CONTENTS

TABLES

FIGURES

3. CLIMATE AND NATURAL DISASTERS

3.1. Climate

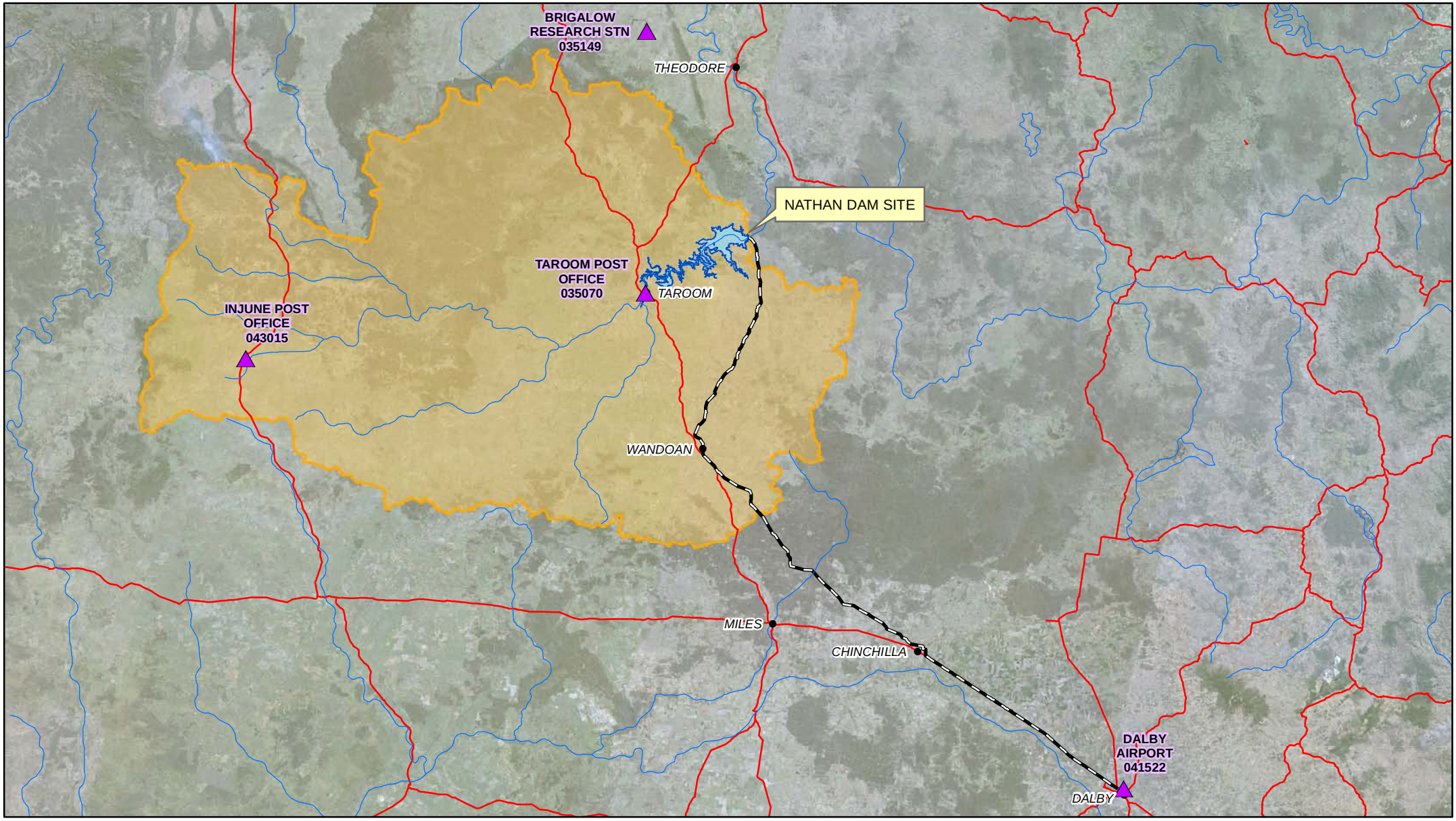
This section addresses Section 3.1 of the TOR and describes the climatic factors that may affect the Project. Meteorological data from a number of Bureau of Meteorology (BoM) stations has been reviewed to describe the existing meteorological and climatic influences in the Project area. The location of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

