11 Air Quality and Greenhouse Gases

11.1 Introduction

This chapter discusses the potential impacts on air quality and the emissions of greenhouse gases (GHG) associated with the McArthur River Mine Phase 3 Development Project (the Project). Mitigation measures are also provided, where required. The primary sources of Project particulate emissions include the processing plant, power station, Overburden Emplacement Facilities (OEFs), mobile plant exhausts, wind erosion and vehicle movements.

The only sensitive receptor identified within 10 km of the Project is the mine accommodation village, within the existing Mineral Leases. The village is located approximately 1,500 m from the existing power station and 2,000 m from the current open pit. No sensitive receptors have been identified within 10 km of the Bing Bong concentrate storage and ship loading facility (Bing Bong).

Potential sources of particulate emissions from the existing surrounding environment include primarily agricultural activities, smoke from bushfires and controlled burns and wind-blown dust.

11.1.1 Background

The Project will include the extraction, handling and placement of topsoil, overburden and ore, and other activities which have the potential to generate air emissions that may impact on the accommodation village. Potential air quality impacts from the Project have been assessed by:

- reviewing legislative requirements and ambient air quality goals
- describing existing air quality and dispersion meteorology within and surrounding the Project site
- identifying the nearest sensitive receptors
- modelling air dispersion to predict concentrations of particulate matter at nearest sensitive receptors
- determining the potential air quality impacts by comparing with air quality goals
- identifying mitigation measures to assist with the management of the potential air quality impacts from the Project.

An air quality impact assessment of the Project was undertaken by URS Pty Ltd. The assessment report is contained in Appendix D5 – Air Quality and Greenhouse Gases. In addition, GHG emissions generated by a number of mining activities are also assessed.

11.2 Air Quality Guidelines

11.2.1 National Environment Protection Council

The National Environment Protection Council (NEPC), comprising Environment Ministers from the Australian Government and from each State and Territory, takes a cooperative approach to the management of environmental issues in Australia.

The purpose of the NEPC is to ensure that:

- Australians enjoy the benefit of equivalent protection from air, water or soil pollution and from noise, wherever they live
- business decisions are not distorted nor markets fragmented by variations in major environment protection initiatives between member governments.

NEPC has powers to make National Environment Protection Measures (NEPMs) on:

- ambient air quality
- ambient marine, estuarine and fresh water quality
- protection of amenity in relation to noise (only if differences in environmental requirements relating to noise would have an adverse effect on national markets for goods and services)
- general guidelines for the assessment of site contamination
- environmental impacts associated with hazardous wastes
- re-use and recycling of used materials
- motor vehicle noise and emissions (in consultation with the National Transport Commission).

Regarding air quality, two NEPMs exist: the Ambient Air Quality NEPM establishes ambient air quality standards, monitoring and reporting protocols for listed air pollutants; and the Air Toxics NEPM establishes procedures to collect information regarding certain hazardous air pollutants in order to develop national standards by 2012.

In the absence of Northern Territory air quality legislation, the Ambient Air Quality NEPM standards have been adopted for the Project. Where the NEPM does not provide a standard for a pollutant associated with this Project, standards have been adopted from other States of Australia.

11.2.2 Ambient Air Quality NEPM

The Ambient Air Quality NEPM provides the following standards for emissions applicable for the Project:

- particles as PM_{10}
- particles as $PM_{2.5}$
- nitrogen dioxide (NO_2)
- sulphur dioxide (SO_2)
- carbon monoxide (CO)
- lead.

Table 11-1 provides the relevant standards and goals.

Table 11-1 Ambient Air Quality NEPM: Standards and Goal for Pollutants

Pollutant	Averaging Period	Maximum Concentration	Goal within 10 years, Maximum allowable exceedances
Particles as PM_{10}	1 day	50 $\mu g/m^3$	5 days a year
Particles as $PM_{2.5}$ *	1 day	25 $\mu g/m^3$	Goal is to gather sufficient data nationally to facilitate a review of Advisory Reporting Standards.
	1 year	8 $\mu g/m^3$	
Nitrogen Dioxide	1 hour	0.12 ppm (225 $\mu g/m^3$)	1 day a year
	1 year	0.03 ppm (56 $\mu g/m^3$)	none
Sulphur Dioxide	1 hour	0.20 ppm (522 $\mu g/m^3$)	1 day a year
	1 day	0.08 ppm (208 $\mu g/m^3$)	1 day a year
	1 year	0.02 ppm (52 $\mu g/m^3$)	none
Carbon Monoxide	8 hours	9.0 ppm (10 $\mu g/m^3$)	1 day a year
Lead	1 year	0.50 $\mu g/m^3$	none
Note *- Particles as $PM_{2.5}$ is an advisory reporting standard			

11.2.3 Other applicable standards and goals

Emissions of the following types are expected to increase with the Project and do not have standards or goals outlined in NEPMs:

- Total Suspended Particulates (TSP)
- dust deposition
- zinc
- nitrogen dioxide
- sulphur dioxide.

The Queensland Department of Environment and Resource Management (DERM) has legislated a standard for emissions of TSP. This is detailed below in Table 11-2.

Table 11-2 Queensland DERM Standard for TSP

Indicator	Environmental Value	Objective ($\mu g/m^3$)	Period
TSP	Health and wellbeing	90	1 year

The Victorian Environment Protection Agency (EPA) legislated standards for dust deposition are detailed below in Table 11-3.

Table 11-3 Victoria EPA Standards for Dust Deposition

Indicator	Environmental Value	Objective	Period
Dust Deposition	Nuisance	4 grams/m^2/month	Monthly (total)
	Nuisance	2 grams/m^2/month	Monthly (increase)

The Ontario Ministry of the Environment (MOE) in Canada has legislated a standard for emissions of Zinc as particulate, as detailed below in Table 11-4.

Table 11-4 Ontario MOE Standard for Zinc

Indicator	Environmental Value	Objective (µg/m^3)	Period
Zinc	Particulate	120	24 hour

Queensland DERM has standards for nitrogen dioxide and sulphur dioxide for the protection of the health and biodiversity of ecosystems, as shown below in Table 11-5.

Table 11-5 Queensland DERM Standard for the Protection of Ecosystems

Indicator	Environmental Value	Objective (µg/m^3)	Period
Nitrogen dioxide	Ecosystems	33	1 year
Sulphur dioxide	Ecosystems	22	1 year

11.2.4 Project goals for air quality

Table 11-6 provides a summary of these standards and goals adopted for each of the applicable pollutants for the Project.

