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3. CLIMATE AND NATURAL DISASTERS

3.1. Climate

This section addresses Section 3.1 of the TOR and describes the climatic factors that may impact the Project. Meteorological data from the Bureau of Meteorology (BoM) has been reviewed to describe the existing meteorological and climatological influences in the Project area. There are a number of BoM stations located in the region. The location of each meteorological station in relation to the Project is presented in Figure 3-1.

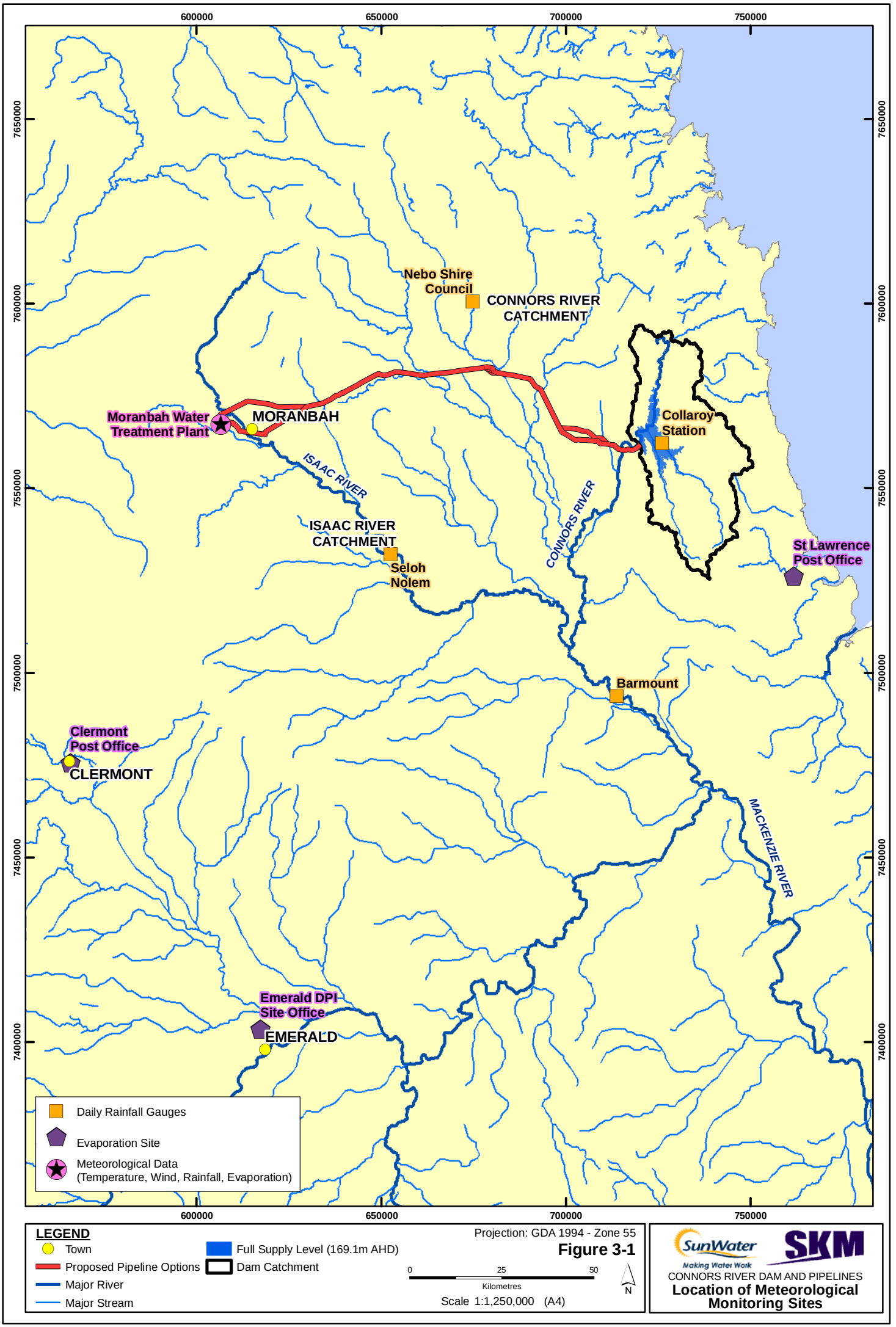
The Project area has a predominantly dry climate with warm to hot wet summers and mild dry winters. Table 3-1 presents a summary of the climate data for the Moranbah meteorological station. Moranbah typically has warm to hot days during summer with average maximum daytime temperatures of approximately 34 °C. Winter average maxima fall to 24 °C. Overnight temperatures vary from an average minimum daily temperature of 10 °C in winter to greater than 21 °C in summer. The maximum temperature on record is 45 °C (6 January 1994) and the minimum temperature on record is 0.2 °C (5 July 1990).

