Air quality assessment of the proposed Wandoan Coal Mine

Prepared for

Parsons Brinckerhoff

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Glossary

Term	*Definition*
%	percent
$\mu g/m^3$	micrograms per cubic metre
μm	microns
<	less than
>	greater than
^0C	degrees Celsius
m AHD	meters Australian Height Datum
AS	Australian Standard
AS/NZS	Australian Standards/New Zealand Standards
BCM	Bulk cubic meter
BoM	Bureau of Meteorology
CHPP	Coal Handling and Preparation Plant
CO	Carbon monoxide
CO_2	Carbon dioxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEM	Dust extinction moisture
e.g.	for example
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EP Act	*Environmental Protection Act 1994* (Qld)
EPA	Queensland Environmental Protection Agency
EPP	Environmental Protection Policy
GWh	Gigawatt hours
i.e.	that is,
kL	kilolitres
kL/day	kilolitres per day
km	kilometre
km/h	kilometre per hour
km^2	square kilometre
m	metre
M	million
m/s	metres per second
m^2	square metres
m^3	cubic metres
m^3/s	cubic metres per second
mg	milligram
MLA	mining lease application
Mm^3	million cubic metres
Mt	million tonnes
Mtpa	million tonnes per annum
MW	megawatt
Nm^3	Normalised cubic metre
No.	Number
NO_2	Nitrogen dioxide

NO_x	Oxides of nitrogen
NPI	National pollution inventory
NWP	numerical weather prediction
ou	Odour units
PM	Particulate matter (fine dust)
$PM_{2.5}$ and PM_{10}	Particulate matter less than 2.5 or 10 microns, respectively
Project	Wandoan Coal Project
SO_2	sulphur dioxide
t	tonnes
tpa	tonnes per annum
TEOM	Tapered element oscillating microbalance
ToR	Terms of Reference as defined by Part 4 of the *State Development & Public Works Organisation Act 1971*
tph	tonnes per hour
TSF	Tailings storage facility
TSP	total suspended particles
TSS	total suspended solids
VOC	Volatile organic compounds
WJV	Wandoan Joint Venture, and the Proponent
Xstrata Coal Queensland	lead proponent representative
XCQ	Xstrata Coal Queensland

Contents

Tables

Figures

Executive Summary

The Wandoan Coal Project (the Project) comprises the development of a mine and extraction of thermal coal resources and is situated immediately west of the Wandoan township in the Dalby Regional Council area. The mining of the coal will be undertaken using a combination of truck, shovel, dozer and dragline mining equipment. Coal will be mined at a rate of around 30 million tonnes per annum (Mtpa) run of mine (ROM) coal. The coal will be crushed, sized and washed before being transported by rail to port facilities at Gladstone.

The key aspects of the Project in terms of the air quality impact assessment are as follows:

- *Potential impacts of dust due to the mine operations for the following representative years over the life of the mine:*
  - *Do nothing (construction impacts only)*
  - *Year 1 of mining operation*
  - *Year 5 of mining operation*
  - *Year 10 of mining operation*
  - *Year 20 of mining operation*
  - *Year 30 of mining operation*
- *Potential impacts of nitrogen dioxide and carbon monoxide due to the potential operation of a gas-fired dual fuel engine power station of up to 80 MW output*
- *Potential impacts of odour due to the upgrade of the Wandoan Wastewater Treatment Plant*
- *Potential impacts of dust due to the construction of the mine and associated infrastructure (including gas and sewerage pipeline, wastewater treatment plant (WWTP), and the upgrade of the potable water supply).*

The air quality assessment has been undertaken in accordance with the Environmental Protection (Air) Policy 1997 (EPP(Air)) goals and recognised techniques for dispersion modeling and emission estimation. The impact assessment presents the worst case scenario for each potential impact.

The overall findings of the air quality assessment are as follows:

Mining operations

- *Dispersion modeling has been undertaken to assess the potential impact of the Project on ground-level concentrations of* PM_{10} *and TSP as well as the dust deposition rate at the Wandoan township and other surrounding sensitive receptors.*
- *The results show:*
  - *Compliance with the annual average EPP(Air) goal of 50* $\mu g/m^3$ *for* PM_{10} *for Year 1, 5, 10, 20 and 30.*
  - *Compliance with the annual average EPP(Air) goal of 90* $\mu g/m^3$ *for TSP for Year 1, 5, 10, 20 and 30.*
  - *Compliance with the annual average recommended guideline of 120* $mg/m^2/day$ *for dust deposition rate for Year 1, 5, 10, 20 and 30.*
  - *At the Wandoan township, maximum 24-hour average ground-level concentrations of* PM_{10} *are predicted to be below the EPP(Air) goal of 150* $\mu g/m^3$ *for* PM_{10} *for Year 1, 10, 20 and 30.*

- *To obtain acceptable levels of PM_{10} in the Wandoan town in Year 5, appropriate management and mitigation measures will need to be adopted at Frank Creek Pit as operations approach within 2 kilometres (km)of the town to ensure compliance with the relevant standards .*
- *In Year 5 sensitive receptors to the north of the tailings storage facility (TSF) along Grosmont Road may be exposed to elevated levels of 24 hour PM_{10} due to operations in the Austinvale Pit and appropriate management and/or mitigation measures will need to be implemented to ensure compliance with the relevant standards*
- *In Years 1 and 10, maximum 24-hour and annual average ground-level concentrations of TSP, PM_{10} and dust deposition are predicted to comply with the EPP(Air) goals for each criteria.*
- *In Years 20 and 30, sensitive receptors within 2 (km)west and south of the MLA's may be exposed to elevated levels of 24 hour PM_{10} due to the proximity of the draglines, and appropriate management and/or mitigation measures will need to be implemented to ensure compliance with the relevant standards,*
- *In Years 20 and 30, sensitive receptors north of the Summer Hill ROM Pad may be exposed to elevated levels of 24 hour PM_{10} due to dust lift off, and appropriate management and/or mitigation measures will need to be implemented to ensure compliance with the relevant standards*

Power Station

- *Dispersion modelling has been undertaken to assess the potential impact of the Power Station on ground-level concentrations of nitrogen dioxide and carbon monoxide at the Wandoan township and other surrounding sensitive receptors.*
- *The results show:*
    - *Predicted ground-level concentrations of nitrogen dioxide and carbon monoxide are higher for Option 1 (80MW output plant) than for Option 2 (30MW output plant). This is to be expected due to Option 1 having a larger capacity than Option 2.*
    - *Compliance with the 1-hour average EPP(Air) goal of 320 $\mu g/m^3$ for nitrogen dioxide for both options.*
    - *Compliance with the 8-hour average EPP(Air) goal of 10,000 $\mu g/m^3$ for carbon monoxide for both options.*

Waste Water Treatment Plant (WWTP)

- *Dispersion modelling has been undertaken to assess the potential impact of the upgraded WWTP on ground-level concentrations of odour.*
- *The results show there are no exceedances predicted of the EPA odour guideline of 2.5 ou (99.5th percentile, 1-hour average) from the WWTP for the baseline and upgrade scenarios.*

Mine Infrastructure Construction

- *A qualitative assessment of construction impacts on air quality was undertaken*
- *The construction impacts to air quality outside of the Mine Lease Application areas will be insignificant.*

Traffic

- *A qualitative assessment of traffic impacts on air quality was undertaken.*
- *The traffic impacts to air quality outside of the Mine Lease Application areas will be insignificant.*

Gas Pipeline Construction

- *A qualitative assessment of Gas pipeline construction air quality impacts was undertaken.*
- *The gas pipeline construction impacts to air quality outside of the Gas pipeline corridor will be insignificant.*

Mitigation

Measures to minimise the potential impact of fugitive dust emissions must recognise all potential sources of dust emissions and have strategies in place to mitigate any unnecessary emissions and adverse impacts that the proposed activities may have on the health and amenity of the surrounding community. An air quality management plan will have both proactive and reactive measures.

As part of the proactive management plan, the following monitoring is recommended for implementation:

- *Maintain real time continuous monitoring of PM_{10} at Wandoan township*
- *Establish continuous real time monitoring of PM_{10} at representative non-mine-owned residences where dispersion modeling suggests dust levels could approach within 80% (120 µg/m^3 of the air quality standard (Figure 74, Table 18)*
- *Establish real time meteorological monitoring to form the basis of a high dust potential forecasting system.*
- *Coupled with the dust monitoring program, meteorological conditions will inform the reactive management plan*

It is recommended that the reactive management plan should include the following mitigation measures where necessary:

- *Implementation of water sprays or chemical suppressants on stockpiles during the adverse meteorological conditions listed below.*
- *Implementation of wind breaks, i.e.* tree planting, *around stockpiles and TSFs that are located within one kilometre of a sensitive receptor.*
- *Adaptive management strategies when meteorological monitoring suggests adverse wind conditions or dust monitoring at sensitive receptors indicates levels are near to exceeding the air quality criteria (*Table 1*)*

For the purpose of the reactive management plan measures, adverse meteorological conditions for the township of Wandoan refer to:

- *Strong (6 to 8 m/s) northwest and westerly winds for dust,*
- *light (< 3 m/s) northwest, westerly winds for CO and NO_x, and*
- *light (< 3 m/s) northeasterly winds for odour.*

The adverse weather conditions for all situations are compounded by an inversion or lowered mixing height. The control measures outlined above are consistent with best practice for this type of Project.

1. Introduction

The purpose of this assessment is to:

- Describe the existing air environment that may be affected by the Project;
- Define and describe the objectives and practical measures for protecting and/or enhancing environmental values for air (including achieving relevant standards and indicators);
- Evaluate the air quality impacts of the Project on the existing air environment Detail proposed monitoring, auditing and management techniques

This assessment does not cover greenhouse gas emissions

1.1 Project background

The Wandoan Coal Project (the Project) comprises the development of a mine and extraction of thermal coal resources and is situated immediately west of the Wandoan township in the Dalby Regional Council area. The Project is located approximately 407 km northwest of Brisbane and 60 km south of Taroom as shown in Figure 1. The coal reserves for this Project are covered by three mining lease applications, MLA 50229, 50230 and 50231 as shown in Figure 2. The coal resources are proposed to be developed as an open cut mine with related infrastructure. The mining of the coal will be undertaken using a combination of truck, shovel, dozer and dragline mining equipment. Coal will be mined at a rate of around 30 million tonnes per annum (Mtpa) run of mine (ROM) coal. The coal will be crushed, sized and washed before being transported by rail to port facilities at Gladstone.

The Project will be developed by the Wandoan Joint Venture. The joint venture partners are Xstrata Coal Queensland Pty Ltd (XCQ), ICRA RPW Pty Ltd and Sumisho Coal Australia Pty Ltd.

1.2 Description of study area

Figure 2 shows the Project area which is located in the Surat Basin immediately west of Wandoan. Other towns of note include Taroom and Miles, which are located approximately 60 km to the north and 69 km to the south of Wandoan, respectively.
Figure 3 illustrates the study area considered for the air quality impact assessment of the Projects, construction, mining activities, power plant, WWTP, rail loop and gas supply pipeline.

The study area covers 1600 km^2 and extends beyond the borders of the MLAs (Figure 3) to encompass the wider community and any sensitive receptors in the region (Table 27). The study area was then further refined to include a high resolution area covering 174 km^2 (Figure 3 inset) ensuring the town of Wandoan is well represented within the modeled domains.

This air quality impact assessment does not cover the transportation of coal along the proposed Surat Basin Rail line, which is the subject of a separate EIS by the Surat Basin Rail Joint Venture. However, the proportion of the Surat Rail that operates within the Mine Lease Application (MLA) Areas of the Project is assessed.

2. Methodology of assessment and limitations

2.1 Relevant legislation and guidelines

2.1.1 Air quality criteria

The Queensland Government's objective in relation to air quality is defined under Section 3 of the *Environmental Protection Act 1994* (EP Act). The object is to protect Queensland's environment while allowing the development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development).

The EP Act gives the Minister for Sustainability, Climate Change and Innovation the power to create Environmental Protection Policies that identify environmental values to be enhanced or protected and aim to protect environmental values of the atmosphere that are conducive to the health and well-being of humans and biological integrity.

The *Environmental Protection (Air) Policy 1997* (EPP(Air)) came into force on 1 February 1998. The administering authority must consider the requirements of the EPP(Air) when it decides an application for an environmental authority, a development application, amendment of a licence or approval of a draft environmental management plan/program.

In making its decision, the administering authority must carry out the following steps for each relevant activity:

(a) consider how the activity may affect the environmental values;
(b) evaluate the activity in relation to the following –
  (i) any relevant program developed by the chief executive
  (ii) the air quality goals
  (iii) any relevant approved code of practice
  (iv) the standard criteria and other matters that must be considered under the EP Act
  (v) matters mentioned in section 12 of the EP Act
(c) review potential conditions with the applicant.

Schedule 1 of the EPP(Air) specifies air quality indicators and goals for Queensland. Indicators and goals that are relevant for this Project are reproduced in Table 1.

The National Environment Protection Council defines national ambient air quality standards and goals in consultation, and with agreement from, all state governments. These were first published in 1997 in the *National Environment Protection (Ambient Air Quality) Measure* (NEPM(Air)).

Compliance with the NEPM(Air) standards is determined via ambient air quality monitoring undertaken at locations prescribed by the NEPM(Air) and that are representative of large urban populations. The NEPM(Air) standards for PM_{10} and $PM_{2.5}$ are based on studies of exposure to urban air pollutants that includes the very fine particles associated with motor vehicles. Consequently, the application of these standards to coarser particulate matter from coal stockpiles and mining activities is likely to overestimate the potential for adverse impact. The NEPM(Air) standards are used to assess the exposure of large residential populations in urban centres and are, therefore, not directly applicable to the Wandoan Coal Project.

The EPP(Air) goals are used to assess impacts at sensitive locations (such as residential areas and isolated dwellings) that are located near industrial sites and extractive industries. The EPP(Air) goals are therefore applicable to the Wandoan Coal Project.

Dust nuisance can occur due to the deposition of larger dust particles in residential areas. Elevated dust deposition rates can cause reduced public amenity through, for example, soiling of clothes, building surfaces and other surfaces. Table 1 shows the dust deposition guideline commonly used in Queensland as a benchmark for avoiding amenity impacts due to dust. The dust deposition guideline is not defined in the EPP(Air) and is therefore not enforceable by legislation, but was recommended by the EPA during consultation as a design goal and has been adopted for this Project.

Table 1 Impact assessment criteria for criteria pollutants - EPP(Air) and recommended dust deposition guideline

Pollutant	Averaging period	Concentration	Units
Nitrogen dioxide	1-hour	320	$\mu g/m^3$
	Annual	30	$\mu g/m^3$
Carbon monoxide	8-hour	10,000	$\mu g/m^3$
Particulate matter (diameter <10 μm) (PM_{10})	24-hour	150	$\mu g/m^3$
	Annual	50	$\mu g/m^3$
Total suspended particulates (TSP)	Annual	90	$\mu g/m^3$
Dust deposition rate	Annual	120	$mg/m^2/day$

2.1.2 Health impacts from mine dust

Under normal conditions a human respiratory tract in good health is able to deal with inhaled particles without undue stress or long-term effects. In sensitive individuals, or when high levels of particles are present, particulate matter may contribute to increased rates of respiratory illnesses and symptoms.

Studies indicate that such adverse effects are dependent on a number of factors (Neale 2005), including:

- particle size (whether particles can penetrate the lower airways),
- the intensity of the exposure,
- the chemical nature of the particles and their interaction with human tissue,
- the presence or absence of pre-existing conditions (especially diseases of the respiratory tract), and
- meteorological factors such as winds, humidity, a temperature inversion, rain or thunderstorms

The vast majority of dust from mining activities consists of coarse particles (around 40 per cent) and particles larger than PM10, generated from natural activities such mechanical disturbance of rock and soil materials by dragline or shovel, bulldozing, blasting, and vehicles on dirt roads. Particles are also generated when wind blows over bare ground and different types of stockpiles (NSW DECC 2007).

2.1.3 Power Station

there are no regulatory limits for gas dual fuel engines in Queensland, the EPA commonly refers to the NSW Clean Air Regulations 2002, which has a stated emission limit of 450 mg/Nm^3 (normalised volumetric flow – which is the standard unit for gas fired power stations) (3% O_2) for a stationary reciprocating internal combustion engine.

2.1.4 Odour

The EPA's odour guidelines are contained in a document titled: *Guideline - Odour Impact Assessment from Developments, July 2004*. The EPA's odour guideline defines three different criteria for assessing odour annoyance for new proposals. Of most relevance to the Project is the odour annoyance threshold (concentration) guideline of 2.5 odour units ou (1-hour average, 99.5th percentile) for ground-level sources.

The odour guideline aims to protect odour sensitive places from odour nuisance. Odour sensitive places for this project include: the Wandoan Health Care Centre, Cultural Centre, community pool, show grounds, shotgun club, sports facilities, shops and business premises and residences.

2.2 How the study was conducted and information obtained

2.2.1 Scope of works

The key aspects of the Project in terms of the air quality impact assessment are the following:

- *Potential impacts of dust due to the mine operations for the following representative years over the life of the mine:*
  - Do nothing (construction impacts only)
  - Year 1 of mining operation
  - Year 5 of mining operation
  - Year 10 of mining operation
  - Year 20 of mining operation
  - Year 30 of mining operation
- Potential impacts of nitrogen dioxide and carbon monoxide due to the operation of a gas-fired dual fuel engine power station
- Potential impacts of odour due to the upgrade of the Wandoan Wastewater Treatment Plant
- Potential impacts of dust due to the construction of the mine and associated infrastructure (including gas and water pipelines, sewerage pipeline and the upgrade of the potable water supply and waste water treatment plant)

2.2.2 Methodology

The air quality assessment was conducted in accordance with recognised techniques for dispersion modeling and emission estimation.

- The prognostic model TAPM (developed by CSIRO, version 3) and the diagnostic meteorological model CALMET (developed by EarthTec, version 6) were used in conjunction with site specific meteorological data to develop a 3-dimensional windfield representing wind flows in the region. Refer to Attachment C for model details.

- The dispersion model CALPUFF (developed by EarthTec, version 6) and the regulatory dispersion model Ausplume (developed by the Victorian EPA) were used in the assessment of ground-level concentrations of pollutants due to the mine, power station and the upgraded Wastewater Treatment Plant.

- Emission factors for dust emissions from the mine were calculated based on emission factors published by the USEPA in their AP-42 documents and in the National Pollutant Inventory Handbooks.

- Emission rates of air pollutants from the power station were calculated from manufacturer specifications and supplementary information supplied by Parsons Brinckerhoff.

- Mining activities, such as extraction rates of coal and overburden, location of equipment and mining schedule were based on information supplied by Xenith Consulting Pty. Ltd, as detailed in Tables A1 to A5 of this report.

- Emission rates of odour from the upgraded Wastewater Treatment Plant were based on sampling of emissions from the existing Wandoan Wastewater Treatment Plant and discussions with wastewater treatment plant operations personnel from the Dalby Regional Council.

3. Existing environment

3.1 Climate

The Bureau of Meteorology (BOM) does not have a long term weather monitoring station in Wandoan, therefore the three closest (BOM) stations have been used to characterise the climatic conditions experienced at the study site. These sites include Miles 69 km to the south, Taroom 60 km to the north and Roma 124 km to the south west (Figure 1 and Table 2). The stations at Miles and Taroom have been operational for over 100 years and the Roma station has been recording data for 23 years. These sites provide a good indication of the prevailing long-term climate in the study area due to their close proximity, similar elevation and land use characteristics (rural).

Table 2 Bureau of Meteorology weather stations in close proximity to Wandoan

Location	BOM code	Range	Location	Elevation (m)
Miles	42023	1885 - 2008	26° 66' S 150° 18' E	302
Taroom	35070	1870 - 2008	25° 64' S 149° 80' E	199
Roma	43091	1985 - 2008	26° 54' S 148° 78' E	303

The climatic patterns at the study area are typical of inland rural sites found within Southeast Queensland, with mean maximum and mean minimum temperatures of 28° Celsius (C) and 13°C respectively. Average annual rainfall can be expected to be around 600 millimeters (mm) from approximately 60 rain days, six to seven of which will be above 25 mm. Relative humidity can vary from 60 % at 9 am to 40 % at 3 pm with a mean temperature of 20°C and 27°C (Table 3). The annual 9 am winds at all sites are dominated by light to moderate north to southeast flow typical of the south east trade winds. The 3 pm winds are characterized by a more varied wind pattern still dominated by the south east trade winds but inlaid with southwesterly and light north westerly flow (Figure 5). The inland regions of South East Queensland are typified by a hot and relatively dry climate, susceptible to drought induced erosion of the ground surface. Hot and dry conditions can lead to a significant amount of dust being generated particularly following the passage of frontal systems.

Table 3 Climate statistics for Miles, Taroom and Roma (BOM, 2008)

Parameter	Miles	Taroom	Roma
Mean maximum temperature (Degrees C)	27.1	28.2	27.8
Mean minimum temperature (Degrees C)	12.2	13.6	12.7
Lowest temperature (Degrees C)	-6.1	-5.6	-5.8
Mean rainfall (mm)	650.6	672.4	571.1
Mean number of days of rain	67.3	61.9	60.2
Mean number of days of rain >= 25 mm	6.6	6.6	6.7
Mean daily solar exposure (MJ/(m*m))	20.3	20.6	20.6
Mean number of clear days	133.6	143.9	155.1
Mean 9am temperature (Degrees C)	19.8	20	20.2
Mean 9am relative humidity (%)	62	65	57
Mean 9am wind speed (m/s)	3.11	2.31	3.97
Mean 3pm temperature (Degrees C)	26.1	27.1	26.6
Mean 3pm relative humidity (%)	40	40	34
Mean 3pm wind speed (m/s)	3.19	2.72	4.22

3.1.1 Regional meteorology

The meteorology in the Wandoan region, particularly in summer, is heavily influenced by the southeast trade winds and the embedded Queensland trough (elongated region of low atmospheric pressure) separating the Cloncurry heat low from the high pressure systems of southern Australia. The location and intensity of the trough is largely determined by the passage of fronts across southern Australia and the location of the Intertropical Convergence Zone (ITCZ). The Queensland trough is generally located to the west of the Great Dividing Range approximately 700 km off the coast; however, it does exhibit a diurnal pattern weakening and migrating inland as the surface cools following sunset. As the surface heats up again the following day the trough will strengthen, increasing the pressure gradient along the coast and return to its offshore position (Sturman and Tapper 1996). The winter pattern is characterised by a high pressure system situated across central Australia where southwesterly winds generated by the passing of fronts and the south-easterly trade winds dominate (Tapper and Hurry 1993).

3.1.2 Local meteorology

3.1.2.1 Wind speed and wind direction

The Wandoan Joint Venture (WJV) installed an automatic weather station (AWS) on the Project site that has measured wind speed and wind direction at ten metres above ground, temperature, pressure, relative humidity, solar radiation and rainfall since 3 April 2007.

Figure 6 shows the frequency of wind speed and wind direction from the 3 April 2007 to 31 March 2008. The wind rose shows moderate to strong (5 to 9 m/s) winds generally occur from the southwest to the southeast to the northeast, accounting for 90% of the wind variability. Light to moderate (< 2 to 4 m/s) winds from the northwest to westerly sector account for the remaining 10%. Maximum wind speeds are typically from the southeast and northeast, and rarely exceed 9 m/s, with a mean wind speed of 3.1 m/s (Table 4).

Table 4 Wind speed by sector and frequency of occurrence for the WJV meteorological monitoring station

Sector (°) Speed (m/s)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.00 - 1.00	26	22	33	58	44	43	54	69	46	33	31	27	19	22	19	21
1.00 - 2.00	60	112	148	162	113	146	201	259	214	110	79	56	56	43	33	38
2.00 - 3.00	104	137	174	155	127	174	175	241	272	207	108	53	60	38	51	72
3.00 - 4.00	86	100	135	189	168	178	130	128	138	166	111	62	27	12	24	35
4.00 - 5.00	137	101	106	153	169	119	88	68	81	102	53	27	11	7	10	34
5.00 - 6.00	94	47	42	83	100	61	54	41	33	49	29	22	5	5	3	21
6.00 - 7.00	30	29	15	43	45	51	42	27	8	42	19	14	1	1	0	10
7.00 - 8.00	9	4	4	6	11	12	34	8	5	13	4	0	1	1	0	0
8.00 - 9.00	0	0	0	10	1	1	11	2	1	1	0	0	0	0	0	0
9.00 - 10.00	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
10.00 +	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Frequency %	6	6	8	10	9	9	9	10	9	8	5	3	2	1	2	3

The location and intensity of the Queensland trough is evident in the seasonal and diurnal variations in the meteorological conditions experienced in Wandoan. Figure 7 is the seasonal break down of wind patterns at the Wandoan meteorological station. Southeasterly winds are clearly dominant in summer and autumn, with spring displaying a prevalent north to northeasterly component. The high proportion of north to northeasterly winds (56%) in spring is due to development of the Cloncurry heat low in the northern tropical regions from intense solar heating of the surface. As spring progresses into summer the heat low extends further south and the trough takes up its mean offshore position. The winter pattern is typical of the Australian east coast with a strong southwest to southeast wind component due largely to the passing of fronts associated with mid-latitude depressions.

The diurnal pattern of the Queensland trough is shown in Figure 8 where the deflection of the south east trade winds to the east and northeast is evident as the day progresses. Local terrain effects are also evident throughout the day as a significant south to southwesterly component is visible particularly from midday to midnight most likely due to channeling of air within the Frank Creek area. Midnight to 6 am is characterised by very light drainage flows from the west and northwest accounting for 5% of the nighttime wind regime. Strong to moderate winds from the southeast to northeast constitute the majority (> 50%) of the wind variability with peak wind speeds between 6 and 7 m/s.

In terms of the proposed mine and related infrastructure (potential power station and upgrade of the wastewater treatment plant) the frequency of wind speed and distribution of wind direction are key factors in the dispersion of pollutants. For example:

- Operations from the mine and power station will have the greatest potential for impact on the Township of Wandoan when the winds are from the west and northwest.
- Wind speed is important for dust emissions from a mine site. Exposed dust sources, such as stockpiles or exposed land, will have higher dust emissions during strong winds than during light winds. During strong winds, dust particles are more likely to be lifted by the wind and carried further off-site than during light winds.
- For stacks, convective conditions (highly unstable conditions) have the tendency to bring a plume to the ground, resulting in elevated ground-level concentrations of those constituents. These conditions generally occur during the day.
- For odour impacts, worst-case meteorological conditions are generally light winds during the evening or early morning.

3.1.2.2 Stability class

Atmospheric stability classes and mixing heights were calculated from CALMET for the period modelled, 3 April 2007 to 31 March 2008 (Table 5). Atmospheric stability is classified under the Pasquill-Gifford scheme and ranges from Class A, which represents very unstable atmospheric conditions that may typically occur on a sunny day, to Class F which represents very stable atmospheric conditions that typically occur during light wind conditions at night. Unstable conditions (Class A-C) are characterised by strong solar heating of the ground that induces turbulent mixing in the atmosphere close to the ground, and usually results in material from a plume reaching the ground closer to the source than for neutral conditions or stable conditions. This turbulent mixing is the main driver of dispersion during unstable conditions. Dispersion processes for neutral conditions (Class D) are dominated by mechanical turbulence generated as the wind passes over irregularities in the local surface, such as terrain features and building structures. During night time, the atmospheric conditions are typically neutral or stable (Class D, E and F). Stability refers to the vertical movement of the atmosphere and is therefore an important factor in the dispersion and transport of particulates within the boundary layer.

Table 5 Frequency distribution of surface atmospheric stability conditions at the Wandoan meteorological site

Pasquill-Gifford Stability Class	Frequency (%)	Classification
A	1.8	Extremely unstable
B	13.7	Unstable
C	20.1	Slightly unstable
D	19.9	Neutral
E	12.1	Slightly stable
F	32.3	Stable

There is a high percentage of F class or very stable conditions. This is due to the inland and relatively flat location of the site, meaning that strong nighttime cooling of the surface is a dominant feature of microclimatic regime. This leads to a lowering of the mixing height and the possible development of low level inversions. The relatively high proportion of B and C class stability is due to strong daytime heating of the surrounding land and relatively light wind conditions.

3.1.2.3 Mixing height

The mixing height refers to the height above ground within which the particulates can mix with ambient air. During stable atmospheric conditions (night time) the mixing height (inversion) is often quite low and particulates are dispersed within this layer. During the day, solar radiation heats the air at the ground level and causes the mixing height to rise. The air above the mixing height during the day is generally colder. The growth of the mixing height is dependent on how well the air can mix with the cooler upper levels of air and therefore depends on meteorological factors such as the intensity of solar radiation and wind speed. During strong wind speed conditions the air will be well mixed, resulting in a high mixing height.

Mixing height information for the Wandoan area has been extracted from CALMET for the modelling period, and is presented in Figure 9. The figure shows that the mixing height tends to develop around 6-7 am, peaks mid-midday (1-2 pm) before decreasing sharply around sunset (5-6 pm). This is indicative of the strong radiative cooling experienced at the site.

3.1.3 Development of meteorological windfield for dispersion modelling

Whilst there is site specific meteorological data available for the assessment, a three dimensional wind field was required for inclusion in the dispersion modelling of potential impacts from the Wandoan Coal Project. A coupled approach using the meteorological models TAPM (CSIRO, version 3) and CALMET (Earthtech, version 6) in conjunction with the on-site measurements has been used. Details of this modelling approach are provided in Attachment C.

3.2 Ambient air quality

The region of Wandoan is primarily rural. There are approximately 400 people living in Wandoan. The Leichhardt Highway is the main transport corridor in the region that links Wandoan with Taroom in the north and Miles in the south. Within the township of Wandoan there is a wastewater treatment plant, a refuse centre, a saw mill and sale yards. Due to the relatively non-industrial nature of the area, the existing air quality in the region is likely to show relatively low levels of TSP, PM10, NO_2 and CO.

3.2.1 Ambient dust levels and dust monitoring

The Wandoan Joint Venture commenced monitoring of PM_{10}, using a TEOM, (Figure 4) in March 2008 to measure the existing levels of PM_{10} at the Township of Wandoan (TEOM 1 located at Short Street) and on the mine site (TEOM 2 located at Jondale Property). Dust deposition rates were also measured at both of these locations. Eight months of monitoring results, from March until October are presented below.

3.2.1.1 PM_{10}

Figure 10 presents the 24-hour average concentrations of PM_{10} measured at the Jondale site and at the Wandoan Township for the period March to October. It is noted that on two occasions, 28 April 2008 and 19 September 2008, the levels of PM_{10} were elevated, above 100 µg/m^3. This can be attributed to two dust storms that covered much of the state following the passage of frontal systems. To ascertain a mean 24 hour background PM_{10}, statistical characteristics of the data measured at the two monitoring sites was compared with the EPA's Toowoomba monitoring station at Willowburn Oval (Table 6 and Figure 11). As the monitoring locations have only been operating for eight months the 95th percentile was chosen as a conservative background value. Therefore this assessment has used a 24 hour PM_{10} concentration of 30 µg/m^3 as a background for the modeling.

To establish a mean annual PM_{10} background the average of the eight months of data was compared with the Willowburn site (Table 6). The annual average ground-level concentrations of PM_{10} was determined to be 15 µg/m^3.

Table 6 Comparison of measured PM_{10} (µg/m^3) for Toowoomba, Jondale and Wandoan

Monitoring Site	Mean	StDev	Max	Min	95th
TOOWOOMBA	15	7	59	4	28
TEOM1 TOWN	15	11	100	5	25
TEOM2 Jondale	12	12	108	5	28

3.2.1.2 TSP and dust deposition rate

There are no known measurements of TSP in the region. Previous assessments by Katestone Environmental and standard conversion ratios detailed in the US EPA's Compilation of Air Pollution Emission Factors Volume 1 (AP-42) and in the National Pollutant Inventory (NPI) Handbooks, have found that PM_{10} is usually 50% of the TSP concentration. In accordance with standard industry practice, this ratio has been employed here giving an annual background level of 30µg/m^3 for TSP.

Dust deposition gauges were co-located with the TEOMs (Figure 4) to provide a baseline from which the estimation of dust deposition was possible. The results of total insoluble solids (mg/m^2/day) for five months of monitoring are presented in Figure 12. The amounts of deposited dust recorded for the month of July appear quite low, while May is quite high at the Jondale site due to region wide dust storms reported during this month. No statistical analysis is available on the frequency of dust storms in the region. However, it is recognised that dust storms are commonly associated with the passage of cold frontal systems. The cold front can generate strong surface winds at the leading edge of the front encouraging the entrainment of dust. The leading edge of the front is also a zone of convergence where vertical uplift of wind and particulates can be quite strong, thus giving rise to localised dust storms (Mcinnes *et. al.* 1994).

Previous studies conducted in Australia have estimated a background dust deposition level of between 45 and 60 mg/m^2/day for rural areas with existing open cut mining activities and urban areas adjacent to existing coal terminals. Neither of which are comparable to the present situation in Wandoan. The statistical breakdown of the monitoring data is shown in Table 7. A maximum monthly average deposition rate of 42 mg/m^2/day was recorded at the Jondale site in May. The average dust deposition rate was 15 mg/m^2/day and 22 mg/m^2/day for the Town and Jondale site respectively. To determine an annual average background deposition rate the second highest record Jondale and the highest Town value were used. Therefore, based on the available data a dust deposition rate of 30 mg/m^2/day has been chosen as a conservative background level of dust deposition in the absence of the mine.

Table 7 Dust deposition statistics for the Town and Jondale monitoring sites

Monitoring site	Min	Max	Mean	Stdev	2nd Highest
Town	6	30	15	10	18
Jondale	3	42	22	14	27

3.2.2 Ambient levels of nitrogen dioxide and carbon monoxide

There are no known measurements of nitrogen dioxide and carbon monoxide at Wandoan. In instances when there are no local measurements, background levels may be inferred from other locations, similar in nature, such as the Willowburn Oval monitoring station in Toowoomba. This monitoring station has been operated by the EPA since July 2003 and measures concentrations of nitrogen dioxide and carbon monoxide as well as other pollutants.

A summary of the background monitoring data at this site is presented in Table 8. These data show that the existing concentrations of nitrogen dioxide and carbon monoxide are well below the EPP (Air) goals (Table 1). The main sources of air pollutants in Toowoomba are industries, motor vehicles and domestic activities such as wood fires that are used for heating and are representative of an urban area. The 1-hour, 95th percentile concentration of nitrogen dioxide is expected to be dominated by emissions from motor vehicles. The area surrounding the subject site is rural and sparsely populated with few industries and consequently levels of air pollutants will be much lower than the Toowoomba measurements. Therefore the background levels used in this assessment will be conservative.

Table 8 Measured concentrations of nitrogen dioxide and carbon monoxide from the EPA's monitoring station at Toowoomba

Air pollutant	Averaging period	Concentration (µg/m^3)		Goal/Standard
		Maximum	95th percentile	
Nitrogen dioxide	1-hour Annual	116 11	36 -	320 30
Carbon monoxide	8-hour	2,625	758	10,000
Note: Data period September 2005 to July 2007				

4. Dust from mining operations

4.1 Description

Six scenarios have been assessed in terms of potential impacts of dust due to the Project, with Year 5 having two subset scenarios given the proximity of the Project to the Wandoan township based on the current projected mine plan: These Scenarios are based on representative years of mine operations over the life of the mine

- Scenario "Do nothing"

  The Do Nothing Scenario assumes that the coal mine is not built, and therefore reflects the existing environment.
- Scenario Year 1

  The Do Something Scenario assumes construction and operation of the coal mine, examining the first year of coal mining
- Scenario Year 5

  The Do Something Scenario assumes construction and operation of the coal mine, examining the fifth year of coal mining

  For Frank Creek Pit:

  a. Year 5 Dragline - operations are examined using blasting of entire bench height and dragline to remove overburden, operating 24 hours a day, seven days a week, with location of the dragline at the eastern edge of the pit
  b. Year 5 Truck and shovel - operations are examined with the exclusion of blasting and dragline operations (truck and shovel only) operating 24 hours a day, seven days a week at a reduced extraction rate.
- Scenario Year 10

  The Do Something Scenario assumes construction and operation of the coal mine, examining the tenth year of coal mining
- Scenario Year 20

  The Do Something Scenario assumes construction and operation of the coal mine, examining the twentieth year of coal mining
- Scenario Year 30

  The Do Something Scenario assumes construction and operation of the coal mine, examining the thirtieth year of coal mining

4.2 Activities on site

The air quality assessment takes into account dust generating activities from mining activities and disturbed surfaces within the mine lease application area boundaries and gas pipeline construction.

The Wandoan Coal Project is an open-cut thermal coal mining operation with a production rate of around 30 million tonnes per annum (Mtpa) run of mine (ROM). The mining method will involve blasting and drilling of overburden and the use of draglines to remove overburden to the upper coal seam. The draglines will side cast into the trailing pit which has already had the coal seam removed. The coal and subsequent partings and inter-burden removal will be by truck and excavator equipment. The coal laden 220 tonne haul trucks will transport to one of three ROM pads along unpaved haul roads. The stockpiled coal will then be transported by covered overland conveyors to the coal handling and processing plant (CHPP) where the raw coal is sized, crushed and washed before being loaded onto trains via chutes. The waste material generated from the washing processes will be placed into an TSF as saturated slurry. The fully loaded trains then shunt towards the Surat Basin Rail mine line via the rail spur and then north to the coal terminals in the Gladstone area. Once the train is outside the MLA area (i.e. before it reaches the main line) it is no longer included in this air quality assessment. These emissions are assessed in the Surat Basin Rail Project Environmental Impact Statement EIS.

Figure 13 illustrates the location of the pits and associated mine infrastructure.

4.3 Emission estimation

Activities for this Project associated with the most significant dust emissions are draglines, coal conveyors, coal stockpiles, truck and shovel operations, blasting and wheel generated dust on haul roads. Minor amounts of wind-blown dust are also associated with wind erosion of dust from bare ground and stockpiles.

Dust emission rates from the mine have been calculated using emission factors published by the US EPA in their Compilation of Air Pollution Emission Factors Volume 1 (AP-42) and in the Department of the Environment, Water, Heritage and the Arts National Pollutant Inventory Handbooks.

For the majority of dust producing activities, the dust emission rate is dependent on the wind speed, with little or no dust emissions occurring for some activities (e.g. stockpiling) below a threshold wind speed. For some dust sources (such as coal conveyors), the wind speed, frequency of utilisation and coal throughput are important determinants of the dust emission rate.

Other factors are also important such as coal type, coal moisture content, coal particle size distribution, rainfall and the mitigation measures that may be employed. The key factors that account for dust emissions have been accounted for in estimating dust emissions from the proposed Project. Details of the methodology for estimating dust emissions are included in Appendix B.

Five dust emission scenarios have been chosen to represent the mining activities that are representative of the mining years with the highest potential for causing offsite impacts. These are Year 1, Year 5, Year 10, Year 20 and Year 30. Dust emission rates have been calculated using the detailed information on mining activities for each of the five scenario years and standard coal mining emission factors. These are provided in Attachment B.

Details of the amount of overburden and coal extracted for each of the mine pits and on the locations where coal and overburden are dumped and where all the equipment will be operating have been provided by Xenith Consulting Pty Ltd. This information was provided for each of the mine scenarios assessed. Figure 14 presents the proposed mining schedule for the Project. Figure 15 to 15 show indicative locations of equipment for the scenarios modelled, except for the Year 1 scenario as the operation is relatively insignificant, and therefore an equipment plan was not supplied for this scenario. Coal and overburden extraction rates for each of the mine pits for each of the scenario years are shown in Appendix A. The area of the coal pit, overburden area and coal stockpiles are also included in Attachment A for each pit area.

The emission factors that have been used to calculate dust emission rates are reproduced in Attachment B. The emission factors are based on the factors developed by the US EPA (AP-42) and National Pollutant Inventory Handbooks for all sources except for the conveyor length. For the length of the conveyors an emission factor has been derived from studies by GHD and Oceanics Australia in 1975 (GHD 1975).

4.4 Model configuration

Dust dispersion modelling was carried out for all scenarios detailed in Section 4.1 except for the Do nothing scenario. All scenarios modelled considered a worst case 24-hour average and annual average simulation for PM_{10}, total suspended particulate (TSP) and dust deposition. Twelve months of modeled meteorological data was used as input for the dispersion model. This encompasses all weather conditions likely to be experienced in the region during a typical year. Results are presented below with and without ambient background levels to assess the potential impacts mining activities may have on the town of Wandoan and surrounding areas. CALPUFF v6.0 was utilised to calculate the dispersion potential of dust generated by mining activities. Meteorological input for CALPUFF was derived from a coupled TAPM/CALMET approach to generate a three dimensional wind field including average observational data assimilation. Details of the model are provided in Attachment C.

For dust deposition modelling, a particle size distribution was included based on size fractions of TSP, PM_{10} and $PM_{2.5}$ reported for the various mine sources in AP-42. Table X shows the background ground level concentrations of 24 hour PM_{10}, annual PM_{10}, TSP and dust deposition that have been added to the modeled results for each scenario (refer Section 3.2).

Table 9 Background ground level concentrations used as baseline for modelling results

Pollutant	Averaging period	Concentration	Units
Particulate matter (diameter <10 μm) (PM_{10})	24-hour	30	μg/m^3
	Annual	15	μg/m^3
Total suspended particulates (TSP)	Annual	30	μg/m^3
Dust deposition rate	Annual	30	mg/m^2/day

4.5 Results

Reference is made to two types of sensitive receptor:

- in Wandoan Township defined as the yellow region in Figures 19 through to Figure 60; and
- adjacent to the MLA area boundaries not located in the town
- The highest ground level concentration at the two types of receptors is presented

4.5.1 Do nothing

The “Do nothing” scenario assumes that the Wandoan Coal Project is not built, and therefore reflects the present environment (refer Section 3). There are no impacts and therefore no need for management or mitigation measures.

4.5.2 Year 1

The maximum 24-hour average and annual average ground-level concentrations of PM_{10}, predicted to occur at the township of Wandoan, MLA-520 and MLA 356 are presented in Table 10.

The results show:

- Compliance with the EPP(Air) 24-hour average goal of 150 $\mu g/m^3$ for PM_{10}. The maximum ground-level concentration predicted at the township of Wandoan is 74.8 $\mu g/m^3$, with a background of 30 $\mu g/m^3$ included. This is less than 50% of the goal. The highest concentration predicted at MLA-520 is 87.9 $\mu g/m^3$ less than 59% of the of the goal

- Compliance with the EPP(Air) annual average goal of 50 $\mu g/m^3$ for PM_{10}. The annual average ground-level concentration predicted at the township of Wandoan is 16.7 $\mu g/m^3$, less than 34% of the goal. The highest concentration predicted at MLA-356 is 29.2 $\mu g/m^3$.

The annual average ground-level concentrations of TSP and annual average dust deposition rates predicted at the Wandoan township and at MLA-356, are also presented in Table 10.

The results show:

- Compliance with the EPP(Air) annual average goal of 90 $\mu g/m^3$ for TSP. The annual average ground-level concentration predicted at the township of Wandoan is 30.4 $\mu g/m^3$, with a background 30 $\mu g/m^3$ included. This is less than 34% of the goal. The highest concentration predicted at a receptor outside of town is 38.7 $\mu g/m^3$ (MLA-356) less than 43% of the goal.

- Compliance with the recommended EPA guideline of 120 $mg/m^2/day$ (annual average) for the dust deposition rate. The annual average dust deposition rate predicted at the township of Wandoan is 30.8 $mg/m^2/day$, less than 26% of the guideline. The highest concentration predicted at a receptor outside of town is 40.4 $mg/m^2/day$ at MLA-356 to the north east of the tailings storage facility.

Figure 19 and Figure 21 present the maximum 24-hour and annual average ground-level concentrations of PM_{10}, predicted due to the mine only. Figure 20 and Figure 22 include background concentrations.

The annual average ground-level concentrations of TSP are presented in Figure 23, due to the mine in isolation and including the background in Figure 24. The annual average dust deposition rate due to the mine in isolation and including background concentrations, are presented in Figure 25 and Figure 26.

Table 10 Maximum predicted ground-level concentrations of PM_{10}, TSP and dust deposition rate, due to the mine operating in Year 1

Pollutant	Averaging period	Predicted ground-level concentrations								Goal/ Standard
		Wandoan Township				Highest at a sensitive receptor[2,3] not in Wandoan Township				
		Mine only		Mine (with b/g)[1]		Mine only		Mine (with b/g)[1]		
		$\mu g/m^3$	% of goal	$\mu g/m^3$	% of goal	μgm^3	% of goal	$\mu g/m^3$	% of goal	
PM_{10}	24-hour	44.8	30	74.8	50	57.9	39	87.9	59[2]	150 $\mu g/m^3$
	Annual	1.7	3	16.7	33	5.5	11	20.5	41[3]	50 $\mu g/m^3$
TSP	Annual	2.1	2	32.1	36	8.7	10	38.7	43[3]	90 $\mu g/m^3$
Dust deposition	Annual	1.3	1	31.3	26	10.4	9	40.4	34[3]	120 $mg/m^2/day$

[1] b/g: background concentration
[2] MLA-520
[3] MLA-356

4.5.3 Year 5

4.5.3.1 Dragline operations

The maximum 24-hour average ground-level concentrations of PM_{10}, predicted to occur at the township of Wandoan and at a sensitive receptor not located in the town are presented in Table 11.

The results show:

- The EPP(Air) 24-hour average goal of 150 $\mu g/m^3$ for PM_{10} is exceeded. The maximum ground-level concentration predicted at the township of Wandoan is 306 $\mu g/m^3$. The highest concentration predicted at a receptor outside of town is 464 $\mu g/m^3$ (MLA-520). This is likely to be due to the close proximity of sensitive receptors east of the Leichardt Highway, and rate of the mining activity. An alternate operating scenario with truck and excavator or shovel was accordingly investigated (refer to Section 4.5.3.2.).

The maximum 24-hour average ground-level concentrations of PM_{10} due to the mine in isolation and with a background are presented in Figure 27 and Figure 28, respectively.

Table 11 Maximum predicted ground-level concentrations of 24-hour average PM_{10} due to the mine operating in Year 5 - dragline

Pollutant	Averaging period	Predicted ground-level concentrations								Goal/ Standard
		Wandoan Township				Highest at a sensitive receptor[2] not in Wandoan Township				
		Mine only		Mine[1] (with b/g)		Mine only		Mine[1] (with b/g)		
		$\mu g/m^3$	% of goal	$\mu g/m^3$	% of goal	$\mu g/m^3$	% of goal	$\mu g/m^3$	% of goal	
PM_{10}	24-hour	276	184	306	204	434	289	464	309	150 $\mu g/m^3$

[1] b/g: background concentration
[2] MLA-520

4.5.3.2 Truck and excavator or shovel operations

For this alternative assessment, operations at the Wandoan mine site were as per the mine schedule for all active pits with the exception of the Frank Creek Pit. The activity rate of overburden removal, partings separation, coal extraction and blasting frequency were reduced to ascertain the maximum rate of activity possible while staying within acceptable air quality goals and guidelines as stated in the EPP(Air).

Details of scenario assumptions are provided below.

- No blasting and drilling
- Overburden removal at 2,842,606 bcm per annum by truck and shovel
- Coal removal at 767,503 tonnes per annum
- Overburden and coal extraction were along the eastern extent of Frank Creek Pit,1 km southeast of the town of Wandoan (Figure 13)

The results of the sensitivity analysis indicate that a reduction in extraction rate and alteration of mining activities, such that drilling and blasting do not occur at the same time as overburden and coal removal, will result in compliance with the EPP(Air) goal (detailed below). This scenario was analysed five times at increasing distances from the township of Wandoan. With each scenario incremental increases in extraction rates and activities were included as the emission source was moved further away from the town.

The maximum 24-hour average and annual average ground-level concentrations of PM_{10}, predicted to occur at the township of Wandoan and at a sensitive receptor not located in the town are presented in Table 12.

The results for PM_{10} show:

- Compliance with the EPP(Air) 24-hour average goal of 150 $\mu g/m^3$ for PM_{10} within the town of Wandoan. The maximum ground-level concentration predicted at the township of Wandoan is 127.4 $\mu g/m^3$, less than 85% of the goal.
- The highest concentration predicted for a receptor outside of the town was 155 $\mu g/m^3$ (MLA-505: Figure 62) located to the south of Wolleebee Creek. One exceedance to the west of Wolleebee Creek was also predicted (MLA-300: Figure 62). Both these exceedances are most likely due to the close proximity of dragline operations. One exceedance to the north of Austivale is the result of terrain blocking during an inversion with light south easterly winds (MLA-297 and MLA-402: Figure 61) (Table 16). Implementation of dust management techniques (Section 5) will minimise the dust impacts under these conditions.
- Compliance with the EPP(Air) annual average goal of 50 $\mu g/m^3$ for PM_{10}. The annual average ground-level concentration predicted at the township of Wandoan is 17.3 $\mu g/m^3$, less than 35% of the goal. The highest concentration predicted at a receptor outside of town is 21.0 $\mu g/m^3$ 42% of the goal.

The annual average ground-level concentrations of TSP and annual average dust deposition rates predicted at the Wandoan township and MLA-505 are also presented in Table 12.

The results for TSP show:

- Compliance with the EPP(Air) annual average goal of 90 $\mu g/m^3$ for TSP. The annual average ground-level concentration predicted at the township of Wandoan is 32.2 $\mu g/m^3$, less than 36% of the goal. The highest concentration predicted at a receptor outside of town is 38.1 $\mu g/m^3$ (MLA-505) less than 36% of the goal,

- Compliance with the recommended EPA guideline of 120 mg/m^2/day (annual average) for dust deposition rate. The annual average dust deposition rate predicted at the township of Wandoan is 35.2 mg/m^2/day, less than 30% of the guideline. The highest concentration predicted at a receptor outside of town is 50.1 mg/m^2/day (MLA-505) less than 42% of the goal.

Figure 29 and Figure 31 present the maximum 24-hour and annual average ground-level concentrations of PM_{10}, predicted due to the mine only. Figure 30 and Figure 32 include background concentrations.

The annual average ground-level concentrations of TSP are presented in Figure 33 due to the mine in isolation and with a background in Figure 34. The annual average dust deposition rates due to the mine in isolation and with a background are presented in Figure 35 and Figure 36.

Table 12 Maximum predicted ground-level concentrations of PM_{10}, TSP and dust deposition rate, due to the mine operating in Year 5

Pollutant	Averaging period	Predicted ground-level concentrations								Goal/ Standard
		Wandoan Township				Highest at a sensitive receptor[2] not in Wandoan Township				
		Mine only		Mine[1] (with b/g)		Mine only		Mine[1] (with b/g)		
		$\mu g/m^3$	% of goal	$\mu g/m^3$	% of goal	$\mu g/m^3$	% of goal	$\mu g/m^3$	% of goal	
PM_{10}	24-hour	97.4	65	127.4	85	156	84	156	104	150 $\mu g/m^3$
	Annual	2.3	5	17.3	35	5.2	10	20.2	40	50 $\mu g/m^3$
TSP	Annual	4.4	5	34.4	38	8.2	9	38.2	42	90 $\mu g/m^3$
Dust deposition	Annual	5.9	4.9	35.9	30	9.4	8	39.4	33	120 $mg/m^2/day$

[1] b/g: background concentration
[2] MLA-505

4.5.4 Year 10

The maximum 24-hour average and annual average ground-level concentrations of PM_{10}, predicted to occur at the township of Wandoan and at sensitive receptor MLA-595 are presented in Table 13.

The results for PM_{10} show:

- Compliance with the EPP(Air) 24-hour average goal of 150 $\mu g/m^3$ for PM_{10}. The maximum ground-level concentration predicted at the township of Wandoan is 57.1 $\mu g/m^3$, less than 38% of the goal. The highest concentration predicted at a receptor outside of town is 123.8 $\mu g/m^3$ (MLA-595) less than 83% of the goal.

- Compliance with the EPP(Air) annual average goal of 50 $\mu g/m^3$ for PM_{10}. The annual average ground-level concentration predicted at the township of Wandoan is 15.5 $\mu g/m^3$, less than 31% of the goal. The highest concentration predicted at a receptor outside of town is 22.3 $\mu g/m^3$ (MLA-595) less than 45% of the goal

The annual average ground-level concentrations of TSP and annual average dust deposition rates predicted at the Wandoan township and at MLA-595 are also presented in Table 13.

The results for TSP show:

- Compliance with the EPP(Air) annual average goal of 90 $\mu g/m^3$ for TSP. The annual average ground-level concentration predicted at the township of Wandoan is 30.2 $\mu g/m^3$, less than 34% of the goal. The highest concentration predicted at a receptor outside of town is 36.8 $\mu g/m^3$ (MLA-595) less than 41% of the goal.

- Compliance with the recommended EPA guideline of 120 $mg/m^2/day$ (annual average) for dust deposition rate. The annual average dust deposition rate predicted at the township of Wandoan is 30.4 $mg/m^2/day$, less than 26% of the guideline. The highest concentration predicted at a receptor outside of town is 47.7 $mg/m^2/day$ (MLA-595) less than 40% of the goal.

Figure 37 and Figure 39 present the maximum 24-hour and annual average ground-level concentrations of PM_{10}, predicted due to the mine only. Figure 38 and Figure 40 include background concentrations.

The annual average ground-level concentrations of TSP are presented in Figure 41 due to the mine in isolation and with a background in Figure 42. The annual average dust deposition rate due to the mine in isolation and with a background is presented in Figure 43 and Figure 44.

Table 13 Maximum predicted ground-level concentrations of PM_{10}, TSP and dust deposition rate, due to the mine operating in Year 10

Pollutant	Averaging period	Predicted ground-level concentrations								Goal/ Standard
		Wandoan Township				Highest at a sensitive receptor[2] not in Wandoan Township				
		Mine only		Mine[1] (with b/g)		Mine only		Mine[1] (with b/g)		
		$\mu g/m^3$	% of goal	$\mu g/m^3$	% of goal	$\mu g/m^3$	% of goal	$\mu g/m^3$	% of goal	
PM_{10}	24-hour	27.1	18	57.1	38	93.8	63	123.8	83	150 $\mu g/m^3$
	Annual	0.5	1	15.5	31	7.3	15	22.3	45	50 $\mu g/m^3$
TSP	Annual	0.6	1	30.6	34	14.0	16	44.0	49	90 $\mu g/m^3$
Dust deposition	Annual	0.4	0.4	30.4	25	20.4	17	50.4	42	120 $mg/m^2/day$

[1] b/g: background concentration
[2] (MLA-595)

4.5.5 Year 20

The maximum 24-hour average and annual average ground-level concentrations of PM_{10}, predicted to occur at the township of Wandoan and MLA-552 are presented in Table 14.

The results show:

- Compliance with the EPP(Air) 24-hour average goal of 150 $\mu g/m^3$ for PM_{10} within the town of Wandoan. The maximum ground-level concentration predicted at the township of Wandoan is 113 $\mu g/m^3$, less than 75% of the goal.

- The highest concentration predicted at a receptor outside of town is 217 $\mu g/m^3$ (MLA-552: Figure 65). The exceedance occurs at a distance of 500 m to 1 km from the western boundary of the Wolleebee Creek MLA (Table 16).
- Impacts to the north of Summer Hill are due to the proximity of the receptors to a ROM stockpile, conveyor and haul road (MLA-687 and MLA-693: Figure 63). These can be mitigated by dust suppression measures outlined in Section 5. I
- Impacts located to the south and west of Turkey Hill and Woleebee Creek (MLA-50, MLA-300, MLA-404, MLA459, MLA-484, MLA-505, MLA-520, and MLA-595: Figure 64 and Figure 66) are a culmination of proximity to dragline operations and low laying terrain. Mitigation and management strategies to minimise the levels of dust are outlined in Section 5

- Compliance with the EPP(Air) annual average goal of 50 $\mu g/m^3$ for PM_{10}. The annual average ground-level concentration predicted at the township of Wandoan is 16.7$\mu g/m^3$, less than 34% of the goal. The highest concentration predicted at a receptor outside of town is 29.4 $\mu g/m^3$ (MLA-552) less than 59% of the goal.

The annual average ground-level concentrations of TSP and annual average dust deposition rates predicted at the Wandoan township and at a sensitive receptor not located in the town are also presented in Table 14.

The results show:

- Compliance with the EPP(Air) annual average goal of 90 $\mu g/m^3$ for TSP. The annual average ground-level concentration predicted at the township of Wandoan is 30.8 $\mu g/m^3$, less than 35% of the goal. The highest concentration predicted at a receptor outside of town is 40.8 $\mu g/m^3$ (MLA-552) less than 46% of the goal.

- Compliance with the recommended EPA guideline of 120 $mg/m^2/day$ (annual average) for dust deposition rate. The annual average dust deposition rate predicted at the township of Wandoan is 30.6 mg/m^3, less than 26% of the guideline. The highest concentration predicted at a receptor outside of town is 56.0 $mg/m^2/day$ (MLA-552) less than 47% of the goal

Figure 45 and Figure 47 present the maximum 24-hour and annual average ground-level concentrations of PM_{10}, predicted due to the mine only. Figure 46 and Figure 48 include background concentrations.

The annual average ground-level concentrations of TSP are presented in Figure 49 due to the mine in isolation, and with a background in Figure 50. The annual average dust deposition rates, due to the mine in isolation, and with a background, are presented in Figure 51 and Figure 52 respectively.

Table 14 Maximum predicted ground-level concentrations of PM_{10}, TSP and dust deposition rate, due to the mine operating in Year 20

Pollutant	Averaging period	Predicted ground-level concentrations								Goal/ Standard
		Wandoan Township				Highest at a sensitive receptor[2] not in Wandoan Township				
		Mine only		Mine[1] (with b/g)		Mine only		Mine[1] (with b/g)		
		$\mu g/m^3$	% of goal	$\mu g/m^3$	% of goal	$\mu g/m^3$	% of goal	$\mu g/m^3$	% of goal	
PM_{10}	24-hour	81.3	54	111.3	74	165.0	110	195.0	130	150 $\mu g/m^3$
	Annual	1.7	3	16.7	33	9.1	18	24.1	48	50 $\mu g/m^3$
TSP	Annual	2.6	3	32.6	36	15.8	18	45.8	51	90 $\mu g/m^3$
Dust deposition	Annual	2.1	2	32.1	27	18.7	16	48.7	41	120 $mg/m^2/day$

[1] b/g: background concentration
[2] MLA-552

4.5.6 Year 30

The maximum 24-hour average and annual average ground-level concentrations of PM_{10}, predicted to occur at the township of Wandoan and MLA-552 are presented in Table 15.

The results for PM10 show:

- Compliance with the EPP(Air) 24-hour average goal of 150 $\mu g/m^3$ for PM_{10}. Within the town of Wandoan. The maximum ground-level concentration predicted at the township of Wandoan is 96.8 $\mu g/m^3$, less than 65% of the goal.
- The highest concentration predicted at a receptor outside of town is 320 $\mu g/m^3$ (MLA-552: Figure 69) The exceedances occur at a distance of 500 m to 1 km from the MLA boundaries (**Table 16**).
- The exceedances to the south and west of the Woleebee Pit area (MLA-300, MLA-420, MLA 443, MLA-484, MLA-505, MLA-557, MLA-659, MLA-679: Figure 68 and Figure 70). Discussion on mitigation options are outlined Section 5.
- It should be noted that the impacts to the north of the town (MLA 520: Figure 67) and to the north of the Summer Hill ROM area are below the EPP(Air) goal or their impacts have significantly reduced compared to those for Year 20 (MLA-693: Figure 71). This is due to the change in mining activity rate near to these areas and illustrates the potential effectiveness of the recommendations outlined in Section 5 in reducing potential impacts at sensitive receptors.

