 1997 when 611.4 mm were recorded. The highest daily rainfall at Cutta Cutta weather station (station closest to the Fishers Ridge site) was 195 mm in the month of December (year unknown).



Source: BOM (2006d, 2006e, 2006h, 2006i)

FIGURE M5.1
Fishers Ridge mean monthly rainfall



Source: BOM (2006d, 2006e, 2006h, 2006i)

FIGURE M5.2
Fishers Ridge highest monthly rainfall

Table M5.1 below shows the results of ARI values calculated as described for Mount Everard (Section M3.1). The ARI 1000 results ranging from 33.4 mm for a 5 minute duration and 573.3 mm for a 72 hour duration.

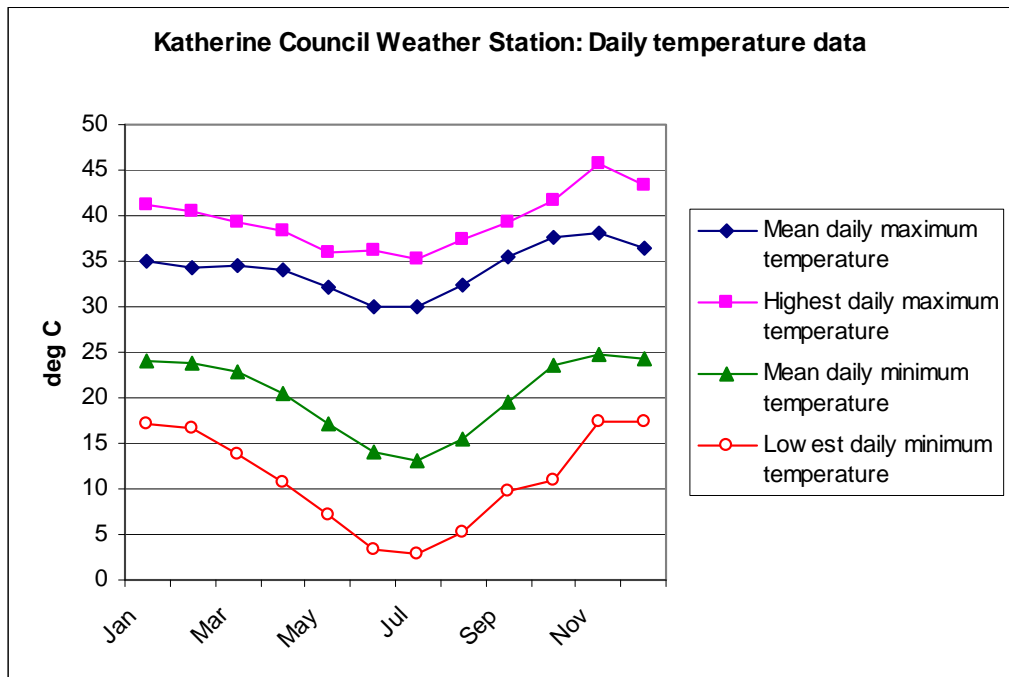
Table M5.1 Fishers Ridge rainfall ARI values in (mm)

Duration	ARI10	ARI20	ARI50	ARI100	ARI200	ARI500	ARI1000
5 mins	16.3	18.7	21.9	24.4	27.0	30.6	33.4
10 mins	25.5	29.2	34.2	38.1	42.1	47.6	51.9
15 mins	32.5	37.1	43.4	48.3	53.3	60.2	65.6
30 mins	47.3	54.0	62.9	69.9	77.0	86.8	94.6
1 hr	66.4	75.7	88.0	97.5	107.3	120.7	131.2
3 hr	87.9	100.8	118.1	131.6	145.4	164.6	179.7
6 hr	103.9	119.6	140.9	157.4	174.6	198.3	217.2
12 hr	123.0	142.3	168.4	188.8	210.0	239.5	263.0
72 hr	234.3	278.2	339.1	388.0	439.9	513.5	573.3

All durations of the ARI 1000 figures should be considered, as a 1 in 1000 year rainfall event which is only 5 minutes in duration and will have a higher intensity than a 1 in 1000 event that lasts for 72 hours (even though overall the 72 hr event will result in a greater volume of water). Therefore, all events need to be considered for drainage purpose. For more discussion on this issue please refer to the hydrology report (Parsons Brinckerhoff 2008).

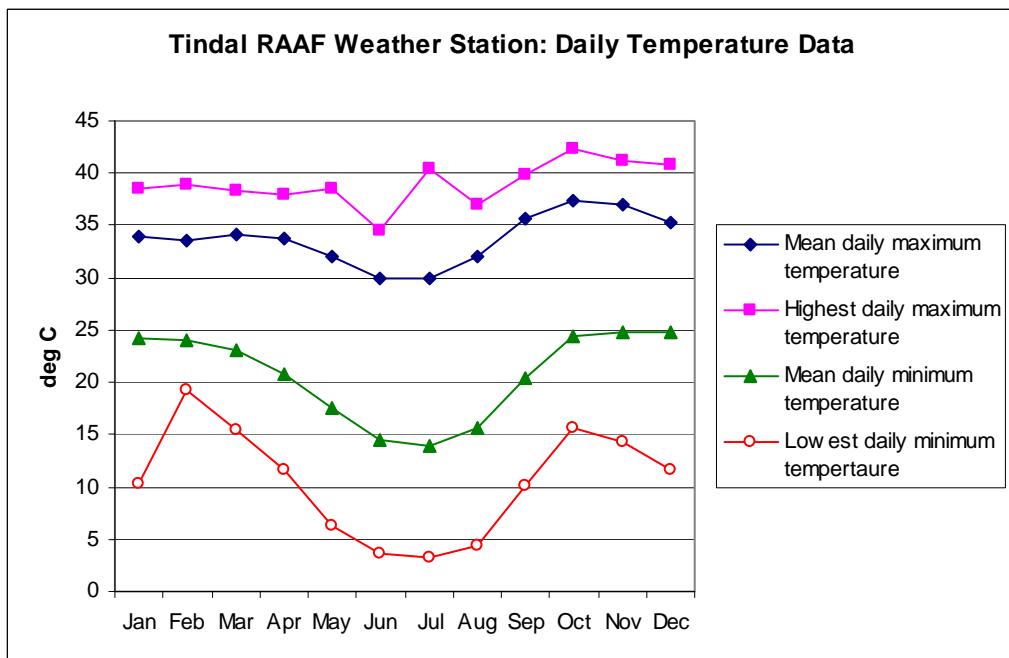
M5.2 Temperature

Fishers Ridge has hot temperatures all year round. At Katherine, winter to summer mean daily maximums range from 30°C in June/July to 38°C in November and mean daily minimums range from 13°C in July to 24°C in November, December and January (Figure M5.3). Figure M5.4 below shows Tindal RAAF weather station recording similar mean daily maximums and minimums suggesting these temperature figures are indicative of the region. The highest recorded temperature near the Fishers Ridge site is 45.6°C recorded in November at the Katherine Council weather station while the lowest recorded temperature was 2.8°C in July at the Tindal RAAF Base Weather Station. Overall, the Fishers Ridge region has a hot climate with average temperatures sitting between 20°C and 35°C all year round.



