6 CLIMATE AND NATURAL DISASTERS

6.1 Introduction

This Chapter outlines the relevant climate characteristics of the Glebe Option study area and the potential for natural hazards and climate change to impact the Glebe Option.

Taroom and Theodore are the closest centres to the Glebe Option for which historical weather data is available from the Bureau of Meteorology (BOM). The Taroom weather station is located at the Taroom Post Office, which is at an elevation of 199 m AHD.

Rainfall data has been recorded since 1870 whilst other data (temperature, humidity and so on) has been recorded since 1952. BOM presents data averages for the period 1952 to 2008. The Theodore station, located at the Theodore Department of Primary Industries (DPI) offices at an elevation of 142 m AHD, was in operation for a period of 78 years before closing in 1994. Temperature and humidity were recorded for a period of 54 years whilst rainfall was recorded for 67 years. BOM presents data averages for Theodore for the period 1950 to 1990. The information from these weather stations provides a representation of weather conditions across the study area.

6.2 Rainfall

Mean monthly rainfall data for the area displays a moderate seasonal trend (Table 6-1 and Figure 6-1). Most rainfall occurs from November through to February with falls peaking in the summer months of December and January. The highest daily rainfall recorded for Taroom is 177 mm, while at Theodore it is 175 mm. Traditionally, the driest period of the year occurs between April and September. The mean monthly rainfall data indicates that August is the driest month of the year, with an average of 28 mm of rain in Taroom and 26 mm in Theodore.

Table 6-1. Mean annual rainfall for selected weather stations (Source: BOM, 2008a & b)

Weather station	Mean annual rainfall (mm)	Median (Decile 5) annual rainfall (mm)	Mean number of rain-days (>1 mm)
Taroom Post Office	673.4	660	47
Theodore DPI	731	715	53

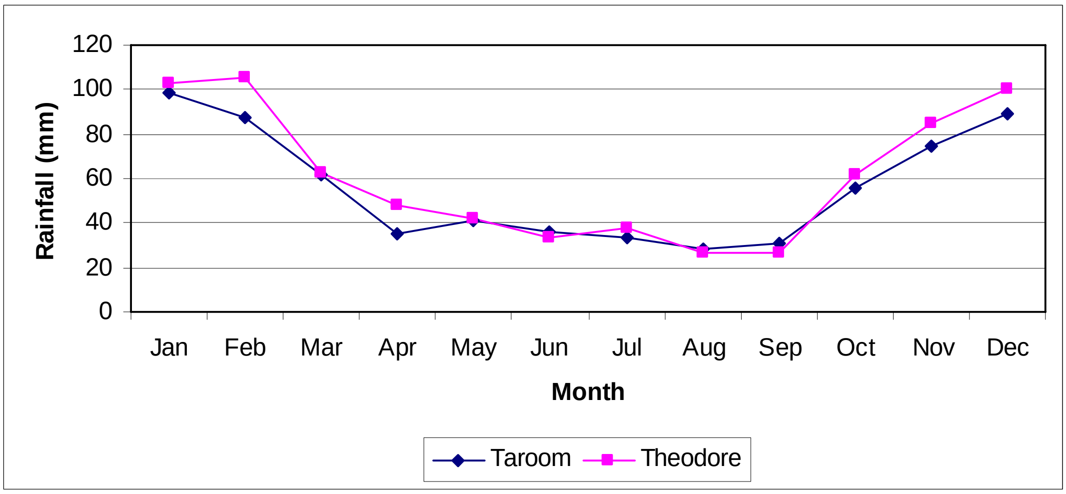


Figure 6-1. Mean monthly rainfall for Taroom and Theodore (BOM, 2008a & b)

(Note flooding is addressed in section 6.7).

6.3 Temperature and Humidity

Temperature data also shows a clear seasonal trend with a warm summer (December through February) and relatively cool winter (June through August). January is typically the hottest month of the year, with mean maximum temperatures of 33.7 °C and 33.5°C in Taroom and Theodore respectively. The highest recorded temperature for either of the stations was 44°C in January 1994. The data also show that July is the coldest month of the year, with a mean minimum temperature of 5°C in Taroom and 6°C in Theodore (Figure 6-2).