- Compliance with the EPP(Air) annual average goal of 50 $\mu g/m^3$ for PM_{10}. The annual average ground-level concentration predicted at the township of Wandoan is 16.3 $\mu g/m^3$, less than 33% of the guideline. The highest concentration predicted at a receptor outside of town is 34.5 mg/m^2/day, less than 70% of the goal.

The annual average ground-level concentrations of TSP and annual average dust deposition rates predicted at the Wandoan township and at a sensitive receptor, not located in the town are also presented in Table 15.

The results for TSP show:

- Compliance of the EPP(Air) annual average goal of 90 $\mu g/m^3$ for TSP. The annual average ground-level concentration predicted at the township of Wandoan is 30.5 $\mu g/m^3$, less than 34% of the goal. The highest concentration predicted at a receptor outside of town is 43.4 $\mu g/m^3$, less than 49% of the goal.
- Compliance with the recommended EPA guideline of 120 mg/m2/day (annual average) for dust deposition rate. The annual average dust deposition rate predicted at the township of Wandoan is 40.8 mg/m^2/day, less than 34 % of the goal. The highest concentration predicted at a receptor outside of town is 61.6 mg/m^2/day less than 52% of the goal.

Figure 53 and Figure 55 present the maximum 24-hour and annual average ground-level concentrations of PM_{10}, predicted due to the mine only. Figure 54 and Figure 56 include background concentrations.

The annual average ground-level concentrations of TSP are presented in Figure 57, due to the mine in isolation and with a background in Figure 58. The annual average dust deposition rates, due to the mine in isolation and with a background are presented in Figure 59 and Figure 59.

Table 15 Maximum predicted ground-level concentrations of PM_{10}, TSP and dust deposition rate, due to the mine operating in Year 30

Pollutant	Averaging period	Predicted ground-level concentrations								Goal/ Standard
		Wandoan Township				Highest at a sensitive receptor[2] not in Wandoan Township				
		Mine only		Mine[1] (with b/g)		Mine only		Mine[1] (with b/g)		
		$\mu g/m^3$	% of goal	$\mu g/m^3$	% of goal	$\mu g/m^3$	% of goal	$\mu g/m^3$	% of goal	
PM_{10}	24-hour	66.8	45	96.8	65	290	193	320	213	150 $\mu g/m^3$
	Annual	1.3	3	16.3	33	13.7	27	28.7	57	50 $\mu g/m^3$
TSP	Annual	1.7	2	31.7	35	24.1	27	54.1	60	90 $\mu g/m^3$
Dust deposition	Annual	1.1	1	31.1	26	34.2	28	64.2	53	120 $mg/m^2/day$

[1] b/g: background concentration
[2] MLA-552

4.6 Summary

Dispersion modelling has been undertaken to assess the potential impact of the Project on ground-level concentrations of PM_{10} and TSP as well as the dust deposition rate at the Wandoan township and surrounding sensitive receptors.

The results show:

- That the project will demonstrate compliance with the annual average EPP(Air) goal of 50 $\mu g/m^3$ for PM_{10} for Years 1, 5, 10, 20 and 30.
- That the project will demonstrate compliance with the annual average EPP(Air) goal of 90 $\mu g/m^3$ for TSP for Years 1, 5, 10, 20 and 30.
- That the project will demonstrate compliance with the annual average recommended guideline of 120 $mg/m^2/day$ for dust deposition rate for Year 1, 5, 10, 20 and 30.
- That at the Wandoan township, maximum 24-hour average ground-level concentrations of PM_{10} are predicted to be below the EPP(Air) goal of 150 $\mu g/m^3$ for PM_{10} for Year 1, 10, 20 and 30.
- As proposed, the project may exceed acceptable levels of mean 24hr PM_{10} in the Wandoan town in Year 5. To obtain complying levels of 24hr PM_{10} in the Wandoan town in Year 5, careful management of extraction rates and methods may be required at the Frank Creek Pit. This could potentially be achieved by the use of truck and excavator or shovel operations rather than the dragline.
- That at sensitive receptors surrounding the Project, maximum 24-hour average ground-level concentrations of PM_{10} are predicted to be below the EPP(Air) goal of 150 $\mu g/m^3$ for PM_{10} for Year 1 and Year 10. In Years 5, 20 and 30, sensitive receptors to the south of Turkey hill, west of Woleebee and north of Summer Hill are likely to be exposed to elevated levels due to the proximity of the draglines (Table 16).

Table 16 Summary of EPP (Air) goal exceedances at receptors outside the Mine Lease Application Area

Year of Operation	Latitude	Longitude	Receptor	Lot	Plan	Type	# of days EPP(Air) 24Hr PM10 goal was exceeded	# of days greater than 80% of EPP(Air) 24Hr PM10 goal
Year 1								
	-	-	-	-	-	-	-	-
Year 5								
	-26° 0" 2'	149° 55" 24'	MLA-297	64	FT525	House	1	1
	-26° 8" 41'	149° 48" 40'	MLA-300	15	FT161	House	1	1
	-26° 0" 14'	149° 54" 49'	MLA-402	1	RP204781	House	1	1
	-26° 10" 47'	149° 53" 44'	MLA-505	6	FT788	Homestead	1	4
YR10								
	-26° 1" 29'	149° 39" 38'	MLA-595	38	AB188	Homestead	-	1
Year 20								
	-26° 4" 9'	149° 42" 22'	MLA-50	1	SP210618	House	2	4
	-26° 8" 41'	149° 48" 40'	MLA-300	15	FT161	House	3	6
	-26° 5" 2'	149° 43" 33'	MLA-404	15	SP180948	House	3	7
	-26° 4" 54'	149° 43" 48'	MLA-459	28	FT467	House	1	8
	-26° 11" 35'	149° 55" 23'	MLA-484	1	RP110817	Homestead	1	1
	-26° 10" 47'	149° 53" 44'	MLA-505	6	FT788	Homestead	1	3
	-26° 6" 38'	149° 57" 15'	MLA-520	36	FT981	House	-	1
	-26° 8" 59'	149° 49" 32'	MLA-552	16	FT1012	House	3	9
	-26° 1" 29'	149° 39" 38'	MLA-595	38	AB188	Homestead	2	6
	-25° 58" 5'	149° 45" 38'	MLA-687	28	FT563	House	1	3
	-25° 58" 48'	149° 46" 28'	MLA-693	41	CP857459	House	1	4
Year 30								
	-26° 8" 41'	149° 48" 40'	MLA-300	15	FT161	House	9	19
	-26° 7" 46'	149° 45" 50'	MLA-420	2	FT1019	House	2	2
	-26° 7" 15'	149° 46" 10'	MLA-443	39	FT576	House	3	3
	-26° 11" 35'	149° 55" 23'	MLA-484	1	RP110817	Homestead	1	3
	-26° 10" 47'	149° 53" 44'	MLA-505	6	FT788	Homestead	11	31
	-26° 8" 59'	149° 49" 32'	MLA-552	16	FT1012	House	13	27
	-26° 10" 48'	149° 59" 26'	MLA-557	3	FT695	House	1	2
	-26° 11" 20'	149° 48" 57'	MLA-659	2	RP123884	Homestead	2	5
	-26° 12" 44'	149° 52" 37'	MLA-679	24	FT41	Homestead	1	1
	-25° 58" 48'	149° 46" 28'	MLA-693	41	CP857459	House	1	1

It is recommended that:

- *Continuous real time monitoring of PM_{10} is maintained at the Wandoan township for the life of the Project*
- *Continuous real time monitoring of PM_{10} at representative non-mine-owned residences where dispersion modelling suggests dust levels could approach within 80% (120 µg/m^3) of the air quality standard (Figure 74, Table 18)*
- *Meteorological monitoring to form the basis of a high dust potential forecasting system. Coupled with the dust monitoring program, meteorological conditions will inform the implementation of the reactive management plan*
- *The forecasting system should be designed to a trigger response criteria, i.e. when PM_{10} levels exceed 80% of the EPP (Air) goal (120 µg/m^3) the reactive management plan is activated*

5. Mitigation measures

5.1 Dust generating activities

The extraction of coal from an open cut mine is a dust generating activity with the potential to impact on human health and amenity. Key activities that contribute to dust generation include:

- Vehicle traffic on haul roads
- Overburden removal by dragline or truck and shovel
- Drilling and blasting
- Extraction activities within the pit itself
- Wind erosion from stockpiles
- Conveyors
- Exposed surfaces
- Train loading
- Product preparation and washing

5.2 Measures to minimise dust emissions

Measures to minimise the potential impact of fugitive dust emissions must recognise all potential sources of dust emissions and have strategies in place to mitigate any unnecessary emissions and adverse impacts that the proposed activities may have on the health and amenity of the surrounding community. An air quality management plan will have both proactive and reactive measures.

The proactive management plan should include, where necessary:

- Watering and grading haul roads and use of surface treatments
- Water sprays, covers and chutes at the Coal Handling and Preparation Plant (CHPP)
- Partial covers on conveyors
- Progressive revegetation of disturbed areas as mining operations develop
- Provision of windbreaks (such as tree planting) around stockpiles and TSFs.
- Progressive rehabilitation and revegetation of mined surfaces within two years of original disturbance
- Minimisation of the drop height for dragline operations
- Continuous real time monitoring of dust concentrations at sensitive receptors
- Continuous real time monitoring of meteorological conditions
- Use of a forecasting system to assist in anticipating adverse meteorological conditions that may give rise to dust generation and implementation of operational changes and improved mitigation to avoid adverse impacts
- Dust suppression of rejects emplacement i.e. wind breaks or chemical suppressants
- Adaptive management strategies such as reduction in extraction rates of operations when meteorological monitoring suggests adverse wind conditions or dust monitoring at sensitive receptors indicates levels are near to exceeding air quality criteria
- Consultation with potentially impacted landowners and negotiation of relevant mitigation measures
- The surface of coal in wagons should be profiled to a flat “garden bed” shape and a surface treatment will be applied to minimise coal dust emissions during transit to the port

- Laboratory has been conducted to investigate the relationship between dustiness and moisture of the Wandoan coal (DEM) to assist in the management of coal dust emissions.
- Laboratory has been conducted to investigate the dustiness of the coarse rejects to assist in the management of dust emissions from the reject emplacement

A reactive management plan (such as a Trigger Action Response Plan) should include:

- Implementation of additional mitigation measures when wind conditions become adverse, such ceasing operations, reducing activity rates or covering equipment
- Trigger points for management decisions based on measurements of wind conditions and/or dust monitoring at sensitive receptors when levels are near exceeding air quality criteria outlined in Table 1

.
These control measures are considered leading industry practice for this Project.

5.2.1 Year 1

No exceedances were predicted at sensitive receptors outside of the MLA (Figure 19 to Figure 26). To ensure that the EPP (Air) goals are maintained a dust management plan will be developed that includes:

- Watering of haul routes as necessary
- Covering haul trucks when travelling outside the MLA
- Continuous monitoring of PM_{10} dust deposition and meteorological variables in the township will be implemented at the first instance and continued for the life of the mine.

5.2.2 Year 5

Preliminary assessments of the potential impacts of mining activities within the Frank Creek area in Year 5 (Year 5 dragline) illustrated that the EPP(Air) goal for 24-hour average concentrations of PM_{10} could be exceeded at the Wandoan township. An extensive sensitivity analysis was undertaken to determine the maximum rate of activity that would result in adherence to EPP(Air) goals relevant for the town of Wandoan (Refer to Section 4.5.3.1. for the modelling results).

Complete modelling scenarios were run using the model setup described above and detailed in Attachment C for dragline operations in Frank Creek Pit. In the model the dragline was placed at the eastern edge of the Frank Creek Pit directly adjacent to the town, subsequent scenarios saw the dragline operate at the same rate and move progressively 300 m to the west of the first position until the EPP(Air) goals were met. Results indicated that the dragline could not operate within 1800 m of the Wandoan township, unless extensive mitigation measures are implemented, such as a reduction in activity rate or implementation of other mitigation measures informed by continuous real time monitoring of PM_{10} and meteorological variables coupled with an air quality forecasting system.

An alternative scenario was modelled that used truck and excavator/shovel operations to remove overburden instead of the dragline. Blasting and drilling were also omitted from the pit operations (Refer to Section 4.5.3.1 for the modelling results). The extraction rates of both overburden and coal were reduced until compliance could be achieved at the Wandoan township, with mining operations occurring at the eastern edge of the Frank Creek Pit.

The modelling showed that the maximum estimated rates that overburden and coal could be removed from the Frank Creek Pit within 1 km of the township of Wandoan with a truck and excavator or shovel were 2,842,606 bcm and 767,503 tonnes per annum, respectively. This is a significant reduction in the initially proposed modeling estimate of 12,636,515 bcm of overburden and 4,605,591 tonnes of coal to be extracted within six months.

The predicted results highlight the need for real time continuous monitoring of ambient of PM_{10} in conjunction with meteorological conditions that give rise to dust. As mining activities progress through Frank Creek Pit, management and mitigation measures will need to be considered so as to ensure compliance with the relevant air quality standards at the town of Wandoan.

The implementation of adaptive management strategies for overburden and coal extraction should be based on real time monitoring data to ensure that the mining activities in Frank Creek Pit adhere to the EPP(Air) goals

One exceedance of the EPP(Air) goal for 24-hour average concentrations of PM_{10} was predicted at a residents of MLA-297 and MLA-300 (Table 16) approximately 5 km to the north of the MLA. This was a one off occurrence attributable to very light southerly winds, a stable nocturnal boundary layer and the receptors location within a natural depression in the terrain. Figure 61 shows the 24-hour average predicted concentrations for the receptor and its closest neighbours. Although only one receptor actually exceeds the goal both show elevated concentrations of PM_{10} for this one time period. For the rest of the year the concentrations of PM_{10} are less than 60% of the goal.

It is recommended that for the Grosmont Road residences continous real time monitoring of PM_{10} be implemented before the commencement of year 5 operations. This will act to inform whether operations should be altered or mitigated according to the dust management plan. The construction of a wind break around the TSF should also be sufficient to avoid any nuisance dust impacts for those receptors.

One exceedance of the EPP(Air) goal for 24-hour average concentrations of PM_{10} was predicted at two residences(MLA-402 and MLA-505) (Table 16) to the south of the Woleebee Creek Pit approximately 500 m outside of the MLA. Figure 62 shows the predicted 24-hour average PM_{10} concentrations for modelling period. Although there is only one instance of where the predicted concentration exceeds the goal, there are three further occasions where concentrations reach within 80% of the goal.

As this is at the beginning of the Woleebee Creek Pit development schedule and seeing that the pit is scheduled to progress further south in subsequent years, particularly years 20 and 30, it is recommended that the proponent implement appropriate management and mitigation strategies when required.

5.2.3 Year 10

No exceedances were predicted at sensitive receptors outside of the MLA (Figure 37 to Figure 44). To ensure that the EPP (Air) goals are maintained a dust management plan will be developed that includes:

- Watering of haul routes as necessary
- Covering haul trucks when travelling outside the MLA
- Continuous monitoring of PM_{10} dust deposition and meteorological variables in the township will be implemented at the first instance and continued for the life of the mine.

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5.2.4 Year 20

The modelling results for Year 20 operations indicate that the 24-hour average ground-level concentrations of PM_{10} would exceed the EPP(Air) goal at several locations to the north, west and south of Turkey Hill, the south of Mud Creek, the west and south of Woleebee Creek and the east of Leichardt Pit on the northern extent of the Wandoan township.

The predicted concentrations to the north of Turkey Hill are due to wind erosion of the ROM stockpiles. Three receptors are located within 1 km of the Summer Hill ROM pad and Turkey Hill haul route (MLA-687 and MLA-693) (Table 16). Figure 63 shows that the predicted concentrations at the receptors exceed the EPP(Air) goal once and approach the goal on several occasions.

Implementation of stockpile management such as water sprays or the application of a dust suppressant is predicted to reduce ground-level concentrations of PM_{10} to below acceptable limits. Continuous real time monitoring at these sites is recommended (refer to Table 18) in order to inform the dust management plan when action is required.

The exceedances to the south and west of Turkey Hill, Mud Creek and Wolleebee Creek are due to the proximity of the dragline operations to sensitive receptors (Table 16). Due to the frequency of exceedances (Figure 64 and Figure 65 and Figure 66), reactive dust mitigation strategies are unlikely to be sufficient to reduce ground-level concentrations at these locations. A proactive and adaptive management strategy using forecasting and monitoring will need to be implemented to ensure compliance with ground level concentrations.

Given the time scale of events (that is, in the twentieth year of operation) it is recommended that the proponent install continuous real time PM_{10} and meteorological monitoring stations at representative sites (Figure 74, Table 18) prior to the commencement of operations in Turkey Hill, Mud Creek and Woleebee Creek and implement other appropriate management measures. For example, where mitigation is unsuccessful, negotiations with impacted properties may be required when and if the monitoring suggests it necessary to do so.

The exceedance to the north of the township of Wandoan did not occur at any specific receptor but appear as an isolated contour extending across the Leichardt highway. This contour is mentioned here due to its proximity to the township. Figure 67 shows the predicted 24-hour average concentration of PM_{10} at the closest receptors (MLA-520) (Table 12). Although no exceedances are predicted at these residences, ambient PM_{10} levels do reach 80% of the EPP(Air) goal. It is therefore recommended that the real time monitoring of PM_{10} along with community engagement be implemented in the first instance for this area. Whereby, alteration of mining schedules and activity rates be determined by forecasting, monitoring and community involvement for operations that directly impact on or nearby the township of Wandoan.

5.2.5 Year 30

The modelling results for Year 30 operations indicated that the 24-hour average ground-level concentrations of PM_{10} would be exceeded to the south and west as per the year 20 exceedances outlined above (Section 4.5.5). Due to the frequency of exceedances, reactive dust mitigation strategies are unlikely to be sufficient to reduce ground-level concentrations. The receptors outlined for year 20 (Table 16) are still valid here (Figure 68 and Figure 69 and Figure 70) with the addition of five more receptors located approximately 6 km to the south and west of the Woleebee Creek MLA boundary (MLA-420, MLA-443, MLA-557, MLA-659 and MLA-679). It is recommended that a continuous real time monitoring and forecasting system be implemented as per year 20, where mitigation is unsuccessful, negotiations with impacted properties may be required when and if the monitoring suggest it necessary to do so.

5.3 Dust characterisitics

Laboratory investigations of the relationship between dustiness and moisture content of the Wandoan coal deposit was undertaken at the University of Newcastle. The laboratory test procedure was conducted in accordance with Australian Standard AS 4156.6-2000, Coal Preparation Part 6: Determination of dust/moisture relationship for coal. The procedure determines the level of dustiness at different moisture levels.

From the test results the relationship between dustiness and moisture content is plotted on a logarithmic graph to determine the dust extinction moisture level (DEM). Figure 72 shows the DEM for uncrushed ROM coal is 14.2%. Figure 73 shows the DEM for uncrushed product coal is 14%. Both graphs are fairly steep, indicating that dustiness increases rapidly when the moisture content falls below the DEM level of 14%.

The surface dust lift-off wind speed under typical stockpile conditions was determined by pre-drying for one hour at 30 degrees Celsius. The test trays were placed in the wind tunnel at an angle of 37 degrees and subjected to gradually increasing wind speed.

Dust lift-off can be considered to develop in three stages:

- Saltation is the term adopted for the initial stage when dust particles begin to move on the surface of a coal stockpile prior to becoming airborne
- Minor dust lift-off refers to the stage where very fine dust particles become airborne
- Major dust lift-off refers to the stage where relatively large quantities of variable size dust particles become airborne

Table 17 Wandoan coal dust lift-off wind speed after pre-drying for 1 hour

Material	Saltation (m/s)	Minor dust lift-off (m/s)	Major dust lift-off (m/s)
Uncrushed Raw Coal	8.4	11	>14
Uncrushed Product Coal	6	10	>13

The results of the laboratory testing indicate that winds above 10 m/s are required for dust lift to occur from ROM pads and reject areas. However, as moisture is withdrawn from the surface the threshold for dust lift off will decrease rapidly allowing significantly lower wind speeds to initiate dust lift off. It is recommended that vegetative wind breaks are planted upwind of the prevailing wind direction around TSFs and ROM pads that are located within one kilometre of a sensitive receptor.

5.4 Monitoring and Forecasting

The following monitoring is recommended to be implemented:

- Maintain the continuous real time monitoring of PM_{10} in Wandoan at the town site already established, as shown in Figure 4
- Establish continuous real time monitoring of PM_{10} at representative sites of potential high dust occurrences as described in section 5.2 and detailed in Figure 74 and Table 18
- Establish real time meteorological monitoring at representative sensitive sites to form the basis of the high dust potential forecasting system as per Figure 74 and Table 18

The real time monitoring system will provide the mine management team with real time information on PM_{10} concentrations outside of the MLA boundaries. The system will be linked to a trigger action response plan (TARP) that will be activated once the 24 hour PM_{10}- ground level concentrations exceed 80% (120 µg/m^3) of the EPP (Air) goal (150 µg/m^3).

it is recommended that a forecasting system be developed which incorporates the coarse resolution numerical weather prediction (NWP) forecast for the whole of Australia updated six hourly from the Bureau of Meteorology. This will be used as the initial boundary conditions to a high resolution forecast specific to the Wandoan region. The meteorological and dust monitoring stations will be used initially to validate the NWP forecast and will eventually be incorporated into the forecast as real time data assimilation, thus improving the systems overall accuracy.

The establishment of a high resolution NWP forecast will provide the mine management team with site specific meteorological conditions, where high dust potential hours of operation can be identified. Thereby, suppression techniques and/or alterations to equipment operations can be affected prior to an incident developing at a sensitive receptor.

The system will allow management to make informed and accurate decisions on mine operations, equipment locations and extraction rates to mitigate any adverse impact on the surrounding sensitive receptors, before any impact actually occurs. For example the forecast system will allow management to determine when conditions are acceptable for blasting to occur near the township of Wandoan. Such that residents in the township of Wandoan are not impacted by fugitive emissions. These situations are identifiable as during inversions, or a lowered mixing height, with a light westerly wind. This situation can occur when a stationary high pressure system develops over the centre of Australia along with high moisture content in the upper atmosphere, where overcast or low cloud conditions dominate.

Table 18 Locations of recommended real time dust and meteorological monitoring sites

Lot/Plan	Receptor	TSP	PM_{10}	Dust deposition	Meteorological variables
47 FT466	-	Y	Y	Y	Y
4 FT758	-	Y	Y	Y	Y
132 SP121742	-	Y	Y	Y	Y
Short Street	Town	Y	Y	Y	Y
6 FT788	MLA-505	Y	Y	Y	Y
28 FT563	MLA-687	Y	Y	Y	Y
1 RP204781	MLA-402	Y	Y	Y	Y

6. Onsite Gas Fired Power station

Should a gas supply power supply option be selected by the Wandoan Joint Venture, it is proposed to install a dual fuel gas engine power station on the proposed mine site to generate electricity for use on the mine. Two options are currently under consideration:

(1) Option 1 – an 80MW total site supply power station comprising of twelve gas dual fuel engines, each with 8 MW of electrical output. Ten units will operate at a time and two will be on standby.

(2) Option 2 – a 30MW partial site supply power station comprising of six dual fuel gas engines, each with 8 MW of electrical output. Four units are expected to operate at a time with two units on standby mode. This option will be in addition to the grid connected power supply for the site.

For the purpose of this assessment a worst case scenario was applied and twelve engines were modeled as operating in Option 1 and six engines operating in Option 2.

The engines will burn natural gas, with gas supply via a new pipeline connecting into the existing Peat-Scotia lateral gas pipeline. The main air pollutants from the engines will be oxides of nitrogen and carbon monoxide. Emissions of particulate matter, volatile organic compounds, unburnt hydrocarbons and oxides of sulphur will also occur, however, these emissions are generally below detection limits and will have a negligible risk of causing an adverse or cumulative impact and therefore have not been considered further in this study.

6.1 Location and layout

The proposed power station will be located to the west of the rail spur loop and approximately 1.5 km to the southwest of the accommodation facilities (Figure 75) and approximately 8.5 km northwest of the town of Wandoan.

The plant layouts for the two potential configurations of plant are presented in Figure 76 and Figure 77.

The stack characteristics for the two plant operations are shown in Table 19.

Table 19 Stack characteristics for Option 1 (80 MW) and Option 2 (30 MW)

Parameter	Units	Option 1	Option 2
Number of engines	-	12	6
Number of stacks	-	4	2
Stack height	m	21	
Effective stack diameter	m	2.08	
Building height (engine hall)	m	9	

6.2 Emission estimation

The emission characteristics for plant Options 1 and 2 operating at full load are presented in Table 20. Those emissions are based on engine specifications from manufacturer Wartsila and the Proponent.

Table 20 Emission characteristics for each 8 MW unit

Parameter	Units	Emission characteristics per unit
		8 MW
Volume flow	m^3/s	28
	Nm^3/s	12.1
Exit velocity	m/s	25.5
Temperature	°C K	375 648.15
Concentration		
Oxides of nitrogen	mg/Nm^3	250
Carbon monoxide	mg/Nm^3	250
Emission rate		
Oxides of nitrogen	g/s	3.23
Carbon monoxide	g/s	2.93

The proposed gas engines will meet emission limits for oxides of nitrogen and carbon monoxide of 250 mg/Nm^3 (5% O_2). Whilst there are no regulatory limits for gas dual fuel engines in Queensland, the EPA commonly refers to the NSW Clean Air Regulations 2002, The proposed engines will comply with the NSW Clean Air Regulations (2002) of an emission limit of 450 mg/Nm^3 (3% O_2) for a stationary reciprocating internal combustion engine. The engine specification supplied emission rates of oxides of nitrogen and carbon monoxide from each engine type. The total emission rates of oxides of nitrogen and carbon monoxide for Option 1 of 38.7 g/s and 35.1 g/s, respectively and for Option 2 are 19.4 g/s and 17.6 g/s, respectively.

6.3 Modelling methodology

6.3.1 Model configuration

The CALPUFF dispersion model version 6.0 was used for the air quality impact assessment of the proposed power station options.

For details on model configuration refer to Attachment C.

6.3.2 Nitric oxide to nitrogen dioxide

The modelling results presented in this report have assumed a constant conversion ratio of nitrogen dioxide to oxides of nitrogen of 30%. The actual degree of conversion of oxides of nitrogen in the plume to nitrogen dioxide will depend on atmospheric conditions at the time that the emissions occur. The percentage of nitrogen dioxide within the plume exiting the stack is usually 5-10%. After release from the stack, nitric oxide gradually oxidises to form nitrogen dioxide. The rate and extent to which this occurs depends on the presence of other atmospheric pollutants such as ozone and volatile organic compounds, and on the presence of sunlight. Measurements around power stations in Central Queensland show, under worst-case conditions, that a conversion rate of 25% to 40% can occur within the first 10 km of plume travel and suggest a rate of 30% at distances less than 10 km. During days with elevated background levels of hydrocarbons (generally originating from bushfires), the conversion is usually below 50% in the first 30 km of travel (Bofinger et al 1986).

6.3.3 Background levels

Background levels used are those previously discussed in Section 3.2.2.

6.4 Results

The maximum predicted 1-hour average ground-level concentrations of nitrogen dioxide and 8-hour average ground-level concentrations of carbon monoxide are presented in Table 21. The predicted 1-hour average ground-level concentrations of nitrogen dioxide and 8-hour average ground-level concentrations of carbon monoxide at the Wandoan Township are presented in Table 22.

Table 21 Maximum ground-level concentrations of nitrogen dioxide and carbon monoxide (in the modelling domain) predicted due to Option 1 and Option 2 for the power station (µg/m³)

Pollutant	Averaging period	Option 1				Option 2				Goal/ Standard
		Without background		With background		Without background		With background		
		µg/m³	% of goal	µg/m³	% of goal	µg/m³	% of goal	µg/m³	% of goal	
Nitrogen dioxide	1-hour	177	55.3	223	69.7	102	31.9	148	46.3	320
	Annual	3.5	11.7	16.5	55.0	1.9	6.3	14.9	49.7	30
Carbon monoxide	8-hour	296	3.0	1,784	17.8	159	1.6	1,647	16.5	10,000

Table 22 Maximum ground-level concentrations of nitrogen dioxide and carbon monoxide (at the Wandoan township) predicted due to Option 1 and Option 2 for the power station (µg/m³),

Pollutant	Averaging period	Option 1				Option 2				Goal/ Standard
		Without background		With background		Without background		With background		
		µg/m³	% of goal	µg/m³	% of goal	µg/m³	% of goal	µg/m³	% of goal	
Nitrogen dioxide	1-hour	12.8	4.0	58.8	18.4	7.4	2.3	53.4	16.7	320
	Annual	0.03	0.1	13.03	43.4	0.01	0.03	13.01	43.4	30
Carbon monoxide	8-hour	5.4	0.1	1493.4	14.9	2.8	0.03	1490.8	14.9	10,000

The results show:

- Predicted ground-level concentrations of nitrogen dioxide and carbon monoxide are higher for Option 1 than for Option 2. This is to be expected due to Option 1 having a larger capacity than Option 2.
- The maximum 1-hour average ground-level concentration of nitrogen dioxide predicted to occur anywhere is less than 70 % of the EPP(Air) goal for both options.
- The maximum 1-hour average ground-level concentration of nitrogen dioxide predicted to occur at Wandoan is less than 19 % of the EPP(Air) goal for both options.

- The highest predicted annual average ground-level concentration of nitrogen dioxide is less than 55% of the EPP(Air) goal for both options.
- The highest predicted 8-hour average ground-level concentration of carbon monoxide is less than 18% of the EPP(Air) for both options.

Figure 78 and Figure 79 present the maximum 1-hour average ground-level concentrations of nitrogen dioxide for Options 1 and 2, respectively. (Background included.)

Figure 80Figure 78 and Figure 81 present the maximum annual average ground-level concentrations of nitrogen dioxide for Options 1 and 2, respectively. (Background included.)

Figure 82 and Figure 83 present the maximum 8-hour average ground-level concentrations of carbon monoxide for Options 1 and 2, respectively. (Background included.)

7. Wastewater Treatment Plant

7.1 Description

The Dalby Regional Council operates and maintains the sewerage system for the town of Wandoan including the Wandoan Wastewater Treatment Plant (WWTP). The development of the Wandoan Coal Project is estimated to increase the total treatment demand on the existing WWTP. Design guidelines require the capacity of the WWTP to treat three times the average dry weather flow (ADWF). Consequently the plant must be upgraded.

Detail on current design and proposed upgrade are detailed in Attachment D.

7.2 Dispersion modelling

7.2.1 Model configuration

Odour impacts for two plant scenarios were modelled to reflect the current baseline and the proposed upgrade of the Plant.

Dispersion modelling was carried out using the AUSPLUME Version 6.0 atmospheric dispersion model. AUSPLUME is a Gaussian, steady-state dispersion model recommended by EPA, in the guideline, *Ecoaccess – Odour Impact Assessment from Developments (2004)*, for application in environments where wind patterns and plume dispersion is not strongly influenced by complex terrain and the land-sea interface. AUSPLUME was found suitable as the local terrain is relatively flat, and there are no significant impediments to wind flows such as tall buildings and dense forests. It also allowed the modelling to be accomplished at a higher resolution than what was available through CALMET/CALPUFF.

The AUSPLUME dispersion model is used to project downwind ground-level concentrations of air contaminants by taking into consideration:

- Odour emissions data - odour emission rate and source dimensions
- Site specific meteorology
- Terrain elevation information
- Building wake effects

For this assessment the air contaminant was odour and ground-level concentrations in odour units (ou) have been projected. While terrain elevation information can be incorporated into the AUSPLUME model and is used for calculating dispersion characteristics from point sources, the model ignores the influence of terrain for area and volume source emissions.

All of the sources input to this model were area sources.

7.2.2 Assessment of the Meteorological Dataset

Site-specific meteorology was developed for this study from the three dimensional meteorological model developed for the assessment of the air quality impacts from the proposed coal mining operations, using local observations, and the TAPM prognostic and CALMET diagnostic meteorological models. A detailed description of the meteorological data used for the dispersion modelling is presented in Attachment C.

7.2.3 AUSPLUME Dispersion Model Configuration

The following input parameters have been used for the odour dispersion modelling:

- Site-specific meteorological data developed using TAPM and CALMET with local observations assimilated. Meteorological parameters include hourly averaged:
    - Wind direction
    - Wind speed
    - Temperature
    - Stability class
    - Mixing height
- Egan half height selected for terrain effects (used for co-ordinate matching in post processing)
- Gridded receptors positioned over a Cartesian grid with the plant at the centre of the grid
    - East-west dimensions: 4,500 m
    - North-south dimensions: 4,000 m
    - Grid spacing: 100 m
- Surface roughness land use (Z_0) of 0.1 to reflect flat terrain
- Pasquill-Gifford horizontal and vertical dispersion curves for sources less than 100 m
- Default options for other model parameters

7.2.4 Emission rates

Table 23 summarises the total emissions for the baseline and upgrade scenarios. Details of emissions from individual sources are provided in Attachment D.

Table 23 Total emission rates for each scenario

Scenario	**OER (ou.m^3 m^{-2} s^{-1})**
WWTP Baseline	3,131
WWTP upgrade	4,242
WWTP upgrade including collection and treatment of Primary Treatment units	2,893

7.3 Results

The odour contour plots for the baseline and upgrade scenarios are presented in Figure 84, Figure 85 and Figure 86 respectively. The predicted highest 1-hour average odour concentration for the 99.5th percentile across the modelling domain and at each of the nearest sensitive receptors is presented in Table 24.

Table 24 Predicted highest 1-hour average ground-level odour concentrations for the 99.5th percentile, in the modelling domain and at sensitive receptor locations

Location	Baseline scenario (ou)	Upgrade scenario (ou)	Upgrade scenario with odour control (ou)
R1 – 2.2 km WNW of STP	0.10	0.14	0.09
R2 – 2.2 km W of STP	0.12	0.17	0.11
R3 – 1.9 km WNW of STP	0.14	0.19	0.13
R4 – 1.2 km WSW of STP	0.26	0.35	0.24
R5 – 1.1 km WSW of STP	0.30	0.40	0.27
R6 – 1.1 km SW of STP	0.29	0.40	0.27
R7 – 1.0 km SW of STP	0.31	0.42	0.28
R8 – 1.0 km SSW of STP	0.35	0.48	0.34
R9 – 0.9 km SSW of STP	0.33	0.43	0.30
R10 – 0.9 km SSW of STP	0.36	0.46	0.33
R11 – 1.1 km SE of STP	0.13	0.18	0.12
R12 – 1.8 km E of STP	0.07	0.10	0.07
EPA guideline: 2.5 ou, 99.5th percentile, 1-hour average			

The modelling results are summarised as follows:

- There are no exceedances predicted of the EPA odour guideline of 2.5 ou (99.5th percentile, 1-hour average) from the Plant for the baseline and upgrade scenarios
- The predicted maximum odour impact at a sensitive receptor for the baseline scenario is 0.36 ou (99.5th percentile, 1-hour average) at R10
- The predicted maximum odour impact at a sensitive receptor for the upgrade scenario is 0.48 ou (99.5th percentile, 1-hour average) at R8
- The predicted maximum odour impact at a sensitive receptor for the upgrade with odour control scenario is 0.34 ou (99.5th percentile, 1-hour average) at R8
- The inclusion of odour control results in the reduction of ground level concentrations of odour at all sensitive receptors

8. Construction impacts

This section examines the potential air quality impacts related to construction of essential mine infrastructure within the MLA areas. A summary of mitigation strategies and measures to address these impacts is provided.

8.1 Methodology

The Environmental Protection Regulation 1998, stipulates that activities that will, or have the potential to, release contaminants into the environment and which may cause environmental harm are defined as Environmentally Relevant Activities (ERAs). Currently there is no ERA covering the construction and operation of a natural gas pipeline. As such the air quality assessment follows the framework set out in the Environmental Protection (Air) Policy 1997 to achieve the objectives of the Environmental Protection Act 1994 with regard to Queensland's air environment

8.2 Construction activities

Construction phase activities can be broadly described as:

- Site clearance of areas for construction activities, including vegetation clearance, topsoil removal and storage, and earthworks
- Civil works including temporary and permanent drainage works
- Structure and plant erection and installation
- Commissioning and testing of plant and equipment
- Construction site demobilisation

Infrastructure that will be constructed during the construction phase or at some time during mine operation includes:

- Coal handling and preparation plant (CHPP)
- Product coal handling and train load out (TLO)
- Rail spur
- Temporary and Permanent accommodation facilities
- Haul roads
- Light and heavy vehicle internal roads
- Main gate and security building
- Airstrip
- Mine Infrastructure Area
    - Administration facility
    - Workshop and store
    - Tyre change and storage facility
    - Fuel facility
    - Lube and oil storage facility
    - Wash down facilities
    - Reticulated services
- Draglines and dragline facility
- Telecommunications
- Power supply and generation, including gas supply pipeline

- Water supply and management facilities, including raw water supply and storage, initial ashdam
- Initiating explosives magazine

8.3 Sensitive Receptors

There are no identifiable sensitive receptors that will be impacted by construction activities within the MLA areas.

8.4 Dust Management

Dust management should include regular watering of roads and exposed areas to reduce wheel-generated dust and restricting vehicle speeds. During high wind conditions, dust-generating activities such as earthworks that could potentially affect residents should not be carried out. The loads of haul vehicles should be covered when moving outside of the construction site and any spillages should be cleaned up. Stockpiled material should be vegetated or kept in appropriate enclosures to prevent wind erosion from the prevailing easterly wind direction.

Installation and use of a sealed area for trucks to stop and "drop dust" will prevent track-out of dust to public roads. If construction machinery is to be used in wet conditions, a regime should be implemented to dislodge dried mud before it goes on the road Burning or incineration of cleared vegetation or other materials should not be carried out on site at any time.

Before construction commences, a dust management plan (DMP) is proposed to be developed in conjunction with the construction management plan to assist in minimising nuisance dust. Dust measures to be included are:

- So far as practical, erecting physical barriers such as bunds and or wind breaks around stockpiles or areas where earth moving is required
- Management of the earth moving activities to coincide with favourable meteorological conditions. That is, schedule high dust potential operations to occur during daytime with light southeast to easterly winds
- Minimising speed of on-site traffic, where applicable, to minimise wheel generated dust
- Ensuring all vehicles are suitably fitted with exhaust systems that minimise gaseous and particulate emissions to meet vehicle design standards
- Watering of bunds and stockpiles to minimise dust lift-off
- Watering high use unsealed roads to minimise dust lift-off from the road surface
- Limiting vegetation and soil clearing to approved areas, so as to minimise the area of exposed soil that may generate dust
- Compaction of construction site and stabilisation of vegetation to minimise dust lift off due to wind erosion
- Monitoring air quality at designated fixed monitoring points

If on-site concrete batching plants, bitumen or asphalt plants are required, these may be a source of dust, odour and other air pollutants. Site-specific air quality assessments should be undertaken if these activities are to be located within close proximity of sensitive receptors and land uses or alternatively kept away from these locations.

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9. Traffic impacts

The main pollutants of concern from vehicular exhaust are nitrogen dioxide, particulate matter, carbon monoxide and sulphur dioxide. The Leichhardt Highway runs north-south on the eastern edge of the Project and connects Taroom, Wandoan and Miles. Vehicles hauling construction material will use this road to access the Project site. During the operation of the mine, haul trucks and other diesel-fuelled vehicles will be a source of air pollutants.

Detail of traffic numbers annual average daily traffic (AADT) currently and proposed are presented in the traffic report. Current traffic numbers for the Leichhardt Highway for 2008 are reproduced in Table 25.

Table 25 Background traffic for 2008 (Table 3-1, Traffic Report)

Road/section	AADT	Daily CVs*	Daily ESAs**
Leichhardt Highway (26A)			
1.62km south of Fitzroy Developmental Road	537	190	666
Leichhardt Highway (26B)			
Taroom – Jackson-Wandoan Road intersection	654	189	661
Jackson-Wandoan Road intersection – Miles	638	203	711
Jackson-Wandoan Road (4302)			
Jackson – chainage 68.5km	66	14	50
Chainage 68.5km – Wandoan	132	27	95
Warrego Highway (18C)			
Main Roads district boundary – Miles	1,846	428	1,500
Warrego Highway (18B)			
Dalby – Road 325 intersection	5,639	861	3,012
Road 325 intersection – chainage 27.0km	4,433	964	3,375
Chainage 27.0km – chainage 10.5km	11,482	1,372	4,802
Chainage 10.5km – intersection McDougall St, Toowoomba	13,068	1,112	3,892
Dawson Highway (46B)			
1km east of Banana	1,384	234	818
900m west of Burnett Highway (41E)	1,832	285	996
700m west of Burnett Highway (41D)	6,091	639	2,236

* CVs = commercial vehicles
** ESAs = equivalent standard axles

The Traffic Report projects that the maximum number of additional vehicles during construction will be 13,251 vehicles per year, during the first two years of construction before reducing to half of this for the remainder of the operations. This equates to an increase of 29 vehicles per day and an increase in the AADT of 4.2% expected on the Leichardt Highway (26B) on the Taroom – Jackson-Wandoan Road intersection link. For the Jackson-Wandoan Road intersection – Miles link this equates to an increase of 12 vehicles per day and an increase in the AADT of 1.8%.

During the operation of the mine, the maximum number of additional vehicles due to construction and operation of the mine is expected to be 6,447 per year, with 45% of these vehicles being B Double trucks and 30% of these vehicles being buses transporting the workers. This equates to an increase of 5 vehicles per day and an increase in the AADT of 0.6% expected on the Leichardt Highway (26B) on the Taroom – Jackson-Wandoan Road intersection link. For the Jackson-Wandoan Road intersection – Miles link this equates to increase of 13 vehicles per day and an increase in the AADT of 1.6%.

In previous work conducted by Katestone Environmental separation distances were calculated using the CAL3QHCR dispersion model for a generic road with free-flowing or congested traffic conditions and for an intersection. The separation distances have been calculated for various daily average traffic flows (AADT). The separation distance has been determined as the distance from the road edge to a point where predicted ground-level concentrations of each air pollutant comply with the air quality goals. An allowance has been made for background air quality.

Nitrogen dioxide is the air pollutant from motor vehicles that requires the largest separation distances. Table 26 presents recommended separation distances for free-flowing and congested traffic. The vehicle speed for free-flowing roads was set at 60 km/hr, while the vehicle speed for congested traffic conditions was set to 30 km/hr.

The study found that if:

- 40,000 vehicles access the road daily;
- 10% of vehicles are heavy vehicles (e.g. trucks);
- the road is congested; and
- the road gradient is zero

the minimum separation distance that is required is four to ten metres.

The Leichardt Highway will only have a maximum of 723 vehicles per day (29 vehicles due to the project) travelling towards Taroom and 667 vehicles per day (12 vehicles due to the project) traveling towards Miles during construction.

Given the relatively small change in traffic numbers and the relatively small number of vehicles that use the Leichhardt Highway, ground-level concentrations of all air pollutants from vehicle exhausts will be below the EPP(Air) goals within and outside of the road corridor. Similarly, given the relatively small number of haul vehicles travelling along the haul roads of the mine-site, ground-level concentrations of air pollutants are unlikely to exceed the EPP(Air) goals within or outside the haul road corridor.

Table 26 Recommended separation distances (metres) for various types of road based on Brisbane City Council fleet emissions spreadsheet and predictions made using the CAL3QHCR dispersion model

AADT	Free flow, flat, 5% heavies		Free flow, flat, 10% heavies		Free flow, slope = 0.5-4%, 5% heavies		Free flow, slope = 0.5-4.0%, 10% heavies		Free flow, slope = 4.0-6.0%, 5% heavies		Free flow, slope = 4.0-6.0%, 10% heavies	
	Free flow	Congested	Free flow	Congested	Free flow	Congested	Free flow	Congested	Free flow	Congested	Free flow	Congested
500	0	0	0	0	0	0	0	0	0	0	0	0
1,000	0	0	0	0	0	0	0	0	0	0	0	0
2,500	0	0	0	0	0	0	0	0	0	0		0
5,000	0	0	0	0	0	0	0	0	0	0	0	0
7,500	0	0	0	0	0	0	0	0	0	0	0	0
10,000	0	0	0	0	0	0	0	0	0	0 - 1	0 - 2	0 - 3
15,000	0	0	0	0	0	0 - 1	0 - 2	0 - 3	0 - 3	0 - 4	1 - 5	2 - 5
20,000	0	0 - 1	0 - 1	0 - 2	0 - 2	0 - 4	0 - 5	1 - 5	1 - 5	3 - 7	3 - 9	4 - 10
30,000	0 - 3	0 - 4	1 - 5	2 - 5	2 - 5	3 - 7	4 - 9	4 - 10	5 - 11	6 - 14	7 - 16	9 - 19
40,000	1 - 5	3 - 7	3 - 8	4 - 10	4 - 10	5 - 12	6 - 14	7 - 16	8 - 18	10 - 21	12 - 24	14 - 27
50,000	3 - 8	4 - 10	5 - 12	5 - 14	5 - 14	8 - 17	9 - 20	11 - 22	12 - 24	15 - 28	17 - 32	19 - 37
80,000	8 - 17	10 - 21	11 - 23	13 - 26	14 - 26	17 - 31	19 - 37	22 - 43	23 - 47	27 - 60	31 - 72	36 - 85
100,000	11 - 23	14 - 27	16 - 30	19 - 35	19 - 36	23 - 46	25 - 54	29 - 64	30 - 70	38 - 89	45 - 103	53 - 115

10. Gas Pipeline

This section examines the potential air quality impacts related to construction of a gas supply pipeline between the Wandoan Coal Project area and the Peat-Scotia Gas Line located approximately 20 km to the east of Wandoan. A summary of mitigation strategies and measures to address these impacts is provided.

10.1 Methodology

The Environmental Protection Regulation 1998, stipulates that activities that will, or have the potential to, release contaminants into the environment and which may cause environmental harm are defined as Environmentally Relevant Activities (ERAs). Currently there is no ERA covering the construction and operation of a natural gas pipeline. As such the air quality assessment follows the framework set out in the Environmental Protection (Air) Policy 1997 to achieve the objectives of the Environmental Protection Act 1994 with regard to Queensland's air environment.

10.2 Site Description

The Wandoan Coal Project proposes to develop thermal coal resources situated immediately west of the Wandoan township, located in Dalby Regional Council. The Wandoan Coal Project site is located approximately 350 km north-west of Brisbane and 60 km south of Taroom. The coal reserves for the Wandoan Coal Project exist within the area of three mining lease applications, MLA 50229, 50230 and 50231 and will be developed as an open cut mine and related local infrastructure. The Wandoan Coal Project covers an area of approximately 32,000 ha.

Due to the existing condition of the power grid in the area compared to power demands of the Wandoan Coal Project, on-site power generation is being considered as a power supply option. Gas from the nearby Peat-Scotia Gas Line has been identified as a potential fuel source for proposed on-site power generation which may be constructed as part of the Wandoan Coal Project. The gas supply pipeline will generally be located underground with 500-700 mm depth of cover and constructed through a section trench and backfill method.

10.2.1 Pipeline Route

The proposed pipeline route is to be co-located along the future Surat Basin Rail line which diagonally traverses the study area in a north-south direction. The route begins at the Peat Scotia Gas Line in the vicinity of Lot 22 on plan RP847424 and travels in a westerly direction until it meets the eastern edge of the proposed Surat Basin Rail route easement on Lot 6 FT801. Throughout the PL area, the pipeline is to be preferably aligned with existing fence lines so as to minimise disruption to existing land use practices. From this point, the pipeline is proposed to be aligned on the southern/eastern side of the Surat Basin Rail route easement until meeting the north-eastern boundary of the Wandoan Coal Project area. The following allotments will be traversed: Lot 48 on FT815, Lot 99 on FT815, Lot 41 FT603, Lot 40 FT329, Lot 22 FT746, Lot 2 RP170076, Lot 5 FT349, Lot 5 FT349, and Lot 160 FT990.

10.3 Sensitive Receptors

Sensitive receptors can be defined as residential areas, isolated dwellings, hospitals, and schools. The Gas supply pipeline will affect 13 privately own properties (refer section 10.2.1) covering a total area of 119 ha. Due to the relatively small nature of the construction activity and non-existent dust emissions from the pipeline operation it was determined that nuisance from dust deposition would be of greatest concern to any sensitive receptors encountered along the proposed route.

Dust nuisance can occur due to the deposition of larger dust particles. Elevated dust deposition rates can cause reduced public amenity through, for example, soiling of clothes, building surfaces or horticultural crops. Table 1 shows the dust deposition guideline commonly used in Queensland as a benchmark for avoiding amenity impacts due to dust. The dust deposition guideline is not defined in the EPP(Air) and is therefore not enforceable by legislation, but is recommended by the EPA as a design goal and has been adopted for this project.

10.4 Construction Activities

Preconstruction activities will include the use of machinery to prepare the area along the pipeline route (and access tracks, if necessary) by clearing vegetation and grading. The use of existing access tracks would be given first preference to avoid any unnecessary clearing.
Trenching would be used to construct the majority of the pipeline route and would be prepared ahead of construction using a wheel trencher and excavator for the majority of the route. In some areas, harder rock may be encountered and hydraulic rock breaking equipment may be required.

Multiple tractors fitted with side cranes and counterweights would be used to lift and move the pipe string over the trench and lower the pipe into position.
Once the pipe is strung, a line-up crew would position the pipe using side boom tractors and internal line-up clamps. The specialist welding crew would then follow, joining the pipes into a continuous string. It is expected that for this size of pipe, welding would be undertaken using an automatic welding machine.

10.5 Equipment

Construction vehicles required for the installation of the pipeline will include wheel trenchers, excavators, side boom tractors, haul trucks and dozers. Additional construction equipment will be required, such as include drill rigs, hydraulic rock breaking equipment and automatic welding machines.

10.6 Potential Impacts

10.6.1 Construction

Emissions during construction of the pipeline will associated with land clearing, ground excavation and back filling.

10.6.2 Earthworks

The excavation of the pipeline trench and subsequent refilling once the pipe has been laid will be a relatively small source of fugitive dust emissions. This is due to the small surface area of worked land (approximately 10 m in width) as dust emissions are proportional to the area of land being disturbed (US EPA AP-42 1995). It was determined that exceedances of the EPP (Air) goals from fugitive emissions could not extend beyond the pipeline corridor.

10.6.3 Traffic

A large portion of fugitive dust emissions results from equipment traffic over temporary unsealed roads. As the majority of the construction activity will be co-located with the proposed Surat Basin Rail Line and the relatively small number of vehicles required for the operation these impacts are considered to be negligible.

10.6.4 Operation

No air emissions will be produced by the operation of the southern pipeline as the pipeline will be operating underground.

10.7 Mitigation Measures

A dust management plan will be developed for the construction of the gas supply pipeline as part of the Projects Construction Management Plan. This plan will include

- Use of water sprays during excavation when sensitive receptors are located within 500 m of the pipeline corridor
- Revegetation of disturbed area as soon as possible following refill

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11. Conclusions

The key aspects of the Project in terms of the air quality impact assessment are as follows:

- *Potential impacts of dust due to the mine operations for the following representative years over the life of the mine:*

    - Do nothing
    - Year 1 of mining operation
    - Year 5 of mining operation
    - Year 10 of mining operation
    - Year 20 of mining operation
    - Year 30 of mining operation

- Potential impacts of nitrogen dioxide and carbon monoxide due to the operation of a gas-fired dual fuel engine power station
- Potential impacts of odour due to the upgrade of the Wandoan Wastewater Treatment Plant
- Potential impacts of dust during the construction of the mine and associated infrastructure (including gas pipelines and the upgrade of the potable water supply)

The findings of the air quality assessment are as follows:

Mining operations

- Dispersion modeling has been undertaken to assess the potential impact of the Project on ground-level concentrations of PM_{10} and TSP as well as dust deposition rate at the Wandoan township and surrounding sensitive receptors.

- The results show:

    - Compliance with the annual average EPP(Air) goal of 50 $\mu g/m^3$ for PM_{10} for Years 1, 5, 10, 20 and 30
    - Compliance with the annual average EPP(Air) goal of 90 $\mu g/m^3$ for TSP for Years 1, 5, 10, 20 and 30
    - Compliance with the annual average recommended guideline of 120 mg/m^2/day for dust deposition rate for Years 1, 5, 10, 20 and 30
    - At the Wandoan township, maximum 24-hour average ground-level concentrations of PM_{10} are predicted to be below the EPP(Air) goal of 150 $\mu g/m^3$ for PM_{10} for Years 1, 10, 20 and 30
    - To obtain acceptable levels of PM_{10} in the Wandoan town in Year 5, extraction rates of overburden and coal need to be reduced at the Frank Creek Pit as activities approach within 2 km of the township. The rate of reduction will be determined by real time monitoring of TSP, PM_{10} and meteorological conditions.
    - At sensitive receptors surrounding the Project, maximum 24-hour average ground-level concentrations of PM_{10} are predicted to be below the EPP(Air) goal of 150 $\mu g/m^3$ for PM_{10} for Year 1 and Year 10
    - Years 20 and 30, sensitive receptors to the south and west (Table 12) are likely to be exposed to elevated levels due to the proximity of the draglines

The need to develop a flexible and holistic dust management plan is evident. A monitoring and forecasting system is recommended to minimize high dust potential events where operations are occurring upwind of receptors less than 2 km from the location of the operations during strong winds and dry atmosphere. For example mitigation measures outlined in Section 5 would be required when mining equipment is operating in Frank Creek Pit during strong northwesterly to westerly winds to ensure receptors on the eastern side of the Leichardt highway and the township of Wandoan remain below the EPP (Air) goal. The dust management plan will require a combination of approaches with the flexibility to implement one or several strategies as required, these management approaches are listed below.

It is recommended that a Proactive management plan should include, where necessary:

- Watering and grading haul roads and use of surface treatments
- Water sprays, covers and chutes at the Coal Handling and Preparation Plant (CHPP)
- Partial covers on conveyors
- Progressive revegetation of disturbed areas as mining operations develop
- Implementation windbreaks i.e. tree planting around stockpiles and TSF's
- Progressive rehabilitation and revegetation of mined surfaces within 2 years of original disturbance
- Minimisation of the drop height for dragline operations
- Continuous monitoring of dust concentrations at sensitive receptors
- Continuous monitoring of meteorological conditions
- Use of a forecasting system to assist in anticipating adverse meteorological conditions that may give rise to dust generation and implementation of operational changes and improved mitigation to avoid adverse impacts
- Dust suppression of stockpiles and rejects emplacement
- Design of mine to ensure sufficient separation to sensitive land-uses to avoid adverse impacts
- Where mining is located in relatively close proximity to residential areas, mining methods and rates will be adapted to minimise due emissions, for example, the use of truck and shovel instead of a dragline. See sections 5.4 for further information.
- The surface of coal in wagons should be profiled to a flat "garden bed" shape and a surface treatment will be applied to minimise coal dust emissions during transit to the port
- Laboratory work should be completed to investigate the relationship between dustiness and moisture of the Wandoan coal (DEM) to assist in the management of coal dust emissions.
- Laboratory work should be conducted to investigate the dustiness of the washery rejects to assist in the management of dust emissions from the reject emplacement

It is recommended that a reactive management plan (such as a Trigger Response Action Plan) should include:

- Implementation of additional mitigation measures when wind conditions become adverse, such ceasing operations, covering equipment.
- Adaptive management strategies such as reduction in extraction rates of operation when meteorological monitoring suggests adverse wind conditions or dust monitoring at sensitive receptors indicates levels could exceed 80% of the 24 hour PM_{10} goal.

Power Station

- Dispersion modeling has been undertaken to assess the potential impact of the Power Station options on ground-level concentrations of nitrogen dioxide and carbon monoxide at the Wandoan township and surrounding sensitive receptors.
- The results show:

    - Predicted ground-level concentrations of nitrogen dioxide and carbon monoxide are higher for Option 1 than for Option 2. This is to be expected due to Option 1 having a larger capacity than Option 2.
    - Compliance with the 1-hour average EPP(Air) goal of 320 $\mu g/m^3$ for nitrogen dioxide.
    - Compliance with the 8-hour average EPP(Air) goal of 10,000 $\mu g/m^3$ for carbon monoxide.

Waste Water Treatment Plant (WWTP)

- Dispersion modelling has been undertaken to assess the potential impact of the upgraded WWTP on ground-level concentrations of odour.
- The results show there are no exceedances predicted of the EPA odour guideline of 2.5 ou (99.5th percentile, 1-hour average) from the WWTP for the baseline and upgrade scenarios.

Construction of Gas pipeline and Mine Infrastructure

- A dust management plan should be developed.

12. References

Bofinger, N.D., Best, P.R., Cliff, D.I., and Stumer, L.J., 1986. The oxidation of nitric oxide to nitrogen dioxide in power station plumes. *Proceedings of the Seventh World Clean Air Congress*, Sydney, 384-392.

TAPM (2006) Version 3.0.7 developed by the CSIRO (http://www.cmar.csiro.au/research/tapm/).

Earth Tech Inc, Concord, MA, USA. CALMET - Version 6.211 - April 14. 2006 http://www.src.com/verio/download/download.htm#MOD6_VERSION

Earth Tech Inc, Concord, MA, USA. CALPUFF - Version 6.112 - April 12, 2006 CALMET - Version 6.211 - April 14. 2006 http://www.src.com/verio/download/download.htm#MOD6_VERSION

Environmental Protection Agency 1997. Environmental Protection (Air) Policy, Subordinate Legislation 1997 No. 468 and amendments. *Office of the Queensland Parliamentary Counsel, Queensland.*

Gutteridge Haskins & Davey (GHD) / Oceanics 1975. *Hay Point Environmental Planning Study.*

MCInnnes K.L, MCBride, J.L., & Leslie, L.M. 1994, Cold fronts over Southern Australia: Their representation in an operational numerical weather prediction model*. Waether and Forecasting*, Vol. 9, 384-409.

National Environment Protection Council (NEPC) 1998. National Environment Protection (Ambient Air Quality) Measure, as amended July 2003.

Neale, D. 2005 Ambient air quality in Queensland 2005 annual summary and trend report. Environmental Protection Agency, Technical Report: ISSN 1037-4671

NSW DECC 2007, Factsheet: Mine dust and you

Park, C.W. & Lee, S.J. 2002, “Verification of the shelter effect of a windbreak on coal piles in the POSCO open storage yards at the Kwang-Yang works” *Atmospheric Environment, Vol.36, 13, 2171-2185.*

Queensland Environmental Protection Agency, 2004 Guideline – Odour Impact Assessment from Developments.

Queensland Environmental Protection Act (1994), Reprinted as in force on 6th June 1996 (includes amendments up to Act No. 10 of 1996).

Sturman, A.P. and Tapper, N.J., 1996, Weather and Climate of Australia and New Zealand. Melbourne Oxford University Press.