Table 11-6 Summary of standard and goals for applicable pollutants

Pollutant	Averaging Period	Project Goal	Jurisdiction
TSP	1 year	90 µg/m^3	QLD DERM
PM_{10}	1 day	50 µg/m^3 (exceedances allowed 5 days per year)	NEPM
$PM_{2.5}$	1 day	25 µg/m^3	NEPM
	1 year	8 µg/m^3	NEPM
NO_2	1 hour	225 µg/m^3 (exceedance allowed 1 day per year)	NEPM
	1 year	56 µg/m^3	NEPM
	1 year	33 µg/m^3 (ecosystems only)	QLD DERM
SO_2	1 hour	522 µg/m^3 (exceedance allowed 1 day per year)	NEPM
	1 day	208 µg/m^3 (exceedance allowed 1 day per year)	NEPM
	1 year	52 µg/m^3	NEPM
	1 year	22 µg/m^3(ecosystems only)	QLD DERM
CO	8 hours	10 mg/m^3 (exceedance allowed 1 day per year)	NEPM
Lead	1 year	0.50 µg/m^3	NEPM
Zinc	1 day	120 µg/m^3	Ontario MOE
Dust Deposition	1 year (total)	4 g/m^2/month	Victoria EPA
	1 year (increase)	2 g/m^2/month	Victoria EPA

11.3 Greenhouse Gas Policies

11.3.1 International Policy

In 1997, the United Nations Framework Convention on Climate Change (UNFCCC) produced the Kyoto Protocol aimed at limiting the GHG emissions of countries that ratified the protocol (United Nations, 1997). The Kyoto Protocol entered into force in 2005, and was designed to work by setting limits to individual mandatory GHG emission targets using the ratifying country's 1990 GHG emissions as their baseline.

The Kyoto Protocol sets out three flexibility mechanisms to allow GHG targets to be met:

- Clean Development Mechanism
- Joint Implementation
- International Emissions Trading.

These three mechanisms effectively allow GHG reductions to be made at the point where the marginal cost of that reduction is lower. An industrialised country sponsoring a GHG reduction project in a developing country may claim that reduction towards its Kyoto Protocol target and those GHG reductions can be traded.

Australia ratified the Kyoto Protocol in December 2007 and has committed to meeting its Kyoto Protocol target of 108% of 1990 emissions by 2012.

11.3.2 Australian Policy

The Australian Policy on climate change released in July 2007 is managed by the Commonwealth Government Department of Climate Change and Energy Efficiency (DCCEE). The policy sets out the Commonwealth Government's focus on reducing GHG emissions, encouraging the development of low emissions and emission reduction technology and climate change adaptation at the same time setting national policies and response to climate change within a global context.

On 24 February 2011, the Australian Prime Minister announced a climate change framework outlining the broad architecture for a National carbon price mechanism, which has been considered by the Multi-Party Climate Change Committee (DCCEE, 2011). The proposed mechanism has been agreed to by members of the Committee.

The proposal focuses on the high level architecture, sectoral coverage, international linking arrangements and potential progression to emissions trading. Outlined in the proposal is a two-stage plan for a carbon price mechanism commencing in July 2012, with a fixed price period for three to five years before transition to an emissions trading scheme.

11.3.2.1 Garnaut Review

The Commonwealth Government commissioned the Garnaut Climate Change Review (Garnaut Review) as an independent study to examine the impacts, challenges and opportunities of climate change for Australia. The Garnaut Review's final report was released on 30 September 2008 (Garnaut, 2008). The Garnaut Review considered the potential impacts that climate change will have on Australia's environment and economy and proposed medium to long-term policies and policy frameworks to improve the prospects for sustainable prosperity.

11.3.2.2 Clean Energy Future

In July 2011, the Australian Government announced a plan for a Clean Energy Future (CEF), which has four key elements (DCCEE, 2011):

- placing a price on carbon pollution
- promoting innovation and investment in renewable energy
- improving energy efficiency
- creating opportunities in the land sector to cut pollution.

The plan will operate in two phases: a fixed price phase commencing July 2012 and a floating price phase commencing July 2015. Carbon permits must be submitted by entities that emit more than 25,000 t CO_2-e. The Clean Energy Legislative Package provides the mechanism by which the CEF will be implemented.

The CEF is supported by the *National Greenhouse and Energy Reporting Act 2007* (NGER Act) which is designed to provide robust data as a foundation to the CEF.

11.3.2.3 *National Greenhouse and Energy Reporting Act 2007* (NGER Act)

The NGER Act established a national framework for Australian corporations to report GHG emissions, reduction removals and offsets, in addition to energy consumption and production.

From 1 July 2008, corporations have been required to register and report if:

- they control facilities that emit 25 kilotonnes or more of GHG (CO_2 equivalent), or produce/consume 100 terajoules or more of energy
- their corporate group emits 125 kilotonnes or more GHG (CO_2 equivalent), or produces/consumes 500 terajoules or more of energy.

Xstrata Holdings Pty Ltd is registered in accordance with the NGER Act and annually submits reports on behalf of its operations including activities at MRM.

11.3.2.4 Energy Efficiency Opportunities (EEO)

The Commonwealth Government's Energy Efficiency Opportunities (EEO) program came into effect in July 2006, and mandates large energy users (over 0.5 petajoules [PJ] of energy consumption per year) to participate in the program. The objective of this program is to drive ongoing improvements in energy consumption amongst large users. Businesses are required to identify, evaluate and report publicly on cost-effective energy saving opportunities.

The EEO program is designed to result in:

- improved identification and uptake of cost-effective energy efficiency opportunities
- improved productivity and lower GHG emissions
- greater scrutiny of energy use by large energy consumers.

The EEO program will be incorporated into the National Framework for Energy Efficiency.

As a large energy user, McArthur River Mining Pty Ltd, the Project's Proponent, is a mandatory participant, for which reporting requirements are triggered under the EEO program. Consequently, the minimum requirements of the scheme will be met by the Project.

As the EEO program's Assessment Framework takes a whole-of-business approach to assessing energy use and energy saving opportunities, the framework involves corporations looking at the many factors influencing energy use. These factors include leadership, management and policy; the accuracy and quality of data and analysis; the skills and perspectives of a wide range of people; decision making; and communication outcomes. Participants are expected to meet minimum requirements in each of these areas.

11.4 Existing Environment

The Project is located approximately 70 kilometres south-west of the township of Borroloola, 120 kilometres south of the Bing Bong concentrate storage and ship loading facility (Bing Bong) on the Gulf of Carpentaria and 900 kilometres south-east of Darwin in the Gulf Region of the Northern Territory. The sparse area surrounding the mine and Bing Bong is used predominantly for cattle grazing by large pastoral properties, whereby limited anthropogenic emissions are released. No monitoring data is available for the township of Borroloola. In the absence of other major sources of air pollution, the baseline environment is expected to be similar to that at the mine. However, given the separation distance and infrequent south-westerly winds, the influence of the mine operations on air quality at Borroloola is considered to be negligible.

11.4.1 Sensitive receptor locations

Borroloola is the closest township to the Project. The closest homestead, McArthur River Station, is approximately 40 km to the south-west of the Project site. Consequently, due to the Project's isolation there are no sensitive receptors that could potentially be affected by the Project other than the accommodation village, which is located approximately 1,500 m from the existing power station and 2,000 m from the existing open pit.

11.4.2 Sources of air emissions

Potential sources of particulate emissions from the existing surrounding environment primarily comprise:

- farming and grazing activities
- traffic on unsealed roads
- existing mining operations
- smoke from grass / bush fires (permitted or otherwise)
- naturally occurring wind-blown dust.