Data from the Taroom Post Office (BoM ref 035070), Brigalow Research Station (BoM ref 035149), Injune Post Office (BoM ref 043015) and Dalby Airport (BoM ref 041522) weather stations were used to characterise climatic conditions within the Project Area and catchment. The closest weather station to the dam site, Brigalow Research Station is located on the Dawson River approximately 30 km west north west of Theodore. Table 3-1 presents a summary of climatic information for the Taroom Post Office and Dalby Airport stations.

Table 3-1 Climatic summary of Taroom Post Office and Dalby Airport

Location	Variable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Taroom	Mean max temp (°C)	33.7	32.8	31.6	28.8	24.5	21.5	21	23	26.7	29.9	31.8	33.5	28.2
Dalby		32.6	31.3	30.2	27.4	23.3	20.2	19.7	21.7	25.6	28.5	30.1	31.7	26.9
Taroom	Highest temp (°C)	44	43.3	42	36.9	34.7	32.8	30	37	38.7	41.2	42.8	44	44
Dalby		41.7	41.5	39.7	35.2	32.9	27.8	27	34.2	35.8	39.5	40.5	41	41.7
Taroom	Mean min temp (°C)	20.6	20.4	18.1	14.1	9.7	6.3	5.1	6.5	10.3	14.6	17.5	19.6	13.6
Dalby		18.8	18.6	16.2	12.5	8.5	5.5	4.1	4.9	8.8	12.6	15.6	17.6	12
Taroom	Lowest temp (°C)	12.6	11.1	7.2	2.9	-3.3	-4.6	-5.6	-4	-2.8	2.2	5.2	8.7	-5.6
Dalby		10	10.6	5	0.6	-2	-4.6	-5.8	-6.2	-2	-0.2	2.5	8.4	-6.2
Taroom	Mean 9am temp (°C)	26.3	25.6	24.1	20.8	15.7	11.8	11	13.6	18.3	22.3	24.7	26.1	20
Dalby		25.2	24.3	22.8	19.7	15.2	11.6	10.8	13.2	17.8	21.1	23.3	24.7	19.1
Taroom	Mean 9am relative humidity (%)	64	67	66	67	72	76	74	67	59	56	57	60	65
Dalby		67	71	67	68	75	80	76	68	63	59	60	63	68
Taroom	Mean 3pm temp (°C)	32.3	31.5	30.5	27.7	23.7	20.6	20.1	22	25.8	28.8	30.6	32.1	27.1
Dalby		31.1	29.8	29	26.1	22.3	19.2	18.8	20.8	24.6	27.2	28.7	30.3	25.7
Taroom	Mean 3pm relative humidity (%)	41	46	42	40	43	45	42	38	33	34	37	38	40
Dalby		45	49	42	40	46	48	45	39	37	37	41	44	43
Taroom	Mean no. frost days (ground. temp ≤ -1°C)	0	0	0	0	0.9	3.5	7.8	4.9	0.8	0.1	0	0	18
Dalby		0	0	0	0	2	7.5	10.9	8.2	1.1	0.1	0	0	29.8

Source: BoM, 2010



LEGEND

- Towns
- BOM Weather Station
- Proposed Pipeline
- Major Road
- Watercourse
- Nathan Dam Catchment
- Full Supply Level (183.5m AHD)

Projection: GDA94 Zone 56

Figure 3-1

0 10 20 40
Kilometres

N

Scale 1:1,750,000 (at A4)

SKM SunWater Making Water Work

NATHAN DAM AND PIPELINES EIS

BoM Weather Stations

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3.1.1. Temperature and humidity

The area is characterised by warm summers (November through March) and relatively cool winters (June through August). January is typically the hottest month of the year and July the coldest.

Relative humidity is subject to seasonal and diurnal variations. The 9am relative humidity tends to be higher in winter than summer in both locations. The 3pm relative humidity is noticeably lower in spring than all other seasons. Frosts are relatively common during winter, although more prevalent in the south.