Tapper, N. and Hurry, L. 1993, Australia's Weather Patterns - An Introductory Guide, Dellasta Pty Ltd, Mt. Waverly, Victoria.

Figure 1 Location of Wandoan Coal Project	
Location: Wandoan	**Data source:** Parsons Brinckerhoff
Prepared by: Natalie Shaw	**Date:** August 2008

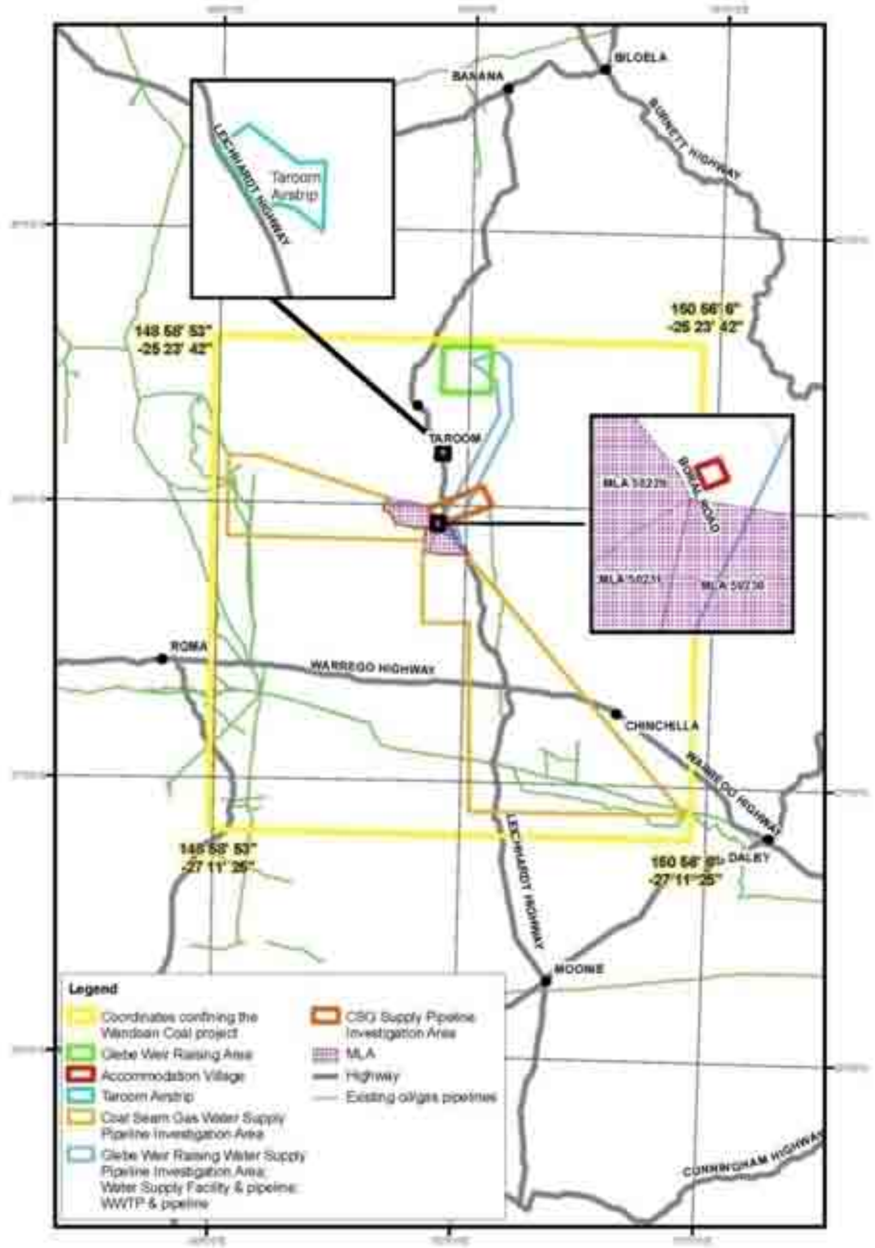


Figure 2 Location of mining lease applications (MLA)

Location: Wandoan	**Data source:** Parsons Brinckerhoff	**Units:** Latitude, longitude
Prepared by: Natalie Shaw	**Date:** August 2008	

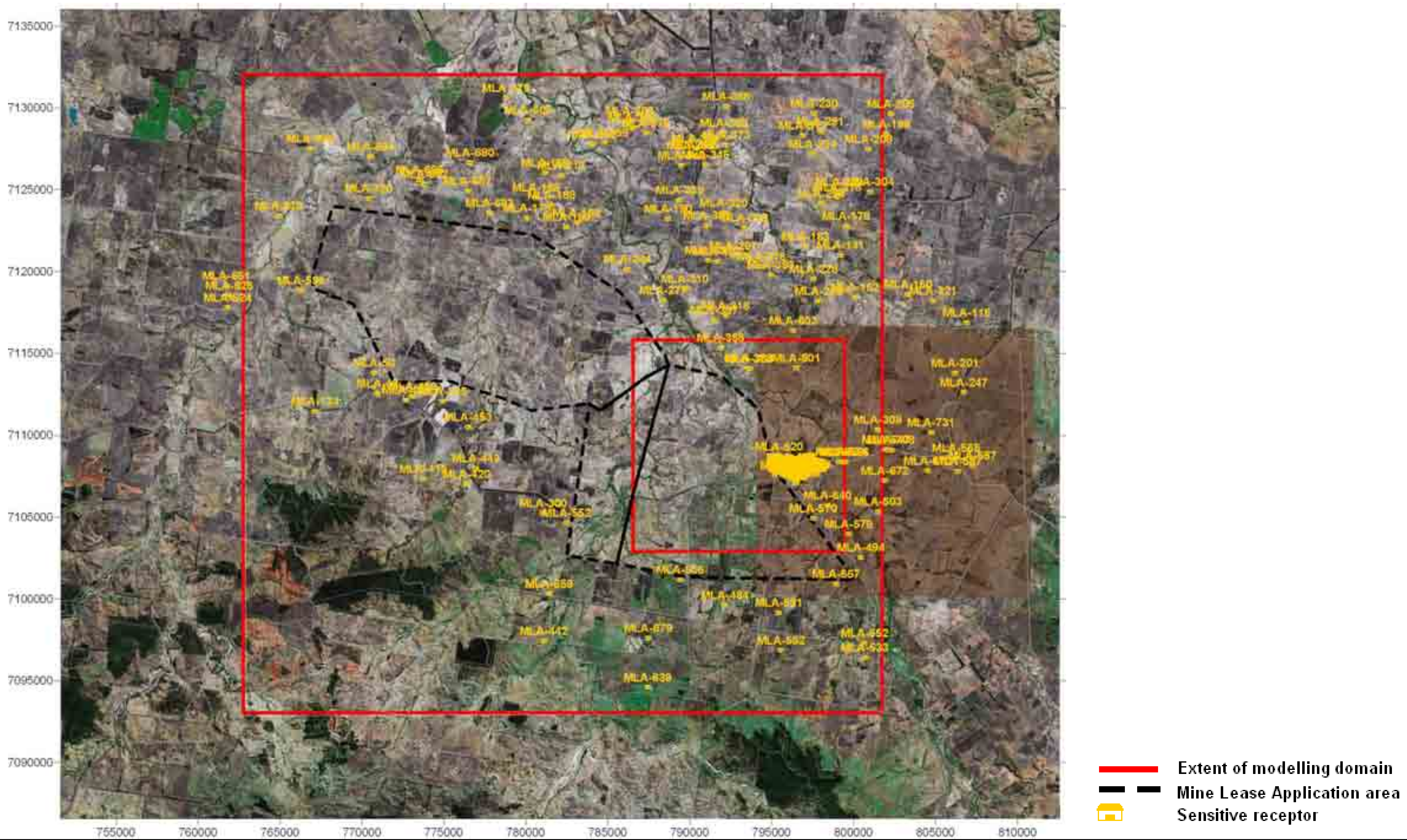


Figure 3 Region of interest in air quality assessment

Location: Wandoan	Data source: Google and Calmet	
Type: Aerial	**Prepared by:** Andrew Wiebe	**Date:** 02/09/08

Table 27 Sensitive receptors included in the air quality assessment

latitude	longitude	Receptor	LOT	PLAN	Type
-26° 6' 50"	155° 57' 2"	Abattoir	-	-	Rural
-26° 4' 41"	155° 56' 8"	Cemetery	-	-	Rural
-26° 7' 4"	149° 57' 38"	MLA-1	-	-	House
-26° 7' 10"	149° 57' 38"	MLA-10	-	-	House
-26° 7' 1"	149° 57' 43"	MLA-103	4	W64121	House
-26° 7' 11"	149° 58' 9"	MLA-104	47	W64126	House
-26° 7' 2"	149° 57' 42"	MLA-105	-	-	House
-26° 7' 2"	149° 57' 42"	MLA-106	-	-	House
-26° 6' 60"	149° 57' 44"	MLA-107	-	-	House
-26° 7' 1"	149° 57' 40"	MLA-108	-	-	House
-26° 7' 12"	149° 57' 49"	MLA-109	-	-	House
-26° 7' 2"	149° 57' 38"	MLA-11	16	RP227966	House
-26° 7' 15"	149° 58' 12"	MLA-110	2	W64139	House
-26° 7' 18"	149° 58' 4"	MLA-111	18	SP127084	House
-26° 6' 60"	149° 57' 42"	MLA-112	5	W64125	House
-26° 7' 1"	149° 57' 41"	MLA-113	-	-	House
-26° 7' 18"	149° 58' 4"	MLA-114	18	SP127084	House
-26° 7' 0"	149° 57' 42"	MLA-115	5	W64125	House
-26° 2' 4"	150° 3' 59"	MLA-116	5	FT1004	House
-26° 7' 11"	149° 57' 50"	MLA-117	10	W6416	House
-26° 7' 11"	149° 57' 50"	MLA-118	11	W6416	House
-26° 7' 12"	149° 57' 49"	MLA-119	11	W6416	House
-26° 7' 2"	149° 57' 38"	MLA-12	16	RP227966	House
-26° 7' 19"	149° 58' 1"	MLA-120	-	-	House
-26° 7' 18"	149° 57' 45"	MLA-121	218	W6411	House
-26° 7' 17"	149° 58' 1"	MLA-122	22	W64139	House
-26° 7' 17"	149° 57' 52"	MLA-123	2	W64110	House
-26° 7' 18"	149° 57' 45"	MLA-124	217	W6411	House
-26° 7' 18"	149° 58' 5"	MLA-125	17	W64139	House
-26° 7' 18"	149° 57' 53"	MLA-126	14	W64110	House
-26° 7' 20"	149° 57' 43"	MLA-127	-	-	House
-26° 7' 3"	149° 57' 37"	MLA-13	-	-	House
-26° 7' 16"	149° 57' 46"	MLA-130	-	-	House
-26° 7' 13"	149° 57' 38"	MLA-132	116	W6411	House
-26° 7' 20"	149° 57' 47"	MLA-133	213	W6411	House
-26° 5' 28"	149° 40' 14"	MLA-134	34	SP106737	House
-26° 7' 13"	149° 57' 39"	MLA-136	115	W6411	House
-26° 7' 14"	149° 57' 40"	MLA-137	114	W6411	House
-26° 7' 10"	149° 57' 34"	MLA-14	23	W64133	House
-25° 59' 56"	149° 59' 19"	MLA-141	41	FT603	House
-26° 7' 25"	149° 57' 54"	MLA-142	5	W64140	House

latitude	longitude	Receptor	LOT	PLAN	Type
-26° 7' 6"	149° 57' 38"	MLA-15	504	W6412	House
-26° 1' 11"	150° 1' 50"	MLA-150	44	FT328	House
-25° 59' 4"	149° 49' 39"	MLA-158	44	FT507	House
-25° 57' 26"	149° 48' 28"	MLA-159	30	FT835701	House
-26° 7' 9"	149° 57' 36"	MLA-16	-	-	House
-26° 1' 18"	149° 59' 54"	MLA-162	40	FT329	House
-25° 58' 15"	149° 48' 9"	MLA-168	29	SP167183	House
-26° 7' 7"	149° 57' 37"	MLA-17	503	W6412	House
-25° 58' 56"	149° 47' 51"	MLA-175	42	FT505	House
-26° 7' 15"	149° 57' 45"	MLA-177	-	-	House
-25° 58' 58"	149° 59' 30"	MLA-178	99	FT815	House
-26° 7' 20"	149° 58' 5"	MLA-18	-	-	House
-25° 59' 41"	149° 58' 3"	MLA-183	61	FT515	House
-25° 58' 29"	149° 48' 44"	MLA-188	32	FT444	House
-26° 7' 6"	149° 57' 37"	MLA-19	506	W6412	House
-25° 58' 51"	149° 52' 60"	MLA-190	38	FT440	House
-26° 7' 15"	149° 57' 52"	MLA-195	-	-	House
-25° 55' 54"	150° 0' 53"	MLA-196	6	FT801	Homestead
-26° 7' 17"	149° 57' 50"	MLA-197	312	W6412	House
-25° 59' 12"	149° 49' 18"	MLA-199	43	FT506	House
-26° 7' 4"	149° 57' 41"	MLA-2	7	W64113	House
-26° 7' 18"	149° 58' 3"	MLA-20	20	W64139	House
-26° 7' 16"	149° 57' 45"	MLA-200	-	-	House
-26° 3' 44"	150° 3' 37"	MLA-201	1	FT740	House
-25° 55' 13"	150° 1' 3"	MLA-205	10	FT486	Homestead
-26° 7' 26"	149° 57' 53"	MLA-207	6	W64140	House
-25° 56' 25"	150° 0' 15"	MLA-208	66	FT517	House
-26° 7' 16"	149° 57' 50"	MLA-209	313	W6412	House
-26° 7' 19"	149° 58' 3"	MLA-21	-	-	House
-26° 7' 16"	149° 58' 6"	MLA-210	-	-	House
-25° 57' 30"	149° 49' 3"	MLA-213	31	FT715	House
-26° 7' 16"	149° 58' 7"	MLA-215	-	-	House
-26° 7' 17"	149° 57' 49"	MLA-216	311	W6412	House
-25° 58' 1"	149° 59' 10"	MLA-218	63	FT960	Homestead
-26° 7' 23"	149° 57' 55"	MLA-219	3	W64140	House
-26° 7' 11"	149° 57' 36"	MLA-22	120	W6411	House
-26° 7' 17"	149° 57' 58"	MLA-221	11	W64139	House
-26° 7' 17"	149° 57' 57"	MLA-224	10	W64139	House
-26° 7' 24"	149° 57' 54"	MLA-227	4	W64140	House
-26° 0' 44"	149° 58' 22"	MLA-228	60	FT904	House
-25° 57' 51"	149° 59' 14"	MLA-229	63	FT960	House
-26° 7' 11"	149° 57' 36"	MLA-23	121	W6411	House
-25° 55' 16"	149° 58' 14"	MLA-230	67	FT518	Homestead

latitude	longitude	Receptor	LOT	PLAN	Type
-26° 1' 28"	149° 58' 34"	MLA-235	59	FT820	House
-26° 6' 60"	149° 47' 53"	MLA-239	47	FT466	House
-26° 7' 8"	149° 57' 37"	MLA-24	502	W6412	House
-26° 0' 33"	149° 51' 33"	MLA-244	45	FT507	Homestead
-26° 7' 16"	149° 58' 5"	MLA-246	-	-	House
-26° 4' 23"	150° 3' 57"	MLA-247	27	FT36	House
-26° 7' 7"	149° 57' 35"	MLA-25	-	-	House
-25° 58' 14"	149° 58' 34"	MLA-254	62	FT815	House
-26° 7' 14"	149° 58' 7"	MLA-26	35	W64126	House
-26° 7' 14"	149° 58' 6"	MLA-27	36	W64126	House
-26° 7' 20"	149° 57' 47"	MLA-270	212	W6411	House
-26° 5' 51"	149° 48' 36"	MLA-271	37	FT494	House
-26° 5' 35"	149° 48' 39"	MLA-274	37	FT494	House
-26° 7' 14"	149° 57' 51"	MLA-276	-	-	House
-26° 1' 33"	149° 52' 53"	MLA-277	50	FT508	Homestead
-26° 7' 9"	149° 57' 40"	MLA-28	420	W6412	House
-25° 56' 37"	149° 58' 13"	MLA-284	64	FT516	House
-26° 7' 10"	149° 57' 39"	MLA-29	-	-	House
-25° 55' 51"	149° 58' 29"	MLA-291	65	FT518	Homestead
-26° 0' 2"	149° 55' 24"	MLA-297	64	FT525	House
-26° 7' 4"	149° 57' 38"	MLA-3	-	-	House
-26° 7' 12"	149° 57' 40"	MLA-30	-	-	House
-26° 8' 41"	149° 48' 40"	MLA-300	15	FT161	House
-25° 57' 49"	150° 0' 21"	MLA-304	48	FT815	House
-26° 5' 3"	149° 44' 55"	MLA-305	29	FT467	House
-25° 59' 3"	149° 54' 25"	MLA-307	48	FT871	Homestead
-26° 5' 40"	150° 0' 50"	MLA-308	20	FT101	House
-26° 7' 59"	149° 49' 15"	MLA-309	45	FT497	House
-26° 7' 12"	149° 57' 37"	MLA-31	118	W6411	House
-26° 1' 10"	149° 53' 40"	MLA-310	49	FT453	House
-25° 56' 0"	149° 57' 50"	MLA-312	65	FT518	Homestead
-26° 2' 1"	149° 55' 10"	MLA-318	66	FT521	House
-26° 7' 14"	149° 57' 37"	MLA-32	-	-	House
-25° 58' 38"	149° 55' 1"	MLA-320	62	FT833	Homestead
-26° 1' 22"	150° 2' 44"	MLA-321	4	FT835681	House
-25° 59' 6"	149° 55' 47"	MLA-329	77	FT565	House
-26° 7' 12"	149° 57' 41"	MLA-33	-	-	House
-26° 0' 12"	149° 54' 30"	MLA-331	2	SP177963	House
-25° 58' 13"	149° 53' 24"	MLA-339	37	FT440	House
-26° 7' 6"	149° 57' 54"	MLA-34	-	-	House
-25° 57' 5"	149° 53' 27"	MLA-340	361	SP143626	House
-25° 57' 2"	149° 54' 19"	MLA-345	76	RP895260	House
-26° 7' 20"	149° 57' 55"	MLA-347	10	W64110	House

latitude	longitude	Receptor	LOT	PLAN	Type
-26° 7' 12"	149° 57' 48"	MLA-35	-	-	House
-25° 56' 27"	149° 50' 10"	MLA-352	23	RP835697	House
-26° 0' 38"	149° 56' 47"	MLA-353	58	FT520	Homestead
-25° 56' 30"	149° 53' 57"	MLA-354	84	FT673	House
-26° 5' 11"	149° 47' 44"	MLA-355	38	CP899702	House
-26° 3' 5"	149° 55' 1"	MLA-356	68	SP137906	House
-25° 56' 23"	149° 50' 36"	MLA-359	22	FT553	House
-26° 7' 7"	149° 57' 55"	MLA-36	-	-	House
-26° 5' 30"	149° 47' 51"	MLA-361	38	CP899702	House
-25° 55' 39"	149° 51' 31"	MLA-362	21	FT552	House
-26° 3' 45"	149° 56' 6"	MLA-364	1	RP144130	Homestead
-25° 56' 44"	149° 53' 55"	MLA-365	87	CP905099	House
-25° 55' 53"	149° 51' 36"	MLA-366	21	FT552	House
-25° 55' 6"	149° 55' 1"	MLA-368	56	FT941	House
-25° 56' 45"	149° 53' 45"	MLA-369	80	FT616	House
-25° 56' 23"	149° 55' 4"	MLA-373	88	FT894	House
-26° 3' 49"	149° 54' 26"	MLA-374	111	FT487	House
-26° 0' 22"	149° 56' 28"	MLA-375	58	FT520	Homestead
-26° 3' 45"	149° 56' 3"	MLA-378	1	RP144130	House
-25° 56' 3"	149° 52' 6"	MLA-379	20	FT436	House
-26° 7' 14"	149° 58' 5"	MLA-38	37	W64126	House
-25° 55' 59"	149° 54' 57"	MLA-388	88	FT894	House
-26° 7' 14"	149° 58' 4"	MLA-39	39	W64126	House
-26° 2' 33"	149° 52' 45"	MLA-390	30	FT491	House
-26° 2' 11"	149° 54' 46"	MLA-397	67	FT873	House
-26° 7' 14"	149° 58' 4"	MLA-4	38	W64126	House
-26° 7' 16"	149° 58' 12"	MLA-40	4	W64139	House
-26° 0' 14"	149° 54' 49"	MLA-402	1	RP204781	House
-26° 5' 2"	149° 43' 33"	MLA-404	15	SP180948	House
-26° 7' 21"	149° 57' 49"	MLA-405	1	W64122	House
-26° 7' 1"	149° 57' 40"	MLA-406	-	-	House
-26° 6' 59"	149° 57' 41"	MLA-407	8	W64125	House
-26° 7' 15"	149° 57' 56"	MLA-408	-	-	House
-26° 7' 15"	149° 57' 57"	MLA-409	-	-	House
-26° 7' 18"	149° 58' 7"	MLA-41	15	W64139	House
-26° 7' 15"	149° 57' 56"	MLA-410	-	-	House
-26° 7' 0"	149° 57' 39"	MLA-412	-	-	House
-26° 7' 16"	149° 58' 8"	MLA-413	-	-	House
-26° 7' 38"	149° 44' 15"	MLA-415	13	FT667	House
-26° 7' 16"	149° 58' 9"	MLA-416	-	-	House
-26° 7' 16"	149° 58' 10"	MLA-419	-	-	House
-26° 7' 20"	149° 58' 6"	MLA-42	-	-	House
-26° 7' 46"	149° 45' 50"	MLA-420	2	FT1019	House

latitude	longitude	Receptor	LOT	PLAN	Type
-26° 7' 17"	149° 57' 58"	MLA-421	11	W64139	House
-26° 7' 17"	149° 57' 59"	MLA-422	12	W64139	House
-26° 8' 3"	149° 58' 4"	MLA-427	88	FT911	House
-26° 8' 1"	149° 58' 3"	MLA-428	88	FT911	House
-26° 7' 20"	149° 58' 6"	MLA-43	-	-	House
-26° 7' 17"	149° 57' 48"	MLA-436	-	-	House
-26° 7' 15"	149° 57' 59"	MLA-437	-	-	House
-26° 7' 15"	149° 57' 59"	MLA-438	-	-	House
-26° 7' 15"	149° 58' 9"	MLA-44	31	W64126	House
-26° 12' 55"	149° 48' 47"	MLA-442	28	FT672	House
-26° 7' 15"	149° 46' 10"	MLA-443	39	FT576	House
-26° 7' 15"	149° 57' 58"	MLA-447	-	-	House
-26° 7' 17"	149° 57' 47"	MLA-448	-	-	House
-26° 7' 15"	149° 58' 9"	MLA-45	32	W64126	House
-26° 7' 18"	149° 57' 49"	MLA-450	-	-	House
-26° 7' 13"	149° 58' 19"	MLA-451	1	W64115	House
-26° 7' 30"	149° 57' 53"	MLA-452	15	SP167195	House
-26° 5' 53"	149° 45' 51"	MLA-453	30	FT468	House
-26° 7' 8"	149° 57' 50"	MLA-457	18	W6416	House
-26° 7' 7"	149° 57' 51"	MLA-458	18	W6416	House
-26° 4' 54"	149° 43' 48"	MLA-459	28	FT467	House
-26° 7' 21"	149° 57' 49"	MLA-46	1	W64122	House
-26° 7' 11"	149° 57' 48"	MLA-461	12	W6416	House
-26° 7' 11"	149° 57' 47"	MLA-462	-	-	House
-26° 7' 18"	149° 57' 46"	MLA-463	216	W6411	House
-26° 7' 19"	149° 57' 46"	MLA-465	215	W6411	House
-25° 54' 59"	149° 46' 59"	MLA-479	-	-	House
-26° 11' 35"	149° 55' 23"	MLA-484	1	RP110817	Homestead
-26° 4' 50"	149° 42' 30"	MLA-49	14	FT165	House
-26° 7' 17"	149° 57' 56"	MLA-491	9	W64127	House
-26° 7' 15"	149° 58' 1"	MLA-493	-	-	House
-26° 9' 55"	150° 0' 19"	MLA-494	28	FT913	House
-26° 7' 15"	149° 58' 0"	MLA-499	-	-	House
-26° 7' 15"	149° 58' 4"	MLA-5	-	-	House
-26° 4' 9"	149° 42' 22"	MLA-50	1	SP210618	House
-26° 8' 23"	150° 0' 55"	MLA-503	18	FT739	Homestead
-26° 10' 47"	149° 53' 44"	MLA-505	6	FT788	Homestead
-25° 55' 42"	149° 47' 48"	MLA-506	14	RP807808	House
-26° 6' 48"	149° 57' 3"	MLA-51	43	FT348	House
-26° 7' 10"	149° 57' 49"	MLA-510	14	W6416	House
-26° 7' 11"	149° 58' 8"	MLA-511	54	W64126	House
-26° 7' 8"	149° 57' 50"	MLA-512	16	W6416	House
-26° 7' 9"	149° 57' 49"	MLA-513	15	W6416	House

latitude	longitude	Receptor	LOT	PLAN	Type
-26° 7' 11"	149° 58' 6"	MLA-514	1	RP203544	House
-26° 7' 12"	149° 58' 8"	MLA-515	-	-	House
-26° 7' 11"	149° 58' 7"	MLA-516	2	RP203544	House
-26° 6' 38"	149° 57' 15"	MLA-520	36	FT981	House
-26° 7' 20"	149° 57' 45"	MLA-532	-	-	House
-26° 13' 13"	150° 0' 33"	MLA-533	23	FT938	House
-26° 7' 8"	149° 57' 59"	MLA-536	-	-	House
-26° 7' 9"	149° 57' 54"	MLA-537	41	W6416	House
-26° 7' 21"	149° 57' 45"	MLA-538	-	-	House
-26° 7' 9"	149° 57' 55"	MLA-540	43	W6416	House
-26° 7' 7"	149° 57' 57"	MLA-542	-	-	House
-26° 7' 21"	149° 57' 46"	MLA-543	2	RP190554	House
-26° 6' 20"	150° 1' 9"	MLA-547	18	FT739	House
-26° 7' 12"	149° 58' 5"	MLA-549	-	-	House
-26° 7' 12"	149° 58' 4"	MLA-550	-	-	House
-26° 8' 59"	149° 49' 32"	MLA-552	16	FT1012	House
-26° 7' 11"	149° 58' 5"	MLA-553	1	RP203544	House
-26° 6' 46"	149° 59' 40"	MLA-556	5	RP900597	House
-26° 10' 48"	149° 59' 26"	MLA-557	3	FT695	House
-26° 7' 11"	149° 57' 56"	MLA-558	27	W6416	House
-26° 7' 10"	149° 57' 57"	MLA-559	-	-	House
-26° 7' 19"	149° 57' 51"	MLA-56	4	W64110	House
-26° 6' 33"	150° 3' 43"	MLA-565	12	FT99	House
-26° 6' 47"	150° 4' 20"	MLA-567	14	FT100	House
-26° 7' 19"	149° 57' 50"	MLA-57	-	-	House
-26° 8' 39"	149° 58' 33"	MLA-570	7	FT912	House
-26° 6' 46"	149° 59' 36"	MLA-574	5	RP900597	House
-26° 6' 46"	149° 59' 27"	MLA-576	3	RP900597	House
-26° 9' 9"	149° 59' 51"	MLA-579	29	FT130	Homestead
-26° 7' 18"	149° 57' 52"	MLA-58	3	W64110	House
-26° 6' 59"	150° 3' 48"	MLA-587	12	FT99	House
-26° 7' 12"	149° 57' 55"	MLA-588	29	W6416	House
-26° 7' 13"	149° 57' 54"	MLA-589	31	W6416	House
-26° 7' 20"	149° 57' 51"	MLA-59	-	-	House
-26° 11' 48"	149° 57' 22"	MLA-591	59	FT105	House
-26° 13' 3"	149° 57' 28"	MLA-592	21	FT191	House
-26° 7' 13"	149° 57' 53"	MLA-593	32	W6416	House
-26° 7' 11"	149° 57' 55"	MLA-594	28	W6416	House
-26° 1' 29"	149° 39' 38"	MLA-595	38	AB188	Homestead
-26° 7' 11"	149° 57' 55"	MLA-597	28	W6416	House
-26° 7' 16"	149° 58' 4"	MLA-6	-	-	House
-26° 3' 42"	149° 57' 49"	MLA-601	22	FT746	Homestead
-26° 2' 28"	149° 57' 40"	MLA-603	69	SP137906	House

latitude	longitude	Receptor	LOT	PLAN	Type
-26° 7' 15"	149° 58' 10"	MLA-61	30	W64126	House
-26° 7' 15"	149° 57' 26"	MLA-616	-	-	House
-26° 7' 11"	149° 58' 10"	MLA-62	51	W64126	House
-26° 2' 6"	149° 36' 58"	MLA-624	42	AB241	Homestead
-26° 1' 42"	149° 37' 1"	MLA-626	41	AB241	House
-26° 7' 11"	149° 58' 11"	MLA-63	49	W64126	House
-26° 14' 22"	149° 52' 38"	MLA-639	48	SP127252	House
-26° 7' 13"	149° 58' 10"	MLA-64	-	-	House
-26° 8' 13"	149° 59' 4"	MLA-640	2	SP106043	House
-26° 6' 4"	149° 56' 46"	MLA-642	154	FT884	House
-26° 7' 16"	149° 58' 12"	MLA-65	-	-	House
-26° 1' 23"	149° 36' 55"	MLA-651	41	AB241	House
-26° 12' 44"	150° 0' 32"	MLA-652	4	FT105	House
-26° 7' 14"	149° 57' 52"	MLA-658	913	W6416	House
-26° 11' 20"	149° 48' 57"	MLA-659	2	RP123884	Homestead
-26° 7' 9"	149° 57' 41"	MLA-66	418	W6412	House
-26° 7' 14"	149° 57' 53"	MLA-663	913	W6416	House
-26° 7' 12"	149° 57' 52"	MLA-665	36	W6416	House
-26° 7' 10"	149° 57' 42"	MLA-67	417	W6412	House
-26° 6' 59"	150° 2' 41"	MLA-670	17	FT99	House
-26° 7' 21"	150° 1' 8"	MLA-672	18	FT739	House
-25° 59' 2"	149° 38' 46"	MLA-678	131	SP121742	House
-26° 12' 44"	149° 52' 37"	MLA-679	24	FT41	Homestead
-26° 7' 13"	149° 58' 10"	MLA-68	-	-	House
-25° 57' 8"	149° 45' 43"	MLA-680	74	FT563	House
-25° 58' 5"	149° 45' 38"	MLA-687	28	FT563	House
-26° 7' 9"	149° 57' 41"	MLA-69	419	W6412	House
-26° 7' 11"	149° 57' 53"	MLA-690	39	W6416	House
-25° 57' 53"	149° 44' 3"	MLA-692	70	FT590	House
-25° 58' 48"	149° 46' 28"	MLA-693	41	CP857459	House
-25° 57' 1"	149° 42' 5"	MLA-694	71	FT590	House
-25° 57' 44"	149° 43' 53"	MLA-695	70	FT590	House
-25° 58' 28"	149° 45' 54"	MLA-697	40	FT503	House
-25° 56' 47"	149° 39' 52"	MLA-698	46	FT64	House
-26° 7' 12"	149° 57' 52"	MLA-699	36	W6416	House
-26° 7' 13"	149° 57' 34"	MLA-7	-	-	House
-26° 7' 20"	149° 57' 55"	MLA-70	11	W64110	House
-26° 7' 11"	149° 57' 53"	MLA-701	917	W6416	House
-26° 6' 20"	150° 1' 20"	MLA-708	18	FT739	House
-26° 7' 19"	149° 57' 54"	MLA-71	12	W64110	House
-26° 7' 9"	149° 57' 56"	MLA-710	25	W6416	House
-25° 58' 19"	149° 44' 58"	MLA-712	39	FT503	House
-26° 7' 9"	149° 57' 57"	MLA-713	24	W6416	House

latitude	longitude	Receptor	LOT	PLAN	Type
-26° 7' 10"	149° 57' 54"	MLA-714	40	W6416	House
-26° 7' 20"	149° 58' 9"	MLA-715	-	-	House
-26° 7' 10"	149° 57' 53"	MLA-716	40	W6416	House
-26° 7' 14"	149° 57' 55"	MLA-719	-	-	House
-26° 7' 11"	149° 57' 39"	MLA-72	-	-	House
-25° 58' 24"	149° 42' 2"	MLA-720	72	FT590	House
-26° 0' 24"	149° 38' 41"	MLA-721	132	SP121742	House
-25° 59' 37"	149° 39' 36"	MLA-725	132	SP121742	House
-25° 59' 3"	149° 38' 46"	MLA-728	131	SP121742	House
-26° 7' 11"	149° 57' 37"	MLA-73	119	W6411	House
-26° 5' 44"	150° 2' 47"	MLA-731	16	FT101	House
-26° 7' 17"	149° 57' 60"	MLA-74	24	W64139	House
-26° 7' 17"	149° 58' 0"	MLA-75	24	W64139	House
-26° 7' 3"	149° 57' 40"	MLA-76	6	W64113	House
-26° 7' 3"	149° 57' 40"	MLA-77	5	W64113	House
-26° 7' 3"	149° 57' 39"	MLA-78	4	W64113	House
-26° 7' 5"	149° 57' 36"	MLA-79	508	W6412	House
-26° 7' 8"	149° 57' 39"	MLA-8	403	W6412	House
-26° 7' 18"	149° 58' 8"	MLA-80	13	W64139	House
-26° 7' 2"	149° 57' 37"	MLA-81	4	SP130877	House
-26° 7' 1"	149° 57' 43"	MLA-82	3	W64121	House
-26° 7' 11"	149° 58' 4"	MLA-83	-	-	House
-26° 7' 9"	149° 57' 51"	MLA-84	7	W6416	House
-26° 7' 18"	149° 57' 57"	MLA-85	-	-	House
-26° 7' 10"	149° 57' 51"	MLA-86	9	W6416	House
-26° 7' 19"	149° 57' 59"	MLA-87	-	-	House
-26° 7' 11"	149° 58' 4"	MLA-88	59	W64126	House
-26° 7' 8"	149° 57' 39"	MLA-9	402	W6412	House
-26° 7' 21"	149° 57' 52"	MLA-90	-	-	House
-26° 7' 8"	149° 57' 52"	MLA-91	6	W6416	House
-26° 7' 8"	149° 57' 53"	MLA-92	4	SP105272	House
-26° 7' 20"	149° 58' 8"	MLA-93	-	-	House
-26° 7' 19"	149° 58' 9"	MLA-94	26	W64139	House
-26° 7' 18"	149° 58' 9"	MLA-95	21	W64139	House
-26° 7' 13"	149° 58' 8"	MLA-97	-	-	House
-26° 7' 19"	149° 57' 43"	MLA-98	-	-	House
-26° 7' 21"	149° 57' 52"	MLA-99	-	-	House
-26° 7' 14"	155° 57' 46"	Town	-	-	Residential

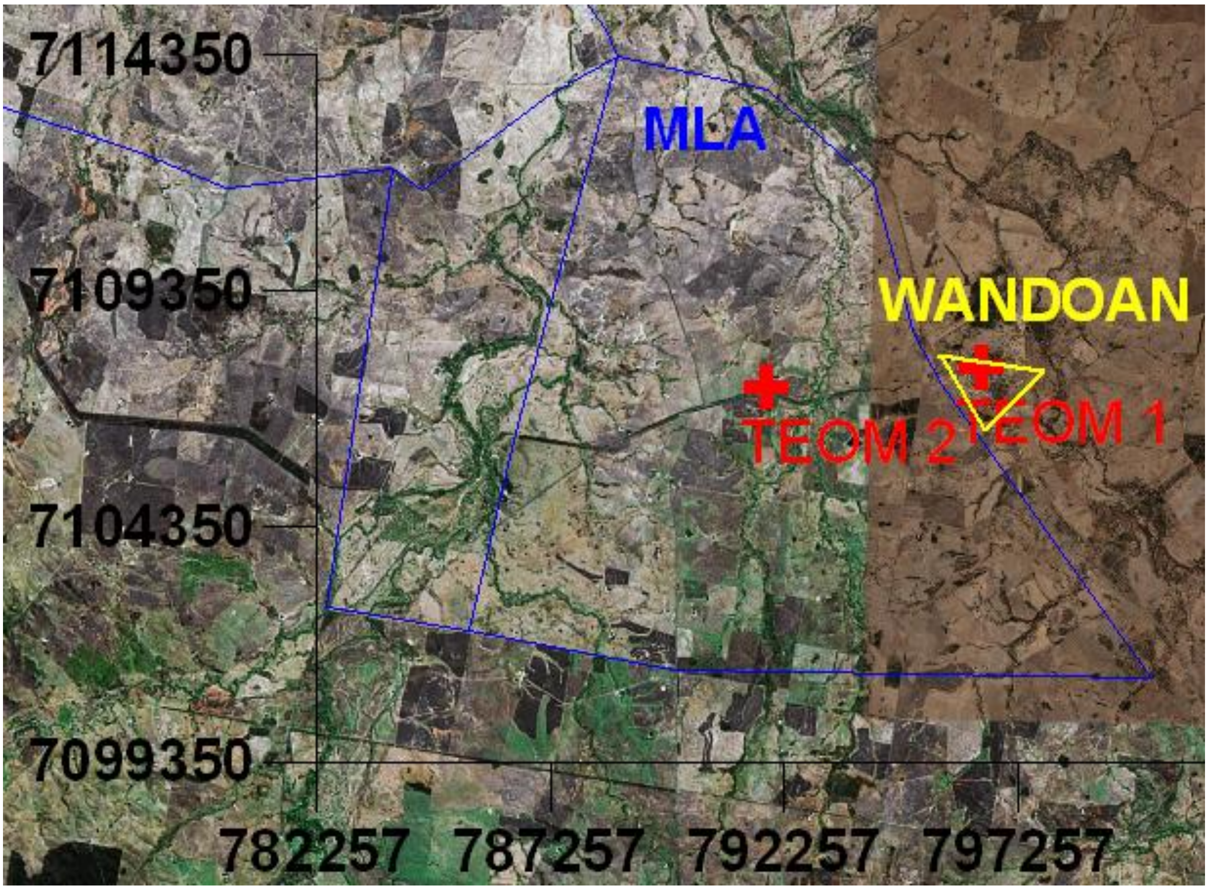


Figure 4 Locations of meteorological and dust monitoring sites

Location: Wandoan	**Period:** n/a	**Data source:** Parsons Brinckerhoff and Google Earth	**Units:** n/a
Type: Satellite image	n/a	**Prepared by:** Andrew Wiebe	**Date:** 02/09/2008

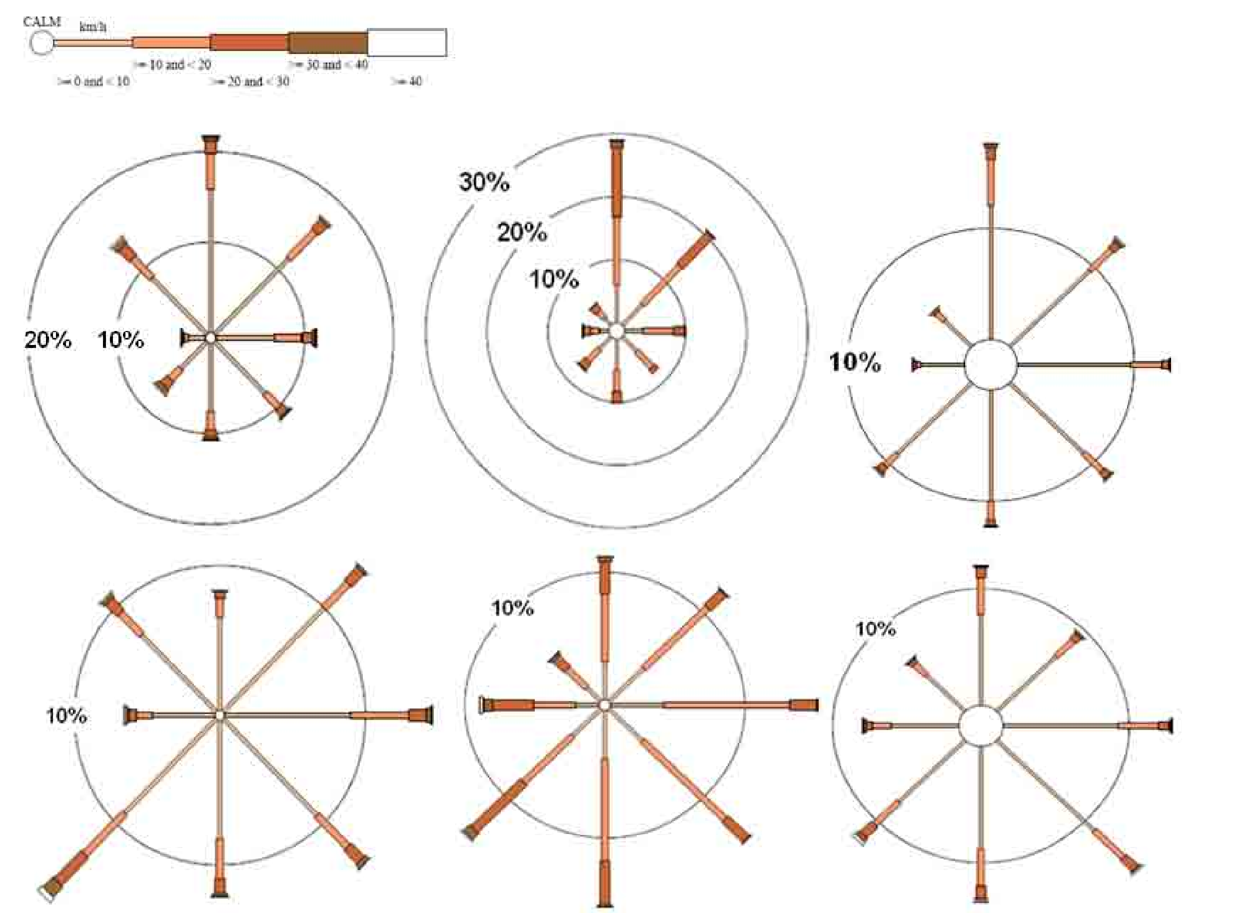


Figure 5 Wind roses for Miles, Taroom and Roma

Location: Miles 26° 66'S 150° 18' E Taroom 25° 64'S 149° 80' E Roma 26° 54' S 148° 78' E	**Period:** Miles 1885 to 2008 Taroom 1870 to 2008 Roma 1985 to 2008	**Data source:** Bureau of Meteorology	**Units:** Kilometres per hour (km/h)
Type: Wind rose	Annual 9 am top Annual 3 pm bottom	**Prepared by:** Andrew Wiebe	**Date:** 02/09/2008

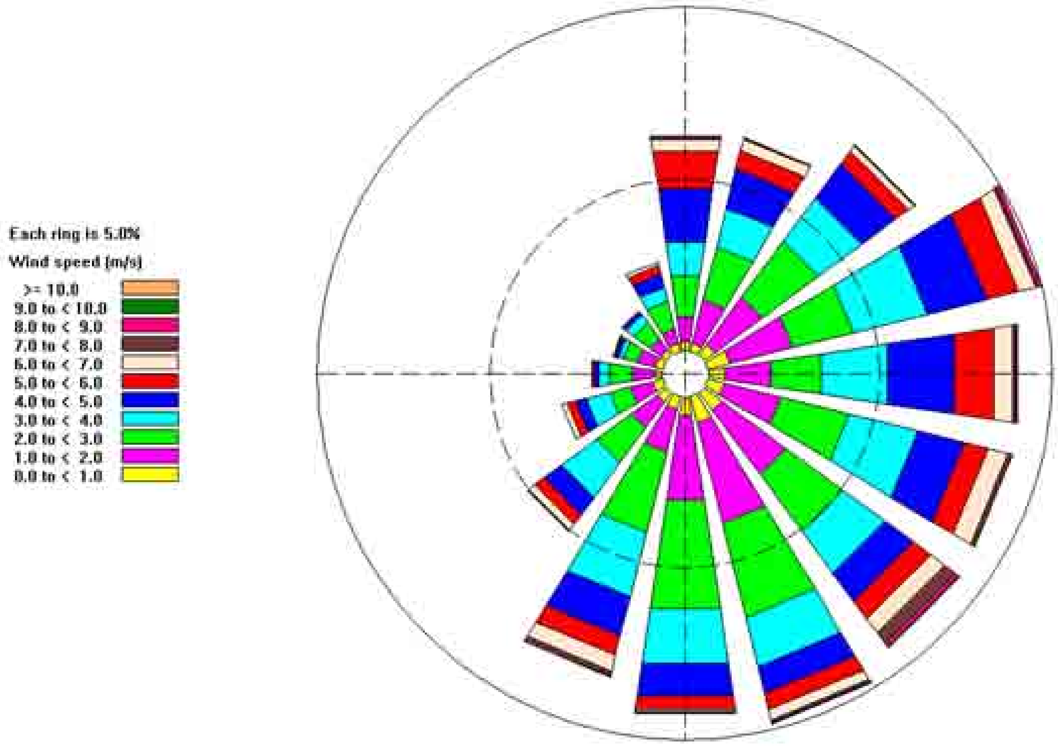


Figure 6 Annual Wind Rose

Location: Wandoan Meteorological station 26° 7' 6" S 149° 56' 28" E	**Period:** 03 April 2007 to 31 March 2008	**Data source:** Observations	**Units:** Metres per second
Type: Wind rose	8725 hourly average records	**Prepared by:** Andrew Wiebe	**Date:** 28/08/2008

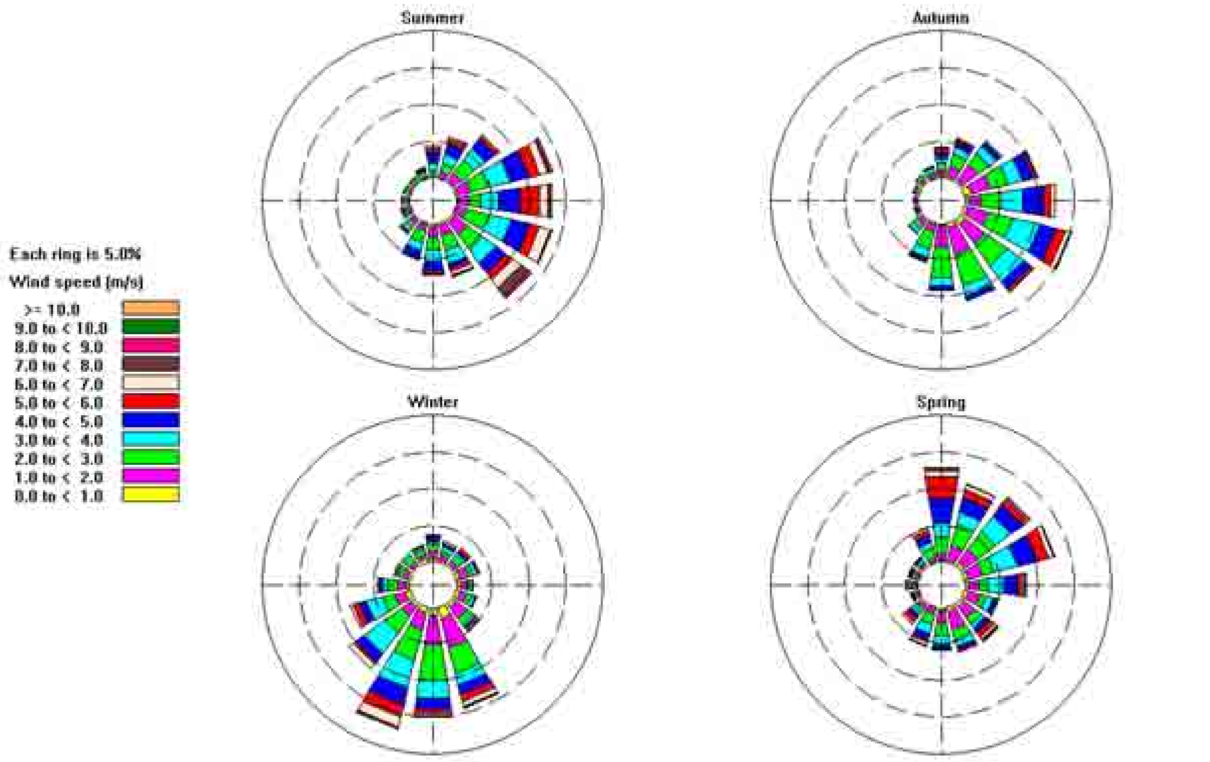


Figure 7 Seasonal Wind Roses

Location: Wandoan Meteorological station 26° 7' 6" S 149° 56' 28" E	**Period:** 03 April 2007 to 31 March 2008	**Data source:** Observations	**Units:** Metres per second
Type: Wind rose	8725 hourly average records	**Prepared by:** Andrew Wiebe	**Date:** 28/08/2008

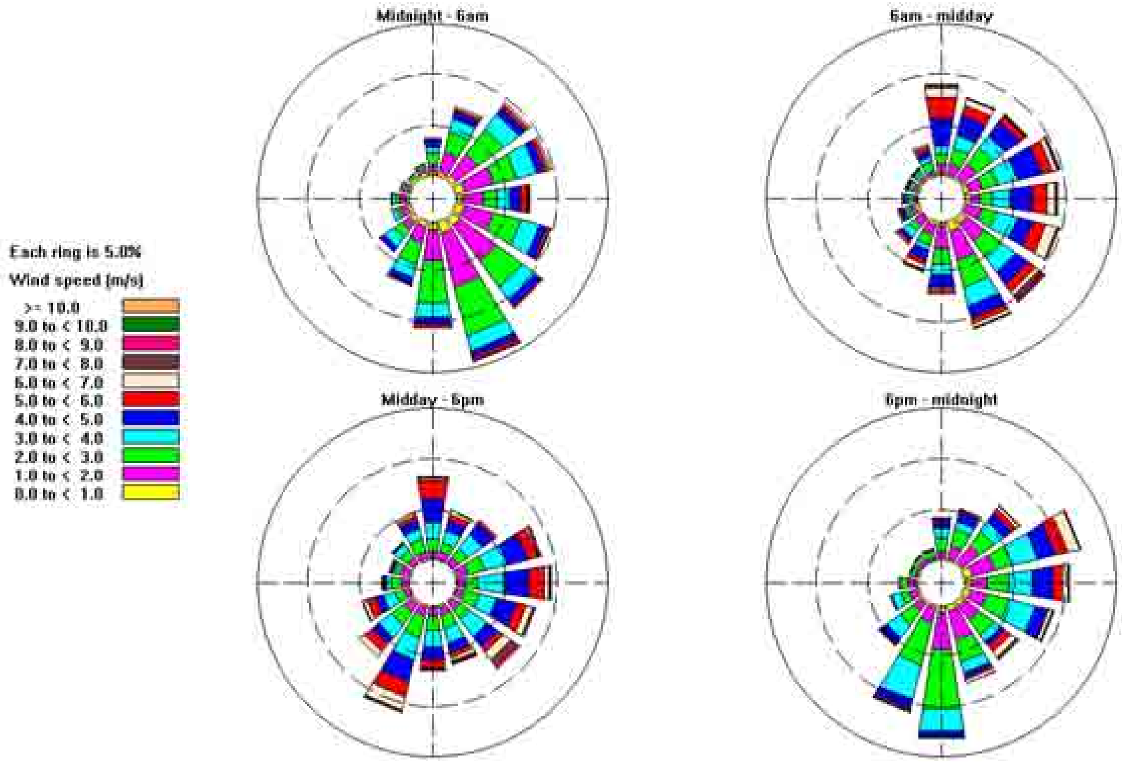


Figure 8 Diurnal Wind Roses

Location: Wandoan Meteorological station 26° 7' 6" S 149° 56' 28" E	**Period:** 03 April 2007 to 31 March 2008	**Data source:** Ecowise	**Units:** Metres per second
Type: Wind rose	8725 hourly average records	**Prepared by:** Andrew Wiebe	**Date:** 28/08/2008

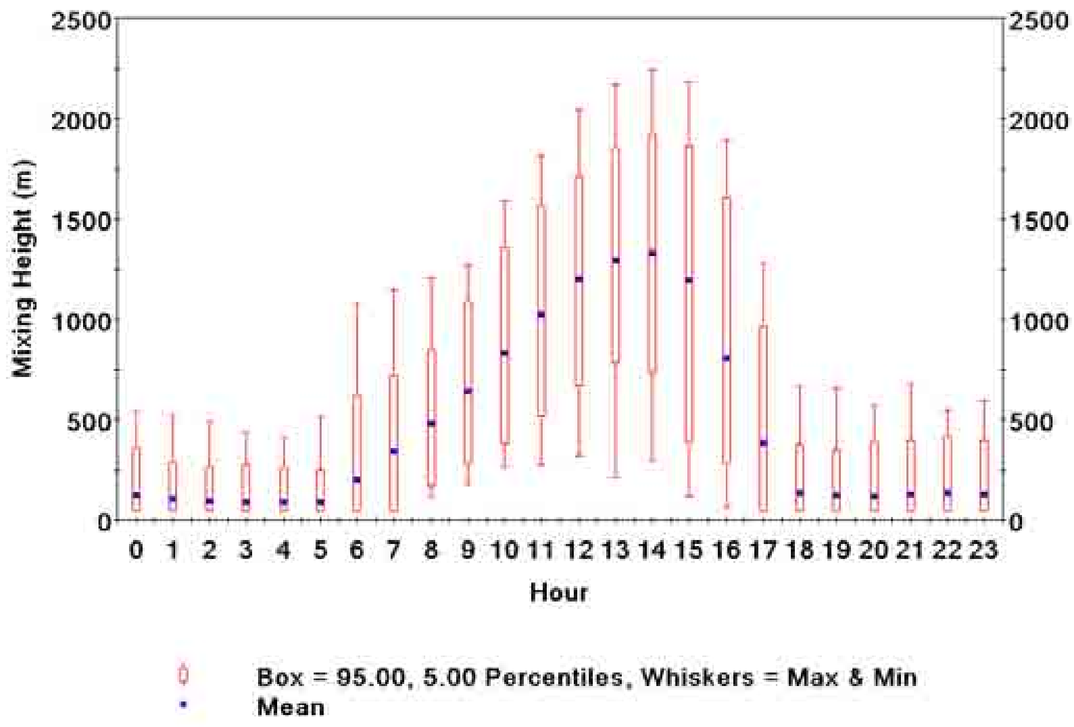


Figure 9 Mixing Height

Location: Wandoan Meteorological station 26° 7' 6" S 149° 56' 28" E	**Period:** April 03 2007 to March 01 2004	**Data source:** CALMET	**Units:** Metres
Type: Box and Whiskers	8725 hourly average records	**Prepared by:** Andrew Wiebe	**Date:** 28/08/2008

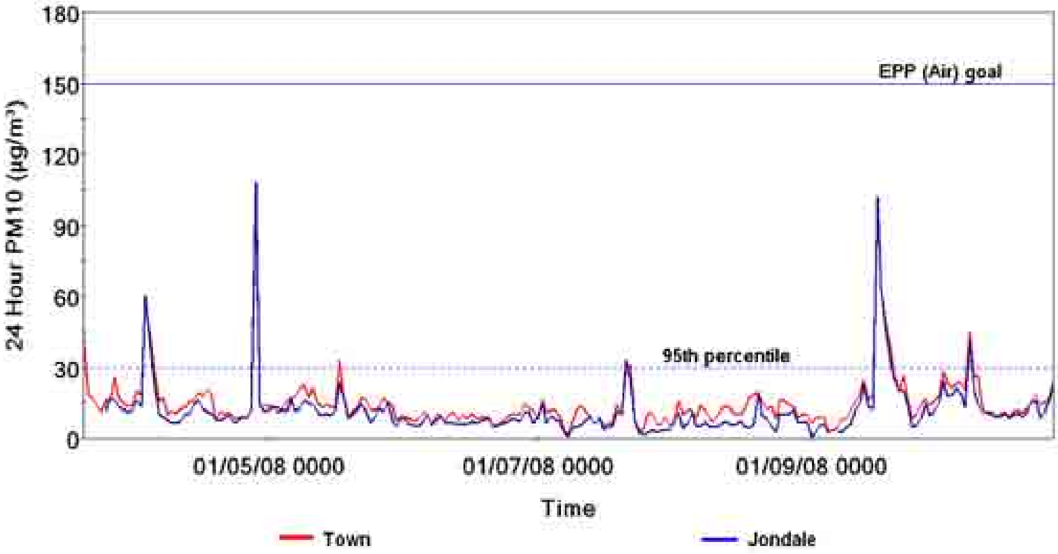


Figure 10 Measured 24-hour average concentrations PM_{10}

Location: Wandoan Town and Jondale	**Period:** March 08 – October 08	**Data source:** Ecowise	**Units:** µg/m³
Type: Time series	**Averaging period:** 24-hour	**Prepared by:** Natalie Shaw	**Date:** August 2008

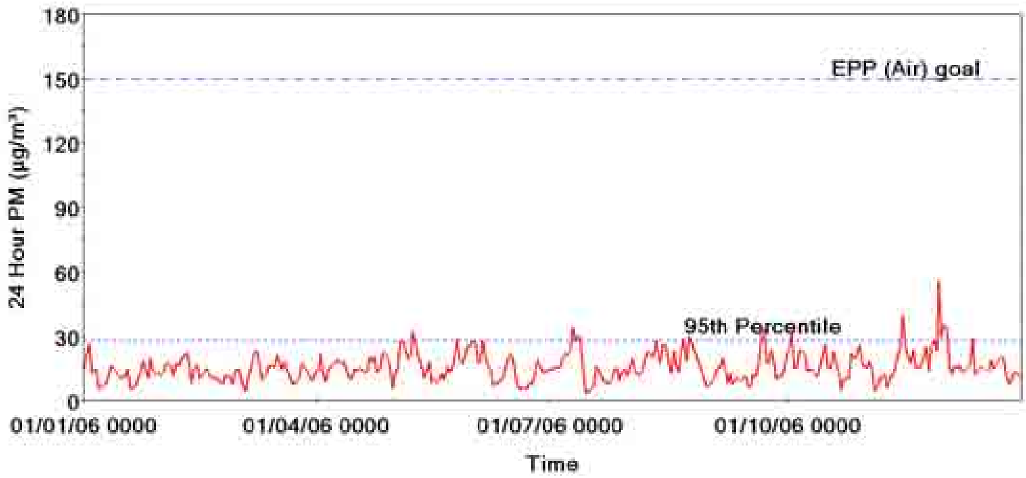


Figure 11 Measured 24-hour average concentrations PM_{10}

Location: Toowoomba	**Period:** Jan 06 – Dec 06	**Data source:** QLD EPA	**Units:** µg/m³
Type: Time series	**Averaging period:** 24-hour	**Prepared by:** Natalie Shaw	**Date:** August 2008

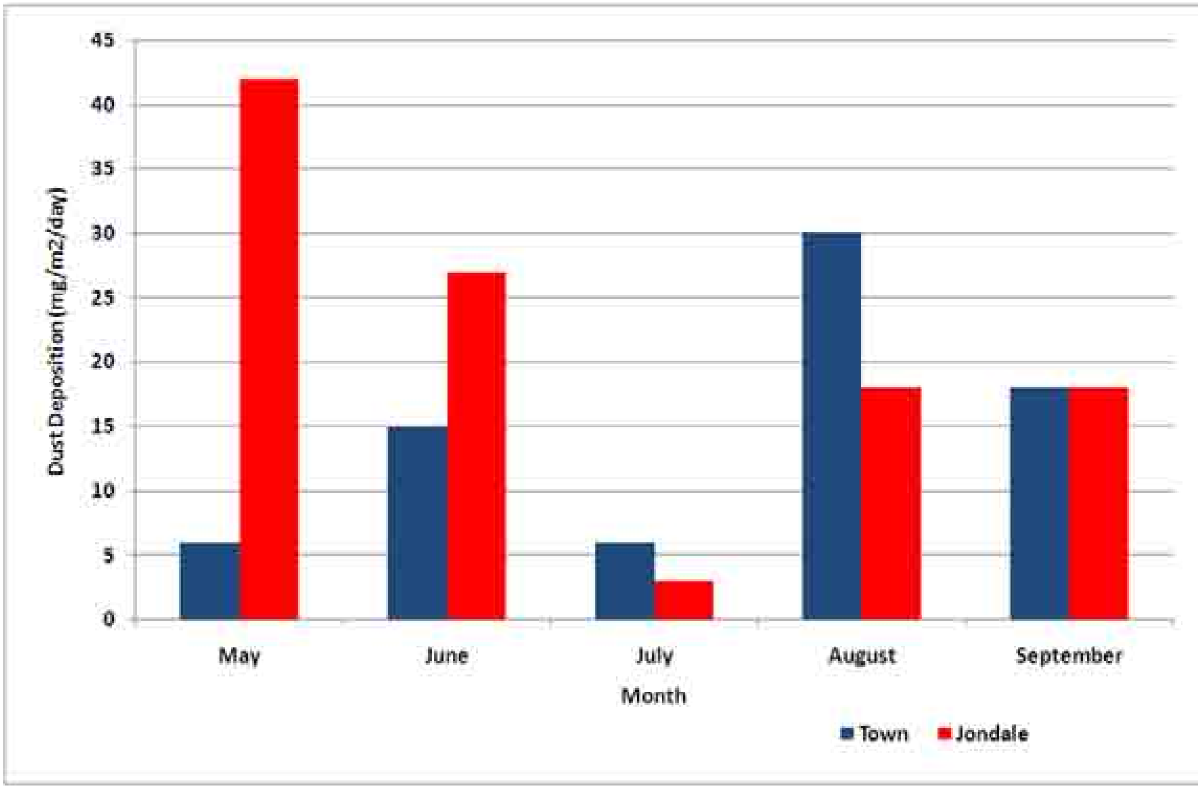


Figure 12 Observed dust deposition rate

Location: Wandoan Town and Jondale	**Period:** May 08 to September 08	**Data source:** Ecowise	**Units:** mg/m^2/day
Type: Bar chart	**Averaging period:** monthly	**Prepared by:** Andrew Wiebe	**Date:** August 2008

what do the sites refer to?