11.4.3 Depositional dust monitoring at McArthur River Mine

Due to the fine-grained nature of the ore body and in particular the bulk concentrate, dust generation is one of the environmental aspects closely managed at the existing mine. The existing monitoring program has the objective to monitor potential contaminated particulate matter (dust particles) arising from mining activities. Depositional dust sampling is undertaken in accordance with *Australian Standard 3580.10.1.2003 Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method*.

Depositional dust gauges located strategically around the mine (to capture fugitive dust sources), are mounted on stands approximately two metres high. Depositional dusts sampled undergo laboratory analysis on a monthly basis. Parameters analysed are:

- total insoluble matter (TIM)
- total lead
- total zinc.

The Project goal for dust deposition (represented as TIM) is no greater than 4 g/m^2/month cumulative (background plus Project related emissions).

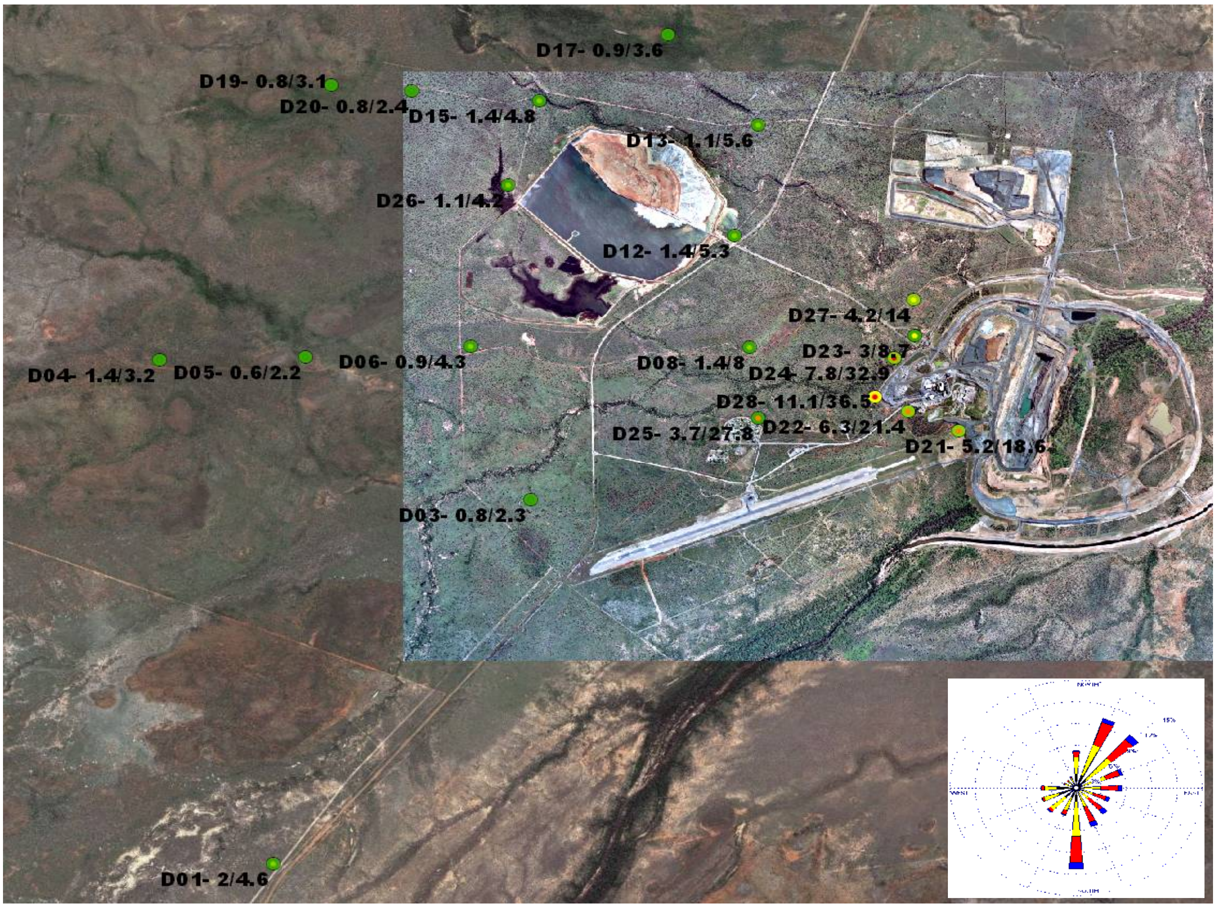
A graphical summary of the depositional dust monitoring program at MRM is provided in Figure 11-1.

Figure 11-1 shows the current mining activities are generally within the Project goals. The larger circles represent the average monthly dust deposition, which, with the exception of sites in the immediate vicinity of the processing plant and pit, are under the 4 g/m^2/month guideline. The smaller circles represent the maximum monthly dust deposition result.

11.4.4 Other existing air quality parameters

No other monitoring is currently undertaken for ambient air quality. While there are emissions from the power station and mine vehicles, there are no other industrial or urban developments in the vicinity of the mine. Background concentrations of pollutants such as SO_2, NO_x, CO and metals are therefore expected to be minor and hence have not been monitored.

The NEPM monitoring of PM_{10} and $PM_{2.5}$ which occurs in Darwin was considered an unsuitable representative background level to use for a remote site. The Project is located approximately 900 kilometres south-east from Darwin, in a remote area where background air quality is unlikely to be influenced by anthropogenic activities to the same extent of the more populous Darwin urban region.



Maximum Monthly Dust Deposition Result (g/m²/month)	Average Monthly Dust Deposition Result (g/m²/month)
2.200000 - 4.000000	0.600000 - 4.000000
4.000001 - 8.000000	4.000001 - 8.000000
8.000001 - 16.000000	8.000001 - 16.000000
16.000001 - 32.000000	16.000001 - 32.000000
32.000001 - 36.500000	32.000001 - 36.000000