Source: BOM (2006d)

FIGURE M5.3
Katherine Council daily temperature data



Source: BOM (2006h)

FIGURE M5.4
Tindal RAAF daily temperature data

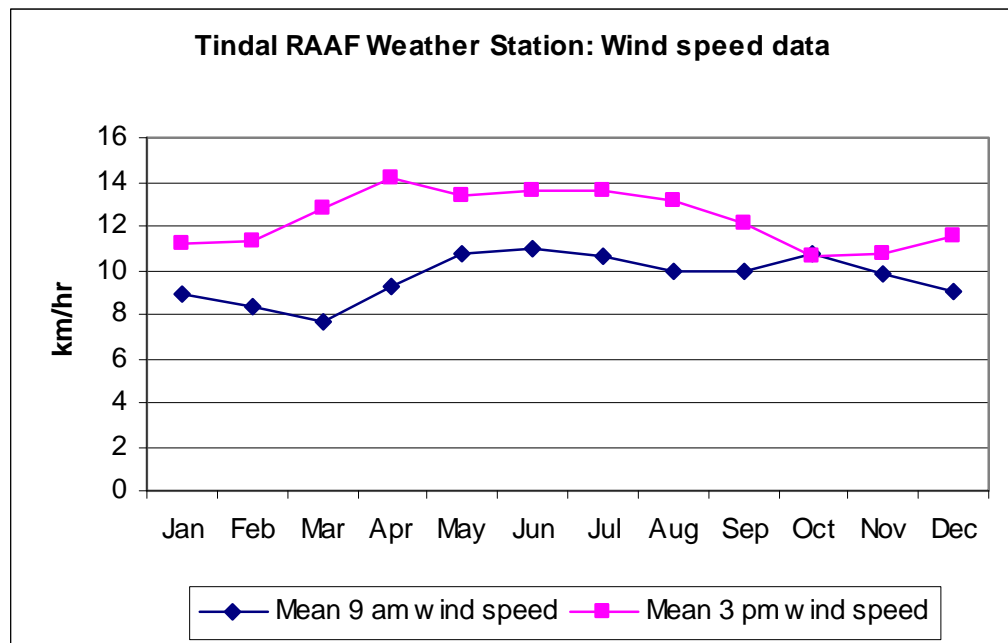
M5.3 Wind

Wind speed data for the Fishers Ridge region (as seen in Figures M5.5 and M5.6 below) shows that the wind is stronger in the afternoons (3 pm) than in the mornings (9 am). The 9 am measurements range from 3–11 km/hr and the 3 pm measurements range from 5–14 km/hr. The highest recorded wind gusts in the region are significantly higher than the recorded mean afternoon and morning wind speeds, as is expected. The wind gusts are stronger in the summer months with the highest measured gust at the Tindal RAAF weather station being 88.9 km/hr in December and the lowest recorded being 44.3 km/hr in July (Figure M5.7 below).

The wind rose data at both Tindal RAAF and Katherine Aviation Museum weather stations are very similar. They both show a north-westerly from December through to February, an easterly from March to August and a north-westerly in the morning and south-easterly in the afternoon from September to November (BOM, 2006d, 2006h).

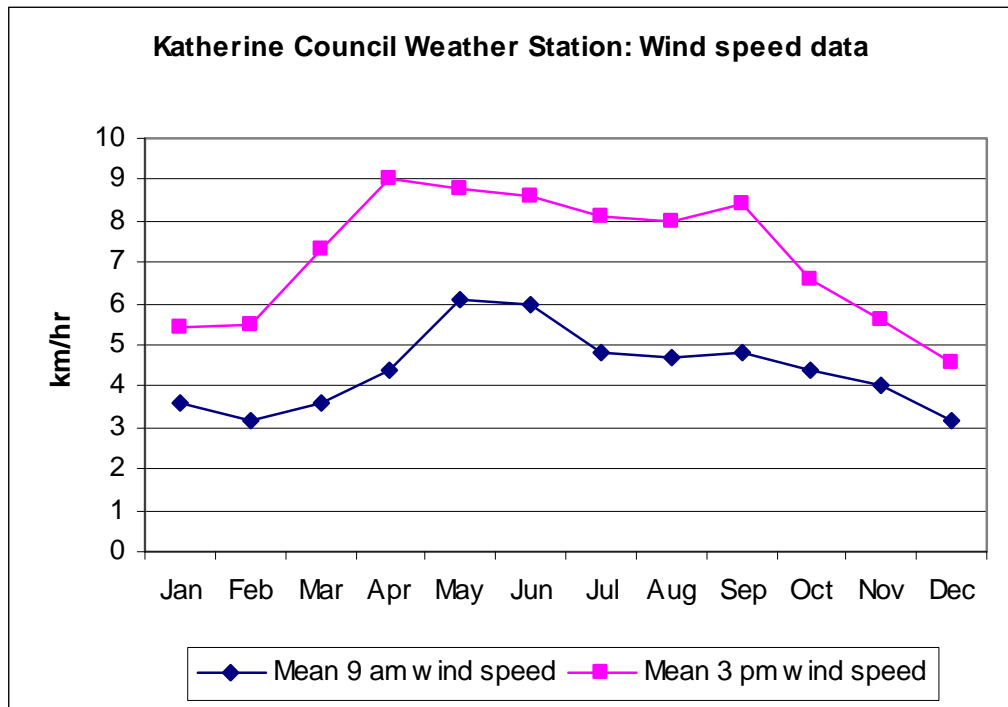
M5.4 Relative humidity

The relative humidity at the Fishers Ridge region is generally higher in the morning (9 am) compared to the afternoon (3 pm) (refer to Figures M5.8 and M5.9). The most humid month is February with over 80% humidity at 9 am and 58% humidity at 3 pm. Over a year the humidity is lowest in winter months and highest towards the end of summer.



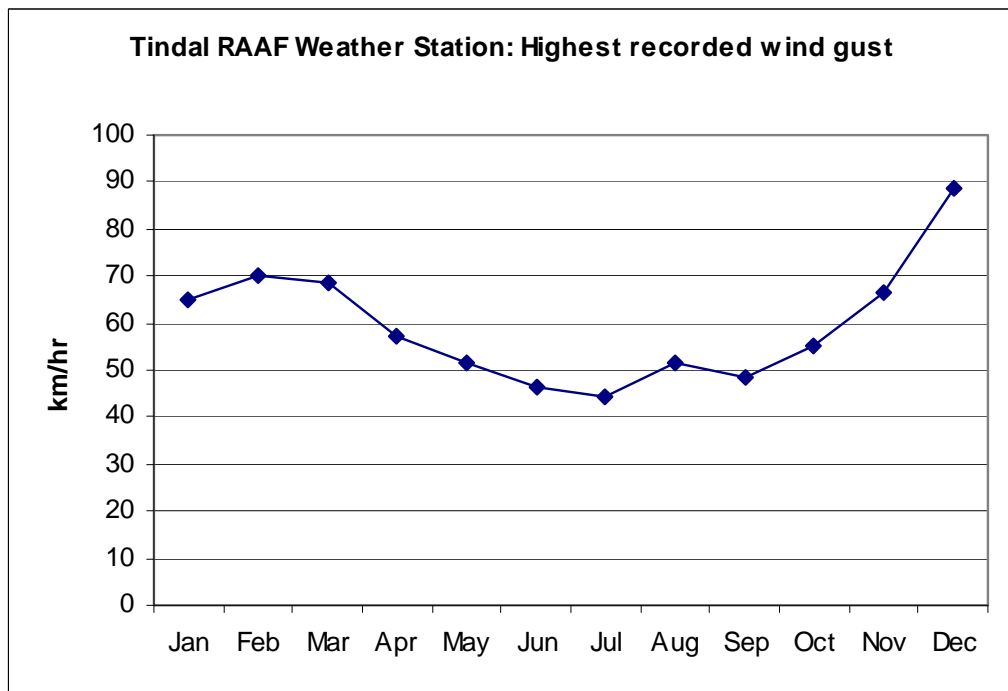
Source: BOM (2006h)