Mean 9 am relative humidity is generally highest during the months from January to June and lowest during September to November. Mean 3 pm relative humidity is lower than 9 am relative humidity throughout the year. August to November generally experiences the lowest 3 pm relative humidity.

Table 3-1 Climatic summary for Moranbah (BoM site 034038)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean daily maximum temperature (°C)	33.9	33.2	32.3	29.6	26.5	23.7	23.6	25.3	29.2	32.4	33.2	34.0	29.7
Highest temperature (°C)	45.0	41.1	40.4	36.0	33.9	31.9	31.0	32.9	38.0	40.5	42.7	42.5	45.0
Mean daily minimum temperature (°C)	21.9	21.8	20.2	17.6	14.4	11.2	9.8	10.9	14.1	17.7	19.5	21.1	16.7
Lowest temperature (°C)	14.9	15.5	14.3	6.0	5.0	1.1	0.2	3.0	5.9	11.2	11.9	15.0	0.2
Mean 9am air temp (°C)	26.4	25.8	24.7	22.1	18.9	15.4	14.6	16.5	20.5	24.0	25.2	26.4	21.7
Mean 9am relative humidity (%)	70	74	70	72	73	73	69	66	59	59	61	64	67
Mean 3pm air temp (°C)	32.7	31.9	31.3	28.6	25.7	22.8	22.8	24.4	28.3	31.3	32.1	32.8	28.7
Mean 3pm relative humidity (%)	42	47	41	43	43	44	39	35	30	30	34	39	39

Source: BoM 2008



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Rainfall and runoff varies across the Isaac-Connors catchment both spatially and over time, while the evaporation rate is high (DNRW, 2008a).

Rainfall is higher in the summer months. Rainfall tends to decrease with distance from the coast and from north to south, with mean annual rainfall ranging from less than 600 mm in the west of the catchment to over 1200 mm in the far northeast. The catchment experiences occasional cyclone activity, producing higher than average rainfall and subsequent flooding.

Average monthly rainfall at key sites across the catchment is shown in Figure 3-2 and demonstrates the seasonal variation experienced across the catchment.