Labelling Code

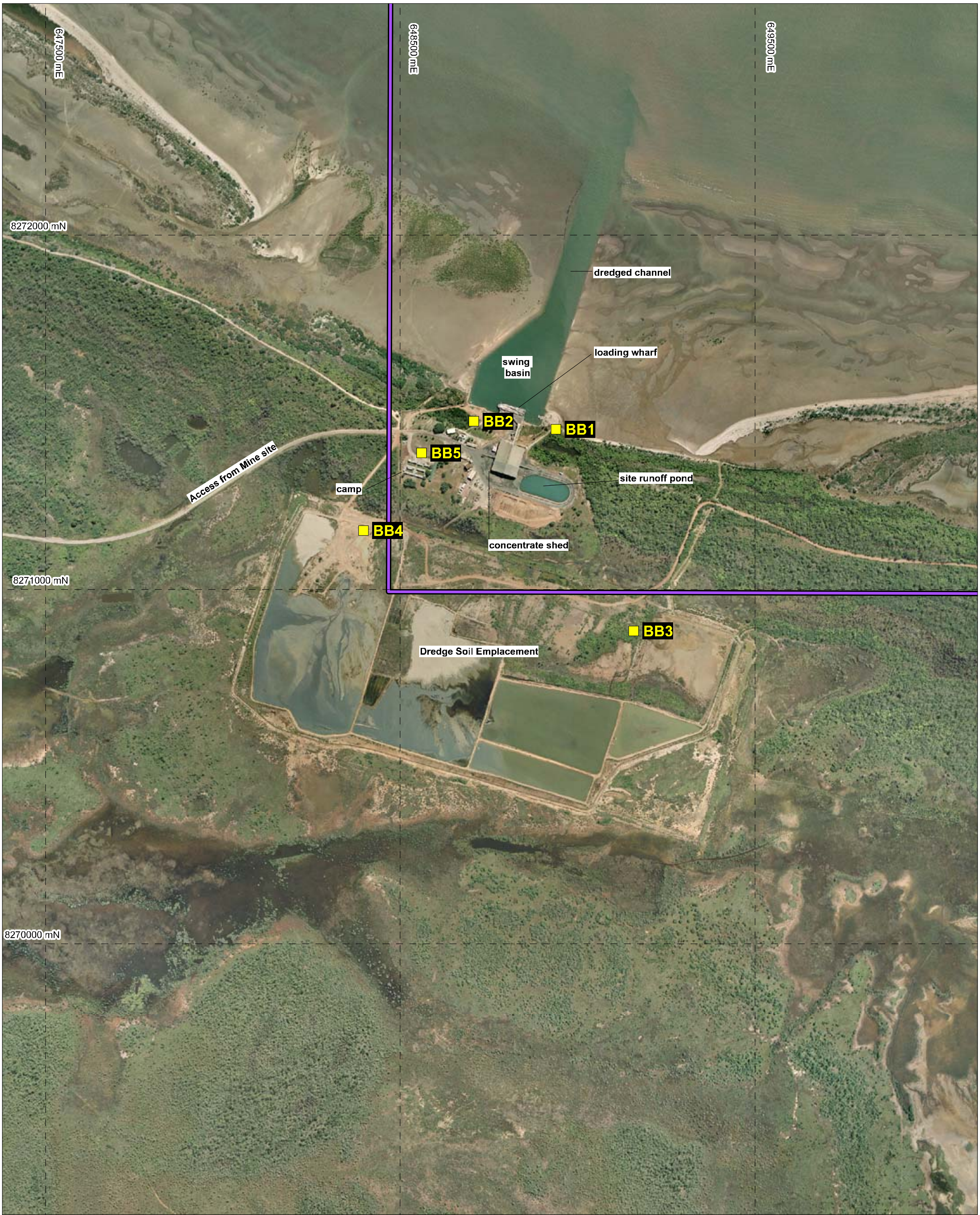
"D##" Sample Point Location Name

"#/#" Average Result at Sample Point / Maximum Result at Sample Point (g/m2/month)

Figure 11-1 Depositional dust summary and monitoring locations at MRM

11.4.5 Depositional dust at Bing Bong

Dust deposition levels are monitored at Bing Bong, using five strategically positioned dust monitoring sites. Dust samples collected are analysed for zinc and lead concentrations as well as TIM. Locations of the depositional dust monitoring sites at Bing Bong are shown in Figure 11-2.



LEGEND

- Project tenement
- Dust Monitoring Site

Data Source: Imagery - Xstrata.

METSERVE Mining & Energy Technical Services Pty Ltd

xstrata zinc

McArthur River Mine
Phase 3 Development Project

Bing Bong Concentrate Storage and Ship Loading Facility - Dust Monitoring Sites

0 400 800
Metres

Scale: 1:15,000 (A4)

13/01/2012

Datum: AGD84
Projection: AMG53

FIGURE 11 - 2

s:\Projects\XZ003 MRM Extension EIS_MapInfo\Workspaces\XZ003_M109A.Wor

Generally, dust levels (total solids) are low to moderate and are generally below levels that would be expected to give rise to complaints in more populated areas. Long term data for TIM indicates consistently high records at BB4 in relation to the other dust monitoring sites (Figure 11-2). BB4 is located on the dredge spoil area that has little vegetation cover and hence, these conditions create the probability of higher than site average dust levels. Importantly, concentrations of metals at BB4 were comparably lower than most other Bing Bong sites.

11.4.6 Climate and Dispersion Meteorology

The Bureau of Meteorology (BOM) has weather monitoring stations located at the MRM and Centre Island. The Centre Island weather monitoring station is considered representative of Bing Bong.

The Project is situated in a grassland environment, a region that experiences a warm climate with two distinct seasons - a dry winter and a wet summer. Mean maximum temperatures range from 29.8–38.6°C and mean minimum temperatures from 12.2–24.9°C. Regional rainfall averages approximately 790 millimetres (mm) annually, falling mostly between December and March.

Bing Bong is situated on the coastline in a monsoonal environment and experiences a climate similar to the mine. However, the region experiences higher rainfall averaging 1069 mm annually. Humidity is generally higher due to the coastal location and winds tend to be south-easterly dominant during the year.

The wet summer season results in increased soil moisture content and grass dominated ground cover, lowering dust emissions from most sources, including local roads. Conversely, during the dry winter season, soil moisture content decreases (particularly at the surface) and grass cover declines. Dust emissions become more prevalent from most sources during this period. Grass fires (including permitted fires) are more likely to occur, releasing significant volumes of smoke into the lower atmosphere.

There is a dominant north-easterly component to the winds at the Project year round, although a pronounced southerly is evident during the dry season. Any particulate or gaseous emissions from the Project are unlikely to travel to a population centre or non-mine related sensitive receptor due to the geographic isolation of the Project. The frequency of Pasquill atmospheric stability classes for the region are summarised in Table 11-7. Table 11-7 indicates that the atmosphere around the Project is stable for approximately 43% of the time; therefore unusual climatic conditions such as temperature inversions are unlikely.

Table 11-7 Frequency of stability classes

Stability Class	Description	Frequency of Occurrence (%)
A	Very Unstable	3
B	Moderately Unstable	19
C	Slightly Unstable	20
D	Neutral	10
E	Slightly Stable	6
F	Stable	43

11.5 Air Quality Assessment

11.5.1 Particulate Matter Inventories

Estimations for particulate matter emissions for the Project have been derived from emission factors provided in the National Pollutant Inventory (NPI), Emission Estimation Technique (EET) Manual, US EPA AP-42 Emission Estimation Manual and information from the Xstrata Zinc. Various site based activities, such as the amount of ore and overburden material mined, have been used to estimate TSP and PM_{10} inventories.

$PM_{2.5}$ estimated inventories have been calculated by developing a ratio of PM_{10} to $PM_{2.5}$. In the absence of additional information, it has been assumed that $PM_{2.5}$ concentrations resulting from Project activities are equal to a conservative 25% of PM_{10} concentrations. This methodology is expected to over-estimate the results of $PM_{2.5}$ concentrations due to the conservative approach.

Analysis of current depositional dust and feed compositions of overburden and ore for lead and zinc at the Project has been used to characterise the amount of lead and zinc in the TSP generated by different emission sources. Emission estimation inventories for the Project are summarised for PM_{10}, $PM_{2.5}$ and TSP in Table 11-8 and lead and zinc in Table 11-9**.**

11.5.2 Point Sources Inventory (Power Station)

There are two options being considered for increasing the supply of electricity to the site to meet demand. This includes an augmentation of the existing power station, and a new power station option. With the augmentation option, the existing facility would be maintained and new generators would be added to the site. There are also a number of potential power station sites that are in relative close proximity to each other. The emission factors for these generator options are shown in Appendix D5 – Air and Greenhouse Gases.