FIGURE M5.5
Tindal RAAF wind speed data



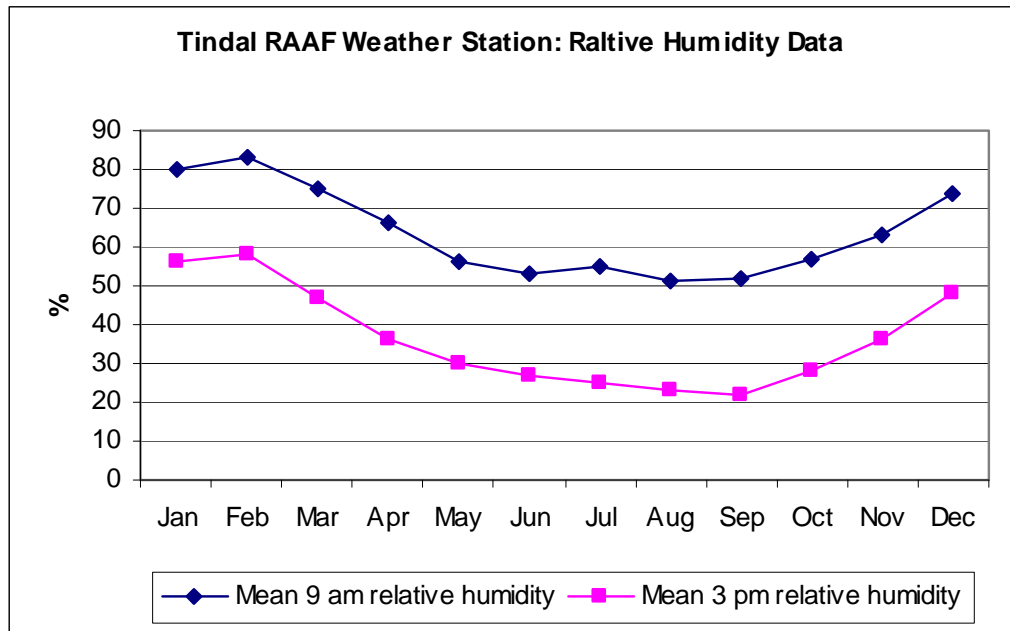
Source: BOM (2006d)

FIGURE M5.6
 Katherine Council wind speed data



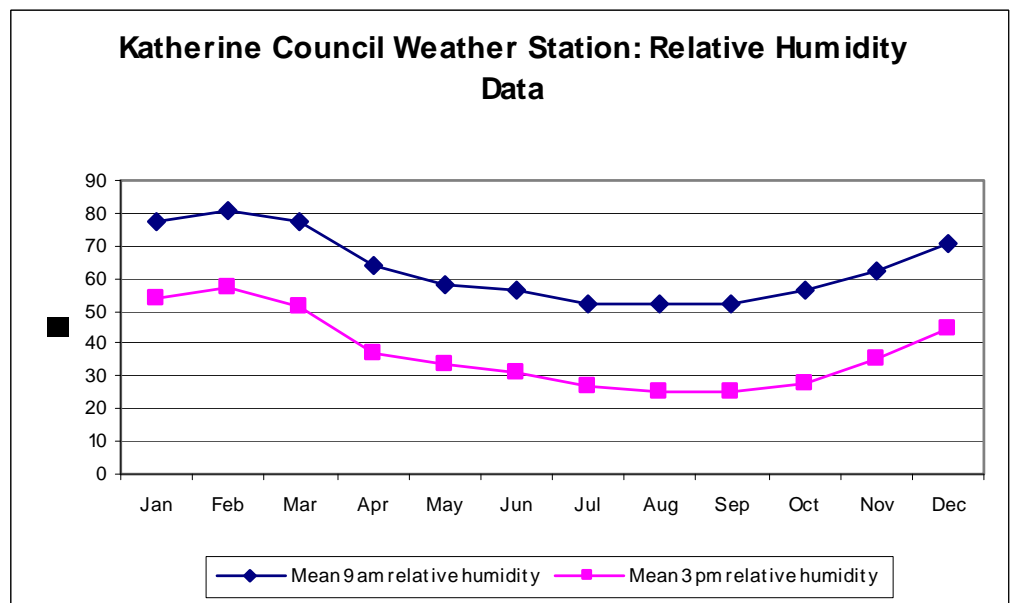
Source: BOM (2006h)

FIGURE M5.7
 Tindal RAAF highest recorded wind gusts



Source: BOM (2006h)

FIGURE M5.8
Tindal RAAF relative humidity data



Source: BOM (2006d)

FIGURE M5.9
Katherine Council relative humidity data

M5.5 Extreme weather

M5.5.1 Tropical cyclones

It is unlikely that the Fishers Ridge region will be directly affected by a tropical cyclone (TC) due to its location inland and a cyclone's nature to dissipate over land. However, it is possible in the future the region will be affected by residual weather conditions created by a cyclone as it has in the past. For instance, Tropical Cyclone Tracy, which hit Darwin in Christmas 1974 and continued travelling south-east inland, had completely dissipated by the time it reached the Roper River, east of Katherine. There are no records of the weather conditions in the Fishers Ridge region during this time, but it is likely that it would have been affected by high winds and rainfall.

It is hard to assess the effect a tropical cyclone will have on the Fishers Ridge region from a desktop study, however, it is likely that tropical cyclones will affect the region. The most recent tropical cyclones that affected the Northern Territory and were considered 'severe weather events' by the Bureau of Meteorology were TC Monica (16–25 April 2006), TC Glenda (15–31 March 2006), TC Ingrid (6–17 March 2005) and TC Steve (27 February – 11 March, 2000).

M5.5.2 Floods

Surface water hydrology including a consideration of flooding is discussed in the hydrology report (Parsons Brinckerhoff 2008) and is not considered in detail here. The Fishers Ridge region is prone to flooding during high rainfall events which are known to occur, especially when the Northern Territory is subject to extreme tropical weather events. One of the worst floods in the Northern Territory occurred due to a 3-day long rainfall event which resulted from TC Les moving inland towards Katherine on the 24 January, 1998. As a result of the cyclone losing energy as it moved inland it proceeded to drop large amounts of rain over the Katherine region. Over a three-day period 400–500 mm of rain fell in areas of the Katherine, Roper and Daly River catchments. This is reflected in the records at Maranboy weather station which measured 664.8 mm of rain in January 1998 (see Figure M5.2).

The BOM data collected in Section M5.1 shows that high rainfall events do occur, with 7 occurrences of >500 mm of rainfall measured in a month at the weather stations used. Due to Fishers Ridge being positioned in both the Daly and Roper River catchments and is near the Katherine River, it is likely that when high rainfall events occur (the weather stations reported on showed 7 occurrences of over 500 mm of rainfall in a month) the region will flood.

M5.5.3 Bushfires

Desktop investigations found that the Fishers Ridge site is within a Northern Territory fire protection zone. In this zone a permit is required prior to lighting any type of fire. Accordingly, there is a total fire ban at Fishers Ridge and its surrounds all year round. The fire season for this region is in the drier months in winter through to spring. While desktop investigations could not find any specific occurrences of bushfires within this region, it is known they occur.