Figure 13 Location of mine pits and associated infrastructure	
Location: Wandoan Mine	**Data source:** Parsons Brinckerhoff
Prepared by: Andrew Wiebe	**Date:** 01/09/2008

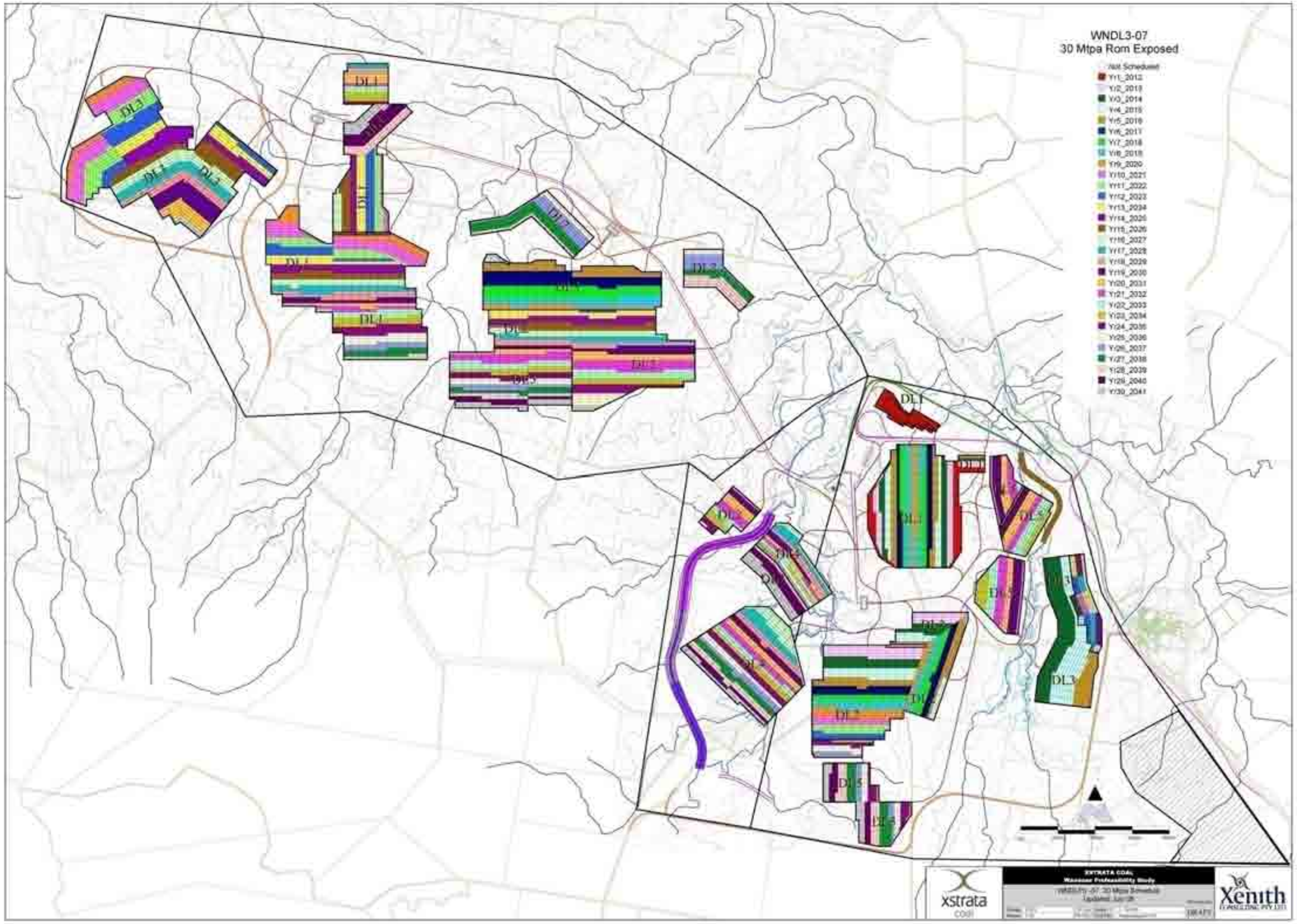


Figure 14 Proposed 30 year mining schedule	
Location: Wandoan Mining Lease Application Areas	**Data source:** Xenith Consulting Pty. Ltd.
Prepared by: Andrew Wiebe	**Date:** 01/09/2008

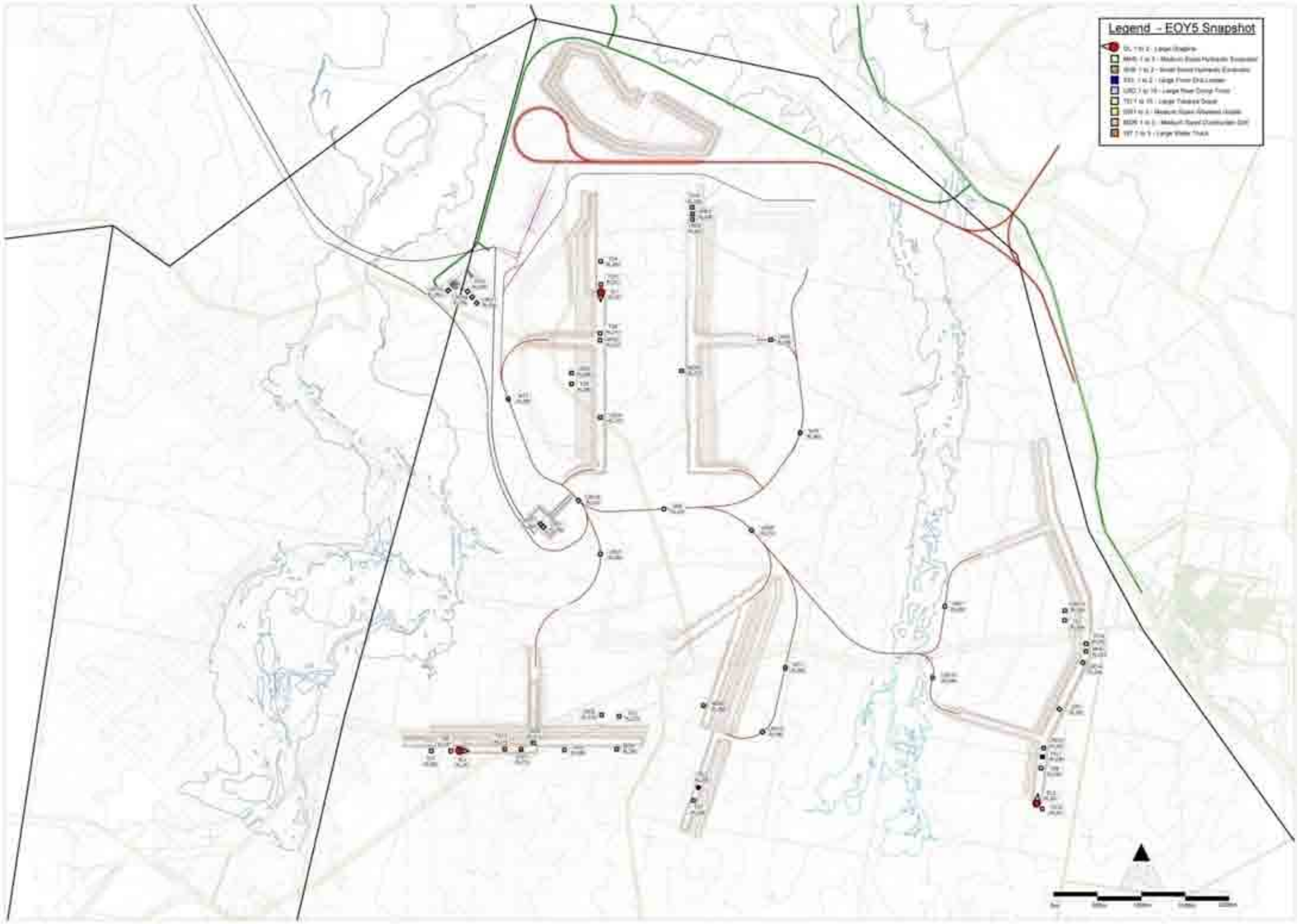


Figure 15 Year 5 – Dragline Indicative location of mining equipment	
Location: Wandoan Mine Lease Application Areas 50230 and 50231	**Data source:** Xenith Consulting Pty Ltd
Prepared by: Andrew Wiebe	**Date:** 01/09/2008

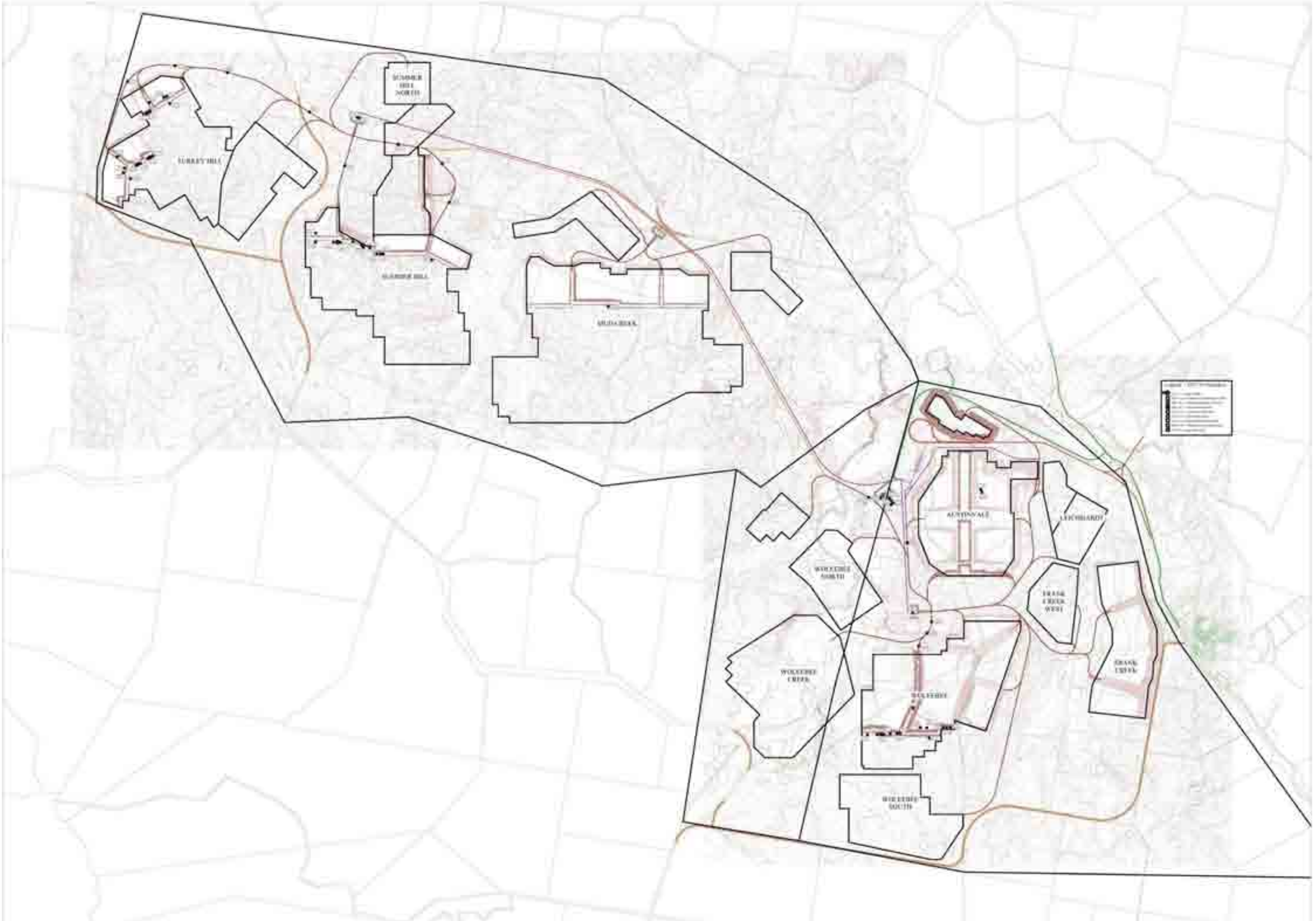


Figure 16 Year 10 - Indicative location of mining equipment	
Location: Wandoan Mine Lease Application Areas	**Data source:** Xenith Consulting Pty Ltd
Prepared by: Andrew Wiebe	**Date:** 01/09/2008

Figure 17 Year 20 – indicative location of mining equipment

Location: Wandoan Mine Lease Application Areas	**Data source:** Xenith Consulting Pty Ltd
Prepared by: Andrew Wiebe	**Date:** 01/09/2008

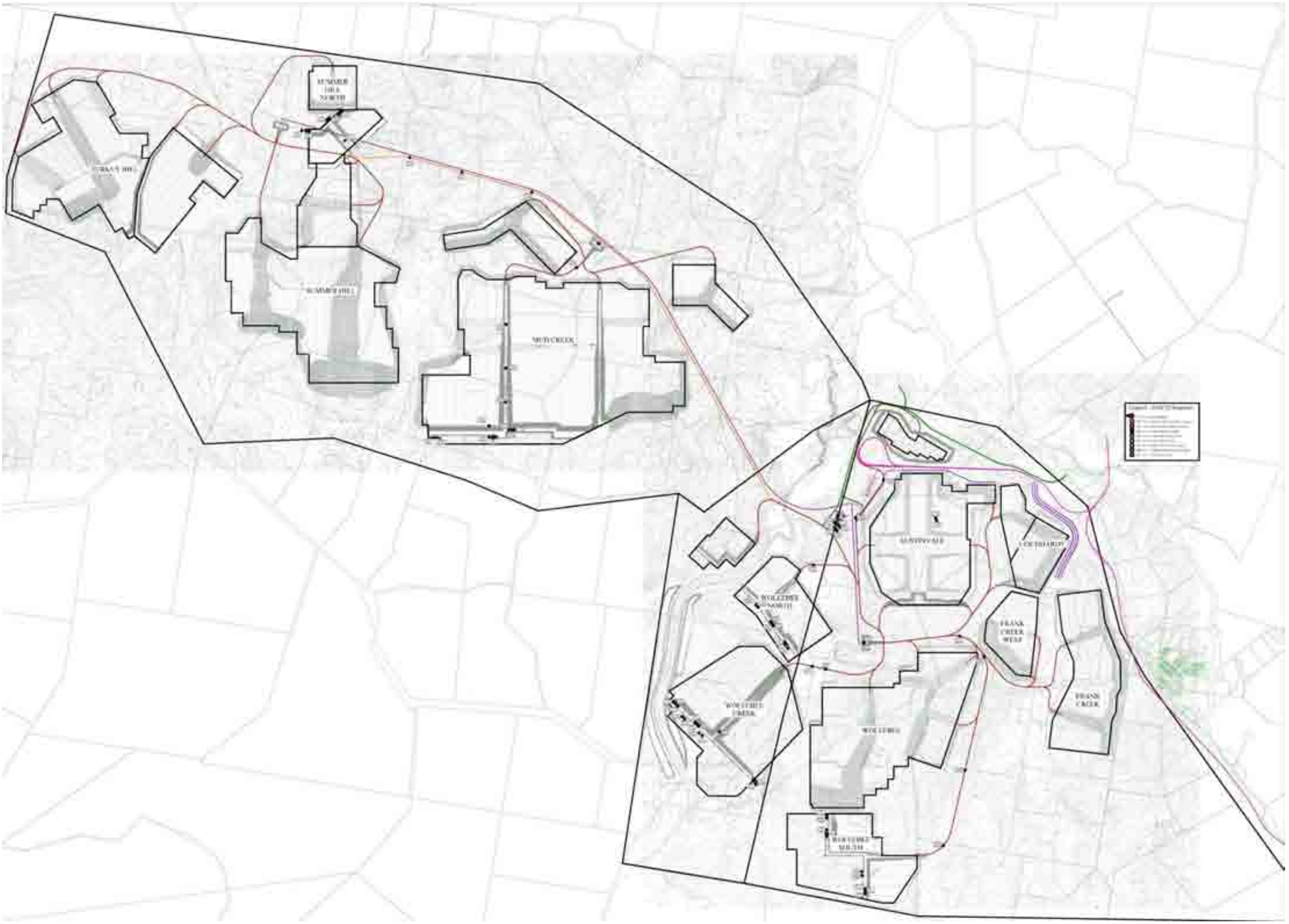


Figure 18 Year 30 Indicative location of mining equipment	
Location: Wandoan Mine Lease Application Areas	**Data source:** Xenith Consulting Pty Ltd
Prepared by: Andrew Wiebe	**Date:** 01/09/2008

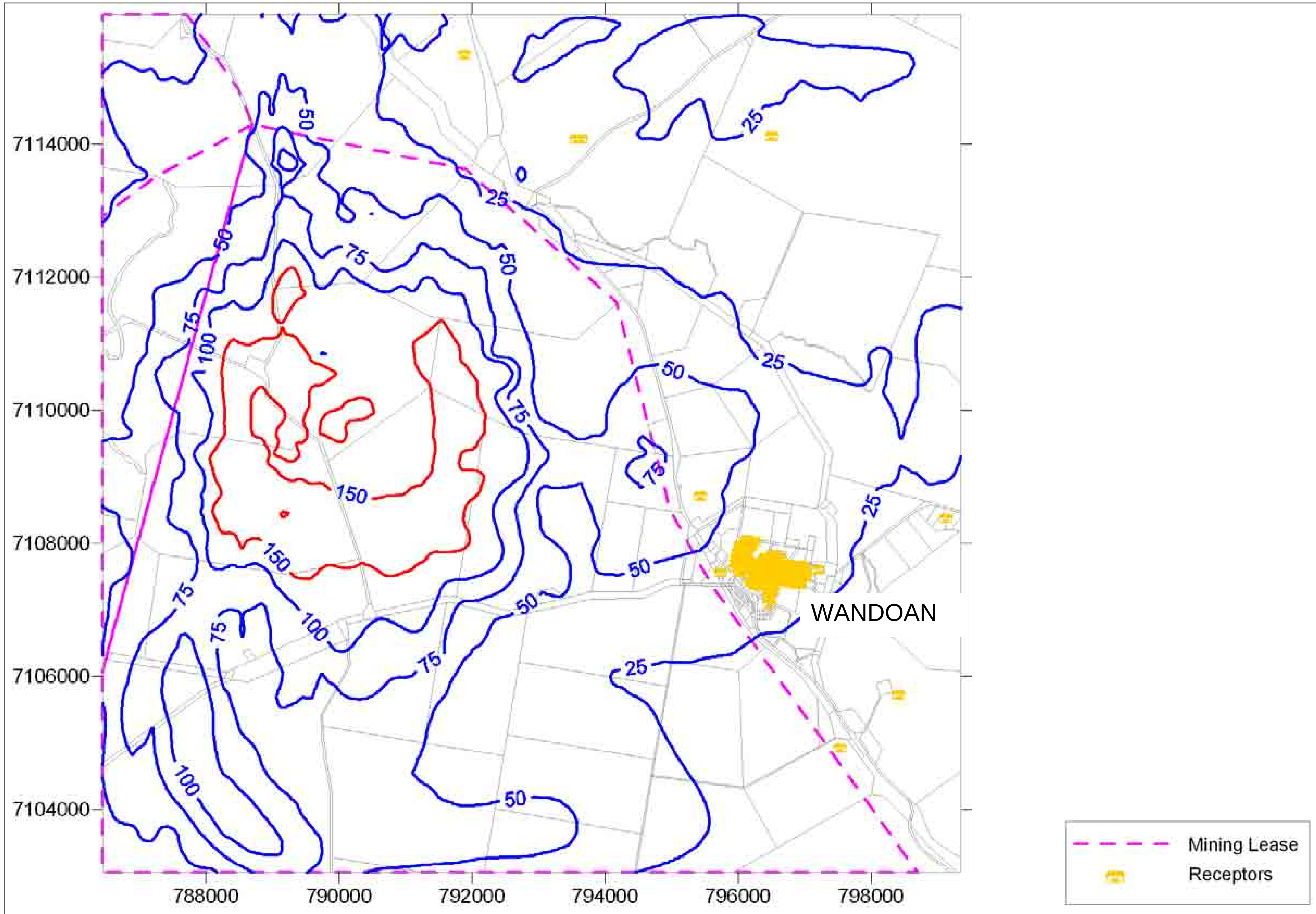


Figure 19 Year 1, PM_{10} maximum 24-hour ground level concentrations for the mine without background

Location: Wandoan	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contours	**Goal:** 150 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

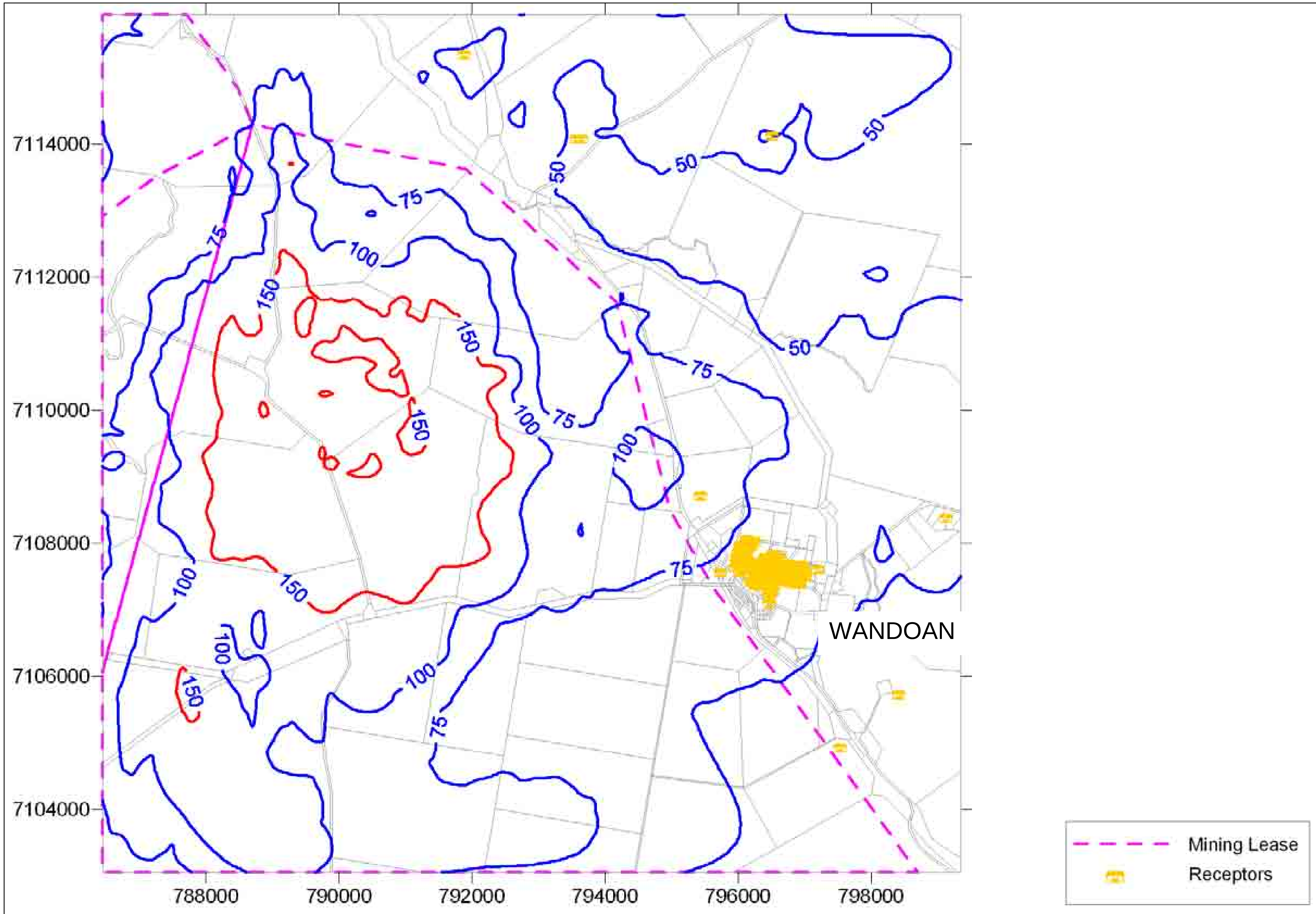


Figure 20 Year 1, PM_{10} maximum 24-hour ground level concentrations for the mine including background			
Location: Wandoan	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contours	**Goal:** 150 µg/m³	**Prepared by:** Andrew Wiebe	**Date:**15 October 2008

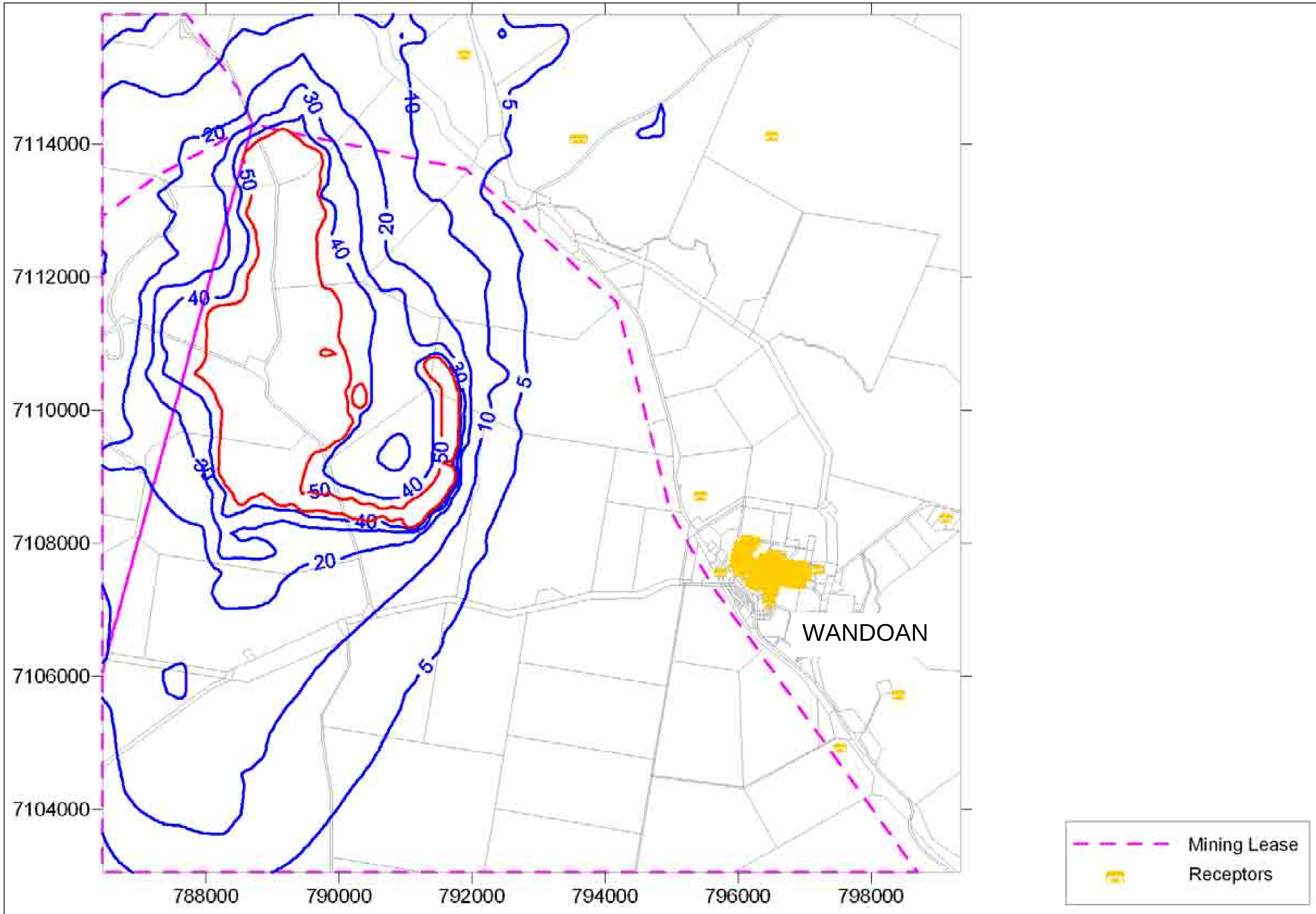


Figure 21 Year 1, PM_{10} annual average ground level concentrations for the mine without background			
Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 50 µg/m³	**Prepared by:** Andrew Wiebe	**Date:**15 October 2008

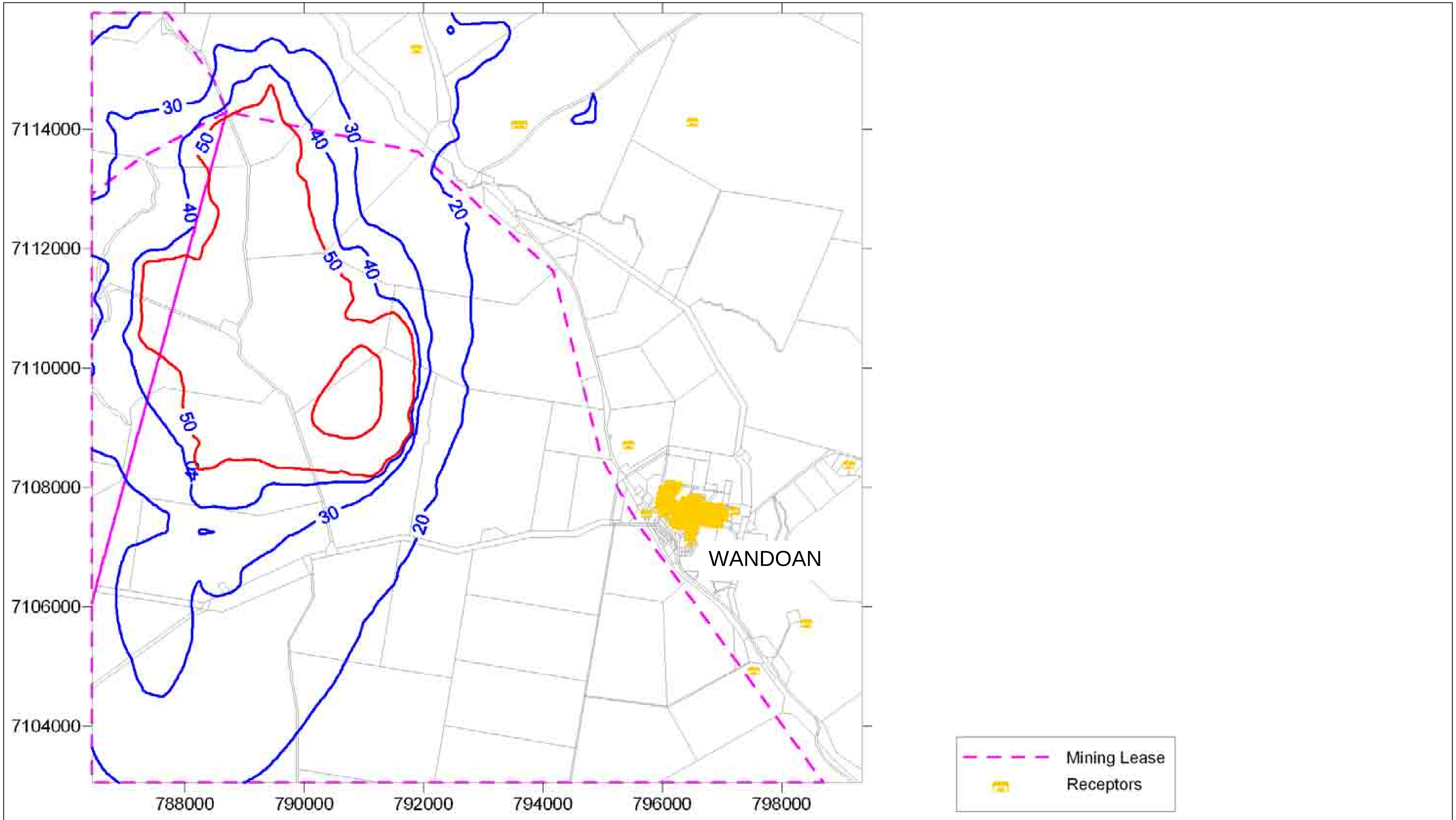


Figure 22 Year 1, PM_{10} annual average ground level concentrations for the mine including background

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 50 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

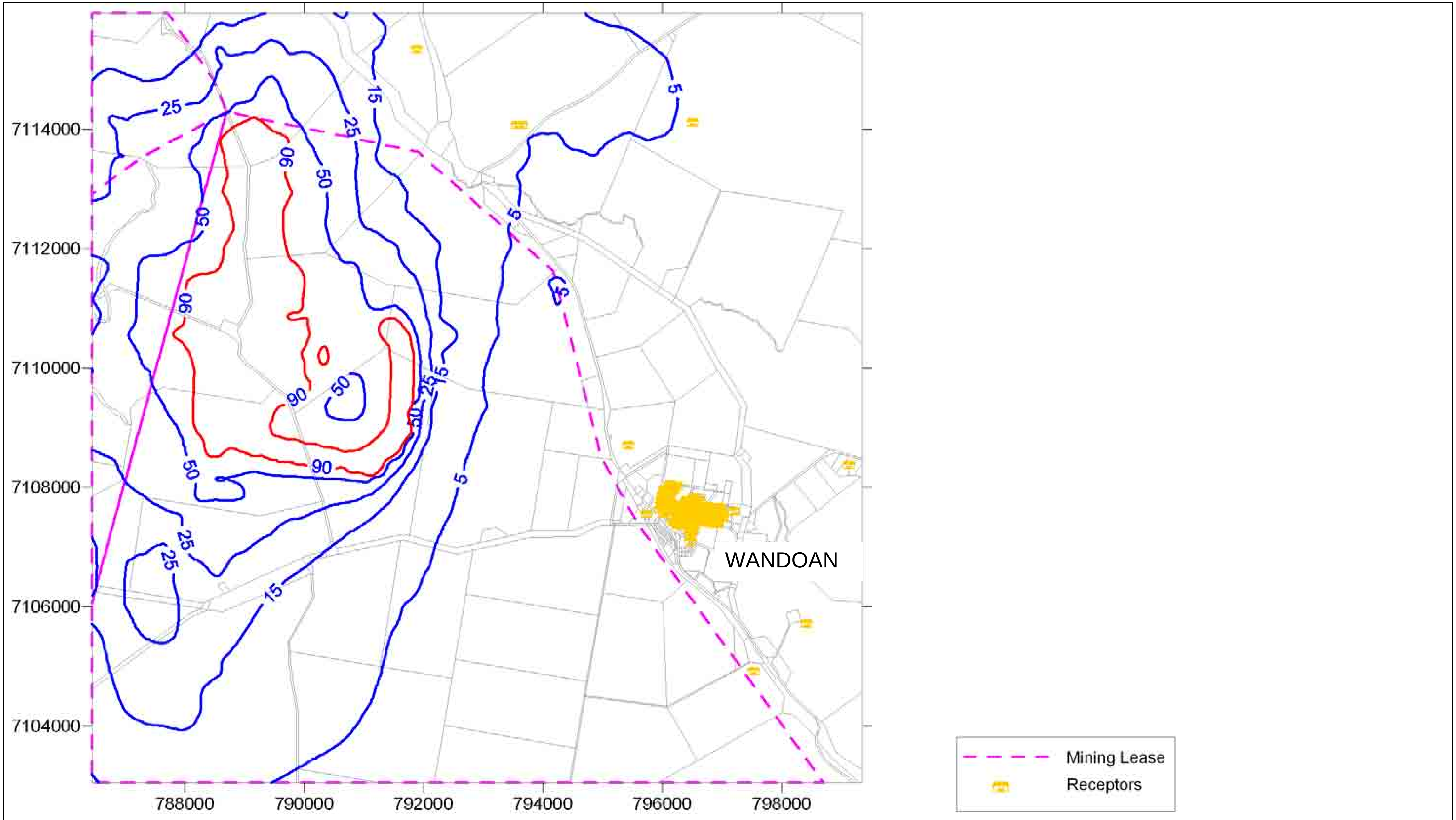


Figure 23 Year 1, TSP annual average ground level concentrations for the mine without background			
Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 90 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

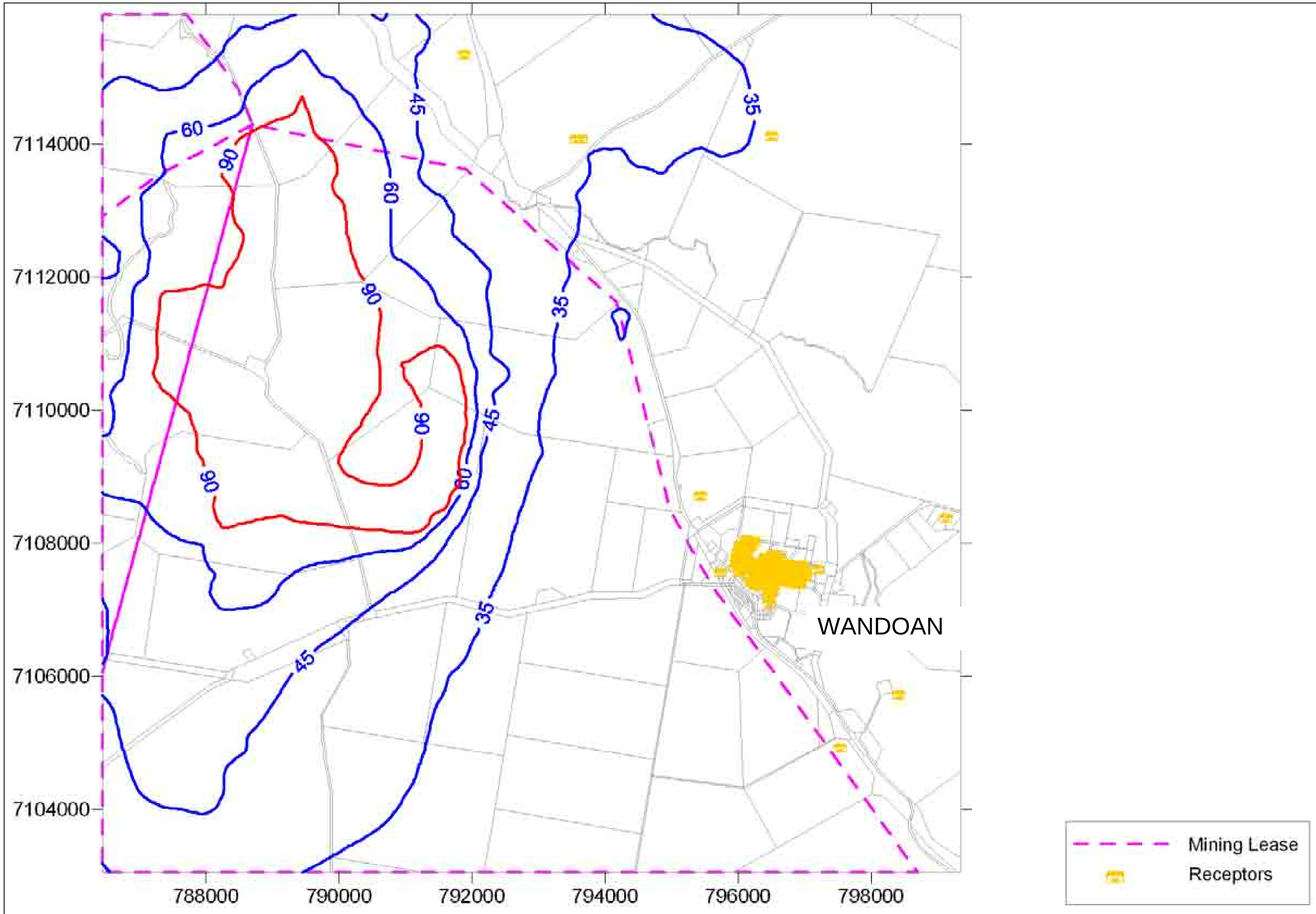


Figure 24 Year 1, TSP annual average ground level concentrations for the mine including background			
Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 90 µg/m³	**Prepared by:** Andrew Wiebe	**Date:**15 October 2008

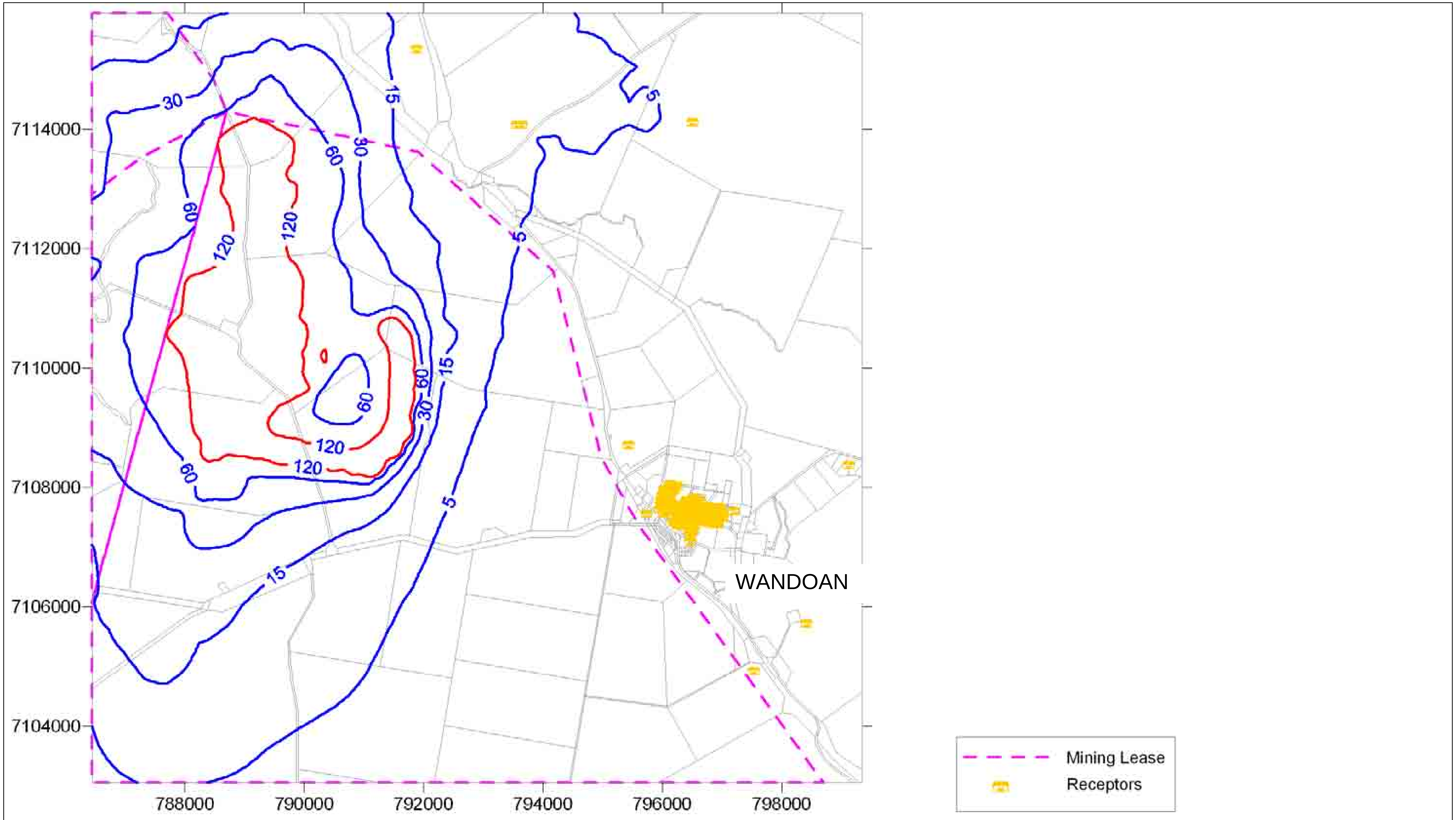


Figure 25 Year 1, dust deposition for the mine without background			
Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** mg/m²/day
Type: Annual contours	**Goal:** 120 mg/m²/day	**Prepared by:** Andrew Wiebe	**Date:**15 October 2008

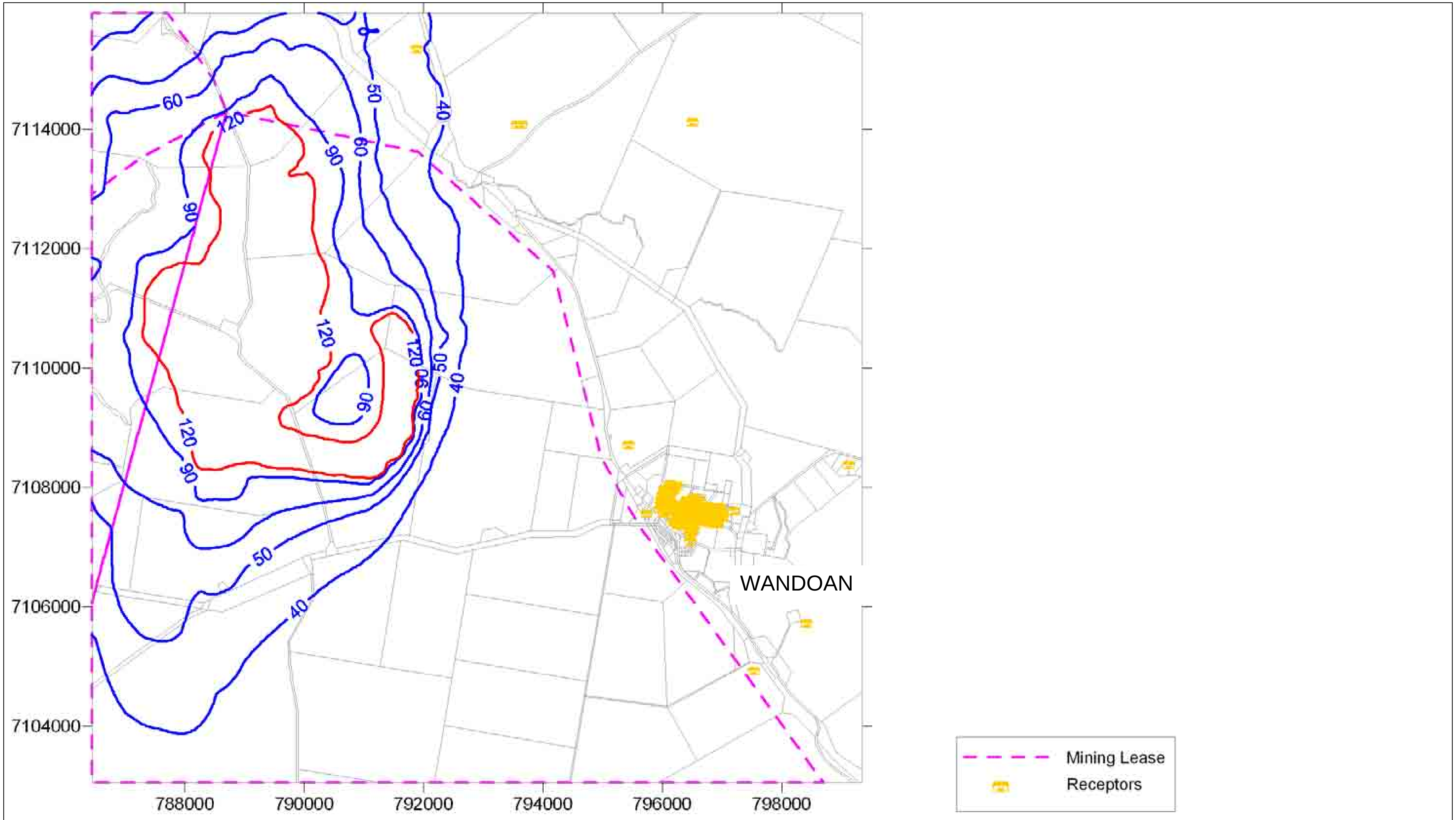


Figure 26 Year 1, dust deposition for the mine including background

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** mg/m²/day
Type: Annual contours	**Goal:** 120 mg/m²/day	**Prepared by:** Andrew Wiebe	**Date:**15 October 2008

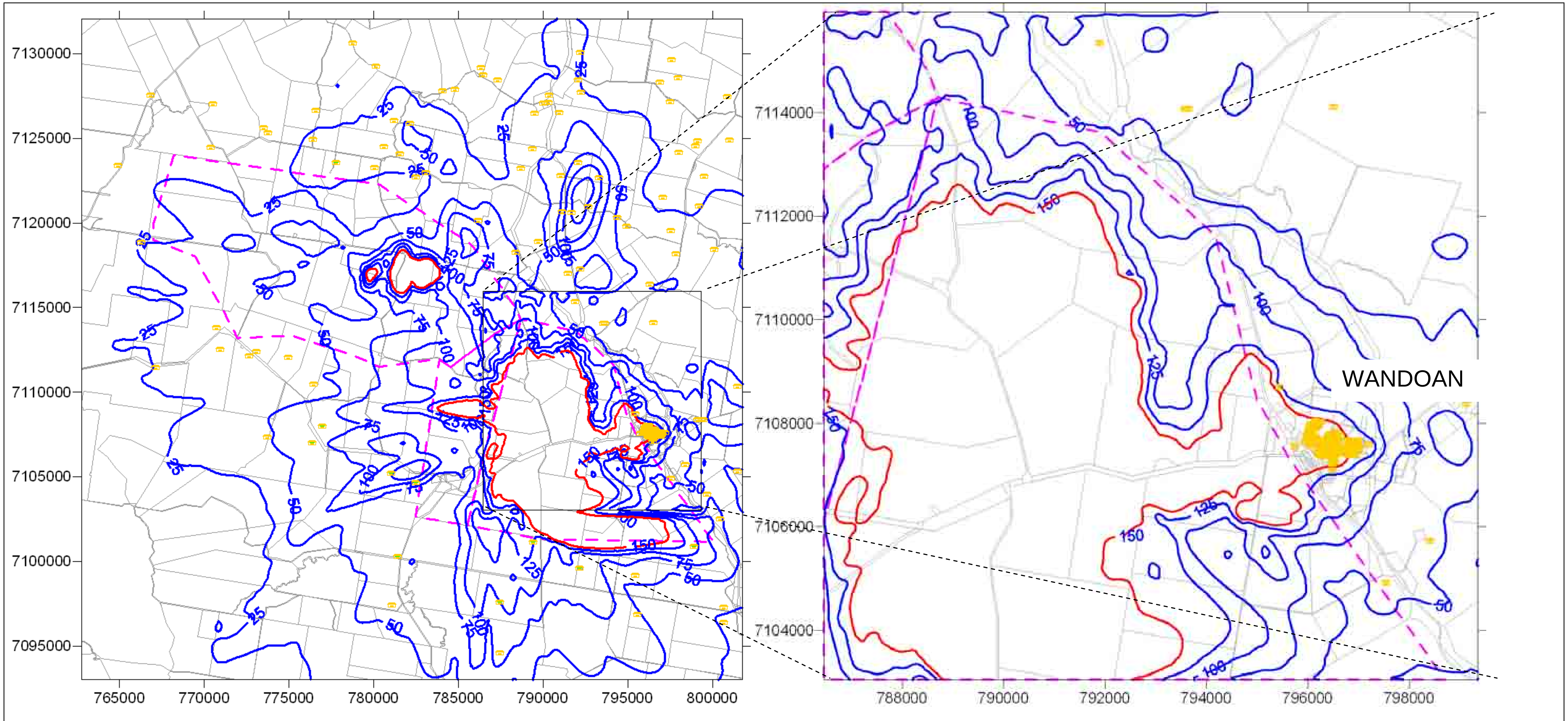


Figure 27 Year 5 - dragline, PM10 maximum 24-hour ground level concentrations for the mine without background			
Location: Wandoan	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contours	**Goal:** 150 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

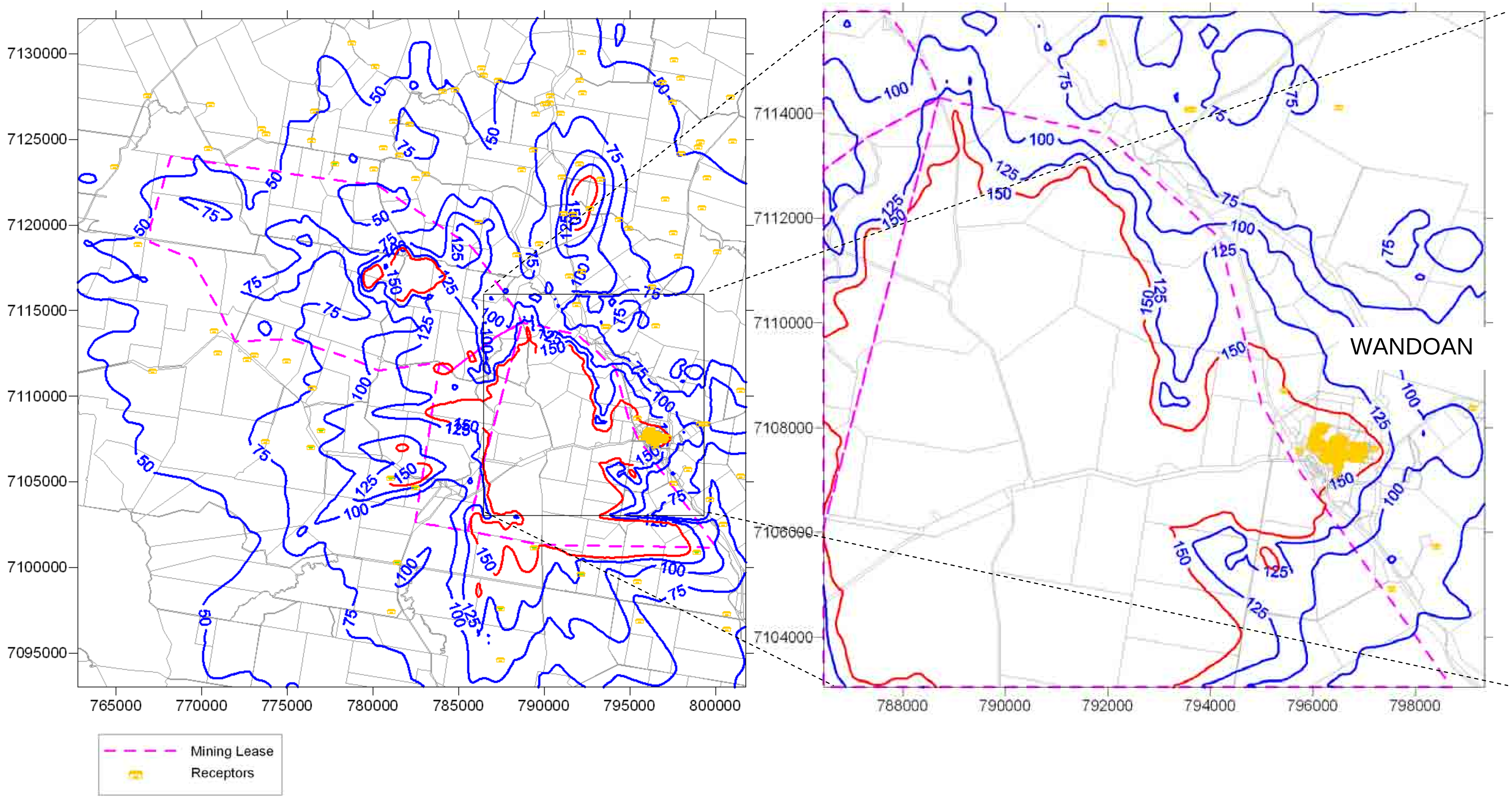


Figure 28 Year 5 - dragline, PM_{10} maximum 24-hour ground level concentrations for the mine including background

Location: Wandoan	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contours	**Goal:** 150 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

