CHAPTER 8- Air quality and greenhouse gas emissions

8.1 Introduction

This chapter discusses the potential impacts on air quality and the emissions of greenhouse gases (GHG) associated with the project; including mitigation measures when practicable.

Emissions from the project are generated primarily from mining activities that result in the movement of waste rock and ore, and subsequent ore processing. The main particulate emission of concern is dust, and to a lesser extent, emissions associated with the vehicles, processing plant and power station operations.

The main impacts on air quality in regards to the Twin Bonanza mine site include:

1. impacts of dust from operations associated with mining
2. vehicle exhaust emissions
3. emissions from power station (gen sets)
4. emissions from processing plant
5. emissions and dust from blasting
6. odours from sewage and landfills

Potential impacts from particle emissions associated with the project are expected to be minimal based on the implementation of a number of mitigation measures, the remote location of the project and the absence of nearby residential facilities will limit any adverse impacts.

ABM's Air Quality Management Plan (AQMP) provides a detailed management system to identify and control potential air quality impacts and to reduce the dust impact generated from operations on ABM Resources staff, external stakeholders and the environment (Appendix K). Additional receptors are limited as there are no settlements within 100km of the site, however, local populations of native flora and fauna, including bilbies, are considered a receptor for the management of air quality at the Twin Bonanza project.

There are limited potential sources of particulate emissions from the existing environment as the environment is considered undisturbed. Existing particulate emissions include primarily vehicle emissions from local traffic, smoke from bushfires and wind-blown dust.

8.1.1. Assessment of potential air quality impacts

Potential air quality impacts from the project have been assessed by:

1. identifying the nearest sensitive receptors describing existing air quality and defining the prevailing wind direction

2. reviewing legislative requirements and ambient air quality goals
3. identifying mitigation measures to assist with the management of the potential air quality impacts from the project.

8.2 Air quality guidelines

The Northern Territory does not have specific air quality legislation so other criteria have been used to determine the environmental goals of the project with regard to air quality. In selecting these, the following sources (listed in order of priority) have been used:

- National Environment Protection Council (NEPC) - *National Environment Protection Council Act 1994* (Cth)
- National Environment Protection Measure for Ambient Air Quality (the 'Air NEPM')
- New South Wales Department of Environment Climate Change and Water (DECCW) has legislated standards for dust deposition
- National Standards for Air Quality - Australian Government, Department of the Environment and Heritage, 2005
- Australian state legislation
- Other international criteria

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.

8.2.1. Waste Management and Pollution Control Act 2009 (NT).

Section 83 of the Northern Territory's Waste Management and Pollution Control Act (WMPC Act) provides for general environmental offences, including that a person must not create an environmental nuisance. Section 4 of the WMPC Act defines environmental nuisance as:

An adverse effect on the amenity of an area that:

1. is caused by noise, smoke, dust, fumes or odour
2. unreasonably interferes with or is likely to unreasonably interfere with the enjoyment of the area by persons who occupy a place within the area or are otherwise lawfully in the area.

The WMPC Act does not provide any specific guidelines or legislation regarding environmental goals for air quality.

8.2.2. National Environment Protection Council

The NEPC comprises environment ministers from the Australian Government and each state and territory and was, established under the National Environment Protection Council Act 1994 (Cth) and corresponding legislation in the other jurisdictions.

The purpose of 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 and markets are not 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
- the protection of amenity in relation to noise (but 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
- the re-use and recycling of used materials
- motor vehicle noise and emissions (in consultation with the National Transport Commission)

The Air NEPM sets national standards for the six key air pollutants to which most Australians are exposed: carbon monoxide, ozone, sulfur dioxide, nitrogen dioxide, lead and particles.

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.

The National Standards for Air Quality are set out below (Australian Government, Department of the Environment and Heritage, 2005);

Table 8-1. National Standards for Air Quality.

Pollutant	Concentration and averaging period
Carbon monoxide	9.0 ppm (parts per million) measured over an eight hour period
Nitrogen dioxide	0.12 ppm averaged over a one hour period
	0.03 ppm averaged over a one year period
Ozone	0.10 ppm of ozone measured over a one hour period
	0.08 ppm of ozone measured over a four hour period
Sulfur dioxide	0.20 ppm averaged over a one hour period
	0.08 ppm averaged over a 24 hour period
	0.02 ppm averaged over a one year period
Lead	0.5 µg/m³ (micrograms per cubic metre) averaged over a one year period
Particles as PM_{10}	50 µg/m³ averaged over a 24-hour period
Particles as $PM_{2.5}$	Advisory reporting standard: 25 µg/m³ over a one day period; 8 µg/m³ over a one year period

Standards of dust deposition and generation are not specified in the NEPM.

8.2.3. Other applicable standards and goals

In lieu of standards in the Northern Territory and under the NEPM ABM has adopted the New South Wales Department of Environment Climate Change and Waters (DECCW) standards for dust deposition. These legislated standards have been adopted for the purposes of dust monitoring and mitigation. A value of 4g grams/m2/month equates to a visible dust layer on outdoor furniture or vegetation. The standard is detailed below.