As an example during geotechnical investigations a site team visited Fishers Ridge from 28 July 2006 to 4 August 2006. When the team arrived on site on 28 July a bushfire was approaching the Fishers Ridge boundary. The fire continued to burn through the site and was still burning when the team left on the 4 August.

M5.6 Air quality

There is no baseline National Pollutant Inventory (NPI) data as part of the National Environment Protection Measures (NEPM) for the region. The only NPI monitoring stations are in the far north of the Northern Territory and in Alice Springs. Despite this the general air quality of the Fishers Ridge region is expected to be high. This estimate is based on:

- the isolated and remote location of the region
- the main surrounding land use is agricultural, not urban residential or industrial
- there being no nearby point sources of pollution
- the fact that the region has high ground cover, limiting dust.

M5.7 Lightning

Lightning at Fishers Ridge is very common especially during the summer storm season. Figure M3.11 below shows the density of lightning strikes over Australia with Fishers Ridge having 6 flashes/km²/yr.

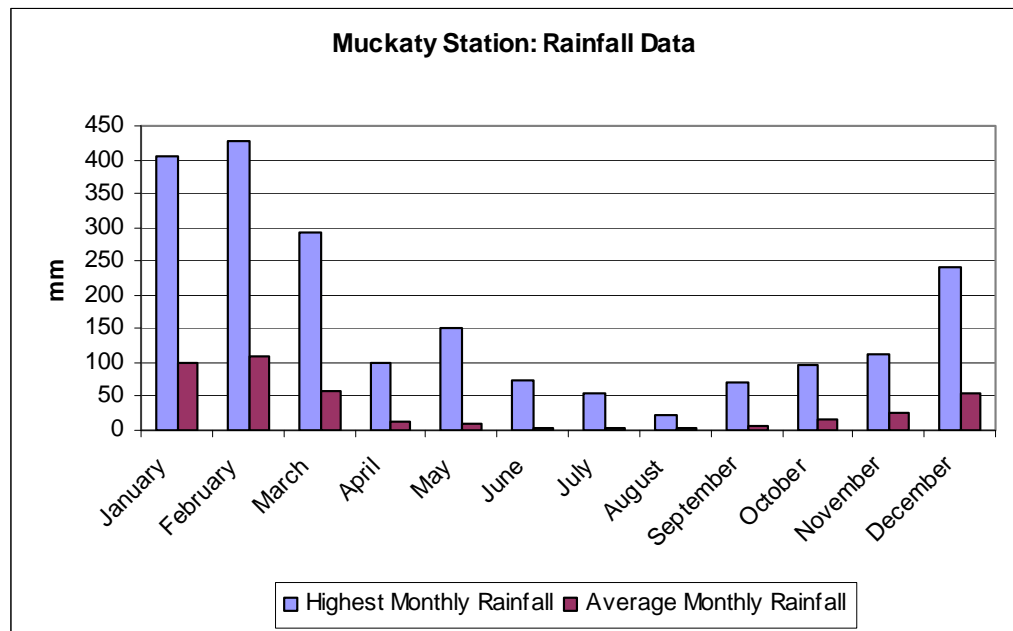


M6. Muckaty Station

The Muckaty Station site is located approximately 110 kilometres north of Tennant Creek in a region with a sub-tropical climate with distinct wet and dry seasons. The wet season is from January to early March with an average of 44 rain days/year in the region. On average in the wet season, the region experiences between 50–125 mm rainfall per month and in the dry season it experiences less than 10 mm. Average temperatures for the region range from 20–35 degrees during the year. The site is located within a Grassland Zone (approximately 100 km north of a Desert Zone) according to the Koeppen Classification System.

M6.1 Rainfall

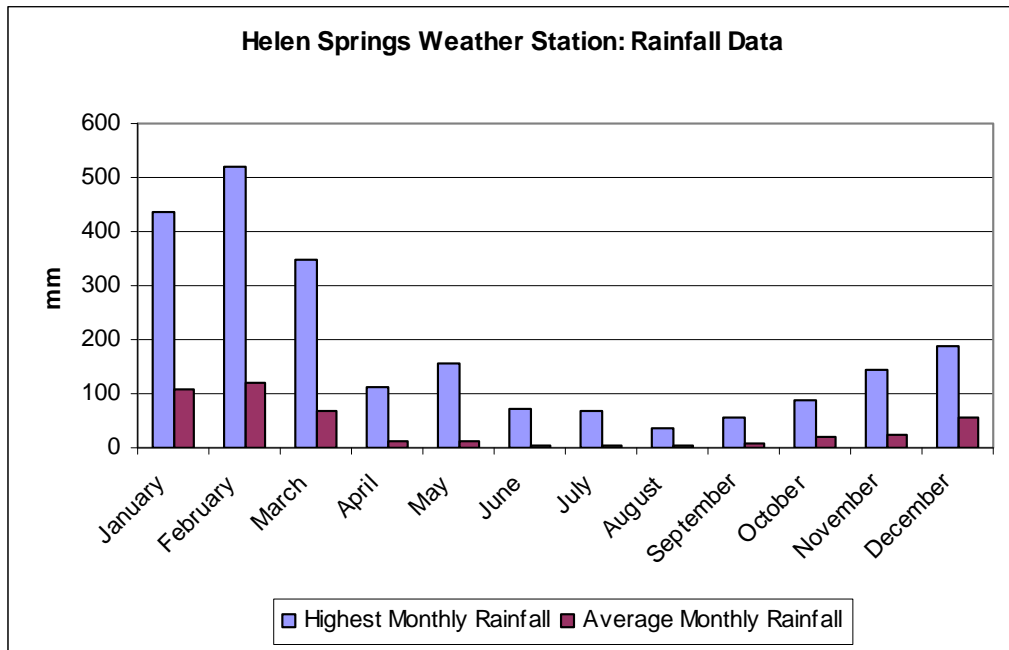
Figures M6.1 to M6.5 below show the monthly rainfall patterns at each of the analysed weather stations. They all show a similar annual rainfall pattern with January to March being the wettest months and April to September being the driest months. February is the wettest month of the year with average rainfall recorded between 80–125 mm at each weather station, while August is the driest month with average rainfall between 0–5 mm.



Source: BOM (2007c)

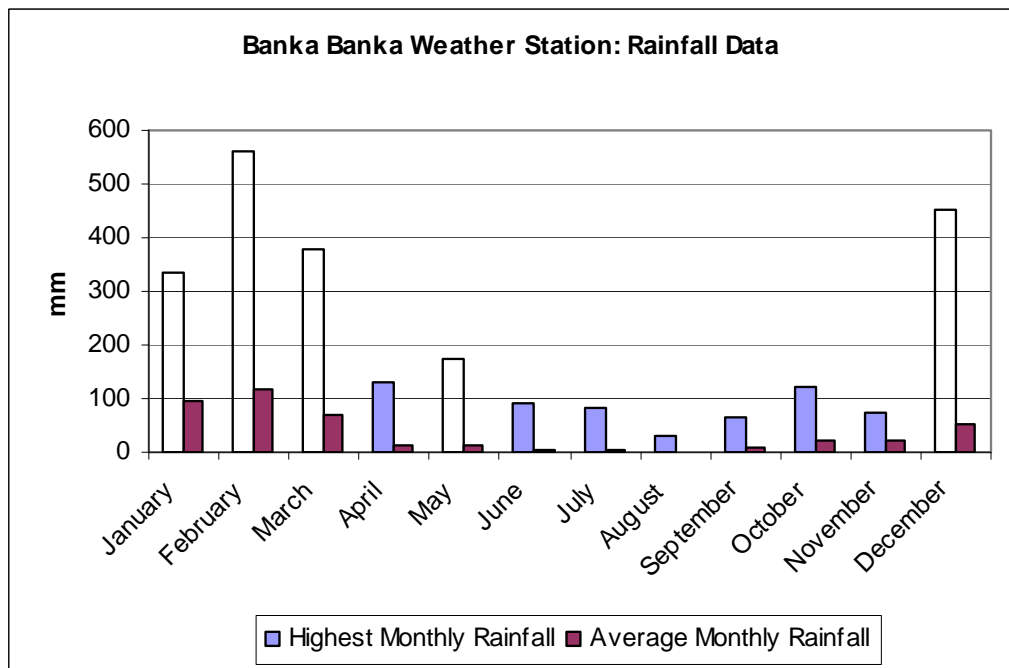
FIGURE M6.1
Muckaty Station weather station monthly rainfall data