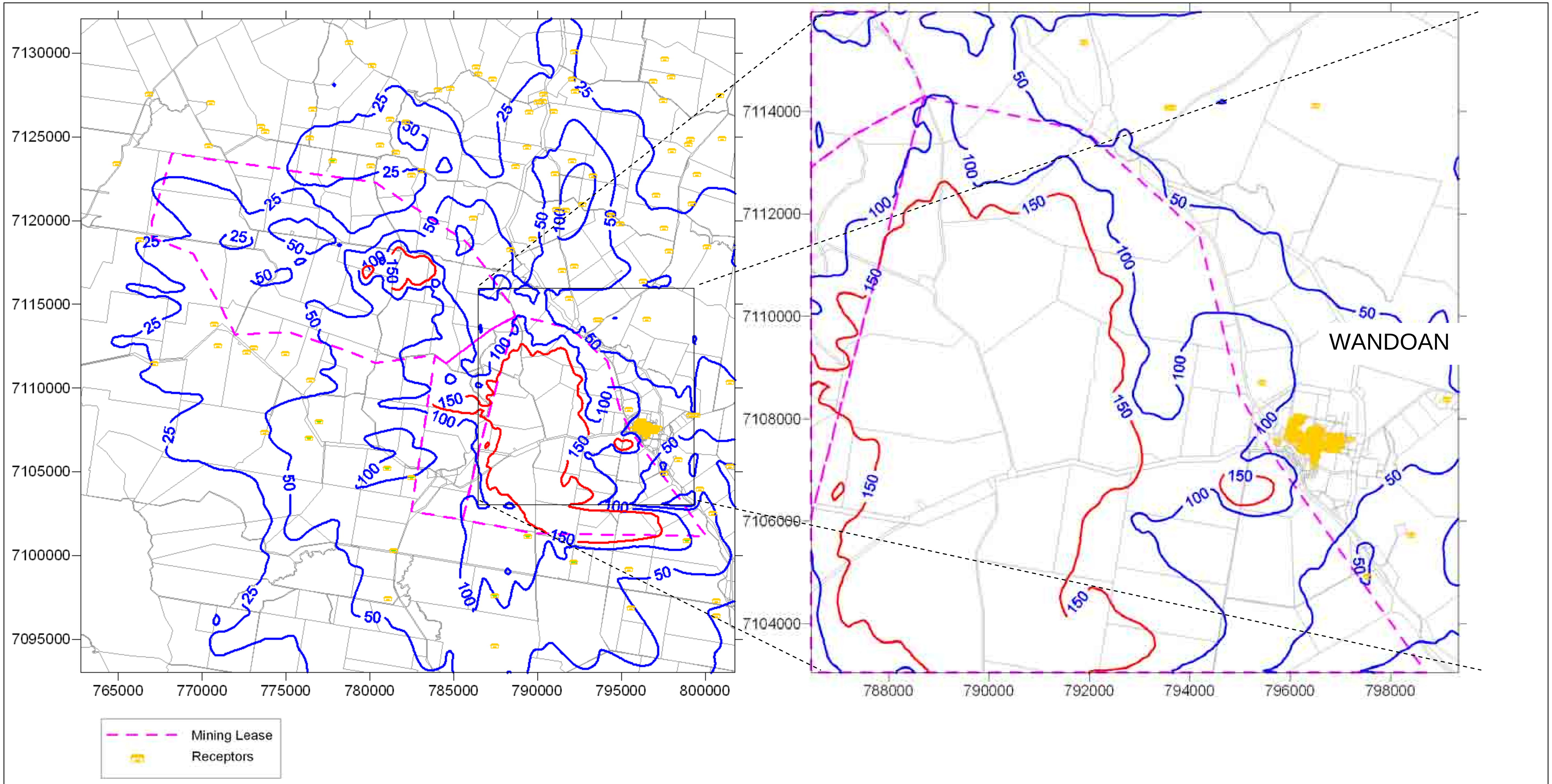


Figure 29 Year 5 – truck and shovel, PM_{10} maximum 24-hour ground level concentrations for the without background – reduced extraction rates

Location: Wandoan	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contours	**Goal:** 150 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

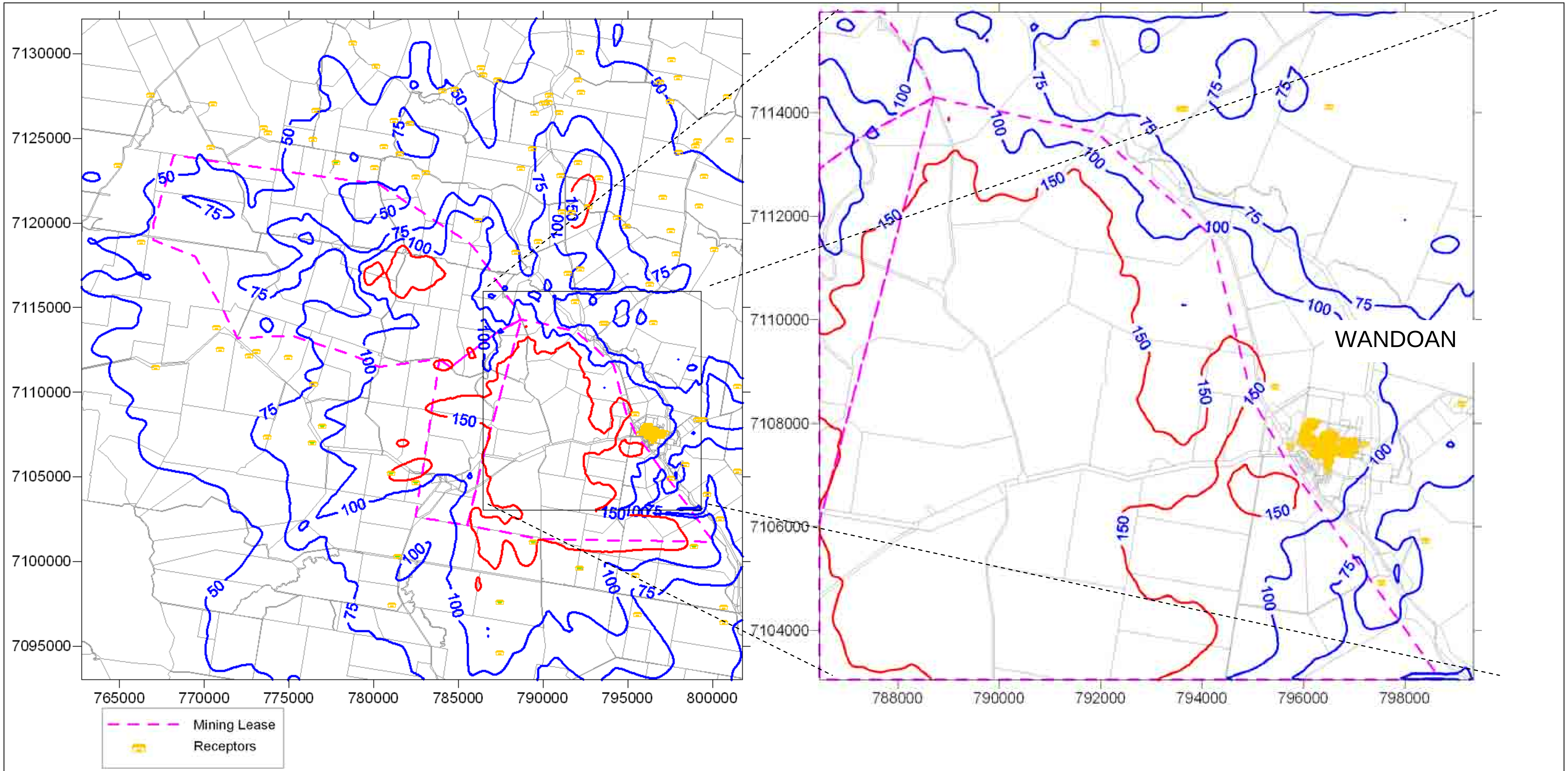


Figure 30 Year 5 – truck and shovel, PM_{10} maximum 24-hour ground level concentrations for the mine including background – reduced extraction rates

Location: Wandoan	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contours	**Goal:** 150 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

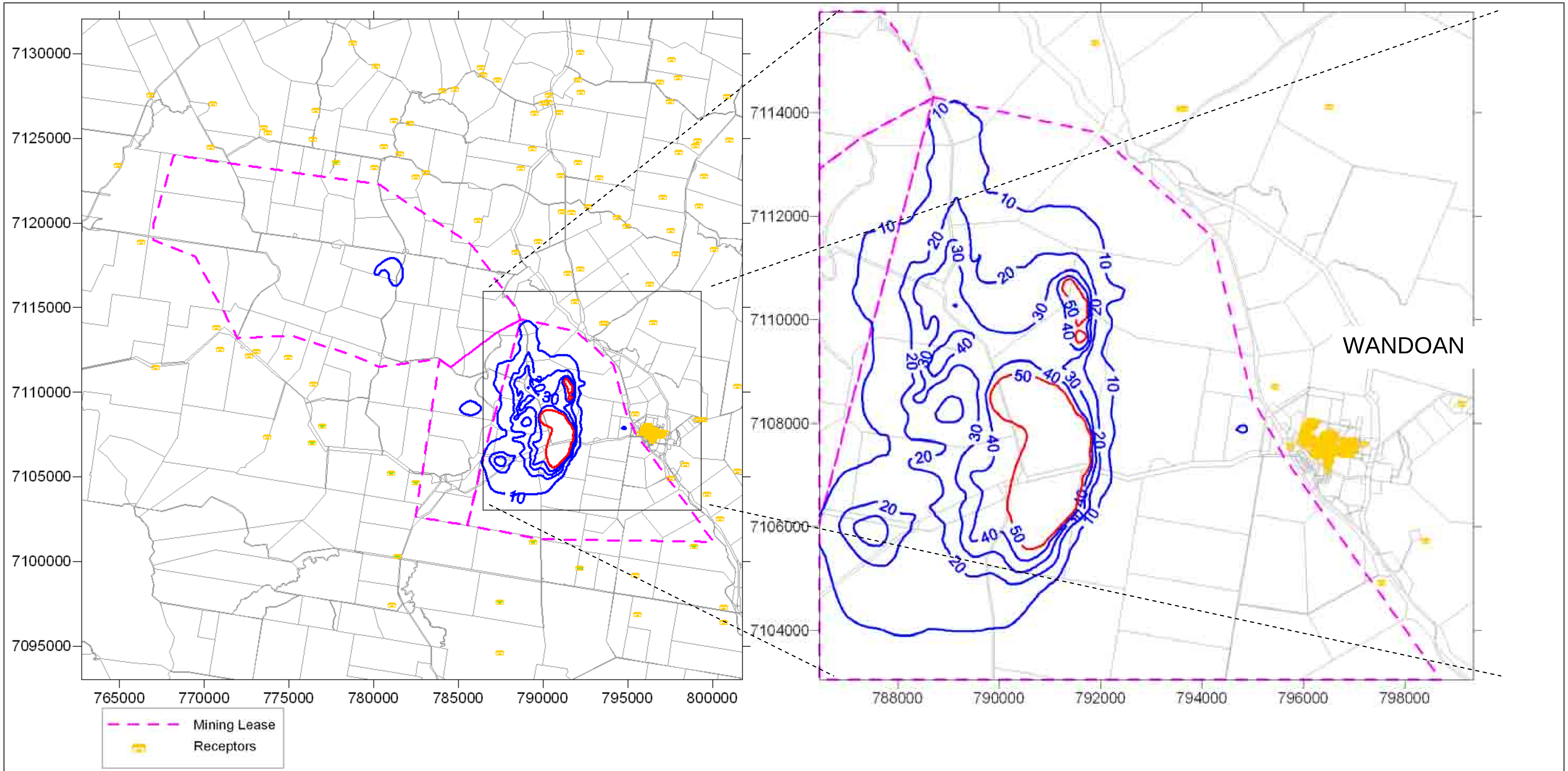


Figure 31 Year 5 – truck and shovel, PM_{10} annual average ground level concentrations for the mine without background – reduced extraction rates			
Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 50 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

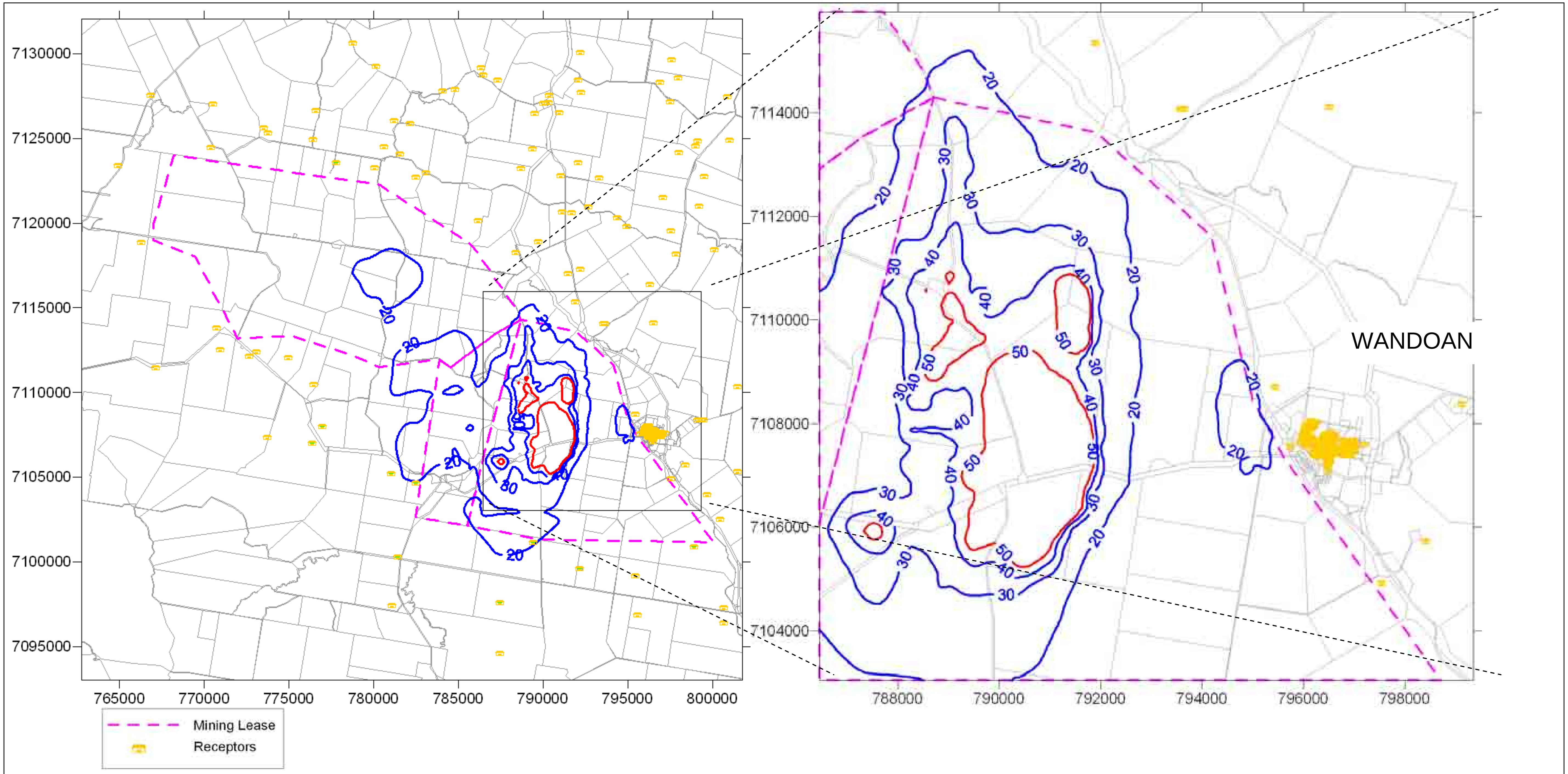


Figure 32 Year 5– truck and shovel, PM_{10} annual average ground level concentrations for the mine including background – reduced extraction rates			
Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 50 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

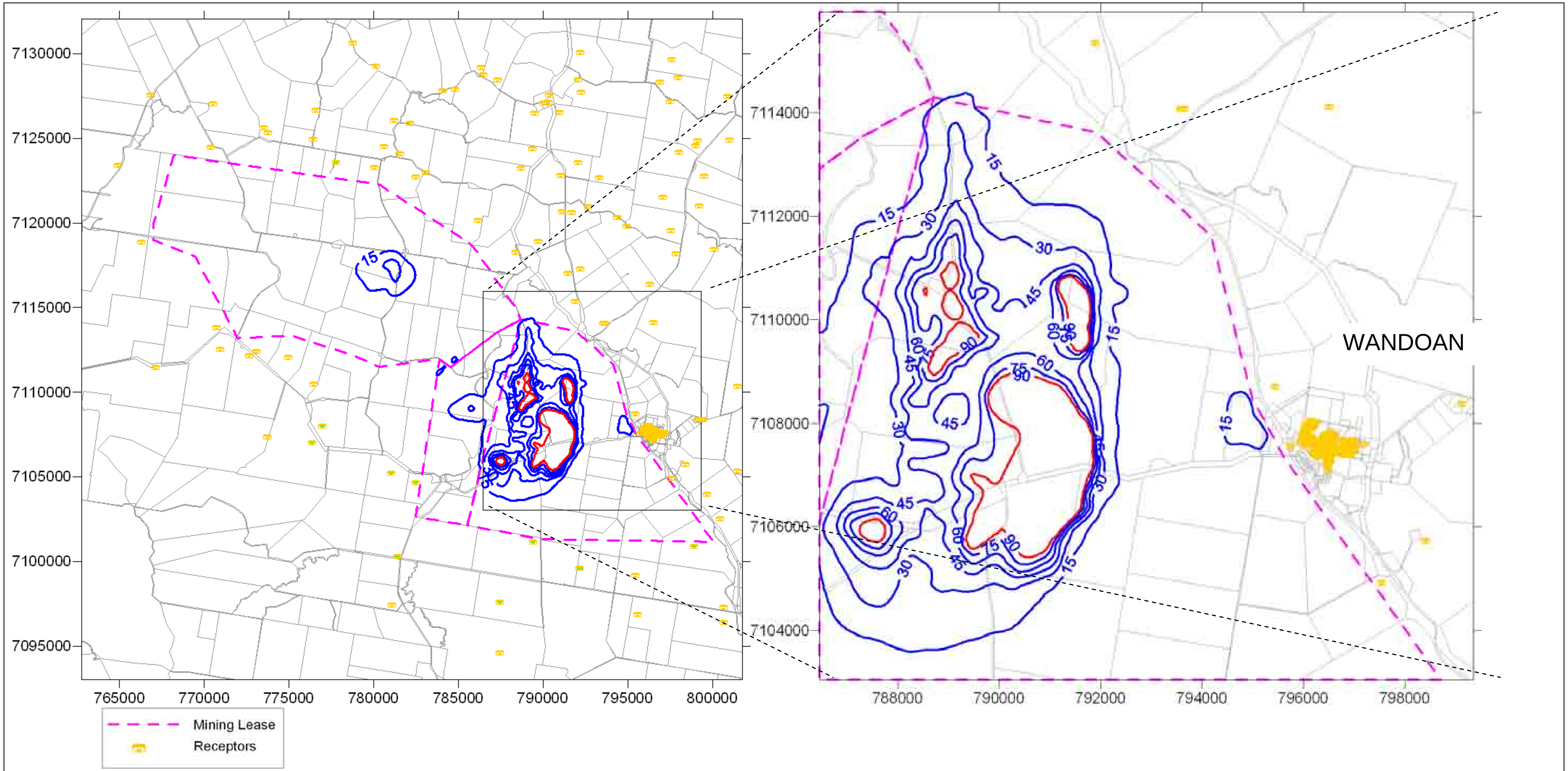


Figure 33 Year 5 – truck and shovel, TSP annual average ground level concentrations for the mine without background – reduced extraction rates

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 90 µg/m³	**Prepared by:** Andrew Wiebe	**Date:**15 October 2008

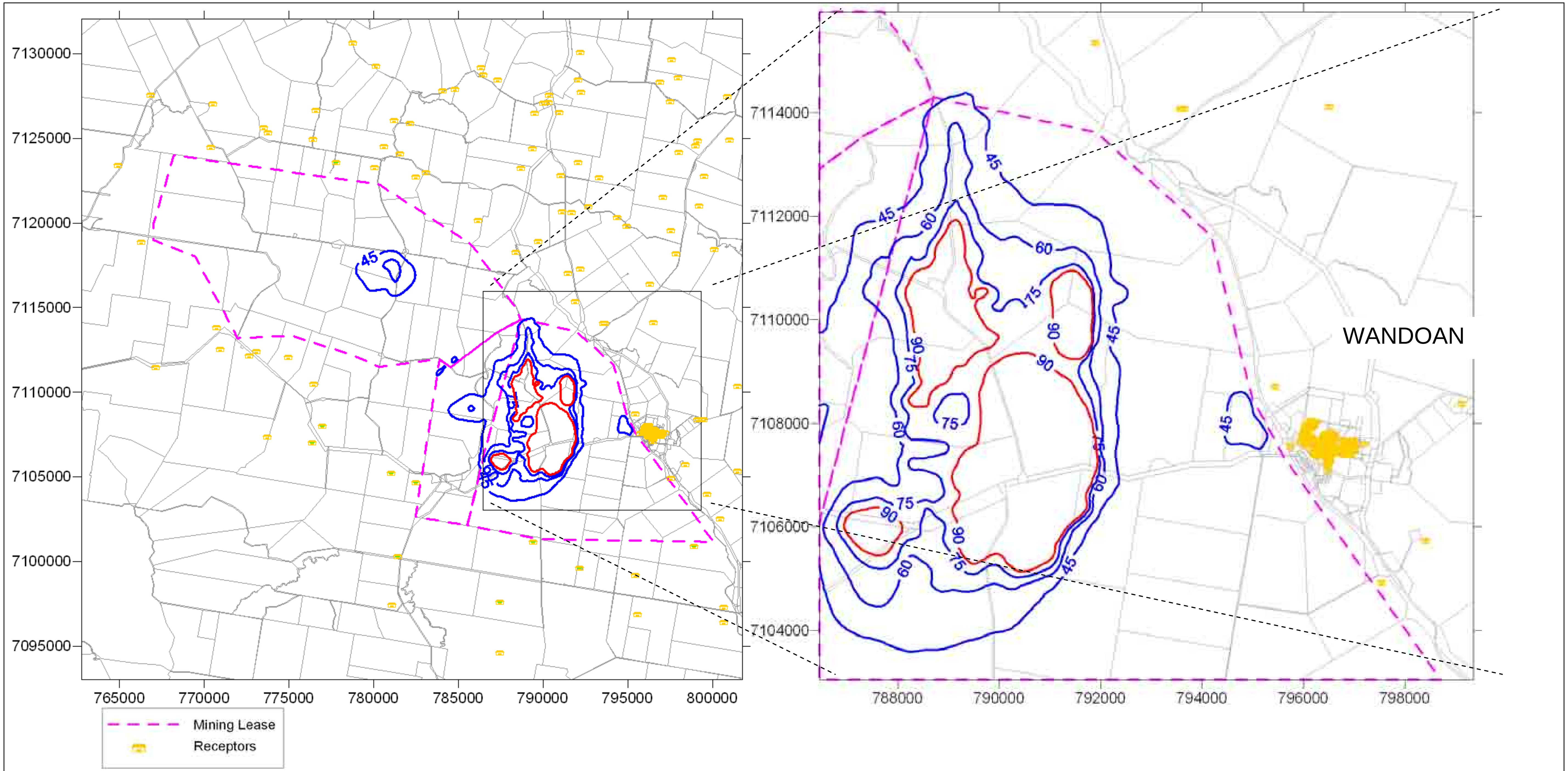


Figure 34 Year 5 – truck and shovel, TSP annual average ground level concentrations for the mine including background – reduced extraction rates

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 90 µg/m³	**Prepared by:** Andrew Wiebe	**Date:**15 October 2008

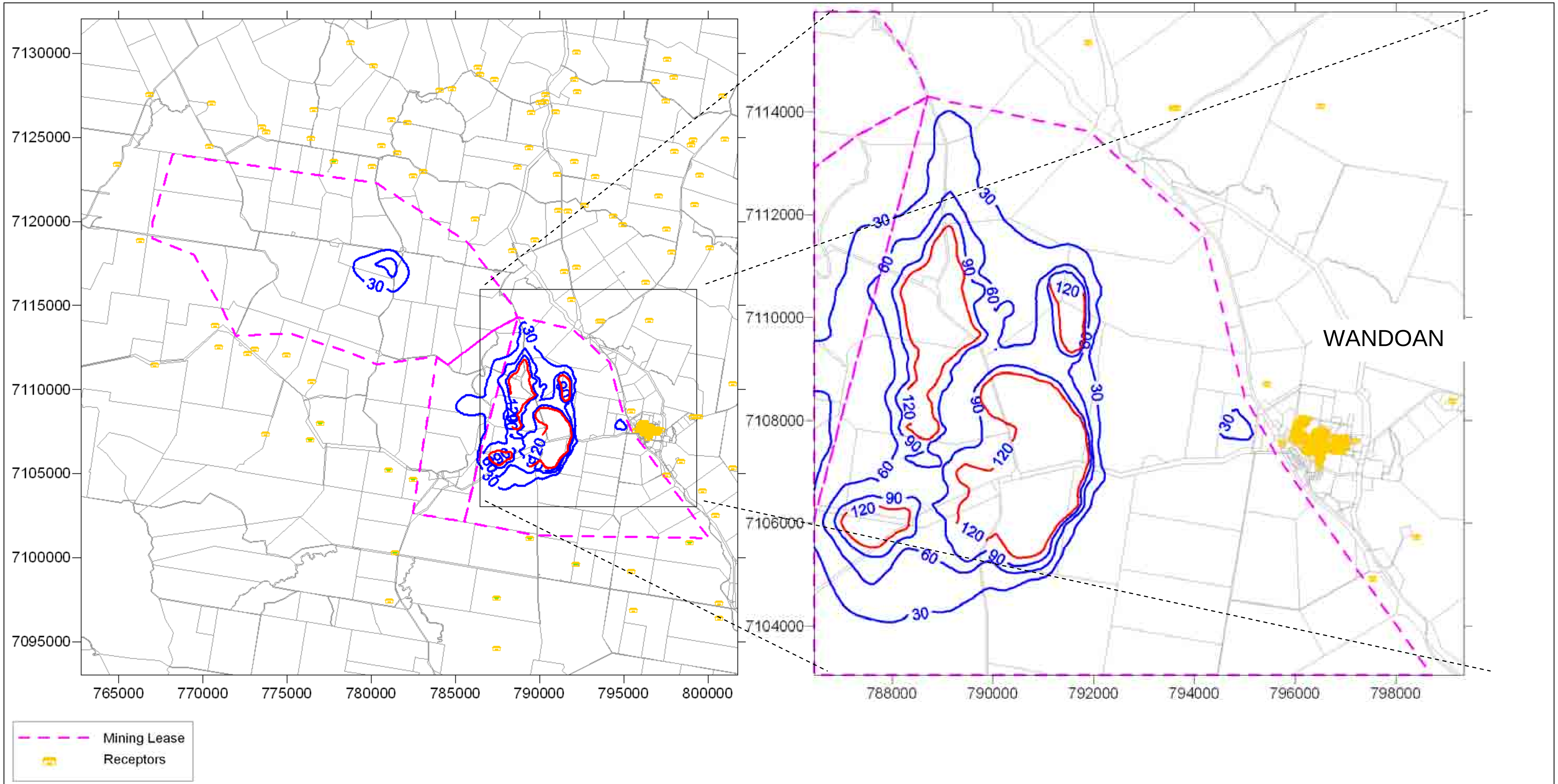


Figure 35 Year 5– truck and shovel, dust deposition for the mine without background –reduced extraction rates			
Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** mg/m²/day
Type: Annual contours	**Goal:** 120 mg/m²/day	**Prepared by:** Andrew Wiebe	**Date:**15 October 2008

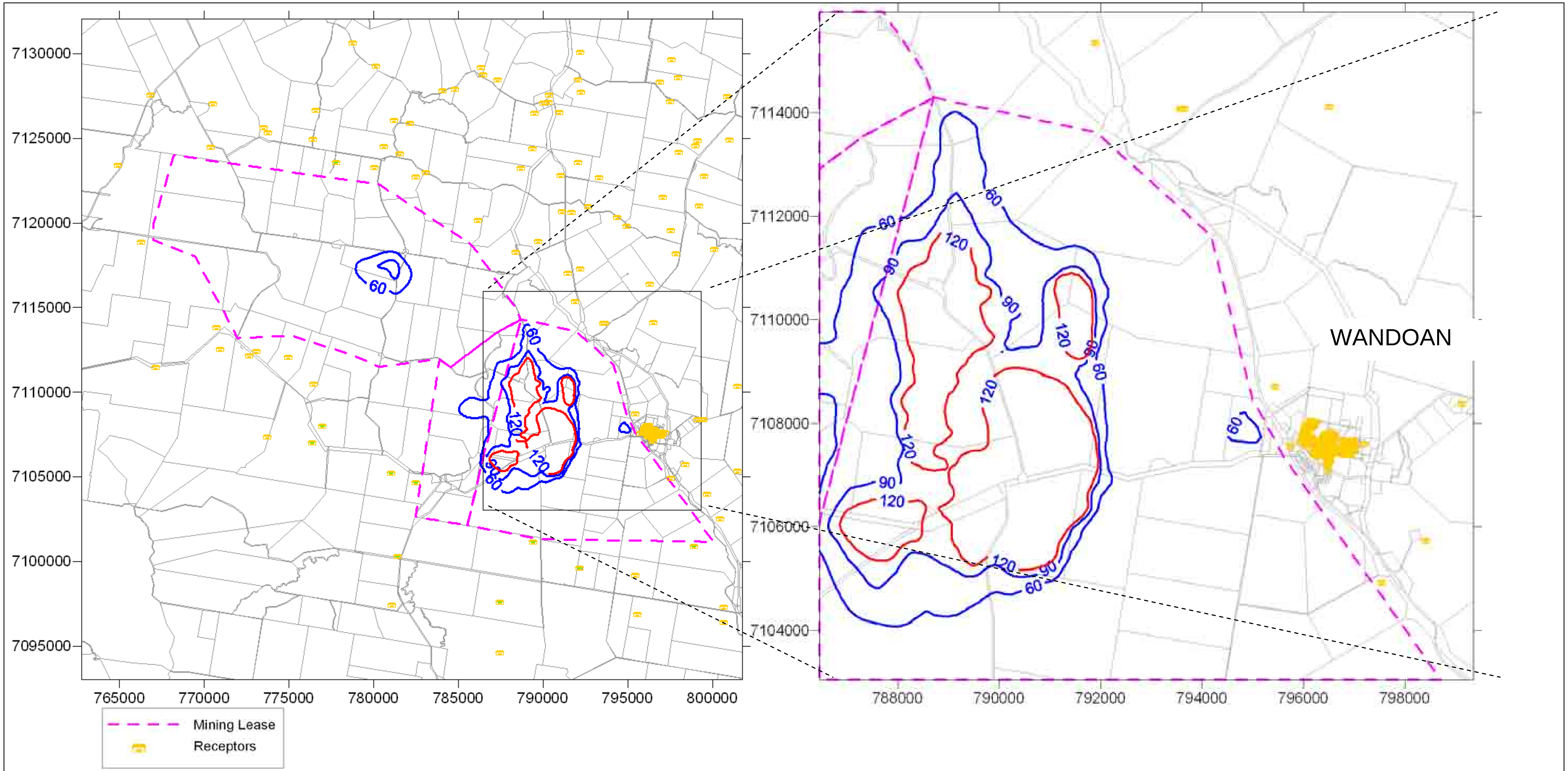


Figure 36 Year 5, dust deposition for the mine including background – truck and shovel at reduced extraction rates			
Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** mg/m²/day
Type: Annual contours	**Goal:** 120 mg/m²/day	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

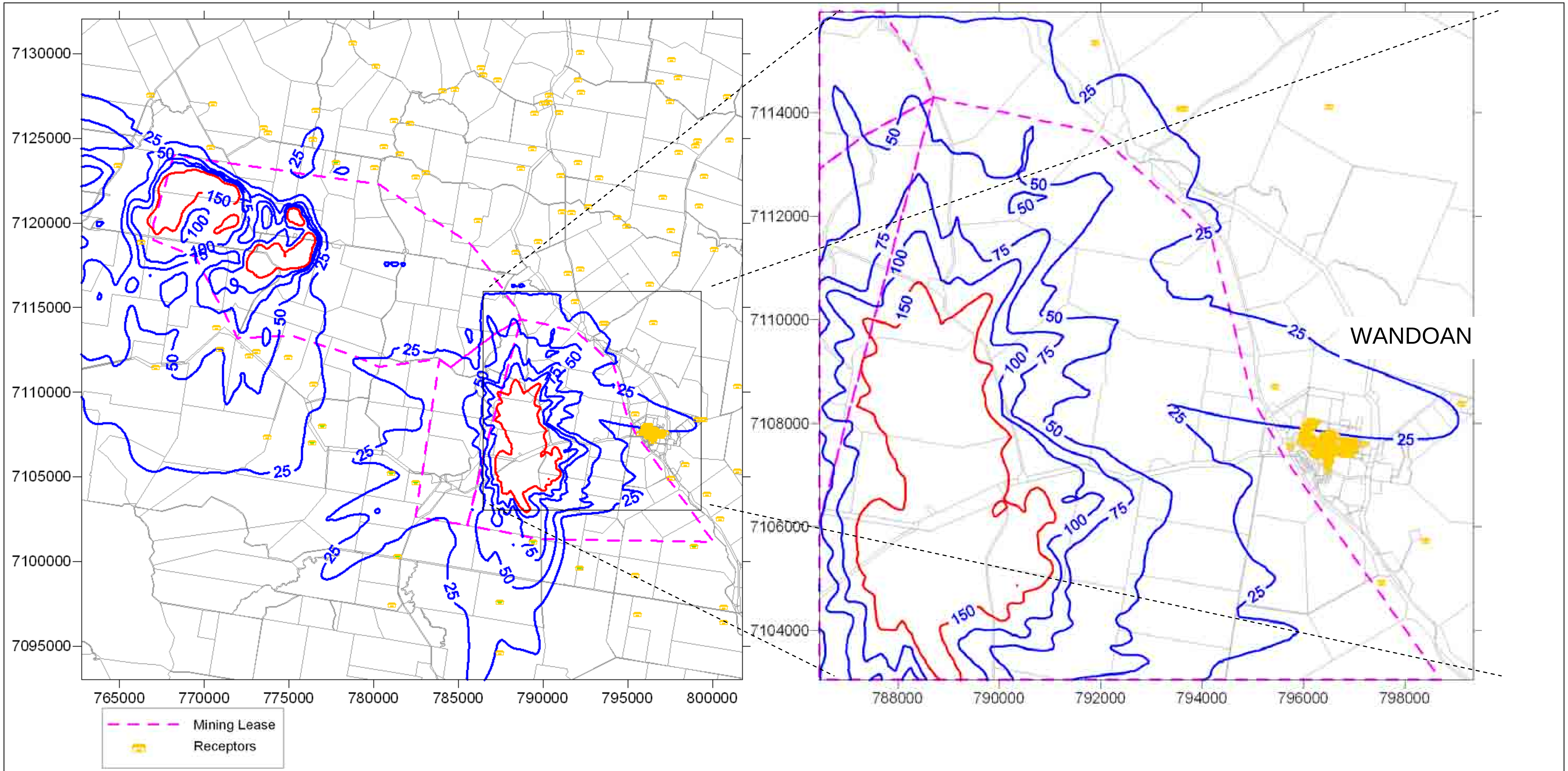


Figure 37 Year 10, PM_{10} maximum 24-hour ground level concentrations for the mine without background

Location: Wandoan	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contours	**Goal:** 150 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

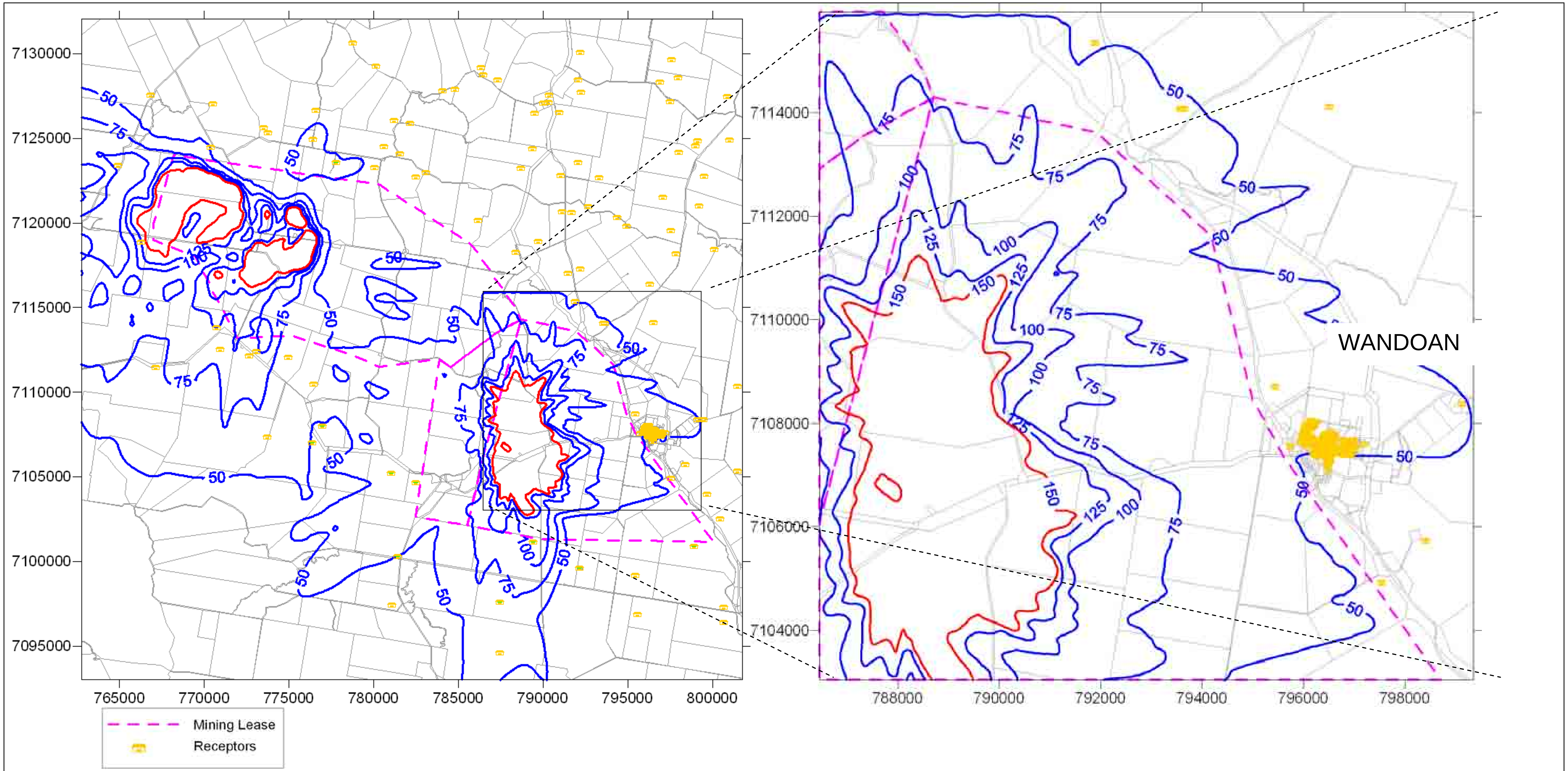


Figure 38 Year 10, PM_{10} maximum 24-hour ground level concentrations for the mine including background

Location: Wandoan	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contours	**Goal:** 150 µg/m³	**Prepared by:** Andrew Wiebe	**Date:**15 October 2008

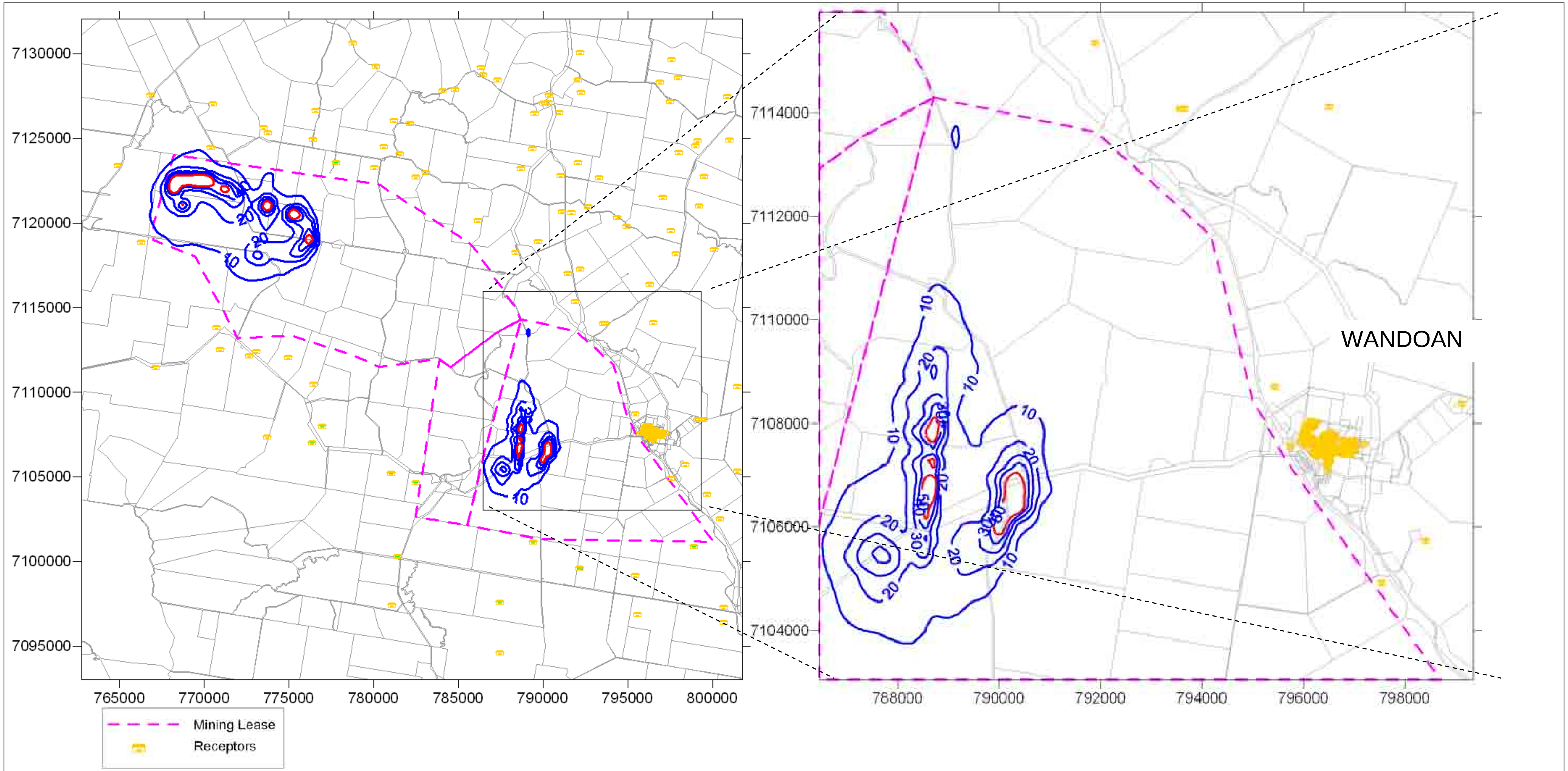


Figure 39 Year 10, PM_{10} annual average ground level concentrations for the mine without background			
Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 50 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

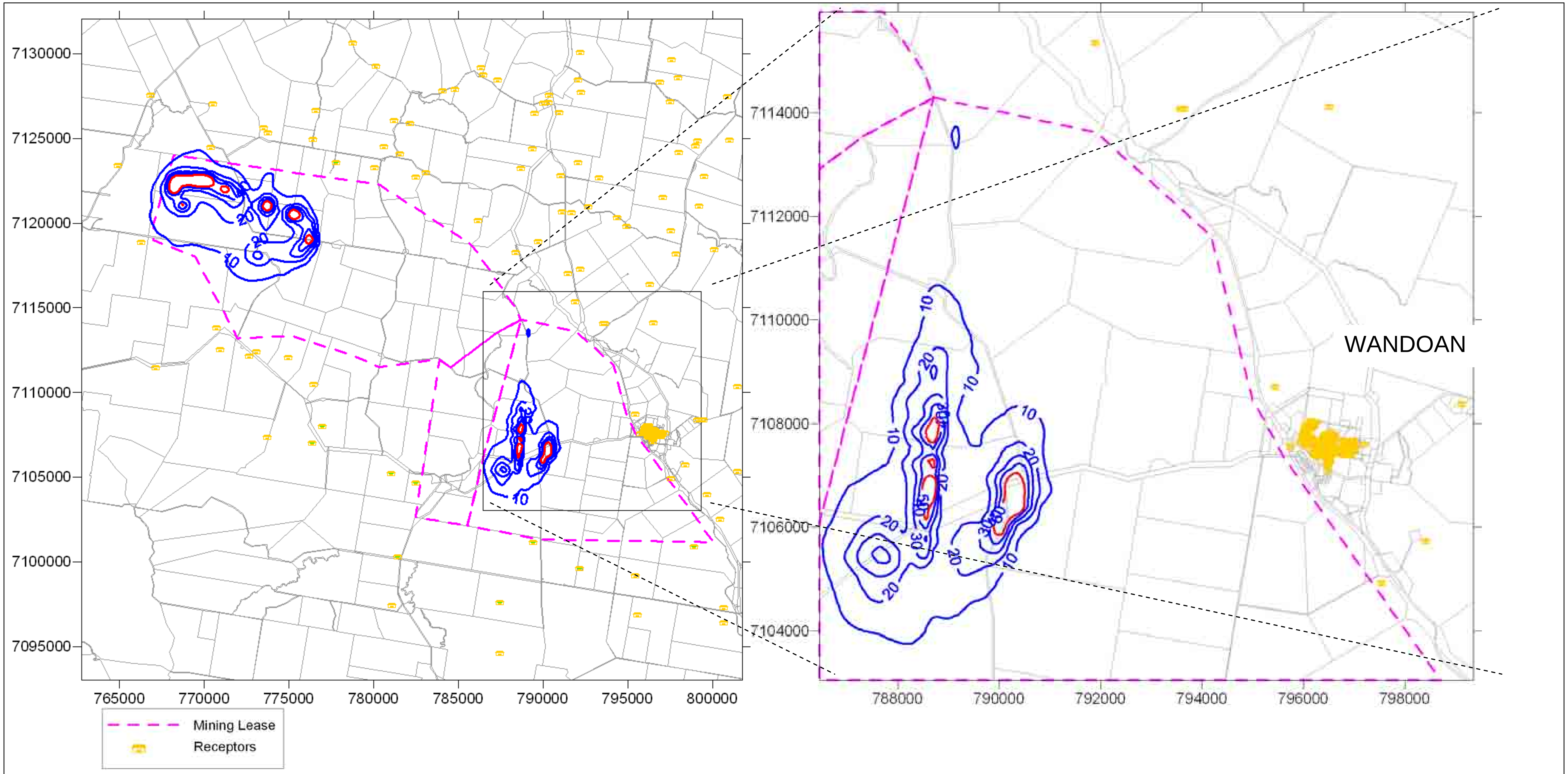


Figure 40 Year 10, PM_{10} annual average ground level concentrations for the mine including background			
Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 50 µg/m³	**Prepared by:** Andrew Wiebe	**Date:**15 October 2008

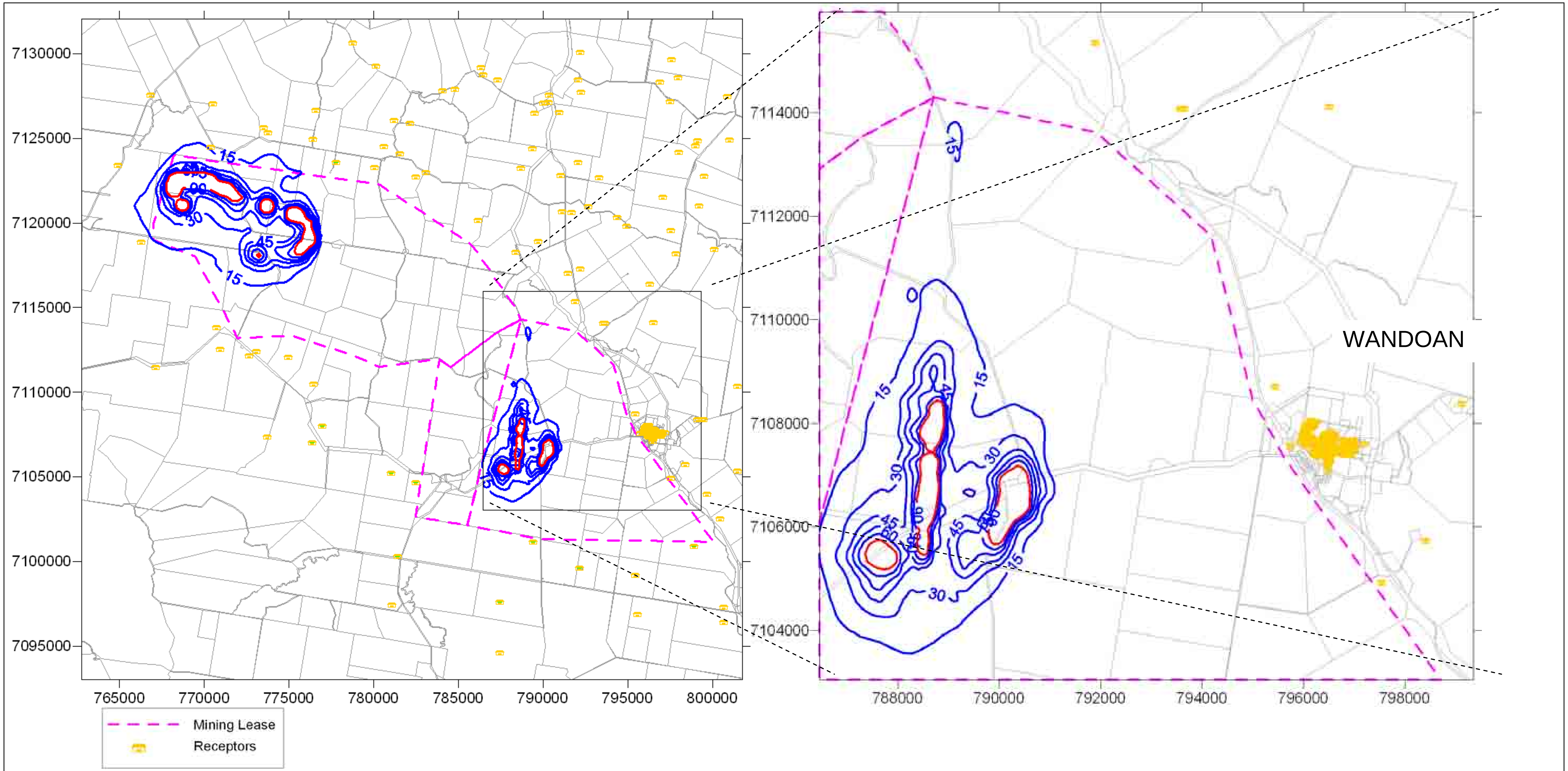


Figure 41 Year 10, TSP annual average ground level concentrations for the mine without background

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 90 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

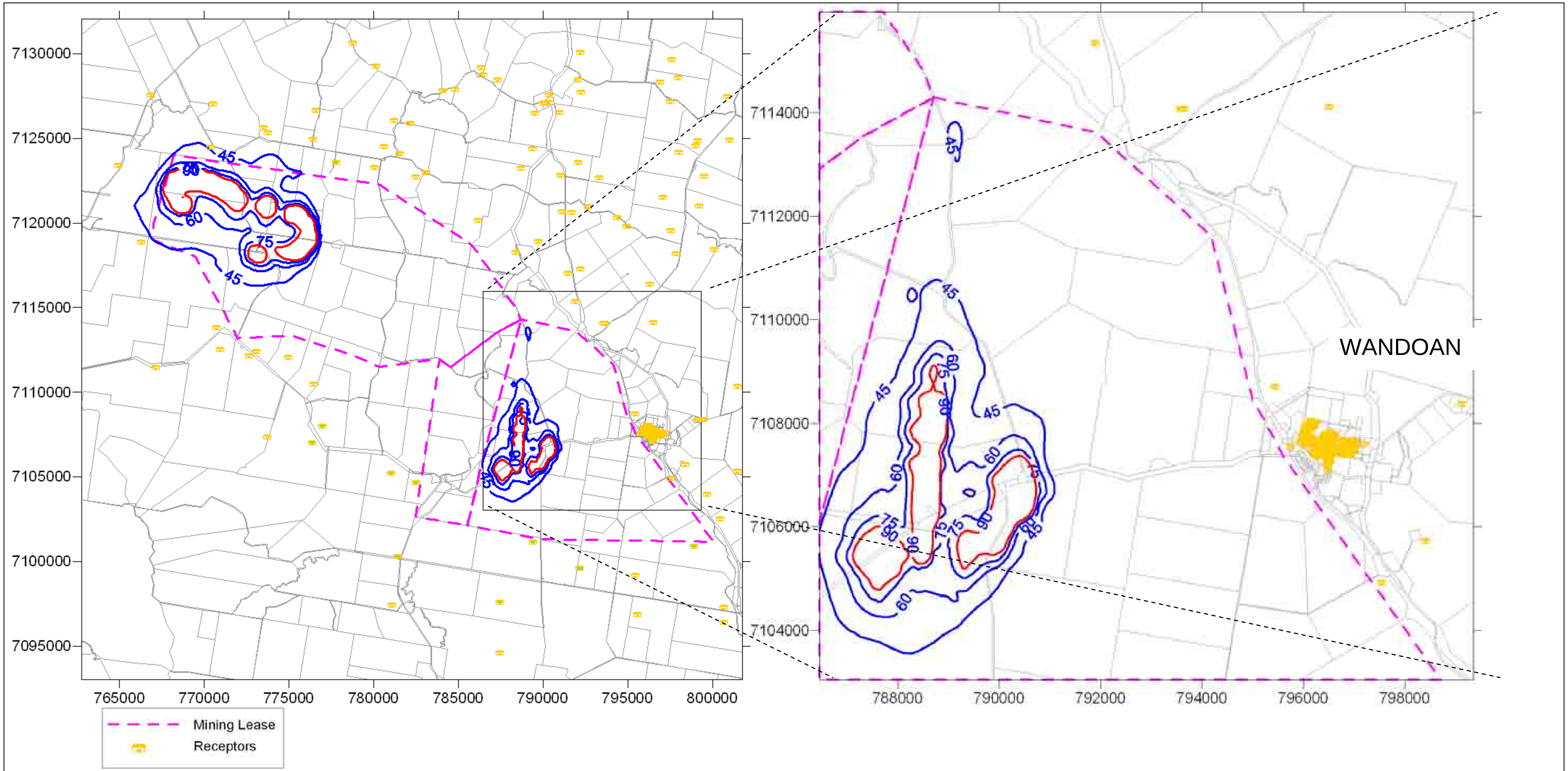


Figure 42 Year 10, TSP annual average ground level concentrations for the mine including background

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 90 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

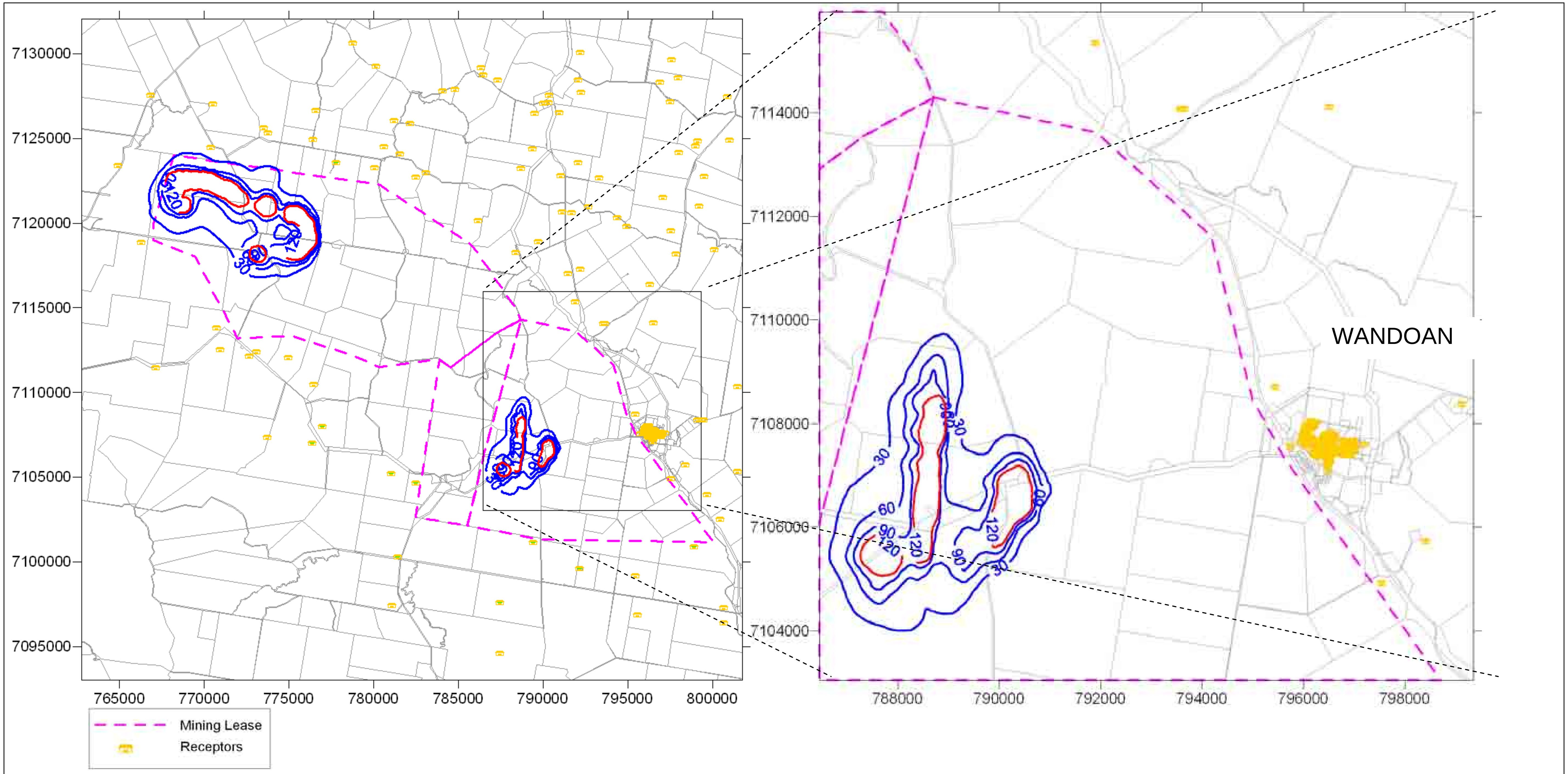


Figure 43 Year 10, dust deposition for the mine without background

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** mg/m²/day
Type: Annual contours	**Goal:** 120 mg/m²/day	**Prepared by:** Andrew Wiebe	**Date:**15 October 2008

