APPENDIX T

Air Quality Assessment

Vista Gold Australia Pty

Mt Todd Gold Project

Air Quality Assessment

June 2013

Executive summary

GHD was commissioned by Vista Gold Australia Pty Ltd (Vista Gold) to undertake an air quality impact assessment for the proposed Mt Todd Gold Mine and Power Station located approximately 55 km northwest of Katherine in the Northern Territory (NT).

This report addresses the EIS guideline requirements of assessment against the *National Environment Protection Measures (Implementation) Act 1998* which includes the assessment of impacts to air quality. This report must be read in conjunction with the limitations set out in section 14 and the assumptions and qualifications contained throughout.

The Mt Todd Gold Mine is a brownfield/disturbed site located in a historical mining district, and was most recently mined for gold in the 1990s. Mining infrastructure such as tailing dams, waste rock dump and the remains of processing facilities are present on site. Vista Gold is proposing to:

- re-establish and operate the Mt Todd Gold Mine; and
- commission a grid connected on-site gas-fired power station.

The assessment has considered the:

- air quality impact assessment criteria applicable in the Northern Territory;
- existing background air quality;
- local meteorological conditions;
- location of sensitive receptors in the study area;
- estimated emissions to air generated by construction and operational activities associated with the:
  - mining operations;
  - power station at the mine site;
- potential for impacts to air quality due to dust and other gaseous emissions associated with the project through an assessment using the AUSPLUME dispersion model and Environmental Risk Assessment process; and
- application of appropriate mitigation measures through the development of a Dust Management Plan (DMP) for the ongoing minimisation of dust emissions.

Particulate emissions, as crustal dust, in three main particle size fractions, were considered to be the primary source of air pollutants released from the combined mine and power station project. The size fractions are based on total suspended particles (TSP), PM_{10} and $PM_{2.5}$ (i.e. particles less than 50 µm, 10 µm and 2.5 µm, respectively). The proposed mine plan was evaluated to determine the key dust generating sources and the worst case dust emissions due to the quantity of material to be excavated, transferred, processed and stored on the site. Year 3 of the mine plan was found to represent the worst case in terms of material volumes moved and dust emissions generated, and consequently, this year was used in the assessment. The volumes of material used to develop the dust emissions inventory were:

- 102 Mtpa of material extracted; and
- 17.8 Mtpa of ore processed.

The estimated total annual dust emissions by size fraction, based on Year 3 activity rates, with dust emission controls applied were calculated to be:

- 5,469 tonnes of TSP;
- 2,569 tonnes of PM_{10}; and
- 1,030 tonnes of $PM_{2.5}$.

The secondary sources of air emissions were considered to be associated with the power station. Particulate emissions from gas-fired engines at the power plant and diesel equipment on site mainly comprise $PM_{2.5}$ and are considered negligible by comparison to mining related dust. Emissions of volatile organic compounds (VOC) released from stationary and mobile combustion sources including earthmoving equipment, haul trucks, site vehicles and the power generating gas-fired turbine and reciprocating engines are also considered to be in trace quantities by comparison with the principle products of combustion, oxides of nitrogen (NO_X) and carbon monoxide (CO). Consequently, NO_X and CO emissions associated with the power station have also been assessed.

Background dust levels in the region are primarily associated with natural sources such as scrub fires and wind generated dust storms during the dry season. There are few significant anthropogenic sources of dust, NO_X and CO in the region. For the cumulative dust assessment, measurements collected at Casuarina, Northern Territory were applied. The background concentrations were:

- 21.8 µg/m³ for the 24-hour average of PM_{10};
- 11.2 µg/m³ for the 24-hour average of $PM_{2.5}$; and
- 42 µg/m³ for the annual average of total suspended particulates (TSP).

The Mt Todd mine is located in a remote region of the Northern Territory where routine meteorological monitoring is not conducted. Consequently, a one-year meteorological dataset for the 12-month period between September 2007 to August 2008, representative of the project area and suitable for input to the AUSPLUME dispersion model was simulated using the CSIRO's TAPM (The Air Pollution Model).

In the absence of Northern Territory published guidance on the assessment of air quality, the standards promulgated in the National Environment Protection (Ambient Air Quality) Measure (Air NEPM) were used to assess the potential for impacts of PM_{10}, $PM_{2.5}$, NO_2 and CO. Where the Air NEPM and state environmental regulator has not developed published air quality assessment criteria for a substance, it is accepted practice that an assessment criterion may be adopted from another national or international jurisdiction. For this assessment, the NSW Office of Environment and Heritage (OEH) impact assessment criteria for TSP and deposited dust have been used.

The impact assessment found that the Air NEPM standards of NO_2 and CO and the OEH impact assessment criteria of TSP and deposited dust are predicted to be met at all identified sensitive receptor locations. However, the assessment also found that the Air NEPM standards of PM_{10} and $PM_{2.5}$, for the protection of human health, have the potential to be exceeded at the Werenbun community between two and seven times per year, depending on the assumptions made. The assessment findings were found to be extremely sensitive to a variety of important assumptions made for the estimation of emissions, dispersion model configuration and the application of existing background concentrations.

In accordance with NEPM guidance (which is a monitoring protocol rather than dispersion model goal setting), conservative assumptions have been applied at each step of the process in order to assess the maximum ground level concentration under worst case conditions. Due to the predicted exceedences of the PM_{10} and $PM_{2.5}$ standards, an Environmental Risk Assessment was undertaken to investigate the frequency of exceedence of the standards and

the conditions under which they occur. The risk assessment found that exceedences were predicted to occur under north-westerly winds during the wet season, and that changing the assumptions used in the emission estimation, dispersion modelling and background concentration calculation to more adequately represent wet season conditions, would be expected to significantly reduce predicted ground level dust concentrations at the Werenbun community and comply with the standards.

While unpopulated areas beyond the mining lease boundary are not considered to be within the assessment jurisdiction of the Air NEPM, dust emissions will be managed and mitigated through the implementation of a Dust Management Plan for the mine site in order to minimise the dust impacts in protected and remote areas. Through the management of mining processes, implementation of a dust mitigation strategy and monitoring program, interactive dust management, and minimisation of dust emission generation during worst case meteorological conditions, the Mt Todd Gold Project is expected to comply with air quality standards.

Abbreviations

Project Specific Terminology	
Abbreviation	**Term**
the EIS	Vista Gold Mount Todd Environmental Impact Statement - refers to the particular document that GHD is preparing to facilitate approval of the Project
the Proponent	Vista Gold Australia Pty Ltd
the Project	Mount Todd Gold Project

Generic Terminology	
Abbreviation	**Term**
AP-42	US EPA Database on Air Pollutant Emission Factors
AWS	Automatic Weather Station
AUSPLUME	Gaussian plume modelling system for the simulation of atmospheric pollution dispersion distributed by EPA Victoria
BoM	Bureau of Meteorology
CSIRO	Australian Government agency Commonwealth Scientific and Industrial Research Organisation
DERM	Queensland Department of Environment and Resource Management
DMP	Dust Management Plan
E_i	Emission rate of pollutant i (kg per activity)
EAD	Equivalent aerodynamic diameter
EETM	Emissions Estimation Technique Manual
EFi	Uncontrolled emissions factor for pollutant i (kg per activity)
EMF	Environmental Management Framework
EPA	Northern Territory Environment Protection Authority
EPP	Environment Protection Policy
ERA	Environmental Risk Assessment
GHD	GHD Pty Ltd
GLC	Ground Level Concentration
ha	hectare
k	Proportional constant to maintain total annual emissions as constant
kg	kilogram
LGO	Low Grade Ore
M	Soil moisture content
MW	Megawatt
NCAR	National Centre for Atmospheric Research
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NOx	Oxides of nitrogen
NPI	National Pollutant Inventory
OCM	Open Cut Mine
OH&S	Occupation Health and Safety
$PM_{2.5}$	Particulate Matter less than 2.5 µm EAD
PM_{10}	Particulate Matter less than 10 µm EAD
ROM	Run-Of-Mine
SO_2	Sulphur dioxide
TAPM	The Air Pollution Model (TAPM) developed and supplied by CSIRO

Generic Terminology	
Abbreviation	**Term**
tpa	tonnes per annum
TSP	Total Suspended Particulates
U	Wind speed at the reference height of 10 m
US EPA	United States Environment Protection Agency
veh	Vehicle
VKT	Vehicle Kilometres Travelled
VOC	Volatile Organic Compound

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1. Introduction

GHD was commissioned by Vista Gold Australia Pty Ltd (Vista Gold) to undertake an air quality impact assessment for the proposed Mt Todd Gold Mine and Power Station located approximately 55 km north west of Katherine in the Northern Territory (NT). The Mt Todd Gold Mine is a brownfield/disturbed site located in a historical mining district. The site was most recently mined for gold in the 1990s. Mining infrastructure such as tailing dams, waste rock dump and the remains of processing facilities are present on site. Vista Gold is proposing to:

- Re-establish and operate the Mt Todd Gold Mine; and
- Commission a grid connected on-site gas-fired power station.

The assessment was subject to the limitations outlined in Section 14 of this report, and has considered the:

- Air quality impact assessment criteria applicable in the Northern Territory;
- Existing background air quality;
- Existing meteorological conditions;
- Location of sensitive receptors in and around the study area;
- Estimated emissions to air generated by construction and operational activities associated with the:
  - mining operations.
  - power station at the mine site
- Impact to air quality of dust and other gaseous emissions associated with the project through an assessment using a regulatory dispersion model; and
- Application of appropriate mitigation measures through the development of a Dust Management Plan (DMP) for the ongoing minimisation of dust emissions.

1.1 Guidelines Addressed

The Northern Territory Government has not published air quality standards or guidance documents for the assessment of air quality impacts from industrial developments in the Territory. Consequently, this report does not address any specific NT guidelines regarding air quality (EPA (formerly NRETAS) 2011). Notwithstanding this, in accordance with the requirements of the *National Environment Protection Measure (Implementation) Act 1998*, an assessment of air quality is required. The requirements of this Act are discussed in section 2.2.

2. Legislative Framework

2.1 Commonwealth Legislation

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), any development requires assessment if it has the potential to affect one or more of eight matters of National Environmental Significance (NES). The matters of NES include:

- World Heritage properties;
- National Heritage places;
- wetlands of international importance (listed under the Ramsar Convention);
- listed threatened species and ecological communities;
- migratory species protected under international agreements;
- Commonwealth marine areas;
- The Great Barrier Reef Marine Park; and
- nuclear actions (including uranium mines).

The environment under the EPBC Act includes:

1. ecosystems and their constituents;
2. natural and physical resources;
3. qualities and characteristics of locations, places and areas;
4. heritage values of places; and
5. the social, economic and cultural aspects.

Mt Todd Gold Project falls within a Site of Conservation Significance (Yinberrie Hills), a key site recognised for EPBC listed 'Endangered' species. A habitat and baseline flora and fauna survey, and assessment were undertaken as part of the Draft EIS to consider potential impacts and mitigation associated with land clearing and mining activities.

2.2 National Environment Protection Measures (Implementation) Act 1998

Under the *National Environment Protection Measures (Implementation) Act 1998*, the National Environmental Protection Council (NEPC) was established to set national environmental goals and standards for Australia through the development of National Environment Protection Measures (NEPMs). The NEPC is part of the Environment Protection and Heritage Council (EPHC). Section 14(1) of the NEPC Act prescribes that NEPMs may relate to any one or more of the following:

- ambient air quality;
- ambient marine, estuarine and fresh water quality;
- the protection of amenity in relation to noise;
- general guidelines for the assessment of site contamination;
- environmental impacts associated with hazardous wastes; and
- the re-use and recycling of used materials.

2.3 Northern Territory Legislation

2.3.1 Mining Management Act 2001

The *Mining Management Act 2001* provides for authorisation of mining activities, management of mining sites, preparation of the environment on mining sites and related purposes. The Act is administered by the Department of Mines and Energy (DME). The objectives of the Act are:

- ensure the development of the Territory's mineral resources in accordance with environmental standards consistent with best practice in the mining industry;
- protect the environment by:
  - the authorisation and monitoring of mining activities;
  - requiring appropriate management of mining sites;
  - facilitating consultation and cooperation between management and workers in implementing environment protection management systems;
  - implementing audits, inspections, investigations, monitoring and reporting to ensure compliance with agreed standards and criteria; and
  - specifying the obligations of all persons on mining sites with respect to protection of the environment.
- assist the mining industry to introduce programs of continuous improvement to achieve best practice environmental management; and
- enable persons connected with the mining industry to participate in the implementation of this Act through the establishment of a Mining Board to advise the Minister on:
  - guidelines for the industry;
  - specification of competencies required by persons involved in the industry;
  - best practice in mining activities; and
  - minimise the liability of the Territory by requiring the payment of security to provide for the rehabilitation of mining sites or to rectify environmental harm caused by mining activities.

2.3.2 Environmental Assessment Act 1982 and Environmental Assessment Administrative Procedures Act 1984

The *Environmental Assessment Act 1982* and the *Environmental Assessment Administrative Procedures Act 1984* ensure, to the greatest extent practicable, that each matter affecting the environment which is, in the opinion of the NT Minister, a matter which could reasonably be considered to be capable of having a significant effect on the environment, is fully examined and taken into account in, and in relation to:

- formulation of proposals;
- carrying out of works and other projects;
- negotiation, operation and enforcement of agreements and arrangements (including agreements and arrangements with authorities of the Commonwealth, the States and other Territories);
- making of, or the participation in the making of, decisions and recommendations; and
- incurring of expenditure.

2.3.3 Waste Management and Pollution Control Act 2009

The purpose of the *Waste Management and Pollution Control Act 2009* is to protect the environment through objectives and approvals, encouraging effective and responsible waste management and reduction and response to pollution. This Act facilitates the implementation of national environment protection measures made under the *National Environment Protection Council (Northern Territory) Act 1999*, and incorporates environmental compliance plans and audits.

Section 14 of the Act establishes a process for notifying the EPA (the administrating agency for the Act) about incidents causing, or threatening to cause pollution. Schedule 2 of the Act requires environment protection/licensing for certain activities.

Protection of the environment through encouragement of effective waste management and pollution prevention and control practices were developed in accordance with the Act.

3. Project Location

3.1 Mine

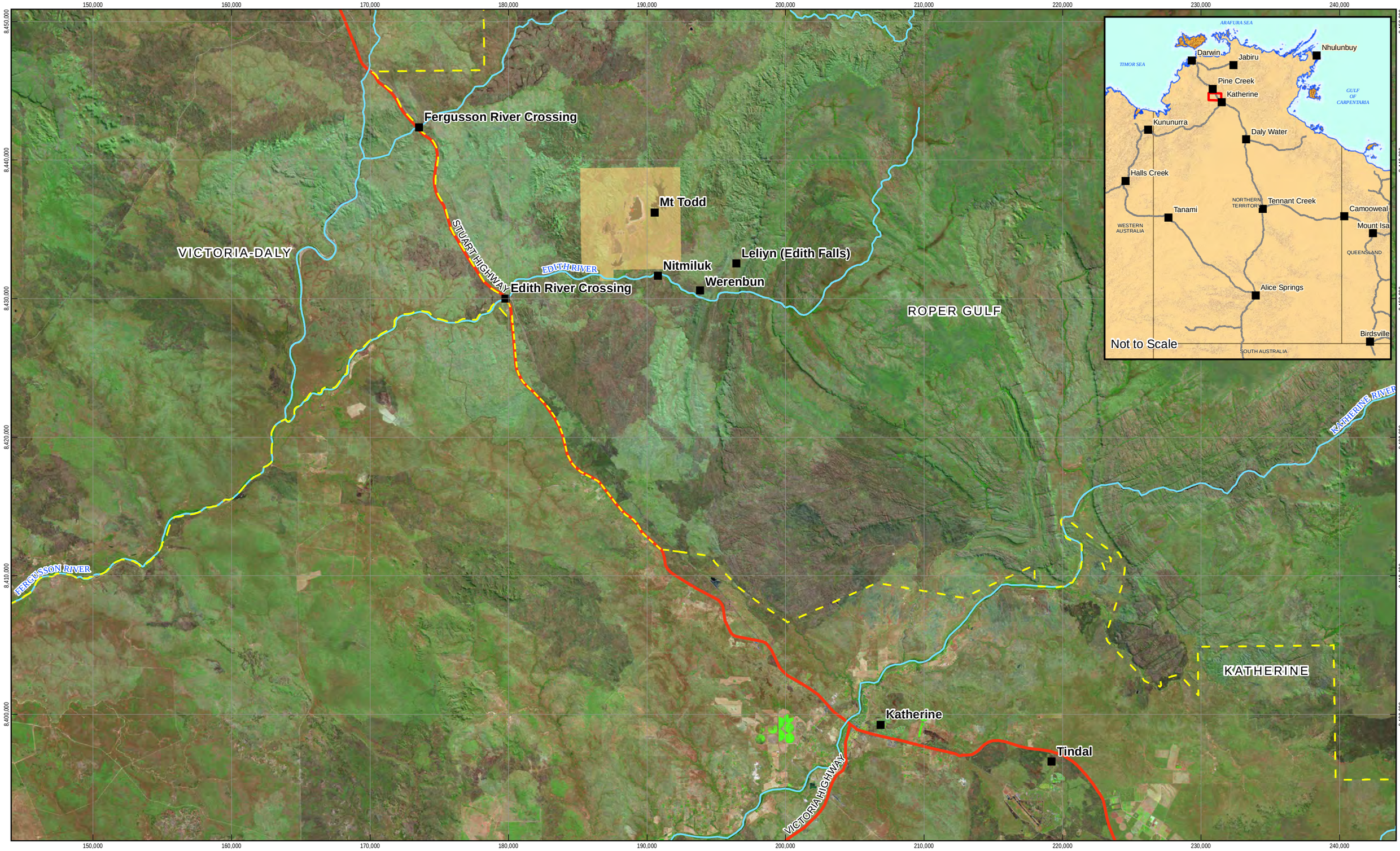
The Mt Todd Gold Mine site is located approximately 55 km north-west of Katherine and 250 km south of Darwin in the Northern Territory (NT) (Figure 1).

Surrounding landmarks immediately adjacent to the mine site include:

- North – Historic Horseshoe Tin Field;
- East – Nitmiluk National Park;
- South – Edith River and Edith Falls Road; and
- West – Yinberrie Hills.

3.2 Power Station

The gas-fired power station will be situated on-site along the south west side of the main entrance road. Power generation will consist of a single Rolls Royce Trent 60 Wet Low Emissions gas turbine generator and two reciprocating MAN engines with a combined installed power generation capacity of approximately 76 MW. For the purposes of this assessment, it has been assumed that the combined emissions from the gas turbine and reciprocating engines will be released from a single exhaust stack.



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0 2.5 5 7.5 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 53

N

LEGEND

- Place Names
- Major Roads
- Rivers
- LGA Boundaries
- Mt Todd Mineral Leases

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Mt Todd Gold Project

Job Number	43-21801
Revision	1
Date	05 Jun 2013

Project Location

Figure 1

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Data source: NRETAS - Drainage (2011). Vista Gold - Mt Todd Mineral Lease (2011). Geoscience Australia - Landsat Imagery (2007), Place Names, LGA Boundaries, Roads, State Boundaries, Shoreline (2008). Created by: CM

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4. Project Operations

4.1 Overview of Construction Activities

Subject to statutory approvals, construction activities are planned to commence during the first quarter of 2014.

Construction works will take place largely between 6 am to 6 pm, with construction workers operating on 12 hour rotating shifts. Administration and management personnel will work a standard 5 x 2 day roster. Occasional night works may be required, for example for concrete pours during hotter months, or to catch up on schedule delays.

Construction works will include the following:

- demolition and disposal of existing process plant and other facilities such as the gate house;
- construction of temporary facilities (i.e. lay down areas, offices, workshops, etc.);
- construction camp (located within 25 km of the mine site and subject to separate approval);
- on site concrete batch plant/s;
- administration and plant site buildings including:
  - mine and plant workshops, warehouses and maintenance facilities;
  - offices, medical facilities and training facilities;
  - security gate house, weighbridge etc.;
  - crib room and ablutions;
  - laboratory.
- ore processing plant;
- power station;
- water treatment plant (WTP);
- sludge disposal cell and equalisation pond;
- site roads;
- pumps and pipelines; and
- new sumps, decant towers, decant ponds, collection ditches and diversions.

In addition, the following activities associated with ongoing operations will progressively occur:

- raising of TSF1 from 16 m in height to approximately 34 m in height in six phases;
- construction of TSF2 to 60 m in height over four stages
- increase in the height of the existing waste rock dump from 24 m to approximately 350 m;
- development of a clay borrow area(s) ;
- construction of LGO stockpile, collection ditch and lined sump;
- construction of water treatment wetlands; and
- potential construction of a re-aligned access road.

The Project will use standard construction machinery, general trade equipment and specialised equipment as required. The indicative number and type of construction equipment required is shown in Table 1.

Table 1 Indicative construction equipment

Equipment	Indicative Number
Scraper/Roller 11T	4
Excavator	4
Front-end loader	6
Grader	2
Crane	6
Water tanker	2
Concrete trucks / pumps	6
Concrete batch plant	1
Dozer D8	2
Dozer D7	1
Rear Dumps or Highway Trucks	10

4.2 Mining and Ore Processing

4.2.1 Overview

Mining operations (Figure 2) will be conducted by conventional open-pit truck and shovel methods, using large haul trucks, hydraulic shovels and front-end loaders to transport material to the crusher, ore stockpiles and waste dumps. Extracted ore will be transported to an ore processing plant where it will be crushed, pre-treated and subjected to carbon in leach (CIL) leaching followed by adsorption, desorption and recovery to produce gold dore (unrefined gold). Gold dore will be transported for onward secure shipment to a refinery.

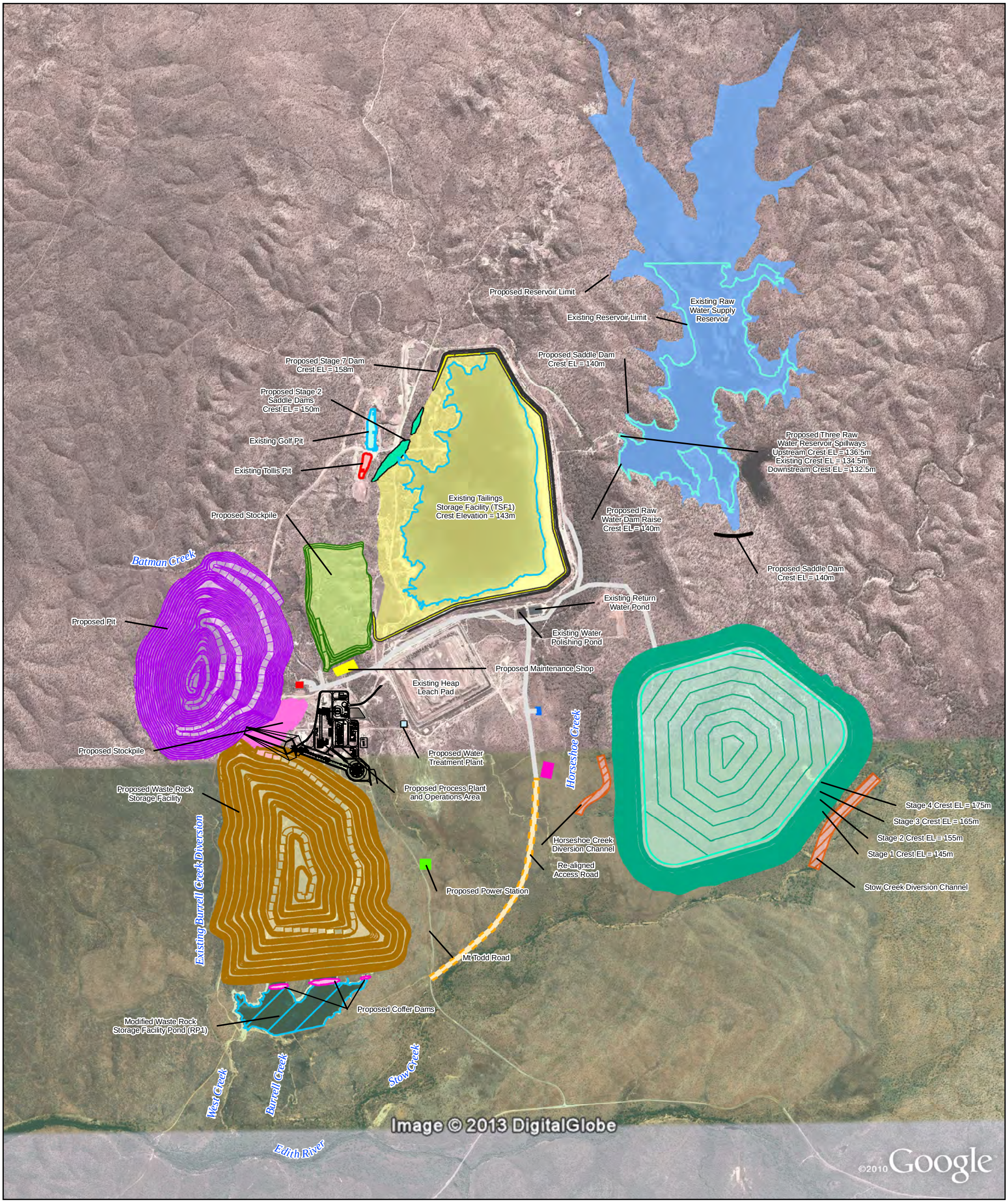
Mining and associated operations will primarily occur on Mineral Leases MLN 1070, MLN 1071 and MLN 1127, covering 5,365 ha.

