HANCOCK PROSPECTING PTY LTD

Alpha Coal Project Environmental Impact Statement

03 Climate and Climate Change

Section 03 Climate and Climate Change

3.1 Introduction

This section provides a description of the climatic conditions within the proposed area of development for the Alpha Coal Project (Rail) (herein referred to as the Project). Based on the climatic conditions within the study area, an assessment has been conducted in relation to the potential for climatic conditions to impact the Project.

3.2 Existing Environment

3.2.1 Overview

A brief description of the climatic conditions likely to be encountered along the Project corridor is provided below. Specific details on the erosive force of rainfall and high risk erosion periods are also provided.

The geographic region is strongly influenced by a range of climate extremes including:

- the Australian monsoon, *El Niño* and *La Niña:*
  - in basic terms the El Niño is associated with lower than average winter / spring rainfall, resulting in drought conditions in the region; and
  - in basic terms the La Niña is associated with higher than average winter, spring and early summer rainfall.
- general storm activity;
- cyclonic events; and
- severe heat waves.

The key aspect of climate relating to soils is the rainfall events, particularly the erosivity of the rainfall. Due to the Project being approximately 495 km in length, the climatic conditions and characteristics change considerably from Alpha to Bowen. In order to provide an overview of the climatic conditions likely to be experienced along the Project, information from the nearest weather stations is provided below in Table 3-1.

Table 3-1: Average Monthly Rainfall and Monthly Rain Days Data[1]

Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Bowen, QLD – Commenced 1987													
Mean rainfall (mm)	**178**	**243**	**76**	**62**	**44**	**24**	**19**	**22**	**7**	**13**	**35**	**135**	**845**
Days of rain	11.7	12.1	9.4	8.2	6	5	3.3	2.7	2.4	3.3	6.3	9.2	79.6
Days of rain ≥ 10 mm	3.7	5.6	2.1	1.5	1	0.6	0.4	0.5	0.2	0.3	1.1	2.9	19.9
Days of rain ≥ 25 mm	2.1	3.4	1	0.7	0.4	0.2	0.2	0.3	0	0	0.3	1.4	10
Erosion Risk	**H**	**E**	**M**	**M**	**L**	**L**	**VL**	**VL**	**VL**	**VL**	**L**	**M**	**N/A**
Collinsville, QLD – Commenced 1939													
Mean rainfall (mm)	**134**	**165**	**93**	**42**	**32**	**27**	**20**	**17**	**11**	**22**	**51**	**95**	**712**
Days of rain	10.5	11.4	8.1	4.8	4.1	3.5	2.4	2.1	1.8	2.9	4.8	7.4	63.8
Days of rain ≥ 10 mm	3.9	4.4	2.7	1	0.8	0.7	0.7	0.5	0.4	0.7	1.5	2.7	20
Days of rain ≥ 25 mm	1.6	2	1.1	0.4	0.3	0.3	0.2	0.2	0.1	0.2	0.6	1.2	8.2
Erosion Risk	**H**	**H**	**M**	**L**	**L**	**VL**	**VL**	**VL**	**VL**	**VL**	**M**	**M**	**N/A**
Clermont, QLD – Commenced 1870													
Mean rainfall (mm)	**118**	**116**	**74**	**39**	**35**	**34**	**25**	**19**	**19**	**35**	**57**	**92**	**662**
Days of rain	8.5	8.1	5.7	3.5	3.5	3.5	2.8	2.3	2.5	4	5.3	7.1	56.8
Days of rain ≥ 10 mm	2.9	2.7	1.7	1	0.8	0.8	0.6	0.5	0.5	1	1.5	2.3	16.3
Days of rain ≥ 25 mm	1.4	1.3	0.7	0.4	0.3	0.3	0.2	0.2	0.1	0.4	0.5	0.9	6.7
Erosion Risk	**H**	**H**	**M**	**L**	**L**	**L**	**VL**	**VL**	**VL**	**L**	**M**	**M**	**N/A**
Barcaldine, QLD – Commenced 1981													
Mean rainfall (mm)	86	78	59	37	31	24	23	16	15	29	38	63	500
Days of rain	7.3	6.8	5.0	3.3	2.8	2.7	2.4	2.1	2.5	4.0	5.1	6.5	50.5
Days of rain ≥ 10 mm	2.5	2.1	1.6	1.0	0.9	0.8	0.8	0.5	0.4	1.0	1.1	1.9	14.6
Days of rain ≥ 25 mm	1.1	0.9	0.7	0.4	0.3	0.3	0.3	0.1	0.1	0.2	0.3	0.7	5.4
Erosion Risk	**M**	**M**	**M**	**L**	**VL**	**VL**	**VL**	**VL**	**VL**	**VL**	**L**	**M**	**N/A**