The prediction of ground-level concentrations of NO_2 has been conducted by modelling the total emission rate in grams per second for NO_X from each source, with the results scaled by an empirical nitric oxide/nitrogen dioxide conversion ratio.

11.6 Potential Impacts

11.6.1 Sources of Air Emissions

The primary sources of particulate emissions at the Project are likely to include:

- clearing of vegetation and removal of topsoil
- drilling and blasting
- in pit loading
- OEFs
- movement of overburden to OEFs
- movement of ore from ROM stockpiles to the processing plant
- ore processing and stockpiling
- fugitive and point source emissions from the power plant
- wind erosion of stockpiles and areas of bare topsoil
- vehicle movement on unsealed roads and ramps (also partially wind generated).

11.6.2 Modelling Methodology

A brief overview is provided of the methodology for meteorological modelling using CALMET, together with atmospheric dispersion using CALPUFF. A more detailed methodology of these models is included in Appendix D5.

Table 11-8 Dust emissions inventory for Project main dust sources

Group	Source	Emission (kg/annum)														
		2011			2015			2025			2030			2035		
		TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Mining	Vegetation Clearing and Soil Removal	40,563	14,367	3,592	49,343	18,332	4,583	25,458	9,562	2,390	9,920	2,964	741	9,028	2,565	641
	Drill and Blasting	71,970	37,577	9,394	71,970	37,577	9,394	71,970	37,577	9,394	71,970	37,577	9,394	71,970	37,577	9,394
	In-pit Loading	11,109	4,968	1,242	16,224	8,490	2,123	21,574	12,936	3,234	10,211	3,968	992	9,640	3,454	864
	OEF	164,057	58,171	14,543	339,960	120,599	30,150	646,561	230,464	57,616	49,109	16,377	4,094	20,314	6,059	1,515
	Run of Mine (ROM) Stockpiles-Processing Plant	20,719	7,496	1,874	63,909	23,122	5,780	63,059	22,814	5,703	61,456	22,234	5,559	53,223	19,256	4,814
Roads	Topsoil to stockpiles	36,734	7,591	1,898	47,192	9,796	2,449	-	-	-	-	-	-	-	-	-
	Overburden to OEF	264,945	54,944	13,736	683,909	142,689	35,672	1,184,070	246,790	61,697	78,813	16,426	4,107	26,174	5,455	1,364
	ROM to Processing Plant	30,787	6,523	1,631	131,095	27,840	6,960	103,808	22,052	5,513	123,814	26,271	6,568	107,228	22,751	5,688

Table 11-8 Dust emissions inventory for Project main dust sources (cont)

Group	Source	Emission (kg/annum)														
		2011			2015			2025			2030			2035		
		TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Wind Erosion	Exposed surfaces	684	650	162	627	596	149	661	628	157	634	603	151	271	257	64
	OEF	430	215	54	2,541	1,270	318	1,883	942	235	726	363	91	1,200	600	150
	Ore Stockpiles	612	306	76	2,331	1,165	291	2,331	1,165	291	2,331	1,165	291	2,331	1,165	291
Process-ing Plant	Processing Plant	325,686	43,510	10,877	990,468	132,321	33,080	971,567	129,796	33,080	946,401	126,434	31,608	816,317	109,055	27,264
Total		**968,296**	**236,318**	**59,080**	**2,399,478**	**523,798**	**130,949**	**3,092,942**	**714,725**	**130,949**	**1,355,386**	**254,382**	**63,596**	**1,117,695**	**208,195**	**52,049**

Note: ROM=Run of Mine, OEF=Overburden Emplacement Facility

Table 11-9 Lead and zinc inventory for Project main dust sources

Group	Source	Emission (kg/annum)									
		2011		2015		2025		2030		2035	
		Lead	Zinc	Lead	Zinc	Lead	Zinc	Lead	Zinc	Lead	Zinc
Mining	Vegetation Clearing and Soil Removal	63	198	76	241	39	124	15	48	14	44
	Drill and Blasting	1,679	3,873	1,679	3,873	1,679	3,873	1,679	3,873	1,679	3,873
	In-pit Loading	478	1,089	698	1,590	928	2,114	439	1,001	415	945
	OEF	253	801	525	1,660	998	3,157	76	240	31	99
	ROM Stockpiles- Processing Plant	891	2,030	2,748	6,263	2,712	6,180	2,643	6,023	2,289	5,216
Roads	All Roads and Ramps	30	196	78	509	116	760	18	120	12	79
Wind Erosion	Exposed surfaces	29	67	27	61	28	65	27	62	12	27
	OEF	1	2	4	12	3	9	1	4	2	6
	Ore Stockpiles	26	60	100	228	100	228	100	228	100	228
Processing Plant	Processing Plant	14,004	31,917	42,590	97,066	41,777	95,214	40,695	92,747	35,102	79,999
Total		**17,454**	**40,234**	**48,524**	**111,504**	**48,380**	**111,724**	**45,694**	**104,346**	**39,655**	**90,516**

Note: ROM=Run of Mine, OEF=Overburden Emplacement Facility

11.6.2.1 Meteorological modelling

Modelling of fugitive and point source emissions has been undertaken using the CALPUFF dispersion model. Detailed data on surface and upper air meteorology is required when using CALPUFF for atmospheric dispersion modelling. The pre-processor CALMET model was used to develop a three dimensional grid of meteorology for the model domain. This model outputs hourly atmospheric parameters such as wind speed and direction (three dimensional), atmospheric mixing heights and stability conditions. Outputs of CALMET are used as inputs in the dispersion model CALPUFF.

11.6.2.2 Dispersion Model

CALPUFF was used to simulate the dispersion of species emitted from specified sources through a three dimensional domain over time using meteorological characteristics developed in Section 11.6.2.1**.**

In order to determine percentage contributions of the different emission sources for concentrations predicted at the monitoring points, each emission source was run as a separate model. The results of all the model runs for each emission were then summed to produce the final total result.

The CALPUFF model is highly regarded in the scientific community as a suitable tool for simulating the dispersion of potential air pollutants. However, as described further in Appendix D-5, CALPUFF has some limitations, including general limitations and Project specific limitations.

11.6.3 Modelling results

With limited site specific data, background concentration levels have not been measured directly, therefore, an uncertainty in background levels exists at the Project. The results in this section have therefore been presented as the Project contribution only.

11.6.3.1 On-site dust emissions

Modelling indicates the main dust sources comprise the processing plant, OEFs, movement of overburden to OEFs, movement of ore from the ROM to processing plant and drilling and blasting as indicated in Table 11-8**.**

11.6.3.2 Impacts on the accommodation village

As discussed in Section 11.4.1, the accommodation village is the only identified sensitive receptor. The accommodation village has been represented in the model as five discrete receptors as presented in Figure 11-3. Predictions of future ground level concentrations and the rates of dust deposition at the accommodation village have been undertaken for the following years of the Project in order to represent the main phases of development through to mine closure:

- Year 2011
- Year 2015
- Year 2025
- Year 2030
- Year 2035.