4.2.2 Production Schedule

Proven and Probable Reserves have been used to schedule mine production. The production schedule of over 222 Mt of processed ore will occur over a 13 year period (Table 2). This does not include pre-production mining during the construction phase.

Based on a review of geological data and current bench slopes, a detailed pit design has been completed. The ultimate pit is achieved by mining in four separate phases or cut backs, as outlined below:

- phase one – mining during pre-production starts from the current pit pushback limit that was started by previous operators and mines it to RL -188 m.
- phase 2 – during year 1 mines around the phase 1 pit and deepens the pit to RL -246 m.
- phase 3 – during year 3 continues to mine around the south end of the phase 2 pit and achieves a RL of -336 m.
- the final phase – during year 5 completes mining in the north and below phase 3 to a RL of -396 m.



LEGEND

- Process Plant
- Power Plant
- Explosives Magazine
- TSF1 Existing Water Body
- TSF2 Impounded Surface Area (Year 12)
- Proposed Saddle Dam (Raw Water Dam)
- Stockpile
- Golf Pit
- Proposed Haul Road
- Diversion Channels
- Proposed Saddle Dam
- TSF2 Contours (Year 12)
- Retention Pond 1
- Tollis Pit
- Re-aligned Access Road
- Raw Water Dam Existing Water Body
- TSF1
- TSF2 Footprint (Year 12)
- Batman Pit Footprint (Year 12)
- Fuel Bays
- Coffer Dams
- Indicative Raw Water Dam
- Low Grade Ore Stockpile Contours
- Water Treatment Plant
- Waste Rock Dump Contours (Year 10)
- Proposed Maintenance Shop
- ANFO Facility
- TSF1 Contours
- Low Grade Ore Stockpile
- Batman Pit Contours (Year 12)
- Waste Rock Dump Footprint (Year 10)

0 0.25 0.5 0.75 1
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 53

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Vista Gold Australia Pty Ltd
Mt Todd Gold Project

Job Number	43-21801
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Mt Todd General Facilities Arrangement

Figure 2

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Data source: Tetra Tech - Process Plant, Golf Pit, Tollis Pit, Fuel Bays, Proposed Maintenance Shop, Power Plant, Realigned Roads, Proposed Haul Road, Coffer Dams, ANFO Facility, Explosives, Diversion Channels, Raw Water Dam Existing Water Body, Indicative Raw Water Dam, TSF1 Contours, TSF1 Existing Water Body, Proposed Saddle Dam, TSF1, Low Grade Ore Stockpile Contours, Low Grade Ore Stockpile, TSF2 Impounded Surface Area, TSF2 Contours, TSF2 Footprint, Water Treatment Plant, Batman Pit Contours, Proposed Saddle Dam (Raw Water Dam), Retention Pond 1, Batman Pit Footprint, Waste Rock Dump Contours, Waste Rock Dump Footprint, Stockpile (2013). Google Earth Pro - Imagery (Date extracted: 17/05/2013). GHD - Creek Names (2011). Created by: CM

Based on the supplied annual mine production schedule (Table 2), year 3 is estimated to have the greatest amount of material excavated from the pit.

Table 2 Annual mine production schedule ('000 tonnes)

Mining year	Total ore mined	Total waste mined	Total tonnes mined	Strip ratio	Total rehandle	Total ore processed
Pre-production	11,764	24,761	36,525	2.10	-	-
1	28,101	33,803	61,905	1.20	316	17,799
2	20,983	55,290	76,273	2.64	5,085	17,750
3	**23,941**	**78,227**	**102,169**	**3.27**	**1,108**	**17,750**
4	18,285	71,608	89,893	3.92	6,061	17,750
5	29,066	58,329	87,395	2.01	-	17,799
6	7,561	71,279	78,840	9.43	10,770	17,750
7	4,777	54,405	59,182	11.39	12,973	17,750
8	7,078	45,482	52,560	6.43	10,672	17,750
9	10,700	38,710	49,410	3.62	7,099	17,799
10	24,331	27,864	52,195	1.15	-	17,750
11	22,861	2,592	25,454	0.11	-	17,750
12	Heap Leach & Stockpile			-	17,750	17,750
13	Heap Leach Only			-	9,505	9,505
Total	209,451	562,349	771,800	2.68	81,339	222,651

Note: Rehandle includes 13,200 t from the existing Heap Leach Pad

4.2.3 Mining

Mine operations will be 24 hour, split across two shifts (6:00 am to 6:00 pm and 6:00 pm to 6:00 am).

Drilling and blasting, to loosen rock ahead of mining, will be undertaken in order to produce rock sizes that conform to processing requirements. Blasted ore will be loaded into haul trucks for transportation either directly to the primary crusher, ROM pad or Low Grade Ore (LGO) stockpile. Ore will be reclaimed from the ROM pad and LGO stockpile by front-end loader and fed to the primary crusher.

The Batman Pit will be significantly deepened and enlarged from its current depth of 114 m to a proposed depth of 588 m (RL - 396). The surface area of the pit will be increased from approximately 40 ha to 137 ha.

Rock will be blasted and extracted by conventional truck and shovel methods. Walls will be scaled during the mining operation in order to maintain a safe work place. Safety berms will be utilised as required to maintain safe working areas. In some cases, primarily on the east wall, these safety berms will be incorporated into haul roads. Where this is done, a berm along the road will be built to contain any sloughing material. The pit will incorporate 6 m benches for mining. In areas where the material is consistently ore or waste, benches may be mined in 12 m heights.

Water will be sprayed onto roads to suppress dust using a water cart. Environmentally benign surfactants will also be used on road surfaces to reduce the water demand for dust suppression where practical.

4.2.4 Ore Processing

A new ore processing facility will be constructed on the site of the previous process plant.

The processing plant has been designed to treat free milling ore using conventional technology to recover cyanide leachable gold using a carbon in leach (CIL) process. The processing plant will consist of the following components:

- gyrator crusher;
- secondary crushers;
- coarse screening;
- coarse ore stockpile;
- high pressure grinding rolls (HPGR);
- fine screening;
- classification;
- ball mills;
- pre-leach thickener;
- CIL circuit;
- elution circuit
- gold room
- cyanide detoxification; and
- tailings pumps.

Support services include reagent mixing and dosing facilities, and a centralised control room.

A simplified process flow sheet is shown in Figure 3.

The following are key components of the Ore Processing Plant:

- Comminution (crushing and grinding of ore);
- Adsorption and detoxification; and
- Gold extraction.

Comminution

Ore will be fed into a primary gyratory crusher, either directly by haul truck from the pit or by front-end loader from the ROM pad and LGO stockpile. Ore contained within the existing LGO stockpile and scats from the scats stockpile will also be reprocessed. Primary crusher product will be reclaimed from the discharge vault by the apron feeder and discharged onto a conveyor.

Primary crushed ore will be secondary crushed using cone crushers. Crusher product will be screened on banana screens with oversized material transferred back to the secondary crusher feed conveyor. Screened undersized material will be transferred onto a coarse ore stockpile where ore will be reclaimed by a feeder, onto a conveyor to the High Pressure Grinding Rolls (HPGR). HPGR product will be conveyed by belt conveyors to a fine ore splitter where it will be transferred across a fine ore screen by two belt conveyors operating in parallel. Screened oversize material will be conveyed back to the HPGR feed conveyor with the undersized material gravitating to a hydrocyclone feed sump. Slurry from the feed sump will be pumped into a hydrocyclone cluster. The hydrocyclone underflow will then gravitate to two ball mills where it will undergo further size reduction. The hydrocyclone overflow slurry will flow by gravity onto three trash removal screens. Screened undersize slurry will gravitate into a pre-leach thickener, after which thickened slurry will be pumped to the CIL circuit.

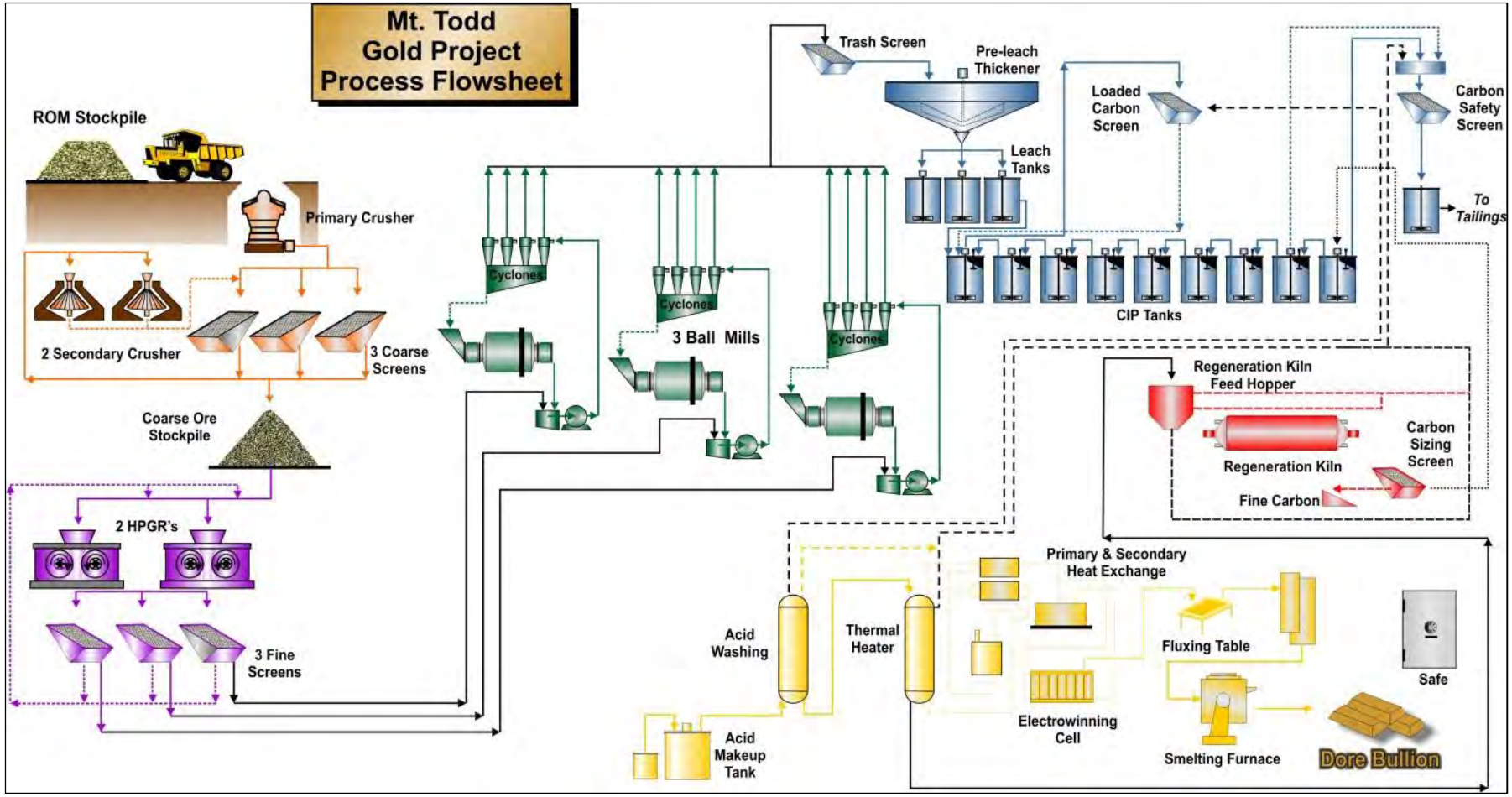


Figure 3 Simplified Process Flowsheet

Adsorption and Detoxification

The CIL circuit will consist of a pre-leach thickening stage followed by conventional leaching and adsorption. Pre-aeration reduces cyanide consumption during leaching. Cyanide will be added to the slurry to dissolve the gold after which carbon is added to adsorb the solubilised gold. Reactivated carbon, supplemented with fresh carbon as necessary, will be added to the final tank in the circuit.

CIL process tailings will be directed to a cyanide detoxification circuit, whereby the cyanide will be reduced and / or eliminated. The slurry exiting the detoxification tanks will gravitate into a tailings pump hopper. From here the slurry will be pumped to tailings storage.

Gold Extraction

Loaded carbon will be separated by screen from the CIL tank located immediately after the leach tanks and transferred to a carbon strip vessel. Prior to gold stripping, copper will be stripped from the loaded carbon via a cold cyanide strip.

Gold will be removed from the loaded carbon using a modified Anglo American Research Laboratories carbon strip. Pregnant solution will be stored in a pregnant solution tank in preparation for electrowinning. Electrowinning will commence once the solution level in the pregnant solution tank is sufficient to cover the electrowinning feed pump intakes. Pregnant solution will be circulated from the pregnant solution tank through electrowinning cells wherein gold will be electrochemically plated onto stainless steel wool. Recirculation of pregnant solution will occur until gold grades are below economic levels. The barren solution will be reintroduced into the CIL circuit to recover any residual gold that was not electrowon.

Gold adhering to the stainless steel cathodes in the electrowinning cells will be washed under high pressure from the cathodes into the bottom of the cell and transferred into a vacuum pan filter. Solids from the filter will be transferred into a drying oven. The dried gold sludge will then be transferred into an induction furnace, fluxed, smelted and poured into dore bars.

4.2.5 Cyanide detoxification circuit

Cyanide will be treated in a detoxification circuit through a reaction with sulphur dioxide (SO_2) in a solution of Sodium Metabisuplhite (SMBS). Information supplied by Vista Gold[1] indicates that gaseous SO_2 emissions from the process are expected to be negligible. Consequently, no emissions to air have been assessed from the cyanide detoxification circuit.

Vista Gold proposes to accept delivery of SMBS as a 95 per cent pure solid powder in shipping containers. A container tipper and solids handling equipment will transfer the powder from the storage containers to the mixing tank. SMBS will be mixed to 20 % (w/v) in solution and dosed to the detoxification tanks via duty/standby dosing pumps. SMBS will be consumed at a rate of 0.73 kg/t of ore treated. This amounts to approximately 12,958 tonnes per year for processing 50 ktpd of ore. The mixing and storage tanks will be enclosed with a roof to minimise the release of air emissions. The SMBS reacts with the cyanide in the detoxification process to produce sulphuric acid that is in-turn neutralised. Dust emissions generated through the handling and transfer of bulk material will be mitigated using source appropriate methods. Dusty areas where site personnel are operating will be well ventilated.

[1] Email from Andrew Sawicki (Vista Gold Mt Todd) to Nikki Conroy (GHD) 21 May 2013 at 2:19 pm. Subject: FW: SO_2 in cyanide detox.

4.2.6 Transport and Ancillary Operations

The gold bars will be stored in a secured area at the project site and transported by secure shipment to a refinery.

The leaching efficiency of the carbon in the CIL process is reduced over time through the build-up of carbonates. Carbon will be regenerated through regular washing in a mild, cold hydrochloric acid wash to remove the carbonates before reactivation in a kiln after carbon stripping. The reactivated carbon will then be screened to remove carbon fines before being reintroduced to the CIL circuit.

GHD understands that power generated on site will be used to heat the kiln and consequently, emissions associated with the kiln have not been assessed.

4.2.7 Site Vehicles

A broad range of vehicles will operate at the mine to undertake a variety of functions including mining, stockpile management, plant feeding, road maintenance, dust suppression, and general personnel movement. The proposed vehicle fleet includes the following:

- 8 Atlas Copco Pit Vider 235 blast-hole drills;
- 1 Atlas Copco 45K rotary drill rig;
- 2 ammonium nitrate / fuel oil truck;
- 1 skid loader;
- 4 Hitachi EX5500 hydraulic shovels;
- 2 Cat 994 loader;
- up to 38 Cat 793C trucks during the mine life;
- 1 Cat D8 track dozer;
- 2 Cat D9 track dozers;
- 2 Cat 16H motor grader;
- 2 Cat 777B with a 70 kL water truck;
- 2 Cat 834H rubber tire dozer;
- 1 36 tonne capacity crane;
- 1 Cat 321DL excavator;
- 1 low-boy trailer with 60 tonne haul truck;
- 1 flatbed truck;
- 1 rock breaker attached to the 321DL excavator;
- 4 light plants;
- 1 fuel / lube truck;
- 16 4WD utes; and
- 2 passenger vans.

Fuel consumption for vehicles operating at the mine is estimated at 90,000 litres per day.

4.3 Infrastructure

4.3.1 Power Supply

During operations, site electrical normal demand (steady state) is 86MW and the peak demand is approximately 95MW

Electrical demand will be met by the installation of a single Rolls Royce Trent 60 Wet Low Emissions gas turbine generator (Figure 4, right) and two reciprocating engines (Figure 4, left) located along the south side of the main entrance road.

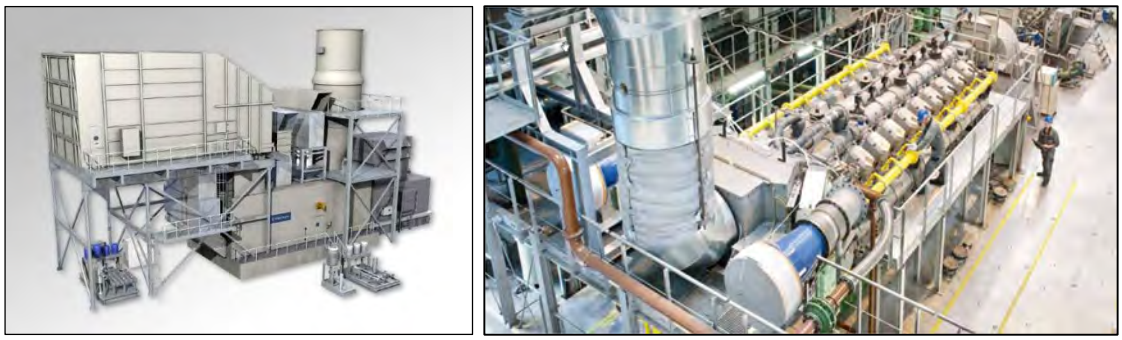


Figure 4 Rolls Royce Trent 60 Gas Turbine (left) and MAN 20V35/44 SG Reciprocating Engine (right)

Total power generation capacity (installed) will be approximately 76 MW. Some power may be obtained from the existing transmission lines if a temporary shortfall occurs. The peak electrical demand will be met by a combination of gas turbine generated power and grid supply.

Water consumption in the power plant is primarily for compressor interstate cooling, control of oxide of nitrogen (NO_X) emissions through injection into the combustor and periodic cleaning of the turbine compressor section. The raw water dam will supply the required 290,000 m³ per annum for power plant operation.

The proposed exhaust stack configuration for the combined emissions will be a single 21.3 m high stack with a 3 m diameter.

Key specifications of the proposed power plant are provided in Table 3.

Table 3 Power Plant Specifications

Specification	Measurement
Gas Consumption	8.9 Peta Joules per year
Electricity produced	18,000 GWh over Project life
Estimated Emissions [(1)]	
Oxides of Nitrogen	50.0 mg/Nm³
Carbon monoxide	54.5 mg/Nm³
Particulate Matter (as TSP)	5.1 mg/Nm³
Volatile Organic Compounds (VOC)	2.5 mg/Nm³

[1] Dry at 15 % O_2.

4.3.2 Chemical and Hydrocarbon Storage

Diesel will be stored on-site for mining equipment and some vehicles. The current API 650 tank (600 kl storage capacity) will be used to store diesel fuel with fuel distributed as required basis through a combination of pipelines and, fuel trucks. It is planned to have a single diesel storage area close to the heavy equipment workshop. Refuelling facilities will be provided in the heavy vehicle workshop area for the vehicles belonging to the operation. It is anticipated that up to 90,000 L of diesel will be used daily (31.5 MLpa). Storage capacity of up to 820,000 L will be maintained on-site.

Various reagents for mixing and processing in the ore processing plant will also be stored on-site and include the following:

- cyanide will be predominantly delivered in bulk isotainer for sparge mixing; however due to the lack of on-site liquid storage, a backup dry solids mixing system will be required that will necessitate the storage of a suitable amount of dry cyanide in boxed form. Liquid cyanide storage is in the order of 2.5 days, which provides an insufficient operational buffer.
- sodium hydroxide will be delivered in one tonne bags with storage capacity of approximately is 12 m^3;
- flocculant will be transported as a solid, stored in a silo and made up into two 180 m^3 tanks;
- loose bulk SMBS will be delivered in 20 foot containers with container liner. Mixed solution will be stored in a 325.4 m^3 tank;
- hydrochloric acid will be delivered in 1,150 kg Intermediate Bulk Containers (IBC);
- activated carbon will be delivered onsite in 500 kg bulk bags;
- fluxes will be delivered to site on approximately one tonne pallets;
- lead nitrate will be delivered in powder form in one tonne bags with 20% solution and stored in a 102 m^3 tank; and
- quick lime will be delivered to site in loose bulk in 20 foot containers.

Lubricating oil will be stored in bulk containers inside a bunded area with spill protection.

Waste oil will be stored in a tank within a bunded area to be held for collection by a contractor for reprocessing and recycling.

All chemicals, fuels and oils will be stored and contained according to Australian Standards.

4.3.3 Explosive Magazines / Depot

The project will require an explosive storage and handling facility for ANFO. Ammonium nitrate will be stored in sea containers and will be emptied into the hopper/bin for discharge into the explosives mixing truck. The emulsion, in gel form, will be stored in the self-contained bullet tank and will be pumped into the mixing truck powder magazines and a cap magazine, which will be built and operated in accordance with Dangerous Goods regulations. Applications for a Magazine Licence or a licence to store dangerous goods will be submitted to the relevant authority before commencing construction of the explosive storage facilities. On average, 3,000 t of explosive will be used each year. Peak year consumption is about 4,100 tonnes of explosive.

4.4 Construction Workforce and Accommodation

4.4.1 Workforce

The construction workforce is expected to peak at about 450. This workforce would be the responsibility of a construction contractor.

The mine workforce, including operations, maintenance, engineering, geological and support personnel, is expected to peak at about 350. It is expected that up to 40 personnel would be required for the decommissioning and closure phases.

4.4.2 Accommodation

The Construction Workforce will be housed in a purpose built camp. The location of this camp is still to be determined but it is likely to be located within 25 km of the mine.

The operations workforce of 350 is expected to comprise 60 personnel drawn from the region with the remaining 290 personnel being new. Initial work has indicated that these personnel could be accommodated as follows:

- 70 workers at the construction camp. This would accommodate mainly FIFO[2] / DIDO[3] personnel and provide an ability to quickly increase capacity and house overflow peak period personnel to meet mining needs or maintenance shut downs;
- 120 workers (family households with or without children) in a mixture of:
  - new three and four bedroom houses located on existing vacant Katherine and regional land;
  - existing (renovated if required) houses located in Katherine and regionally; and
  - subject to real estate availability at the time of the arrangement, a small contained development on Katherine land.
- 100 workers located in a Katherine based single person accommodation facility.

The ultimate accommodation strategy adopted will be developed following further discussions with local and territory government agencies.

For the decommissioning and closure phase, the 40 required workers would be housed in either the previous FIFO / DIDO accommodation or in the Katherine based single person accommodation.

4.5 Waste Management

4.5.1 Waste Rock Dump (WRD)

The existing WRD, located to the southeast of Batman Pit, will be extended. The WRD will be created in stages. To facilitate this ultimate plan, coffer dams will be constructed upstream of RP1.

The existing WRD comprises approximately 16 Mt of waste rock. The ultimate WRD dump will contain around 510 Mt of waste rock material, an addition of approximately 494 Mt. From its current area of 69 ha, the WRD will expand to around 217 ha. The current WRD is around 24 m high. The ultimate WRD design will be approximately 350 m high.

[2] FIFO: Fly In, Fly Out

[3] Drive In, Drive Out

The WRD will be constructed:

- to avoid grading of waste rock at the end of the mine-life;
- at an effective angle of 30^{o} (with interbench slopes of 34^{o});
- with eight metre wide benches constructed in lifts resulting in 30 m vertical intervals on the exterior faces; and
- with geosynthetic clay liner (GCL) covers spanning approximately 52 m on top of each lift, covering the eight metre bench and running below the subsequent lift.

A Waste Rock Management Plan (WRMP) will be developed that specifies how waste rock will be handled in order to maximise its beneficial use. The WRMP will include, but not limited to, the following provision for dust minimisation:

- vehicular speed limits on areas of unconsolidated or unsealed soil associated with the WRD;
- water spraying onto roads to suppress dust using a water cart;
- application of environmentally benign surfactants may be used on road surfaces to reduce the water demand for dust suppression;
- prompt mitigation of visible dust emissions from operations;
- sequential closure of inactive dump areas and faces as mining progresses.