The trends for mean monthly temperatures are almost the same, with a minor difference in that Theodore has a slightly higher average minimum temperature.

Relative humidity is consistently higher in the mornings (9 am), compared to measurements in the afternoon (3 pm), throughout the year. The humidity ranges from 56-76% in the morning, compared to 35-46% in the afternoons, with minimal differences between the weather stations.

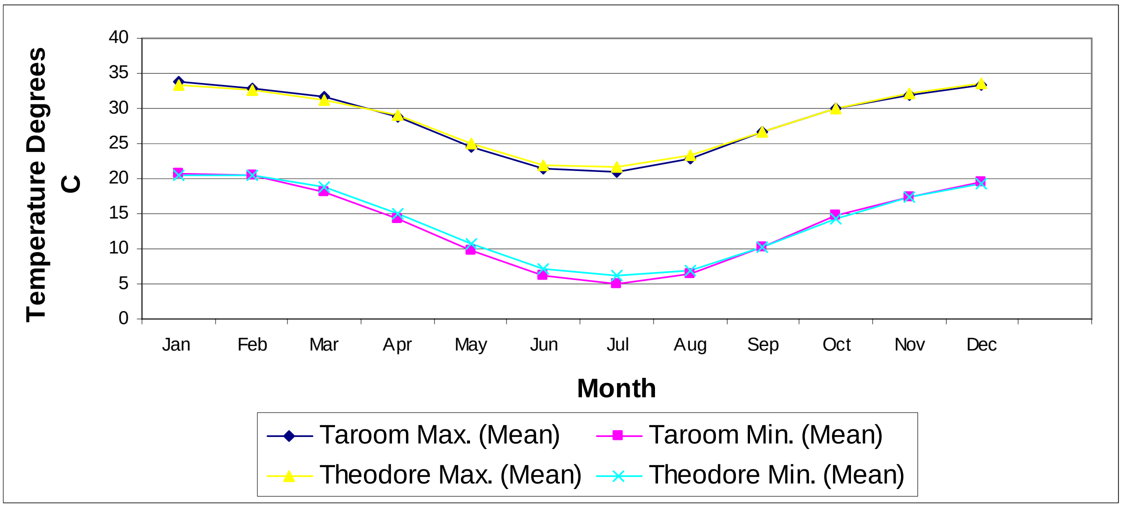


Figure 6-2. Mean monthly minimum and maximum temperatures for Taroom and Theodore (BOM, 2008a & b)

6.4 Wind

Wind roses have been developed based on the climatic records obtained from the BOM. Wind roses were developed for each station to depict seasonal variation using direction and speed data for observations recorded at 9 am and 3 pm for selected months (Figure 6-3 and Figure 6-4) (Taroom data from 1957 to 2006; Theodore data from 1924 to 1990).

The wind direction has some seasonality but it is not pronounced. The summer wind directions vary between Taroom and Theodore. In general, there is a tendency for light south-easterly breezes in the afternoons over the summer months. The morning winds are more erratic. The morning and afternoon autumn winds are more pronounced, with the dominant wind direction from the south-east for both locations. The winter winds vary between the south-east and the south-west. In spring, the dominant wind direction is from the north (Taroom) and from the north-west (Theodore). Overall, the most dominant wind direction for any of the seasons occurs in spring for Taroom (over 30% from the north in the mornings) and autumn for Theodore (over 30% from the south-east in the afternoons).

6.5 Bushfires

The recognised bushfire season extends from late winter through to summer, with the greatest danger occurring in the period towards the end of winter and into spring. The risk generally eases following the first rains of the spring thunderstorm season and is largely absent during the summer wet season. Nevertheless, dry spells, particularly those following periods of above average rainfall, can create bushfire risk at any time.