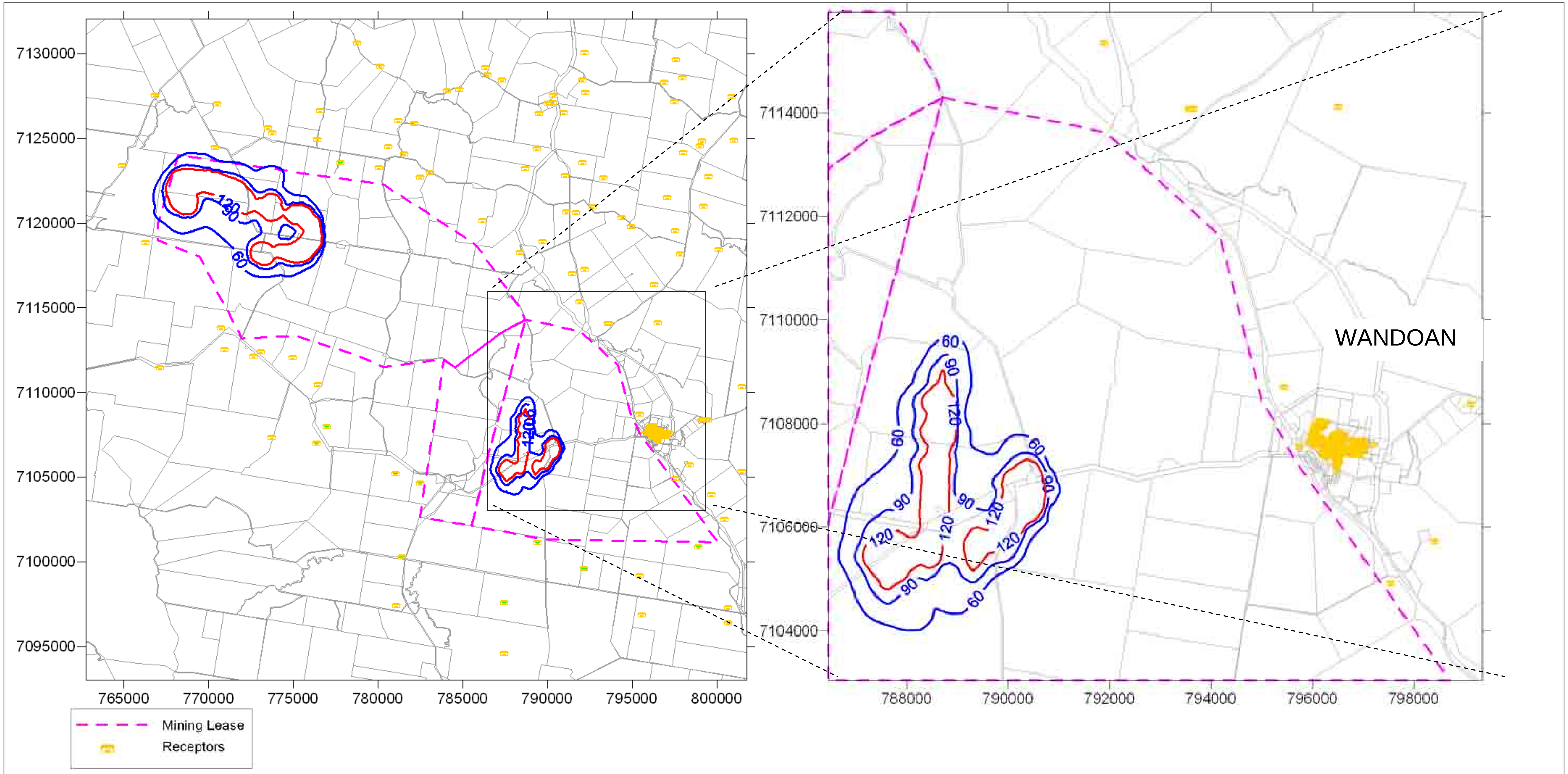


Figure 44 Year 10, dust deposition for the mine including background

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** mg/m²/day
Type: Annual contours	**Goal:** 120 mg/m²/day	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

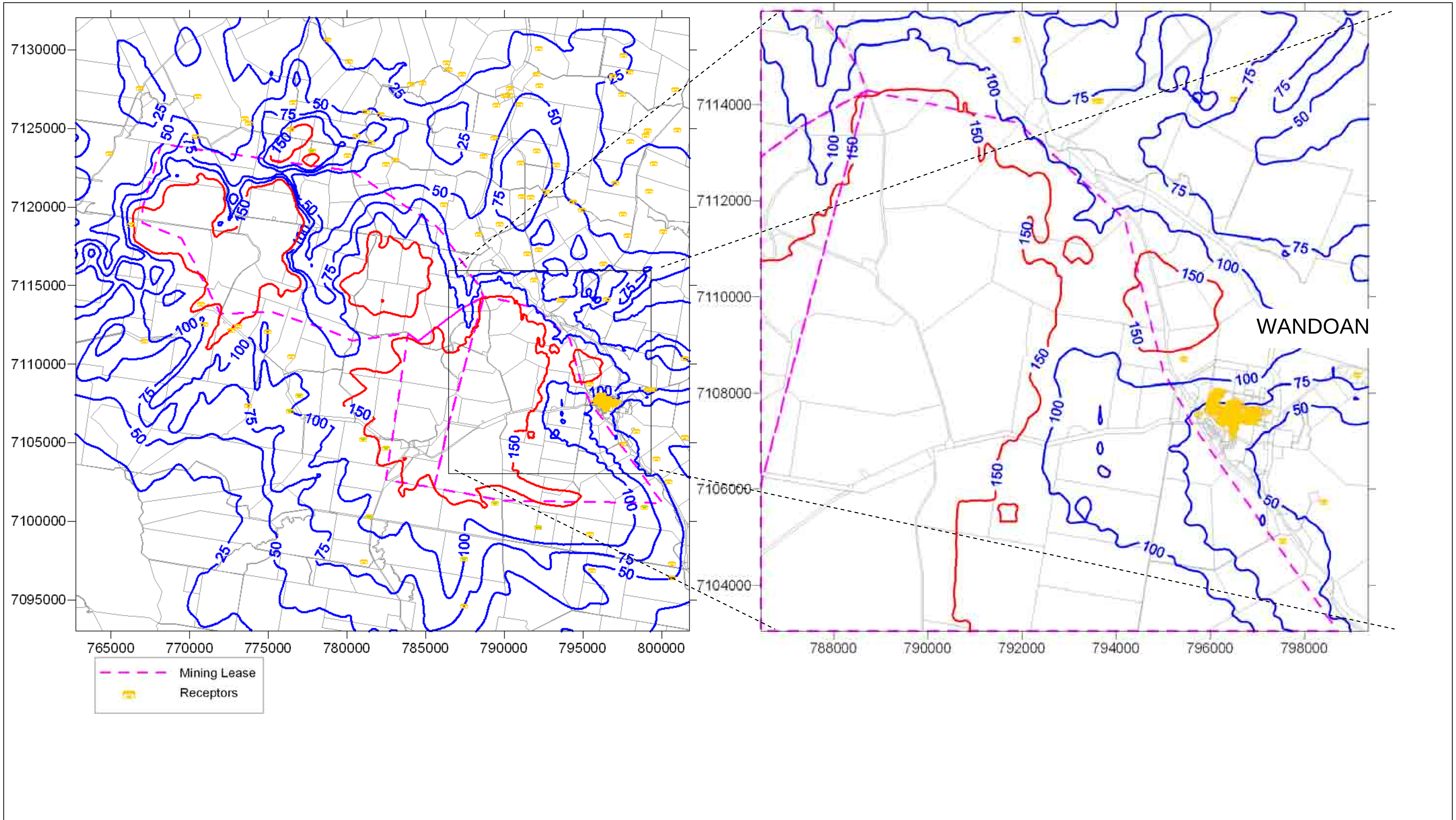


Figure 45 Year 20, PM_{10} maximum 24-hour ground level concentrations for the mine without background

Location: Wandoan	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contours	**Goal:** 150 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

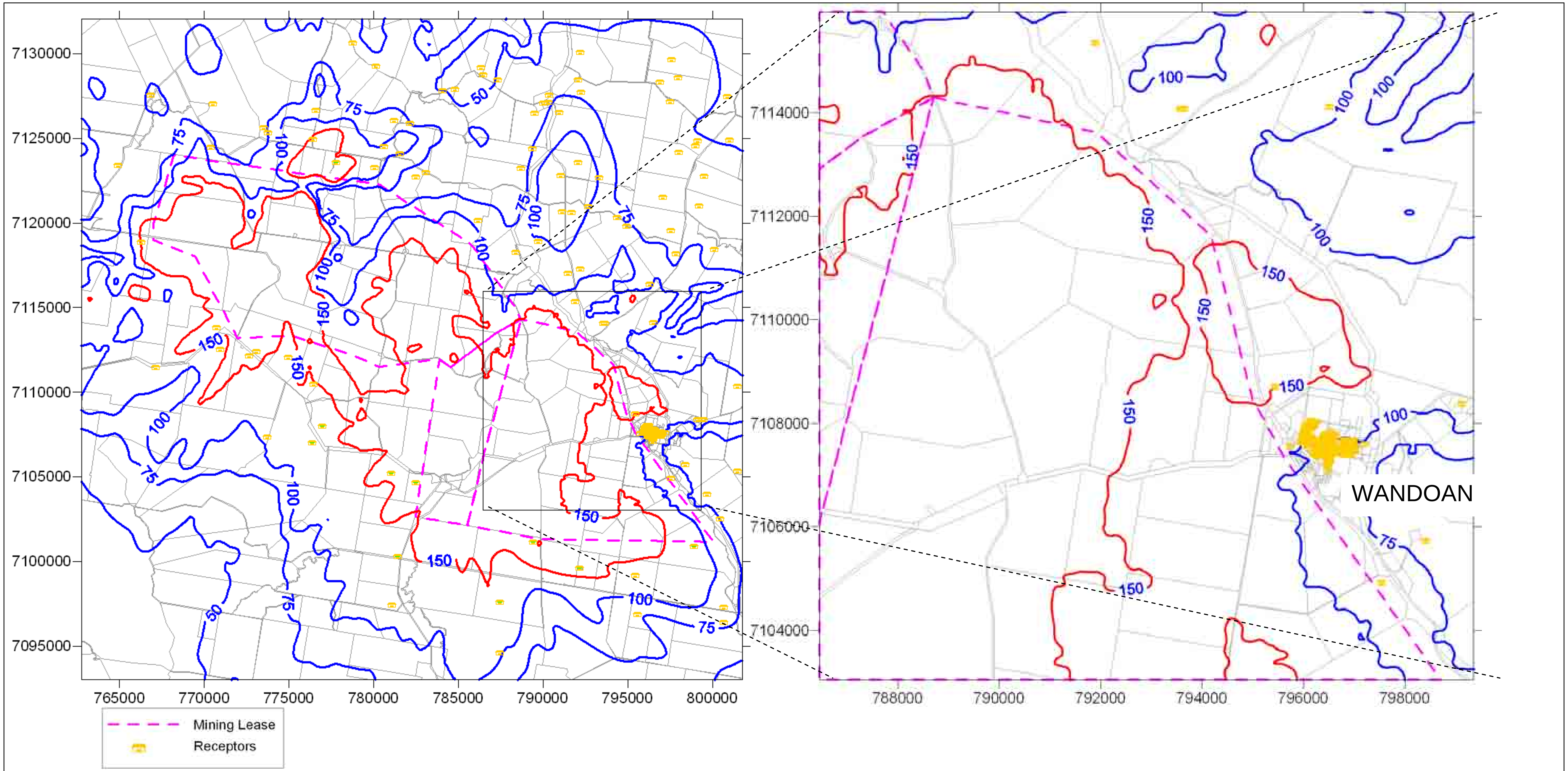


Figure 46 Year 20, PM10 maximum 24-hour ground level concentrations for the mine including background			
Location: Wandoan	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contours	**Goal:** 150 µg/m³	**Prepared by:** Andrew Wiebe	**Date:**15 October 2008

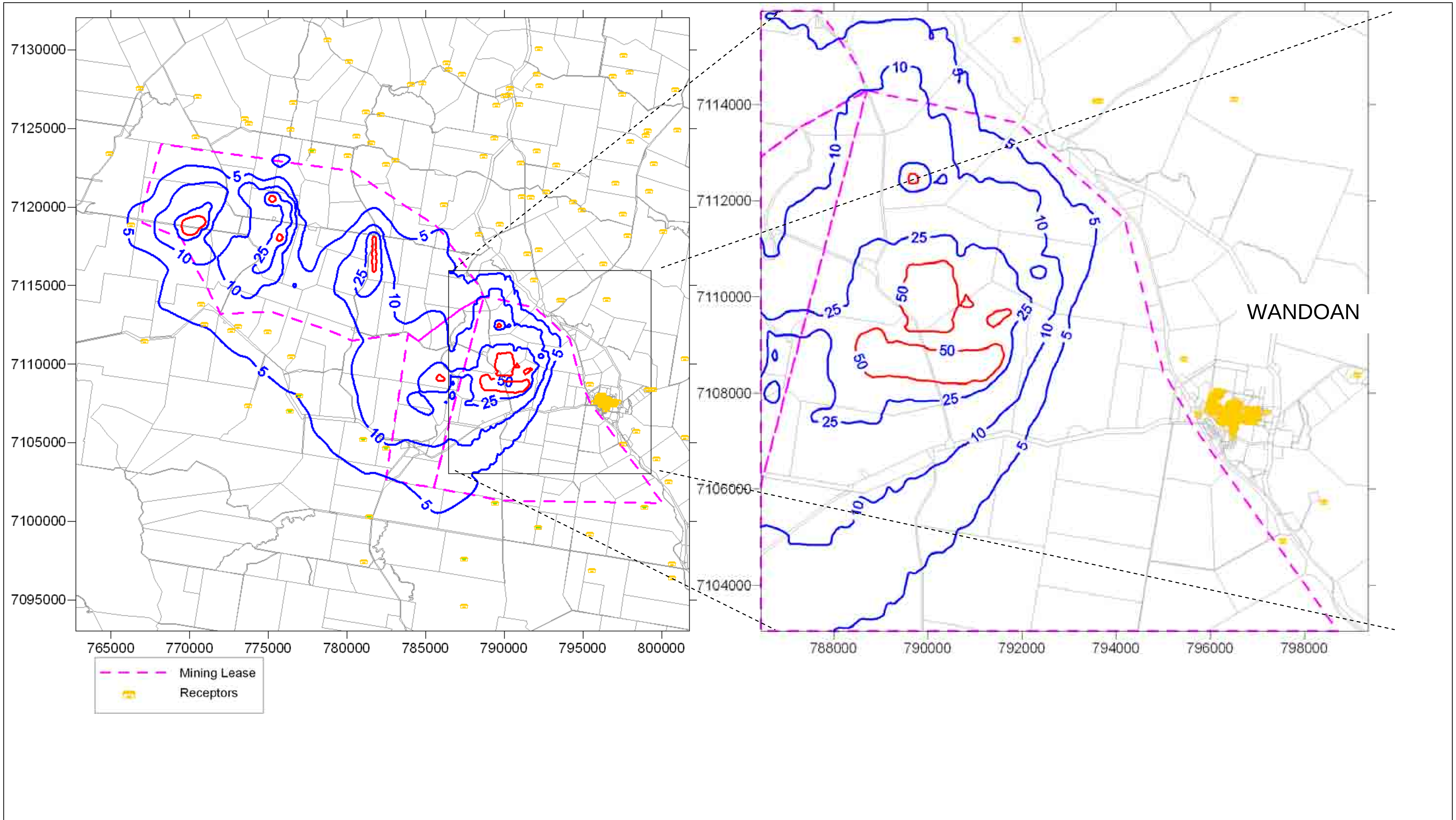


Figure 47 Year 20, PM_{10} annual average ground level concentrations for the mine without background

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 50 µg/m³	**Prepared by:** Andrew Wiebe	**Date:**15 October 2008

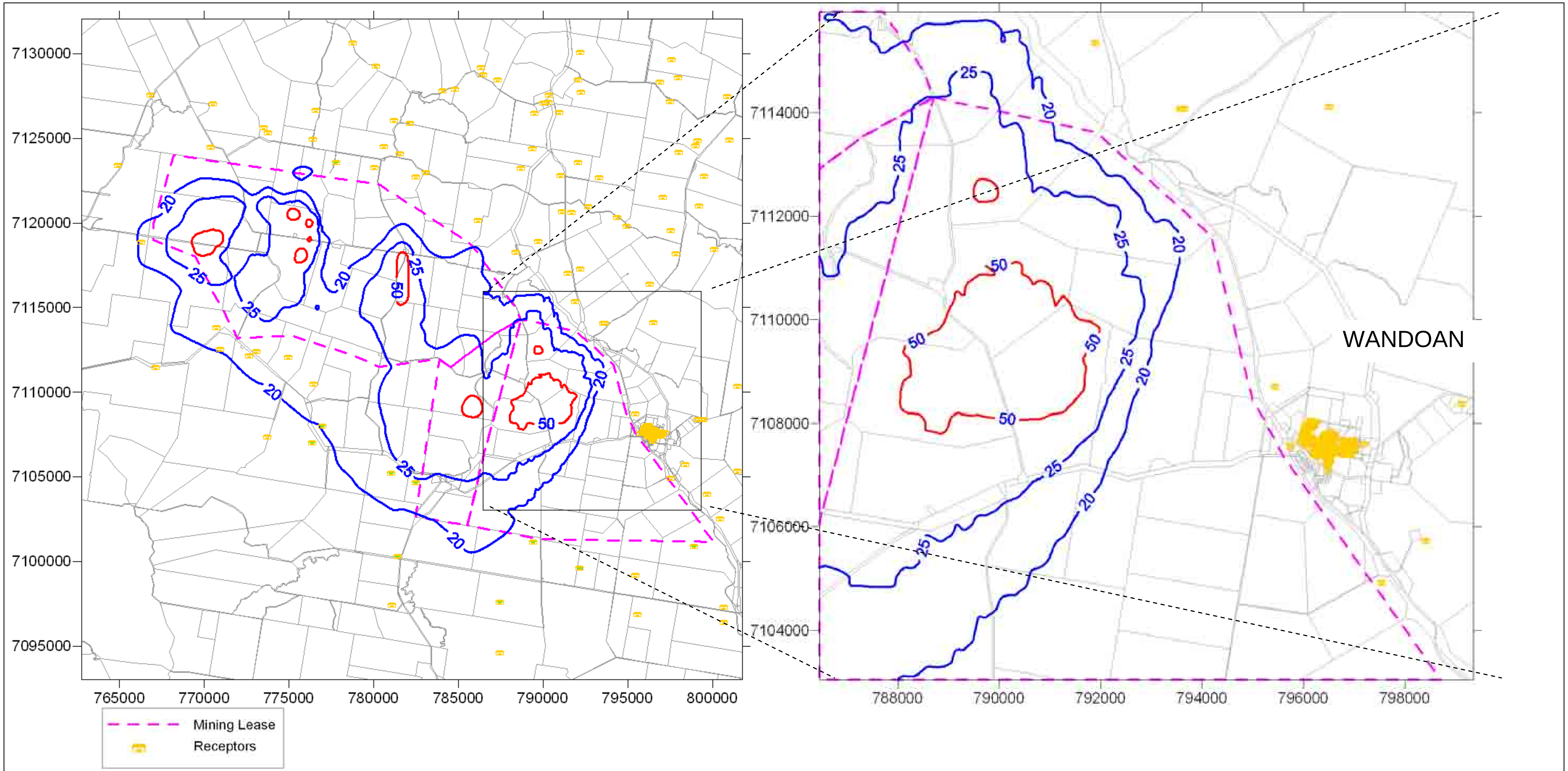


Figure 48 Year 20, PM_{10} annual average ground level concentrations for the mine including background

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 50 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

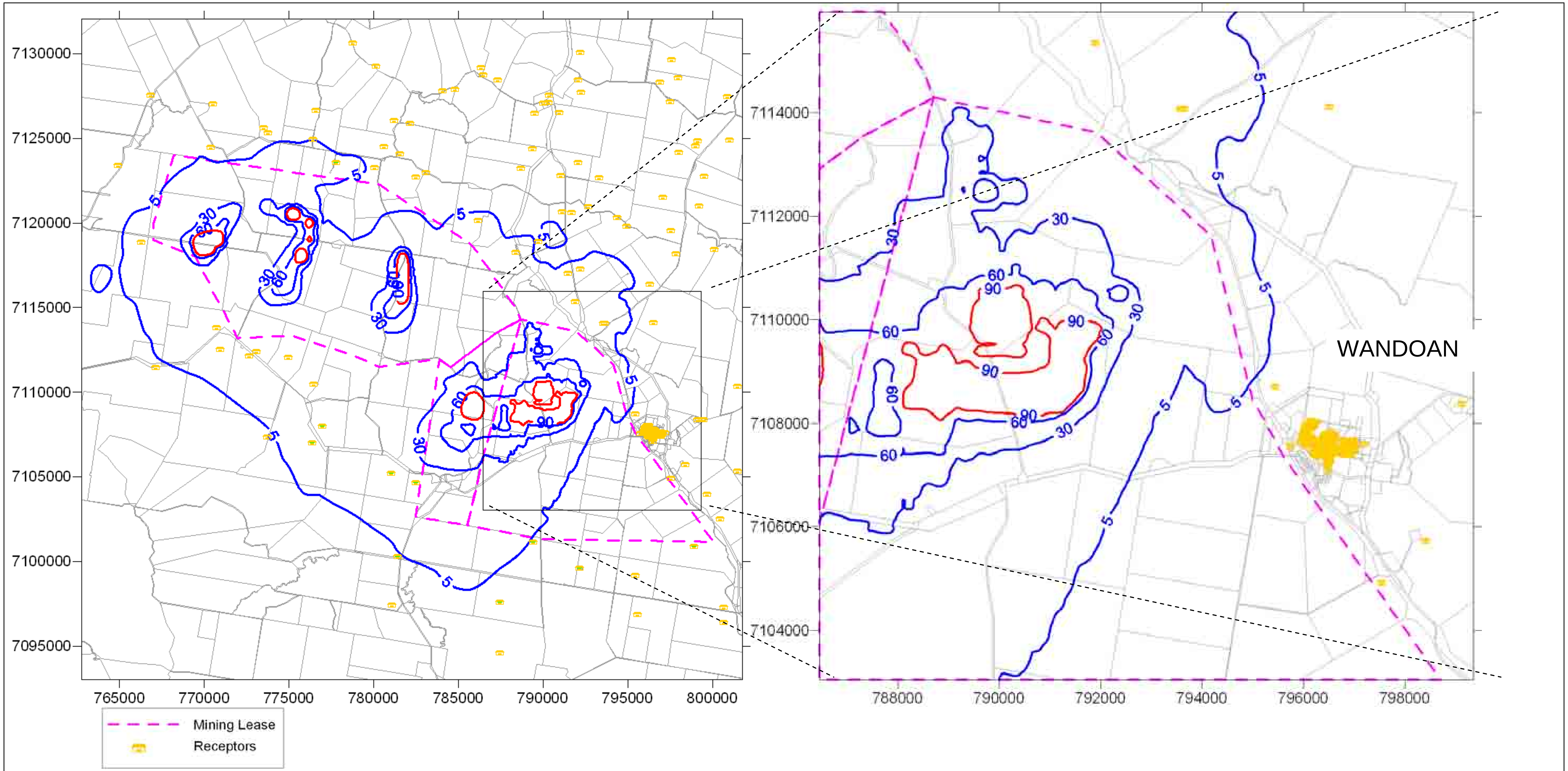


Figure 49 Year 20, TSP annual average ground level concentrations for the mine without background

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 90 µg/m³	**Prepared by:** Andrew Wiebe	**Date:**15 October 2008

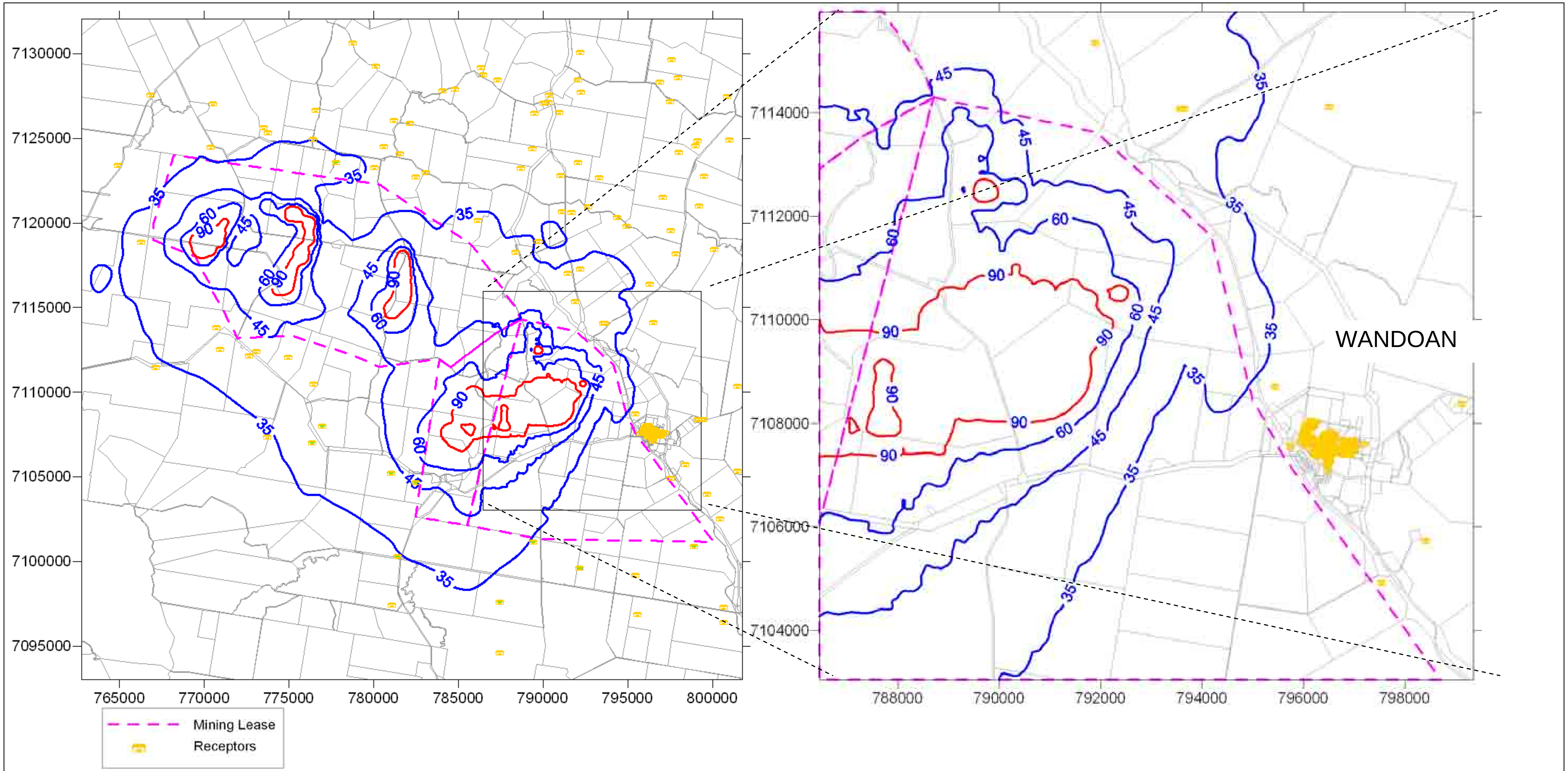


Figure 50 Year 20, TSP annual average ground level concentrations for the mine including background

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 90 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

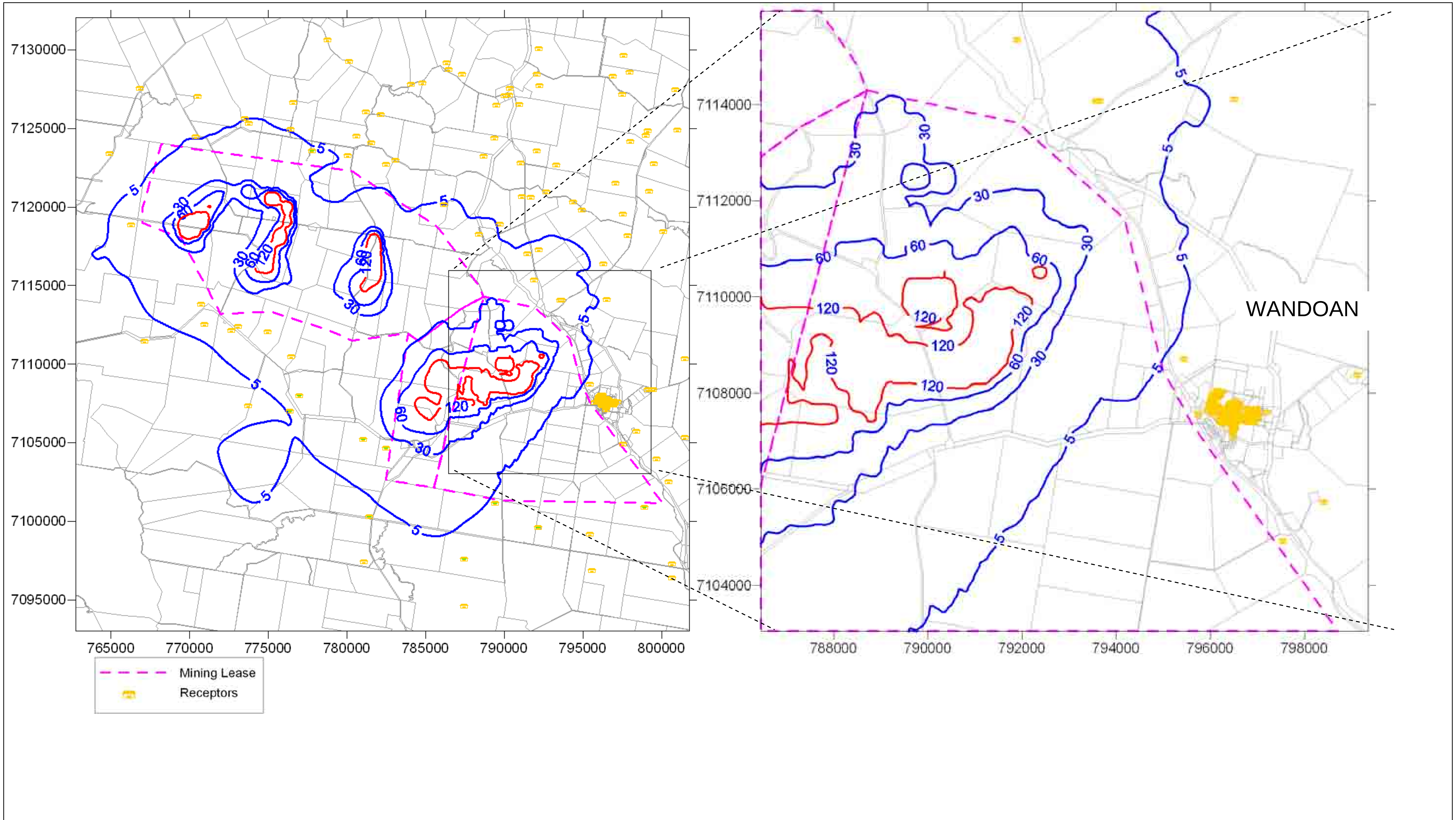


Figure 51 Year 20, dust deposition for the mine without background

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** mg/m²/day
Type: Annual contours	**Goal:** 120 mg/m²/day	**Prepared by:** Andrew Wiebe	**Date:**15 October 2008

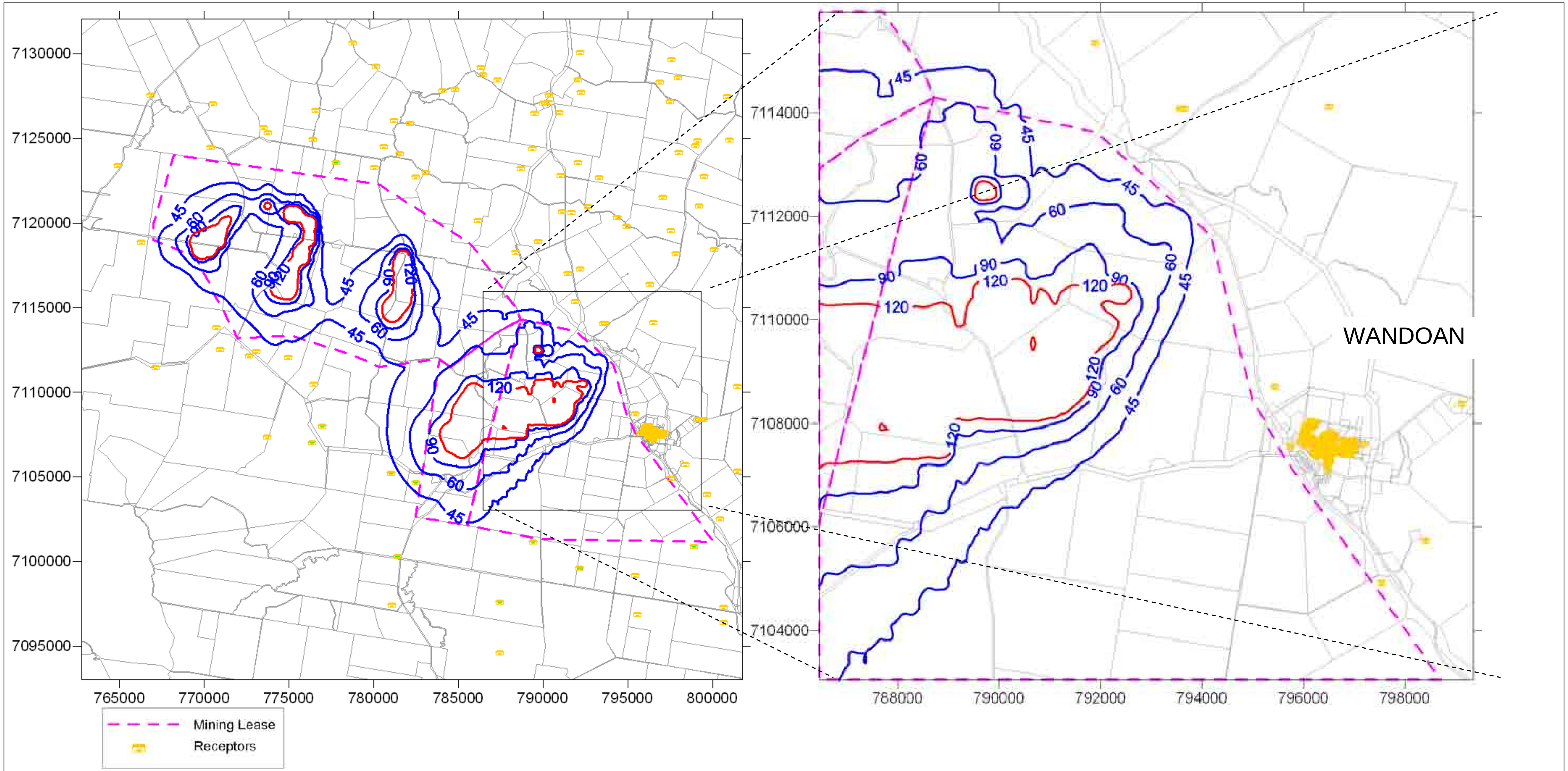


Figure 52 Year 20, dust deposition for the mine including background

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** mg/m²/day
Type: Annual contours	**Goal:** 120 mg/m²/day	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

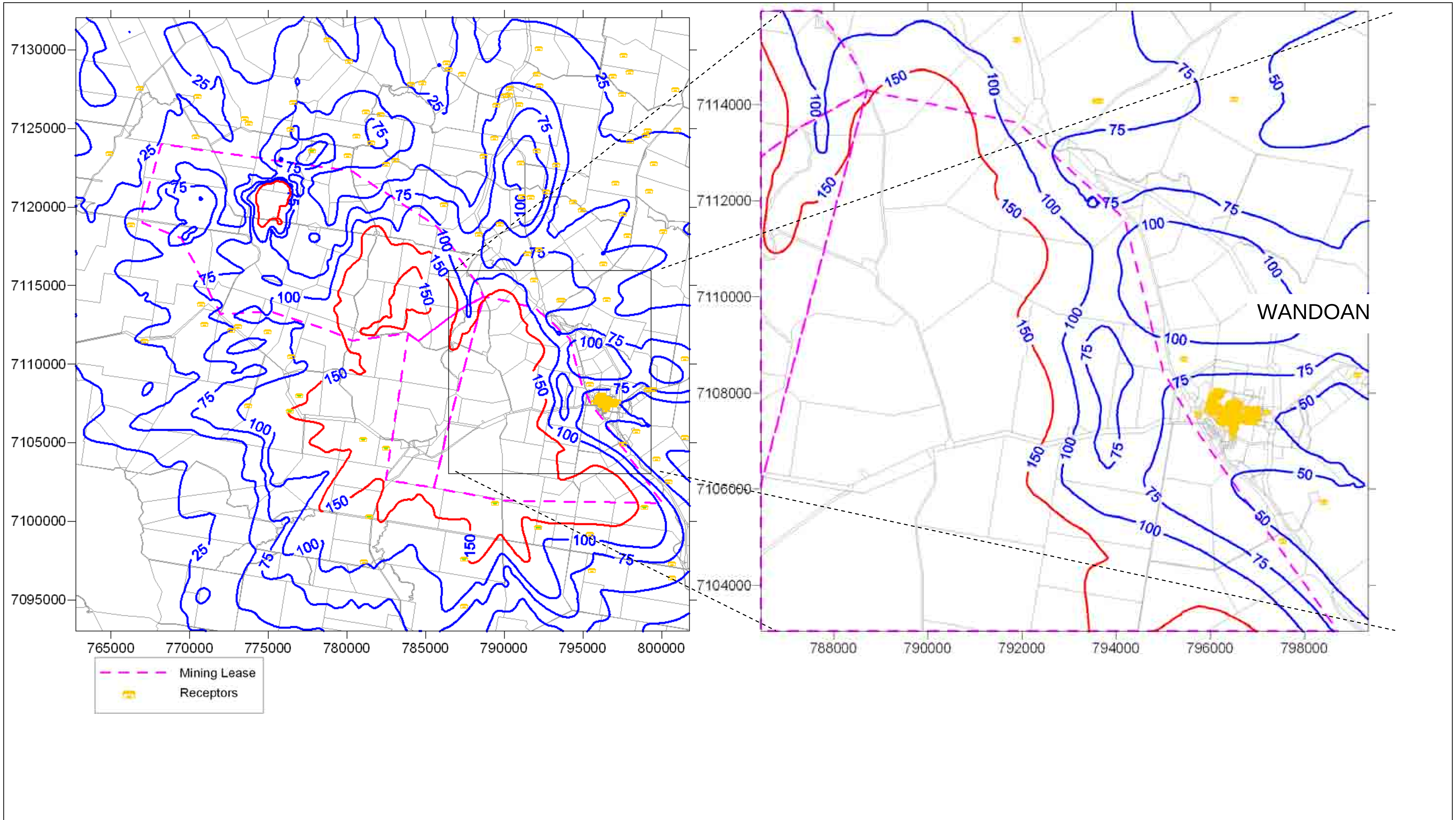


Figure 53 Year 30, PM_{10} maximum 24-hour ground level concentrations for the mine without background

Location: Wandoan	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contours	**Goal:** 150 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

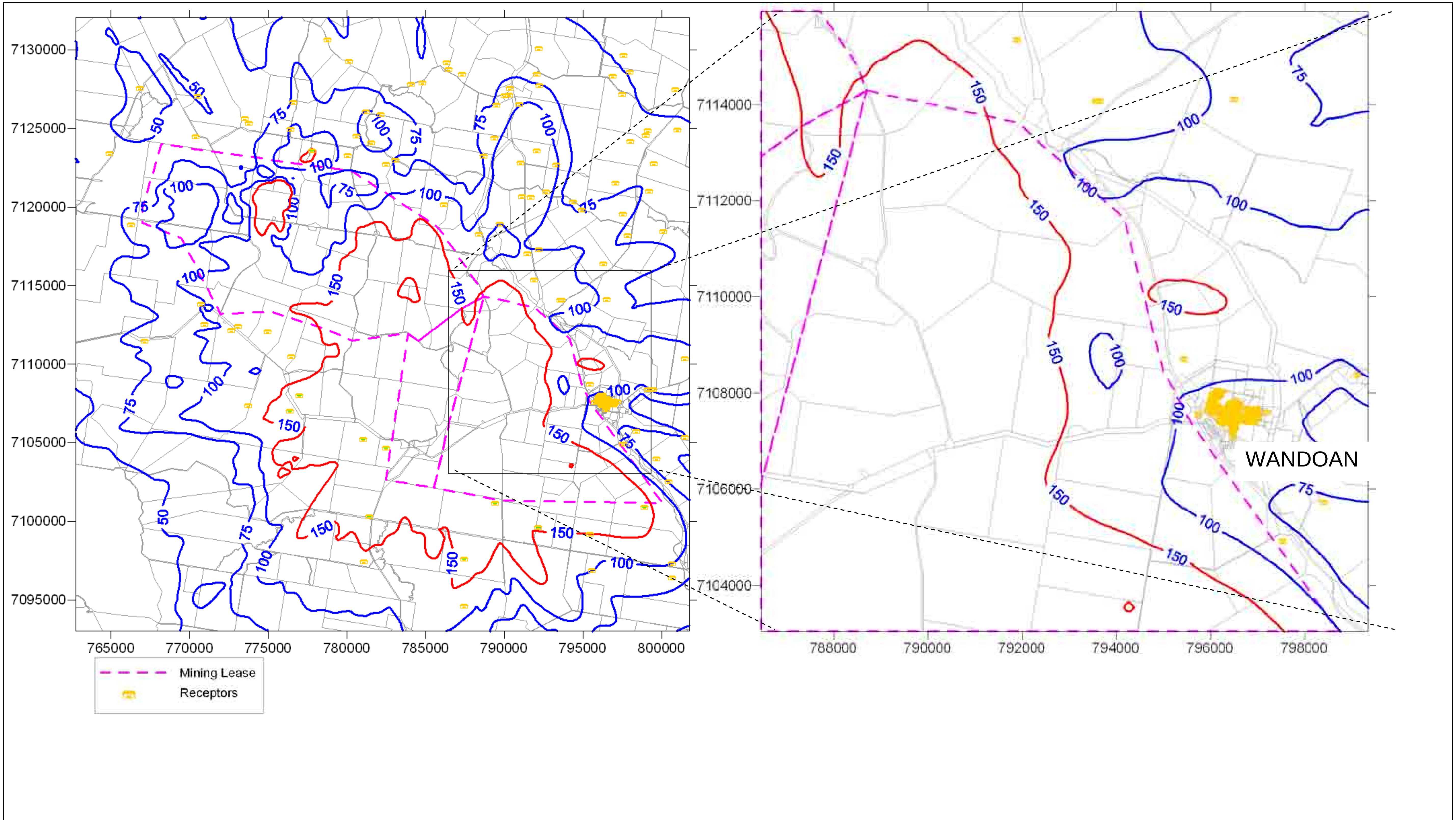


Figure 54 Year 30, PM_{10} maximum 24-hour ground level concentrations for the mine including background

Location: Wandoan	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contours	**Goal:** 150 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

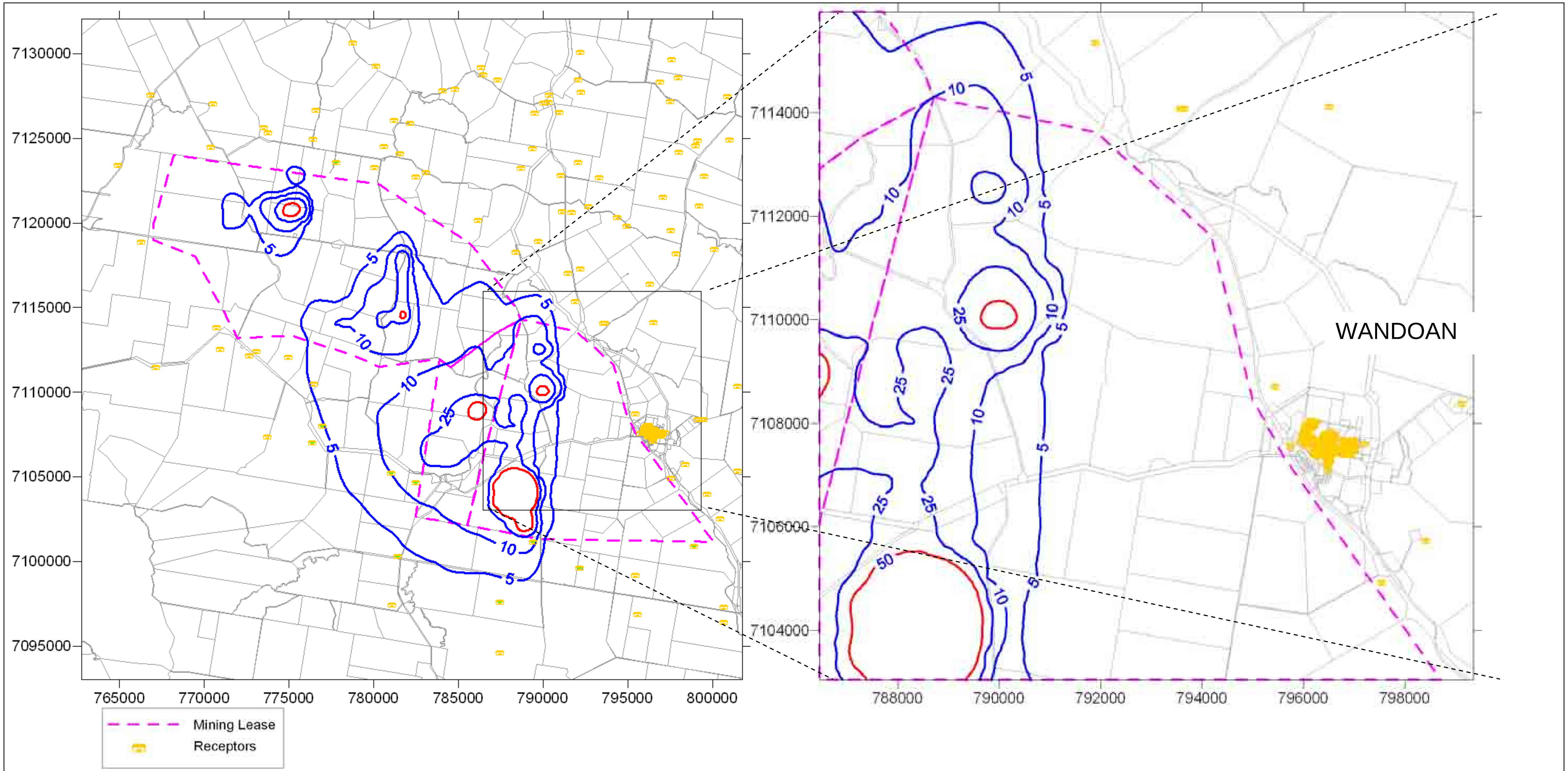


Figure 55 Year 30, PM_{10} annual average ground level concentrations for the mine without background

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 50 µg/m³	**Prepared by:** Andrew Wiebe	**Date:**15 October 2008

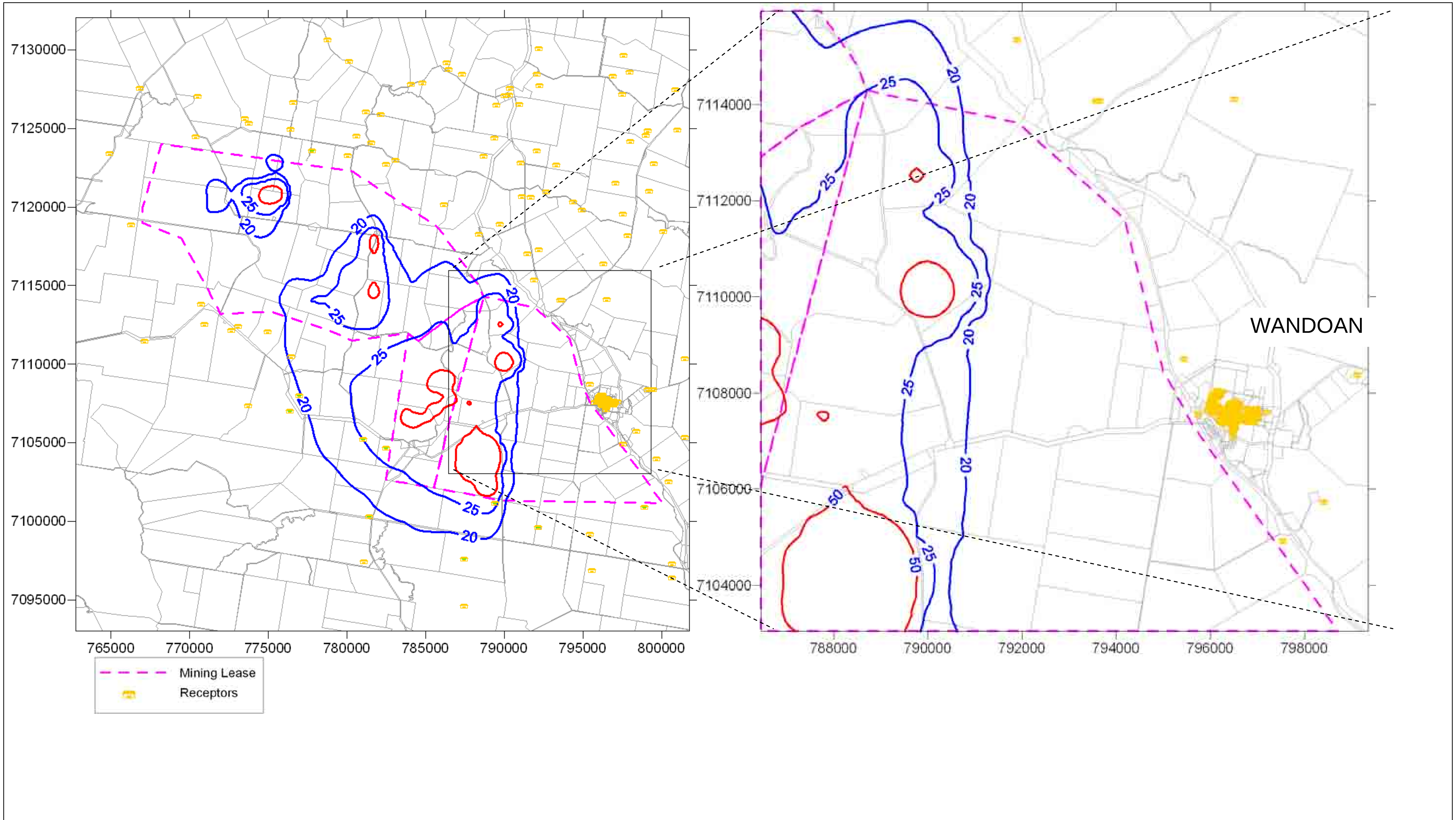


Figure 56 Year 30, PM_{10} annual average ground level concentrations for the mine including background			
Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 50 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

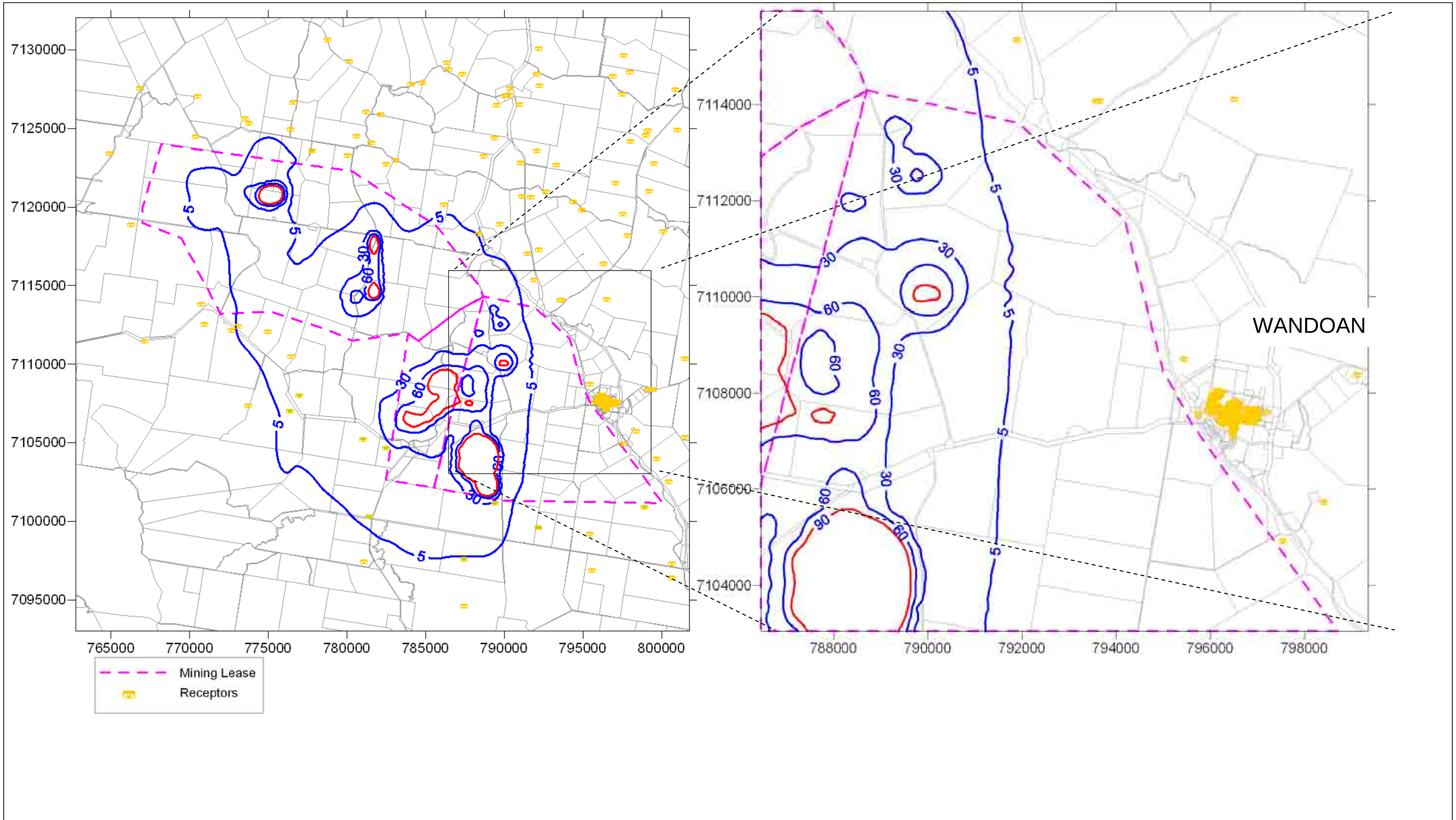


Figure 57 Year 30, TSP annual average ground level concentrations for the mine without background

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 90 µg/m³	**Prepared by:** Andrew Wiebe	**Date:**15 October 2008

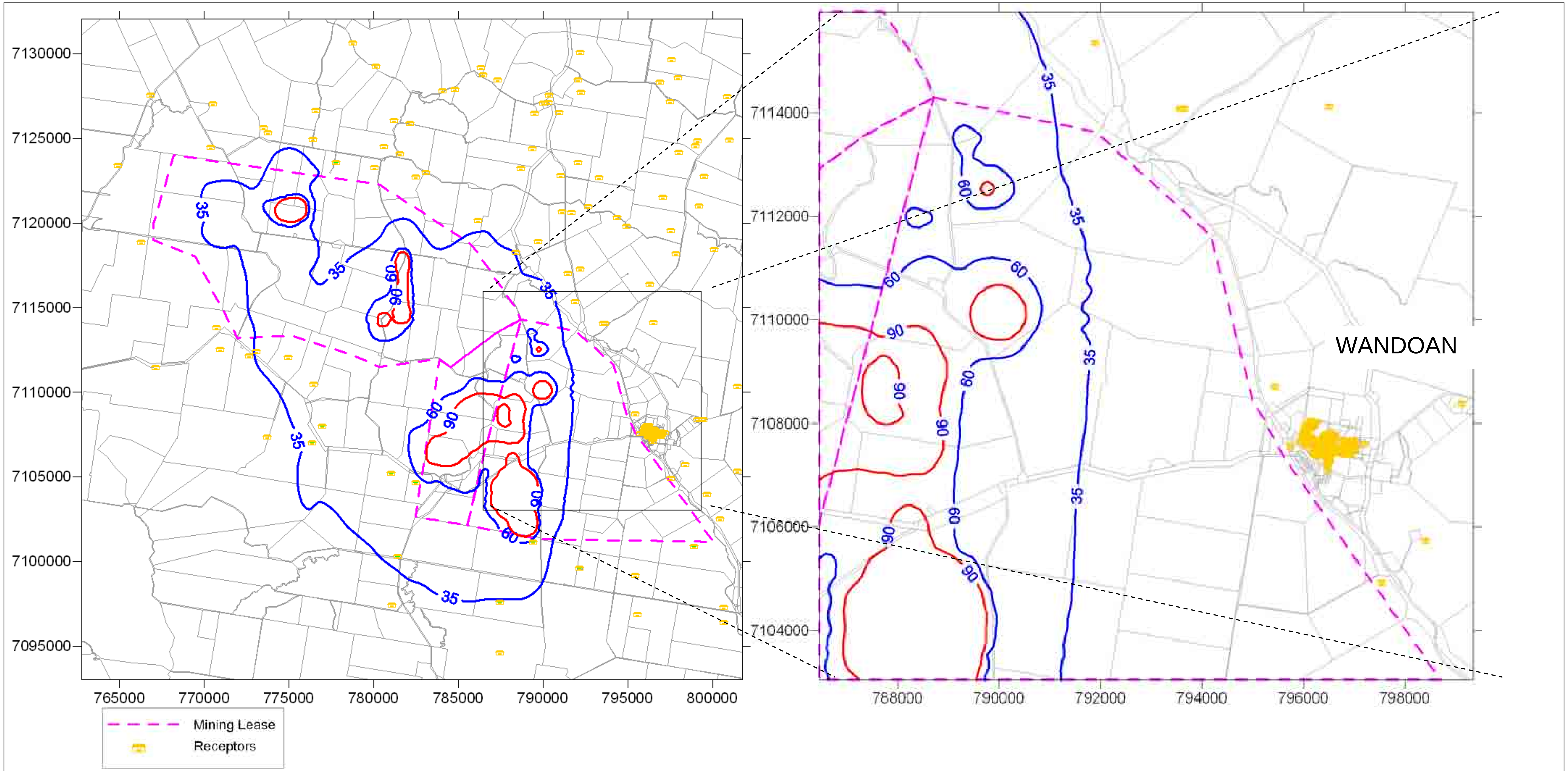


Figure 58 Year 30, TSP annual average ground level concentrations for the mine including background

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual contours	**Goal:** 90 µg/m³	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