The WRMP will also emphasise the implementation of operational techniques and dump designs that encourage clean water diversion, rapid internal surface runoff, and seepage control during operations and at closure.

In addition to the primary dump, additional waste will be placed to level out an area to the northeast of the waste dump and extend north around the crushing area. This area will be built to provide truck access to the crushing facility.

4.5.2 Tailings Storage Facility (TSF)

Thickened tailings will be generated from the ore processing plant. Over the estimated 15 year mine life, the Project will require a total of approximately 223 Mt of new tailings storage. Vista Gold proposes to store tailings in two facilities; the existing TSF1 to the northeast of the existing ore processing plant pad and a proposed new TSF2 in the valley southeast of TSF1 (Figure 2).

It is proposed to dispose approximately 62 Mt of tailings at the existing TSF1 in the first five to six years of production. TSF1 will be raised from 16 m above ground level to approximately 34 m. The embankment will be raised in six stages:

- Stage 1 – The design will involve a centreline raise type of construction. The thickened tailings will be discharged by spigots from the embankment crest to form a beach behind the embankment wall. The embankment crest will be composed of either fill or waste rock, and raised vertically; and
- Stages 2 to 6 – These will require upstream raise construction methods. The thickened tailings will again be discharged by spigots from the embankment crest to form a beach behind the embankment wall, driving the water pool to the west. The embankment crest will be raised upstream as material (fill or waste rock) for the embankment is placed on the tailings beach. Water will be removed from the water pool using the existing decant towers, which will be raised along with the embankment stages. The existing toe drain and under-drains will convey seepage water to the return water pond, where it will be pumped back to the impoundment.

Approximately four million tonnes of material is required for the construction of TSF1. This will be acquired through the mining of non acid forming waste rock from open pit mining operations.

On the west side of TSF1, two saddle dams (Saddle Dam North and Saddle Dam South) will be constructed concurrently with the Stage 2 embankment raise. These dams will be constructed using non acid forming waste rock. The design crest width for both the saddle dams is eight metres, with a final design crest elevation of 152.5 m.

The remaining 161 Mt of tailings will be disposed of in the new TSF2. TSF2 will be constructed over four stages commencing in year 4/5 of production. Stage 1 will be constructed entirely on native ground using bulldozers for clearing and grubbing. Soil will be salvaged from the footprint of TSF2 and temporarily stockpiled prior to construction commencing. Stages 2 through 4 will be constructed using embankment raise construction methods in order to contain the tailings deposited in the facility. Approximately 45 Mt of material is required for the construction of TSF2. This will be acquired through the mining of waste rock from open pit mining operations.

The ultimate height of TSF2 is approximately 60 m above ground level (RL175 m).

Thickened tailings will be pumped via a pipeline to the crest of the embankment and sub-aerial tailings deposition from spigot points along the crest. The tailings will form a consolidated beach along the crest, creating a water pool towards the centre of the facility. Water will be removed from the water pool using a floating barge with pumps and pipes to convey the reclaimed water back to the processing facilities.

TSF2 has been designed to operate as a zero-discharge facility, so all seepage from the underdrain, toe drain, and overdrain systems will be collected and pumped back to the impoundment during operations.

5. Existing Environment

Two key factors are important in the assessment of air quality impacts in the project region. These are the region's existing air quality and meteorology. Background concentrations of important air pollutants are required to carry out a cumulative impact assessment, while a good understanding of the region's meteorology is required to simulate emission plume transport and assess their ground level impact. Data used in the assessment is described in this section.

5.1 Climate Classification

The project area is situated between the Inter-Tropical Convergence Zone (ITCZ) and the Subtropical pressure ridge. There is a distinct wet and dry season with little variation in temperature throughout the year. Inland regions experience hot and dry air outside the wet season. Consequently, the region is classified as a Tropical Savannah climate.

5.2 Local Meteorology used in the Assessment

The project is located in a remote region of the Northern Territory and meteorological monitoring is not conducted in the immediate region. Consequently, site-representative meteorological observations suitable for use in dispersion modelling were unavailable and to provide data for the assessment, the prognostic meteorological model TAPM (The Air Pollution Model) was used to simulate regional and local flows.

5.2.1 Meteorological Modelling

A one-year meteorological dataset representative of the project area and suitable for input to the AUSPLUME dispersion model was simulated using TAPM.

TAPM (version 4) was developed by the CSIRO Marine and Atmospheric Research Division and is a desktop computer based prognostic meteorological modelling system that can predict regional-scale three-dimensional meteorology. It is suitable for use with complex geographical sites and/or when the available site representative meteorological data are not adequate for use in air quality assessment.

The model can be used with no local surface meteorological data and, instead, can be initiated with synoptic weather analyses from the United States Global Forecasting System (GFS) that is regularly used in Numerical Weather Prediction to provide global weather forecasts. TAPM provides the link between the synoptic large-scale flows and the local meteorology, which in this case includes such phenomena as broader scale terrain wind channelling. Any surface observations can optionally be partially assimilated into the predicted flow field.

The performance of TAPM to simulate regional meteorology was evaluated against Bureau of Meteorology (BoM) observations at the Tindal and Pine Creek monitoring stations. This evaluation found that the distribution of modelled wind speed and direction are generally in agreement with the observations. These sites were selected for comparison as an assessment of the BoM data found that they were more regionally representative and suitable for evaluating the performance of TAPM than the monitoring sites located closer to the Mt Todd site.

5.2.2 Model Configuration

Synoptic data for the 12-month period between September 2007 to August 2008 was used to initiate TAPM. This year was chosen as it experienced near average regional rainfall and captured one full representative wet season. TAPM was initially configured with a nested model grid coverage designed to capture:

- broad scale synoptic flows;
- regional and broader scale land breezes;
- regional and broader wind channeling around terrain features; and
- the influence of land use.

The nested grids were then configured with the surface characteristics, such as terrain elevation; surface roughness/vegetation type; soil type and monthly varying (initial) deep soil moisture content.

The terrain elevation data, at a 9-second (300m) resolution, was obtained from Geoscience Australia. The characterised vegetation and land use was determined from the use of aerial photographs in conjunction with the datasets provided within the model. Soil type information was derived from the default US Geological Survey dataset provided with the model.

Deep soil moisture content was varied to reflect actual rainfall during the year (Table 4). The wet season, based on meteorological records for the region, was determined by an experienced meteorologist to have begun on 1 December 2007 and to have finished on 11 March 2008. In this period the region experienced persistent rainfall events. As a result, the initial deep soil moisture content was increased for the months December to March to take into account the persistent intake of moisture. It should be noted that when modelled, the wet season conditions were applied to the whole of March as the extensive rainfall in the preceding three months would result in wet soils for some time after the rain stopped. The build-up to the wet season for the examined period was found to occur during November, when rainfall events were present, but not consistent. Similarly, in April the soil holds some residual moisture from the wet season. The initial deep soil moisture content is increased slightly in these months to reflect this.

Table 4 Initial Deep Soil Moisture Content – Input into TAPM

Month	Initial Deep Soil Moisture Content, m^3/m^3 (volume of water per volume of soil)	Modelled Season
September	0.15	Dry
October	0.15	Dry
November	0.2	Onset Wet
December	0.4	Wet
January	0.4	Wet
February	0.4	Wet
March	0.4	Wet – transition
April	0.2	Dry
May	0.15	Dry
June	0.15	Dry
July	0.15	Dry
August	0.15	Dry

Other specific model settings were as follows:

- 4 nested grids at 1000 m, 2000 m, 6000 m and 18,000 m resolution;
- 25 vertical levels, ranging up to 8000 m;

- 60 x 60 grid points;
- surface vegetation and precipitation processes included (snow processes and non-hydrostatic processes were excluded).

At the completion of the TAPM run, hourly varying surface winds, temperatures and atmospheric stability were extracted at the mine site. For the purpose of validation, the same information was also extracted for the locations of RAAF Base Tindal AWS and Pine Creek, where there is comparable meteorological data recorded by the BoM. BoM station data, as opposed to other sites, is of sufficient quality and known to be measured to the appropriate Australian Standards for an accurate assessment to be completed.

5.2.3 Meteorological Model Evaluation

Overall, the TAPM model provided a good representation of the meteorology in the project region. Wind directions and speeds are generally in agreement with both the Tindal (AWS site 014932) and Pine Creek (AWS site 014960) observations obtained from the BoM. This can be seen in Figure 5 and Figure 6.

Some subtle differences between the modelled data exist but these are not likely to influence the findings of the impact assessment that is based on the highest ground level concentrations under worst case meteorological conditions. As shown in Table 5, the predicted wind speed at Tindal AWS varies from the corresponding BoM measured values by less than three per cent.

At Pine Creek, wind speed and direction is measured once daily at 3pm. Notwithstanding the single spot reading each day, TAPM overpredicts wind speed at Pine Creek by ~ 65 per cent.

Table 5 Mean Wind Speed Comparison

Site	BoM Observations	TAPM Modelled
Tindal	2.84 m/s	2.76 m/s
Pine Creek (3 pm)	2.12 m/s	3.52 m/s

The frequency of observed winds from the east-southeast is higher than in the TAPM data where the winds are of higher frequency from the southeast.

During the wet season, the wind direction is more varied in the observations compared to TAPM at Tindal. However, the wind direction is confined to the same quadrant (the northwest).

5.2.4 Wind Climate and Atmospheric Stability

The predicted annual distribution of winds at the mine site based on the TAPM simulation is illustrated in Figure 7. This wind rose shows the prevailing wind to be from the southeast quadrant. Winds from the southeast comprise 20 per cent of annual winds, followed in frequency by winds from the east-southeast (19 per cent). This pattern reflects the easterly trade winds experienced at this latitude of the southern tropical belt.

The incidence of light winds, which give rise to poor dispersion of emissions released at ground level, is also highest from the southeast. These winds comprise 19.5 per cent of winds in the less than 2.1 m/s category. The average wind speed, based on the TAPM modelling at the mine site was 2.46 m/s.

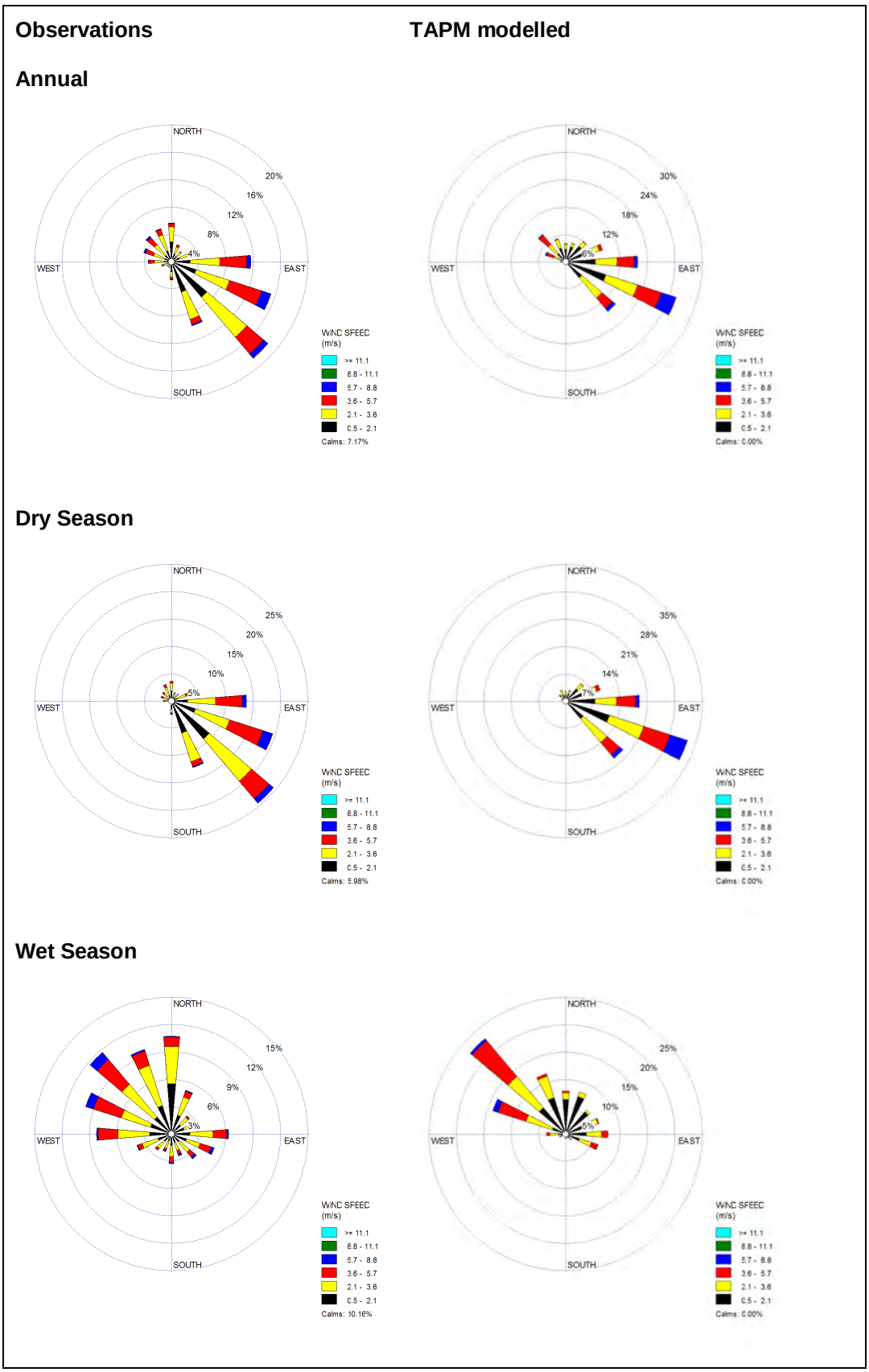


Figure 5 Comparisons of Predicted and Observed Distributions of Wind at Tindal

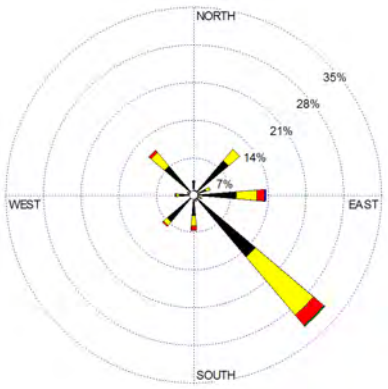
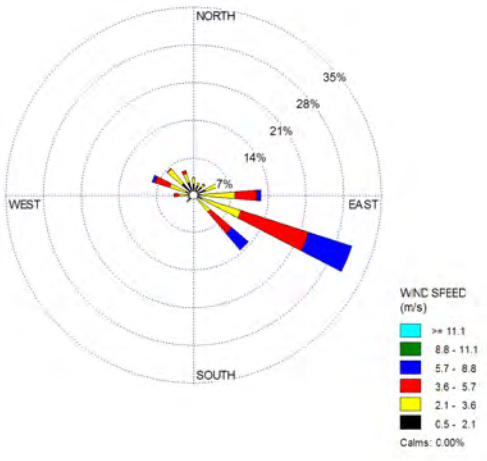
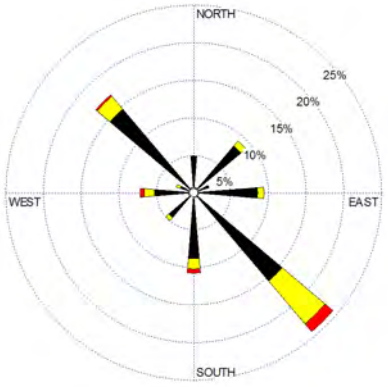
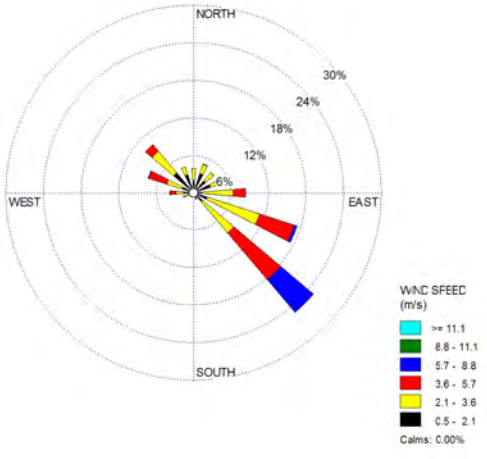
Observations (8-pt compass only)	**TAPM modelled (16-pt compass)**
Annual 3 pm	Annual 3 pm
	
Annual 9 am	Annual 9 am
	

*Figure continued on next page.

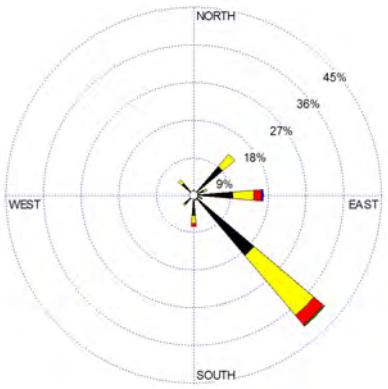
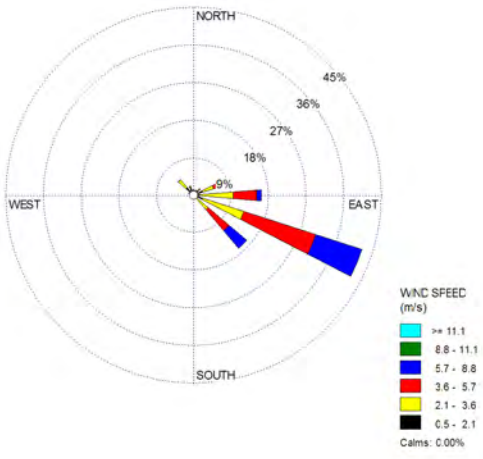
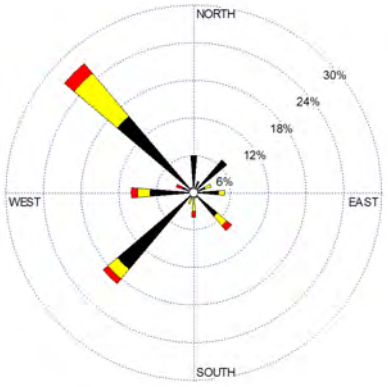
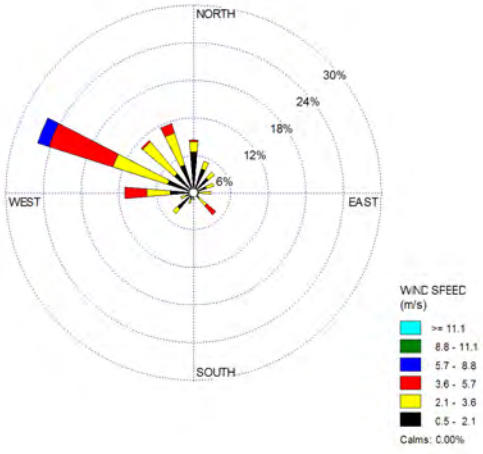
Observations (8-pt compass only)	**TAPM modelled (16-pt compass)**
Dry Season 3 pm	Dry Season 3 pm
	
Wet Season 3 pm	Wet Season 3 pm
	

Figure 6 Comparisons of Predicted and Observed Distributions of Wind at Pine Creek

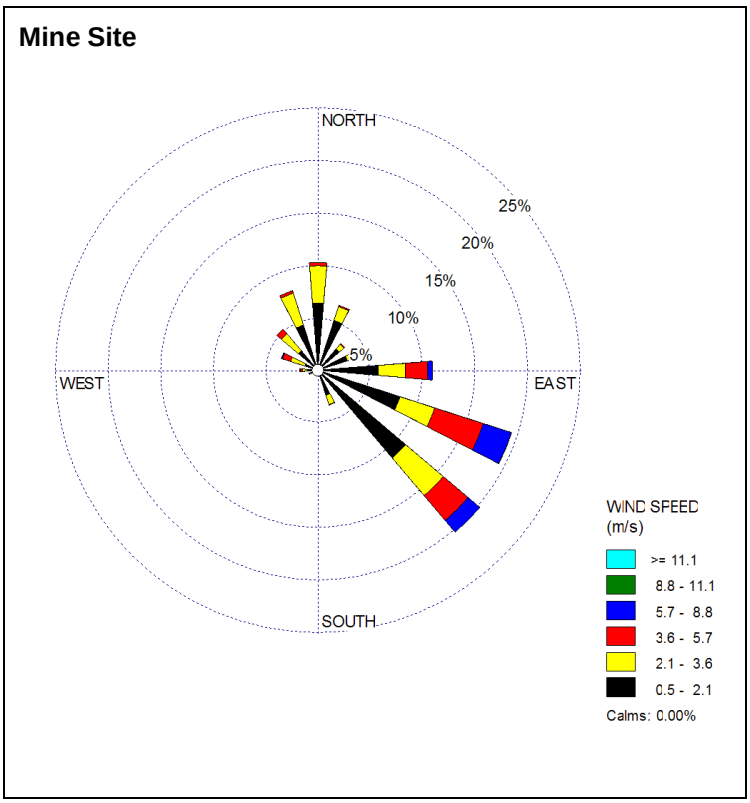


Figure 7 Predicted Annual Distribution of Winds at the mine site (TAPM simulation September 2007 to August 2008)

Seasonal Variation in Wind Climate

There is a clear distinction in incident wind direction between the wet and dry season shown in Figure 8. During the wet season the Australian Monsoon dominates synoptic flows altering the prevailing wind to be from the northwest. Synoptic flows during the dry season are characterised by the east to southeasterly Trade Winds.

Atmospheric Stability

Atmospheric stability dictates how effectively and efficiently a plume will disperse. The Pasquill/Gifford scale of atmospheric stability consists of six stability classes. Classes A, B and C represent strongly, moderately and slightly unstable atmospheres, respectively. These conditions only occur during daylight hours and are normally associated with increasing levels of solar radiation combined with decreasing wind speeds. For example, strongly unstable atmospheric conditions (A Class) will typically occur around midday when solar radiation levels are high, with no or little cloud cover. They will also occur during high solar radiation conditions with light wind speeds. Should the wind speed increase during A class conditions, the stability class is likely to transition from A through to C with wind speed increases. Under unstable conditions the dispersion of ground level emissions is efficient due to convective turbulent vertical mixing; thereby lowering predicted ground level impacts. However, elevated plumes from stack emissions are also vertically mixed by atmospheric convection and as such, high ground level impacts can result.

Category D classifies a neutral atmosphere where there is minimal solar induced convective mixing. These conditions typically occur during overcast daylight and night time hours or when wind speeds are high. Dispersion of both stack and ground based emissions are dominated by mechanical mixing of the Earth's atmosphere.

Stability classes E and F represent slightly and moderately stable atmospheres respectively. Stable conditions will generally develop at night, under clear skies and with light to moderate

wind speeds. Such conditions are often coupled with ground based, radiation forced temperature inversions (where the air at ground level is cooler than that above it), sometimes with mist or fog events. In a stable atmosphere (categories E and F), dispersion is poorest for ground based sources as vertical mixing of air is suppressed. This can result in higher downwind plume concentrations to that compared to similar emissions under unstable conditions. Conversely, elevated plumes from stack sources released above an inversion layer or with sufficient vertical momentum to penetrate an inversion layer are very unlikely to reach ground level unless they encounter rare events such as rain or showers producing wind downdraughts. It is commonly stable conditions that result in off-site impacts at a maximum range.

The modelled annual distribution of atmospheric stability for the data set is depicted in Figure 9. The following features are evident:

- Stability class D (neutral) is the most frequently experienced atmospheric condition and occurs for 38 per cent of the time;
- Stable classes E and F combined comprise 34 per cent of atmospheric condition; and
- The highest incidence of E and F conditions occur during winds from the southeast.

A seasonal analysis of atmospheric stability and wind direction indicates that the highest incidence of stable conditions corresponds to the change in prevailing wind (Figure 10) due to the wet season.