Most bushfires originate from accidental or deliberate actions by humans but lightning strikes can initiate fires. Trees may smoulder for a few days after a lightning strike then fall into dry fuel and start a bushfire.

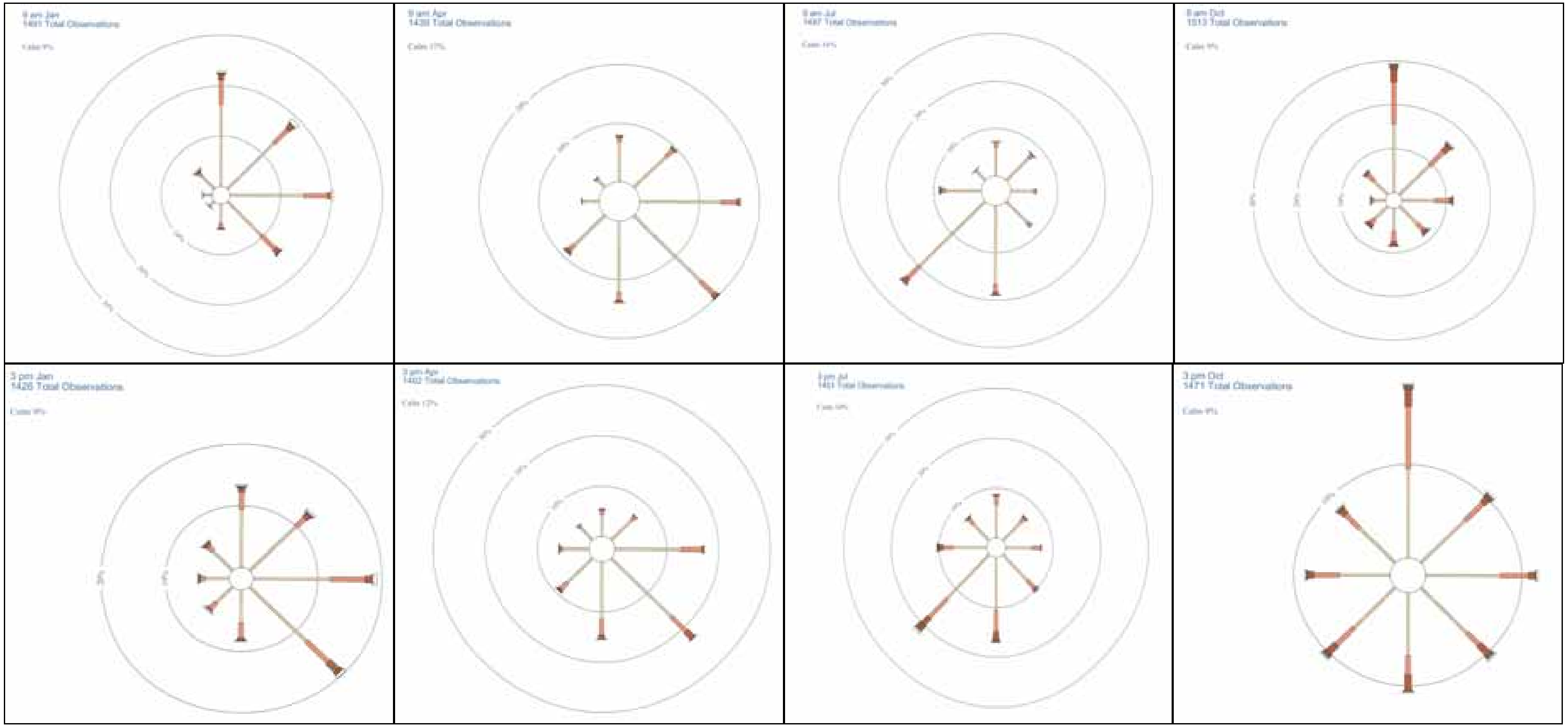
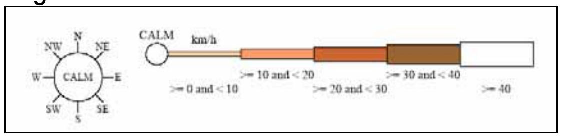