Source: Bureau of Meteorology (accessed 27/01/2010).

1 Erosion Risk Ratings derived from IECA Best Practice Erosion and Sediment Control Guidelines 2008, and DMR Road Drainage Design Manual (2002).

The erosion risk ratings detailed above are based on average monthly rainfall depth, and not the erosive force of the rainfall. The above data represents the rainfall information for the closest weather stations along the Project. The following can be interpreted from the above data:

- the portion of the Project corridor nearest to the coast will be subject to a greater number of rainfall events annually with a higher likelihood of a rainfall event exceeding 25 mm over a 24 hour period;
- higher erosion risks are prevalent as the Project moves towards Abbot Point from the Alpha Coal Mine, with the areas nearest to the coastline experiencing the higher erosion risks;
- the number of rainfall days that have in excess of 20 mm of rain generally increases as the Project travels towards Abbot Point from the Alpha Coal Mine;
- the period with lowest erosion risk is from April to October across the whole Project; and
- the period with the highest erosion risk is during the summer months from December to March.

Climate information is an integral part in limiting the risk of erosion of exposed soils due to rainfall events. Relevant land study reports have been referred to for the Project area that details the specific climate information and patterns for each of the study areas.

3.2.2 Climate

In order to accurately describe the climatic conditions of the Project area, the following section describes the climate on the basis of three sections of the Project corridor – namely Section 1 – Alpha Coal Mine to chainage 230 km, Section 2 – chainage 230 km to chainage 410 km and Section 3 – chainage 410 km to chainage 495.

3.2.2.1 Section 1 - Alpha Coal Mine to Chainage 230 km

Gunn *et.al* (1967) *Lands of the Nogoa – Belyando Area* describes the climate of Section 1 – Alpha Coal Mine to chainage 230 km. Broad transition rather than clearly defined climatic zonation is characteristic within this section of the Project. The principal transitions are toward increasing aridity westward and increasing temperature northward. The climate is thus difficult to characterise in any single climatic "type", but it can be described generally as ranging from tropical to subtropical and from sub-humid to semi-arid. Approximately three-quarters of the mean annual rainfall occur during the six summer months.

3.2.2.2 Section 2 - Chainage 230 km to Chainage 410 km

Shields (1984) in *Land Suitability Study of the Collinsville-Nebo-Moranbah region* describes the weather pattern of the area surrounding Section 2 – chainage 230 km to 410 km of the Project corridor. The majority of the region is dominated by dry tropical / sub-tropical weather patterns which have distinct wet (November to April) and dry (May to October) seasons. Rainfall decreases westward across the region, with high rainfall variability due to the sporadic incidence of rainfall depressions associated with the tropical cyclones and the convective origin of much of the rainfall.

Typically the region experiences hot, humid summer months (December to February) with a winter dry season. Heavy rainfall predominately occurs within the summer months (late December to February) of the year. Cloud cover generally increases in the lead up to the wet season with ‘build up’ thunderstorms starting in late December. Skies are generally clear during the dry season. The wet season occurs between December and March where rainfall occurs between six to nine days per month. The driest months are between May to October when very little rainfall occurs. Rainfall in the area is known to be infrequent with annual rainfall commonly being either well above or well below the annual average rainfall for the region.