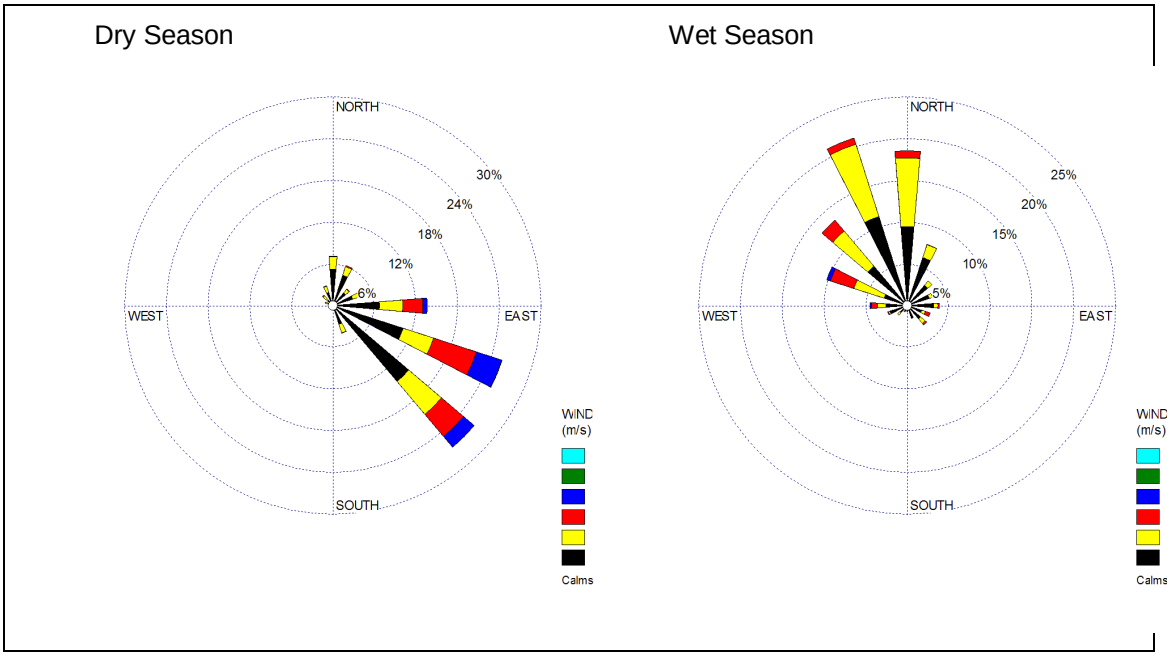


Figure 8 Predicted Seasonal Distribution of Winds at the mine site

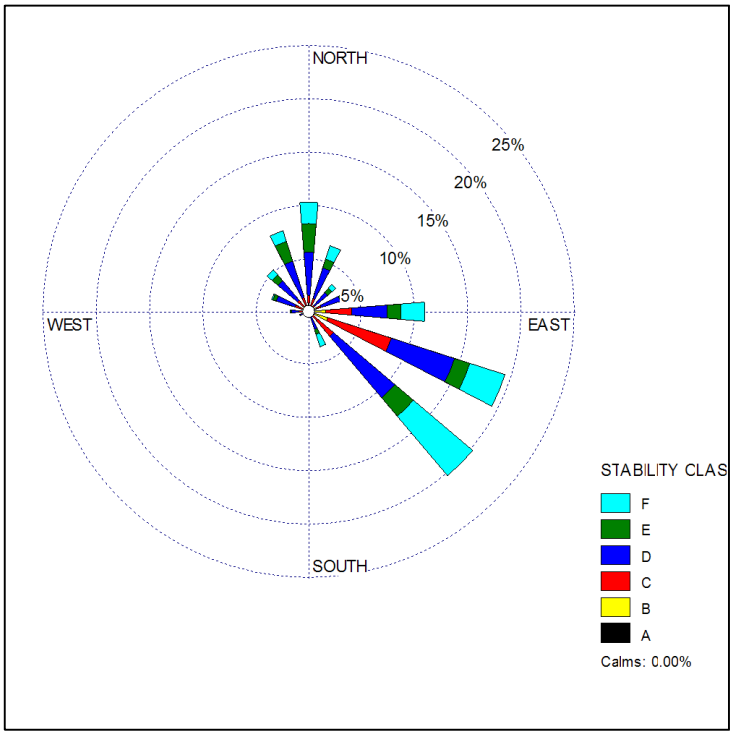


Figure 9 Predicted Annual Distribution of Atmospheric Stability by Wind Direction at the Mine site

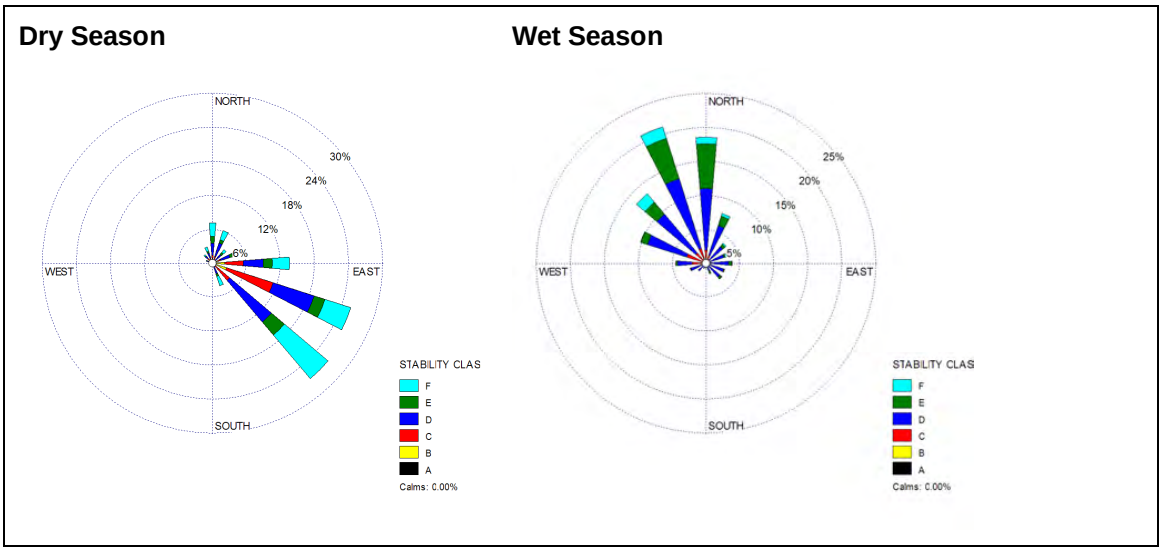


Figure 10 Predicted Seasonal Distribution of Atmospheric Stability by Wind Direction at the Mine site

5.3 Existing Ambient Air Quality

The assessment of criteria air pollutants, such as particulate matter, is made by comparison of ground level concentrations of emissions associated with the project combined with existing pollutant background concentrations against the air quality standards. Consequently, it is important to understand the background air quality at the mine and the location of sensitive receptors. This provides for the assessment of the potential total exposure of receptors to air pollutants as well as the incremental increase above background levels generated by the project.

The project is situated in a sparsely populated rural area primarily consisting of scrubby vegetation with the nearest urbanised areas, Katherine and Pine Creek, located more than 50 km to the south-southeast and northwest, respectively. The main naturally occurring sources of dust in the region are smoke from low temperature scrub fires, wind erosion of large areas of sparsely vegetated exposed ground and sealed and unsealed roads. Other dust sources in the project area include the wind erosion of existing non-operational facilities such as the heap leach, waste rock dump and tailings pond. Ambient concentrations of other air contaminants including combustion products, that are generally associated with urban development, motor vehicles and industry, are expected to be very low.

The most important air contaminant associated with the construction and operation of open-cut mining projects is particulate matter (as dust), generated through the extraction, handling, transfer, storage and processing of bulk material such as overburden, ore, waste rock, tailings and soil. Dust is assessed in various size fractions and applies to all dust generated. The dust is assessed against human health protection criteria as airborne ground level concentrations (i.e. within the human breathing zone between the ground surface and approximately two metres above the ground) and amenity criteria as dust deposited on surfaces.

A power plant comprising a gas turbine and two gas-fired reciprocating engines is also proposed for development. Combustion emissions from the plant will contribute to a relatively small local increase in ambient concentrations of NO_2 and CO and trace quantities of $PM_{2.5}$ and VOCs. Notwithstanding this, the location of the plant is remote and well separated from other similar sources of pollutants and regional ambient air quality is not expected to be altered from that of the existing rural setting.

Particulates are commonly monitored in three size ranges:

- less than 2.5 micron fraction ($PM_{2.5}$);
- less than 10 micron fraction (PM_{10}); and
- Total Suspended Particles (TSP).

All particle size ranges are capable of being suspended in ambient wind. TSP is generally considered to describe a particle size of less than 50 µm. Larger particles contribute most to potential nuisance, while the finer particles (PM_{10} and $PM_{2.5}$) can present a health issue. The most important size fraction of the particulate load generated in both the ambient environment and by the project is PM_{10} and $PM_{2.5}$.

Dust levels in the ambient environment are expected to be variable due to a range of factors from climatic conditions (wet and dry seasons, wind speed and direction to and from sources to receptors), and the movement of people in the region including tourists (270,000 in 2007) during the dry season. Vehicle movement along the sealed Stuart Highway will generate some wheel dust and vehicle exhaust emissions in the area and contribute a small amount to background levels of particulate matter. Furthermore, some minor wheel generated dust is likely to be produced by tourists travelling along the Edith Falls Road during the dry season.

5.4 Background Dust Concentrations used in the Cumulative Impact Assessment

Ambient air quality performance monitoring in accordance with the requirements of the *National Environment Protection Council Act 1994* is not required in the Mt Todd region as the population is less than 25 000 people. In addition to this, regional ambient air quality has not been monitored by the Northern Territory environmental regulator or by the previous mine operator.

The *National Environment Protection (Ambient Air Quality) Measure 2003* (Air NEPM) provides guidance on the monitoring and assessment of criteria air pollutants, including the promulgation

of national air quality standards but stops short of providing guidance on the determination of representative background air quality for use in cumulative impact assessment and in instances where no regionally-specific data are available. Notwithstanding this, the *Victorian State Environment Protection Policy (Air Quality Management*) (SEPP(AQM), 2001 does provide such guidance. It states that the 70th percentile of one year's observed hourly concentrations may be used as a constant value to represent background in numerical modelling.

PM_{10} and $PM_{2.5}$ levels at Casuarina in the Northern Territory are monitored annually. The average of the 75th percentile for years 2004 to 2009 is given in Table 6. As these levels will be marginally higher than the 70th percentile values, they are used here to infer background particulate levels for Mt Todd. While the Casuarina monitoring location is situated nearer to the Darwin urban area, it is considered to be a suitable, though conservative, representation of ambient background levels of particulate matter for use in the impact assessment. In the absence of monitoring data for TSP, a value of 42 µg/m^3 has been adopted. This concentration is based on measurements in other Australian airsheds where the ratio of ambient concentrations of TSP to PM_{10} is 2:1.

Table 6 Ambient Background Concentrations used in the Assessment

TSP	PM_{10}	$PM_{2.5}$
42	20.8	11.2
Units are in µg/m³. Data sourced from Charles Darwin University Casuarina and calculated from Northern Territory Air Monitoring Report 2009. Average 75th Percentile Daily Peak Concentration Particulate Levels		

5.5 Sensitive Receptors and Surrounding Land Uses

The areas surrounding the mine site are rural and sparsely populated, with the nearest identified community residing as Werenbun. The Stuart Highway (the main arterial road in the region), is located west of the mine site. Figure 1 depicts the current land use around the mine site.

A sensitive receptor may be defined as any location where people reside or are present for an extended period of time. This may include any of the following:

- A dwelling, mobile home or caravan park or other residential premises;
- a motel, hotel or hostel;
- a kindergarten, school, university or other educational institution;
- a medical centre or hospital;
- a place of worship;
- a protected area;
- a public park or gardens;
- a commercial place or part of the place potentially affected.

The nearest sensitive receptor to the project area is the Werenbun Community situated approximately 6 km to the southeast (upstream of the Edith River located to the immediate south of the mine site). The location of an accommodation camp has not yet been selected. However, it is likely to be situated up to 25 km from the project area.

In addition to sensitive human receptors, a population of the endangered Gouldian Finch has been identified as an inhabitant of the Yinberrie Hills area to the west of the Batman Pit (NSR, 1992, p.81-84). While no specific impact assessment criteria for particulate matter has been developed for this species, the impact of dust emissions associated with the project on this species has been considered.

6. Air Quality Assessment Criteria

The Northern Territory government has not published any guidance or objectives for the assessment of air quality in the territory. In the absence of state or territory-specific environmental protection regulations, suitable air quality assessment criteria and guidance have been sought from other national and state legislation. In this case, and in accordance with the requirements of the Commonwealth *National Environment Protection Measures (Implementation) Act 1998*, air quality standards for criteria air pollutants promulgated under the Air NEPM (2003) have been adopted for the assessment.

The Air NEPM standards have been used to assess the potential for impacts of PM_{10}, $PM_{2.5}$, NO_2 and CO. In addition to the lack of state and territory-specific air quality criteria, where the Air NEPM has not published air quality assessment criteria for a substance, assessment criterion may be adopted from another national or international jurisdiction. For this assessment, the NSW Office of Environment and Heritage (OEH) impact assessment criteria for TSP and deposited dust have been used. The EPA Victoria *Mining and Extractive Industries Protocol for Environmental Management 2007* (EPA Victoria, 2007) assessment criteria for $PM_{2.5}$ and PM_{10} have also been referenced.

The air quality assessment criteria used in the dust impact assessment have been determined and promulgated to protect human health and well-being, and to minimise the loss of amenity and the causation of nuisance affects. Objectives for protecting terrestrial flora and fauna and aquatic environments have not been specifically derived and published. Consequently, the air quality criteria identified for use in this impact assessment apply specifically to the protection of human receptors. Air quality criteria appropriate for use in the protection of the Gouldian finch and its identified area of habitat, for example, have not been identified in this assessment. Issues regarding Gouldian finch habitat are addressed in more detail in the flora and fauna chapters of the EIS.

The air quality standards and impact assessment criteria used in the assessment are presented in Table 7.

Table 7 Air Quality Standards and Impact Assessment Criteria used in the Assessment

Indicator	Air Quality Standard [a]	Impact Assessment Criterion [b]	Intervention Level [c]	Averaging Time
PM_{10}	50 µg/m³	50 µg/m³	60 µg/m³	24-hour
$PM_{2.5}$	25 µg/m³		36 µg/m³	24-hour
TSP	N/A	90 µg/m³	N/A	Annual
Deposited dust	N/A	Total: 4 g/m²/month Incremental: 2 g/m²/month	N/A	Annual
NO_2	226 µg/m³ 56 µg/m³	N/A	N/A	1-hour Annual
CO	10,260 µg/m³	N/A	N/A	8-hour

a. Ambient Air Quality NEPM

b. NSW DECCW criterion

c. EPA Vic. Mining PEM

N/A: Not applicable

7. Air Emissions

The generation of dust emissions is dependent on the intensity of mine construction and operations and the volume of material to be extracted, handled and processed. For this reason it is necessary to define the expected construction and the ongoing mining operations at the site, which include, but are not limited to:

- details of project activities including sequencing and timelines;
- vehicle and plant type;
- patterns of movement and shift timing; and
- power station emissions.

Given the evolving nature of mine planning, this assessment is based on a selected mine stage that represents the worst potential impact due to estimated maximum emissions.

7.1 Emission Sources and Pollutants

7.1.1 Construction Emissions

As discussed in section 5.3, the most important air pollutant emitted during mine construction, including the mine pit, ore processing plant and conveyor system, is anticipated to be dust (TSP, PM_{10}, and $PM_{2.5}$) due to the disturbance and clearing of land. Refer to section 4.1 for more detail regarding construction activities.

In addition to particulate matter, minor quantities of vehicle, mobile and fixed plant exhaust emissions during the construction phase, such as NO_X, CO and trace quantities of VOCs, are expected to have a negligible impact on regional air quality. This is due to the several factors including the short-term, transient and spatially variable location of emission sources, the paucity of sensitive receptors in the region, the separation of sensitive receptors from the emissions sources and the low background concentrations of gaseous pollutants.

Activities which will generate emissions during construction of the Mt Todd mine include, but are not limited to:

- hazard or ‘fuel’ reduction burning;
- excavating and levelling of disturbed surfaces;
- handling and localised stockpiling of soil and overburden;
- localised welding, cutting and grinding (includes fumes);
- vehicles driving on unsealed roads and unconsolidated soil surfaces including delivery of materials;
- blasting;
- wind erosion of exposed unstable soil and stockpiles; and
- power plant emissions (particulates and fumes).

7.1.2 Operational Emissions

Mining Operations

In a similar manner to that of construction emissions, the most important emissions associated with the mine's operation will be dust generated by many different processes. These include, but are not limited to:

- wind erosion of unconsolidated exposed and open surfaces, including stockpiles;
- hazard or 'fuel' reduction burning;
- overburden removal;
- loading ore onto haul trucks;
- wheel generated dust from vehicles on unpaved roads (mine haul roads);
- wheel generated dust from vehicles on paved roads (access roads and ore processing area);
- dumping of ore at ROM (run of mine) pad stockpile;
- primary and secondary crushing;
- screening;
- conveyor transfer points between different process stages;
- motor vehicle exhaust; and
- heating and power generation.

Tailings Storage (TSF)

During operation, the moisture content of the mine tailings in storage facilities TSF1 and TSF2, as detailed in section 4.5.2, is expected to result in negligible dust emissions. While the drying of the TSF material may produce a hard crust on the surface by the end of the dry season, dust emissions from these areas are expected to remain very low as the surface will not be mechanically disturbed.

Dust emissions during the construction and/or modification of the TSFs are assumed to be caused by bulldozer operations. Dust emissions generated through wind erosion of exposed surfaces will be minimised using dust management practices to be outlined in the site Dust Management Plan. Dust management techniques may comprise the use of water sprays and the re-vegetation of exposed surfaces, as discussed further in section 12.

Based on supplied information and site drawings, the construction of an expanded TSF1 and a second TSF (TSF2) is to be undertaken in stages by increasing the height of the earth dam wall as additional capacity is required. Dust emissions associated with this process were estimated based on a bulldozer operating during daytime hours (i.e. 6 am to 6 pm) and the unloading of waste rock from the pit to build up the TSF walls.

Power Generation

On site power will be generated from a single gas-fired turbine and two gas-fired reciprocating gas engines (section 4.3.1). The key combustion related air pollutants emitted from the power plant are NO_X (as NO_2) and CO. Emissions of fine particles ($PM_{2.5}$) and VOCs are expected to be negligible and contribute only a very small fraction to the ambient environment. Consequently, the assessment of potential air quality impacts associated with the power station has focussed on emission of NO_2 and CO.

7.2 Conditions for Worst Case Dust Emission Generation

The assessment of potential impact to air quality associated with the project has been based on emissions estimated under worst case dust generation conditions. Air quality criteria are designed to assess impacts of the maximum allowable emissions.

Worst-case dust generation and impact is most likely to occur under the following conditions:

- when rainfall is at a minimum (dry season);
- construction or operational activities are at a peak; with
- additional particles from vegetation burning (higher regional background levels); and
- when winds are light and stable, leading to poor dispersion of dust emissions from operational activities; or
- when winds are stronger and hence able to both:
  - generate higher emissions through dust lift-off; and
  - transport larger particles for a greater distance before settling.

When two or more of these conditions coincide there is potential for dust emissions to cause an impact beyond the boundary.

7.3 Considerations and Assumptions in Emission Inventory Development

An air emissions inventory of dust and other gaseous constituents for the Mt Todd mine and power plant was developed for the first 10 years of production with the year of maximum production and worst case potential for dust generation determined to be year 3 of the mine plan. This inventory is summarised in Table 8. For the mine during the operational phase, total dust emissions were estimated according to the mining process and activity rates outlined in Section 4, published emission factors for mining and based on a nominal total quantity of earth moved of 102.169 Mt. Emissions factors were sourced from the following documents:

- NPI Emission Estimation Technique Manual for Gold Ore Processing Version 2.0 EETM NPI, Dec 2006;
- NPI Emission Estimation Technique Manual for Mining Version 3.1 EETM NPI Jan, 2012;
- US EPA AP-42, Heavy Construction Operation Guideline[4] (Section, 13.2.3, AP-42); and
- NPI Emission Estimation Technique Manual for Combustion Engines Version 3.0 EETM NPI Jun, 2008.

$PM_{2.5}$ emissions are not calculated directly from the NPI Emission Estimation Techniques Manuals (EETM). Alternatively they are calculated from the particle size distribution ratios for three identified distinct dust generation sources. The $PM_{2.5}$ distributions are detailed in section 8.5, and indicate that the ratio of $PM_{2.5}$ to TSP size fractions varies from 0.16 to 0.08 depending on the source.

Calculations for the emissions inventory are detailed in Appendix A.

Estimated dust emissions are directly proportional to the total amount of material extracted and moved through the process. The inventory indicated that total annual emissions of PM_{10}, accounting for the application of dust emission controls, was highest in year 3 and at least seven per cent higher than the second highest year. This estimate is based on a static nominal

[4] AP 42, Heavy construction operation guideline. www.epa.gov/ttnchie1/ap42/ch13/final/c13s02-3.pdf

mine plan and does not take into account the year-to-year variations based on the different stages of construction of the Tailing Storage Facilities and other augmentations of the mine plan. In addition, the overall project footprint including waste rock dump is likely to have a similar size footprint to the year modelled, with the exception of the mine pit.

Minor dust emission sources and sources that can be minimised using standard practice emission controls that were considered to contribute only a negligible proportion of total emissions were omitted from the inventory for assessment. Sources that were omitted included the construction of temporary facilities, permanent workshops, offices and pipelines. Drilling emissions were considered negligible due to the high level of dust mitigation that has become standard practice in the industry. Emissions associated with the HPGR were found to be minor as the belt feeds directly into the HPGR rather than entering via a transfer point[5] and dust emissions generated from paved roads were also omitted as the amount generated is negligible by comparison to emissions from unpaved roads and other mining operations.

Table 8 Estimated PM_{10} annual emissions for the first ten years

Production Year	Total Mined Earth Mined (Mtpa)	Total Ore Processed (Mtpa)	Estimated Annual PM_{10} Emissions (tonnes per year)
1	61.9	17.80	1,893
2	76.3	17.75	2,144
3	102.2	17.75	2,569
4	89.9	17.75	2,376
5	87.4	17.80	2,315
6	78.8	17.75	2,212
7	59.2	17.75	1,891
8	52.6	17.75	1,776
9	49.4	17.80	1,718
10	52.2	17.75	1,738
Average	71.0	17.76	2,063

The distribution of material moved around the mine site during Year 3, and used in the development of the emissions inventory, is summarised in Table 9.

Table 9 Year 3 Mining Schedule

Material Component	Year 3 (Mt)
Total Earth Moved	102.169
Total Ore Mined	23.971
Total to Processing Plant	17.750
Total To Ore Stockpile	6.191
Total to Waste or TSF construction	78.227

The emission inventory and dispersion model configuration was based on the following assumptions. These assumptions have been developed from process information supplied by Vista Gold and described in Chapter 2 of the EIS.

- Wind erosion of exposed areas and stockpiles was only considered for the dry season;
- Wind erosion was assumed to be wind speed dependent based on a total annual emission rate re-distributed as a function of the wind speed;

[5] Mt Todd Gold Project Engineering and Cost Study pg 8 AUSENCO Appendix E

- Water spray controls were applied to the loading, unloading and wind erosion of stockpiles. A control factor of 50 per cent was applied to the uncontrolled emissions of these sources as per the NPI Mining EET (2012, p.21) guidance;
- Blasting frequency, area and depth were developed in reference to assumptions made in previous projects. Emissions were calculated from a worst case assumption of blasts occurring everyday covering an area of 2,000 m^2 and a depth of 10 m. This allows the determination of predicted maximum daily impacts to be made accurately, without missing days. Blasting was assumed to be undertaken daily at 8 am, however, this will be confirmed during detailed mine plan development. Furthermore, any differences in predicted 24-hour average ground level concentrations of dust are expected to be negligible if blasting was to occur at other times of the day. An hourly variable emissions file was used to model blast emissions with the dust emissions for all hours except for the blast hour (hour 9 each day) set to zero;
- The assessment does not take into account any emissions from processing beyond the fine screening stage just prior to grinding and classification;
- It was assumed that all ore will be processed by the primary crusher, with 20 per cent of ore undergoing secondary crushing and coarse screening twice. Similarly, 20 per cent of HPGR ore was assumed to undergo screening for a second time[6];
- A dust emission control efficiency of 70 per cent was applied to the primary crushing, secondary crushing, screening and conveyor transfer operations. This was considered to be a conservative value as Vista Gold has not yet indicated whether water spraying or dust collection to a wet scrubber or fabric filter (i.e. a control efficiency of 99.5 per cent) would be used as the control method;
- The NPI (2012, p.62) dust emission estimation equation for primary ore crushing assumes an ore moisture content of at least four (4) per cent. The moisture content of the Mt Todd ore entering the primary crusher was considered to be relatively high at approximately 10 per cent. It is assumed that this will be achieved in the process by the application of water sprays should the ore moisture at any particular time fall below this level. During the wet season, it is expected that the ore moisture content would be higher than during dry season periods;
- The HPGR will operate without air conveying or classification. It is assumed that adequate controls will be applied to suppress at least 99 per cent of the potential dust;
- Pit retention factors of 5 per cent for PM_{10} and 50 per cent for TSP were applied to all processes which will occur in the mine pit as per the NPI (2012) guidance. Affected processes include blasting, loading mined material, wind erosion and haul road dust. The NPI (2012) equations do not have variable pit retention factors based on pit depth. It is conservatively (and simply) assumed that pits of 5 or 500 m deep will have the same retained amount of dust;
- Due to a lack of site-specific information, haul road dust emissions were calculated using the default surface silt content of 10 per cent and surface moisture content of 2 per cent (NPI, 2012). These assumptions, particularly for silt content and moisture content during the wet season, are considered to be conservative and provide an overestimation of haul road dust emissions;
- Emission mass rates from area sources were determined based on the appropriate emissions inventory data;

[6] Revision B Vista Gold Corp- Mt Todd Gold Project, Engineering and cost study – 11Mt/y option study 17 December 2010, Pg 8

- ROM, LGO stockpile and WRD areas were assumed fixed and at a maximum size estimated from the corresponding areas designated for year 12 operations. The specific emission rate (in g/s/m²) was changed based on the emission inventory specific for that year of operations;
- Haul routes were conservatively calculated from the proposed works with details provided in Appendix A;
- Dust emissions from light vehicles were considered negligible and were not modelled;
- Dust from sealed road surfaces was not modelled as the application of the NPI (2012, p.21) emission control factors for the mitigation of dust emissions on sealed haul roads provides a control factor of 100 per cent;
- Emissions for screening and transfer points within the ore crushing circuit were modelled as individual units as each of the units are connected by long conveyors – greater than 100 m. However, unloading the crusher or screen unit to a conveyor was included in that unit's emission factor in accordance with NPI (2012, p.62);
- Operational wind erosion emissions from the TSF were considered as negligible;
- A maximum dust emission control efficiency factor of 90 per cent was assumed for the unpaved haul roads. This emission control efficiency is based on the work of Kinsey and Cowherd (Buonicore and Davis, 1992, p.144) that showed that dust emissions from unpaved roads can be reduced by greater than 90 per cent by using chemical stabilisation. The chemicals generally have a petroleum resin basis, and need to be regularly re-applied. These generally do not have any adverse effects on the local environments; however, the specifics of each chemical should be assessed on a case-by-case basis prior to application;
- Loading of the re-claim stockpile was assumed to be undertaken with the application water spray controls to provide a nominal 50 per cent dust emission control efficiency. Dust emissions associated with a greater level of control, such as that achieved using a telescopic chute and variable height stacker were not modelled but will be considered during the detailed design phase;
- Water spray controls were assumed for truck unloading at the ROM and LGO stockpile. This gives a nominal 50 per cent reduction (NPI, p.21); and
- No dust controls were applied to the unloading of haul tracks at the WRD and TSF1 construction areas. As the areas of these sites are large, it is unreasonable to assume that water sprays can be applied to every variable location that a truck unloads.