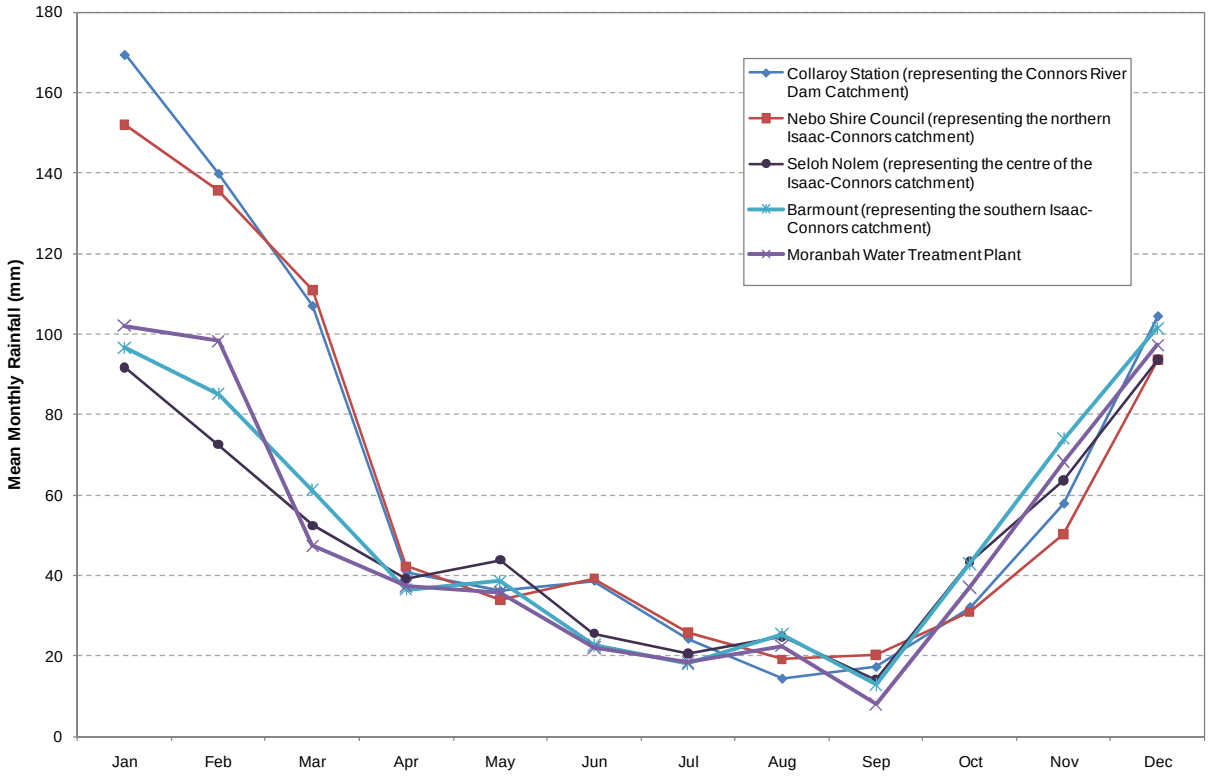

Figure 3-2 Average monthly rainfall at four BoM sites in Isaac-Connors catchment

Source: BoM 2008

Evaporation in the region is high and increases with distance from the coast. Mean annual evaporation ranges from 1700 mm at the coast to 2400 mm at Moranbah (Figure 3-3). Mean monthly evaporation exceeds mean monthly rainfall for each month; hence most of the streamflow in the area occurs during the summer months when high rainfall events take place.