The combination of high temperatures and low relative humidity results in high evaporation rates and low effective rainfall. Annual evaporation in the region is just under three times higher than the annual average rainfall (711 mm).

3.2.2.3 Section 3 – Chainage 410 km to Chainage 495 km

Weather patterns surrounding Section 3 – chainage 410 km to chainage 495 km of the Project are described in *Soils of the Elliot River*, (Aldrick, 1988). Seasonal weather conditions are generally controlled by the conjunctive activity of the subtropical high-pressure belt and equatorial low pressure belt, both of which migrate southwards during summer. The interaction between these movements and the prevailing easterly wind-flows largely accounts for summer rainfall maxima. The area is subject to high frequency cyclonic activity, flooding and prolonged drought. According to the Bureau of Meteorology (BoM, 1970), rainfall decreases south-westward from Bowen. Rainfall averages along this portion of the coast are the lowest for the North Queensland. Rainfall variability, however, is particularly high.

A high proportion of the total rainfall is of high intensity, with some 309 mm of the annual average rainfall occurring as heavy storms. Probable maximum one-hour rainfalls are cited by BoM (1970) as 87 mm once in 10 years and 132 mm once in 100 years. Storm incidence tends to be confined to the December-March period. Prevailing winds in summer are from the east to north-east and in the winter from the east to south-east. Frosts occurring in the region are mostly light, and number from two to three per year. Most occur between July and August.

3.2.3 Erosive Rainfall

Erosivity Ratings of the rainfall events have been established for areas along the Project corridor. These have been developed with reference to the Department of Transport and Main Roads Road Drainage Design Manual (DTMR, 2002). The Erosive potential of rainfall, termed erosivity, is highly correlated with annual rainfall and rainfall intensity, which in turn are dependent upon the number of wet days and thunder days, temperature, latitude, and rainfall seasonality. The ability of rainfall to cause erosion is a product of total storm energy (E) and the maximum 30 minute intensity of each storm (I30), which is known as the erosion index (EI) (DTMR, 2002).

The DTMR manual has average annual EI values for selected stations across Queensland. The relevant stations in relation to the Project are listed below:

- Ayr (used in lieu of data for Bowen);
- Milaroo;
- Collinsville;
- Twin Hills;
- Kilmalcolm; and
- Alpha.

These sites each experience different seasonal rainfall, rainfall intensities and other climatic conditions, and are considered as a snap shot of the climatic conditions likely to be encountered along the Project corridor. Table 3-2 below details the erosivity of rainfall at relevant sites along the Project. From the information presented in Table 3-2, the most erosive rainfall events occur during the summer months with the erosive force of the rainfall increasing as the Project travels towards Abbot Point, with the highest erosivity values being recorded around the Collinsville and Milaroo regions.

Table 3-2: Erosivity rating of rainfall for relevant locations during construction

Selected Sites	Average Annual Erosion Index (EI) [1]	Highest Monthly EI (as percentage of Average Annual EI) [2]	Rainfall Erosivity Rating [3]
Ayr	481	27.9 (February)	Moderate
Milaroo	590	35.4 (January)	High
Collinsville	277	31.5 (January)	Moderate
Twin Hills	311	29.1 (January)	Moderate
Kilmalcolm	357	21.1 (December)	Low
Alpha	152	22.8 (December)	Very Low

1. Average annual EI for sites taken from DTMR, Road Drainage Design Manual, Table 2.6
2. Highest monthly EI as percentage of average annual taken from DTMR, Road Drainage Design Manual, Table 2.7
3. Erosivity ratings established used Table 2.8 of DTMR, Road Drainage Design Manual

3.2.4 Temperature

The temperature projections in Table 3-3 have been sourced from Queensland Office of Climate Change (QOCC, 2009). The mean values show a projected increase in average temperature for the region of around 1°C for 2030, and approximately 1.6 to 3 °C for 2070. For the 2070 high emissions scenario, the high range of model outputs projects a possible average temperature increase of up to 4.2 °C. The table also identifies the implications of these projected increases in average temperature for the number of days per year with temperatures over 35°C based on projected change for Rockhampton.