Estimated maximum dust emission rates for mine operations in Year 3 are presented in Table 10. The calculation of the emission rates is detailed in Appendix A. The inventory indicates that during peak production periods, wheel generated dust comprises approximately 50 per cent of total annual PM_{10} emissions. The only other single source to exceed 10 per cent of the total inventory was unloading waste rock to the waste rock dump (11 per cent).

Construction of TSF1 will be undertaken during year 3 and therefore dust emissions have been estimated and assessed. The TSF2 is not scheduled to have construction commenced until year 5 of operations and consequently, it has not been included in the assessment of year 3 emissions. Emissions from the operation of one continuous bulldozer and the corresponding unloading of waste rock from the pit for its construction have been modelled. Unpaved haul road emissions associated with the movement of haul trucks transferring waste rock from the pit to TSF1 for construction have also been modelled.

Modelling assumed that the TSF1 operational area would remain wet and those constructed areas would have the exposed soil stabilised as quickly as practicable.

Table 10 Estimated Maximum Annual Controlled Dust Emissions for Mt Todd Mine Site Operations

Location of dust source	Dust emitting process	Estimated Emissions (tonnes/year)		
		$PM_{2.5}$	PM_{10}	TSP
Mine Pit	Blasting	1.0	3.5	3.6
	Loading mined material to trucks	19.9	62.5	69.9
	Wind erosion from mine pit	22.4	149.1	157.0
ROM pad	Loading Stockpile (50% water sprays)	16.0	37.3	106.5
	Wind erosion of ROM stockpile (50% reduction)	0.7	4.9	9.9
LGO Stockpile	Loading LGO Stockpile (50% water sprays)	5.6	13.0	37.1
	Wind Erosion Of LGO stockpile (50% reduction)	3.8	25.5	51.0
Waste Rock Dump	Wind Erosion of WRD (30% reduction – rock armour)	26.1	174.3	348.5
	Loading WRD	120.5	281.2	803.5
Haul Roads	Wheel Generated Dust (90% reduction chemical stabilisation)	649.3	1,277.7	2,706.9
	Wind Erosion of Haul Roads (50% reduction)	0.4	2.8	5.6
Processing Plant	Loading Primary Crusher (70% reduction as enclosed)	1.1	3.4	7.3
	Conveyor transfer points(1) (70% reduction for enclosure)	7.5	20.4	47.1
	Primary Crusher (75% reduction due to scrubbers)	7.1	17.8	44.4
	Secondary Crusher (1) (75% reduction due to scrubbers)	25.6	63.9	159.8
	Screening (75% reduction due to scrubbers)	70.9	332.3	443.0
	Wind Erosion of Coarse Ore Stockpile	0.2	1.2	2.3
	HPGR(1) (99% reduction as enclosed)	40.9	33.2	255.6
Tailings Storage Facility 1	Bulldozer Operation	11.2	17.9	74.5
	Waste Rock Unloading for Construction	20.3	47.3	135.3
Total		**1,030**	**2,569**	**5,469**

(1) Includes total values for material which is oversized and reprocessed.

7.3.1 Emissions from Power Generation

Emissions associated with power generating equipment were calculated from vendor supplied data provided by Vista Gold. Power generation will be provided by:

- A single Rolls-Royce Trent 60 Wet Low Emissions gas turbine generator; and
- Two MAN 20V35/44 gas-fired reciprocating engines.

Emissions were calculated assuming that all equipment is operating at full capacity, i.e. a total of 76 MW electricity generation, 24 hours per day, 365 days per year.

The Trent 60 Wet Low Emissions single gas turbine generator does include capacity to reduce NOx emissions.

Nominal flue gas stack exit conditions are summarised in Table 11.

Table 11 Stack Source Characteristics used in the Modelling Assessment

Parameter	Units	Gas turbine	Reciprocating engines
Model	--	Rolls-Royce Trent 60	MAN 20V35/44
Number of units assessed	--	1	2
Number of discharge points	--	1	1
Stack height	m	21.3	21.3
Stack exit plane diameter	m	3.05	1.83
Stack exhaust exit plane velocity	m/s	48.3	12.5
Stack exhaust temperature	^{o}C	422	298
Mass flow rate	kg/s	166	N/A
Emission controls	--	NO_X – Wet Low Emissions Technology	None

N/A: Not available

Modelled power plant emission rates of NO_2 and CO are presented in Table 12. An NO_2 to NOx ratio of 30 per cent was assumed for the modelling.

Table 12 Stack Emission Rates used in the Modelling Assessment

Pollutant	Gas turbine	Reciprocating engines
Nitrogen dioxide [a] (g/s)	1.84	2.32
Carbon monoxide (g/s)	6.69	4.66

[a] NO_2 was calculated from vendor supplied NOx, assuming an NO_2 : NO_x ratio of 30 per cent for a conservative approach.

8. Modelling Methodology

The impact assessment was conducted using EPA Victoria's AUSPLUME (Version 6.0) dispersion model to simulate plume transport and predict ground level pollutant concentrations and dust deposition for the estimated worst case operational emissions. AUSPLUME was used to model the dispersion of fugitive dust emissions from the mine and stack emissions of fuel combustion products from the power plant.

8.1 Model Configuration for Assessment of Mine Fugitive Dust Emissions

The AUSPLUME model configuration is summarised below. Further detail is given in the sample AUSPLUME output text file, shown in Appendix C.

Model:	AUSPLUME Version 6.0
Meteorology:	Representative of the mine site (see section 5) for the period September 2007 to August 2008
Emission rates:	Time varying
Receptor Grid:	15 km x 15 km, grid interval 300 m (N/A for deposition – discrete receptors only)
Nearest Sensitive Receptor:	Werenbun Community (193,545 mE, 8,430,319 mN);
Surface Roughness:	Zo = 0.1 m flat rural
Terrain:	Not required – relatively flat terrain. Note: surface and volume sources in AUSPLUME ignore terrain.
Dry Plume Depletion:	No depletion options applied.
Particle Size Distribution:	See Section 8.5.

8.2 Model Configuration for Assessment of Power Station Stack Emissions

The AUSPLUME model configuration to assess the impact associated with three stacks combined is summarised below.

Meteorology:	Representative of the mine site (see section 5) for the period September 2007 to August 2008
Receptor Grids:	1 km x 1 km Cartesian gridded receptors with 25 metres increments; and 19.6 km x 27.44 km Cartesian gridded receptors with 280 m increments
Surface Roughness:	Zo = 0.1 m flat rural
Terrain:	Not required – relatively flat terrain in the near-field
Emission Rate:	See Section 7.3.1 and Appendix B.
Stack Source Characteristics:	See Section 7.3.1 and Appendix B.

8.3 Model Limitations

AUSPLUME model predictions are subject to the inherent limitations of a Gaussian dispersion model. Dispersion and predicted ground level pollutant concentrations from one hour do not contribute to the predicted concentrations of subsequent hours. Furthermore, the effect of potential alterations to the landscape by the construction of both the open cut mine pit and the WRD on the local wind effects is not modelled.

8.4 Source Characterisation

Emissions rates for area and volume sources are detailed in Appendix B. All source initial dispersion characteristics were modelled based on the AUSPLUME model guidance. This equated to volume initial source emission dispersion being equal to one quarter of the relevant dimension. Modelled areas, not the actual mine surface areas, are provided for area sources in Appendix B.

A variable emissions file was created to model emissions associated with blasting once per day, wind speed dependent wind erosion during dry months and no wind erosion during wet season months for the years 2007-08. The wet season was determined to extend over the period 1 December 2007 to 31 March 2008 inclusive.

8.5 Particle Size Distribution

In order to model dust deposition, which is based on emission rates of TSP, the particle size distribution must be specified. The model algorithms then simulate the fall velocities, with the coarser particles settling out from the dust plume at shorter distances and under higher wind speeds than the finer fractions. There are nominally three sources of dust from the site. These sources are from unprocessed/stockpiled ore, process ores and wind erosion from exposed surface areas.

To give a representative pattern of dust deposition from the site, particle size distributions for TSP were applied across the three sources (Table 13). These distributions are based on US EPA references.

TSP was only modelled up to a size of 50 µm. This is based on two factors, 1) large particles fall out close to the source and are therefore unlikely to cause an impact beyond the mine site boundary; and 2) TSP is defined under Queensland air quality regulations for the purpose of assessing air quality as having a mean EAD of *not more than 50 microns* (Air EPP 2008, p.11).

Table 13 Particle Size Distributions of Modelled TSP

Range (µm)	Mean Size (µm)	Unprocessed Ore [(a)] Mass Fraction	Processed Ore [(b)] Mass Fraction	Wind Erosion [(c)] Mass Fraction
0 to 2.5	1.25	0.15	0.16	0.08
2.5 to 6.0	4.25	0.19	0.21	0.27*
6.0 to 10	8.0	0.17	0.25	0.16*
10 to 50	30	0.49	0.38	0.50
Total		1.00	1.00	1.00

(a) US EPA Document EPA-450/4-86-013 July 1986, Table 3-2, p.22.

(b) US EPA Document EPA-450/4-86-013 July 1986, p.A-7.

(c) US EPA AP-42 Industrial Wind Erosion, Chapter 13.2.5, Equation 2.

***** Distribution derived from unprocessed ore distribution.

9. Air Quality Assessment

9.1 Predicted Maximum Ground Level Dust Concentrations

The predicted maximum incremental and cumulative ground level concentrations of TSP, PM_{10} and $PM_{2.5}$ for year 3 of mine operations are presented in Table 14

Table 14 Summary of Maximum Predicted Dust GLCs for Operational Year 3

Air Quality Indicator	$PM_{2.5}$		PM_{10}	TSP
Averaging Period	24 hours	Annual	24 hours	Annual
EPA Victoria Mining Criterion (µg/m^3)	36	-	-	-
NEPM Criterion (µg/m^3)	25	8	50	90
Background (µg/m³)	11.2	11.2	20.8	42
Compliant at Site Boundary	N/A*	N/A	N/A	N/A
Incremental @ Werenbun Community GLC (µg/m³)	21.6	1.4	49.7	6.9
Total @ Werenbun Community GLC (µg/m³)	32.8	12.6	70.5	48.9
% of Criterion at Werenbun Community	131	157	141	54
Incremental @ Katherine (µg/m³)	5.6	0.3	12.6	1.4
Incremental @ Pine Creek (µg/m³)	7.4	0.8	17.4	3.9

*N/A – the NEPM criteria for dust to be met at the site boundary may not be applicable in the Northern Territory. This must be determined by the appropriate regulator in NT.

The assessment found that maximum cumulative ground level dust concentrations are predicted to comply with air quality criteria at sensitive human receptor locations for the annual average of TSP only. The cumulative annual average ground level concentration of TSP at Werenbun is predicted to be about 54% of impact assessment criteria, while the incremental impact is predicted to be very low at 16% of the assumed background concentration and less than 8% of the criteria.

The maximum cumulative 24-hour average ground level concentrations of PM_{10} and $PM_{2.5}$ are predicted to exceed the Air NEPM standards of 50 µg/m³ and 25 µg/m³, respectively at the Werenbun community centre due to high estimated dust emissions at the mine. While PM_{10} and $PM_{2.5}$ ground level concentrations are predicted to be relatively high at Werenbun the highest concentrations associated with mine emissions in isolation are expected to meet the air quality standards. The frequency of exceedences has been examined in detail in an Environmental Risk Assessment (ERA), detailed in section 10.

Notwithstanding the predicted exceedence of the Air NEPM standard of $PM_{2.5}$ for the maximum 24-hour average ground level concentration, the annual average ground level $PM_{2.5}$ concentration at Werenbun is predicted to exceed the Air NEPM advisory standard due to a very high background concentration of 11.2 µg/m³ that is 140% of the standard of 8 µg/m³. It should be noted that the predicted incremental annual average ground level concentration of $PM_{2.5}$ is very low at less than 18% of the standard and less than 13% of the background.

Predicted maximum 24-hour average ground level concentrations of PM_{10} at the site boundary and across the local area are illustrated as a concentration contour isopleth in Figure 11. This figure indicates that the predicted highest concentrations of PM_{10} occur to the northwest of the mine emission sources due to the dominant southeast trade winds.

The assessment has also found that the Gouldian Finch habitat at the Yinberrie Hills (to the west of the Batman Pit) has the potential to be exposed to predicted maximum 24-hour ground level concentrations of PM_{10} of greater than 200 µg/m³, including background of 20.8 µg/m³.

As detailed in the assessment methodology, the dispersion modelling assessment is based on a complex series of assumptions. As the mine footprint is mobile, dust emission sources are temporally and spatially variable and meteorological conditions are also highly variable, a direct assessment of ground level concentrations at fixed locations such as the mining lease boundary and sensitive receptors over the life of the mine is difficult to achieve. The potential risk of environmental impacts is discussed in section 10, while mitigation measure and dust emissions management is detailed in section 11.

9.2 Predicted Maximum Dust Deposition Rates

In the absence of measured regional dust deposition rate information, the assessment of deposited dust has been made against the incremental annual average impact assessment criterion of 2 g/m^2/month. The assessment found that the incremental dust deposition rate was predicted to meet the impact assessment criterion at the sensitive human receptors, as shown in Figure 12. This is based on model predictions that ignore the dry depletion of particles and consequently, can be considered to be a conservative estimate. The inclusion of the dry depletion option in the model is expected to further reduce predicted deposition rates beyond the lease boundary. Furthermore, wet removal of process generated dust, i.e. ore loading and crushing operations, during the four wet season months has also not been modelled. It is highly likely that the inclusion of wet depletion will significantly reduce the annual average deposition rates in key sensitive areas as illustrated in Table 12.

At the nearest sensitive receptor, the Werenbun community, the incremental deposition rate was predicted to be 0.4 g/m^2/month, without the inclusion of dry and wet depletion. This value is expected to be a conservative upper limit as dust depletion through wet removal mechanisms is expected to be large during the wet season.

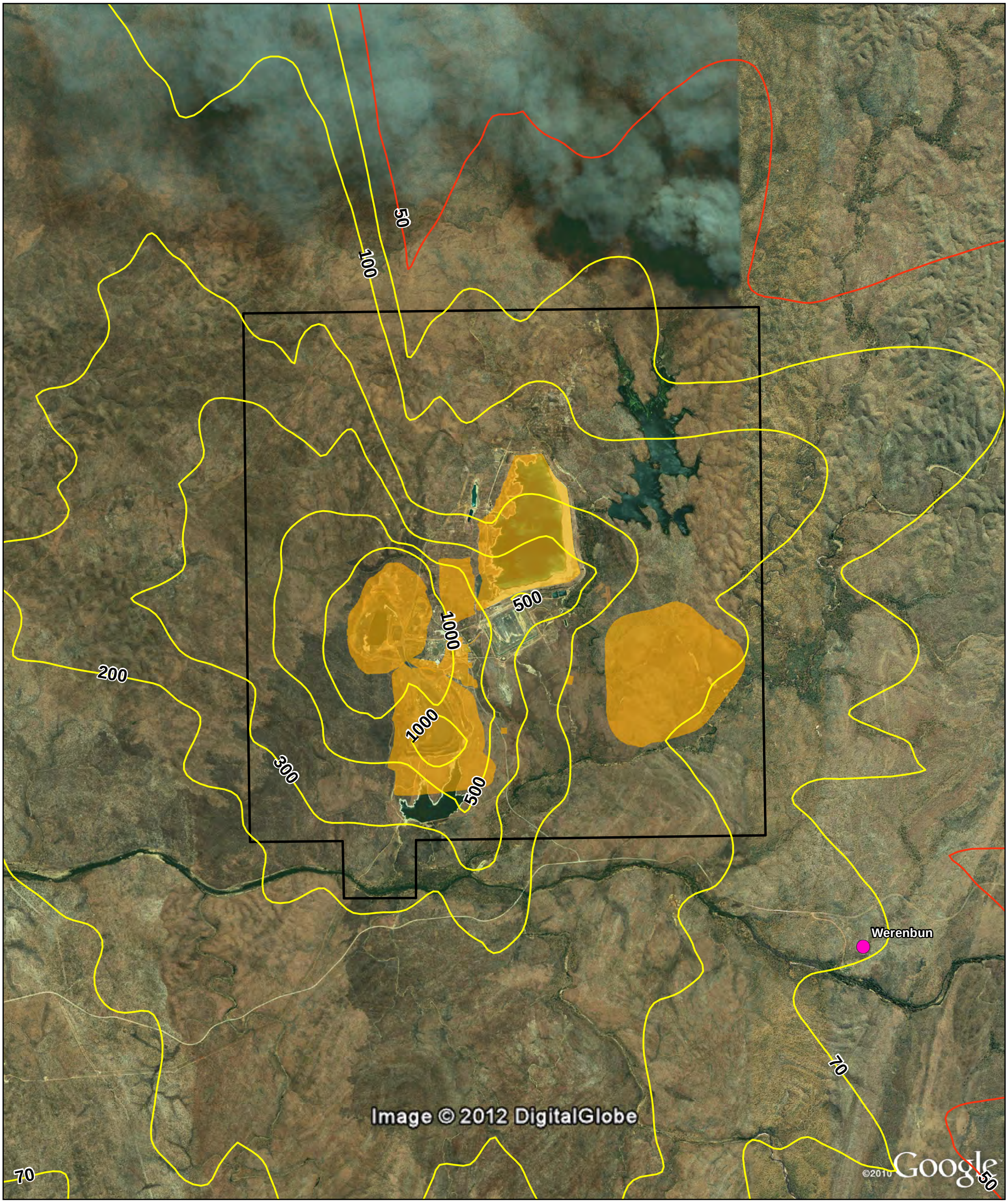
The Gouldian Finch habitat in the Yinberrie Hills area to the west of the Batman Pit is predicted to have the highest deposition rates due to the prevailing southeast trade winds. Dust impacts at sensitive places can be managed through the implementation of a Dust Management Plan.

9.3 Predicted Maximum Ground Level Concentrations of Nitrogen Dioxide and Carbon Monoxide

The predicted maximum 1-hour (Figure 13) and annual average ground level concentration of NO_2 and 8-hour average ground level concentration of CO at any location beyond the mine site boundary is presented in Table 15. The predicted maximum ground level concentrations at the nearest sensitive receptor, the Werenbun community, are well below the Air NEPM standards.

Table 15 Predicted Maximum Ground Level Concentrations of NO_2 and CO in the region

Constituent	Averaging Time	Predicted Peak GLCs (µg/m³)	NEPM Air Quality Criteria (µg/m³)	Percentage of Criterion (%)
CO	8 hours	15.7	10,260	0.2
NO_2	1 hour	11.8	226	5.2
	1 year	0.8	56	1.4



LEGEND

- Sensitive Receptors
- Concentration ug/mg^3 (Criterion 50 ug/m^3)
- Criterion 50 ug/m^3
- Mineral Lease
- Emission Sources

0 0.5 1 1.5 2
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 53

N

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Predicted GLC for the 24-hour PM10 - With Background (20.8 ug/m^3)

Job Number	43-21801
Revision	1
Date	05 Jun 2013

Figure 11

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66 Smith Street Darwin NT 0800 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drwmail@ghd.com **W** www.ghd.com.au

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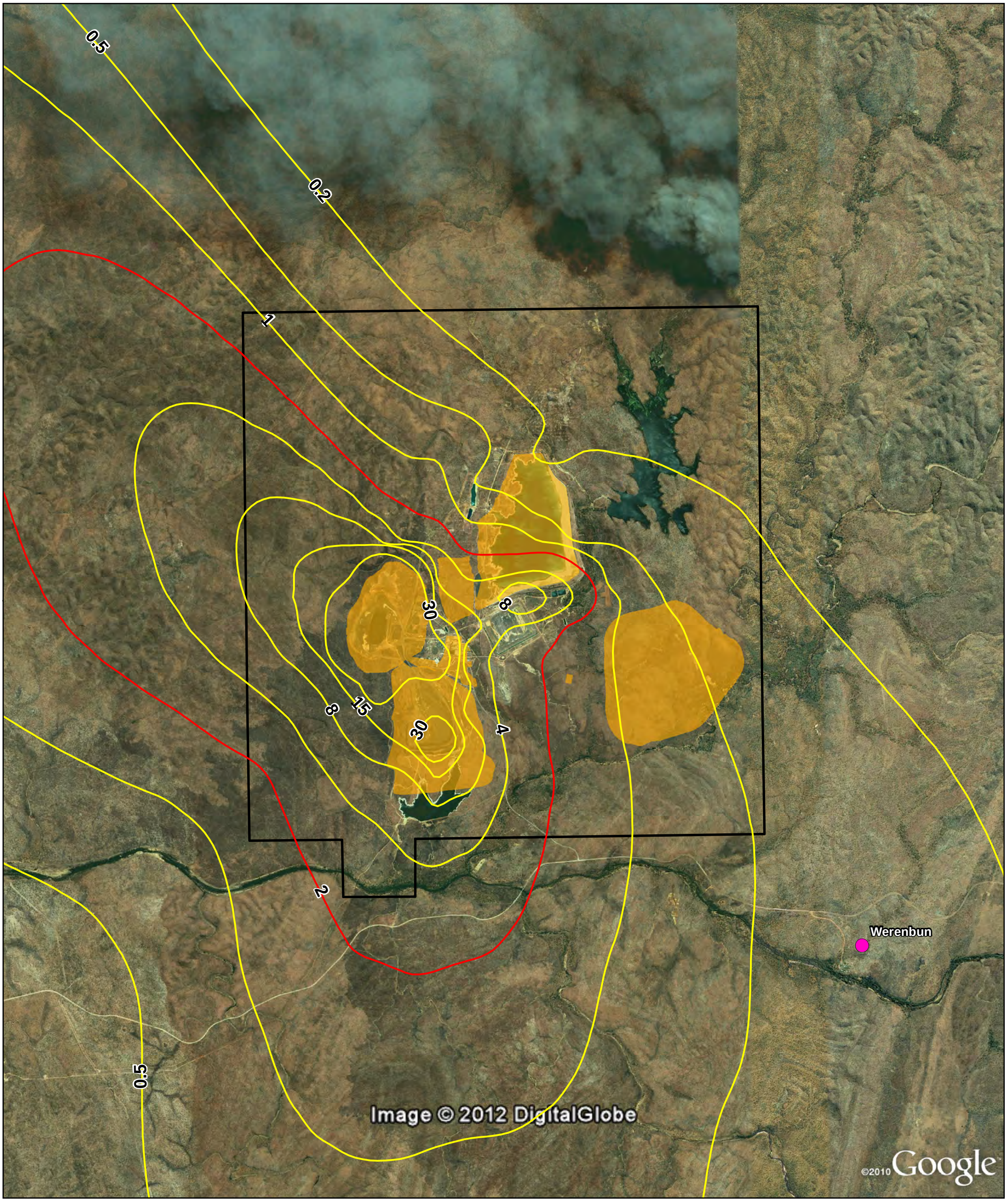
Data source: NRETAS - Mineral Lease (2011). Tetra Tech - Emission Sources (2013). Google Earth Pro - Imagery (Date extracted: 11/05/2012). GHD - Ground Level Concentration (2012). Created by: CM