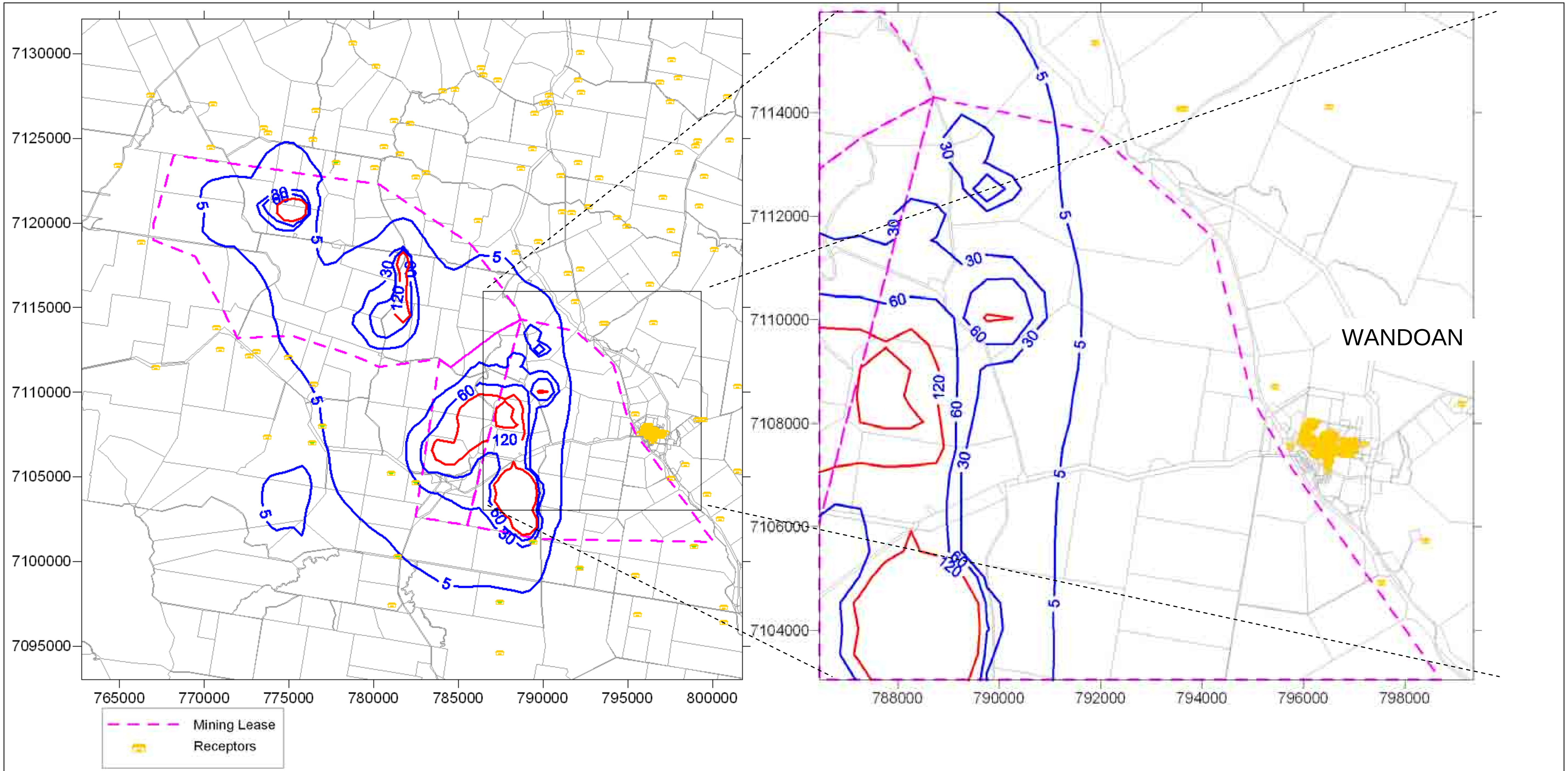


Figure 59 Year 30, dust deposition for the mine without background

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** mg/m²/day
Type: Annual contours	**Goal:** 120 mg/m²/day	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

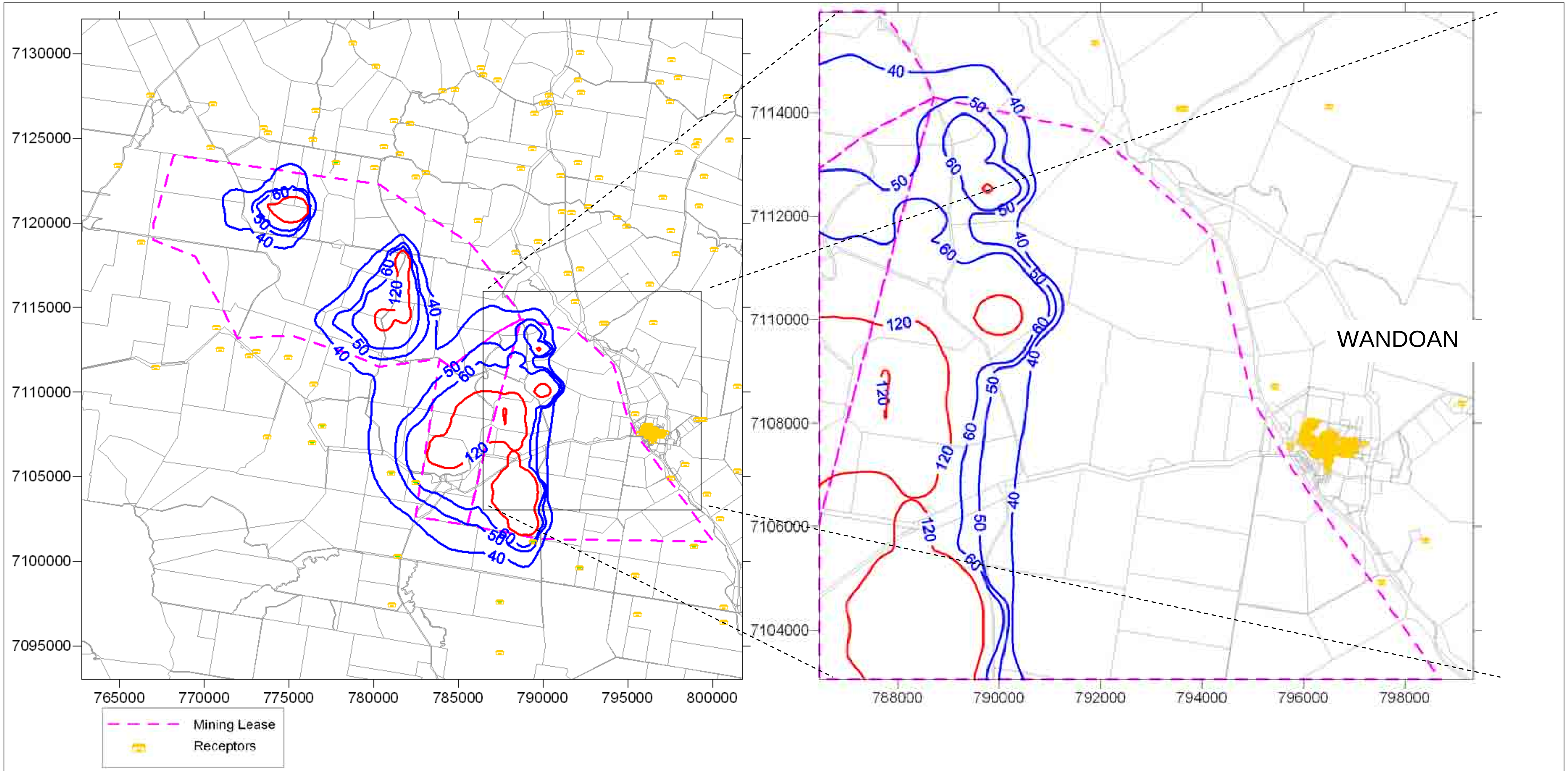


Figure 60 Year 30, dust deposition for the mine including background

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** mg/m²/day
Type: Annual contours	**Goal:** 120 mg/m²/day	**Prepared by:** Andrew Wiebe	**Date:** 15 October 2008

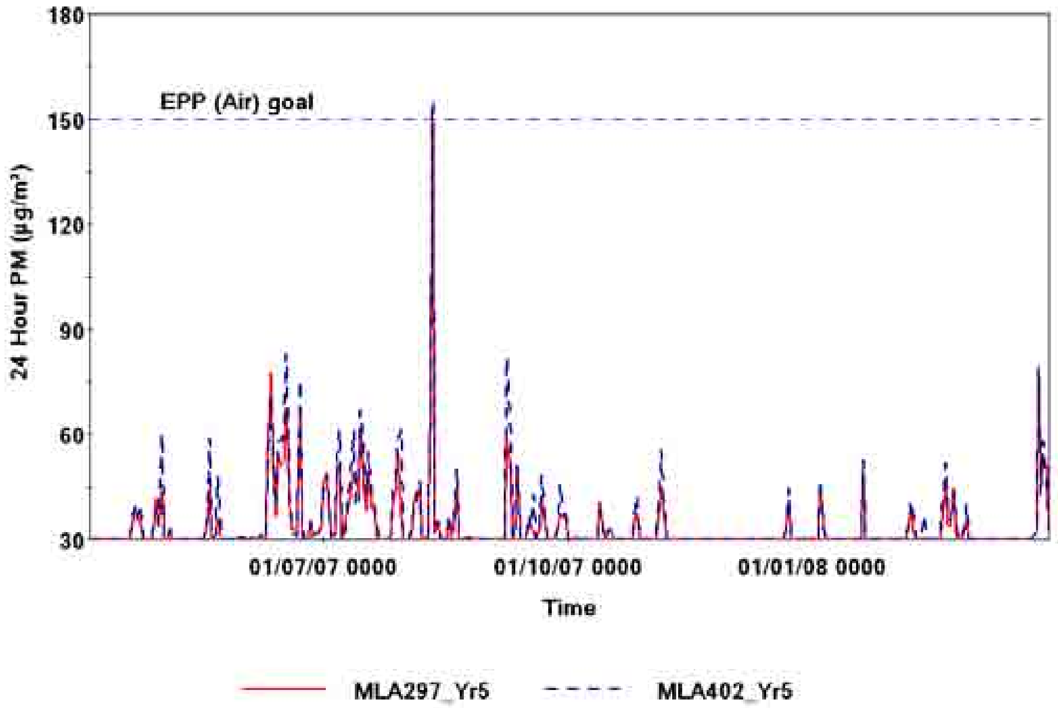


Figure 61 Year 5 Grosmont RD Receptors outside the Austinvale MLA Boundary

Location: MLA-297 MLA-402	**Period:** April 4 2007 to April 30 2008	**Data source:** CALPUFF	**Units:** µg/m^3
Type: Time series	**Averaging Period:** 24 hour	**Prepared by:** Andrew Wiebe	**Date:** 22/09/2008

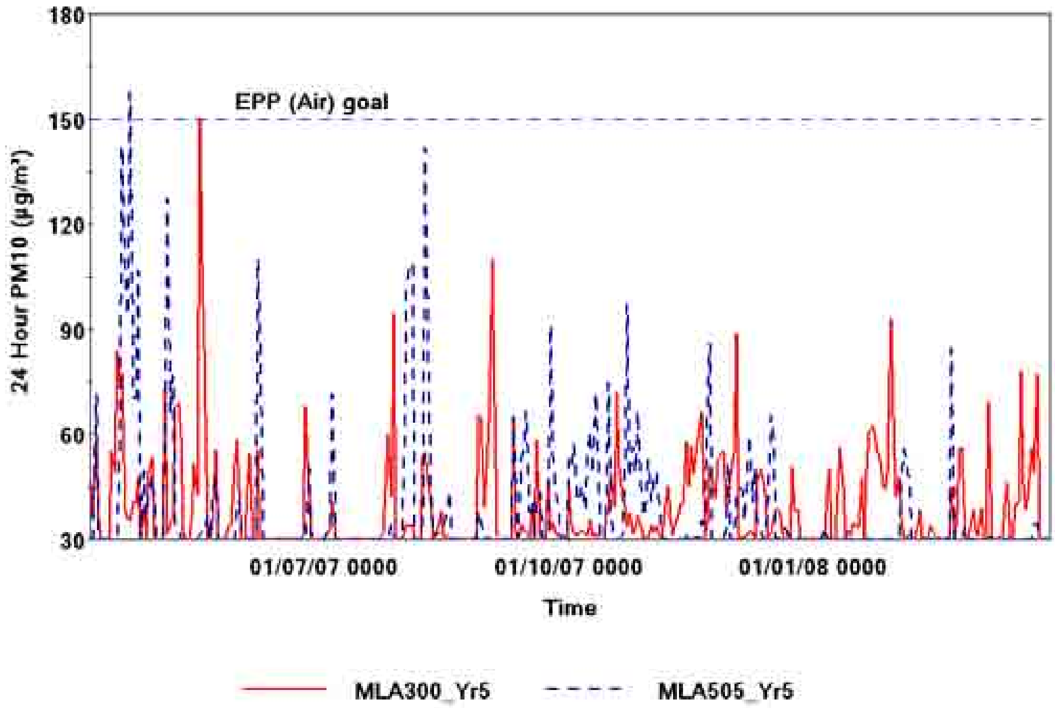


Figure 62 Year 5 receptors South of Woleebee Pit area outside the MLA boundary

Location: MLA-300 MLA-505	**Period:** April 4 2007 to April 30 2008	**Data source:** CALPUFF	**Units:** µg/m³
Type: Time series	**Averaging Period:** 24 hour	**Prepared by:** Andrew Wiebe	**Date:** 22/09/2008

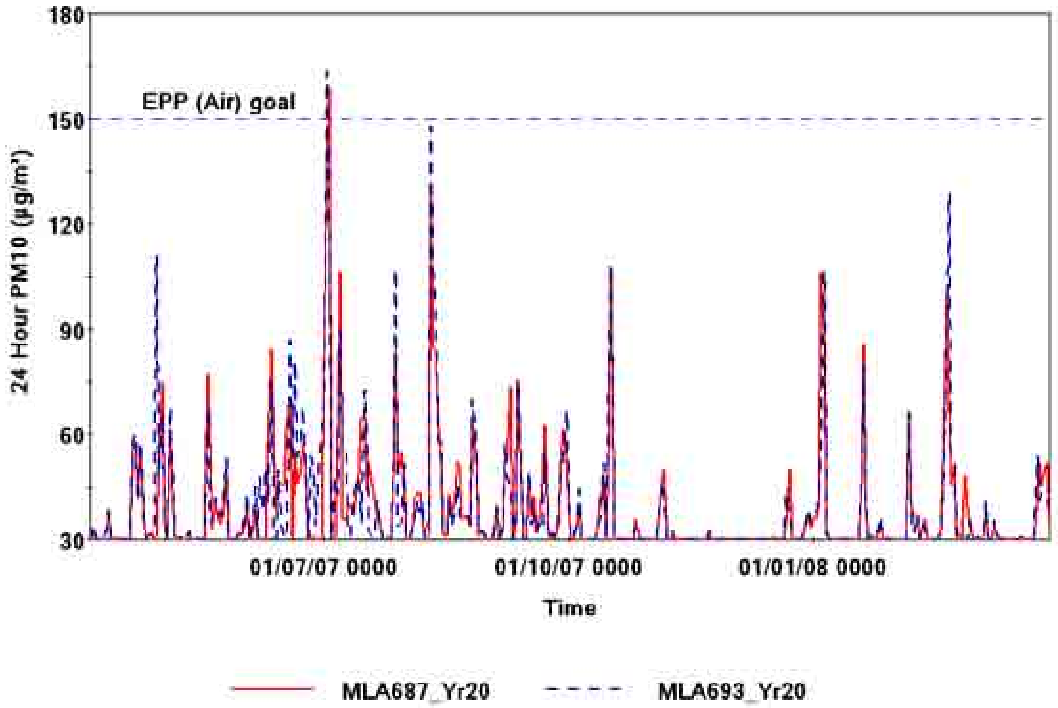


Figure 63 Year 20 north of Summer Hill ROM, receptors outside the MLA

Location: MLA-687 MLA-693	**Period:** April 4 2007 to April 30 2008	**Data source:** CALPUFF	**Units:** µg/m³
Type: Time series	**Averaging Period:** 24 hour	**Prepared by:** Andrew Wiebe	**Date:** 22/09/2008

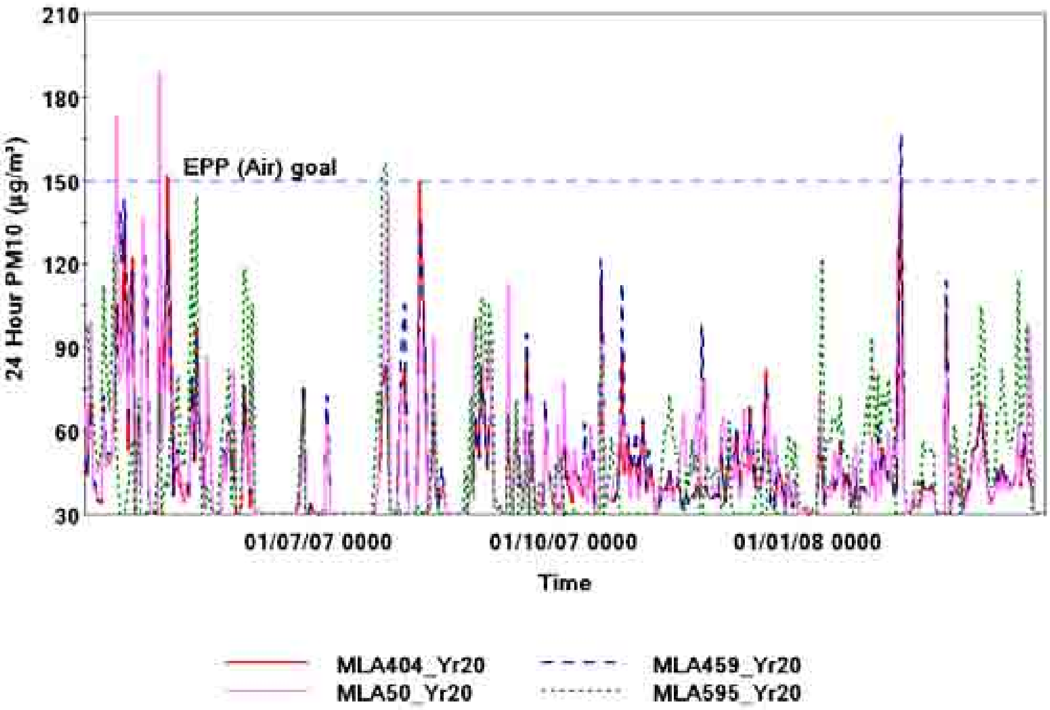


Figure 64 Year 20 South of Turkey Hill, receptors outside the MLA

Location: MLA-404 MLA-50 MLA-459 MLA-595	**Period:** April 4 2007 to April 30 2008	**Data source:** CALPUFF	**Units:** µg/m³
Type: Time series	**Averaging Period:** 24 hour	**Prepared by:** Andrew Wiebe	**Date:** 22/09/2008

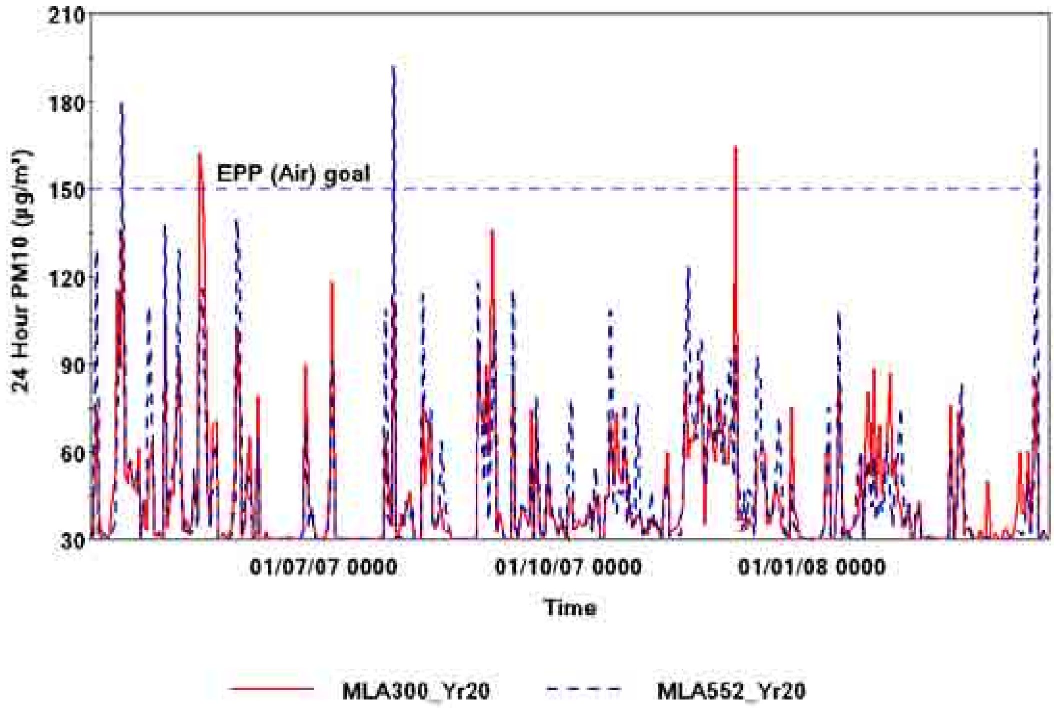


Figure 65 Year 20 west of Woleebee Creek, receptors outside the MLA boundary

Location: MLA-300 MLA-552	**Period:** April 4 2007 to April 30 2008	**Data source:** CALPUFF	**Units:** µg/m³
Type: Time series	**Averaging Period:** 24 hour	**Prepared by:** Andrew Wiebe	**Date:** 22/09/2008

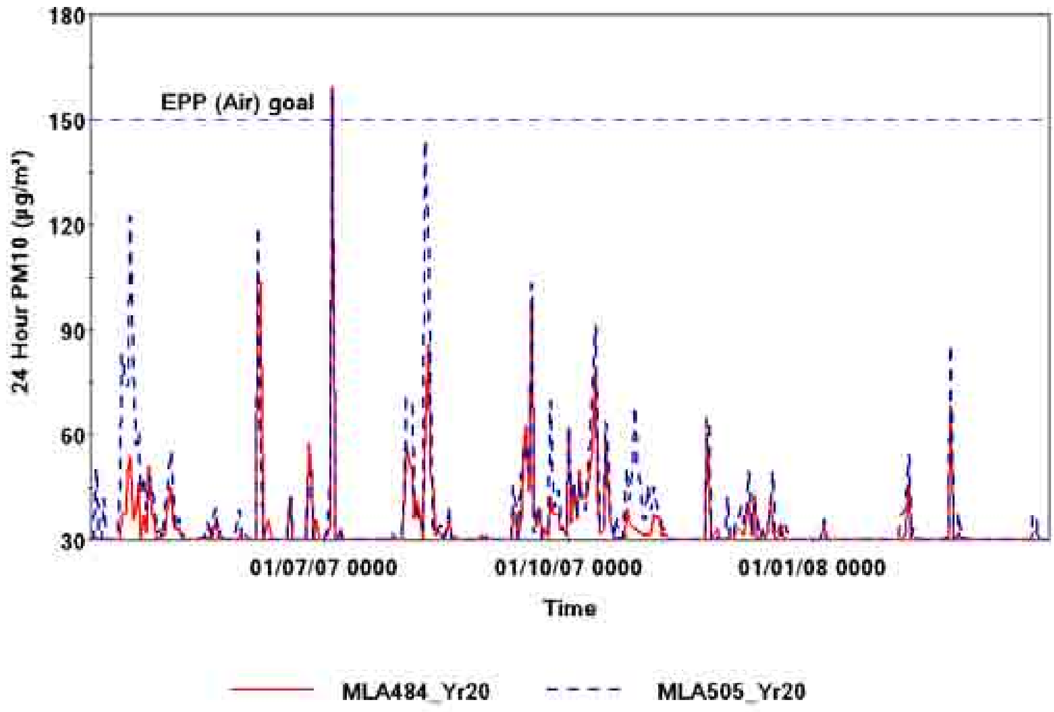


Figure 66 Year 20 south of Woleebee Creek receptors outside MLA boundary

Location: MLA-484 MLA-505	**Period:** April 4 2007 to April 30 2008	**Data source:** CALPUFF	**Units:** µg/m³
Type: Time series	**Averaging Period:** 24 hour	**Prepared by:** Andrew Wiebe	**Date:** 22/09/2008

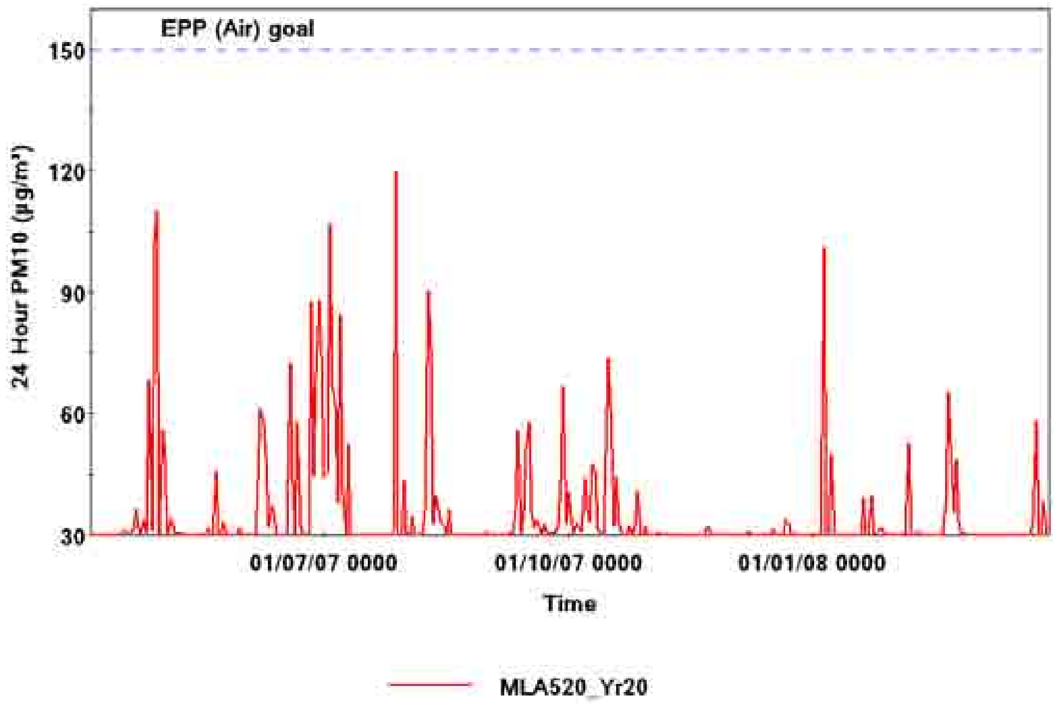


Figure 67 Year 30 North of town receptors outside MLA boundary

Location: MLA-520	**Period:** April 4 2007 to April 30 2008	**Data source:** CALPUFF	**Units:** µg/m³
Type: Time series	**Averaging Period:** 24 hour	**Prepared by:** Andrew Wiebe	**Date:** 22/09/2008

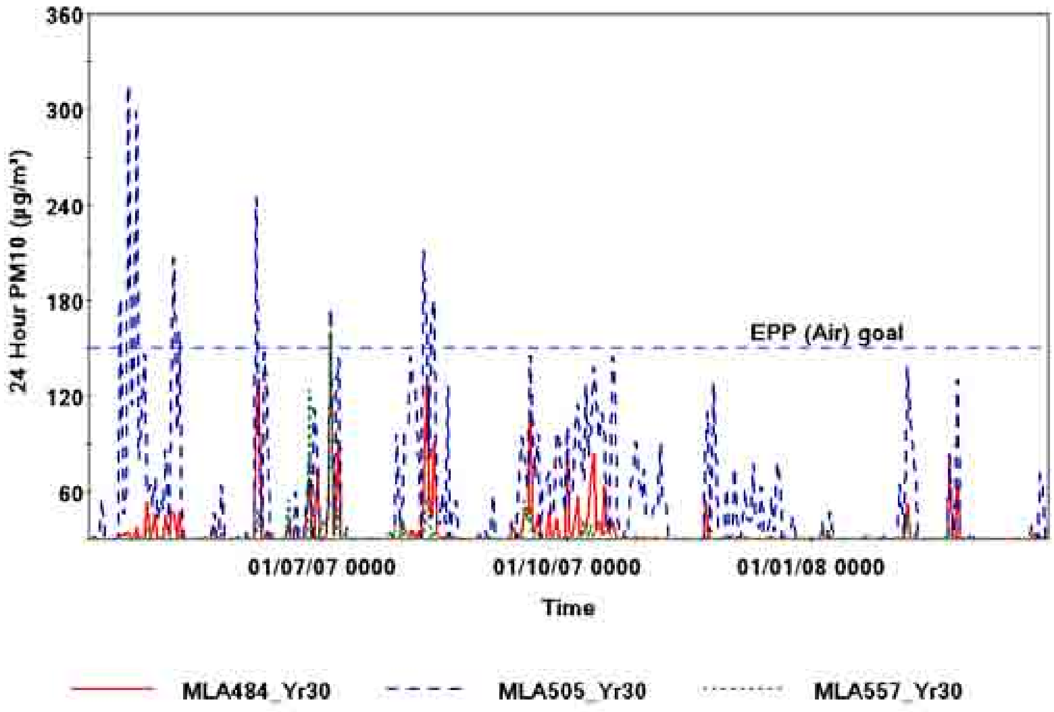


Figure 68 Year 30 south of Woleebee Creek Receptors outside the MLA boundary

Location: MLA-484 MLA-505 MLA-557	**Period:** April 4 2007 to April 30 2008	**Data source:** CALPUFF	**Units:** µg/m³
Type: Time series	**Averaging Period:** 24 hour	**Prepared by:** Andrew Wiebe	**Date:** 22/09/2008

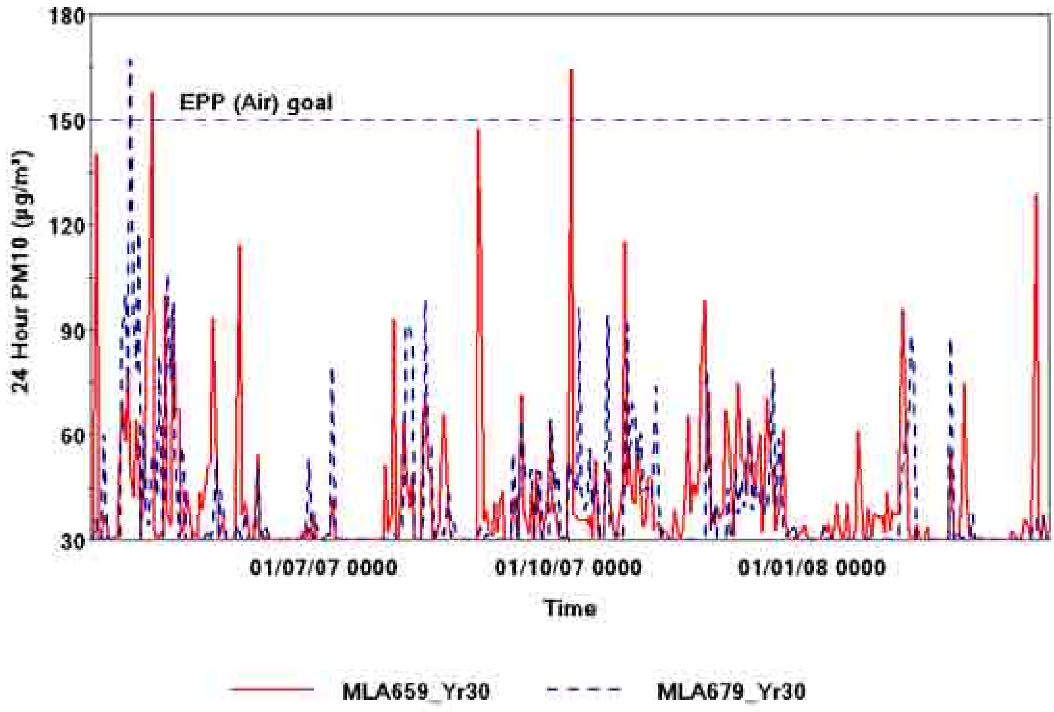


Figure 69 Year 30 south west of Woleebee Creek Receptors outside the MLA boundary

Location: MLA-659 MLA-679	**Period:** April 4 2007 to April 30 2008	**Data source:** CALPUFF	**Units:** µg/m³
Type: Time series	**Averaging Period:** 24 hour	**Prepared by:** Andrew Wiebe	**Date:** 22/09/2008

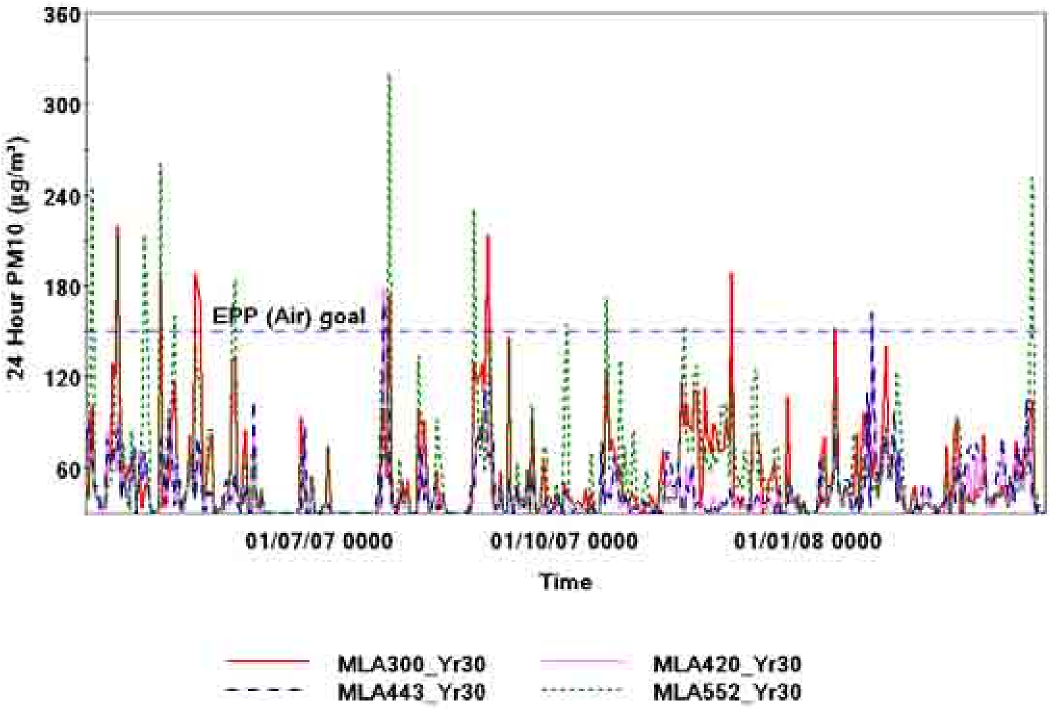


Figure 70 Year 30 west of Woleebee Creek Receptors outside the MLA boundary

Location:	**Period:**	**Data source:**	**Units:**
MLA-300 MLA-420 MLA-443 MLA-552	April 4 2007 to April 30 2008	CALPUFF	µg/m³
Type: Time series	**Averaging Period:** 24 hour	**Prepared by:** Andrew Wiebe	**Date:** 22/09/2008

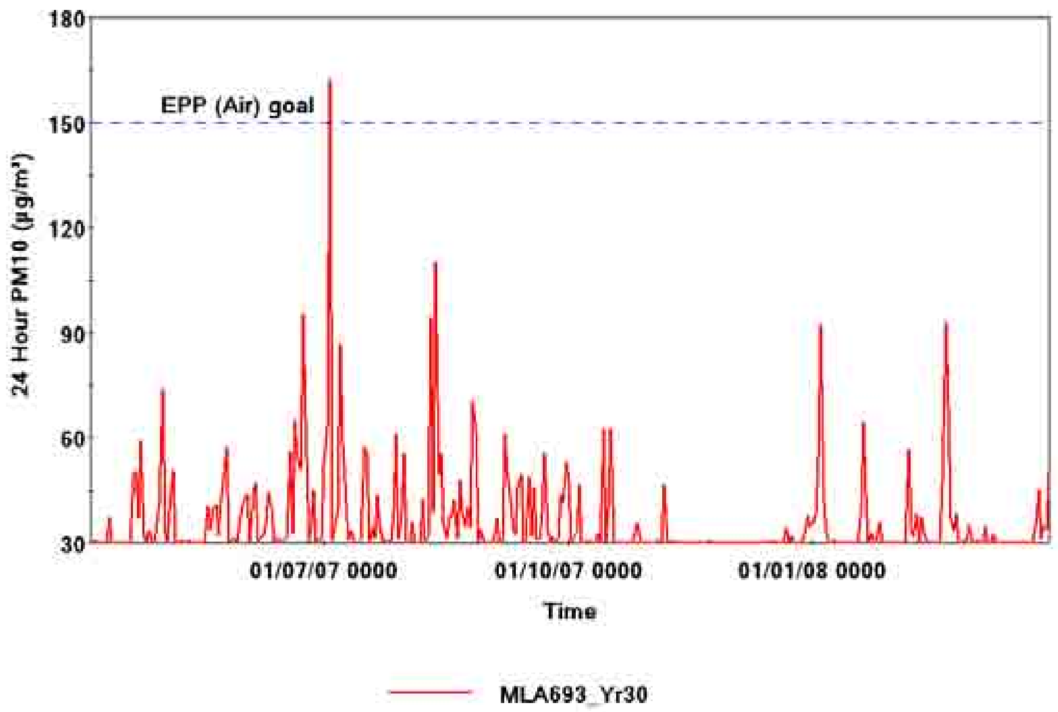


Figure 71 Year 30 north of Summerhill ROM Receptor outside the MLA boundary

Location: MLA-693	**Period:** April 4 2007 to April 30 2008	**Data source:** CALPUFF	**Units:** µg/m³
Type: Time series	**Averaging Period:** 24 hour	**Prepared by:** Andrew Wiebe	**Date:** 22/09/2008

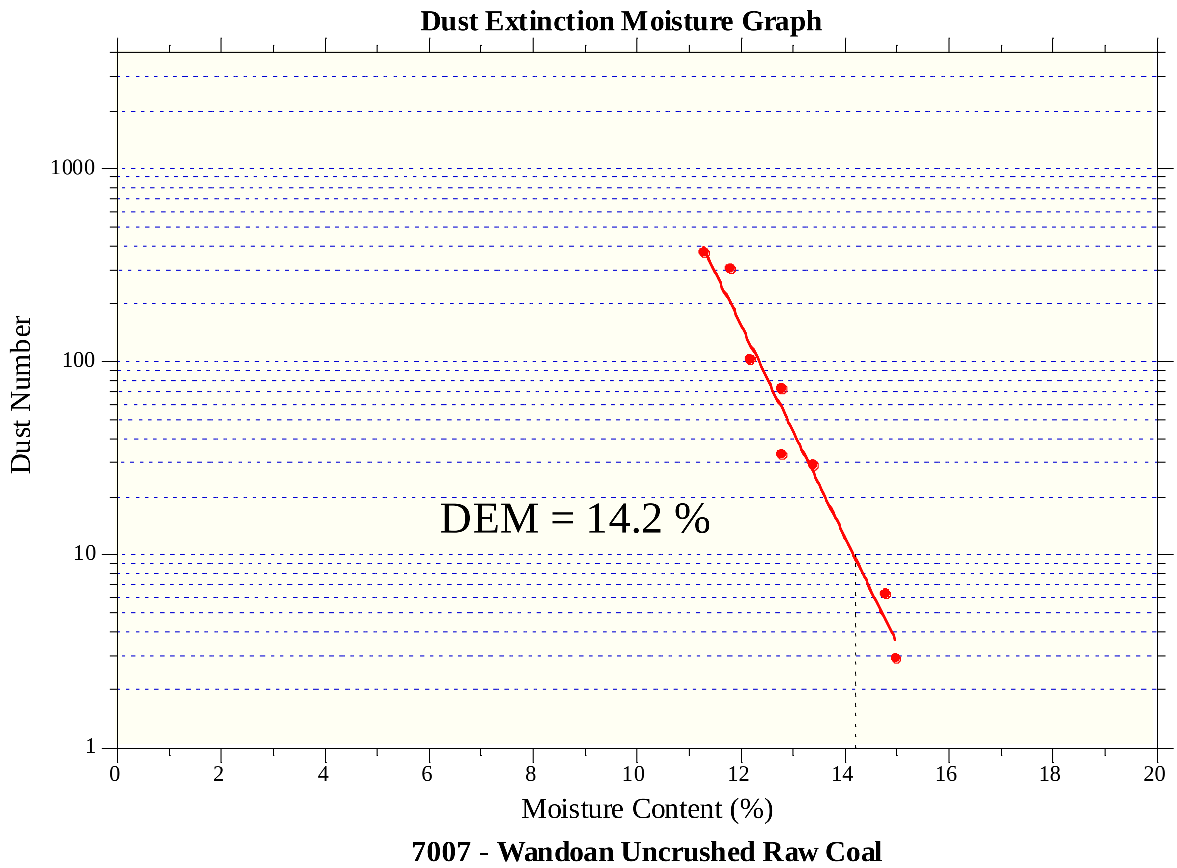


Figure 72 Dustiness/moisture relationship and DEM for Wandoan uncrushed raw coal

Location: n/a	**Period:** n/a	**Data Source:** Introspec Consulting	**Units:** percent
Type: X-Y scatter plot	**Averaging Period:** n/a	**Prepared by:** Andrew Wiebe	**Date:** 22/09/2008

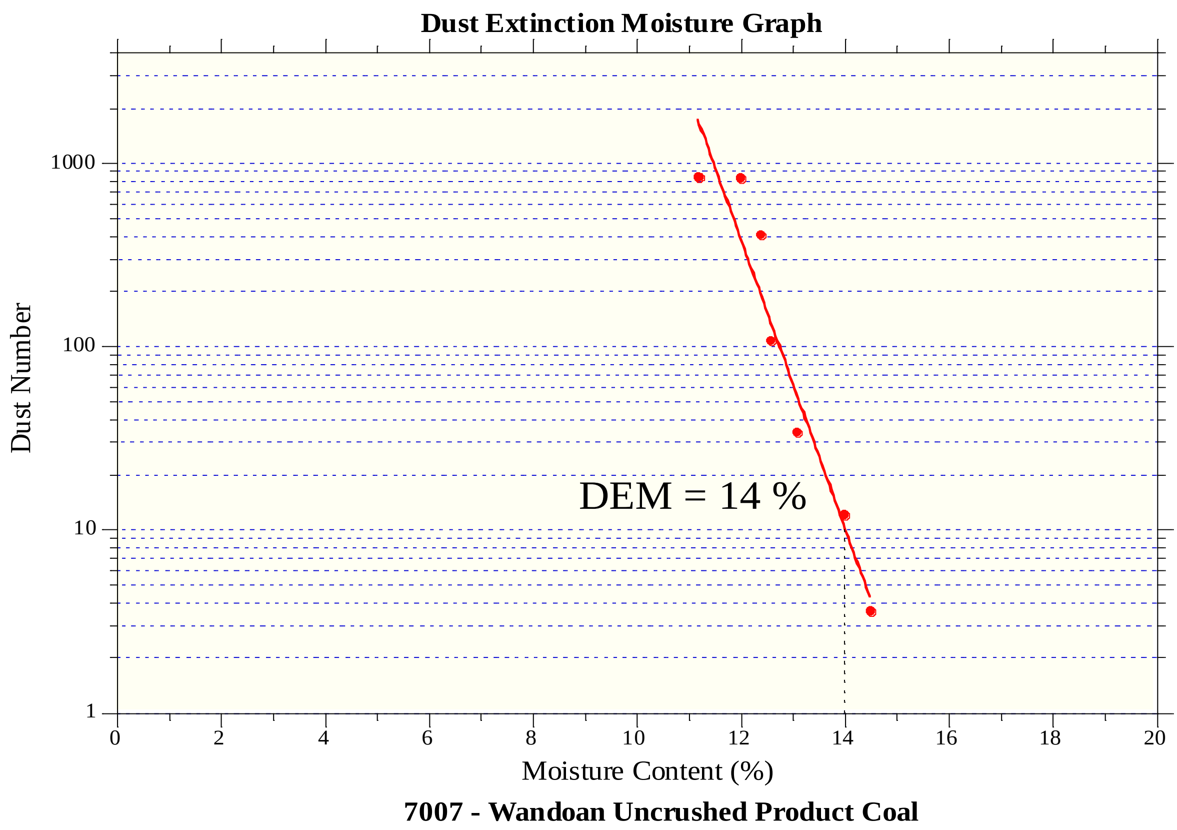


Figure 73 Dustiness/moisture relationship and DEM for Wandoan uncrushed product coal

Location: n/a	**Period:** n/a	**Data Source:** Introspec Consulting	**Units:** percent
Type: X-Y scatter plot	**Averaging Period:** n/a	**Prepared by:** Andrew Wiebe	**Date:** 22/09/2008

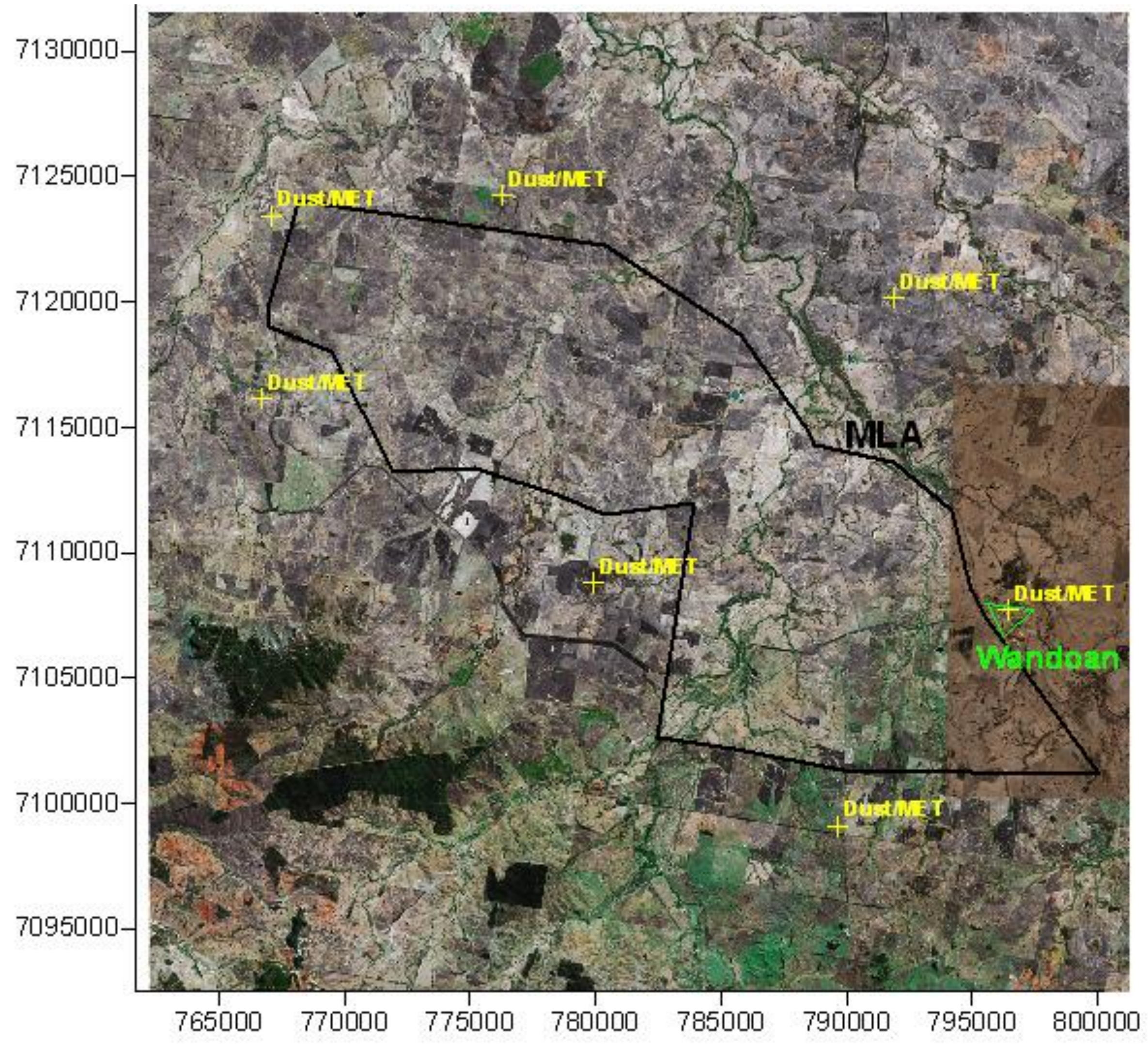


Figure 74 Recommended locations for continuous dust and meteorological monitoring

Location: Wandoan	**Period:** n/a	**Data Source:** Google Earth	**Units:** n/a
Type: Satellite image	**Averaging Period:** n/a	**Prepared by:** Andrew Wiebe	**Date:** 22/09/2008

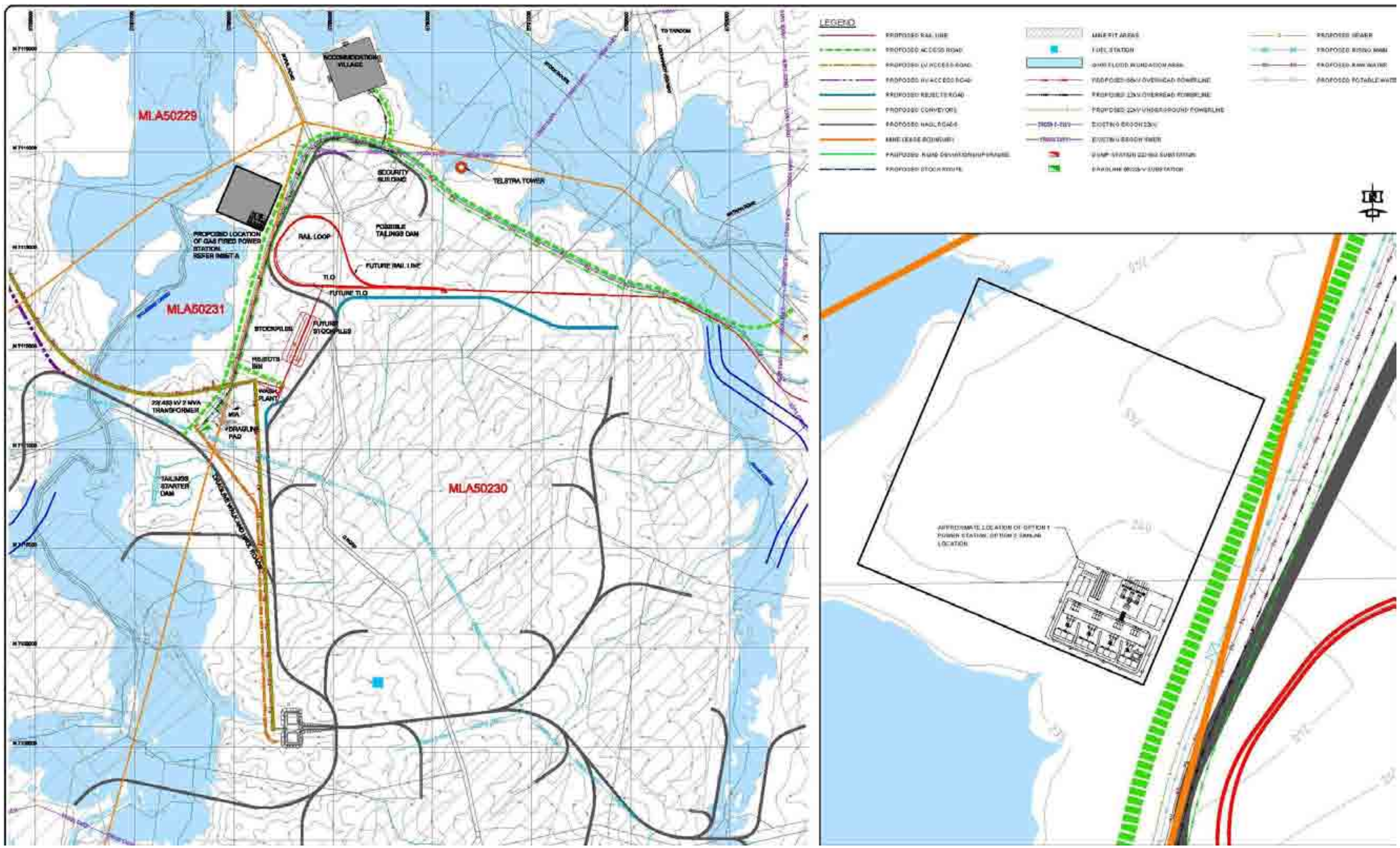
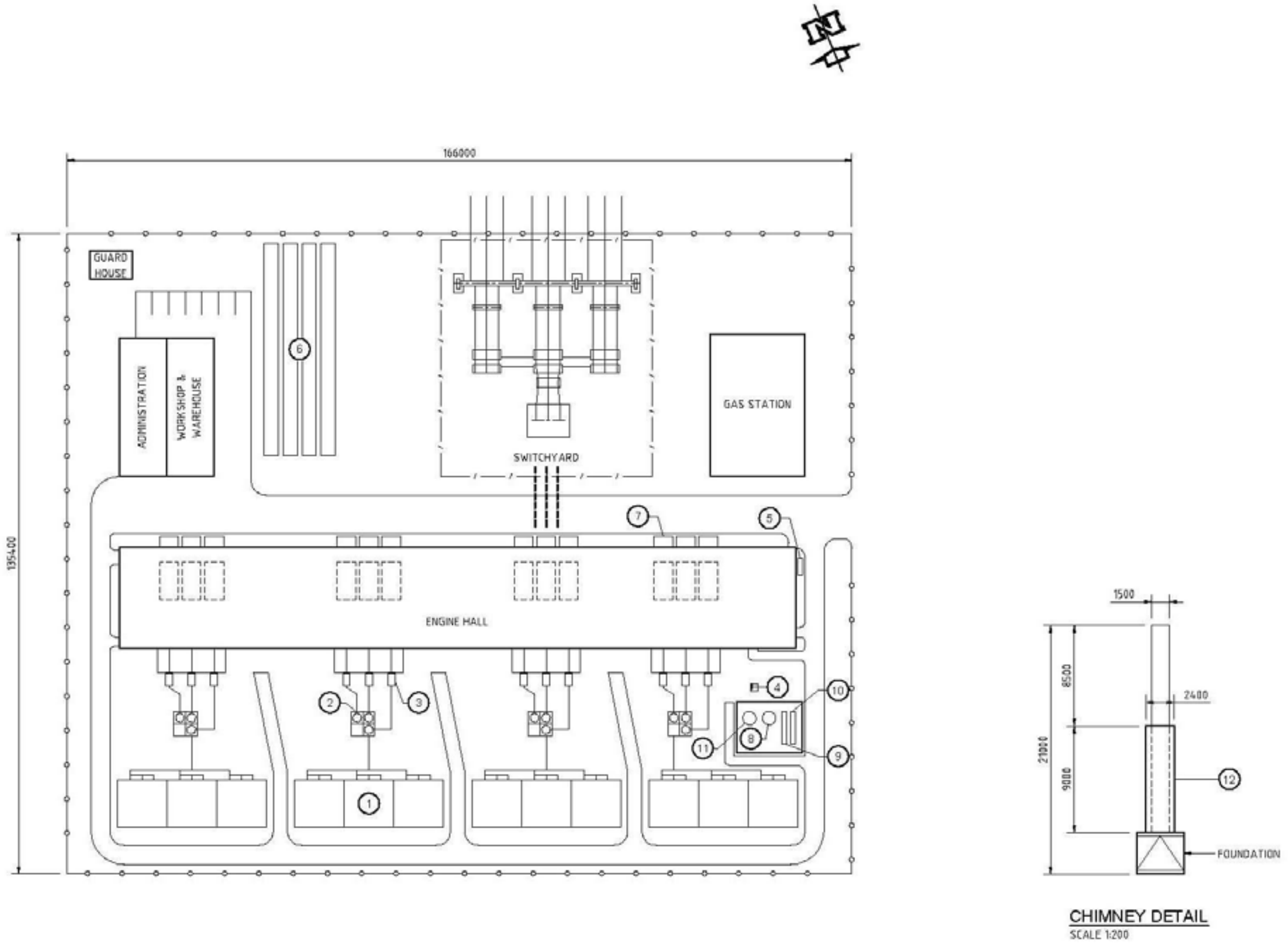


Figure 75 Indicative location of power station	
Location: Wandoan Coal Project	**Data source:** Parsons Brinckerhoff
Prepared by: Natalie Shaw	**Date:** 01/09/2008



SCHEDULE

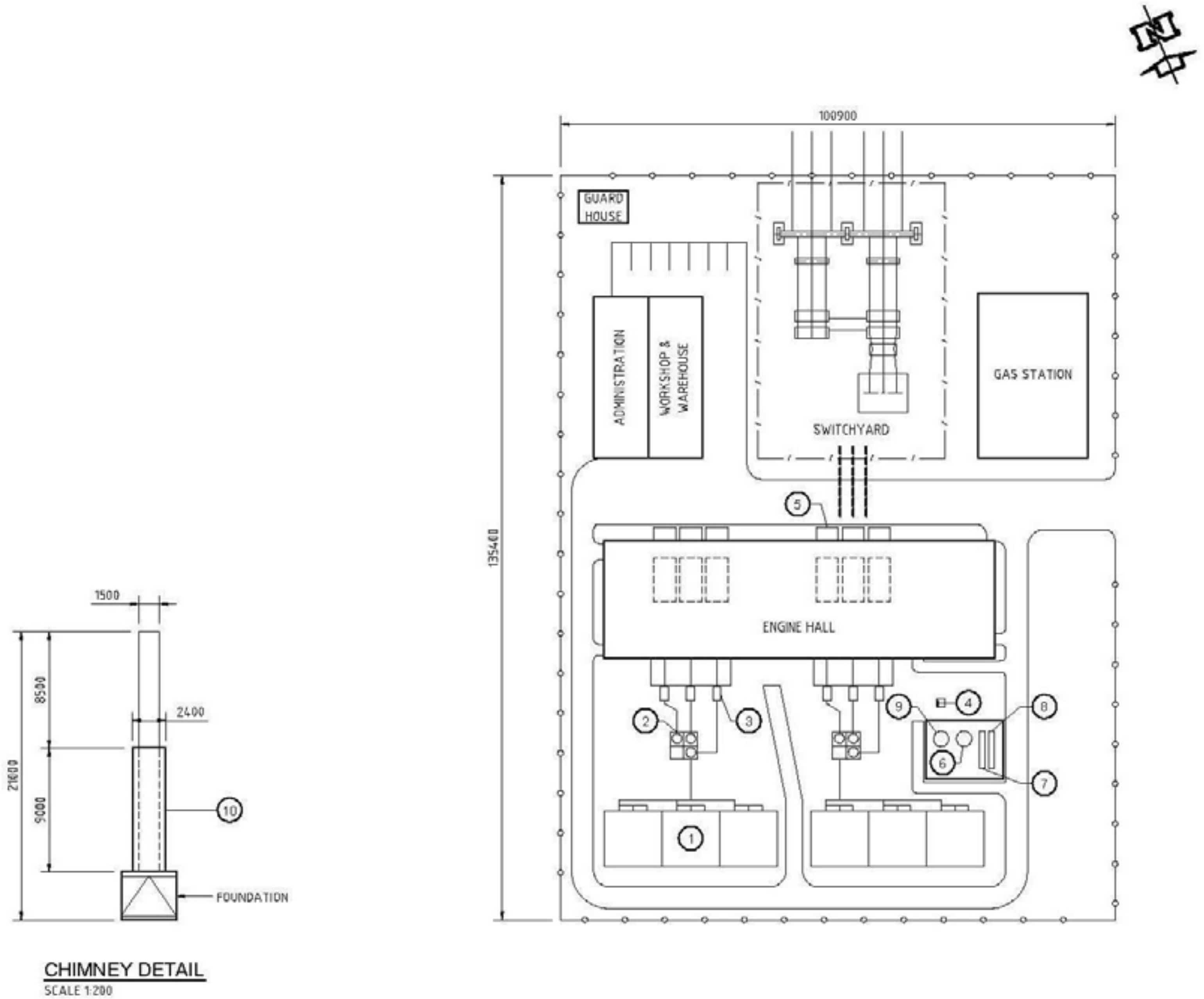
ITEM No	DESCRIPTION
1	RADIATOR
2	EXHAUST GAS CHIMNEY
3	SCR/OXI-CAT (OPTIONAL)
4	OILY WATER COLLECTING PIT
5	BLACK START UNIT
6	FLYWHEELS
7	TRANSFORMERS
8	CLEAN LO TANK $70m^3$/18492gal
9	USED LO TANK $25m^3$/6604gal
10	LUBE OIL SERVICE TANK $25m^3$/6604gal
11	SCR REGENT TANK $70m^3$/18492gal
12	ACOUSTIC INSULATION

NOTES:

1. SCR/OXI-CAT IS SELECTIVE CALALYTIC REDUCTION OXIDATION CATALYST IS A SYSTEM TO REDUCE NOX TO MEET NOX EMISSION LIMIT.
2. BLACK START UNIT IS REQUIRED FOR STARTING THE STATION FROM TOTAL BLACK OUT. NOT REQUIRED WHERE GRID POWER IS AVAILABLE.