Table 8-2. New South Wales DECCW Standards for dust deposition

Indicator	Environmental value	Objective	Period
Dust Deposition	Nuisance	4 grams/m2/month	Monthly (total)
	Nuisance	2 grams/m2/month	Monthly (increase)

8.3 Greenhouse gas policies

The National Greenhouse and Energy Reporting Act 2007 (Cth) (Division 1 - Part 2 provides a GHG emissions threshold that regulates the corporate responsibility in terms of reporting of GHG for inclusion in the National Greenhouse Gas Account (NGA).

The Act specifies that any corporation, which generates more than 50 kilotonnes of GHG as a group has to provide annual report of the emissions to the NGA.

8.4 Existing environment

The Twin Bonanza project is located approximately 820km NW of Alice Springs (Figure 1-1 Chapter 1) and approximately 16km east of the Northern Territory and West Australian border. The site is located approximately 33km south of the Tanami Road, which runs west from Tanami to the Northern Territory and West Australian border. The Tanami road is unsealed.

8.4.1 Climate

The Tanami region has a distinct 'wet season' between November and April when the majority of the rainfall occurs. The summers are hot with temperatures in excess of 40ºC and winters are usually mild although nights are cold with occasional overnight minimum temperatures below 0 ºC. The closest weather station is located at Rabbit Flat, less than 90km to the east. The dominant wind direction is from the east, the Wind rose in Figure 8-1 shows data from Rabbit Flat (Site No: 015666). Rabbit Flat is the nearest weather station with most accurate weather observations for Twin Bonanza project.

Average annual rainfall is 430.7mm. Average pan evaporation for this region is between 2400 and 2800mm per annum, far exceeding the average rainfall (EcOz Environmental Services, 2012).

Winds are calm year round, particularly during the dry season and generally in an easterly direction, tending northeast during the wet season. Wind speeds average 14.9km/hour in the morning to 15.5km/hour in the afternoon (EcOz Environmental Services, 2012).

8.4.2 Sensitive receptors

The project is located within the Central Desert, which is a remote and sparsely populated region of Central Australia. The nearest community to the project is Balgo (120 kilometres west). Other communities in the region include Mulan / Lake Gregory (160 kilometres west); Lajamanu (250 kilometres north-east); and Yuendumu (360 kilometres south-east). Alice Springs is located 800 kilometres to the south-east; and Halls Creek is located 400 kilometres to the north-west.

The area surrounding the mine is used predominantly for traditional Aboriginal uses whereby limited anthropogenic emissions are released. No monitoring data is available for the community of Balgo. However, given the large distance, the influence of the mine operations on air quality at Balgo is considered to be negligible.

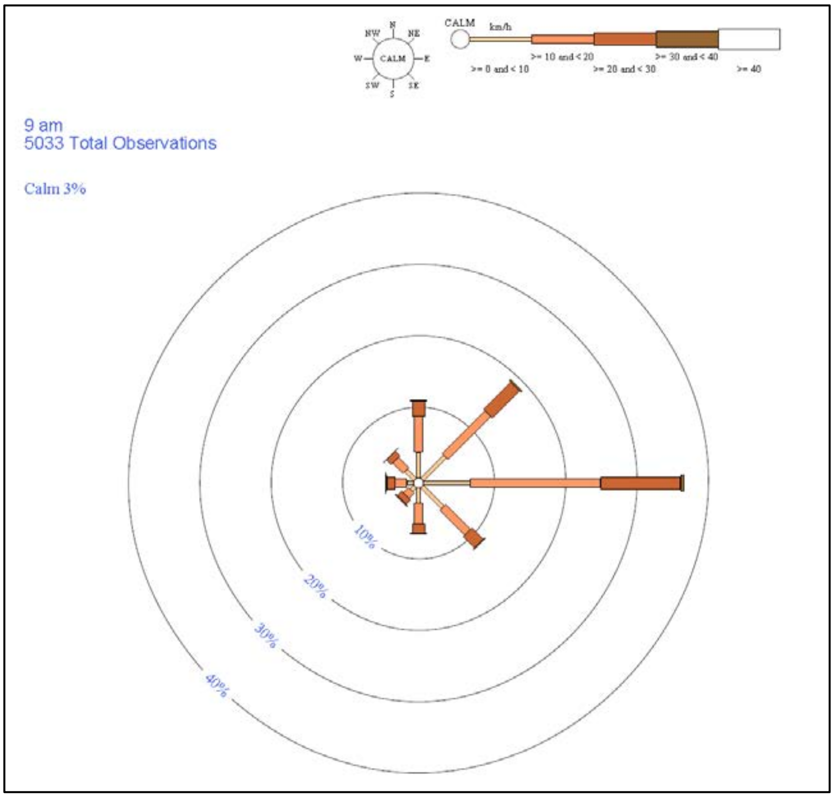

Figure 8-1. Speed Rose of Wind direction versus Wind speed in km/h (15 Nov 1996 to 30 Sep 2010) at Rabbit Flat. Rabbit Flat is the nearest weather station with most accurate weather observations for the Twin Bonanza project (National Climate Centre of the Bureau of Meteorology, 2012).