Figure 6-3. Wind roses (Taroom)

Legend



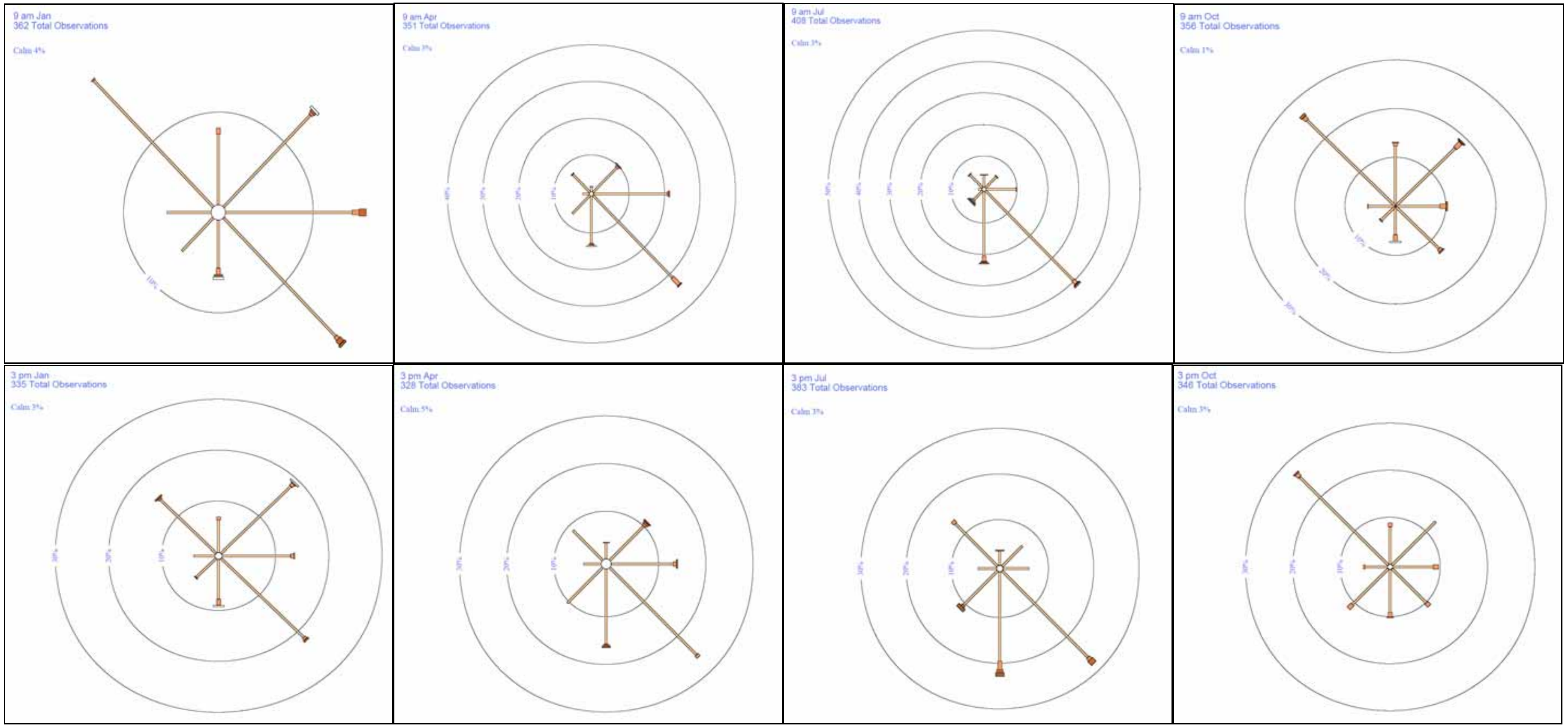


Figure 6-4. Wind roses (Theodore)