LEGEND

- Sensitive Receptors
- Mineral Lease
- Deposition g/m^2/month
- Emission Sources
- Criterion 2 g/m^2/month

0 0.5 1 1.5 2
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 53

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Job Number 43-21801
Revision 1
Date 05 Jun 2013

Predicted Incremental Annual TSP Deposition Rate (g/m^2/month)

Figure 12

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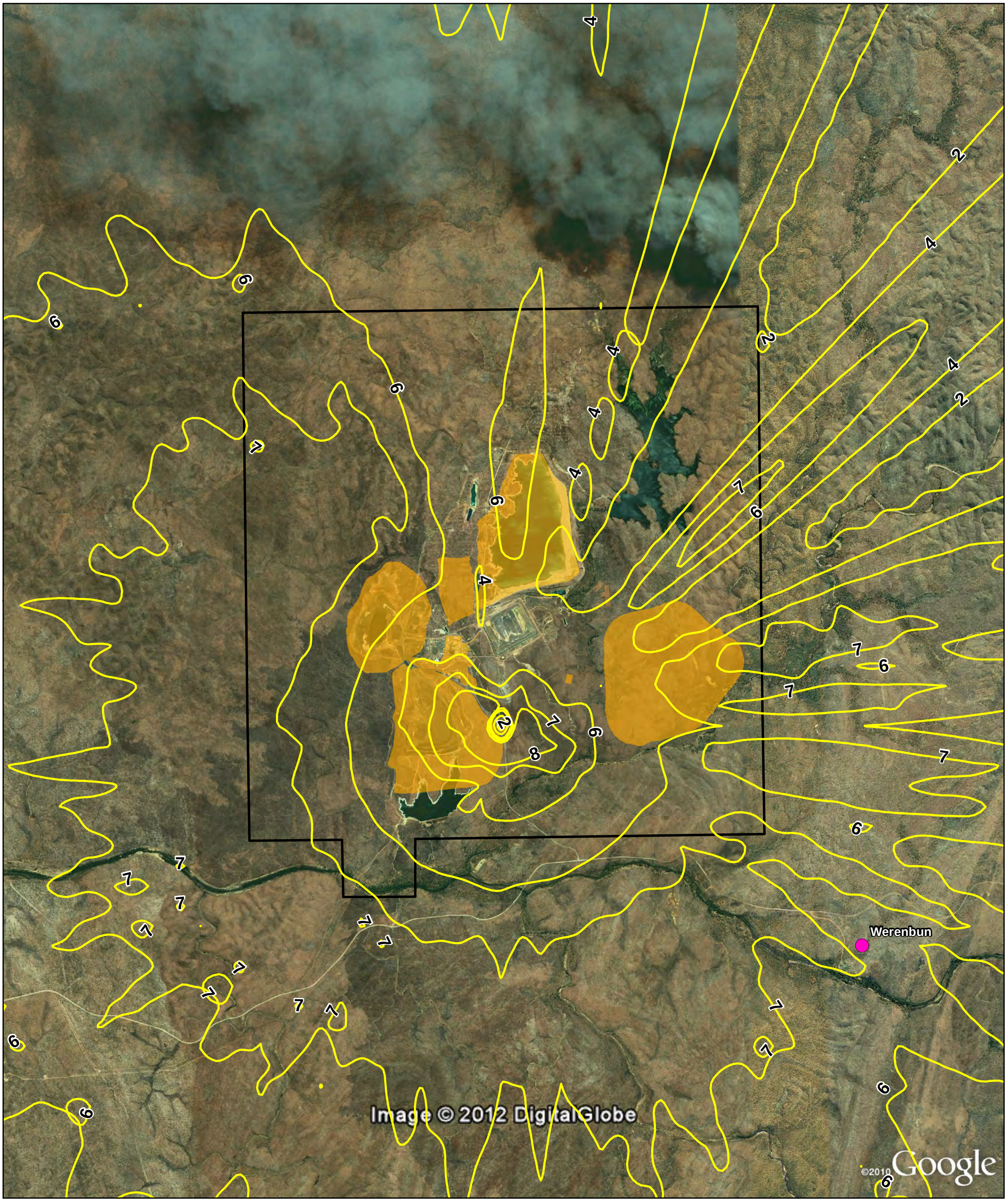
Data source: NRETAS - Mineral Lease (2011). Tetra Tech - Emission Sources (2013). Google Earth Pro - Imagery (Date extracted: 11/05/2012). GHD - Deposition Rate (2012). Created by: CM



LEGEND

Sensitive Receptors

Concentration ug/m^3 (Criterion = 226 ug/m^3)

Mineral Lease

Emission Sources

0 0.5 1 1.5 2

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 53

N

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Job Number 43-21801
Revision 1
Date 05 Jun 2013

Predicted Maximum 1-Hour Average NO2 GLC Contours. Criterion = 226 ug/m^3

Figure 13

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Data source: NRETAS - Mineral Lease (2011). Tetra Tech - Emission Sources (2013). Google Earth Pro - Imagery (Date extracted: 11/05/2012). GHD - NO2 Concentration (2012). Created by: CM

10. Environmental Risk Assessment

An environmental risk assessment (ERA) was undertaken to investigate the frequency and magnitude of predicted exceedences of the Air NEPM standards of PM_{10} and $PM_{2.5}$ at the Werenbun community receptor. The use of the ERA approach is prescribed in both the NSW and Victorian air quality regulations. Through an examination of the causes of, and the degree of, exceedences of the assessment criteria, an ERA assesses and assigns a level of risk to the overall impact of the project in regard to air emissions. The approach and methodology of the ERA are detailed in Appendix D.

10.1 PM_{10} Impact at Werenbun

The air quality assessment found that the air pollutant of most concern due to exceedences of the Air NEPM standard is PM_{10}. While the Air NEPM standards are designed to be applied to average ambient concentrations monitored across a regional network that covers an urban airshed with a population of greater than 25,000 people, the PM_{10} criteria of 50 µg/m³ has been adopted as an air quality objective in the Queensland *Environmental Protection (Air) Policy* and an impact assessment criterion in the NSW *Approved Methods for the Modelling and Assessment of Air Pollutants*. Consequently, the application of the Air NEPM standard of PM_{10} in this assessment is considered to be able to provide guidance on environmental impact despite the standard really being for a monitoring assessment rather than a modelling assessment.

Notwithstanding the suitability of the Air NEPM standard for PM_{10}, the assessment criterion of $PM_{2.5}$ is promulgated in the Air NEPM as an advisory standard, and consequently, it is not considered appropriate that it be used with equal weighting to assess the impact to air quality. This is particularly relevant as the annual average background level of $PM_{2.5}$ used in the cumulative impact assessment already exceeds the Air NEPM advisory standard. Furthermore, $PM_{2.5}$ impacts are mostly concerned with particulate matter generated from combustion processes, i.e. diesel engines, as opposed to mechanically generated crustal dust.

The Air NEPM standard of PM_{10} has an allowance of 5 days exceedence per year. These five days are to take into account extreme events such as bush fires and dust storms. They are not an allowance for an operation to design a management plan to have five exceedences of the criterion. Best practice environmental management must still be undertaken by the mine operators.

Further AUSPLUME modelling was carried out to assess the sensitivity of dry particle depletion on ground level concentrations of PM_{10} at the Werenbun receptor. Particle depletion is also commonly known as dust settling or fallout. Large particle size fractions fall out of the plume closer to the source, and therefore will not travel the distance from the mine to the Werenbun community.

The initial assessment presented in section 9 provided maximum ground level concentrations without dry depletion configured in the model due to the prohibitive computational times for the calculation of particle depletion for a large number of gridded receptors. For this assessment, only a single receptor has been modelled at Werenbun and consequently, dry particle depletion could be easily included. The 20 highest ranked 24-hour average ground level concentrations of PM_{10} are presented in Table 16 for the modelling with and without dry depletion. The results for the without depletion option are included here for consistency with the results presented in Table 14.

The assessment indicates (Table 16) that five exceedences of the Air NEPM standard of PM_{10} are predicted at Werenbun when dry depletion is taken into account. By comparison, seven exceedences of the Air NEPM standard of PM_{10} are predicted at Werenbun when dry depletion is ignored.

Table 16 Ranked GLC of 24 hour averaged PM_{10} at Werenbun

Rank	With Particle Depletion			Without Particle Depletion		
	Incremental Impact (µg/m³)	Total Impact (µg/m³)	Date	Incremental Impact (µg/m³)	Total Impact (µg/m³)	Date
1	44.2	**65.0**	17 Feb 2008	49.7	**70.5**	17 Feb 2008
2	43.8	**64.6**	18 Feb 2008	49.6	**70.4**	18 Feb 2008
3	33.1	**53.9**	15 Jan 2008	36.5	**57.3**	15 Jan 2008
4	31.1	**51.9**	23 Feb 2008	35.3	**56.1**	23 Feb 2008
5	29.7	**50.5**	16 Jan 2008	32.9	**53.7**	24 Jan 2008
6	26.6	47.4	24 Feb 2008	32.0	**52.8**	16 Jan 2008
7	26.5	47.3	17 Jan 2008	31.2	**52.0**	30 Dec 2007
8	26.2	47.0	30 Dec 2007	29.1	49.9	24 Feb 2008
9	25.8	46.6	24 Jan 2008	28.5	49.3	17 Jan 2008
10	24.4	45.2	31 Dec 2007	28.1	48.9	31 Dec 2007
11	22.5	43.3	6 Feb 2008	26.6	47.4	28 Dec 2007
12	21.2	42.0	3 Feb 2008	24.9	45.7	6 Feb 2008
13	21.1	41.9	28 Dec 2007	24.0	44.8	28 Oct 2007
14	20.8	41.6	28 Oct 2007	24.0	44.8	3 Feb 2008
15	18.1	38.9	14 Feb 2008	20.6	41.4	25 Nov 2007
16	18.0	38.8	25 Nov 2007	20.4	41.2	14 Feb 2008
17	17.0	37.8	2 Jan 2008	19.6	40.4	2 Jan 2008
18	16.8	37.6	7 Oct 2007	19.4	40.2	7 Oct 2007
19	16.3	37.1	22 Feb 2008	18.1	38.9	23 Jan 2008
20	15.9	36.7	23 Jan 2008	18.0	38.8	1 Feb 2008

Background = 20.8 µg/m³

NEPM Criterion = 50 µg/m³

10.2 PM_{10} Exceedence Times

The 12 highest ranked 24-hour average ground level concentrations of PM_{10} at the Werenbun community are all predicted to occur during the months of December, January or February. This coincides with a shift in the prevailing southeast wind to the northwest due to the wet season monsoon. Also associated with these months is a significant amount of rainfall. Rainfall has not been accounted for in the modelling assessment except in the removal of dust emissions associated with wind erosion of exposed surfaces during the wet season months. Mechanically generated dust from crushers and haul truck movement has not taken into consideration rainfall and moisture conditions during the wet season. Notwithstanding the general changes in meteorological conditions during the wet season, worst case assumptions have been applied, as it cannot be assumed that a northwest wind will always deliver significant amounts of rain.

In regard to model assumptions, the wet season will assist in the removal of mechanically generated dust through the mechanism known as wet depletion or wet deposition. This has not been modelled. The inclusion of dry depletion was found to reduce the maximum incremental impact by 5.5 µg/m³. Consequently, it is reasonable to expect that the wet depletion mechanism will remove at least an equivalent amount of dust. Therefore, this will result in only two days of exceedences of the PM_{10} standard per year. This is likely to be well within the requirements of the Air NEPM PM_{10} standard as the predicted highest incremental ground level concentrations of PM_{10} at Werenbun occur during the wet season when background dust levels are likely to be relatively low due to moist soil conditions and no seasonal vegetative burning.

In addition, significant rain events are also likely to enhance dust controls such as water sprays that are already being applied. Notwithstanding this, the NPI (2012) and other regulatory authorities do not provide guidance on the characterisation, control and assessment of dust emissions in monsoonal conditions. Consequently, the modelling assumptions made in this assessment are considered to be highly conservative and likely to provide for the overestimation of dust emissions.

10.3 Assessment of Risk Level

The application of the risk matrix presented in Appendix D, and using the results in Table 16, indicates that the level of risk associated with dust emissions at the Werenbun community is ranked as "**Low**" for both methods of modelling, i.e. with and without dry particle depletion.

11. Interpretation of Assessment Findings

The air quality assessment found that the air quality standards for the protection of human health, of the key air pollutants for the study PM_{10} and $PM_{2.5}$, have the potential to be exceeded at the Werenbun community between two and seven times per year. Notwithstanding this, the findings were also found to be extremely sensitive to a variety of important assumptions made in the modelling assessment, and that depending on assumptions made to determine the existing background it is highly likely that air quality standards of PM_{10} and $PM_{2.5}$ would be met. This is due to a combination of ambient environment and site conditions.

During the wet season northwest winds due to monsoon wind patterns, and increased rainfall, surface and soil moisture is likely to reduce natural dust emissions sources and ambient dust concentrations. Consequently, a reduction in the cumulative dust impact of the project at Werenbun is expected.

The mitigation measures assumed in this modelling, in particular the use of chemical stabilisation and dust suppression agents on all active haul roads to achieve an emission reduction of greater than 90 per cent, were found to be insufficient as the Air NEPM standards were exceeded at the Werenbun sensitive receptor. Notwithstanding this, all of the predicted peak dust impacts at the Werenbun community occur during the wet season months, when the prevailing southeast wind turns to the northwest. During the wet season, it is highly likely that the winds will be associated with a significant amount of rainfall and therefore the generation of dust is likely to be significantly lower than the conservative values estimated for this assessment. There is no current guidance documentation as to how to characterise emissions and emission controls during monsoonal events. In addition to this, proactive and interactive dust management strategies can be implemented to minimise dust emissions during worst case conditions, in order to reduce the impacts on the days when the highest concentrations are predicted.

The influence of the wet season meteorological conditions to cause elevated ground level concentrations is further supported by the findings for the incremental annual averages of TSP, $PM_{2.5}$ and deposited dust. While the wind primarily blows from either the southeast or northwest, the incremental annual averages of these fractions were predicted to be very low. This indicates that there may be some extraordinary conditions that occur periodically that cause the highest ground level concentrations, with average conditions causing only a minor impact. By identifying and managing the mining process and meteorological conditions under which the highest ground level concentrations occur, compliance with all air quality standards can be achieved.

It is also noted that the predicted exceedence of the annual average standard of $PM_{2.5}$ is due to the very high background concentration adopted for this assessment. In the absence of a complete site-specific monitoring station dataset, the reported 75th percentile 24-hour average background concentration of $PM_{2.5}$ at Casuarina was adopted for the annual average background. This is considered to be conservative, particularly as the background concentration exceeds the standard by 40 per cent. The predicted annual average of TSP was found to emphatically comply at 54 per cent of the assessment criterion.

In regard to the assessment of PM_{10} in sensitive ecological areas that are not inhabited by humans, it is not clear that the Air NEPM standards apply. A more appropriate approach to manage air quality in the areas surrounding the mining lease may be sought through the application of the EPA Victoria *Protocol for Environmental Management 2007* (PEM) for Mining and Extractive Industries. This is discussed further in Section 12.

Figure 11 shows that predicted maximum 24-hour average ground level concentrations of PM_{10} during maximum mining activity are predicted to exceed the Air NEPM standard at significant distances from the site boundary to the northwest and south-southeast. These impacts will be managed through the implementation of a site Dust Management Plan to identify the worst case conditions and alter production and control methods to minimise ground level concentrations in sensitive areas.

12. Mitigation Measures

12.1 Dust Controls Assumed in the Assessment

Dust mitigation measures assumed in the modelling include:

- chemical stabilisation of haul roads to achieve a 90 per cent emissions reduction;
- regular water spraying of stockpiles to achieve a 50 per cent emissions reduction;
- water spraying while loading and unloading of stockpiles and processing equipment, including conveyor transfer points, i.e. primary crusher, to achieve a 50 per cent emissions reduction as indicated as the maximum allowable in NPI (2012). However, it is expected that water spraying during these activities will result in an 80 per cent reduction. The more conservative NPI (2012) control factor has been applied to the modelling;
- application of water to the ore prior to crushing to obtain a minimum moisture content of 4 per cent;
- hooding of crushers with a dust collection system capable of achieving a 75 per cent emissions reduction; and
- enclosure of the HPGR to achieve a 99 per cent emissions reduction.

12.2 Proposed Additional Dust Control Measures

Further mitigation measures can be progressively implemented as required to meet required air quality objectives. The following mitigation measures, either individually or in combination, are available:

- all construction and maintenance equipment/vehicles to be operated and maintained to manufacturers' specifications in order to minimise exhaust emission;
- defined haul routes to be used wherever it is necessary for vehicles to traverse unsealed surfaces or unformed roads;
- all gravel roads to and from the Project location can be upgraded from gravel to a spray sealed surface of "all weather" road designation;
- vehicular speeds can be limited to 25 km/h on areas of unconsolidated or unsealed soil associated with the Project;
- watering of exposed stockpiles and ROM surfaces as required;
- water spraying onto roads to suppress dust using a water cart;
- application of environmentally benign surfactants may be used on road surfaces to reduce the water demand for dust suppression;
- full enclosure of processing equipment including crushers, screens and transfer points;
- prompt mitigation of visible dust emissions from operations, which may involve a combination of:
  - stabilisation of surface silt content through application of localised water sprays, or the use of chemical dust suppressants (suitable for access roads which are traversed less frequently);
  - control of mechanically induced dust emissions (from clearing, scraping, excavation, loading, dumping filling and levelling activates etc.) by application of water sprays;
  - areas of disturbed soil are to be re-vegetated as soon as practical; and

  - minimising exposed subsoil through progressive clearing and reinstatement;
- retention of existing vegetation around the boundary as a buffer, and to limit potential dust sources;
- covering areas of disturbed soil, stockpiles and temporary spoil containment with mulch or other material as best as practicable;
- a Dust Management Plan (DMP) typically includes some audit monitoring to indicate how well the system is performing and whether additional mitigation is required. It is recommended that such monitoring be done at the site boundary with higher levels of mitigation to be implemented when dust levels are found to be excessive, as predicted for the worst case modelling; and
- the PEM for Mining (EPAV, 2007) provides guidance on operational control requirements and monitoring for reactive management purposes which can be adopted by Northern Territory industries as there are no specific Territory guidelines. The principles used could be adopted for use in the Project. In this operational environment, the use of dust deposition monitors to establish the effectiveness of management practices is most appropriate. The reactive management approach dictates, on a monthly basis, that if dust levels exceed monthly trigger levels inclusive of adjustment for background being the lowest reading in the month for the gauge network, the DMP is reviewed and additional dust control measures used to reduce dust levels to the guideline value.

13. Conclusions and Recommendations

Subject to the Limitations outlined in Section 14, GHD draws the following conclusions from this Air Quality Impact Assessment:

- Based on a series of conservative assumptions for dust emission estimation, maximum rates of mining activity during the highest production year (year 3) and worst case meteorological conditions, the proposed Mt Todd Gold Project is predicted to exceed the Air NEPM standards of PM_{10} and $PM_{2.5}$, at the sensitive receptor location of Werenbun on up to seven days;
- The number of exceedences of the Air NEPM standards have the potential to be reduced to zero through further refinement of the:
  - assumptions used in the modelling;
  - further implementation of dust mitigation strategies;
  - mining process during the year of maximum activity to ensure maximum earth moving works do not take place on days when the worst case dust impacts are expected to occur;
- Compliance with Air NEPM standards was predicted to occur at the townships of Katherine and Pine Creek for the worst case scenario;
- Compliance with the impact assessment criteria of TSP and dust deposition is predicted at all sensitive places;
- An environmental risk assessment evaluated the level of risk associated with predicted ground level concentration of PM_{10} at the community of Werenbun. This risk was found to be low;
- GHD considers that the application of the Air NEPM standards of PM_{10}, and particularly $PM_{2.5}$, are not appropriate to assess the level of risk associated with dust impacts from mines in the Northern Territory. The EPA Victoria Mining PEM (2007) approach to the assessment and management of mining related dust impact is considered to be more appropriate. In accordance with the Mining PEM (2007) the air quality criteria is expected to be met at sensitive receptor locations and not the mine site boundaries;
- The progressive nature of open cut mining will result in continual changes in mine and haul road locations throughout the Project lifespan, including progressive rehabilitation of disturbed areas. As such, the impacts associated with these sources, in combination with other fixed location sources will vary over the Project lifespan; and
- Targeted particulate emission mitigation measures can be considered if Air NEPM standards are to be met at the site boundary. A Dust Management Plan can be implemented to assess the need for or effectiveness of these mitigation measures.

14. Limitations

This Report has been prepared by GHD for Vista Gold Australia Pty Ltd and may only be used and relied on by Vista Gold Australia Pty Ltd for the purpose agreed between GHD and Vista Gold Australia Pty Ltd as set out in Section 1 of this Report.

GHD otherwise disclaims responsibility to any person other than Vista Gold Australia Pty Ltd arising in connection with this Report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this Report were limited to those specifically detailed in the Report and are subject to the scope limitations set out in the Report.

The opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the date of preparation of the Report. GHD has no responsibility or obligation to update this Report to account for events or changes occurring subsequent to the date that the Report was prepared.

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD described in this Report and provided by Vista Gold. GHD disclaims liability arising from any of the assumptions being incorrect.

This report presents the results of an air quality impact assessment prepared for the purpose of this commission. The data and advice provided herein relate only to the project and structures described herein and must be reviewed by a competent engineer / scientist before being used for any other purpose. GHD accepts no responsibility for other use of the data.

Where monitoring results, physical tests, data collection and similar work have been performed and recorded by others the data is included and used in the form provided by others. The responsibility for the accuracy of such data remains with the issuing authority, not with GHD.

An understanding of site's environmental impact depends on the integration of many pieces of information, some regional, some site specific, some structure specific and some experience based. Hence this report should not be altered, amended or abbreviated, issued in part or issued incomplete in any way without prior checking and approval by GHD. GHD accepts no responsibility for any circumstances, which arise from the issue of a report that has been modified in any way as outlined above.

The results and therefore the conclusions from this desktop study are based on a number of assumptions which may or may not alter the outcomes if they were subsequently found to be inaccurate or inappropriate. All reasonable efforts have been made by GHD to use the most appropriate data and models for the specific process.

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Appendices

Appendix A - Mine Operations Emissions Estimates

Emissions Inventory Calculations

A1.1 Blasting

Emissions from blasting were estimated using the following equation:

$$E_i = n\,EF_i$$

where

E_i = emission rate of species i (kg/y)

n = number of blasts per year (blasts/y)

EF_i = Uncontrolled emissions factor for species i (kg/blast)

The number of blasts per year, n, was assumed to be one every day.

The uncontrolled emission factor for TSP was calculated using NPI (2012, equation 19, p.53):

$EF_{TSP} = 0.00022A^{1.5}$ [kg/blast]

where

A = blast area, assumed to be 2000 m².

PM_{10} was assumed to be 52 per cent of TSP, as per NPI (2012).

$PM_{2.5}$ was assumed to be 15 per cent of TSP.

Blasting emissions were modelled as evenly distributed throughout the year from the pit, with pit retention factors of 50 per cent for TSP and 5 per cent for PM_{10} and $PM_{2.5}$ applied.

A1.2 Shovel Excavators on Overburden

Emissions from shovel excavator operations inside the pit to load haul trucks with ore and waste rock, assumed to be overburden as described in NPI (2012), were estimated using the following equation:

$$E_i = M \times EF_i$$

where

E_i = emission rate of species i (kg/y)

M = number of tonnes of overburden removed per year (tonne/y)

EF_i = Uncontrolled emissions factor for species i (kg/tonne)

The number of tonnes of ore (or overburden) removed from the pit was based on detail supplied by Vista Gold. The ore tonnage per year modelled is:

- Year 3: 102,169,000 tonne/y

The uncontrolled emission factors for TSP and PM_{10} used the specified site average wind speed, U (m/s), and soil moisture content, M (%), related equations as per NPI (2012, p.48).

$$EF_{TSP} = 0.74 \times 0.0016 \left(\frac{U}{2.2}\right)^{1.3} \left(\frac{M}{2.0}\right)^{-1.4} \text{[kg/tonne]}$$

$$EF_{PM10} = 0.35 \times 0.0016 \left(\frac{U}{2.2}\right)^{1.3} \left(\frac{M}{2.0}\right)^{-1.4} \text{[kg/tonne]}$$

where

U = average wind speed of 2.46 m/s (From TAPM Modelling).

M = soil moisture content of 2 per cent by weight (Assumed NPI (2012) Default).