There are no communities within 100 km of the Twin Bonanza mine site; therefore sensitive receptors are staff, contractors and visitors to the site as well as local flora and fauna. ABM respects the traditional land use practices of the aboriginal landowners and through this management plan will aim to reduce the effect that dust, emissions have on their land and odours may have on their activities

Excessive dust will also affect the local vegetation which can ultimately lead to smothering and plant deaths, increasing erosion and decreasing biodiversity in the area. This can have a direct and indirect effect on sensitive fauna which includes the local bilby and mulgara populations which are located adjacent to the mine site within the Mineral Lease

The mine site accommodation will be located on the western edge of the mine lease, approximately 1 km away from the processing plant and the mine site, and therefore will be sufficiently distant to any potential air quality disturbance. The power plant will be located within the northern bounds of the processing plant.

8.4.2.1 Risks to biodiversity and native fauna

There are no government policies or widely accepted guidelines with regard to air quality criteria for animals; however the effect of air quality on wildlife can be similar to the effects observed in humans. Air quality, particularly dust, can adversely affect wildlife by interfering with communication, breeding activities, cause stress or avoidance reactions and (in the extreme) result in temporary or permanent habitat damage. The implementation of the measures detailed in section 8.6 will also manage air quality with respect to biodiversity and native fauna.

8.4.3 Existing sources of emissions

There are limited potential sources of particulate emissions from the existing environment as the environment is undergone limited disturbance. Existing particulate emissions primarily include:

1. vehicle emissions from local traffic
2. activities associated with the bulk sampling (including trenching, carting of samples and activities in the processing area
3. smoke from bushfires and controlled burns
4. naturally occurring wind-blown dust

8.4.3.1 Greenhouse gases

Emissions of GHGs from the proposed project will be generated primarily from electricity generation and fuel use. In accordance with the National Greenhouse and Energy Reporting Act 2007 the following GHG are predicted to be the most prominent:

1. carbon dioxide (CO2)
2. methane (CH4)
3. nitrous Oxide (N2O)
4. sulfur dioxide (SO2)

Prior to commencement of the operation the ambient levels of CO2, CH4 N2O and SO2 are the product of biological activities, bush fires, vehicle traffic, power generation and machinery. In the absence of vehicles CO2, CH4 and N2O would be present in the atmosphere as part of the carbon and nitrogen cycles.

An assessment of the expected GHG emissions from the Twin Bonanza project was undertaken as a requirement for this Environmental Impact Statement as determined under the Environmental Assessment Act and in conjunction with the AQMP (Appendix K). Refer to section 8.5 for details of the assessment.

As the nearest residence is over 100km away and the scale of activity is small creating low levels of emissions further investigations will not occur as the impact is deemed to be low.

8.4.3.2 Odours

Potential sources of nuisance odours at the project are the refuelling areas, landfill, sewage system and the concentrated leach. As the facilities that have the potential to produce nuisance odours they will be located away from accommodation areas and the concentrated leach area will be fully enclosed the potential nuisance odour risk to onsite receptors is deemed to be low. Based on the low risk no further odorous emissions investigations and monitoring will be implemented.

8.4.4 Existing monitoring of emissions

8.4.4.1 Depositional dust monitoring

There is no existing depositional dust monitoring at the Twin Bonanza mine site. However due to the fine grained nature of the soil substrate and the dry, windy climatic conditions dust generation is one of the key environmental aspects managed at the mine site. Current management involves visual observations of dust generation, minimal vegetation clearing (when practicable) and traffic management, including vehicle speed. The scalable nature of the project has not required in-depth dust management practices to be implemented prior to this stage.

Refer to section 8.6 for management and mitigation measures ABM propose to implement through the AQMP (Appendix K). A baseline dust study will be conducted during the 2014 dry season; results of the study will be reported in ABM Mine Management Plan.

8.4.4.2 Other existing air quality parameters

No other monitoring is currently undertaken for ambient air quality, while there are emissions from the power station (gen sets) and vehicles from the Bulk Sample phase, there are no other industrial or urban developments in the vicinity of the mine. Background concentrations of pollutants such as SO2, NOx, CO and metals are therefore expected to remain relatively low in comparison to industrialised areas and hence have not been monitored.

8.5 Air quality assessment

8.5.1 Dust emissions

Depositional dust can be generated through the operation of the mine site; dust can be generated from:

- disturbance of vegetation and topsoil
- areas cleared of vegetation, exacerbating natural erosion
- during construction activities
- drilling and blasting programmes
- excavation and movement of topsoil, waste rock and ore
- vehicle movements along unsealed access and haul roads
- ore processing and movements of mobile equipment in the process area
- closure and rehabilitation activities including contouring of landforms and ripping.