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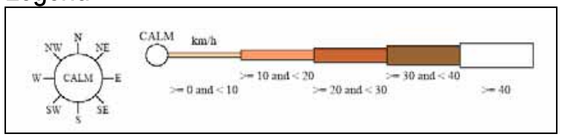

The weir and pipeline are located within a low to medium risk bushfire hazard area (Department of Emergency Services, 2008, Figure 6-5). Land within and adjacent to the flood plain of the Dawson River is classed as a low bushfire hazard but those areas along the pipeline route that are uncleared and have significant regrowth have a medium bushfire hazard rating. There is a risk of fire during the construction period from accidental fires being started by machinery or workers at the site. Mechanisms that can be employed to minimise the risk of bushfire include:

- no burning of vegetation or other activities likely to significantly increase the risk of uncontrolled fires;
- establish and maintain contact with local emergency services;
- seek approval from local Fire Warden before any burning is undertaken;
- strictly observe periods of total fire bans in the area;
- maintain work areas and temporary accommodation clear of high fire risk areas;
- establish dedicated smoking areas; and
- ensure that litter build-up under vehicles does not occur.

Bushfire warnings are issued by the BOM. Fire weather warnings are issued by the BOM when the rating on the fire danger scale is extreme over an area, usually a weather forecast district. Total Fire Bans are declared by the Queensland Fire and Rescue Service but the BOM assists in publicising them.

Those managing construction and operation will need to monitor BOM bushfire warnings, liaise with local Rural Fire Service personnel and be alert for unreported fires in or in the vicinity of the Glebe Option area.