Likely dust levels due to Project operations at the accommodation camp monitoring locations have been determined and are provided in Table 11-10 for the Project years. Lead and zinc concentrations have also been determined at sensitive receptors and are presented in Table 11-11. Concentrations of nitrogen dioxide are presented in Table 11-12.

Table 11-10 Predicted dust concentration for Project receptor locations

Receptor Locations		Calculated Dust Levels at Receptor Locations			
		$PM_{2.5}$ (24 Hour) (Maximum)(µg/m^3)	$PM_{2.5}$ (Annual Average) (µg/m^3)	PM_{10} (24 Hour) (5th Highest) (µg/m^3)	TSP (Annual Average) (µg/m^3)
Project goals for air quality		**25**	**8**	**50**	**90**
Year 2011	Receptor 1	4	1	6	6
	Receptor 2	4	1	7	8
	Receptor 3	4	1	7	7
	Receptor 4	3	1	5	5
	Receptor 5	4	1	6	7
Year 2015	Receptor 1	12	3	34	14
	Receptor 2	13	3	39	18
	Receptor 3	13	3	39	15
	Receptor 4	10	2	30	11
	Receptor 5	12	3	36	15
Year 2025	Receptor 1	11	3	40	15
	Receptor 2	13	4	48	20
	Receptor 3	13	4	40	17
	Receptor 4	12	3	27	13
	Receptor 5	13	3	36	18
Year 2030	Receptor 1	6	1	17	10
	Receptor 2	6	2	20	13
	Receptor 3	6	1	17	11
	Receptor 4	5	1	11	7
	Receptor 5	6	1	14	11
Year 2035	Receptor 1	5	1	14	8
	Receptor 2	5	1	16	11
	Receptor 3	5	1	17	9
	Receptor 4	4	1	12	6
	Receptor 5	5	1	14	9

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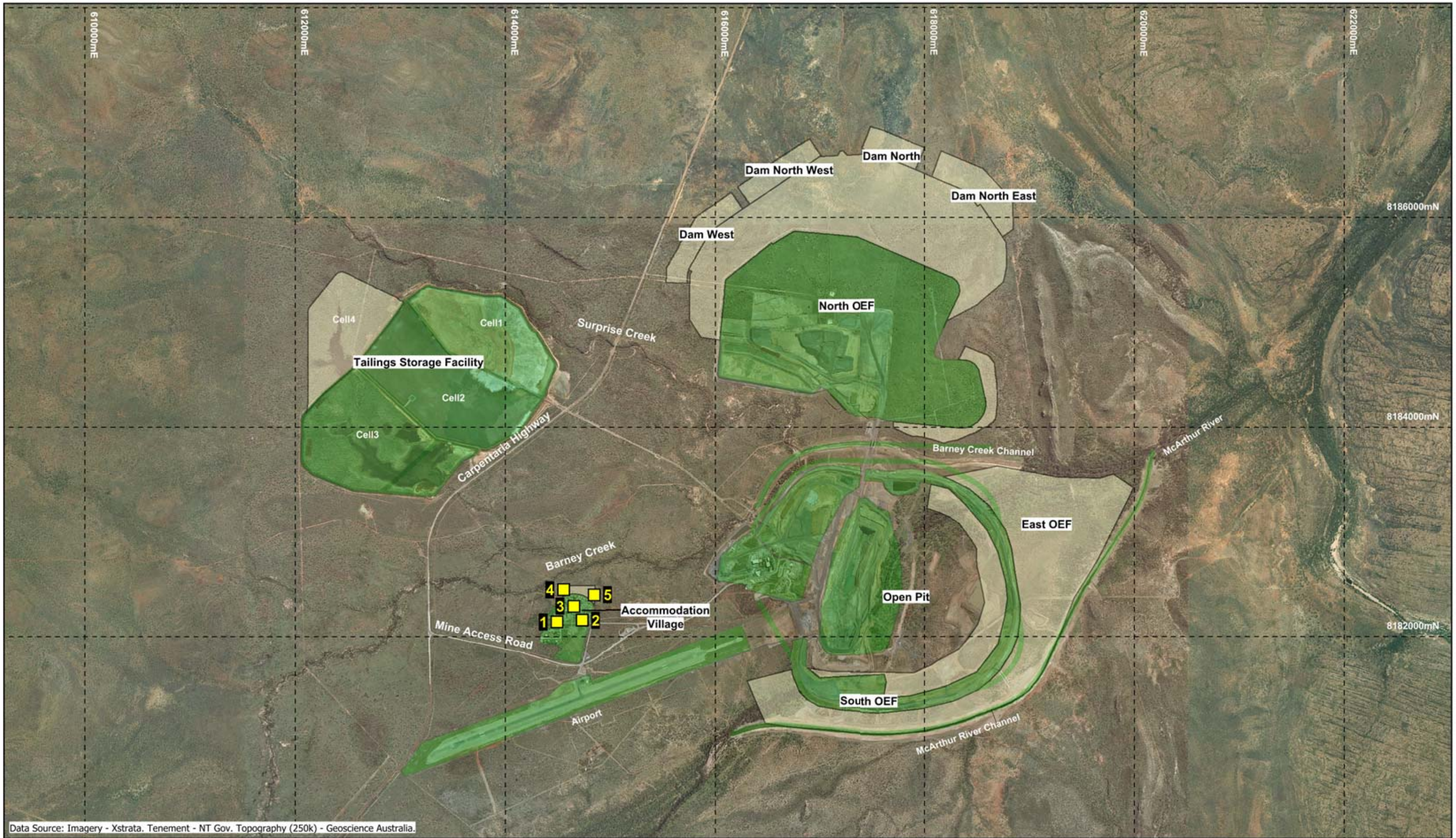

METSERVE

xstrata zinc

0 1

Kilometres

Scale: 1:50,000 (A4)

LEGEND

- Proposed Infrastructure
- Existing Infrastructure
- Sensitive Receptor and Number

McArthur River Mine Phase 3 Development Project

Sensitive Receptors

16/01/2012

Datum: AGD84
Projection: AMG53

FIGURE 11 - 3

Table 11-11 Predicted lead and zinc concentration for Project receptor locations

Receptor Locations		Calculated concentrations of Lead and Zinc at Receptor Locations	
		Lead (µg/m^3)	Zinc (µg/m^3)
Project goals for air quality		**0.5**	**120**
Year 2011	Receptor 1	0.1	2
	Receptor 2	0.1	3
	Receptor 3	0.1	3
	Receptor 4	0.1	2
	Receptor 5	0.1	2
Year 2015	Receptor 1	0.3	6
	Receptor 2	0.4	7
	Receptor 3	0.3	7
	Receptor 4	0.2	6
	Receptor 5	0.3	7
Year 2025	Receptor 1	0.3	6
	Receptor 2	0.4	7
	Receptor 3	0.3	7
	Receptor 4	0.2	6
	Receptor 5	0.3	7
Year 2030	Receptor 1	0.3	6
	Receptor 2	0.4	7
	Receptor 3	0.3	7
	Receptor 4	0.2	5
	Receptor 5	0.3	7
Year 2035	Receptor 1	0.2	5
	Receptor 2	0.3	6
	Receptor 3	0.3	6
	Receptor 4	0.2	5
	Receptor 5	0.3	6

Table 11-12 Nitrogen dioxide concentrations at Project receptor locations

Receptor Locations	Calculated concentrations of NO_2 at Receptor Locations			
	NO_2 Maximum Hourly Concentrations (µg/m^3)		NO_2 Annual Average Concentrations (µg/m^3)	
Project goals for air quality	**225**		**56**	
Loading	**Average Load**	**Peak Load**	**Average Load**	**Peak Load**
Receptor 1	59	147	1	1
Receptor 2	64	151	1	1
Receptor 3	111	106	1	1
Receptor 4	105	74	1	1
Receptor 5	110	94	1	1

Modelled air quality concentrations at the receptor points established at the accommodation village have been compared with the appropriate Project goals as discussed in Section 11.2. The averaging period for ground level concentrations of contaminants is consistent with the averaging periods for acceptable air quality levels in the NEPM (*Ambient Air Quality*) at all monitoring points.