Dust emissions from the processing plant will be limited to the stockpiling of ore on the ROM pad and loading of the plant as the remainder of the process requires the input of water thus preventing dust.

During dryer periods potential exists for tailings dust to be generated from the tailings dam.

8.5.2 Greenhouse gases point sources inventory

Emissions from the project are generated primarily from mining activities. The main particulate emission of concern is dust, and to a lesser extent, emissions associated with the vehicles, processing plant and power station operations.

There are 4 main point sources considered in the AQMP that are relevant to the Twin Bonanza project.

1. combustion of fuel from engines of mobile equipment
2. combustion of fuel from engines of stationary equipment
3. combustion of fuels for power generation (power station – gen sets)
4. GHG emissions associated with clearing vegetation and carbon sequestration

The principle GHG generated by the combustion of fossil fuels for energy is carbon dioxide. The quantity of gas produced depends on the carbon content of the fuel and the degree to which the fuel is fully combusted (Department of Climate Change and Energy Efficiency 2012a); the oxidation factor generally ranges from 98% and 99.5%. Small quantities of methane and nitrous oxide are also produced, depending on the actual combustion conditions.

Primary fuel sources on site include:

1. ultra low sulfur diesel
2. aviation fuel (avgas)

8.5.2.1 Assessment methodology

Vehicle and machinery emissions

Estimates of emissions from the combustion of individual fuel types were performed for each relevant greenhouse gas (in this case, carbon dioxide, methane and nitrous oxide. Separate calculations were carried out for each fuel type and each piece of machinery.

Emissions estimations were then summarised into each of the 5 components of the mine site (Table 8-3):

1. construction
2. mine camp operations
3. mine
4. processing plant and ROM pad
5. employee transport
6. vegetation clearing

Table 8-1. Summary of emission sources for the Twin Bonanza Project.

Mine site component	Emission source	Details	Quantity	Fuel type
Construction	Dozer	Caterpillar D9T Dozer	1	Diesel
	Excavator	Komatsu PC1800 Excavator - Fuel Consumption estimated based on Komatsu PC2000-8 Hydraulic Excavator	1	Diesel
	Water cart	Caterpillar 8 wheel water cart - Fuel Consumption estimated based on CAT 777D Flat floor haul truck.	1	Diesel
	Light vehicles	Toyota Landcruiser	2	Diesel
	Compaction rollers	Fuel consumption estimated based on Caterpillar CB434D XW (double drum).	1	Diesel
	Haul trucks	Komatsu haulage dump truck HD785-5	1	Diesel
	Front end loaders	Fuel consumption estimated based on CAT 990 Series II	1	Diesel
Mine Camp operations / power generation	Power (including camp, RO plant, processing plant, office and workshop, ancillary	(4 x 1MWA Diesel gensets - two full time, one half time, one for servicing and breakdowns).	4	Diesel

Mine site component	Emission source	Details	Quantity	Fuel type
	equipment (i.e. 5 x lighting plants).			
	Generator - Wilsons Bore	30 kVA Genset - powers bore pump	1	Diesel
	Generator - Corsair Bore	28 kVA Genset - powers bore pump	1	Diesel
Mine	Excavators	Hitachi EX1200-6	2.00	Diesel
	Haul trucks	Hitachi B50D	4.00	Diesel
	Dozer	Caterpillar D9T Dozer	1.00	Diesel
	Grader	Caterpillar 14H Grader	1.00	Diesel
	Water cart	Fuel consumption estimated based on Hitachi B50D	1.00	Diesel
	Drill rig	PowerROC T30: Tophammer drill rig	1.00	Diesel
	Service truck	Toyota service truck - Fuel consumption estimated based on Toyota Landcruiser	1.00	Diesel
	Light vehicles	Toyota Landcruiser	8.00	Diesel
	Front end loaders	Fuel consumption estimated based on CAT 990 Series II	1.00	Diesel
Processing plant & ROM pad	Loader	estimated based on CAT 938H Medium wheel loader	1	Diesel
Employee transport	Aircraft	Metro	1	AvGas
	Bus	Toyota coaster bus (21 seats)	1	Diesel

Annual emissions results were then multiplied by 3 (years) to account for the projected span of the project life. The AQMP contains details of the methodology and calculations used to calculate these figures.

Assessment of energy emissions

The NGA factors (Department of Climate Change and Energy Efficiency 2012a) were then used to estimate the CO2 annual emissions (CO2-eTonnes) for each emission source, energy content factor (GJ/t) and emission factors (kg CO2-e/GJ) for CO2, CH4 and N2O (Table 8-4). The relative global warming potential of the greenhouse gases is considered by expressing the factors as a carbon dioxide equivalent (CO2-e).

Table 8-4. Fuel combustion emission factors - liquid fuels and certain petroleum based products for stationary energy purposes. Source: National Greenhouse and Energy Reporting (Measurement) Determination 2008 (Schedule 1). Notes: All emission factors incorporate relevant oxidation factors (sourced from the DCCEE's National Inventory Report).