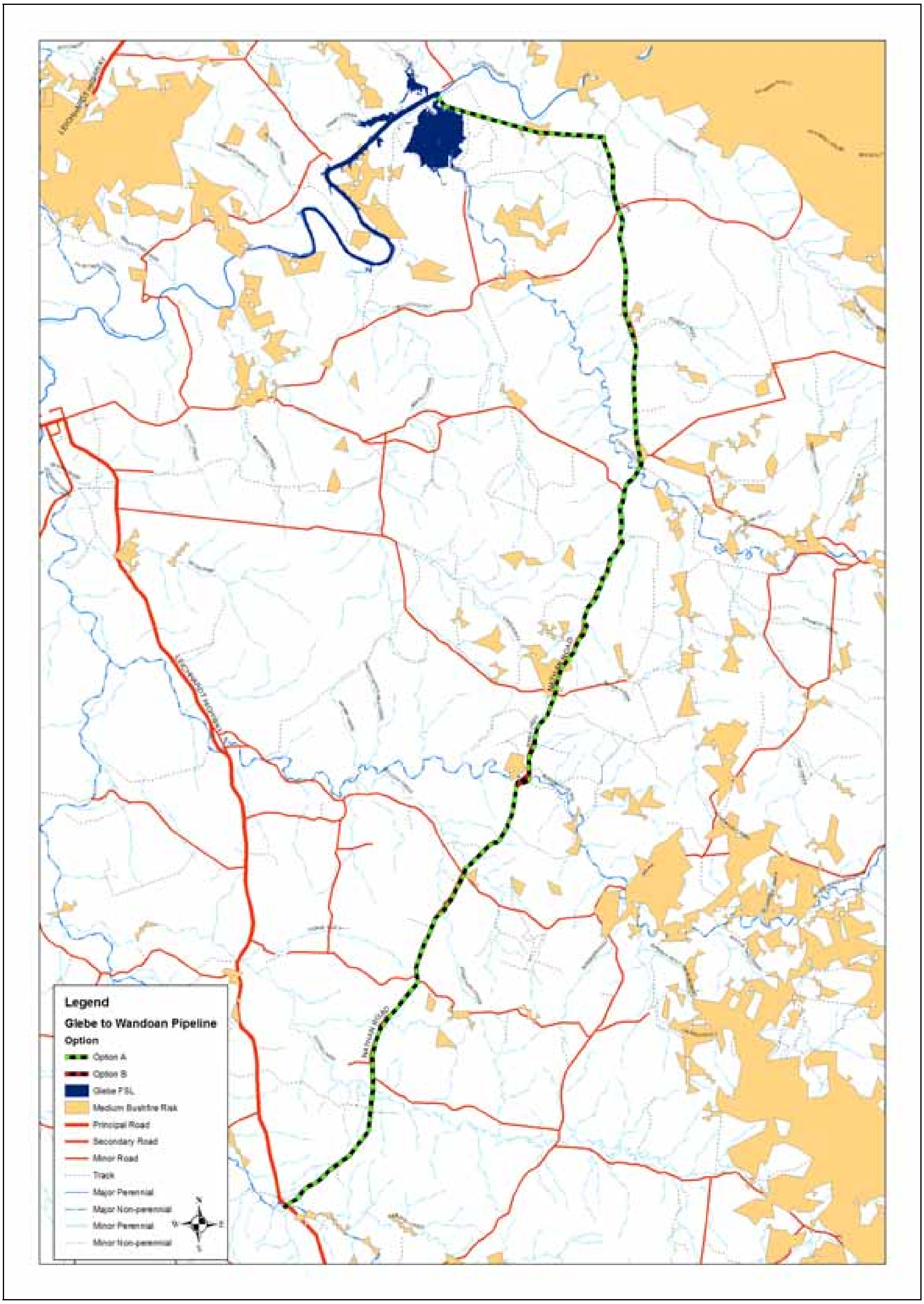

Figure 6-5. Bushfire hazard rating in the vicinity of Glebe Weir and along the pipeline route (Department of Emergency Services, 2008)

6.6 Earthquakes

South-eastern Australia is situated more than 1,500 km from the boundary between the Australian and Pacific Tectonic Plates. Movement on this boundary is the main centre of earthquake activity in the vicinity of eastern Australia but earthquakes still have the potential to occur and impact on the region. Several notable earthquakes have been reported in Queensland. The larger ones (up to 6 on the Richter scale) include:

- Bundaberg 1918; and
- Gayndah 1883, 1910, and 1935.

Some of the larger earthquakes were felt over a wide area including south-east Queensland and NSW.

Based on records obtained from the Geoscience Australia Earthquake Database (Geoscience Australia, 2008a), areas in the vicinity of the Glebe Option have experienced very minor earthquakes in recent years but, historically, there have been no earthquakes of appreciable magnitude in the area. The largest recorded was a Magnitude 4.0 earthquake in February 1998, approximately 66 km to the south-south-east of the weir. The scale of this earthquake would have been felt indoors and outdoors, with the vibration similar to a passing truck.

The closest earthquake to the weir was recorded in 1994 with a Magnitude of 2.5, approximately 22 km to the north-east. There are a number of recorded earthquakes in the Geosciences Australia Earthquake Database within a 1.5 degree of latitude and longitude rectangle centred on the weir site (Table 6-2).

The Glebe Option lies within an intermediate hazard zone with a 10% chance of an acceleration coefficient of 0.05 – 0.06 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.

Table 6-2. Records for earthquakes in the vicinity of Glebe Weir and pipeline

Date	Latitude	Longitude	Magnitude	Depth (km)
1985 0120	-25.073	150.675	1.7	19
1991 0207	-26.03	150.526	1.6	8
1991 0603	-25.357	150.622	2.1	6
1991 1001	-25.702	150.543	2.6	10
1992 0331	-25.382	150.429	1.9	8
1993 1006	-25.784	150.588	1.9	5
1994 0130	-24.768	150.728	1.4	8
1994 0208	-25.328	150.176	2.5	0
1994 0309	-25.303	150.334	1.4	8
1994 1226	-25.48	150.643	2	8
1998 0213	-25.70	150.62	4	0
1991 1001	-25.702	150.543	2.6	10

The existing weir wall is constructed of mass concrete and sheet pile with the rows of sheet pipe tied together so the structure should maintain its integrity through appreciable seismic events. Rock in the bed of the Dawson River through Nathan Gorge provides a control on the depth of alluvium at the weir site so that it is likely that there is little unconsolidated material between the bottom of the sheet pile and underlying rock. Thus, the risk of failure due to liquefaction of material below the weir during a seismic event is low.