Years 2015 and 2025 are identified as representing worst case scenario impacts for the Project. However, these modelled years are both well within the Project goals for ambient air quality at the accommodation village. In comparison to the other modelled years of the Project, evident increases in dust levels are witnessed during these periods which may be attributed to the increase in production and the expansion of the pit and OEFs.

11.6.3.3 Bing Bong Concentrate Storage and Ship Loading Facility

Bulk concentrate will continue to be exported via the loading facility at Bing Bong in the same way that is used for the current operations; however the volume of concentrate will increase accordingly. Fugitive dust from the concentrate will be minimised by the material's moisture content of approximately 12% to 13%.

Further dust mitigation measures to be installed at Bing Bong and is part of works that are independent of the Project. These upgrades include a wet scrubber dust extraction system at the concentrate shed. A negative airflow generated by the system will contain any airborne dust within the shed. The dust extraction system is then wet filtered. In addition, fast opening/closing doors will be installed on the unload ramps so that concentrate transfer out of the road trains can occur with the main doors closed.

Taking into account the proposed upgrades to dust mitigation, no significant adverse impacts on local air quality at Bing Bong are anticipated as a result of the Project.

Exhaust emissions from the delivery trucks and the barges will be minimised through appropriate tuning and maintenance and would not significantly impact local air quality.

11.7 Mitigation Measures

The environmental values of the air environment to be enhanced or protected are the qualities of the air environment that are conducive to suitability for the life, health and well-being of humans.

Based on the air quality modelling conducted, the overall impact of the Project on air quality is expected to be low and within standards and goals adopted for the Project. Although the overall impact of the Project on air quality is expected to be low, the Project will maintain and implement dust minimisation strategies to ensure emission levels are minimised at the accommodation village as well as for occupational health and safety reasons.

Measures proposed to minimise potential adverse air quality impacts associated with the Project are described in Table 11-13.

The existing dust deposition monitoring and meteorology programmes at the mine site and Bing Bong will be continued for the Project. Dust collected at the monitoring sites will continue to be analysed for lead and zinc concentrations. Results of the dust monitoring program will be used to provide an indication of the effectiveness of the dust control measures being implemented at the mine site and Bing Bong.

An additional monitoring programme will be undertaken at monitoring points at the accommodation village to:

- measure PM_{10} that will evaluate the effectiveness of dust controls in place at the mine and, in particular, at the mill's grinding and crushing points
- monitor nitrogen dioxide emissions from the power station (on a campaign basis) to confirm ambient standards are being met.

In the event that monitoring identifies a non-compliance with air quality limits, additional corrective mitigation measures will be investigated and implemented.

Table 11-13 Project dust minimisation measures

Source	Minimisation Measures
Mining Areas	Disturb the minimum area necessary for mining Rehabilitate disturbed areas promptly Remove overburden and emplace as soon as practicable after blasting Avoid topsoil stripping and replacement on high wind days, where practicable
Bing Bong	Install a wet scrubber dust extraction system at the concentrate storage shed Install fast opening/closing doors at the unload ramp to prevent dust escaping from shed as haulage vehicles unload
Stockpiles	Water ore stockpiles when necessary
Processing Plant	Install windbreaks at the crushing and grinding points upwind of sensitive receptors if required Various emission points will be hooded and use water sprays to prevent dust emissions
Haul Roads	Maintain haul roads in good condition and regularly use water trucks
Other Roads	Keep number of other active roads to a minimum, maintain those required in good condition and regularly use water trucks Barricade and revegetate once a road is no longer in use
OEFs	Keep areas moist, particularly areas used by dump trucks
General	Strictly limit vehicular access within the site to authorised vehicles and designated routes - i.e. bitumen and major haul/access roads Limit the internal speed on unsealed roads, as required Keep dump truck routes as short as practicable

A site contact number will be provided to facilitate lodgement of complaints about air quality. The site will maintain a complaints register. Any legitimate air quality complaints will be investigated and appropriate mitigation measures instigated.

11.8 Greenhouse Gas Emissions

Emissions of GHGs from the Project will be generated primarily from electricity generation and fuel use. The following greenhouse gases have been considered in the assessment:

- carbon dioxide (CO_2)
- methane (CH_4)
- nitrous Oxide (N_2O).

In preparing a GHG assessment, two forms of boundaries are to be specified:

- organisational boundaries
- operational boundaries.

The organisational boundary of the mine is defined by the Project's Proponent, McArthur River Mining Pty Ltd, a company wholly-owned by global mining company (Xstrata Zinc), the operator of MRM. The operational boundary is delineated by the physical mine area comprising seven Mineral Leases, and includes all the GHG emissions controlled or influenced by the Project. GHG emissions that are outside the control or influence of the Project, such as the processing of the MRM bulk concentrate into a product, lay outside this boundary.

The operational boundary for the GHG assessment includes both direct and indirect emissions from the Project. The National Greenhouse and Energy Reporting System Measurement Technical Guidelines (Technical Guideline) further define direct and indirect emissions through the concept of emission scope as follows:

- Scope 1: Direct GHG emissions are those released from a facility as a direct result of the activities of the facility. For example:
    - Emissions from combustion in boilers, furnaces, vehicles, etc.
    - Emissions from on-site power generators.
- Scope 2: Indirect GHG emissions are activities that generate electricity, heating, cooling or steam that is consumed by the facility but do not form part of the facility. They occur principally at electricity generators as a result of electricity consumption at another facility. Scope 2 emissions are recorded principally as a measure of potential national emissions as a result of the consumption of electricity from facilities.

The Project already has a power station located on-site to generate electricity for the existing operations. Ordinarily this would be considered Scope 1, however for this Project it is considered Scope 2 as the power station is operated by a third party with electricity sold back to the Project.

11.9 Greenhouse Gas Results

The GHG Scope 1 and 2 emission sources from the Project that are included in this inventory are:

- diesel combustion in vehicles (Scope 1)
- diesel combustion for stationary energy (i.e. pumps) (Scope 1)
- carbon Sink Capacity Loss (Scope 1)
- electricity consumption (Scope 2).

Based on regulated guidelines and their standard assumptions contained, the projected minimum, maximum and average emissions from the Project are presented in Table 11-14, as well as total GHG emissions over the Life of Mine (LOM).