Fuel type	Emission source	Energy content (GJ/kL)	Emission factor kg CO2-e/GJ (relevant oxidation factors incorporated)			Equipment type
			CO2	CH4	N2O	
Diesel	Stationary	38.60	69.20	0.1	0.2	All heavy vehicles, power generators and stationary plant equipment
Diesel	Transport	38.60	69.20	0.2	0.5	Light vehicles only, including service truck and Bus
AvGas	Transport	33.10	66.30	0.04	0.7	Aircraft

Vegetation emissions

The removal of vegetation via land clearing for the purposes of mining will contribute carbon dioxide and other greenhouse gases to the atmosphere. Once rehabilitation commences post mining, the regeneration of vegetation over these areas will provide an important carbon sink, reversing the process and providing removal of carbon dioxide from the atmosphere.

The Australian Government Department of Climate Change's National Carbon Accounting System (NCAS) FullCAM tool was used to estimate greenhouse gas emissions from land clearing at the Twin Bonanza Project.

FullCAM is a carbon ecosystem model that calculates greenhouse gas emissions and removals in both forest and agricultural lands using a mass balance approach to carbon cycling. As the most significant emissions and removals of greenhouse gases in the land sector occur with transitions between forest and agricultural land use, the model fully integrates agricultural and forestry modelling.

ABM specified the cleared area (modelled plot area) to be 300 ha and masses are measured in tonnes per hectare so results are presented as mass per unit area. Refer to Appendix K Air Quality Management Plan for further details of the methodology and calculations.

Events were input to simulate the range of activities proposed to be undertaken at Twin Bonanza during the life of the mine (Table 8-5). Initial vegetation clearance was assumed to start during April 2014, with annual maintenance through windrow clearing and burning as a result of bushfires (10 % of the cleared area and only if necessary) assumed to occur annually every June thereafter.

To determine emissions in tonnes of carbon lost per hectare (tC ha-1), total onsite carbon mass (tC/ha) in October 2017 was subtracted from initial onsite C mass (tC/ha) in 2013 (prior to clearing). Results were later converted from tonnes of carbon per hectare (tC ha-1) to carbon equivalent emissions (CO2-e t ha-1) by multiplying by 3.667.

Table 8-5. Simulated events input for the FullCAM model at Twin Bonanza.

Event	Date	% forest affected
Native vegetation	2014 / 01	
Clearing	2014/04	100 – assumes no regrowth (days 20)
Windrows burnt / firebreaks	2014 / 07 2015 / 07 2016 / 07	10% area, 90 leaf regrowth (10 days)
Rehabilitation	2017 /09	
Native vegetation	2017 / 09	

Revegetation was not modelled in the FullCAM programme as it is difficult to predict how long the vegetation will take to regenerate back to its original state; however the sequestering of carbon will be present during all stage of vegetation regrowth back to original levels. The tailings dams and other artificial landforms will revegetate back to their original state slower.

Historical rehabilitation (ripping and natural re-seeding) of drill pads and tracks from exploration activities at the Twin Bonanza project have proven that the native woodlands and grasses establish a good ground cover within a year and in less than 4 years are barely noticeable as having been disturbed. Fully established trees will take longer, however there are limited numbers of trees that will be disturbed in the clearing process.

8.5.2.2 Results

Vehicle and machinery emissions

The total fuel consumption and GHG emissions for the operation of the Twin Bonanza project are presented in Table 8-6. The total emissions for the first year include additional fuel consumption associated with the construction of the tailings dam.

The annual GHG emissions from the operation of the Twin Bonanza project will not exceed the 50 kilotonnes threshold specified in the National Greenhouse and Energy Reporting Act (2007). As such no greenhouse gas emissions reporting is required to the National Greenhouse Gas Account (NGA). If at any stage the Twin Bonanza project exceeds the threshold, ABM will report to the National NGA.

Table 8-2. Twin Bonanza total fuel consumption and GHG emissions.

Source	Consumption total (KL/Year)	Annual emissions (CO_2-eTonnes)			Combined total CO_2-eTonnes
		CO_2	CH_4	N_2O	
Construction subtotal	189.06	505.00	0.77	1.61	507.38
Mine camp operations / power generation & bores subtotal	1638.84	4377.53	6.33	12.65	4396.51
Mine subtotal	1899.20	5072.98	7.68	15.71	5096.37
Processing plant & ROM pad subtotal	96.36	257.39	0.37	0.74	258.50
Employee transport subtotal	189.01	418.12	0.30	4.35	422.77
TOTAL EMISSIONS - Breakdown					
First year (including construction)	4012.46	10631.03	15.45	35.06	10681.53
Second Year	3823.40	10126.03	14.68	33.45	10174.15
Third Year	3823.40	10126.03	14.68	33.45	10174.15
FULL PROJECT (3 years)	11659.27	30883.08	44.80	101.97	31029.84

Vegetation emissions

The total GHG emissions for the land clearance at the Twin Bonanza project are shown in Figure 8-2, where clearing shows a large loss of carbon from the initial native vegetation, followed by a slow decline over the life of the mine. Annual clearing (of windrows and subsequent burning by bushfires) are highlighted by sharp drops in the on-site carbon.