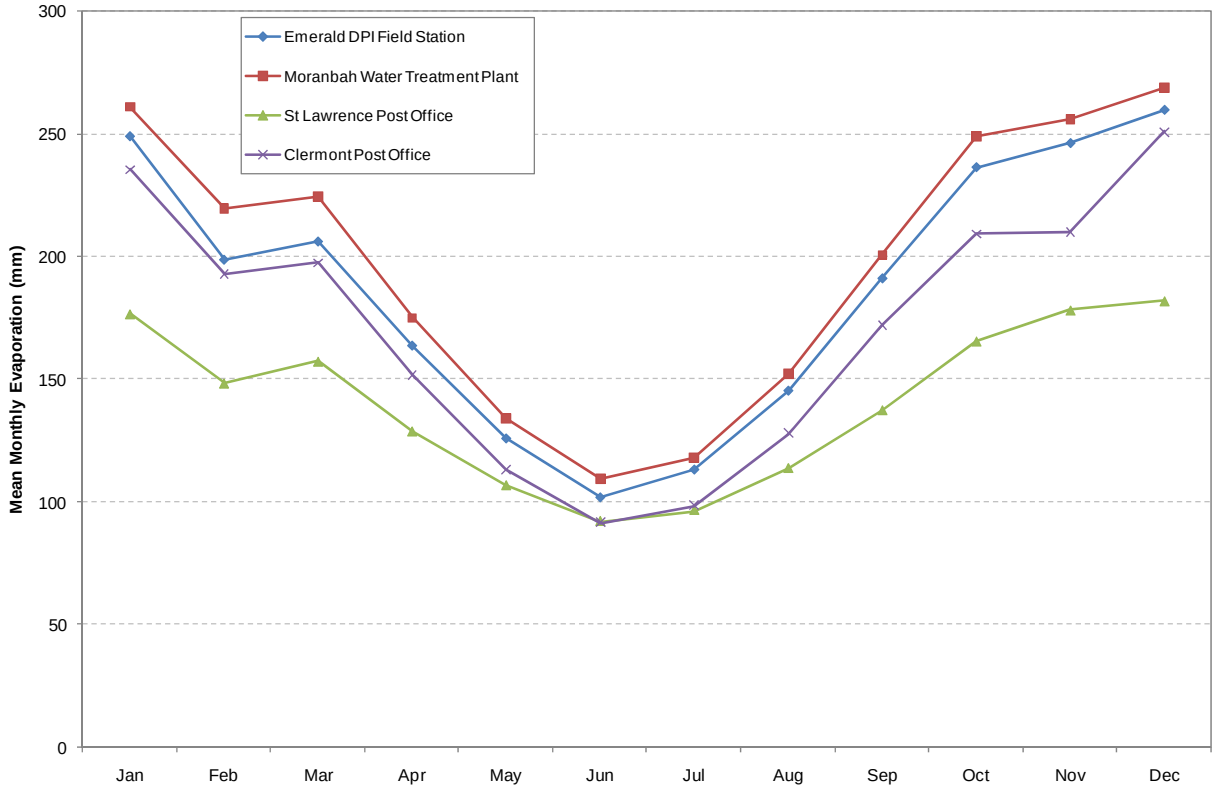

Figure 3-3 Average monthly evaporation at four BoM sites in Isaac-Connors catchment

Source: BoM (2008)

The prevailing wind patterns as recorded by the BoM at Moranbah from 2003 to 2005 are presented in Figure 3-4. Each windrose shows the direction the wind is blowing from. Winds at Moranbah are predominantly light south-easterlies in the early morning transitioning to stronger easterlies in the afternoon.

The general features of the wind environment at Moranbah are:

- winds are predominantly from the east and southeast;
- wind speeds are fairly light, generally less than 5 m/s;
- approximately 0.2% of wind readings recorded at Moranbah were more than > 11 m/s; and
- winds in the morning are generally light from the southeast, gaining in strength during the day from the east.