The two highest rainfall months both occurred in February at Banka Banka (Figure M6.3) and Helen Springs (Figure M6.2) weather stations. Banka Banka recorded 561.9 mm in February 1967 and Helen Springs recorded 519.4 mm in 1993.



Source: BOM (2007c)

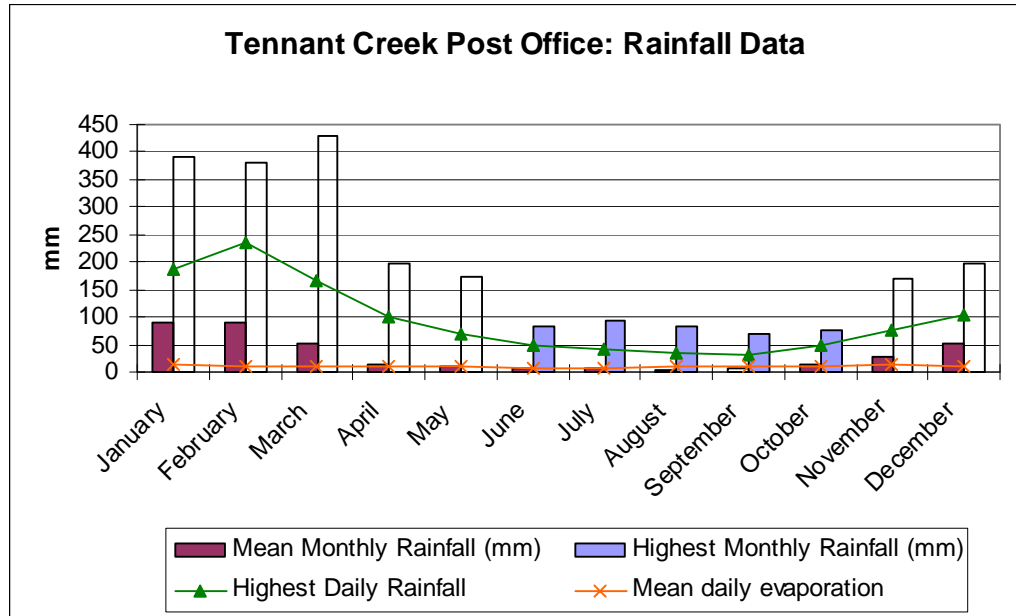
FIGURE M6.2
Helen Springs weather station monthly rainfall data



Source: BOM (2007c)

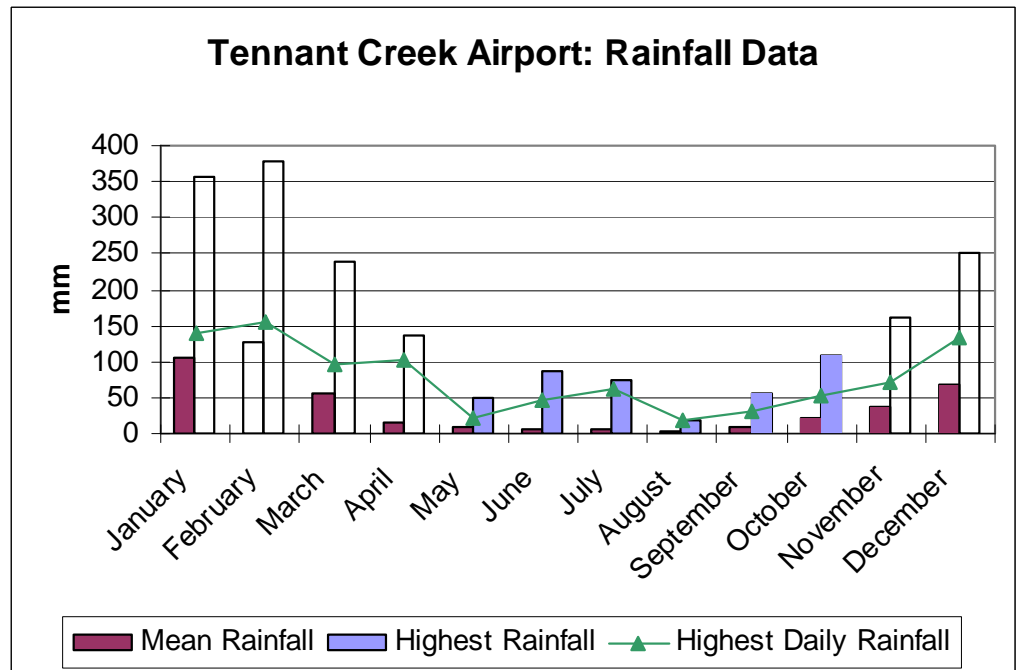
FIGURE M6.3
Banka Banka weather station monthly rainfall data

Highest daily rainfall data was only provided for the two Tennant Creek weather stations (Figure M6.4 and M6.5). The highest recorded daily rainfall at Tennant Creek Post Office was 234.2 mm in February 1910 and Tennant Creek Airport it was 153.6 mm also in February, although similar rainfall was recorded in January at both stations.



Source: BOM (2007a)

FIGURE M6.4
Tennant Creek Post Office weather station monthly rainfall data



Source: BOM (2007b)

FIGURE M6.5
Tennant Creek Airport weather station monthly rainfall data

Table M6.1 below shows the results of ARI values calculated as described for Mount Everard (Section M3.1). ARI 1000 results range from 25.4 mm for a 5 minute duration and 495.9 mm for a 72 hr duration. As expected from the site's location the values are lower than Fishers Ridge. For more discussion on this issue please refer to the hydrology report (Parsons Brinckerhoff 2008).

Table M6.1 Muckaty Station rainfall ARI values (in mm)

Duration	ARI10	ARI20	ARI50	ARI100	ARI200	ARI500	ARI1000
5 mins	12.1	14.0	16.6	18.5	20.5	23.3	25.4
10 mins	19.2	22.3	26.3	29.5	32.6	36.9	40.3
15 mins	24.7	28.6	33.8	37.8	41.8	47.3	51.6
30 mins	36.5	42.4	50.1	56.0	62.0	70.1	76.4
1 hr	52.4	60.7	71.7	80.1	88.7	100.3	109.3
3 hr	73.6	85.7	101.9	114.3	127.0	144.2	157.7
6 hr	90.3	105.6	126.0	141.7	157.9	179.8	197.1
12 hr	111.2	130.5	156.2	176.2	196.7	224.7	246.7
72 hr	197.2	237.3	292.3	335.9	381.5	445.0	495.9

All durations of the ARI 1000 figures should be considered, as a 1 in 1000 year rainfall event which is only 5 minutes in duration and will have a higher intensity than a 1 in 1000 event that lasts for 72 hours (even though overall the 72 hr event will result in a greater volume of water). Therefore, all events need to be considered for drainage purpose. For more discussion on this issue please refer to the hydrology report (Parsons Brinckerhoff 2008).