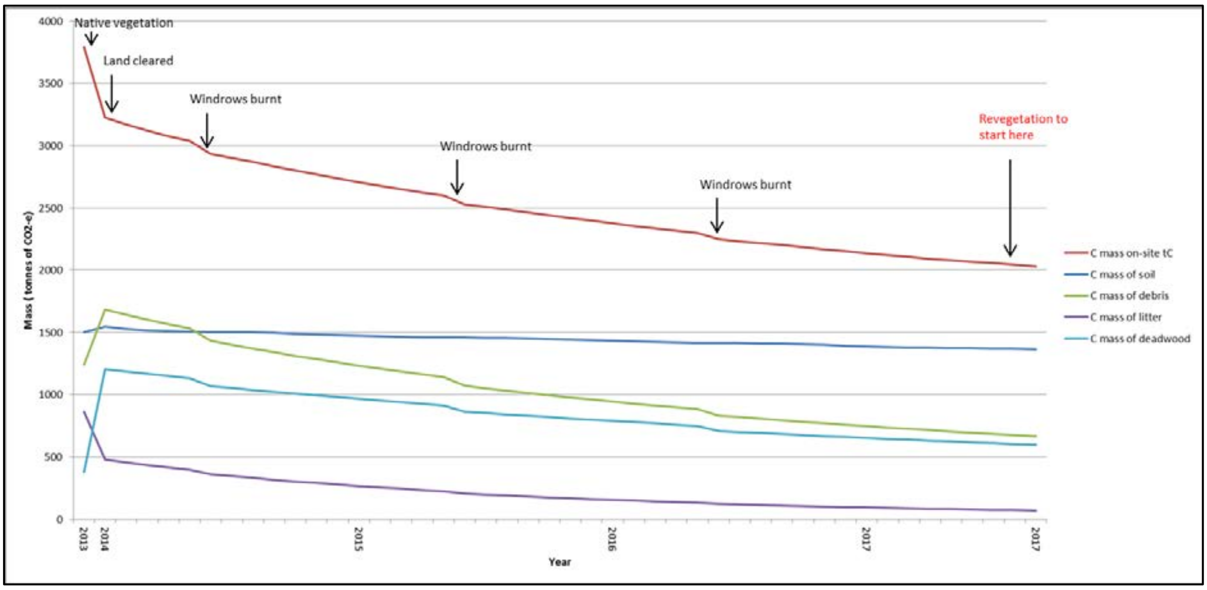

Figure 8-2. NCAS FullCAM output from plot simulation showing loss of carbon through time after clearing and burning. The total mass of carbon per hectare is shown (in tCO2-e) by the red line, and broken down into carbon stored in the soil, debris, litter and deadwood.

The total carbon mass of plants on site prior to clearing is estimated at 1049.27 tonnes of Carbon (based on assumptions and parameters in the Air Quality Management Plan

(Appendix K). The estimated total emissions in tonnes of carbon lost per hectare totals 21.50(tC ha-1).

The estimated GHG emissions from the annual windrow clearing and burning (which covers 10% of the total cleared area) are estimated in table 8-7.

Table 8-3. GHG emissions for the annual windrow clearing and burning.

Proxy date	GHG emitted due to fire		
	C mass	**CH4**	**N2O**
	tC	**tCO2-e**	**tCO2-e**
02/07/2014	65.63	9.92	2.71
02/07/2015	47.63	7.2	1.97
02/07/2016	36.72	5.55	1.51
Total (tonnes/project period)	**149.98**	**22.67**	**6.19**

8.6 Management and mitigation

The AQMP (Appendix K) outlines the commitments of ABM for the management and mitigation of adverse effects to air quality.

8.6.1 Operational management and mitigation

ABM's environmental manager will conduct a baseline study during the 2014 dry season and implement ongoing monitoring of air quality in respect to dust. This monitoring will aid in ongoing assessment of air quality around the site. In the event that monitoring identifies that air quality limits have been exceeded, additional corrective mitigation measures will be investigated and implemented. Further, complaints regarding air quality will be investigated and action taken if required.

The following are some of the management and mitigation strategies and measures that will be implemented at the Twin Bonanza mine and accommodation camp to reduce dust, GHG emissions and odour impacts from operations on staff and fauna.

8.6.1.1 General operations

To reduce greenhouse gases staff and contractors will:

- maintain equipment including tyres to maximise efficiency and prevent incomplete combustion of hydrocarbons
- source and procure machinery with high fuel efficiencies and combustion technologies including catalytic convertors when practicable
- investigate alternative energy sources (i.e. solar power) where applicable

- purchase fuel produces with a low sulfur content if practicable.