3.1.2. Rainfall

Mean annual rainfall does not vary significantly across the Nathan Dam catchment and along the pipeline route and is in the range of 600-700 mm. Most rainfall across the region occurs in late spring and summer. Average monthly rainfall at key sites across the catchment is shown in Figure 3-2 and demonstrates the seasonal variation experienced across the catchment.

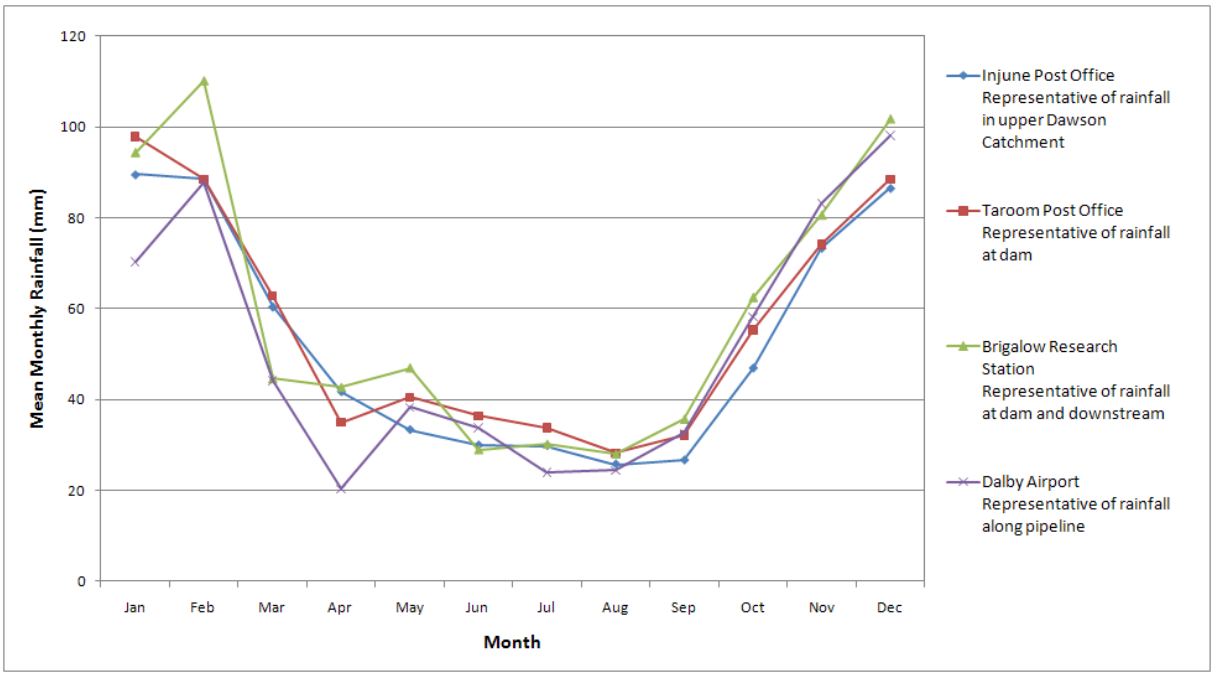


Figure 3-2 Average monthly rainfall at the reference sites

Source: BoM, 2010

3.1.3. Evaporation

Mean annual evaporation in the region ranges from around 2110 mm at Brigalow Research Station to 2260 mm at Dalby. Mean monthly evaporation (Figure 3-3), exceeds mean monthly rainfall for each month.