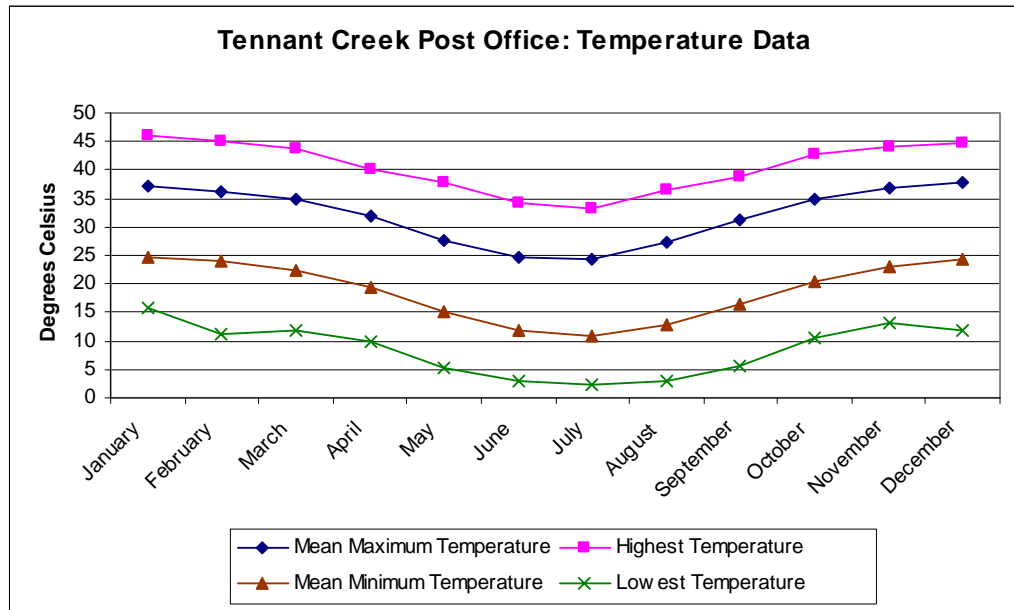
M6.2 Temperature

Temperature data was only available from the Tennant Creek weather stations (Figures M6.6 and M6.7). The hottest months of the year at both Tennant Creek weather stations were from October to March and the coolest were May to August. The highest mean maximum temperatures at the Airport and Post Office weather stations were 37.3 and 37.7°C respectively both in December. The lowest mean minimum temperatures were 12.2 and 11 at the Airport and Post Office respectively, both in July. In general, temperatures all year round site between 10–37°C.

In terms of extreme temperatures the hottest temperature recorded at Tennant Creek was 46.1°C in January 1939 at the Post Office weather station. The lowest temperature recorded was 2.4°C in July 1919 also at the Post Office.

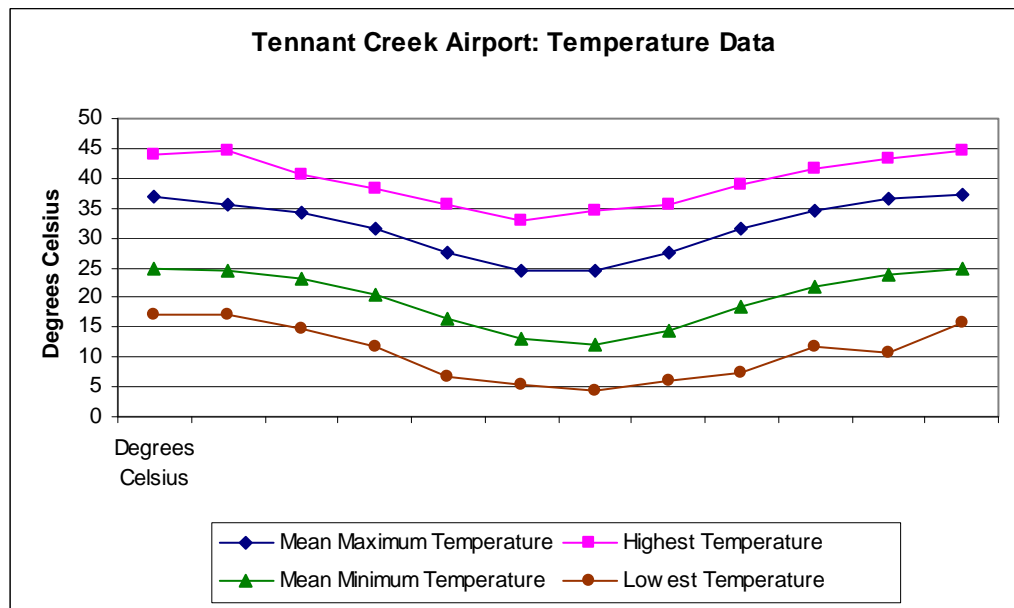
M6.3 Wind

As outlined in Table M2.4, wind speed data was only available for the Tennant Creek weather stations. At both the Airport and Post Office stations there was very little variation in recorded wind speeds throughout the year. At the Post Office (Figure M6.8) the mean 9 am recordings range from 10.5 km/hr in December to 19.1 km/hr in September. The mean 3 pm recordings range from 9.9 km/hr in February to 12.7 km/hr in April.



Source: BOM (2007a)

FIGURE M6.6
Tennant Creek Post Office daily temperature data



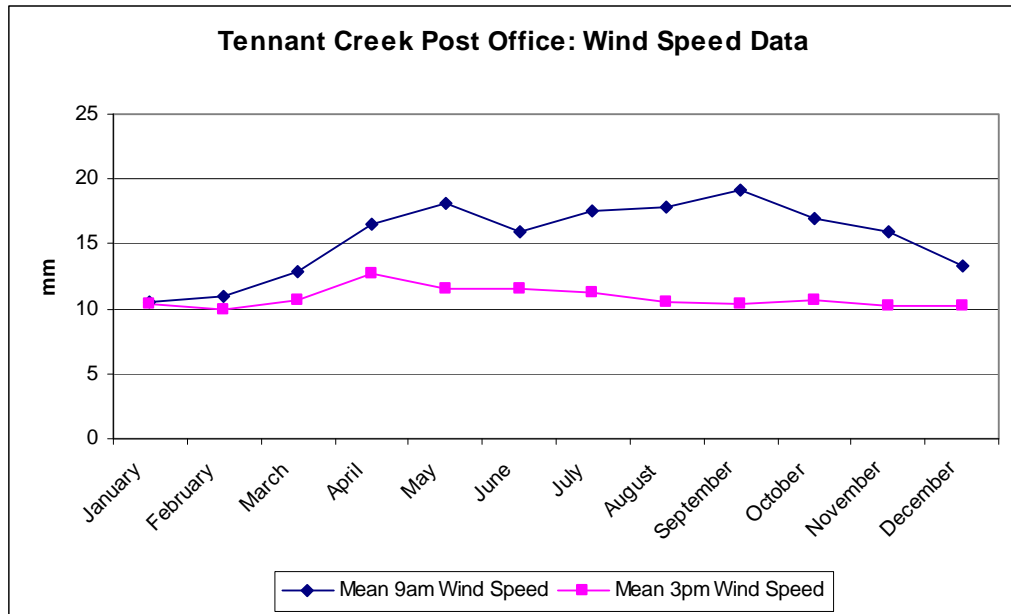
Source: BOM (2007a)

FIGURE M6.7
Tennant Creek Airport daily temperature data

At the Airport (Figure M6.9) the mean 9 am recordings range from 16.9 km/hr in February to 25.6 km/hr in September. The mean 3 pm recordings range from 13.9 km/hr in November to 17.6 km/hr in March.