If employees and contractors are working in confined spaces or are undertaking tasks that may generate localised dust, breathing protection equipment will be provided and is to be worn by all personnel while completing the task or within breathing protection areas. Appropriate signage under the Australian Standards will designate these protection areas.

Odour will be mitigated by:

- managing chemicals and hydrocarbons appropriately under the standard AS1940-2004 - The storage and handling of flammable and combustible liquids
- containing putrescible waste and disposing of it in accordance to on site waste management procedures that includes incineration and/or disposal in a landfill
- treating sewage via onsite septic and waste water disposal systems
- ensuring the concentrate leach system is closed to prevent the release of cyanide gases into the environment.

ABM Resources are also exploring clean technologies for power generation refer to section 8.6.1.3 Solar Energy.

8.6.1.2 Dust generation

It is expected that the dust levels at the site will be low to moderate with the exception of during windy dry periods. ABM proposes to mitigate and manage dust generation through the strategies outlined below.

- A conservative and a progressive approach to vegetation clearances will be followed, ensuring a minimum area is clear at any one time and the majority of the area is still vegetated and undistributed.
- Topsoil will be removed during periods when soil moisture and wind conditions limit dust generation where practical.
- Dust generation will be mitigated by regular applications of water by a water cart along haul roads and cleared areas to reduce dust from mine traffic and wind.
- The use of a dust suppressant will be investigated to reduce the water consumption while maintaining dust suppression.
- Dust from blasting will be managed by blasting personnel to ensure fine material produced by drilling is used to stem blast holes and adequate stemming will be used at all times.
- A vegetative cover will be established by progressively ripping and rehabilitating areas no longer required.

- Vehicle speeds will be limited around site.

8.6.1.3 Greenhouse gases

The current modelled emissions do not exceed the 50 kilotonnes threshold specified in the National Greenhouse and Energy Reporting Act 2007; therefore no formal reporting will be required.

ABM proposes to mitigate and manage GHG generation through:

1. regular maintenance of all vehicles and machinery to ensure efficient machine performance and minimisation of GHG emissions
    a. tyre pressure management
    b. engine life
2. maintenance of roads to achieve optimum fuel efficiency and reduce annual fuel consumption
3. ensuring all operators are aware of optimum operating conditions and pay load capacities to ensure optimum usage of fuel and prevent unnecessary excess GHG emissions
4. ensuring all endeavours will be made to reduce traveling distances where practicable, particularly for hauling
5. minimising clearing at the site and conducting progressive rehabilitation where practicable
6. using renewable energy sources where practicable (see below)
7. use of ultra-low sulphur diesel.

<u>**Offsetting carbon emissions**</u>

<u>Progressive clearing and rehabilitation</u>

Indirect means of reducing GHG emissions will include carbon sequestration by rehabilitating disturbed areas progressively and clearing areas progressively. The current GHG inventory (section 8.5) accounts for the loss of carbon sink capacity due to clearing of vegetation but does not account for rehabilitation. ABM will undertake progressive clearing to reduce the immediate reduction in carbon sink capacity, and will offset any clearing with progressive rehabilitation elsewhere on site to ensure a balance is maintained and the carbon sink capacity is relatively stable. For the purposes of the assessment (section 8.5) a conservative modelling approach was used where by the entire area was cleared and maintained for the life of the mine, until rehabilitation in late 2017. Model constraints meant that the progressive clearing and rehabilitation were unable to be incorporated into the model; the model is therefore an overestimate of the impact to total carbon sink capacity for the project.

Solar energy

At present ABM is exploring the option of clean technologies for power generation. Due to the vast distance fuel needs to be transported and the environmental cost of using fuel to generate power of the mine operations, ABM is investigating the feasibility of installing a solar thermal plant to partially power the Twin Bonanza operations. The solar project is in its early stages and will involve research by the University of Sydney and collaboration with Suntrof Australia (Refer to Chapter 3: Project description).

8.7 Monitoring and compliance

ABM will report the monitoring results within the Mining Management Plan pursuant under section 40 of the Mining Management Act 2001. If the project exceeds substance emission limits as defined by categories 1, 1a, 1b, 2a, 2b or 3 of the National Pollutant Inventory as administered by the Commonwealth Department of the Environment, then ABM will report as required. For further details refer to the Appendix K: AQMP.

8.7.1 Dust monitoring

Dust monitoring at the Twin Bonanza mine site and accommodation facilities will be comprise dust deposition monitoring points and daily visual monitoring. Dust deposition levels are to be monitored using six dust monitoring sites (Figure 8-3). Strategically positioned dust gauges mounted on stands will be established based on the prevailing wind with a focus on the processing plant, waste dump, tailings dam, proximal to the main haul road and near the accommodation complex. Deposition dust monitors provide details of dust deposition within a defined time period but cannot be correlated to specific dust events or sources. To be able to monitor dust on a daily basis managers within the process, accommodation and mining area will observe current dust conditions. Depending on conditions this will facilitate management measures for example more frequent water application via a water cart.