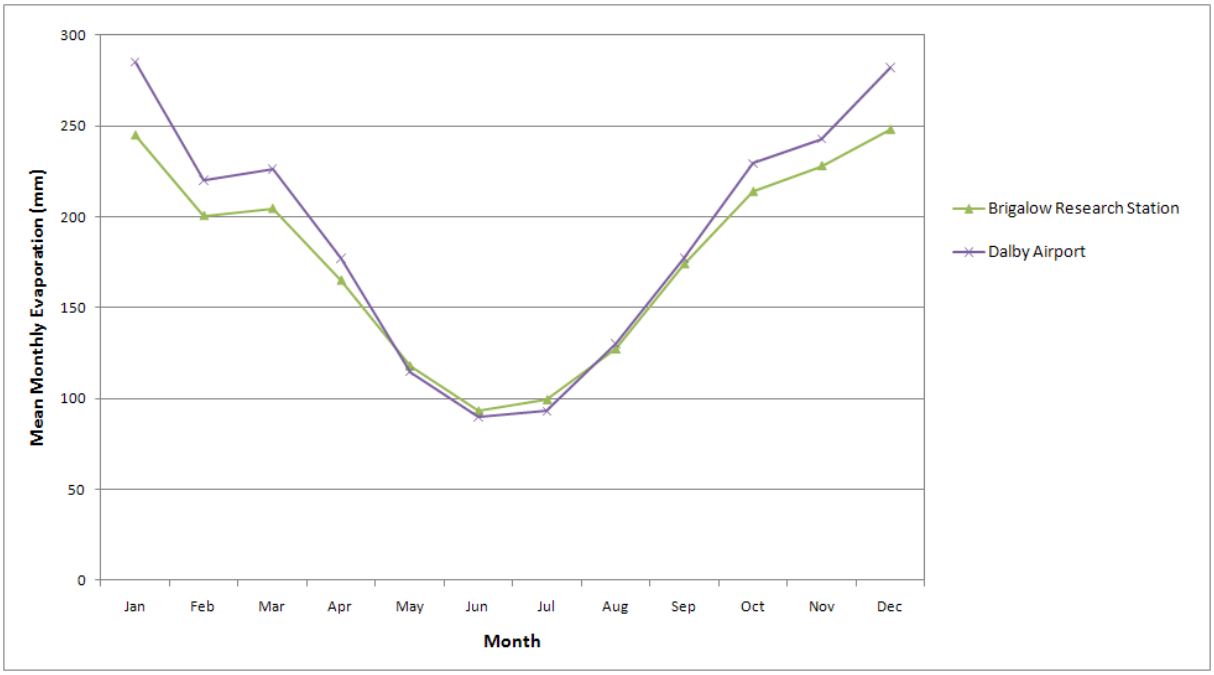
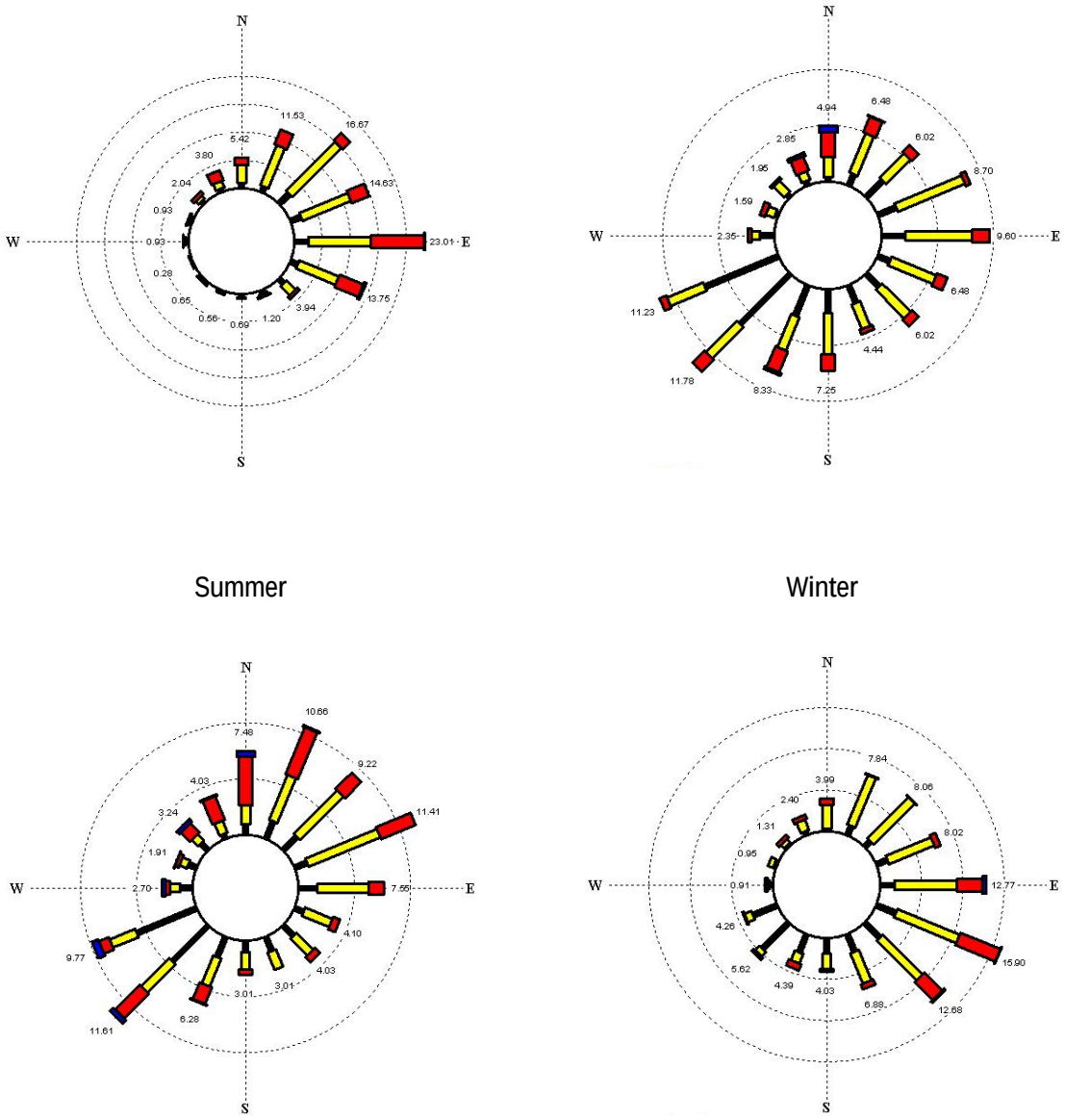