$PM_{2.5}$ was assumed to be 15 per cent of TSP

Shovel excavator emissions from the pit were modelled as evenly distributed throughout the year.

A similar approach was applied to other sources where front end loaders were used to load ore, for example, loading of the primary crusher.

A1.3 Bulldozers on Overburden

Emissions from bulldozer operations were modelled from the Tailings Storage Facility 1 (TSF1) for year 3 operations. Emissions from an overburden source were estimated using the following equation:

$E_i = n \times EF_i$

where

E_i = emission rate of species i (kg/y)

n = total number of operational hours of all bulldozers per year (veh.h/y)

EF_i = Uncontrolled emissions factor for species i (kg/veh.h)

It was assumed that 1 bulldozer operates continually for a 12 hour day every day of the year – 4380 hours per year.

The default uncontrolled emission factors for TSP and PM_{10} were used as per NPI (2012, p.51).

EF_{TSP} = 17 [kg/veh.hr]

EF_{PM10} = 4 [kg/veh.hr]

$PM_{2.5}$ was assumed to be 15 per cent of TSP

Bulldozer operation emissions on overburden were modelled as evenly distributed throughout the 12 hour operational day across the WRD.

A1.4 Trucks Dumping Overburden

Emissions from haul trucks dumping overburden at the waste rock dump, Low Grade Ore stockpile and TSF1 construction were estimated using the following equation:

$E_i = M \times EF_i$

where

E_i = emission rate of species i (kg/y)

M = number of tonnes of overburden dumped per year (tonne/y)

EF_i = Uncontrolled emissions factor for species i (kg/tonne)

The mass of overburden removed dumped on each location was based on details supplied by Vista Gold. The waste tonnes per year is summarised below for year 3:

- Waste Rock Dump: 78,227,398 tonne/y
- Low Grade Ore Stockpile: 6,941,362 tonne/y
- TSF1 Construction: 11,272,727 tonne/y

The uncontrolled emission factors, EF_i, for TSP and PM_{10} used the default factors as per NPI (2011, p.51).

EF_{TSP} = 0.012 [kg/tonne]

EF_{PM10} = 0.0043 [kg/tonne]

$PM_{2.5}$ was assumed to be 15 per cent of TSP

Overburden dumping operation emissions were modelled as evenly distributed throughout the year and across waste dump source.

A1.5 Trucks Unloading Ore at ROM Pads

Emissions from haul trucks unloading ore at ROM pads were estimated using the following equation:

$$E_i = M \times EF_i$$

where

E_i = emission rate of species i (kg/y)

M = total mass of ore (in tonnes) removed per year (tonne/y)

EF_i = Uncontrolled emissions factor for species i (kg/tonne)

The number of tonnes of ore unloaded at the ROM pad from the pit was based on details supplied by Vista Gold. The ore extraction rate per year is summarised below:

- Year 3: 17,750,014 tonne/y

The uncontrolled emission factors, EF_i, for TSP and PM_{10} used the default values as per NPI (2011, p.16).

EF_{TSP} = 0.004 [kg/tonne]

EF_{PM10} = 0.0017 [kg/tonne]

$PM_{2.5}$ was assumed to be 15 per cent of TSP

Ore unloading from truck emissions was modelled as evenly distributed throughout the year and across the ROM pad source.

A1.6 Loading Primary Crusher

Emissions from loading of the primary crusher were estimated using the following equation:

$$E_i = M \times EF_i$$

where

E_i = emission rate of species i (kg/y)

M = total mass of ore (in tonnes) process per year (tonne/y)

EF_i = Uncontrolled emissions factor for species i (kg/tonne)

The number of tonnes of ore processed by the primary crusher from the pit was based on details supplied by Vista Gold. The ore extraction rate per year is summarised below:

- Year 3: 17,750,014 tonne/y

The uncontrolled emission factors, EF_i, for TSP and PM_{10} used the suggested Equation 10 in NPI (2012, p.48) assuming that the primary crusher was being loaded by a front end loader as per NPI.

$$EF_{TSP} = 0.74 \times 0.0016 \left(\frac{U}{2.2}\right)^{1.3} \left(\frac{M}{2.0}\right)^{-1.4} \text{[kg/tonne]}$$

$$EF_{PM10} = 0.35 \times 0.0016 \left(\frac{U}{2.2}\right)^{1.3} \left(\frac{M}{2.0}\right)^{-1.4} \text{[kg/tonne]}$$

$PM_{2.5}$ was assumed to be 15 per cent of TSP

Loading of the primary ore crusher was modelled as evenly distributed throughout the year.

It was assumed that all ore would be processed by the primary crusher.

A1.7 Primary Crusher Emissions

Emissions from the primary crusher were estimated using the following equation:

$$E_i = M \times EF_i$$

where

E_i = emission rate of species i (kg/y)

M = total mass of ore (in tonnes) process per year (tonne/y)

EF_i = Uncontrolled emissions factor for species i (kg/tonne)

The number of tonnes of ore processed by the primary crusher from the pit was based on details supplied by Vista Gold. The processed ore rate per year is summarised below:

- Year 3: 17,750,014 tonne/y

The uncontrolled emission factors, EF_i, for TSP and PM_{10} used the default values assuming that the ore was “high” in moisture as per NPI (2012, p.62) guidelines.

EF_{TSP} = 0.01 [kg/tonne]

EF_{PM10} = 0.004 [kg/tonne]

$PM_{2.5}$ was assumed to be 16 per cent of TSP.

The primary crusher was modelled as having operational hours evenly distributed throughout the year and occurring at the Benefication Plant.

It was assumed that all ore would be processed by the primary crusher.

A1.8 Secondary Crusher Emissions

Emissions from secondary crusher were estimated using the following equation:

$$E_i = M \times EF_i$$

where

E_i = emission rate of species i (kg/y)

M = total mass of ore (in tonnes) process per year (tonne/y)

EF_i = Uncontrolled emissions factor for species i (kg/tonne)

The number of tonnes of ore processed by the secondary crusher from the pit was based on details supplied by Vista Gold. The secondary crushed ore rate per year for the operations are summarised below:

- Year 3: 17,750,014 tonne/y

The uncontrolled emission factors, EF_i, for TSP and PM_{10} used the default values assuming that the ore was "high" in moisture as per NPI (2012, p.62) guidelines.

EF_{TSP} = 0.03 [kg/tonne]
EF_{PM10} = 0.012 [kg/tonne]

$PM_{2.5}$ was assumed to be 16 per cent of TSP.

The secondary crusher was modelled as having operational hours evenly distributed throughout the year and occurring at the Benefication Plant.

It was assumed that 120 per cent of the ore would be processed by the secondary crusher.

A1.9 Screening Emissions

Emissions from screens were estimated using the following equation:

$$E_i = M \times EF_i$$

where

E_i = emission rate of species i (kg/y)

M = total mass of ore (in tonnes) process per year (tonne/y)

EF_i = Uncontrolled emissions factor for species i (kg/tonne)

The number of tonnes of ore processed by each of the individual screens (coarse and fine screens) was based on details supplied by Vista Gold. The screened ore rate per year for the operations are summarised below:

- Year 3: 17,750,014 tonne/y

The uncontrolled emission factors, EF_i, for TSP and PM_{10} used the default values assuming that the ore was "high" in moisture as per NPI (2012, p.62) guidelines.

EF_{TSP} = 0.03 [kg/tonne]
EF_{PM10} = 0.012 [kg/tonne]

$PM_{2.5}$ was assumed to be 16 per cent of TSP.

The coarse and fine screens were modelled as having operational hours evenly distributed throughout the year and occurring at the Benefication Plant.

It was assumed that 120 per cent of the ore would be processed by the screens.

The screens cannot be considered as part of the crusher units as they are separated by a considerable distance using conveyors.

A1.10 Grinding Emissions

Emissions from high pressure grinding rolls were estimated using the following equation:

$$E_i = M \times EF_i$$

where

E_i = emission rate of species i (kg/y)

M = total mass of ore (in tonnes) process per year (tonne/y)

EF_i = Uncontrolled emissions factor for species i (kg/tonne)

The number of tonnes of ore processed by the HPGR from the pit was assumed to be all of the ore passing through the primary crusher. The HPGR ore rate per year for the operations are summarised below:

- Year 3: 17,750,014 tonne/y

The uncontrolled emission factors, EF_i, for TSP and PM_{10} used the default values assuming that the grinding process did not include air conveying of classification, as per NPI (2012, p.20) guidelines.

EF_{TSP} = 1.2 [kg/tonne]

EF_{PM10} = 0.16 [kg/tonne]

$PM_{2.5}$ was assumed to be 16 per cent of TSP.

The HPGR was modelled as having operational hours evenly distributed throughout the year and occurring at the Benefication Plant.

It was assumed that 120 per cent of the ore would be processed by the HPGR.

A1.11 Overland Conveyor Emissions

Emissions from conveyors were estimated using the relationship derived by Witt et al. (1999).

With respect to the location, the relationships indicate that the wind speed is not great enough to pick-up particles smaller than 60 µm from the surface of the conveyor.

Therefore, conveyor emissions were modelled as zero.

A1.12 Unpaved Haul Roads

Emissions from haul trucks travelling along unpaved haul roads were estimated using the following equation:

$$E_i = VKT \times EF_i$$

where

E_i = emission rate of species i (kg/y)

VKT = total vehicle kilometres travelled by all haul vehicles (in km) per year (VKT/y)

EF_i = Uncontrolled emissions factor for species i (kg/VKT)

The uncontrolled emission factors, EF_i, for TSP and PM_{10} used the as per NPI (2011, p.16) equations which relate to heavy vehicle movement at industrial sites.

EF_{TSP} = 1.38 $\left(\frac{s}{12}\right)^{0.9}\left(\frac{W}{3}\right)^{0.45}$ [kg/VKT]

EF_{PM10} = 0.42 $\left(\frac{s}{12}\right)^{0.9}\left(\frac{W}{3}\right)^{0.45}$ [kg/VKT]

where

s = average silt content of 10 precent. (NPI Default)

W = haul truck total mass (tonne).

$PM_{2.5}$ was assumed to be 15 per cent of TSP.

The NPI Mining (2012) emissions estimation equations separate emissions from heavy vehicles and light vehicles, with heavy vehicle movement generated dust emissions independent of vehicle speed and soil moisture content, unlike previous versions of the NPI Mining manual.

Haul truck movements were modelled as evenly distributed throughout the year and across all haul roads based on the amount of earth moved and the haul vehicle capacity – 218 tonnes. Furthermore, haul truck movement generated dust from within the pit has been assumed to be "released from the pit" at ground level. The number of truck movements required to determine the total annual VKT were based a Caterpillar Type 793C trucks. These have a haul capacity of 218 tonnes and a vehicle mass when full of 385 tonnes.

Emission factors were based on the average of the fully loaded haul truck and empty returning haul truck.

The number of tonnes of ore required to be removed from the pit was based on details supplied by Vista Gold. The total earth extraction rate per year are summarised below:

Estimates of haul road distances were based on preliminary mine plan.

The total haul road distance was estimated to be approximately 11.4 km. This was based on supplied drawings for year 3 and straight line distances to the centre of designated stockpile areas.

Based on the fleet of trucks, the estimated number of required trips to move the amount of ore was determined. This enabled an estimate of the total annual VKT's for various parts of the mining operation. A summary of the calculated VKTs is given below.

- Year 3:
  - Number of Cat 793C trucks: 38
  - Total Haul Road Distance: 11.4 km
  - Total Earth Mined from Pit: 102,169,000 tonne/year
  - Total Ore to ROM: 17,750,014 tonne/year
  - Total Ore to LGO Stockpile: 6,191,349 tonne/year
  - Total Waste Rock to TSF1 Construction: 11,272,727 tonne/year
  - Total Waste Rock to WRD: 78,227,398 tonne/year
  - Total number of Haul trips out of Pit: 468,665 loaded trips per year

Estimated Haul Road Distances

Route	Year 3 Distance (km)
In Pit	4.0
Pit to WRD	1.5
Pit to LGO stockpile	1.6
Pit to ROM stockpile to Processing Plant	0.4
Pit to TSF1	3.9
Total	11.4

A1.13 Wind Erosion

Emissions by wind erosion from exposed surfaces were estimated using the following equation:

$$E_i = A \times EF_i$$

where

E_i = emission rate of species i (kg/y)

A = total amount of exposed or disturbed surface area (plan) (ha)

EF_i = Uncontrolled emissions factor for species i (kg/ha/y)

Wind erosion was based on the NPI (2012) defaults of 0.4 kg/ha/h for TSP and 0.2 kg/ha/h for PM_{10}. $PM_{2.5}$ was assumed to be 8 per cent of TSP. These are conservative estimates and are normally applied as they are simple to implement, especially when a source is of comparatively low magnitude to some of the other sources, for example wheel generated dust from haul roads. However, to improve the model accuracy wind erosion from all surface area sources was modelled as wind speed dependent, based on a third order relationship with respect to wind speed. That is:

$$EF_{iTSP} = k\,U^3 \ \text{(kg/ha/y)}$$

Where U is the wind speed at the reference height of 10 m and k is a proportional constant to maintain total annual emissions as a fixed total. This annual fixed total amount was derived from the default emission factors, i.e. 0.4 kg/ha/h multiplied by 5856 hours (244 days in the modelled year) to give 2342.4 kg/ha/year. For the modelled conditions at the Mt Todd location, wind erosion was considered non-existent during the wet season months of December, January, February and March (122 days), which reduced the annual emissions accordingly, but did not reduce the rate of wind erosion emissions for each hour that they did occur.

In effect, the annualised emissions as determined by the default NPI (2012) emission factors are distributed throughout the year based on a wind dependent relationship. The emission factors were “binned” to different wind speeds, based on the default wind categories used by AUSPLUME. The uncontrolled wind erosion EF’s are summarised below. A variable emissions file was created to implement the model.

Uncontrolled Wind Erosion Emission Factors

AUSPLUME Wind Speed Upper Value (m/s)	Category Fraction	Emission Factor (kg/ha/h)		
		TSP	PM_{10}	$PM_{2.5}$
1.54	0.241	0.003	0.002	0.0002
3.09	0.463	0.095	0.047	0.004
5.14	0.185	0.531	0.265	0.025
8.23	0.110	2.271	1.136	0.106
10.8	0.001	6.545	3.273	0.306
10.8+	0.000	–	–	–

Appendix B - AUSPLUME Area, Volume and Point Sources

Mine Site Emissions

The location of emissions sources was determined based on supplied information. In particular, information supplied in Figure 2 (proposed development layout) and Appendix C (process plant map) were used.

Area Sources

Area sources were input into the model with associated areas as given below. Area sources were located as close as possible to the supplied mine plan as practicable. Actual emissions rates, in g/s/m², were determined based on total annual emissions and the associated "modelled" area as opposed to the actual mine surface area that is indicated in the mine plan supplied documentation. This conserves total mass emission rates, which will not make a significant difference to the predicted off-site emissions at identified sensitive receiver locations.

Individual haul roads were not specifically modelled, except for the longer haul road to the TSF1. Haul road emissions were based on estimates of vehicle kilometres travelled (VKT) in each of the individual areas, and then distributed across the entire area as haul road locations will change during the 12 years of operations.

Area Source Model Settings.

Type of Area Source	Description	Modelled Area (m²)	Emission Rate (g/s/m²)		
			$PM_{2.5}$	PM_{10}	TSP
Wind Erosion	Mine Pit	1,344,161	WS Dep.	WS Dep.	WS Dep.
	Haul Roads - Wind Erosion only for TSF1 transport	48,000	WS Dep.	WS Dep.	WS Dep.
	RoM Stockpile	84,513	WS Dep.	WS Dep.	WS Dep.
	Low Grade Ore Stockpile	436,373	WS Dep.	WS Dep.	WS Dep.
	Waste Rock Dump	2,131,338	WS Dep.	WS Dep.	WS Dep.
	Coarse Ore Stockpile	20,106	WS Dep.	WS Dep.	WS Dep.
Wheel Generated Dust	In-pit Haul Roads	1,344,161	1.21×10^{-5}	2.38×10^{-5}	4.25×10^{-5}
	ROM Haul Roads	84,513	1.90×10^{-5}	3.75×10^{-5}	1.27×10^{-4}
	LGO Haul Roads	436,373	7.87×10^{-6}	1.55×10^{-5}	5.25×10^{-5}
	WRD Haul Roads	2,131,338	9.71×10^{-7}	$1.91x\ 10^{-6}$	6.48×10^{-6}
TSF2 Haul Road	Transport of Waste Rock for TSF1 construction	48,000	7.79×10^{-5}	1.53×10^{-4}	5.19×10^{-4}

Volume Sources

Volume sources were input into the model with locations as given below. Volume sources were located at the indicated location as supplied in the processing plant map (Appendix C) or at representative central mine site locations as indicated in Figure 2 (proposed development).

This was to provide a representative scenario for emission distributions. Appropriate source release height and initial dispersion characteristics were applied to each of the volume sources, as specified in the AUSPLUME guidance documentation.

All volume sources were modelled as continuous, except for blasting emissions that wre modelled as occurring at 8 am, for one hour, each day of the year and for the construction of the TSF1, which was assumed to occur during 12 daylight hours each day of the year.

Volume Source Model Settings

Source	Description	Coordinates UTM Zone 53 (mE, mN)	Emission Rate (g/s)		
			$PM_{2.5}$	PM_{10}	TSP
Mine Pit	Blasting	187140, 8435150	0.8 /blast	2.7 /blast	2.73 /blast
	Loading Haul Trucks	187140, 8435150	0.63	2.0	2.2
LGO	Loading LGO stockpile	188140, 8435740	0.18	0.41	1.18
ROM Pad	Loading - ROM Stockpile	187750, 8434650	0.51	1.18	3.4
Processing Plant	Loading Primary Crusher	187800, 8434450	0.03	0.11	0.23
	Primary Crusher	187820, 8434450	0.23	0.56	1.41
	Loading Secondary Crusher	187860, 8434440	0.01	0.03	0.06
	Secondary Crusher	187860, 8434440	0.81	2.0	5.1
	Loading Coarse Screen	188040, 8434390	0.01	0.03	0.06
	Coarse Screening	188040, 8434390	2.2	10.1	13.5
	Loading Coarse Ore Stockpile (Re-Claim stockpile)	188250, 8434300	0.18	0.47	1.12
	Apron Feeder Re-Claim	188200, 8434350	0.009	0.03	0.05
	Loading HPGR	188030, 8434500	0.01	0.03	0.06
	High Pressure Grinding Roll	188030, 8434500	1.3	1.05	8.1
	Loading Fine Screening	188010, 8434730	0.01	0.03	0.06
	Fine Screen	188010, 8434730	0.09	0.41	0.54

	Loading Grinder	188030, 8434730	0.009	0.03	0.05
TSF2	Bulldozer on TSF2	189150, 8436400	0.71	1.13	4.7
	Unloading Waste Rock	189150, 8436400	1.3	3.0	8.6
WRD	Unloading Waste Rock	188000, 8433500	3.8	8.9	25.5

Stack Sources

Power generation from the three on-site gas engines was modelled with the stack characteristics detailed below. NO_2 emissions rates were based on vendor supplied emissions of oxides of nitrogen and the conservative assumption of an NO_2:NOx ratio of 30 per cent.

Stack source model settings

Parameter	Gas Turbine	Reciprocating Engines	
Model	Rolls-Royce Trent 60	MAN 20V35/44	MAN 20V35/44
Exit Velocity (m/s)	48.3	12.5	12.5
Exit Temperature (^oC)	422	298	298
Stack Diameter (m)	3.0	1.83	1.83
Stack Height (m)	21.3	21.3	21.3
Number of Stacks	1	1	1
Stack Location (mE, mN)	188820, 8433590	188820, 8433580	188820, 8433600
NO_2 Emissions (g/s)	1.84	2.32	2.32
CO Emissions (g/s)	6.69	4.66	4.66

Appendix C – Process Plant Map

Supplied by Vista Gold

INFORMATION ONLY
PRELIMINARY UNCHECKED
PROTEUS DRG No. 12240-DM-002
VISTA GOLD Australia Pty Ltd
MT TODD GOLD PROJECT
PROCESS PLANT
GENERAL ARRANGEMENT
SCALE 1:1500
A1
3000-DM-001
A
proteus
VISTA GOLD

Appendix D – Environmental Risk Assessment

Development of Risk Descriptors for Assessment of Impact

Background

The Victorian *State Environment Protection Policy (Air Quality Management)* ('SEPP (AQM)') and the NSW *Approved Methods* specifies design criteria for individual pollutants, where the design criterion is the concentration that is not to be exceeded in ambient respirable air.

The SEPP (AQM) allows for a risk assessment to be conducted in the event that design criteria cannot be met, to determine the consequences of non-compliance. Where the emission is of a toxic substance with a design criterion based on health effects (such as a carcinogen), the risk assessment will take the form of a Health Risk Assessment (HRA). Where the emission is an unclassified substance such as odour or nuisance dust, then the criterion is based on amenity, and the risk assessment is termed an Environmental Risk Assessment (ERA).

To date no Australian government authority (such as an EPA) has developed an ERA for dust emissions. However, there have been some draft ERA methodologies for odour emissions and impact for the broiler industry, and one of the early drafts (January 2006) used an approach based on the Risk Management standard AS/NZS 4360:2004, developing measures of 'likelihood' and 'consequence' to evaluate risk. In this draft ERA methodology, if the risk of nearby sensitive uses (i.e. residences) being exposed to dis-amenity from odour is 'Low', then the responsible authority may accept the proposed facility. If the risk is 'Medium', then mitigation measures would be needed. If the risk is 'High', then another site must be found. However, a set of descriptors and matrix for determining the risk level in terms of these three categories has not been provided. Later draft ERA methodologies developed by EPA Victoria appear to have drawn away from this risk assessment approach, but no alternate methodology has been provided. EPA Victoria has since issued guidance relating to landfill licence assessments[7] in which a risk matrix approach has been applied, and this supports the use of the risk matrix approach to assessing risk.

In the absence of published guidance specific to odour emissions, it has been the practice of professionals in this field to develop and apply risk matrix schemes that they consider reflect the level of risk of odour emissions from premises. Similarly, a risk matrix has been developed here to assess the level of risk of dust emissions from the Mt Todd project on the nearest identified sensitive human receptors located at the Werebun community.

Basis for Development of Risk Descriptors

GHD has previously developed (and has used for some years) an approach to risk assessment for odour, which is now being applied here for dust. This risk assessment approach was developed with consideration to relevant regulatory requirements, policies, guidance documents and standards, including:

- AS/NZS ISO 31000:2009 – Risk Management: Principles and Guidelines
- The SEPP (AQM)
- EPA Publication AQ 2/86 – Recommended Buffer Distances for Industrial Residual Air Emissions
- EPA, Draft Guidelines for Environmental Risk Assessments Code for Broiler Farms, January 2006
- EPA Publication 1321.2 Licence Assessment Guidelines

In June 2011, the Victorian Civil and Administrative Tribunal (VCAT) proposed a risk assessment matrix for odour similar to that of GHD, but with a more conservative selection of risk weighting (refer to page 21 of the Victorian Civil and Administrative Tribunal (VCAT)

[7] EPA Publication 1321.2 *Licence Assessment Guidelines*

decision 1146). Though this decision was in relation to a request for expansion of a broiler farm in a rural area, it is likely to set a precedent for any industry where the standard criteria are often not met, i.e. waste water treatment plants, landfills and composting operations. The risk matrix presents the level of risk as a function of consequence (i.e. odour level) and likelihood (i.e. frequency of odour event). In the absence of a regulatory risk assessment approach for dust impacts, this odour based system has been adopted for this investigation.

In developing the risk table below, GHD has considered the level of risk that would result from the application of the matrix, and consider that it would appear to provide a reasonable description of the level of risk. It is expected that the outcome of the application of the matrix will be the subject of review by numerous environmental regulatory agencies and other third parties, and some further adjustment may be found to be necessary.

The risk matrix has taken into account the NEPM allowance of 5 days per year of exceedence of the 50 µg/m³ standard, the EPA Victoria SEPP(AQM) air quality intervention level of 60 µg/m³ and the EPA Victoria SEPP(AQM) nuisance dust level of 330 µg/m³ and adjusted for equivalent time averaging.