The risk from earthquakes to the pipeline is considered to be low. A majority of the pipeline would consist of rubber ring joint pipe (flexible joints) surrounded by bedding sand which could accept some deformation due to lateral displacement if an earthquake was to occur. In the unlikely event of an earthquake which damaged the pipeline, it would be expected that the damage would be restricted to limited lengths of the pipeline which could be repaired relatively quickly following shut-down of the pumps.

6.7 Floods

Glebe Weir has historically spilled (overflowed) almost annually. These incidents vary from minor short term flow events to extended high level floods. There have been several major floods recorded at the Dawson River Gauging Station at Taroom (Gauge Id: 130302A, AMTD 384.6 km), since the 1950s with the following heights recorded:

- February 1954 – 8.05 m;
- May 1955 – 7.66 m;
- Feb 1956 – 9.27 m;
- Feb 1971 – 6.88 m; and
- May 1983 – 7.42 m.

Only the May 1983 flood occurred after the construction of Glebe Weir in 1971. Flows in the Dawson River have been recorded at the Glebe Weir site since October 1919. The highest recorded flow of 4,610 m^3/s occurred in February 1956. The weir drowns out at a flow of approximately 1200m^3/s or a recurrence interval of about 1 in 5 years.

More detail is provided in **Section 8.1 Hydrology.**

6.7.1 Flood Warnings

The BOM provides a flood warning service for most major rivers in Australia, including the Dawson River which forms part of the Fitzroy River Flood Warning System (http://www.bom.gov.au/hydro/flood/qld/brochures/fitzroy/fitzroy.shtml) (BOM, 2008c). This service is provided with the cooperation of other government authorities, such as the State Emergency Service (SES) in each State/Territory, water agencies (including SunWater) and local councils. The BOM delivers this service through Flood Warning Centres and Regional Forecasting Centres in BOM Regional Offices in each State and the Northern Territory. The Flood Warning Service provides different types of information depending on the type of flooding and the flood risk. The range of information, which may vary between States and areas within a State, includes:

- an Alert, Watch or Advice of possible flooding, if flood producing rain is expected to happen in the near future. The general weather forecasts can also refer to flood producing rain;
- a Generalised Flood Warning that flooding is occurring or is expected to occur in a particular region. No information on the severity of flooding or the particular location of the flooding is provided. These types of warnings are issued for areas where no specialised warning systems have been installed. As part of its Severe Weather Warning Service, the BOM also provides warnings for severe storm situations that may cause flash flooding. In some areas, the BOM is working with local councils to install systems to provide improved warnings for flash flood situations.
- warnings of 'Minor', 'Moderate' or 'Major' flooding in areas where the BOM has installed specialised warning systems. In these areas, the flood warning message will identify the river valley, the locations expected to be flooded, the likely severity of the flooding, and when it is likely to occur; and
- predictions of the expected height of a river at a town or other important locations along a river, and the time that this height is expected to be reached. This type of warning is normally the most useful as it allows local emergency authorities and people in the flood threatened area to more precisely determine the area and likely depth of the flooding. This type of warning can only be provided where there are specialised flood warning systems and where flood forecasting models have been developed, as they have been for the town of Taroom, which is located approximately 65km upstream of the weir.

As the weir is located within a watercourse, construction works are exposed to flooding and associated damage during the construction period. Where possible construction works will be completed outside of the wet season to reduce the risks associated with flooding. The construction sequence at the weir will proceed such that the abutment and protection works are completed prior to works on the spillway section to ensure erosion and damage during any flood events is minimised.

As a majority of the pipeline alignment is not located within a watercourse, flooding risk to the construction works is not significant. Construction risks due to flooding exposure to the pipeline will be alleviated by reducing the length of open trench as much as possible and by constructing creek crossings outside wet periods.