Figure 3-3 Average monthly evaporation at the Brigalow and Dalby reference sites

Source: BoM, 2010

3.1.4. Wind

From the wind roses (Figure 3-4) it can be clearly seen that the predominant winds are from the east and the north-east while there are winds blowing from the south-west and the south-east direction during spring and autumn respectively. North easterlies are the more dominant winds for most of the day, except during the afternoon period where stronger winds tend to come from the east and south-east.



Summer

Winter

Spring

Autumn

Figure 3-4 Seasonal wind roses for Taroom by season

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 Chapter 26.

3.2.1. Bushfires

The proposed dam and pipeline are located within a low to medium risk bushfire hazard area (Rural Fire Service, 2008) (Figure 3-5). Land within and adjacent to the floodplain of the Dawson River is classed as a low bushfire hazard but those areas along the pipeline route that are uncleared or have significant regrowth have a medium bushfire hazard rating. The potential risk of bushfires to construction and operation of the Project is presented in Chapter 26.

3.2.2. Flooding

Flooding in the Fitzroy region typically occurs in summer or early autumn, in association with tropical cyclones, tropical troughs/lows and deep tropical lows (Grootemaat 2008, p. 93). These weather systems can produce very high rainfall totals over a short period of time. The region experiences intense rainfall events and subsequent flooding on a fairly regular basis.

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.

3.2.3. Drought

The frequency of droughts in the region can be determined from the dam storage trace presented in Figure 14-29 in Chapter 14. The dam storage trace shows the region has experienced three significant 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 14.2.2.7.