Dust deposition limits are not specified in the Northern Territory and the NEPM, therefore for the purposes of the EIS the New South Wales Department of Environment Climate Change and Water (DECCW) has legislated standards for dust deposition; these have been adopted for dust monitoring and mitigation.

Nuisance dust levels are defined as a total of 4 grams/m2/month, and monitoring is recommended over the space of a month. Also an increase of 2 grams/m2/month can be considered a nuisance.

The dust collected in the gauges will in accordance to standard AS/NZS 3580 be tested for insoluble solids and ash content. The results of the monitoring program will be used to provide an indication of the effectiveness of the dust control measures being implemented at the mine site. Where the dust limit is exceeded targeted dust management actions are to be implemented.

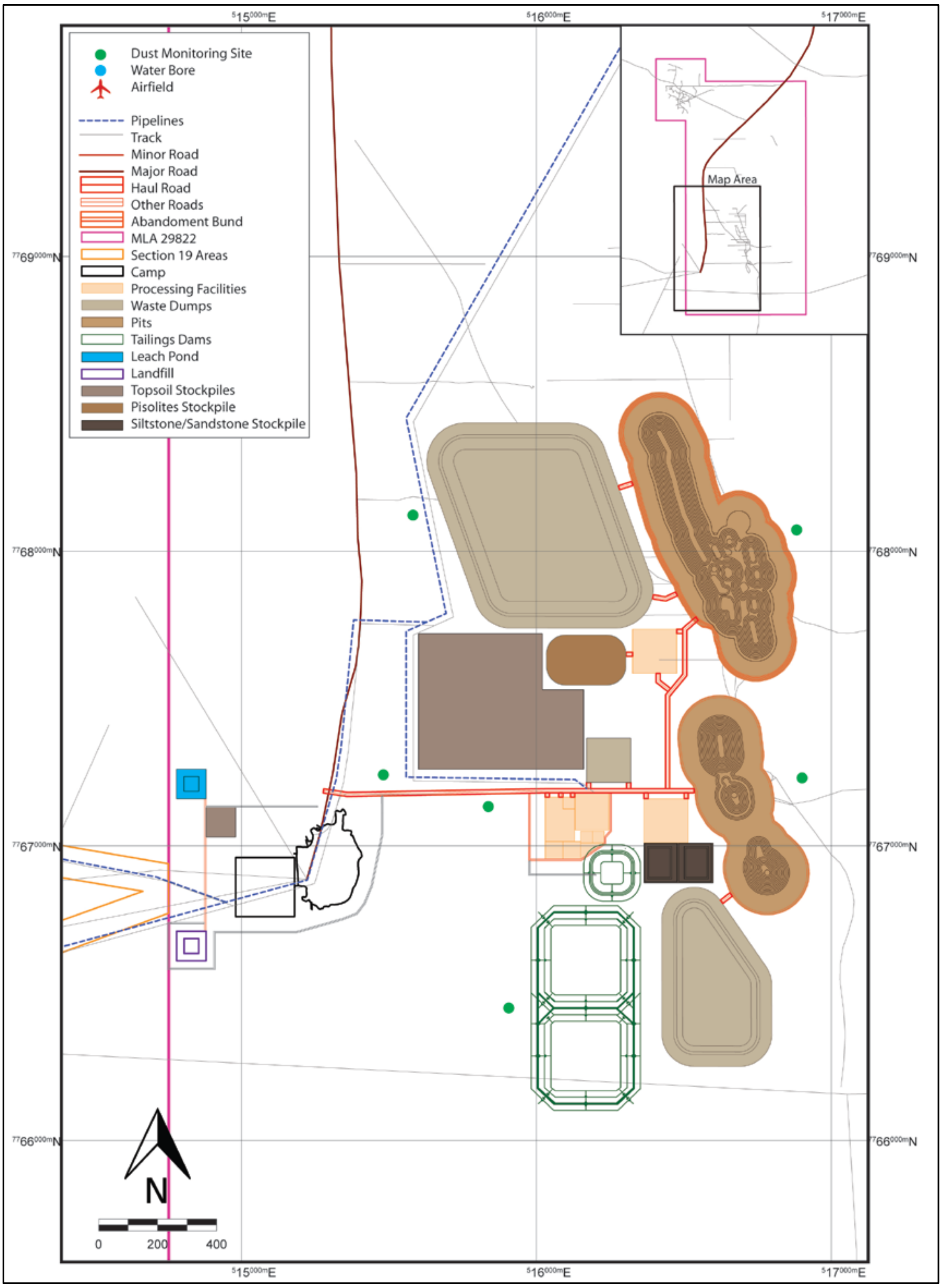

Figure 8-3. Dust monitoring sites in relation to infrastructure at Twin Bonanza project.

8.7.2 Community / social monitoring

ABM will also monitor its operations by recording and trending complaints over time by entering these in the complaints register and reviewing the nature of complaints on an annual basis. This will assist in determining the environmental aspects of the complaint and requirement for additional controls or management strategies to limit the air quality impacts.