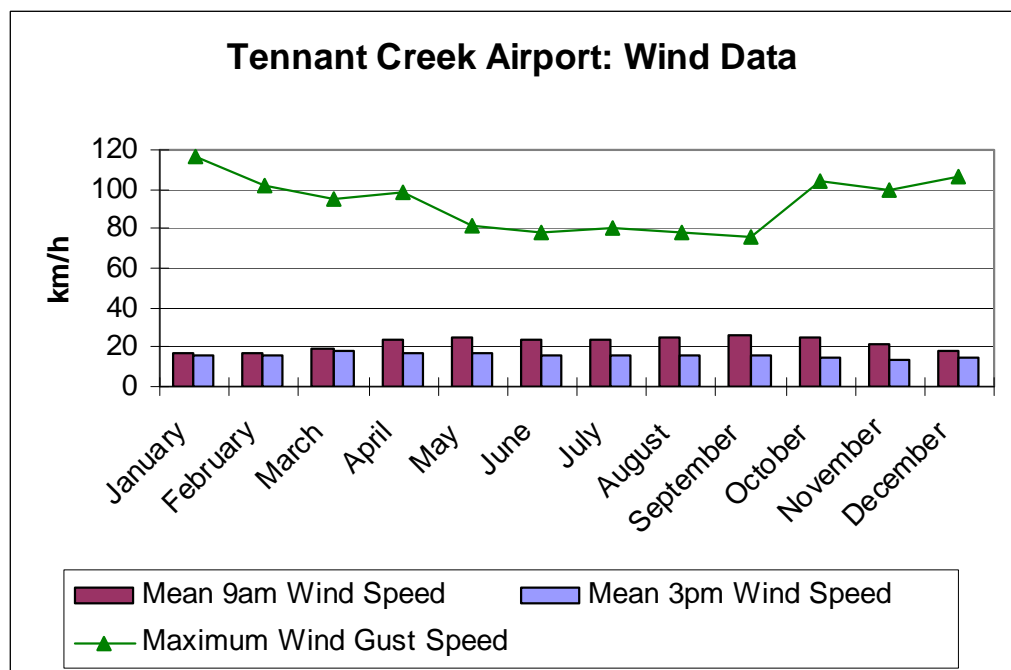
The Tennant Creek Airport weather station also records maximum wind gust speed (Figure M6.9). Maximum wind gust speed was higher in the summer months to coincide with the wet season with January having the fastest recorded wind gust at 117 km/hr (January 2004), while the winter months generally experience slower wind gusts with the lowest maximum wind gust speed being 76 km/hr (September 2005).

Wind roses were only available at Tenant Creek Post Office and Airport weather stations. The dominant wind direction at both weather stations is from the east and south-east. During summer months northerly winds picked up, however the easterlies still dominated.



Source: BOM (2007a)

FIGURE M6.8
Tennant Creek Post Office monthly wind speed data

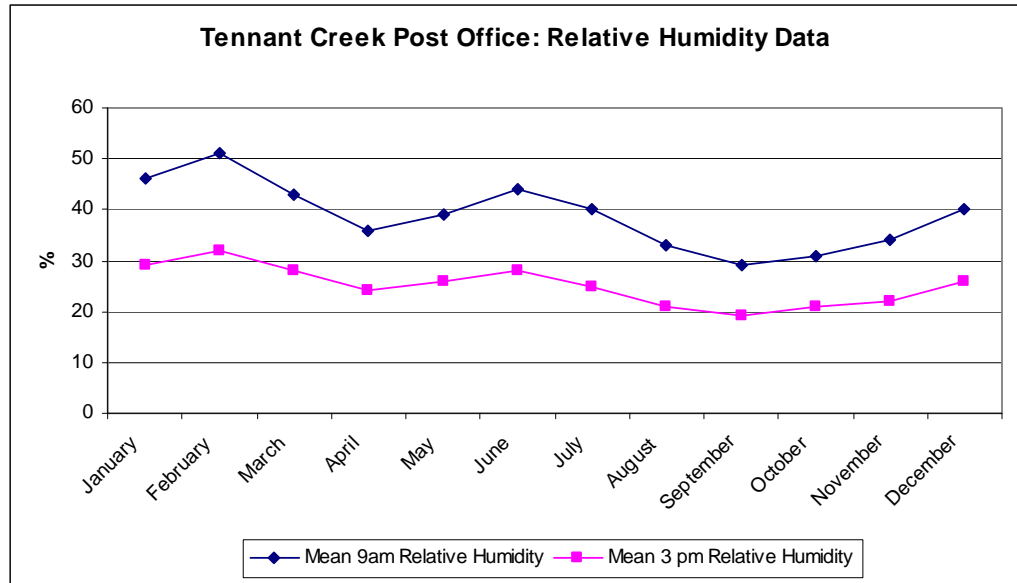


Source: BOM (2007b)

FIGURE M6.9
Tennant Creek Airport monthly wind data

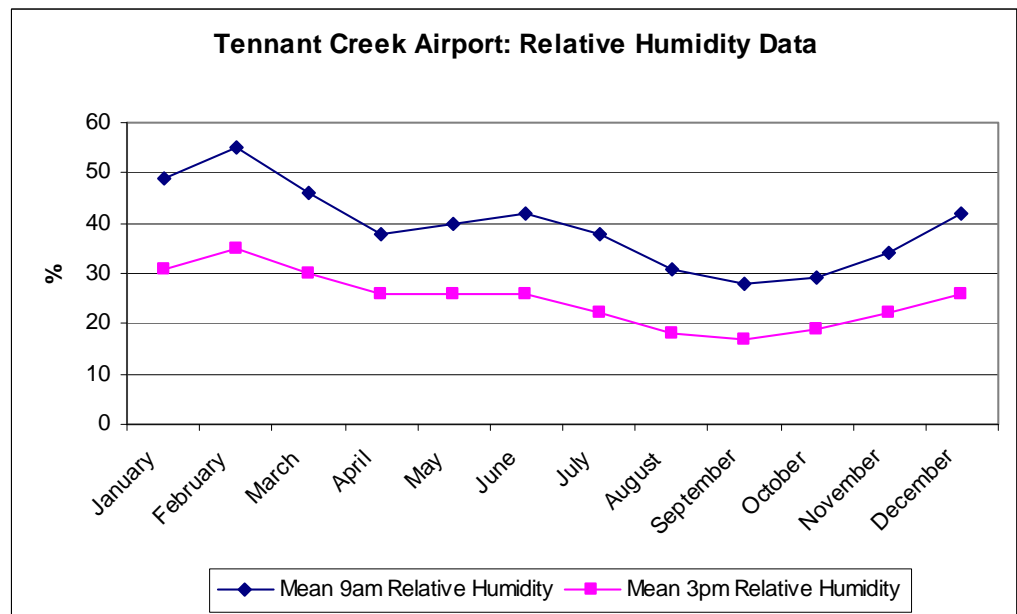
M6.4 Relative humidity

Relative humidity data was only available at the Tennant Creek weather stations. Both stations (airport and post office) showed very similar trends with regards to relative humidity (Figures M6.10 and M6.11). Humidity is always higher at the 9 am readings than the 3 pm readings. The months with the lowest relative humidity are April and September. Relative humidity is highest on average during January, February, March and June.