6.8 Climate Change

The uncertainty related to future rainfall patterns associated with climate change has raised concern about the impact that this will have upon long-term water supplies in Queensland. Whilst there is still inherent uncertainty in climate change modelling and an indication that existing records are not sufficient to capture the full effects of climatic variability, CSIRO research suggests that over the last 50 years, Queensland's climate has, on average, become both warmer and drier. Climate Change in Australia (CSIRO & BOM, 2007) and the associated web site (climatechangeinAustralia.com.au) presents predictions from a range of models and does so using the median result for various parameters plus the 10^{th} and 90^{th} percentile results to give a measure of variability in the estimates (current as at October 2007).

For Central Queensland in the area of the Dawson catchment, the median projection, high emissions scenario predicts an average annual temperature increase by 2030 of between 0.6 and 1.5^{o}C with most of the Fitzroy catchment being in the 0.6-1.0ºC range. Coastal and near coastal areas are the most buffered from change. For rainfall the same prediction is a change of between -2 and +2%. Some northern parts of the basin are in the -5 to -2% range.

The models also generally predict increases in the frequency of days over 35ºC, in daily rainfall intensity and in the number of dry days. An increase in the number of dry days leads to an increase in drought duration and higher fire risks. In general, the number of cyclones may decrease but their intensity may increase.

Given the relatively small degree of change in this catchment from the proposed Glebe Option, substantial risk management strategies are not justified. Natural climatic variability is likely to remain a more significant difficulty for management, particularly in terms of providing a secure water supply, than is climate change, at least in the foreseeable future.

With respect to particular areas of management, the following strategies can be identified:

- lowered river flows
  - purchase further allocations to ensure the WJV's share is maintained
  - identify other source or source substitution options

- increased flood severity
  - should not be an issue because the weir is designed to cater for the Probable Maximum Flood and the predicted rainfall changes are unlikely to alter that event (see below)

- increased risk of bushfire
  - the area is generally classified as low risk with some areas of medium and climate change will not alter the fuel load appreciably so little further risk is expected (see below).

To accommodate the predicted increase in extreme storm events, adjustments have been made to the peak design discharges for events greater than 100 years Average Recurrence Interval (ARI) for the Dawson River. This has been incorporated into the design of the new weir and is further described in Section 8-3 Hydrology.

The risk to property and human injury as a consequence of more extensive flooding may be increased under extreme climatic conditions. Whilst the extent of flooding cannot be easily mitigated, early warning systems will allow monitoring of flood conditions downstream. Other mitigation strategies may include:

- development of detailed flood evacuation plans as part of the Shire and State natural disaster management plans; and
- amendment of Natural Disaster Plans to reflect the potential for increased flooding (both extent and duration).

In terms of assessing the flood impact, downstream flood levels for medium to large floods are generally unaffected by the existing weir, with the weir effectively 'drowned out' (Section 8-3). The inflatable rubber dam used to raise Glebe weir could potentially increase flood levels upstream of the dam and erosion downstream of the dam if not operated correctly, and these impacts would be exacerbated by climate change. The increase in the risk of this happening under extreme conditions will not be increased if the weir is operated correctly. Operating rules will be developed for the weir to mitigate these impacts and these are described in Section 8-3.

The higher fire risk areas are currently along the pipeline route and are uncleared or have significant regrowth. The impact of climate change on bushfire hazard is inconclusive. As specified in *SPP 1/03 Guideline : Mitigating the Adverse impacts of Flood, Bushfire and Landslide*….." (Department of Emergency Services, 2003) climate change is expected to cause a gradual change in vegetation health and vigour, and some species and vegetation communities will be advantaged over others.

Climate change impacts will be reflected over time through changes to vegetation communities and fuel characteristics. These changes are difficult to predict and are likely to occur very gradually over a long timeframe. The changes to bushfire hazard associated with climate change impacts will generally be outweighed by changes caused by human activity in the short-term. For these reasons it is not practicable to consider the impacts of climate change in bushfire hazard assessment studies at present.