3.2.4. Earthquakes

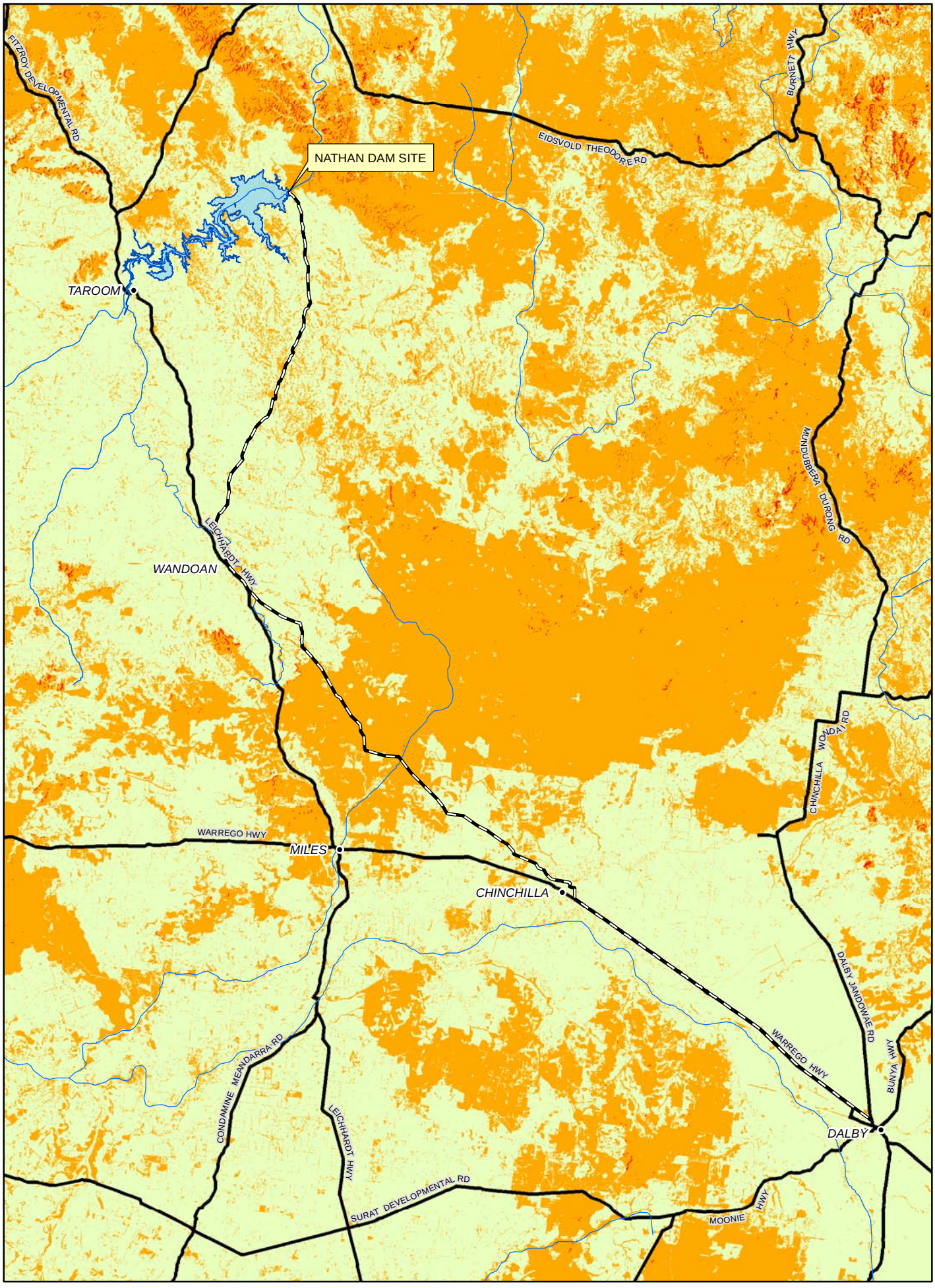
Based on records obtained from the Geoscience Australia Earthquake Database (Geoscience Australia, 2008), areas in the vicinity of the project have experienced very minor earthquakes in recent years but, historically, there have been no major earthquakes recorded in the area.

The largest recorded earthquake was a Magnitude 4.7 earthquake in November 1910, approximately 75 km to the east-south-east of the proposed dam site. An earthquake of this scale would have been felt by many people (e.g. rattling windows, disturbing dishes and rocking standing cars).

The closest earthquake to the proposed dam site was recorded in 1994. The magnitude 2.5 quake's epicentre was approximately 22 km to the north-east. Earthquakes recorded within 1.5 degrees latitude and longitude of the dam site are shown in Figure 3-6.

The proposed dam site lies within an intermediate hazard zone with a 10% chance of an earthquake acceleration coefficient of 0.05 – 0.10 being exceeded in 50 years. The hazard is greater in areas that are built on unconsolidated sediments. The risk from earthquakes in the area is largely from low probability, high consequence events. Earthquake hazard can vary considerably, primarily because of differences in local geology.