Source: BOM (2007a)

FIGURE M6.10
Tennant Creek Post Office mean daily relative humidity data



Source: BOM (2007b)

FIGURE M6.11
Tennant Creek Airport mean daily relative humidity data

M6.5 Extreme weather

M6.5.1 Floods

Flooding may occur in periods of high rainfall. However, Muckaty Station is not very prone to high rainfall events as there was only one month that the rainfall was just over 400 mm. Year to year flooding would not occur, but may occur in periods of extreme rainfall.

M6.5.2 Bushfires

Bushfires can and have affected the Muckaty Station region, including the surrounding areas such as Tennant Creek. The extreme temperatures encountered during the year would mean this is a fairly dry region and together these make ideal conditions for a bushfire to occur. However, as rainfall is low in this region, any vegetation should generally be sparse and hence the intensity of any fire that does occur will be low.

The pastoralist at Muckaty Station reported that bushfires are frequently used to manage vegetation growth for grazing purposes (R. Aylett 2008, pers. comm.).

Although, in years of unusually high rainfall, the growth of fire fuel is increased, this would increase the risk of severe bushfires in the region.

M6.5.3 Tropical cyclones

The Muckaty Station region will not be directly affected by tropical cyclones due to its distance inland. However, it may be indirectly affected by weather patterns created by tropical cyclones.

M6.6 Air quality

There is no baseline NPI data as part of the NEPM for the region. The only NPI monitoring stations are in the far north of the Northern Territory and in Alice Springs. Despite this, the general air quality of the Muckaty Station region is expected to be high. This estimate is based on:

- the isolated and remote location of the region
- the main surrounding land use is agricultural, not urban, residential or industrial
- there being no nearby point sources of pollution.

M6.7 Lightning

Data from the Bureau of Meteorology (Figure M3.11) shows that Muckaty Station experiences between 1–2 flashes $\text{km}^{-2}\text{yr}^{-1}$. Muckaty Station does not experience the full force of the tropical storms that cover the northern area of the state with lightning flashes, especially through the summer storm season.

M7. Discussion

M7.1 Rainfall

Based on average monthly rainfall records at each of the four sites, Fishers Ridge is the wettest site and Harts Range is marginally wetter than Mount Everard and Muckaty Station. These observations are the same when considering highest recorded rainfall with Fishers Ridge recording 704.6 mm, Harts Range recording 550–716 mm, Muckaty Station around 450 mm and Mount Everard recording around 350 mm.

Predicted ARI 1000 (worst case scenario) at each of the four sites consist of:

Table M7.1 Selected extreme ARI 1000 rainfall events

Site	5 mins duration	72 hr duration
Fishers Ridge	33.4 mm	573.3 mm
Harts Range	24.7 mm	553.2 mm
Muckaty Station	18.5 mm	495.4 mm
Mount Everard	26.2 mm	480.7 mm

Based on different durations the sites give different results, however, in general Fishers Ridge will experience the highest 1 in 1000 year rainfall event, Harts Range will experience the second highest events and Muckaty Station and Mount Everard would be the lowest.

M7.2 Temperature

In terms of temperature there is little to differentiate the Mount Everard and Harts Range sites. Fishers Ridge has similar maximum temperatures to the southern two sites, however temperatures do not get as low. The extreme temperature range at Harts Range and Mount Everard is the greatest at -5.6°C to 45.8°C and -7°C to 45°C respectively. The extreme range at Fishers Ridge is from 3°C to 46°C and Muckaty Station temperatures range from 2.4°C to 46.1°C . The daily mean temperature ranges are very similar at all three sites. Fishers Ridge daily means range from 13°C to 38°C ,

Harts Range from 5°C to 38°C, Mount Everard from 4°C to 36°C and Muckaty Station from 12°C to 37°C.

M7.3 Humidity

As with temperature, there is minimal difference in relative humidity between the southern sites (Harts Range and Mount Everard) and Muckaty Station. They are most humid during their wet season (winter) and the relative humidity ranges from approximately 30–60% at 9 am and from approximately 20–30% at 3 pm. Fishers Ridge has higher humidity with a range from approximately 50–80% at 9 am and from approximately 20–60% at 3 pm. The most humid time at Fishers Ridge is in summer (the wet season).

M7.4 Wind

Average wind speeds are considered neutral at each site as the facility will need to be designed to appropriate building codes for the region, this will include consideration of average wind effects. However, highest recorded wind gusts at each site are not considered neutral. Fishers Ridge and Harts Range have very similar highest recorded monthly wind gusts ranging from 45 km/hr (July) to 90 km/hr (December) and 50 km/hr (March and June) to 85 km/hr (January, July, November and December) respectively. Wind gusts at Mount Everard are significantly higher ranging from 80 km/hr (April) to 170 km/hr (November). At Muckaty Station the wind gusts speed varies from around 80 km/hr in May to September to 100–120 km/hr in the summer months. In considering the aspect of wind gusts, Mount Everard is the most impacted, Muckaty Station is moderately impacted while Fishers Ridge and Harts Range are both equally less impacted.

M7.5 Extreme events

M7.5.1 Bushfires

At both Mount Everard and Harts Range the annual risk of bushfires is low due to sparse vegetation coverage. However, bushfires do occur in these regions, especially after a high rainfall period followed by a dry period. This risk is minimised at Mount Everard by controlled burn offs when high fuel loads occur (after high rainfall). There is a much higher risk of bushfire at Fishers Ridge especially from winter to spring (dry season). Muckaty Station has a higher risk of bushfires due to the higher vegetation coverage of the site and the practice of lighting fires to control this vegetation for grazing purposes.

M7.5.2 Tropical cyclones

Fishers Ridge is the only site that could be affected directly by a tropical cyclone. Fishers Ridge has in the past experienced high winds and extreme rainfall as a result of a dissipating tropical cyclone. Harts Range, Mount Everard and Muckaty Station are



too far south for direct effects, although they could be indirectly affected by the weather system created by a former tropical cyclone.

M7.5.3 Lightning

Lightning is much more common at Fishers Ridge during the summer months than at any time at Harts Range, Mount Everard or Muckaty Station. This is a result of Fishers Ridge having a tropical climate and being subject to tropical storms throughout the summer (wet) season.



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M9. Statement of limitations

Scope of services

This environmental site assessment report (“the report”) has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Parsons Brinckerhoff (PB) (“scope of services”). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

Reliance on data

In preparing the report, PB has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report (“the data”). Except as otherwise stated in the report, PB has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (“conclusions”) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. PB will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to PB.

Environmental conclusions

In accordance with the scope of services, PB has relied upon the data and has not conducted any environmental field monitoring or testing in the preparation of the report. The conclusions are based upon the data and visual observations and are therefore merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of contaminants or emissions.

Within the limitations imposed by the scope of services, the assessment of the site and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

Report for benefit of client

The report has been prepared for the benefit of the Client and no other party. PB assumes no responsibility and will not be liable to any other person or organisation for

or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of PB or for any loss or damage suffered by any other party in relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

Other limitations

PB will not be liable to update or revise the report to take into account any events, emergent circumstances or facts occurring or becoming apparent after the date of the report.

The scope of services did not include any assessment of the title to nor ownership of the properties, buildings and structures referred to in the report, nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.