Adopted risk matrix for dust impact

Frequency	**PM_{10} 24 hour Average Concentration (µg/m³)**				
	>100 µg/m³	**>80 µg/m³ and ≤ 100 µg/m³**	**>60 µg/m³ and ≤ 80 µg/m³**	**>50 µg/m³ and ≤ 60 µg/m³**	**≤ 50 µg/m³**
More than once per week (>52 per year)	Extreme	Extreme	High	Medium	Negligible
1 per week to 1 per fortnight (>26 to ≤52 per year)	Extreme	High	High	Medium	Negligible
1 per fortnight to 1 per month (>12 to ≤26 per year)	High	High	Medium	Low	Negligible
1 per month to 1 per 2 months (>6 to ≤12 per year)	Medium	Medium	Medium	Low	Negligible
Every 2 months to every 4 months (>3 to ≤6 per year)	Low	Low	Low	Low	Negligible
Once to 3 times (>1 to ≤3 per year)	Low	Low	Low	Negligible	Negligible

Appendix E - AUSPLUME Output Text Files

Mine Site PM_{10} Ground Level Concentrations

1

Mt Todd May 2013 var emiss W/E cont 22/5/13 PM10 no depletion

Concentration or deposition	Concentration
Emission rate units	grams/second
Concentration units	microgram/m3
Units conversion factor	1.00E+06
Constant background concentration	0.00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	No
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Use the convective PDF algorithm?	No

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Pasquill-Gifford
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Pasquill-Gifford
Vertical dispersion curves for sources >100m high	Pasquill-Gifford
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.100m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise?	Yes
Stack-tip downwash included?	Yes
Building downwash algorithm:	PRIME method.
Entrainment coeff. for neutral & stable lapse rates	0.60,0.60
Partial penetration of elevated inversions?	No
Disregard temp. gradients in the hourly met. file?	No

and in the absence of boundary-layer potential temperature gradients
given by the hourly met. file, a value from the following table
(in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Rural" values (unless overridden by met. file)

AVERAGING TIMES
24 hours
average over all hours

1

Mt Todd May 2013 var emiss W/E cont 22/5/13 PM10 no depletion

SOURCE CHARACTERISTICS

INTEGRATED POLYGON AREA SOURCE: PIT

X0(m)	Y0(m)	Ground El	No. Vertices	Ver. spread	Height
187270	8435950	0m	19	1m	0m

Integrated Polygon Area Source Vertice Locations (in metres)

No.	X	Y	No.	X	Y
1	187270	8435950	2	187431	8435901
3	187631	8435745	4	187734	8435473
5	187801	8435254	6	187734	8435067
7	187703	8434849	8	187631	8434684
9	187431	8434612	10	187315	8434474
11	187176	8434407	12	186873	8434389
13	186664	8434648	14	186606	8434933
15	186601	8435165	16	186788	8435460
17	186878	8435682	18	187052	8435825
19	187167	8435946			

(Constant) emission rate = 1.00E+00 grams/second per square metre

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

INTEGRATED POLYGON AREA SOURCE: WRD

X0(m)	Y0(m)	Ground El	No. Vertices	Ver. spread	Height
188000	8434350	0m	19	88m	175m

Integrated Polygon Area Source Vertice Locations (in metres)

No.	X	Y	No.	X	Y
1	188000	8434350	2	188406	8434074
3	188611	8433784	4	188812	8433400
5	188776	8433119	6	188620	8432856
7	188232	8432789	8	187670	8432722
9	187313	8432709	10	187318	8432950
11	187197	8433142	12	187278	8433396
13	187295	8433686	14	187300	8433882
15	187269	8434225	16	187278	8434399
17	187518	8434430	18	187764	8434444
19	187902	8434390			

(Constant) emission rate = 1.00E+00 grams/second per square metre

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

INTEGRATED POLYGON AREA SOURCE: LGO

X0(m)	Y0(m)	Ground El	No. Vertices	Ver. spread	Height
188000	8436160	0m	14	10m	20m

Integrated Polygon Area Source Vertice Locations (in metres)

No.	X	Y	No.	X	Y
1	188000	8436160	2	188305	8436151
3	188332	8435935	4	188375	8435788
5	188395	8435549	6	188381	8435311
7	188328	8435188	8	188123	8435099
9	188058	8435047	10	188002	8435257
11	187913	8435500	12	187918	8435748
13	187891	8435982	14	187938	8436140

(Constant) emission rate = 1.00E+00 grams/second per square metre

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

INTEGRATED POLYGON AREA SOURCE: ROM

X0(m)	Y0(m)	Ground El	No. Vertices	Ver. spread	Height
187740	8434830	0m	15	5m	10m

Integrated Polygon Area Source Vertice Locations (in metres)

No.	X	Y	No.	X	Y
1	187740	8434830	2	187912	8434830
3	187934	8434790	4	187896	8434692
5	187840	8434634	6	187780	8434591
7	187742	8434509	8	187682	8434489
9	187555	8434464	10	187537	8434442
11	187430	8434520	12	187457	8434556

```
                13  187519 8434596        14  187662 8434661
                15  187718 8434750
          (Constant) emission rate = 1.00E+00 grams/second per square metre

       Hourly multiplicative factors will be used with
       this emission factor.
                No gravitational settling or scavenging.


                INTEGRATED CIRCULAR AREA SOURCE: RCST

 X0(m)   Y0(m)  Ground El  Radius  No. Vertices  Ver. spread  Height
188250 8434300         0m     80m             8            8m     16m

          (Constant) emission rate = 1.00E+00 grams/second per square metre

       Hourly multiplicative factors will be used with
       this emission factor.
                No gravitational settling or scavenging.


                INTEGRATED POLYGON AREA SOURCE: WEPIT

 X0(m)   Y0(m)  Ground El  No. Vertices  Ver. spread  Height
187270 8435950         0m            19            1m      0m


          Integrated Polygon Area Source Vertice Locations (in metres)
                 No.       X       Y       No.       X       Y
                   1  187270 8435950         2  187431 8435901
                   3  187631 8435745         4  187734 8435473
                   5  187801 8435254         6  187734 8435067
                   7  187703 8434849         8  187631 8434684
                   9  187431 8434612        10  187315 8434474
                  11  187176 8434407        12  186873 8434389
                  13  186664 8434648        14  186606 8434933
                  15  186601 8435165        16  186788 8435460
                  17  186878 8435682        18  187052 8435825
                  19  187167 8435946
          (Constant) emission rate = 1.00E+00 grams/second per square metre

       Hourly multiplicative factors will be used with
       this emission factor.
                No gravitational settling or scavenging.


                INTEGRATED POLYGON AREA SOURCE: WEWRD

 X0(m)   Y0(m)  Ground El  No. Vertices  Ver. spread  Height
188000 8434350         0m            19           88m    175m


          Integrated Polygon Area Source Vertice Locations (in metres)
                 No.       X       Y       No.       X       Y
                   1  188000 8434350         2  188406 8434074
                   3  188611 8433784         4  188812 8433400
                   5  188776 8433119         6  188620 8432856
                   7  188232 8432789         8  187670 8432722
                   9  187313 8432709        10  187318 8432950
                  11  187197 8433142        12  187278 8433396
                  13  187295 8433686        14  187300 8433882
                  15  187269 8434225        16  187278 8434399
                  17  187518 8434430        18  187764 8434444
                  19  187902 8434390
          (Constant) emission rate = 1.00E+00 grams/second per square metre

       Hourly multiplicative factors will be used with
       this emission factor.
                No gravitational settling or scavenging.


                INTEGRATED POLYGON AREA SOURCE: WELGO

 X0(m)   Y0(m)  Ground El  No. Vertices  Ver. spread  Height
188000 8436160         0m            14           10m     20m


          Integrated Polygon Area Source Vertice Locations (in metres)
                 No.       X       Y       No.       X       Y
                   1  188000 8436160         2  188305 8436151
```

```
                  3  188332 8435935         4  188375 8435788
                  5  188395 8435549         6  188381 8435311
                  7  188328 8435188         8  188123 8435099
                  9  188058 8435047        10  188002 8435257
                 11  187913 8435500        12  187918 8435748
                 13  187891 8435982        14  187938 8436140
            (Constant) emission rate = 1.00E+00 grams/second per square metre

      Hourly multiplicative factors will be used with
      this emission factor.
               No gravitational settling or scavenging.


                INTEGRATED POLYGON AREA SOURCE: WEROM

 X0(m)   Y0(m)  Ground El  No. Vertices  Ver. spread  Height
187740 8434830         0m            15           5m     10m


         Integrated Polygon Area Source Vertice Locations (in metres)
                No.       X       Y       No.       X       Y
                  1  187740 8434830         2  187912 8434830
                  3  187934 8434790         4  187896 8434692
                  5  187840 8434634         6  187780 8434591
                  7  187742 8434509         8  187682 8434489
                  9  187555 8434464        10  187537 8434442
                 11  187430 8434520        12  187457 8434556
                 13  187519 8434596        14  187662 8434661
                 15  187718 8434750
            (Constant) emission rate = 1.00E+00 grams/second per square metre

      Hourly multiplicative factors will be used with
      this emission factor.
               No gravitational settling or scavenging.


                INTEGRATED CIRCULAR AREA SOURCE: WERCST

 X0(m)   Y0(m)  Ground El  Radius  No. Vertices  Ver. spread  Height
188250 8434300         0m     80m             8           8m     16m

            (Constant) emission rate = 1.00E+00 grams/second per square metre

      Hourly multiplicative factors will be used with
      this emission factor.
               No gravitational settling or scavenging.


                INTEGRATED AREA SOURCE: HRROM

 X0(m)   Y0(m)  Ground El  Length X  Length Y  Or. Angle  Ver. spread  Height
187500 8434600         0m      400m       20m     -15deg           3m      6m

            (Constant) emission rate = 1.00E+00 grams/second per square metre

      Hourly multiplicative factors will be used with
      this emission factor.
               No gravitational settling or scavenging.


                INTEGRATED AREA SOURCE: HRLGO

 X0(m)   Y0(m)  Ground El  Length X  Length Y  Or. Angle  Ver. spread  Height
187500 8434600         0m     1350m       20m     -60deg           3m      6m

            (Constant) emission rate = 1.00E+00 grams/second per square metre

      Hourly multiplicative factors will be used with
      this emission factor.
               No gravitational settling or scavenging.


                INTEGRATED AREA SOURCE: HRWRD

 X0(m)   Y0(m)  Ground El  Length X  Length Y  Or. Angle  Ver. spread  Height
187500 8434600         0m     1350m       20m      65deg           3m      6m

            (Constant) emission rate = 1.00E+00 grams/second per square metre

      Hourly multiplicative factors will be used with
```

this emission factor.
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: HRTS1

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
187740	8434880	0m	2400m	20m	-20deg	3m	6m

(Constant) emission rate = 1.00E+00 grams/second per square metre

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

INTEGRATED AREA SOURCE: WHRTS1

X0(m)	Y0(m)	Ground El	Length X	Length Y	Or. Angle	Ver. spread	Height
187740	8434880	0m	2400m	20m	-20deg	0m	0m

(Constant) emission rate = 1.00E+00 grams/second per square metre

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: BLAST

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
187140	8435150	0m	0m	50m	1m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: LHTR

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
187140	8435150	0m	0m	50m	1m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: UROM

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
187750	8434650	0m	4m	20m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: ULGO

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
188140	8435740	0m	4m	50m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: UWRD

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
188000	8433500	0m	4m	50m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: LPCR

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
187800	8434450	0m	2m	2m	1m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: PCR

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
187820	8434450	0m	4m	5m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: LSCR

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
187860	8434440	0m	4m	5m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: SCR

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
187860	8434440	0m	4m	5m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: LCS

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
187040	8434390	0m	4m	5m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: CS

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
187040	8434390	0m	4m	5m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: LREC

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
188250	8434300	0m	30m	5m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: APFRC

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
188200	8434350	0m	1m	5m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: LHPGR

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
188030	8434500	0m	5m	5m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: HPGR

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
188030	8434500	0m	5m	5m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: LFSCR

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
188010	8434730	0m	5m	5m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: FSCR

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
188010	8434730	0m	5m	5m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: LGR

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
188030	8434730	0m	5m	5m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with

this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: TSF1B

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
189150	8436400	0m	5m	500m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: TSF1UL

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
189150	8436400	0m	5m	500m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: TSF2B

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
191000	8434500	0m	5m	500m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

VOLUME SOURCE: TSF2UL

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
191000	8434500	0m	5m	500m	2m

(Constant) emission rate = 1.00E+00 grams/second

Hourly multiplicative factors will be used with
this emission factor.
No gravitational settling or scavenging.

1

Mt Todd May 2013 var emiss W/E cont 22/5/13 PM10 no depletion

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
178680.m 179080.m 179480.m 179880.m 180280.m 180680.m 181080.m
181480.m 181880.m 182280.m 182680.m 183080.m 183480.m 183880.m
184280.m 184680.m 185080.m 185480.m 185880.m 186280.m 186680.m
187080.m 187480.m 187880.m 188280.m 188680.m 189080.m 189480.m
189880.m 190280.m 190680.m 191080.m 191480.m 191880.m 192280.m
192680.m 193080.m 193480.m 193880.m 194280.m 194680.m 195080.m
195480.m 195880.m 196280.m 196680.m 197080.m 197480.m 197880.m
198280.m

and these y-values (or northings):
8424229.m 8424629.m 8425029.m 8425429.m 8425829.m 8426229.m 8426629.m
8427029.m 8427429.m 8427829.m 8428229.m 8428629.m 8429029.m 8429429.m
8429829.m 8430229.m 8430629.m 8431029.m 8431429.m 8431829.m 8432229.m
8432629.m 8433029.m 8433429.m 8433829.m 8434229.m 8434629.m 8435029.m
8435429.m 8435829.m 8436229.m 8436629.m 8437029.m 8437429.m 8437829.m
8438229.m 8438629.m 8439029.m 8439429.m 8439829.m 8440229.m 8440629.m
8441029.m 8441429.m 8441829.m 8442229.m 8442629.m 8443029.m 8443429.m
8443829.m

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	193545	8430319	0.0	0.0	5	187685	8436800	0.0	0.0
2	193111	8431033	0.0	0.0	6	183000	8435000	0.0	0.0
3	187685	8436064	0.0	0.0	7	157800	8469350	0.0	0.0
4	187685	8431900	0.0	0.0	8	205000	8400000	0.0	0.0

METEOROLOGICAL DATA : Ausplume- Mt Todd Mine - TAPM

HOURLY VARIABLE EMISSION FACTOR INFORMATION

The input emission rates specfied above will be multiplied by hourly varying factors entered via the input file:
G:\43\2180110\Tech\Ausplume\may2013\input\PM10_yr3_var_emissions01.csv
For each stack source, hourly values within this file will be added to each declared exit velocity (m/sec) and temperature (K).

Title of input hourly emission factor file is:
Mt Todd - PM10 Variable Emissions File May 2013 Year 3

HOURLY EMISSION FACTOR SOURCE TYPE ALLOCATION

Prefix WEPIT allocated: WEPIT
Prefix WELGO allocated: WELGO
Prefix WERCST allocated: WERCST
Prefix WEROM allocated: WEROM
Prefix WEWRD allocated: WEWRD
Prefix WHRTS1 allocated: WHRTS1
Prefix PIT   allocated: PIT
Prefix WRD   allocated: WRD
Prefix HRLGO allocated: HRLGO
Prefix HRROM allocated: HRROM
Prefix HRTS1 allocated: HRTS1
Prefix HRWRD allocated: HRWRD
Prefix LGO   allocated: LGO
Prefix RCST   allocated: RCST
Prefix ROM   allocated: ROM
Prefix BLAST allocated: BLAST
Prefix LHTR   allocated: LHTR
Prefix UROM   allocated: UROM
Prefix ULGO   allocated: ULGO
Prefix UWRD   allocated: UWRD
Prefix LPCR   allocated: LPCR
Prefix PCR   allocated: PCR
Prefix LSCR   allocated: LSCR
Prefix SCR   allocated: SCR
Prefix LCS   allocated: LCS
Prefix CS   allocated: CS
Prefix LREC   allocated: LREC
Prefix APFRC allocated: APFRC
Prefix LHPGR allocated: LHPGR
Prefix HPGR   allocated: HPGR
Prefix LFSCR allocated: LFSCR
Prefix FSCR   allocated: FSCR
Prefix LGR   allocated: LGR
Prefix TSF1B allocated: TSF1B
Prefix TSF1UL allocated: TSF1UL
Prefix TSF2B allocated: TSF2B
Prefix TSF2UL allocated: TSF2UL

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1 HIGHEST RECORDINGS FOR EACH RECEPTOR (in microgram/m3)
AVERAGING TIME = 24 HOURS

At the discrete receptors:
1: 4.97E+01 @Hr24,17/02/08
2: 5.99E+01 @Hr24,17/02/08
3: 4.08E+02 @Hr24,01/01/08
4: 2.15E+02 @Hr24,04/11/07
5: 1.70E+02 @Hr24,20/07/08
6: 2.08E+02 @Hr24,12/06/08
7: 1.74E+01 @Hr24,14/08/08
8: 1.26E+01 @Hr24,01/12/07

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1 SECOND-HIGHEST RECORDINGS FOR EACH RECEPTOR (in microgram/m3)
AVERAGING TIME = 24 HOURS

At the discrete receptors:

1: 4.96E+01 @Hr24,18/02/08	5: 1.31E+02 @Hr24,01/01/08
2: 5.95E+01 @Hr24,18/02/08	6: 1.88E+02 @Hr24,13/06/08
3: 3.49E+02 @Hr24,01/02/08	7: 1.69E+01 @Hr24,17/04/08
4: 2.11E+02 @Hr24,12/11/07	8: 7.55E+00 @Hr24,23/11/07

---

1 Peak values for the 100 worst cases (in microgram/m3)
Averaging time = 24 hours

Rank	Value	Time Recorded hour,date	Coordinates (* denotes polar)
1	5.83E+03	24,26/02/08	(187080, 8434229, 0.0)
2	5.50E+03	24,19/02/08	(187080, 8434229, 0.0)
3	4.24E+03	24,25/02/08	(187080, 8434229, 0.0)
4	3.93E+03	24,05/02/08	(187080, 8434229, 0.0)
5	3.85E+03	24,04/11/07	(187080, 8434229, 0.0)
6	3.84E+03	24,09/10/07	(187080, 8434229, 0.0)
7	3.82E+03	24,08/10/07	(187080, 8434229, 0.0)
8	3.77E+03	24,31/01/08	(187080, 8434229, 0.0)
9	3.68E+03	24,28/01/08	(187080, 8434229, 0.0)
10	3.67E+03	24,12/03/08	(187080, 8435029, 0.0)
11	3.55E+03	24,27/02/08	(187080, 8434229, 0.0)
12	3.53E+03	24,11/10/07	(187080, 8434229, 0.0)
13	3.46E+03	24,09/02/08	(187080, 8434229, 0.0)
14	3.32E+03	24,03/02/08	(187080, 8434229, 0.0)
15	3.22E+03	24,08/02/08	(187080, 8434229, 0.0)
16	3.22E+03	24,27/11/07	(187080, 8434229, 0.0)
17	3.20E+03	24,17/12/07	(187080, 8434229, 0.0)
18	3.13E+03	24,07/10/07	(187080, 8434229, 0.0)
19	3.12E+03	24,30/04/08	(186680, 8434629, 0.0)
20	3.12E+03	24,17/11/07	(187080, 8434229, 0.0)
21	3.08E+03	24,30/01/08	(187080, 8434229, 0.0)
22	3.06E+03	24,29/12/07	(187080, 8434229, 0.0)
23	3.04E+03	24,28/02/08	(187080, 8434229, 0.0)
24	3.02E+03	24,15/02/08	(187080, 8434229, 0.0)
25	2.97E+03	24,20/01/08	(187080, 8434229, 0.0)
26	2.95E+03	24,10/02/08	(187080, 8434229, 0.0)
27	2.94E+03	24,07/01/08	(187080, 8434229, 0.0)
28	2.92E+03	24,28/12/07	(187080, 8435029, 0.0)
29	2.92E+03	24,27/01/08	(187080, 8434229, 0.0)
30	2.91E+03	24,08/01/08	(187080, 8434229, 0.0)
31	2.90E+03	24,19/01/08	(187080, 8434229, 0.0)
32	2.89E+03	24,11/03/08	(187880, 8433429, 0.0)
33	2.87E+03	24,14/12/07	(187080, 8434229, 0.0)
34	2.86E+03	24,24/03/08	(187080, 8435029, 0.0)
35	2.82E+03	24,01/03/08	(187080, 8434229, 0.0)
36	2.81E+03	24,24/01/08	(187480, 8435029, 0.0)
37	2.79E+03	24,26/11/07	(187080, 8434229, 0.0)
38	2.79E+03	24,13/02/08	(187080, 8434229, 0.0)
39	2.78E+03	24,10/12/07	(187080, 8434229, 0.0)
40	2.74E+03	24,25/03/08	(187080, 8434229, 0.0)
41	2.74E+03	24,23/12/07	(187080, 8435029, 0.0)
42	2.73E+03	24,08/12/07	(187080, 8434229, 0.0)
43	2.73E+03	24,03/03/08	(186680, 8434629, 0.0)
44	2.72E+03	24,04/02/08	(187080, 8434229, 0.0)
45	2.72E+03	24,25/01/08	(187880, 8433429, 0.0)
46	2.70E+03	24,18/11/07	(187080, 8434229, 0.0)
47	2.69E+03	24,26/01/08	(187080, 8435029, 0.0)
48	2.69E+03	24,26/12/07	(186680, 8434629, 0.0)
49	2.68E+03	24,03/05/08	(186680, 8434629, 0.0)
50	2.64E+03	24,27/12/07	(187880, 8433429, 0.0)
51	2.63E+03	24,27/03/08	(187080, 8435029, 0.0)
52	2.61E+03	24,26/03/08	(187080, 8435029, 0.0)
53	2.61E+03	24,07/11/07	(187080, 8434229, 0.0)
54	2.61E+03	24,29/04/08	(186680, 8434629, 0.0)
55	2.60E+03	24,15/12/07	(187080, 8434229, 0.0)
56	2.60E+03	24,20/07/08	(187080, 8434229, 0.0)
57	2.57E+03	24,22/03/08	(187080, 8435029, 0.0)
58	2.57E+03	24,20/11/07	(187080, 8434229, 0.0)
59	2.55E+03	24,21/12/07	(187080, 8434229, 0.0)
60	2.54E+03	24,23/10/07	(187080, 8434229, 0.0)
61	2.54E+03	24,21/03/08	(187080, 8435029, 0.0)
62	2.53E+03	24,11/12/07	(187080, 8435029, 0.0)
63	2.52E+03	24,05/11/07	(187080, 8435029, 0.0)
64	2.51E+03	24,28/05/08	(186680, 8434629, 0.0)
65	2.51E+03	24,02/02/08	(187080, 8434229, 0.0)

66	2.48E+03	24,11/02/08	(187080, 8434229, 0.0)
67	2.47E+03	24,07/07/08	(186680, 8434629, 0.0)
68	2.44E+03	24,20/03/08	(187880, 8433429, 0.0)
69	2.44E+03	24,29/01/08	(187080, 8435029, 0.0)
70	2.43E+03	24,10/01/08	(187080, 8434229, 0.0)
71	2.43E+03	24,23/04/08	(186680, 8434629, 0.0)
72	2.42E+03	24,30/12/07	(187480, 8435029, 0.0)
73	2.39E+03	24,09/12/07	(187080, 8434229, 0.0)
74	2.38E+03	24,22/10/07	(187080, 8434229, 0.0)
75	2.37E+03	24,16/02/08	(187080, 8434229, 0.0)
76	2.36E+03	24,23/01/08	(187080, 8434229, 0.0)
77	2.35E+03	24,19/05/08	(186680, 8434629, 0.0)
78	2.35E+03	24,24/04/08	(186680, 8434629, 0.0)
79	2.33E+03	24,09/01/08	(187080, 8434229, 0.0)
80	2.31E+03	24,30/03/08	(186680, 8434629, 0.0)
81	2.30E+03	24,02/01/08	(187480, 8434629, 0.0)
82	2.30E+03	24,12/11/07	(187080, 8434229, 0.0)
83	2.29E+03	24,31/03/08	(186680, 8434629, 0.0)
84	2.28E+03	24,07/04/08	(186680, 8434629, 0.0)
85	2.28E+03	24,06/10/07	(187080, 8434229, 0.0)
86	2.27E+03	24,01/07/08	(186680, 8434629, 0.0)
87	2.26E+03	24,30/10/07	(187080, 8434229, 0.0)
88	2.26E+03	24,21/02/08	(187080, 8434229, 0.0)
89	2.25E+03	24,01/02/08	(187480, 8435029, 0.0)
90	2.24E+03	24,05/05/08	(186680, 8434629, 0.0)
91	2.24E+03	24,08/04/08	(186680, 8434629, 0.0)
92	2.23E+03	24,29/11/07	(187080, 8434229, 0.0)
93	2.23E+03	24,06/08/08	(186680, 8434629, 0.0)
94	2.22E+03	24,06/12/07	(187080, 8434229, 0.0)
95	2.22E+03	24,15/03/08	(187880, 8433429, 0.0)
96	2.20E+03	24,13/03/08	(187080, 8435029, 0.0)
97	2.19E+03	24,12/04/08	(187880, 8433429, 0.0)
98	2.18E+03	24,27/05/08	(186680, 8434629, 0.0)
99	2.18E+03	24,29/10/07	(187080, 8434229, 0.0)
100	2.18E+03	24,27/04/08	(186680, 8434629, 0.0)

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
1	D Featherston B Cook	Andrew Balch		Ian McCardle		6/6/2013