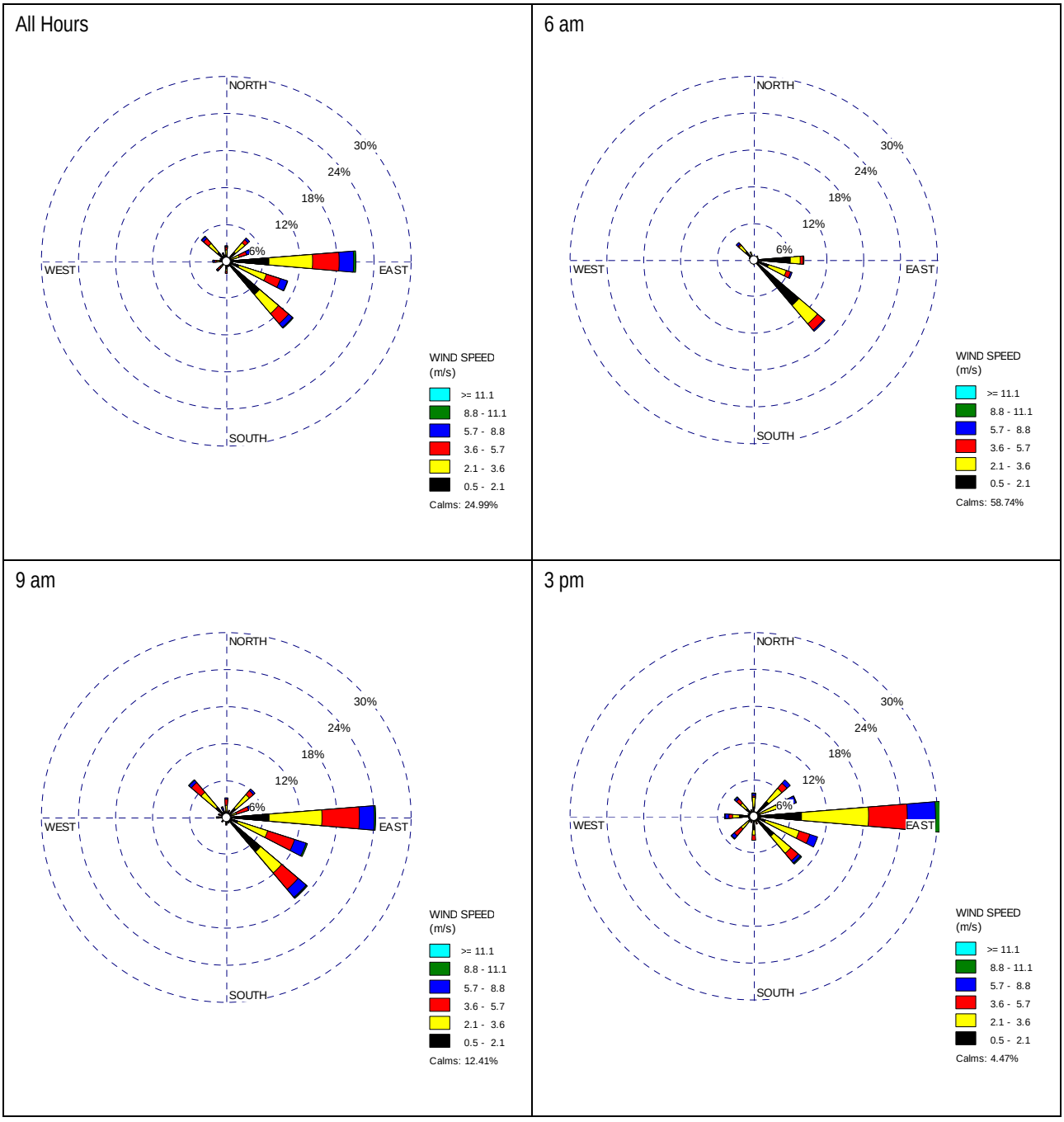

Figure 3-4 Windroses all hours and by time of day for Moranbah (BoM site 034038)

3.2. Natural disasters

This section discusses the vulnerability of the Project area to natural and induced hazards. The potential risk these hazards pose to the Project and appropriate means of management is assessed and presented in Section 26.

3.2.1. Bushfires

The bushfire risk analysis for Isaac Regional Council is presented in Appendix E-2.0. The vulnerability of the Project area is generally considered a medium risk by the Queensland Fire and Rescue Service. The potential risk of bushfires to construction and operation of the Project is presented in Section 26.

3.2.2. Flooding

The region experiences occasional cyclone activity, producing higher than average rainfall and subsequent flooding.

During construction, all flood events will either pass around the dam works via the diversion channel or over the works area. The diversion channel is intended to cater for only small events while the RCC construction technique will allow the dam structure to be overtopped without damage. Stream and river rises can occur quickly associated with wet season rainfall, particularly if related to cyclones (Figure 14-2 in Section 14).

3.2.3. Drought

The frequency of droughts in the region can be determined from the dam storage trace presented in Section 14. The dam storage trace shows the region has experienced three droughts since 1950; from 1963 to 1971, from 1983 to 1988 and from 2000 to 2007.

The potential impact of droughts on the yield of the dam is assessed in detail in Section 14.

3.2.4. Earthquakes

The record of earthquakes in Queensland indicates 245 earthquakes, registering above 0 on the Richter scale, in the Mackay map region between 1866 and 2000. The largest event in the vicinity of Mackay had a magnitude of 4.7 on the Richter scale and struck 20 km offshore in 1960.

No seismic activity has been recorded at the proposed dam site or water storage area. No seismic activity has been registered along the pipeline route to Moranbah.

The potential impact of seismic activity on the Project is assessed in Section 6.

3.2.5. Climatic extremes

The Project area generally does not experience climatic extremes. There have been only two cyclone events (Ivor in 1990 and Erica in 2003) in the broader region since 1985 (BoM 2009b). There were no gale force winds (>17 m/s) recorded at Moranbah during either of these cyclones. Climatic extremes for temperature and wind speeds are not considered a hazard for either the construction or operation of the Project.