Table 3-3: Temperature Projections

		2030 Average* (mid emissions)	2070 Average* (low emissions)	2070 Average* (high emissions)
Temperature	Mean increase in annual temperature (°C)	+1 °C	+1.7°C	+3.2°C
	Model output range	+0.7 to 1.4°C	+1.1 to 2.3°C	+2.2 to 4.5°C
Increase in number of days over 35°C	Mean increase in number of days above 35°C	+10 days	+20 days	+48 days
	Model output range	+6 to 17 days	+11 to 31 days	+26 to 84 days

3.2.5 Wind

Average wind speed change projections are available for the 10 m above ground wind data from 19 climate models for the Australian region (CSIRO, 2007a). The changes in wind speed below represent the approximate range of percentage change from the models for the annual average 10 m wind speed values for the Central Queensland region.

Table 3-4: Average wind projections

	2030 Average (mid emissions)	2070 Average (low emissions)	2070 Average (high emissions)
Annual average wind speed % change - Model output range	0 to +5%	0 to +10%	0 to +15%

3.3 Potential Impacts and Mitigation Measures

3.3.1 Potential Impacts

The potential impacts associated with the erosive rainfall is the increased likelihood of erosion and sediment movement, impacting successful rehabilitation of the disturbed areas, and delays to construction and Project delivery (Department of Transport and Main Roads, 2002). Developed the erosivity ratings assuming the impacted sites are under construction where there has been disturbance to the soil surface, which results in a higher risk of erosion due to the rainfall events.

A potential impact arising from the variable climatic conditions experienced along the Project is the delay of works associated with high rainfall periods. Depending on the soil types / slopes and other environmental aspects, a rainfall event of >10 mm over a day period can cause the ground conditions to become a constraint on construction works, which could lead to additional disturbance due to wet and boggy conditions, compaction, soil structure damage and soil permeability.

Works that are required to be undertaken within streams or watercourses will be impacted on by high erosion risk rainfall events and the rainfall erosivity. Several stream / waterways will be required to be traversed as part of the Project, some of which are subject to flooding. Any in-stream works that are undertaken during high risk rainfall periods can result in erosion, sedimentation of the waterways, closure of works and potential loss of productivity due to works being stopped.

Poor staging of construction works can lead to ongoing delays, stand down time and remobilisation. Planning construction events around the climatic conditions will be beneficial and will result in a beneficial impact on the receiving environments as erosion and the associated deposition of sediments in the receiving environments will be reduced.

Some possible impacts to infrastructure due to projected climate change identified in the CSIRO report, *Infrastructure and Climate Change Risk Assessment for Victoria* (CSIRO, 2007), are listed in Table 3-5 below. The table demonstrates an assessment of potential climate change impacts to the Project, as well as the adaptation measures identified, adapted from the Queensland Environmental Protection Agency Guidelines for preparing a Climate Change Impact Statement (CCIS). It includes temperature rise; rainfall increase and decrease; sea level rise; and extreme weather events such as storms and cyclones.

3.3.2 Mitigation Measures

Construction works will be timed where possible to avoid working in areas of erosive soils, steep slopes, cracking clays and sensitive environments during high risk rainfall and erosive rainfall periods. Construction staging plans will be developed with consideration given to the climatic conditions in order to avoid the negative impacts of erosion on receiving environment. Works during the summer months will be confined if possible to areas considered to have a low risk of erosion occurring from rainfall events. These areas should have topography and soils that are not as susceptible to erosion from erosive rainfall events.

Table 3-5 provides a summary of the potential impacts and mitigation measures.