Table 11-14 Estimated GHG Emissions for the Project.

Scope	Source	Minimum Emissions (t CO_2–e/yr)	Maximum Emissions (t CO_2–e/yr)	Average Emissions (t CO_2–e/yr)	Life of Mine (LOM) Emissions (t CO_2–e/yr)
1	Diesel Combustion (transport)	791	4,128	2,252	58,543
1	Diesel Combustion (stationary)	19,099	99,634	54,351	1,413,114
1	Carbon Sink Capacity Loss	-	26,383	5,926	154,067
	Annual Scope 1[1]	19,890	128,459	62,528	1,625,724
2	Electricity Consumption	107,535	215,070	202,662	5,269,215
	Annual Scopes 1 and 2[2]	145,317	343,529	265,190	6,894,939

[1]This row indicates the minimum, maximum, average and LOM emissions of all the totalled Scope 1 emissions and hence will not equal the total of the Scope 1 emissions included in this table.

[2]This row indicates the minimum, maximum, average and LOM emissions of all the totalled Scopes 1 and 2 emissions and hence will not equal the total of the Scopes 1 and 2 emissions included in this table.

Analysis of the annual GHG inventory for all Scope 1 and Scope 2 emissions indicate GHG emissions will continue to increase with the clearing of vegetation works which are to occur for the expansion of the pit and OEFs. Once these activities have been completed, GHG emissions from the Project slightly reduce and become steady for a remainder of the mine life. Project year 2020 is predicted to have the largest GHG emissions for the Project.

Loss of a carbon sink capacity from vegetation clearing is not considered cumulative (AGO, 2005). Once an area is cleared, any regrowth is considered as a negative carbon emission as the regrowth reduces the overall emissions.

11.10 Greenhouse Gas Minimisation Measures

Minimisation measures appropriate for the reduction of GHG emissions that will be considered for the Project include the sizing and selection of mobile diesel powered equipment. Fuel consumption rates are an integral part of the Xstrata decision matrix for the selection of equipment, for both economic and environmental reasons.

Direct means of reducing GHG emissions include such measures as:

- minimising clearing at the site
- integrating transport for the Project with other local industries, so that GHG emissions from the construction and running of transport are minimised
- maintenance of heavy mobile equipment (including tyres) and roads
- using renewable energy sources where practicable
- replacing sand with ceramic media in the primary grinding mills
- replacing some diesel powered light towers with mains connected LED's at the mine

- installing timers to control lighting across the site
- upgrading to more efficient heavy equipment in the mining fleet to reduce diesel derived GHG emissions
- using driver simulation software for bulldozers and loaders instead of equipment when training personnel.

Indirect means of reducing GHG emissions could include such measures as:

- carbon sequestration at nearby or remote locations by:
    - rehabilitating disturbed areas progressively
    - planting trees or other vegetation to achieve biomass greater than that cleared for the Project
    - carbon trading through recognised markets.

11.10.1 Offsetting carbon emissions

The GHG inventory accounts for the loss of carbon sink capacity of vegetation due to clearing. However, the Proponent also has in place a rehabilitation program, which will offset this by providing new vegetation to sequester carbon dioxide from the atmosphere. In 2010, 60 ha of land was rehabilitated (compared to 15 ha in 2009) and included the planting of 40,000 native species seedlings. Growth and establishment of vegetation through the continuation of the rehabilitation programme represents a significant opportunity to offset emissions from the Project directly within the Northern Territory.

Further offsetting of emissions is likely to be accomplished in accordance with the Clean Energy Future legislation. This may include carbon trading during the floating price phase (due to commence in 2015) where international permits such as certified emissions reduction units under the Kyoto Protocol Clean Development Mechanism and emission reduction units under the Kyoto Protocol Joint Implementation arrangements may be used for up to 50% of an organisation's carbon liabilities under the legislation.

11.10.2 Climate change adaption

The Garnaut Review (2008) states: 'Effects of future warming on rainfall patterns are difficult to predict because of interactions with complex regional climate systems. Best estimate projections show considerable drying in southern Australia, with the risk of much greater drying. Mainstream Australian science estimates that there may be a 10% chance of a small increase in average rainfall, accompanied by much higher temperatures and greater variability in weather patterns.'

Over the life of the Project until the year 2036, likely changes will be relatively minor. A small increase in average rainfall will have the effect of reducing dust emissions from the Project, while an increase in temperatures and higher evaporation rates could increase dust emissions. As slight positive and slight negative impacts are predicted, the best estimate at the present time is that climate change is unlikely to have any discernible impact on the air quality of the Project.

The Proponent commits to undertake, where practicable, a cooperative approach with government and other industry and sectors to address the issue of adaptation to climate change. The Proponent is committed to reducing its GHG emissions on a per-tonne mined basis and is a contributor to research programs to develop energy efficiency technologies, such as technology and improvements to grinding processes.

11.10.3 Greenhouse Challenge Plus Program

The Proponent is a signatory to the Greenhouse Challenge Plus Program, and accordingly, will continuously improve reporting on emissions management. The Greenhouse Challenge Plus Program is a voluntary program coordinated by the Department of Climate Change and Energy Efficiency, aimed at reducing the greenhouse gas emissions of organisations.

11.10.4 Commitments

Xstrata's Climate Change Policy supports the precautionary principle in relation to climate change and believes action is required to avoid potential climate change impacts. The group believe that the environment will continue to change and that this may pose social, economic and environmental risks and consequences which can only be addressed through comprehensive global action.

Xstrata believes that access to affordable, reliable and secure energy is fundamental to economic and social development. The group understands that to meet rising global energy demand in both the developed and developing economies, a suite of energy sources (including fossil fuels) and low emission technologies will be required to meet the objectives of energy security, economic growth and sustainable environmental performance.

Xstrata believes that emission reductions and increased energy efficiency associated with the production and end use consumption of fossil fuels are necessary and achievable as part of its contribution to addressing the global issue of climate change.

As part of Xstrata's approach to climate change, the group are committed to:

- Participating constructively in the development of effective public policy for climate change by working with governments, researchers, industry and other stakeholders around the world.
- Measuring and managing its energy and greenhouse gas emission footprint and identifying opportunities to abate or mitigate these emissions.
- Investing and promoting the research, development and demonstration of low emission technologies that have the potential to deliver large scale emission reductions.
- Integrating the cost of carbon into our business planning and development practices.

MRM operates in accord with this group policy.

11.10.5 Training and awareness

Energy efficiency and GHG awareness is primarily communicated to all employees and contractors during site inductions and specific awareness sessions conducted throughout the year during monthly safety or sustainable development meetings. Posters promoting energy saving initiatives are distributed around the workplace.

11.10.6 Electricity generation

The existing combined cycle gas turbine technology will continue to be used to generate Project electricity. Combined cycle gas turbines, widely used throughout the world to abate greenhouse gas production from power generation, are the most greenhouse efficient gas-fired power generation technology currently available. Gas fuel has the least carbon intensity of all the fossil fuels and waste heat from the operation of the gas turbine can be used to raise steam and generate additional energy from the same fuel energy input.