3.3. Climate change

Changes in local weather patterns resulting from climate change have the potential to affect the operation of the Project in the future. A preliminary climate change risk assessment has been undertaken for the operation of the Project.

3.3.1. Methodology

The preliminary climate change risk assessment is based on a climate change scenario from Climate Change in Australia (CSIRO 2007). The 50th percentile changes for the medium emissions scenario in 2030, 2050 and 2070 and high emissions scenario are presented in Table 3-2.

Table 3-2 Potential change in climate for the Project area relative to 1990 for medium and high emissions scenario

Climate change parameter	2030	2050	2070
Increase in annual average temperature	+0.6 to +1 °C	+1.5 to +2 °C	+2 to +2.5 °C
Decrease in annual average rainfall	-2 to -5%	-5 to -10%	-5 to -10%
Change in seasonal average rainfall:			
▪ Summer	-2 to -5%	-2 to -5%	-5 to -10%
▪ Autumn	-2 to -5%	-5 to -10%	-10 to -20%
▪ Winter	-2 to -5%	-5 to -10%	-5 to -10%
▪ Spring	-5 to -10%	-10 to -20%	-10 to -20%
Increase in annual average potential evaporation	+2 to +4%	+4 to +8%	+8 to +12%

Source: CSIRO (2007)

3.3.2. Potential impacts and mitigation measures

The potential risk to the Project posed by each climate change parameter has been assessed and mitigation measures have been proposed, where appropriate, in Table 3-3.

The Project generally has a limited vulnerability to the impact of climate change with the greatest potential impact a reduction in yield as a result of decreased annual rainfall and increased evaporation.

Predicted increases in tropical cyclone intensity in Queensland have the potential to increase extreme daily rainfall and increase flood peaks. The dam will be designed to over-top in extreme events and will be able to withstand the associated loads. The potential downstream flooding impacts of the Project are assessed in more detail in Section 14.

Table 3-3 Potential impacts of climate change and proposed mitigation measures

Climate change parameter	Potential impact	Mitigation measures
Increase in annual average temperature	Potential for temperature increase to affect reliability of infrastructure or equipment (e.g. pumps) Potential to increase vulnerability to bushfires.	Infrastructure and equipment design will allow for extreme operating temperatures and conditions. Facilities and equipment will be inspected and tested for fire safety on a regular basis and relevant site staff will complete fire safety training during induction.
Decrease in annual average rainfall	Potential to reduce the yield from the dam. The potential impact of climate change on the yield of the dam is assessed in detail in Section 14.	Operational yield of the dam has been assessed conservatively. Connors Dam provides additional storage capacity and yield hence a buffer compared to the existing situation.
Change in seasonal average rainfall	Potential to reduce yield from the dam due to predicted decrease in rains during summer, autumn, winter and spring.	As for decrease in annual rainfall.
Increase in annual average potential evaporation	Potential to reduce the yield from the dam due to increase in average potential evaporation. Potential to reduce runoff to the dam due to increased catchment losses leading to reduced yield from the dam however this is partially offset by the forecast increase in rainfall intensity, hence runoff, in summer.	Operational yield of the dam has been assessed conservatively. Connors Dam provides additional storage capacity and yield hence a buffer compared to the existing situation.

The implications of potential climate change impacts on other aspects of the Project are discussed in the relevant sections, as follows:

- implications for nature conservation - Section 9.3;
- implications for water resource management - Section 14.2.2.6;
- implications for the Project's commercial viability - Section 25.3.3; and
- implications for hazard and risk management - Section 26.

3.4. Summary

The Project area has a predominantly dry climate with warm to hot wet summers and mild dry winters. The Project area has limited vulnerability to natural hazards. There is a medium bushfire risk and the region occasionally experiences some flooding associated with cyclone activity.

The Project generally has a limited vulnerability to the impact of climate change with the greatest potential impact a reduction in yield as a result of decreased annual rainfall and increased evaporation. The potential impacts of climate change on yield are assessed in more detail in Section 14.