Table 3-5: Potential climate change impacts and mitigation measures

Question	Response	Potential Impacts	Mitigation Measures
Asset Life			
Will the proposal exist in 2030 and beyond?	Yes ☑ No ☐	--	--
Temperature			
Will an average annual temperature rise of up to 4.5°C impact the proposal? Will an increase in extreme heat events (of up to 64 days greater then 35°C per year) impact the proposal?	Yes ☑ No ☐ Potential ☐	• higher temperatures may stress steel in bridges and rail tracks through expansion and increased movement.; • degradation, failure and replacement of rail structures due to increases in movement and material breakdown; • increased frequency and intensity of bushfires; • increases in ambient temperatures might result in greater thermal movement of materials (e.g. concrete, steel), increasing the risk of cracking and subsequent degradation; • reduced work capacity and increased risk of heat stress for employees; and • reduce Project life expectancy and increased maintenance and replacement costs of rail infrastructure.	It is considered that potential thermal movement in material will not result in any noticeable impact in any of the materials used. Potential climate impacts have already been considered into the standards.
Rainfall			
Will a 35% decrease in rainfall impact the proposal?	Yes ☐ No ☑ Potential ☐	• It is considered that there will be no noticeable impact in any of the Project assets.	--

Question	Response	Potential Impacts	Mitigation Measures
Will a 17% increase in rainfall, impact the proposal? Will a potential increase in intensity of extreme rainfall events impact the proposal?	Yes ☑ No ☐ Potential ☐	• increased ground movement and changes in groundwater associated with longer term changes in moisture levels could accelerate degradation of materials, structures and foundations of transport infrastructure; • increased flood risk / damage; • potential changes in the frequency and severity of extreme rainfall events may impact on the heights of creek crossings required to avoid disruptions to the rail service; • increased maintenance of the infrastructure; • degradation, failure and replacement of bridge structures due to increases in frequency and intensity of high stress events on structural integrity; • ports and coastal infrastructure associated with the Project are particularly at risk from storm surges which will be made worse by sea level rise. This could lead to disruptions in coal exports; and • reduction in life expectancy, increased maintenance costs and potential structural failure during extreme events.	Potential climate impacts have already been considered into the standards.
Will changes in relative humidity and potential evaporation of 7% to 15% impact the proposal?	Yes ☐ No ☑ Potential ☐	• it is considered that there will be no noticeable impact in any of the Project assets.	--
Sea Level Rise			
Will a sea level rise of 30 cm by 2100 impact the proposal?	Yes ☐ No ☐ Potential ☑	It is considered that there will be no noticeable impact in any of the Project assets. Ports and coastal infrastructure associated with the Project are particularly at risk from sea level rise. This could lead to follow on disruptions in the operation of the Project.	--

Question	Response	Potential Impacts	Mitigation Measures
Extreme Weather			
Will a 10% increase in cyclone intensity and frequency impact the proposal?	Yes ☐ No ☐ Potential ☑	• it is considered that there will be no noticeable impact in any of the Project assets; and • coastal inundation/erosion that could affect the associated port infrastructure.	--
Will an increase in storm surge of .5m in the 1-in-100 year event impact the proposal?	Yes ☑ No ☐ Potential ☐	• same implications as extreme rainfall intensity increase.	--
Will an increase in hail risk with hail days increasing by up to 4 days per year impact the proposal?	Yes ☐ No ☐ Potential ☑	• it is considered that there will be no noticeable impact in any of the Project assets.	--
Will an increase in frequency and intensity of storms impact the proposal?	Yes ☑ No ☐ Potential ☐	• degradation, failure and replacement of rail structures due to increase in damage from flooding, debris, fallen trees and landslides in rail cuttings; • damage to bridges during flood events is widespread with potential loss of structures. Increased frequency of storm events reduces the capacity to repair damage before subsequent storm events compound structural damage sustained; • increased maintenance and replacement costs of bridge infrastructure; and • a rise in the frequency of lightning strikes would affect rail operations.	Potential climate impacts have already been incorporated into the standards.
Will an increase in annual average wind speed impact the proposal?	Yes ☐ No ☐ Potential ☑	It is considered that there will be no noticeable impact in any of the Project assets.	--

3.4 Conclusions

The assessment of climatic conditions and potential future climate change has concluded that the design standards utilised for the Project have sufficiently considered any potential impacts and that no specific mitigation or management measures are required.