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



LEGEND

- Towns
- Proposed Pipeline
- State Controlled Roads
- Major Watercourses
- Full Supply Level (183.5 m AHD)

Bushfire Hazard

- High
- Medium
- Low

Projection: GDA94 Zone 56

Figure 3-5

0 5 10 20
Kilometres

N

Scale 1:1,000,000 (at A4)

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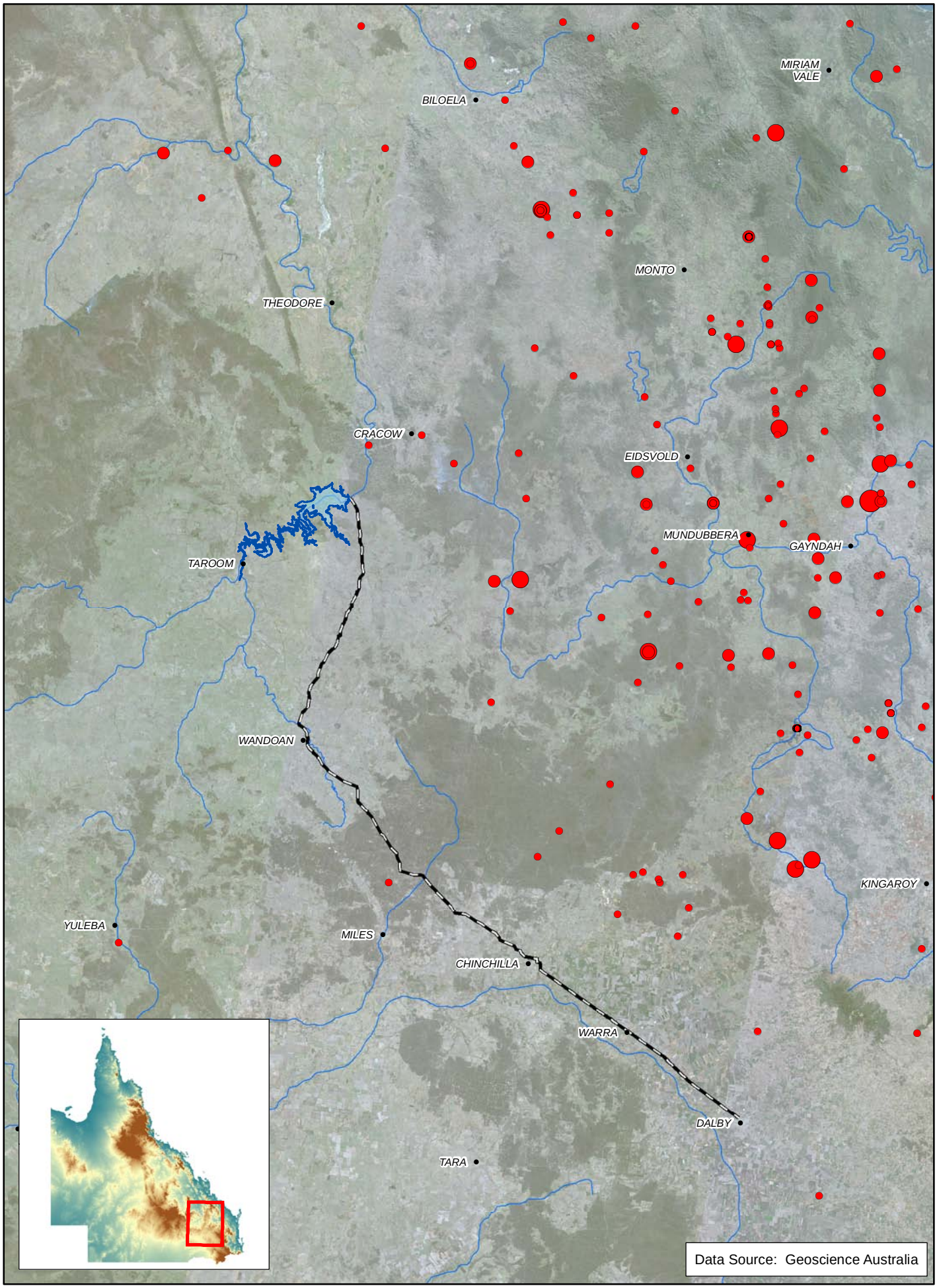
NATHAN DAM AND PIPELINES EIS

Bushfire hazard rating in the Nathan Dam catchment and along the pipeline route (Rural Fire Service, 2008)



LEGEND

- Towns
- Proposed Pipeline
- Major Watercourses
- Full Supply Level (183.5m AHD)

Recorded Earthquakes (Magnitude)

- 0.1 - 2.5
- 2.5 - 3.5
- 3.5 - 4.5
- 4.5 - 5.5

Projection: GDA94 Zone 56

Figure 3-6

0 10 20 40
Kilometres

N

Scale 1:1,500,000 (at A4)

SKM SunWater Making Water Work

NATHAN DAM AND PIPELINES EIS

Recorded earthquakes in the vicinity of the proposed dam and the pipeline (Geoscience Australia, 2008)

3.2.5. Climatic extremes

The Project area itself, does not experience intense rainfall events associated with cyclones on a regular basis. Since 1959, 10 cyclones have been recorded within 200 km of the Nathan Dam site (Bureau of Meteorology, 2008a). However, daily rainfall associated with those cyclones has only exceeded 100 mm on one occasion. Intense rainfall within the Project site has typically been associated with non-cyclonic events. The maximum daily rainfall experienced in each month is provided in Table 3-2.

Table 3-2 Maximum Daily Rainfalls by Month, Taroom Post Office

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Highest daily rainfall	119	144	125	109	142	97	109	92	81	176	109	177
Date	15th 1910	7th 1995	2nd 2010	22nd 1928	9th 1930	9th 1912	12th 1954	8th 1998	4th 1917	31st 1993	25th 1998	19th 1984

Source BoM, 2010

The Dawson River catchment upstream of the Nathan Dam site is susceptible to severe thunderstorms particularly during the summer months. Almost 50% of the floods that have occurred at Taroom since 1912 have been classified as major floods on the basis of BoM criteria. The history of flooding in the catchment is provided in Figures 14-13 to 14-16 in Chapter 14. The storm season typically begins in October and ends in April. In the ten year period from 1990 to 1999 the dam area annually averaged 20 – 25 thunder days (where thunder was heard at least once) (Bureau of Meteorology, 2009).

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 and high emissions scenarios in 2030, 2050 and 2070 are presented in Table 3-3. (Note that as the climate change projection horizon extends there are greater levels of uncertainty in the predictions, e.g. the estimates for 2070 contain greater uncertainty than for 2030.)

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

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%

Note: Range between medium and high scenario predictions presented for each horizon (2030, 2050 and 2070).
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 3-4.

The Project generally has a limited vulnerability to the impact of climate change with the greatest potential impact a reduction in yield from the storage as a result of decreased annual rainfall, increased temperature or increased evaporation (Cai and Cowan, 2008). Climate change impacts on hydrology are addressed in detail in Section 14.2.2.6.

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 for the probable maximum flood and will be able to withstand the associated loads. The potential downstream flooding impacts of the Project are assessed in more detail in Section 14.2.3. With the dam in place, impacts of flooding downstream will be less than if the dam was not in place.

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 - Chapter 26.

Table 3-4 Potential impact 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 severity or frequency of bushfires. Reduced yield of dam.	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. The operational yield of Nathan Dam has been assessed conservatively and complies with the Water Resources (Fitzroy Basin) Plan 1999. Nathan Dam provides additional storage capacity and yield within the Dawson catchment and hence a buffer with respect to water supply security compared to the existing situation.
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 **Chapter 14**.	As above
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 above
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.	As above
Change in frequency of large rainfall events	Increase in frequency of large flood events, increasing potential for dam break.	Dam has been designed to safely pass the Probable Maximum Flood.

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 low to medium bushfire risk. The region occasionally experiences some flooding associated with cyclone activity but more frequently experiences flooding associated with thunderstorm 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 Chapter 14.