Figure 76 Layout of Option 1 (nominal 80 MW) power station

Location: Wandoan Coal Project	**Data source:** Parsons Brinckerhoff
Prepared by: Natalie Shaw	**Date:** 01/09/2008



SCHEDULE

ITEM No	DESCRIPTION
1	RADIATOR
2	EXHAUST GAS CHIMNEY
3	SCR/OXI-CAT (OPTIONAL)
4	OILY WATER COLLECTING PIT
5	TRANSFORMERS
6	CLEAN LO TANK 35m^3/9246gal
7	USED LO TANK 13m^3/3434gal
8	LUBE OIL SERVICE TANK 13m^3/3434gal
9	SCR REGENT TANK 35m^3/9246gal
10	ACOUSTIC INSULATION

NOTES:

1. SCR/OXI-CAT IS SELECTIVE CALALYTIC REDUCTION OXIDATION CATALYST IS A SYSTEM TO REDUCE NOX TO MEET NOX EMISSION LIMIT.

Figure 77 Layout of Option 2 (nominal 30 MW) power station

Location: Wandoan Coal Project	**Data source:** Parsons Brinckerhoff
Prepared by: Natalie Shaw	**Date:** 01/09/2008

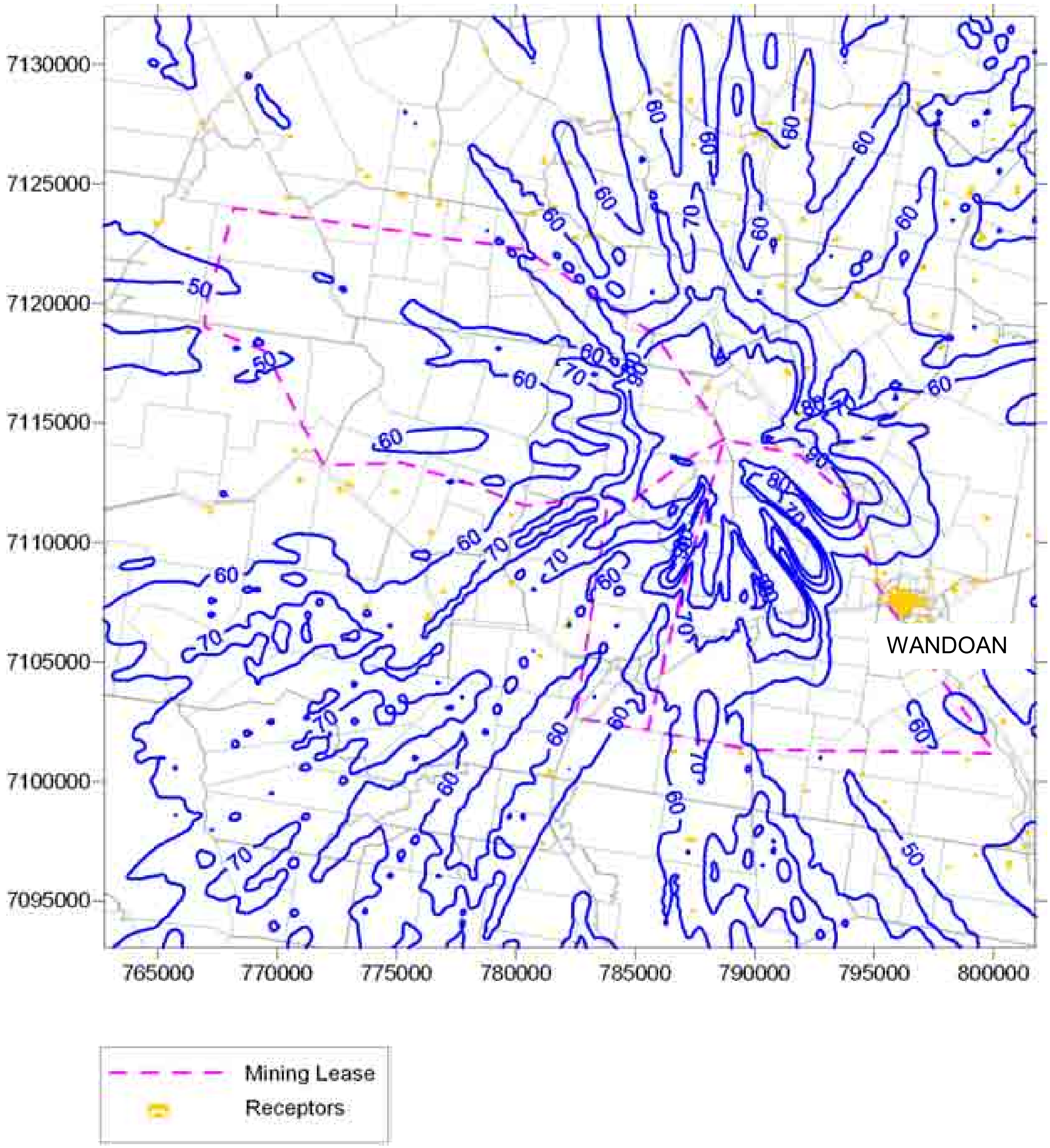


Figure 78	**Option 1 Power Station – Predicted 1-hour average ground-level concentrations of nitrogen dioxide (background included)**		
Location: Wandoan	**Averaging period:** 1-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contours	**Goal:** 320µg/m³	**Prepared by:** Natalie Shaw	**Date:** 28/08/08

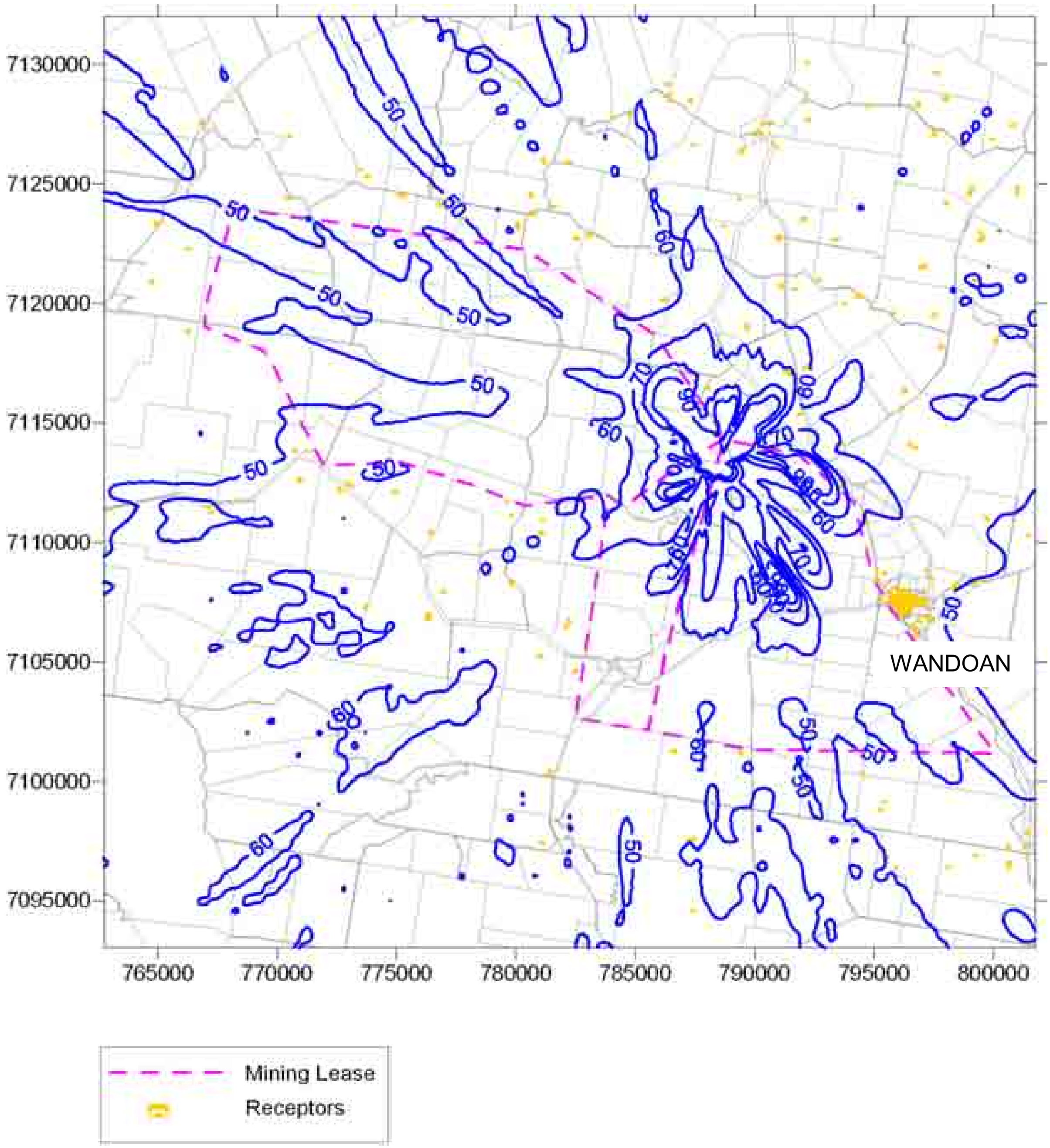


Figure 79 Option 2 Power Station – Predicted 1-hour average ground-level concentrations of nitrogen dioxide (background included)

Location: Wandoan	**Averaging period:** 1-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contours	**Goal:** 320µg/m³	**Prepared by:** Natalie Shaw	**Date:** 28/08/08

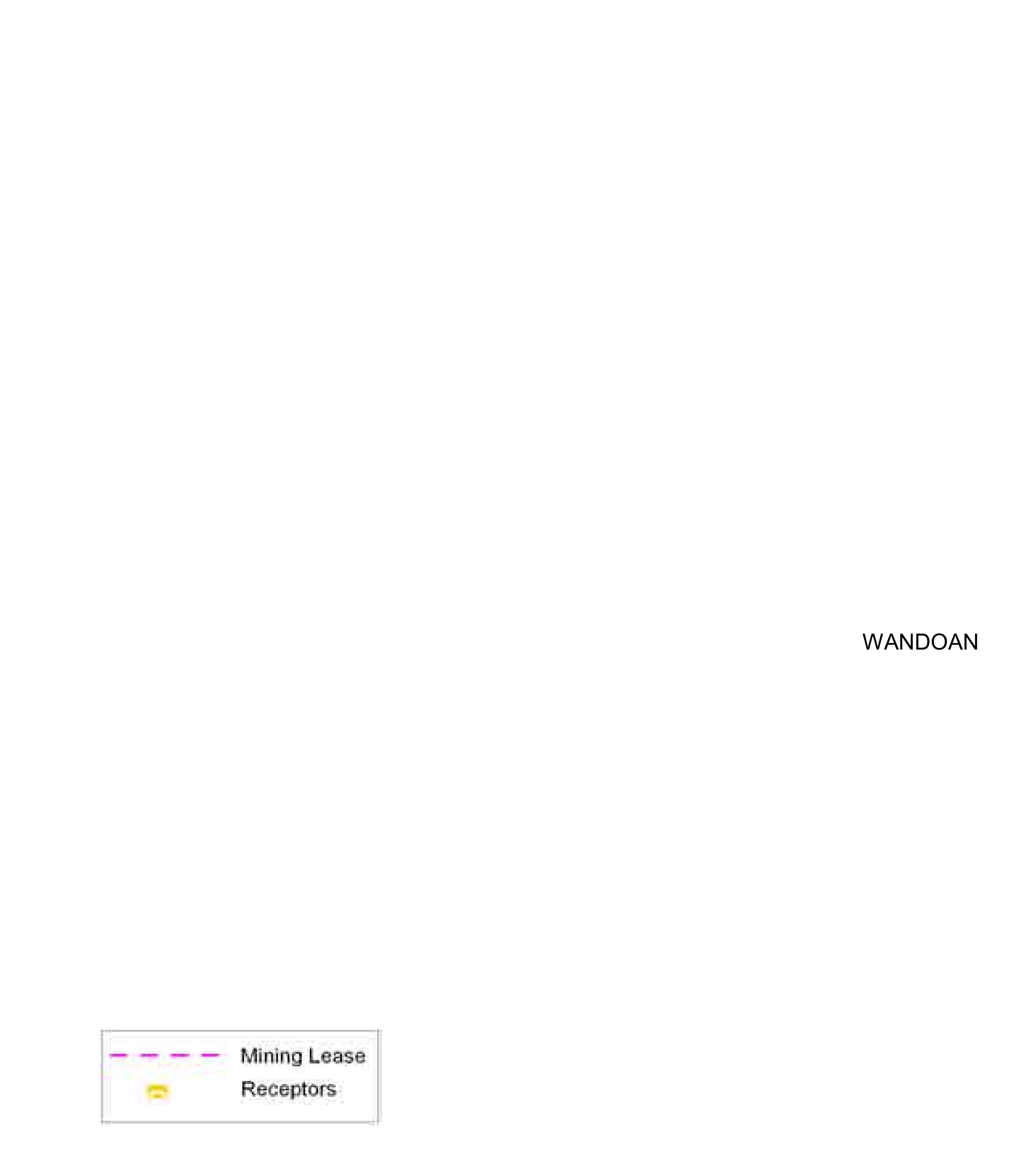


Figure 80 Option 1 (80 MW) Power Station – Predicted annual average ground-level concentrations of nitrogen dioxide (background included)

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** $\mu g/m^3$
Type: Maximum contours	**Goal:** 30 $\mu g/m^3$	**Prepared by:** Natalie Shaw	**Date:** 28/08/08

WANDOAN

Figure 81 Option 2(30 MW) Power Station – Predicted annual average ground-level concentrations of nitrogen dioxide (background included)

Location: Wandoan	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** μg/m^3
Type: Maximum contours	**Goal:** 30 μg/m^3	**Prepared by:** Natalie Shaw	**Date:** 28/08/08

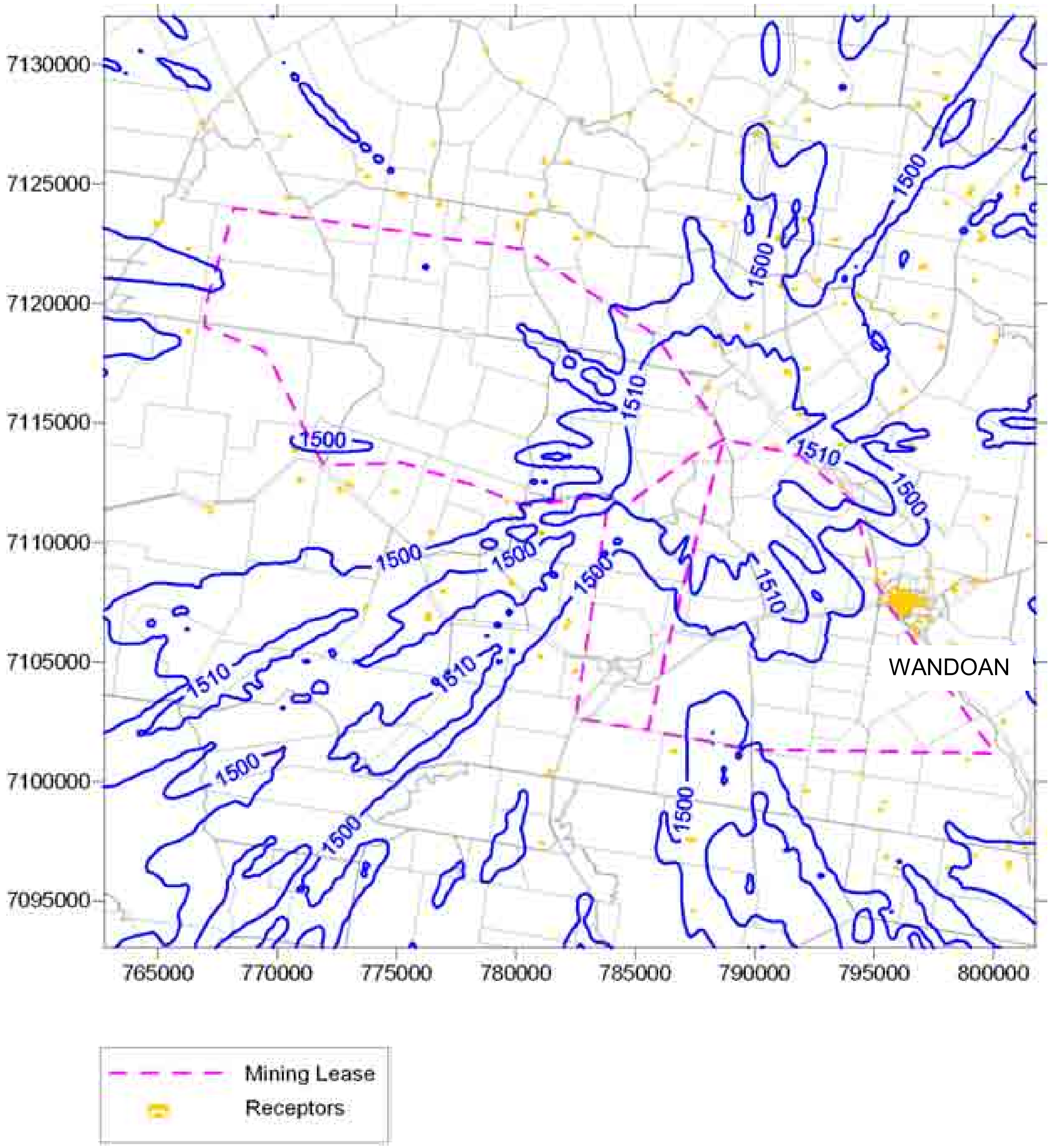


Figure 82 Option 1 (nominal 80MW) Power Station – Predicted 8-hour average ground-level concentrations of carbon monoxide (background included)

Location: Wandoan	**Averaging period:** 8-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contours	**Goal:** 10,000 µg/m³	**Prepared by:** Natalie Shaw	**Date:** 28/08/08

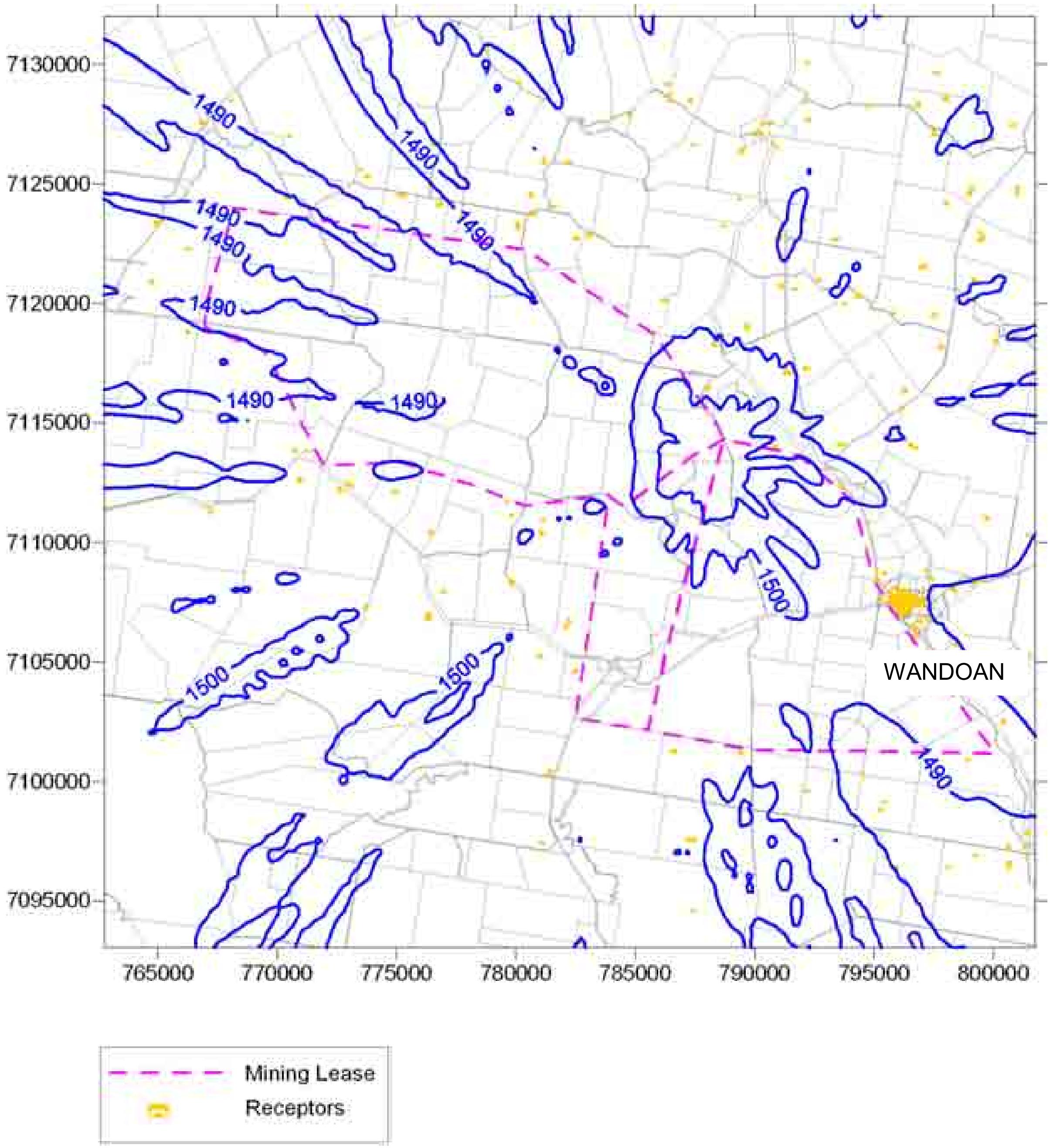


Figure 83 Option 2 (nominal 30MW) Power Station – Predicted 8-hour average ground-level concentrations of carbon monoxide (background included)

Location: Wandoan	**Averaging period:** 8-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contours	**Goal:** 10,000 µg/m³	**Prepared by:** Natalie Shaw	**Date:** 28/08/08

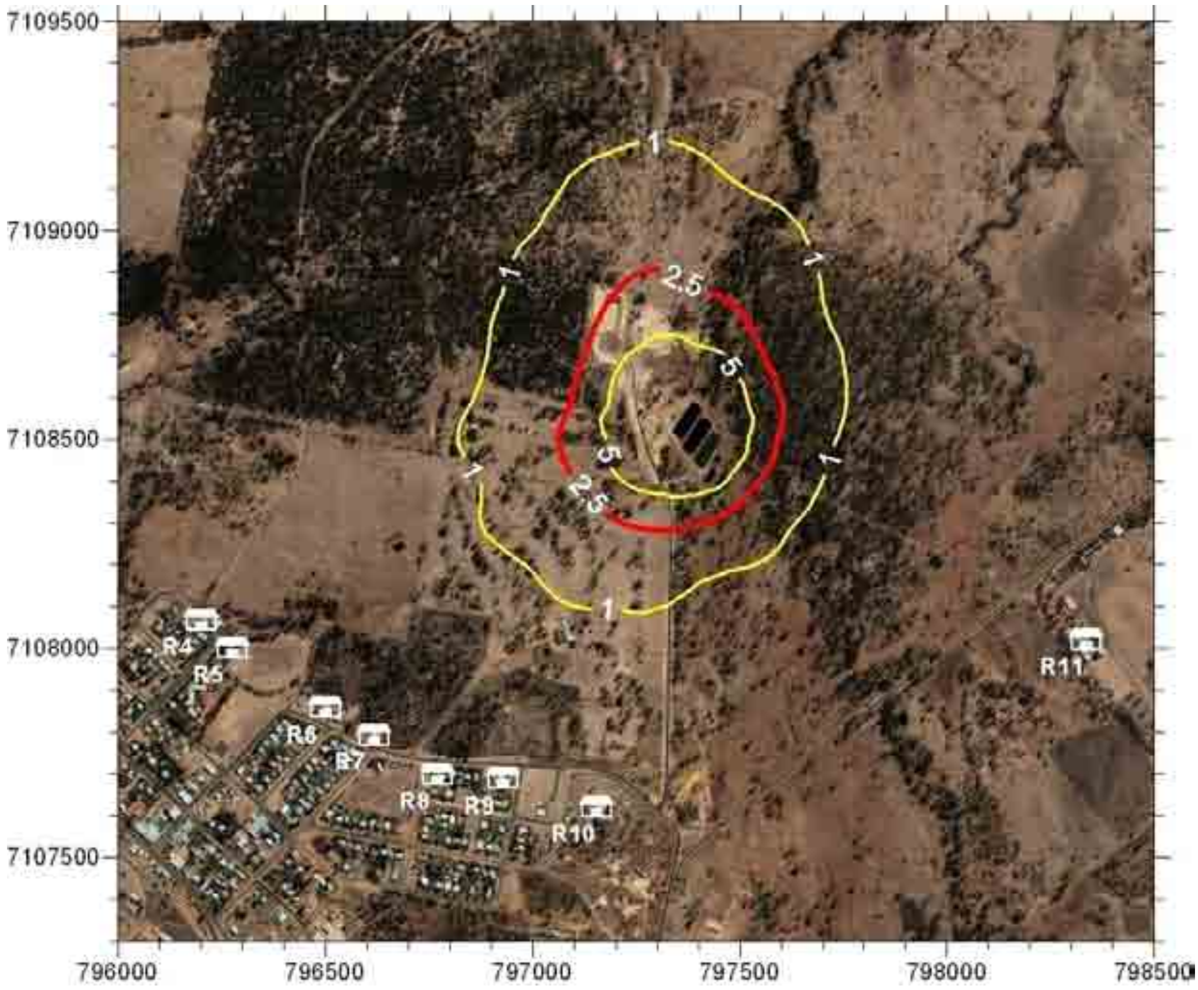


Figure 84 Predicted baseline odour impact from the current Wandoan WWTP based on August 2008 odour survey data

Location: Wandoan WWTP	**Averaging period:** 1-hour	**Data source:** Ausplume	**Units:** Odour units
Type: 99.5th percentile contours	**Guideline:** 2.5 odour units	**Prepared by:** Andrew Balch	**Date:** 28/08/08

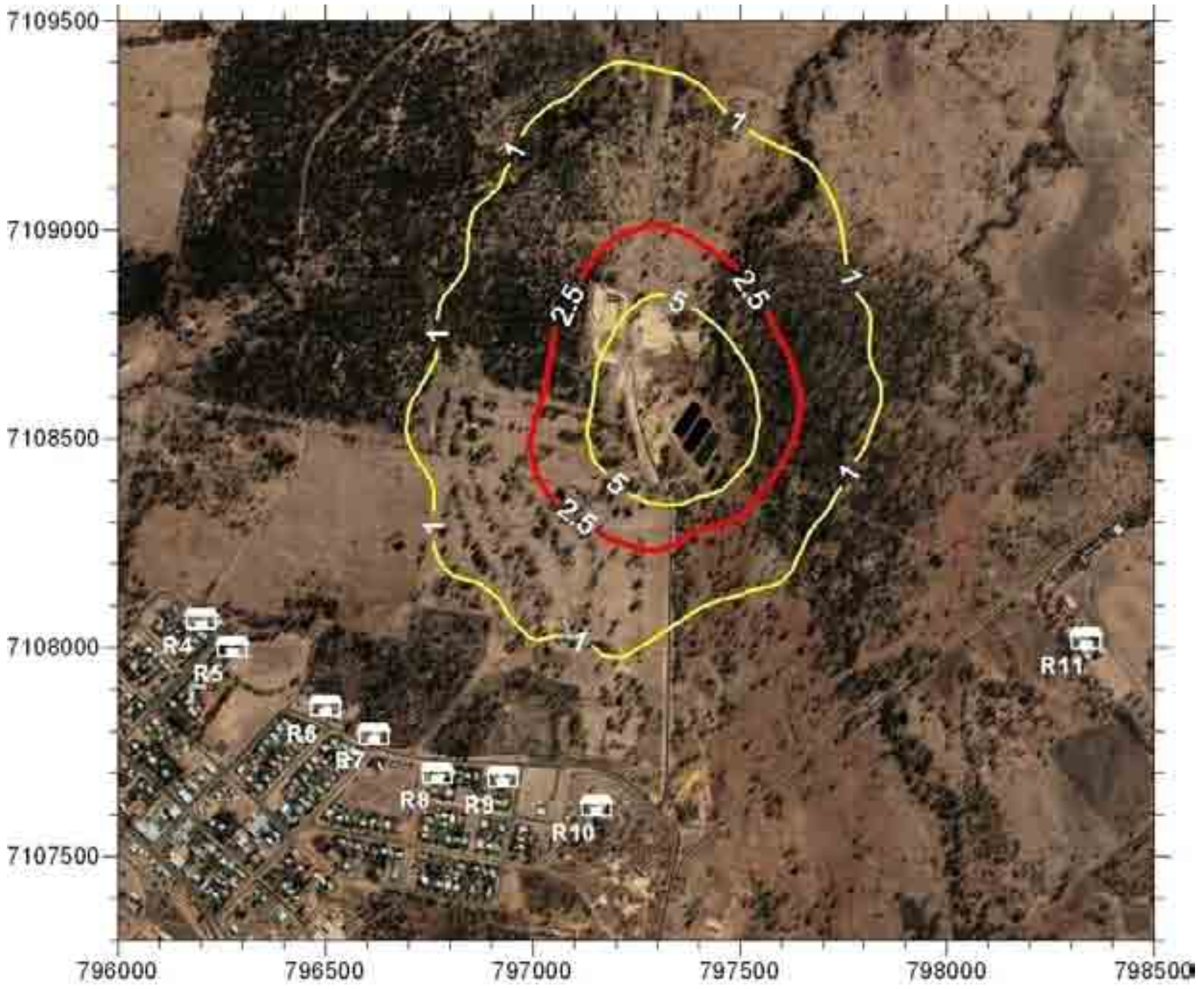


Figure 85	**Predicted odour impact from the upgraded Wandoan WWTP based on August 2008 odour survey data and proposed expanded plant**

Location: Wandoan WWTP	**Averaging period:** 1-hour	**Data source:** Ausplume	**Units:** Odour units
Type: 99.5th percentile contours	**Guideline:** 2.5 odour units	**Prepared by:** Andrew Balch	**Date:** 28/08/08

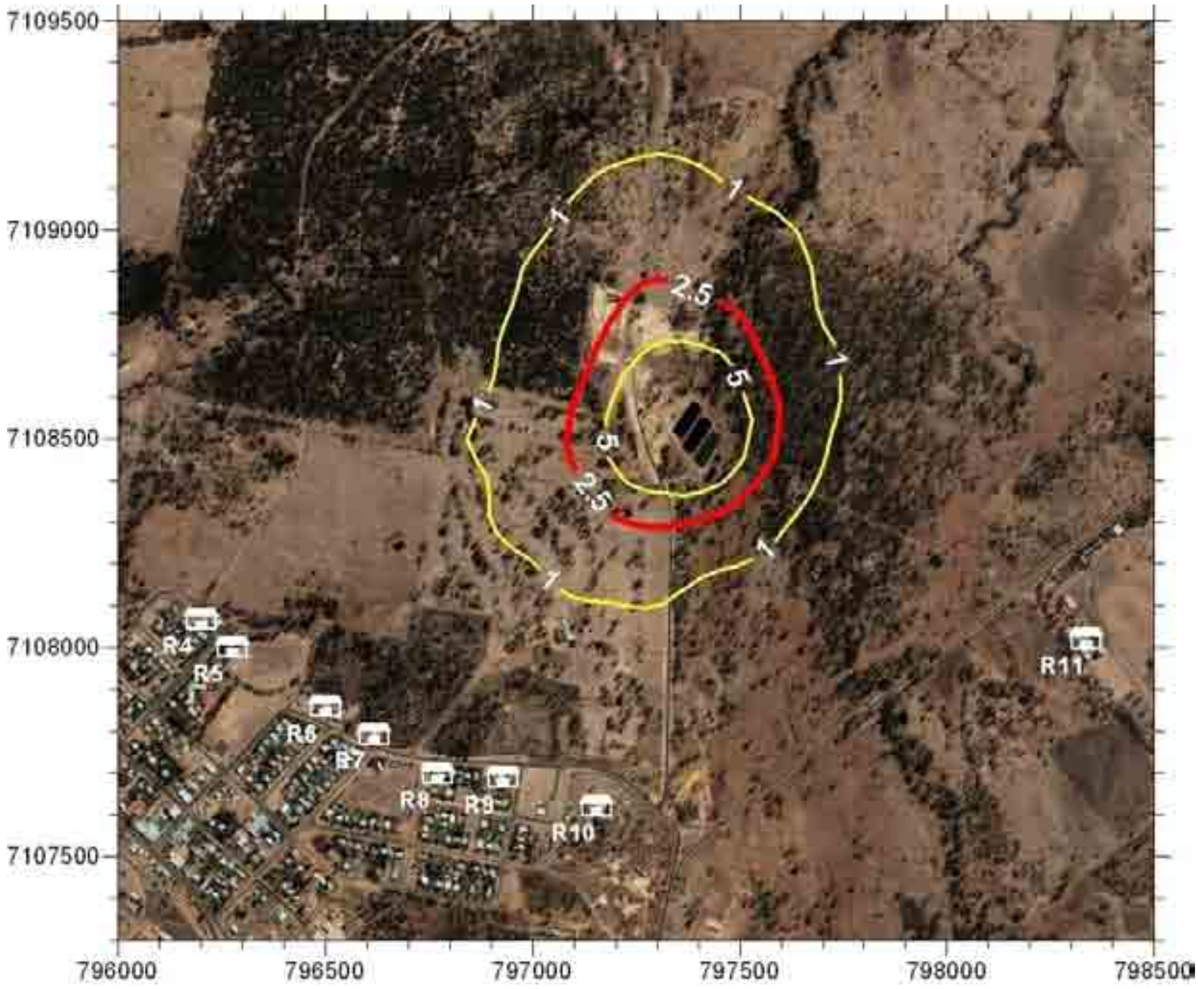


Figure 86	**Predicted odour impact from the upgraded Wandoan WWTP based on August 2008 odour survey data and proposed expanded plant with collection and treatment of odour emissions from Primary Treatment units.**

Location: Wandoan WWTP	**Averaging period:** 1-hour	**Data source:** Ausplume	**Units:** Odour units
Type: 99.5th percentile contours	**Guideline:** 2.5 odour units	**Prepared by:** Andrew Balch	**Date:** 28/08/08

ATTACHMENT A: WANDOAN COAL PROJECT MINE ACTIVITY DATA

Table A1 Coal and overburden throughputs and areas of coal pit and overburden working area for Year 1

Pit	Tailings Dam	Austinvale	Total of all pits
Coal (tpa)	n/a	10,000,000	10,000,000
Overburden removed by dragline (m^3)	n/a	21,796,343	21,796,343
Overburden removed by truck (m^3)	5,685,211	n/a	5,685,211
Pit area disturbed (m^2)	339,100	1,269,332	1,608,432

Note n/a - Not applicable for this pit

Table A2 Coal and overburden throughputs and areas of coal pit and overburden working area for Year 5 (dragline operations)

Pit	Austinvale	Woleebee	Frank Creek	Mud Creek	Total of all pits
Coal (tpa)	11,343,221	9,235,436	4,605,591	4,815,753	30,000,000
Overburden removed by dragline (m^3)	23,154,219	27,325,232	12,636,515	12,636,515	75,752,482
Overburden removed by truck (m^3)	n/a	n/a	n/a	n/a	0
Pit area disturbed (m^2)	1,269,332	997,879	1,090,265	1,719,900	5,077,376
n/a - Not applicable for this pit					

Table A3 Coal and overburden throughputs and areas of coal pit and overburden working area for Year 5 (truck and shovel operations for Frank Creek Pit only)

Pit	Austinvale	Woleebee	Frank Creek	Mud Creek	Total of all pits
Coal (tpa)	11,343,221	9,235,436	767,503	4,815,753	26,161,913
Overburden removed by dragline (m^3)	23,154,219	27,325,232	n/a	12,636,515	65,958,573
Overburden removed by truck (m^3)	n/a	n/a	2,842,606	n/a	2,842,606
Pit area disturbed (m^2)	1,269,332	997,879	181,688	1,719,900	4,168,799
n/a - Not applicable for this pit					

Table A4 Coal and overburden throughputs and areas of coal pit and overburden working area for Year 10

Pit	Woleebee	Summer Hill	Turkey Hill	Total of all pits
Coal (tpa)	5,450,082	11,216,491	13,333,427	30,000,000
Overburden removed by dragline (m^3)	53,936,740	57,801,519	56,881,600	76,645,391
Overburden removed by truck (m^3)	n/a	n/a	n/a	n/a
Rehabilitation area (m^2)	n/a	n/a	n/a	n/a
Pit area disturbed (m^2)	1,350,608	483,975	1,351,785	3,186,368
n/a - Not applicable for this pit				

Table A5 Coal and overburden throughputs and areas of coal pit and overburden working area for Year 20

Pit	Leichardt	Woleebee North	Woleebee Creek	Mud Creek	Turkey Hill	Summer Hill	Total of all pits
Coal (tpa)	3,611,686	3,434,914	9,407,935	5,048,149	4,242,430	4,254,887	30,000,000
Overburden removed by dragline (m^3)	25,352,225	n/a	27,804,285	22,276,980	24,01,9413	18,269,012	117,721,915
Overburden removed by truck (m^3)	n/a	2,312,789	n/a	n/a	n/a	n/a	2,312,789
Pit area disturbed (m^2)	868,140	34,532	982,789	598,260	832,104	600,112	3,915,937
n/a - Not applicable for this pit							

Table A6 Coal and overburden throughputs and areas of coal pit and overburden working area for Year 30

Pit	Woleebee North	Summer Hill	Turkey Hill	Woleebee Creek	Mud Creek	Total of all pits
Coal (tpa)	4,303,229	3,873,047	653,053	10,581,467	4,589,205	24,000,000
Overburden removed by dragline (m^3)	19,369,611	22,627,572	21,792,778	27,804,285	20,531,512	112,125,758
Overburden removed by truck (m^3)	n/a	n/a	n/a	n/a	n/a	0
Pit area disturbed (m^2)	624,129	588,569	416,559	322,690	380,036	2,331,983
n/a - Not applicable for this pit						

Table A7 Summary of emissions calculated for each of the pits and activity areas for TSP and PM_{10} (g/s) for Year 1.

Year 1 emissions from various sources	Ashdam		Austinvale		CHPP		ROM Dump Station 1	
	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}
Trucks hauling coal	-	-	17.1	4.7	-	-	43.5	11.9
Trucks hauling overburden	-	-	-	-	-	-	-	-
Wind erosion - rehabilitation	-		-	-	-	-	-	-
Wind erosion - overburden	3.8	2.0	-	-	-	-	-	-
Wind erosion - coal stockpile	-		-	-	-	-	0.05	0.02
Draglines overburden	-		11.7	2.9	-	-	-	-
Truck loading coal	-		11.6	1.8	-	-	-	-
Truck loading overburden	7.1	1.8	-	-	-	-	-	-
Truck dumping coal	-		-	-	0.03	0.01	3.2	1.3
Truck dumping overburden	0.4	0.1	0.3	0.1	-	-	-	-
Blasting drilling - overburden and coal	4.1	2.1	4.1	2.1	-	-	-	-
Drilling - overburden and coal	0.1	0.1	0.1	0.1	-	-	-	-
Grading	0.1	0.02	-	-	-	-	-	-
Bulldozing - overburden and coal	1.0	0.2	1.0	0.2	-	-	-	-
Train loading	-	-	-	-	0.03	0.01	-	-
Conveyor transfer	-	-	-	-	0.04	0.02	-	-
Conveyor	-	-	-	-	0.1	0.03	-	-

Table A8 Summary of emissions calculated for each of the pits and activity areas for TSP and PM_{10} (g/s) for Year 5 - dragline.

Year 5 emissions from various sources	Ashdam		Austinvale		Frank Creek dragline		Mud Creek		Woleebee Creek		CHPP		ROM Dump Station 1		ROM Dump Station 2	
	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}
Trucks hauling coal	-	-	9.8	2.7	7.2	2.0	20.9	5.7	6.0	1.7	31.0	8.5	13.3	3.6	-	-
Wind erosion - overburden	3.8	2.0	0.1	0.1	0.1	0.1	-	-	0.1	0.1	-	-	-	-	-	-
Wind erosion - coal stockpile	-	-	-	-	-	-	-	-	-	-	-	-	0.1	0.0	0.1	0.02
Draglines overburden	-	-	14.6	3.6	14.1	3.5	12.9	3.2	13.5	3.4	-	-	-	-	-	-
Truck loading coal	-	-	13.2	2.0	5.3	0.8	11.7	1.8	10.7	1.7	-	-	-	-	-	-
Truck loading overburden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Truck dumping coal	-	-	-	-	-	-	-	-	-	-	0.1	0.04	9.5	4.0	1.5	0.6
Truck dumping overburden	-	-	0.4	0.1	0.5	0.1	0.5	0.1	0.4	0.1	-	-	-	-	-	-
Blasting - overburden and coal	-	-	4.1	2.1	4.1	2.1	4.1	2.1	4.1	2.1	-	-	-	-	-	-
Drilling - overburden and coal	-	-	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-	-	-	-	-	-
Grading	0.1	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bulldozing - overburden and coal	-	-	1.0	0.2	1.0	0.2	1.0	0.2	1.0	0.2	-	-	-	-	-	-
Train loading	-	-	-	-	-	-	-	-	-	-	0.1	0.1	-	-	-	-
Conveyor transfer	-	-	-	-	-	-	-	-	-	-	0.1	0.1	-	-	-	-
Conveyor section 1	-	-	-	-	-	-	-	-	-	-	0.1	0.03	0.03	0.02	-	-

Table A9 Summary of emissions calculated for each of the pits and activity areas for TSP and PM_{10} (g/s) for Year 5- truck and shovel

Year 5 emissions from various sources	Ashdam		Austinvale		Frank Creek truck & shovel		Mud Creek		Woleebee Creek		CHPP		ROM Dump Station 1		ROM Dump Station 2	
	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}
Trucks hauling coal	-	-	9.8	2.7	1.2	0.3	20.9	5.7	6.0	1.7	31.0	8.5	13.3	3.6	-	-
Wind erosion - overburden	3.8	2.0	0.1	0.1	0.1	0.1	-	-	0.1	0.1	-	-	-	-	-	-
Wind erosion - coal stockpile	-	-	-	-	-	-	-	-	-	-	-	-	0.1	0.0	0.1	0.02
Draglines overburden	-	-	14.6	3.6	-	-	12.9	3.2	13.5	3.4	-	-	-	-	-	-
Truck loading coal	-	-	13.2	2.0	0.9	0.1	11.7	1.8	10.7	1.7	-	-	-	-	-	-
Truck loading overburden	-	-	-	-	3.6	0.9	-	-	-	-	-	-	-	-	-	-
Truck dumping coal	-	-	-	-	-	-	-	-	-	-	0.1	0.04	9.5	4.0	1.5	0.6
Truck dumping overburden	-	-	0.4	0.1	0.2	0.1	0.5	0.1	0.4	0.1	-	-	-	-	-	-
Blasting - overburden and coal	-	-	4.1	2.1	4.1	2.1	4.1	2.1	4.1	2.1	-	-	-	-	-	-
Drilling - overburden and coal	-	-	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-	-	-	-	-	-
Grading	0.1	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bulldozing - overburden and coal	-	-	1.0	0.2	1.0	0.2	1.0	0.2	1.0	0.2	-	-	-	-	-	-
Train loading	-	-	-	-	-	-	-	-	-	-	0.1	0.1	-	-	-	-
Conveyor transfer	-	-	-	-	-	-	-	-	-	-	0.1	0.1	-	-	-	-
Conveyor section 1	-	-	-	-	-	-	-	-	-	-	0.1	0.03	0.03	0.02	-	-

Table A10 Summary of emissions calculated for each of the pits and activity areas for TSP and PM_{10} (g/s) for Year 10.

Year 10 emissions from various sources	Ashdam		Turkey Hill		Summer Hill		Woleebee Creek		CHPP		ROM Dump Station 1		ROM Dump Station 2	
	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}
Trucks hauling coal	-	-	76.3	20.9	46.7	12.8	25.7	7.1	-	-	-	-	-	-
Wind erosion - overburden	3.8	2.0	-	-	0.2	0.1	-	-	-	-	-	-	-	-
Wind erosion - coal stockpile	-	-	-	-	-	-	-	-	-	-	0.1	0.02	0.1	0.02
Draglines overburden	-	-	13.8	3.4	13.1	3.3	14.1	3.5	-	-	-	-	-	-
Truck loading coal	-	-	13.0	2.0	13.0	2.0	11.7	1.8	-	-	-	-	-	-
Truck dumping coal	-	-	-	-	-	-	-	-	0.1	0.04	1.7	0.8	7.8	3.3
Truck dumping overburden	-	-	0.1	0.0	0.1	0.0	0.1	0.0	-	-	-	-	-	-
Blasting - overburden and coal	-	-	4.1	2.1	4.1	2.1	1.0	0.5	-	-	-	-	-	-
Drilling - overburden and coal	-	-	0.1	0.1	0.1	0.1	0.1	0.1	-	-	-	-	-	-
Grading	0.1	0.02	-	-	-	-	-	-	-	-	-	-	-	-
Bulldozing - overburden and coal	-	-	0.2	0.1	0.2	0.1	0.2	0.1	-	-	-	-	-	-
Train loading	-	-	-	-	-	-	-	-	0.1	0.04	-	-	-	-
Conveyor transfer	-	-	-	-	-	-	-	-	0.1	0.1	-	-	-	-
Conveyor section 1	-	-	-	-	-	-	-	-	0.1	0.03	0.1	0.03	-	-

Table A11 Summary of emissions calculated for each of the pits and activity areas for TSP and PM_{10} (g/s) for Year 20.

Year 20 emissions from various sources	Ash Dam		Turkey Hill		Summer Hill		Woleebee Creek		Leichhardt		Mud Creek		Woleebee North		CHPP		ROM Dump Station 1		ROM 2 and 3	
	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}
Trucks hauling coal	-	-	34.0	9.3	57.5	9.3	30.9	8.5	-	-	36.6	10.0	23.5	6.5	20.9	5.7	-	-	-	-
Wind erosion - overburden	3.8	2.0	0.3	0.2	0.3	0.1	0.1	0.0	-	-	0.0	0.0	0.3	0.2	0.0	0.0	2.0	1.1	-	-
Wind erosion - coal stockpile	-	-	-	-	-	-	-	-	0.1	0.02	-	-	-	-	-	-	-	-	5.1	0.04
Draglines overburden	-	-	30.5	7.6	32.1	8.0	15.9	4.0	-	-	27.2	6.8	23.7	5.9	-	-	-	-	-	-
Truck loading coal	-	-	4.9	0.8	4.9	0.8	20.1	3.1	-	-	7.7	1.2	10.8	1.2	-	-	-	-	-	-
Truck loading overburden	-	-	-	-	-	-	-	-	1.7	0.8	-	-	-	-	3.6	1.0	-	-	-	-
Truck dumping coal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	0.04	9.61	4.05
Truck dumping overburden	-	-	0.4	0.1	0.4	0.1	0.2	0.1	-	-	0.8	0.2	0.4	0.1	0.5	0.1	-	-	-	-
Blasting - overburden and coal	-	-	4.1	2.1	4.1	2.1	4.1	2.1	-	-	4.1	2.1	4.1	2.1	4.1	2.1	-	-	--	-
Drilling - overburden and coal	-	-	0.1	0.1	0.1	0.1	0.1	0.1	-	-	0.1	0.1	0.1	0.1	0.1	0.1	-	-	-	-
Grading	0.1	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bulldozing - overburden and coal	-	-	1.0	0.2	1.0	0.2	1.0	0.2	-	-	1.0	0.2	1.0	0.2	1.0	0.2	-	-	-	-
Train loading	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.09	0.04	-	-	-	-
Conveyor transfer	-	-	-	-	-	-	-	-	0.1	0.03	-	-	-	-	0.1	0.06	-	-	-	-
Conveyor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06	0.03	0.3	0.15

Table A12 Summary of emissions calculated for each of the pits and activity areas for TSP and PM_{10} (g/s) for Year 30.

Year 30 emissions from various sources	Ashdam		Summer Hill & Turkey Hill		Woleebee Creek		Woleebee		Mud Creek		Woleebee North		CHPP		ROM Dump Station 1		ROM 2 and 3	
	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	TSP	PM_{10}	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}
Trucks hauling coal	-	-	8.5	2.3	38.0	10.4	15.4	-	-	4.2	29.0	7.9	30.4	8.3	-	-	-	-
Wind erosion - overburden	3.8	2.0	0.0	0.0	0.1	0.1	0.1	-	-	0.0	0.4	0.2	0.1	0.0	2.0	1.1	-	-
Wind erosion - coal stockpile	-	-	-	-	-	-	-	0.1	0.02	-	-	-	-	-	-	-	0.2	0.1
Draglines overburden	-	-	24.8	6.2	24.3	6.0	19.3	-	-	4.8	23.6	5.9	22.0	5.5	-	-	-	-
Truck loading coal	-	-	5.3	0.8	11.3	1.7	9.2	-	-	1.5	9.8	1.5	9.2	1.4	-	-	-	-
Truck loading overburden	-	-	-	-	-	-	-	1.7	0.8	-	-	-	-	-	-	-	-	-
Truck dumping coal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.6	3.2
Truck dumping overburden	-	-	0.5	0.1	0.4	0.1	0.2	-	-	0.1	0.4	0.1	0.3	0.1	-	-	-	-
Blasting - overburden and coal	-	-	4.1	2.1	4.1	2.1	4.1	-	-	2.1	4.1	2.1	4.1	2.1	-	-	-	-
Drilling - overburden and coal	-	-	0.1	0.1	0.1	0.1	0.1	-	-	0.1	0.1	0.1	0.1	0.1	-	-	-	-
Grading	0.1	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bulldozing - overburden and coal	-	-	1.0	0.2	1.0	0.2	1.0	-	-	0.2	1.0	0.2	1.0	0.2	-	-	-	-
Train loading	-	-	-	-	-	-	-	-	-	-	-	-	0.1	0.0	-	-	-	-
Conveyor transfer	-	-	-	-	-	-	-	0.1	0.03	-	-	-	0.1	0.1	-	-	-	-
Conveyor	-	-	-	-	-	-	-			-	-	-	-	-	0.1	0.0	0.3	0.2

ATTACHMENT B: EMISSION FACTORS

B1 DRILLING

The emission factors for drilling were calculated from the AP42 documents, chapter 11.9 "Western Surface Coal Mining" (October 1998).

Material	Units	TSP	PM_{10}
Overburden	kg/hole	0.59	Assumed TSP to PM_{10} ratio same as blasting overburden

The number of holes drilled per blast was 50, provided verbally by Andrew Scott.

B2 BLASTING

The emission factor for blasting were calculated from the NPI "Emission Estimate handbook for Mining v 2.3 (2001).

Material	Units	TSP	PM_{10}
Coal or overburden	kg/blast	$344 \times A^{0.8}/(m^{1.9} \times D^{1.8})$	TSP x 0.52

Where A = the blasted area (40,000 m^2)
B = moisture content of the blasted material (4.8%)
D = depth of the blast holes (this varied depending on pit)

It was assumed that one blast per day occurred in each pit.

B3 BULLDOZING

The emission factors for bulldozing were calculated from the AP42 documents, chapter 11.9 "Western Surface Coal Mining" (October 1998).

Material	Units	TSP	PM_{10}
Overburden	kg/hr	$\frac{2.6(s)^{1.2}}{(M)^{1.3}}$	$\frac{0.45(s)^{1.5}}{(M)^{1.4}} \times 0.75$

Where s = material silt content (%)
M = material moisture content (%)

For the overburden emissions the material moisture content has been assumed as 4.8 %. A silt content of 6.9 % has been assumed from the average of the AP42 studies across eight samples (chapter 11.9).

B4 TRUCK LOADING

The emission factors for truck loading were calculated from the AP42 documents, chapter 11.9 “Western Surface Coal Mining” (October 1998).

Material	Units	TSP	PM_{10}
Coal	kg/Mg	$\frac{0.580}{(M)^{1.2}}$	$\frac{0.0596}{M^{0.9}}$ x 0.75
Overburden	kg/Mg	0.018	Assumed ratio of TSP to PM_{10} for bulldozer operating on overburden

Where M = material moisture content. Moisture content for coal of 10 % has been assumed based on data supplied by the Proponent.

B5 TRUCK DUMPING

The emission factors for truck loading were calculated from the AP42 documents, chapter 11.9 “Western Surface Coal Mining” (October 1998) and the NPI “Emission Estimation Handbook for Mining 2.3” (2001).

Material	Units	TSP	PM_{10}
Coal	kg/Mg	0.01	Assumed ratio of TSP to PM_{10} for truck loading of coal
Overburden	kg/Mg	0.001	Assumed ratio of TSP to PM_{10} for bulldozer operating on overburden

The NPI Handbook recommended that the emission factors for trucks unloading coal from the AP42 documents appeared too low for Australian conditions and therefore 0.01 kg/Mg should be used.

B6 DRAGLINE

The emission factors for dragline operations were calculated from the AP42 documents, chapter 11.9 “Western Surface Coal Mining” (October 1998).

Material	Units	TSP	PM_{10}
Overburden	kg/m³	$\frac{0.0046(d)^{1.1}}{(M)^{0.3}}$	$\frac{0.0029(d)^{0.7}}{(M)^{0.3}}$ x 0.75

Where d = drop height (m)
M = material moisture content (%)

An average drop height of 5 m has been assumed in the assessment. The material moisture content of 4.8 % has been assumed (based on the AP42 chapter 11.9 reported average results from 8 samples at various coal mines).

B7 GRADING

The emission factors for grading were calculated from the AP42 documents, chapter 11.9 “Western Surface Coal Mining” (October 1998).

Material	Units	TSP	PM_{10}
Overburden	kg/VKT	$0.0034 (S)^{2.5}$	$0.0056 (S)^{2.0} \times 0.6$

Where S = mean vehicle speed (km/hr).

For the modelling assessment a mean vehicle speed of 20 km/hr has been adopted.

B8 ACTIVE STORAGE PILE (WIND EROSION)

The emission factors for coal stockpiles were calculated from the NPI “Emission Estimation Handbook for Mining v2.3” (2001).

Material	Units	TSP	PM_{10}
Coal	kg/(hectare)(hour)	0.4	Assumed PM_{10} to be 50 % of TSP based on wind erosion factor in NPI mining version 2.3.

Where u = wind speed (m/s)

For this assessment the wind speed has been taken as the average wind speed from the monitoring station on site. The average wind speed was 3.14 m/s.

B9 WIND EROSION

The emission factors from wind erosion for the exposed areas of overburden and rehabilitated areas were calculated from the AP42 documents, chapter 11.9 “Western Surface Coal Mining” (October 1998).

Material	Units	TSP	PM_{10}
Overburden and rehabilitated areas	Mg/(hectare)(year)	0.85	TSP x 0.5 (assumed from the NPI mining version 2.3 where a 50 % ratio of TSP to PM_{10} was found.

B10 UNPAVED ROADS

The emission factors for unpaved roads were calculated from the AP42 documents in chapter 13.2.2 titled “unpaved roads” dated December 2003.

The equation included in the assessment is as follows:

$$E = k (s/12)^{a} (W/3)^{b}$$

Where s = surface material silt content (%)
W = mean vehicle weight (tons) and the following constants were assumed.

Constant	TSP (assumed from PM_{30})	PM_{10}
k (lb/VMT)	4.9	1.5
a	0.7	0.9
b	0.45	0.45

1 lb/VMT is equivalent to 281.9 g/VKT.

The surface material silt content of 6.9 % has been assumed based on the average from the AP42 chapter 11.9 as overburden will be used to create the haul roads.

A 50% control was assumed for watering of the haul roads.

B11 CONVEYOR

The dust emissions from conveyors are wind speed dependent with stronger wind speeds causing dust particles to be entrained by the wind. The wind speed dependence has been based on the recommendations of Parrett (1992) where the dust emission rate is equivalent to a constant multiplied by the difference between the friction velocity (u*) and the threshold friction velocity of the coal (u*t). The value of u* was determined as typically 0.11 times the 10 m level wind speed, and for coal the threshold wind speed for coal dust to be lifted (particles in the 20-30 µm range) is 3.1 m/s (u*t therefore is typically 0.34 m/s). Emissions for wind speeds below 3.1 m/s are likely to be negligible.

The constant (c) has been calculated from Parrett's equation (F=c(u*-u*t)) and data reported by GHD/Oceanics (1975) for measured conveyor emissions at a wind speed of 10 m/s. Account has also been taken of the distribution of particle sizes as suggested by WBM (2004). In this case, the constant (c) was found to be 0.0082 ($g/m^2/s^2$).

B12 TRANSFER POINTS

Transfer points are locations within the coal loading system where coal is transferred from one conveyor to another or from a conveyor to a hopper. The emission rates for any transfer points were calculated using the following equation (NPI 2001):

$$E = k0.0016\left(\frac{U}{2.2}\right)^{1.3}\left(\frac{M}{2}\right)^{-1.4} kg/t$$

k	=	0.74 for particles less than 30 µm
k	=	0.35 for particles less than 10 µm
U	=	mean wind speed in m/s
M	=	material moisture content %. A moisture content of 10 % was adopted in this study.

Hourly wind speeds have been used to calculate the hourly emissions in kg/tonne.

The number of transfer points to and from each stockpile has been calculated based on the annual throughput of coal to and from each stockpile. A transfer point along the conveyors from the train unloading area was also included.

References

Gutteridge Haskins & Davey (GHD) / Oceanics (1975), Hay Point Environmental Planning Study.

National Pollutant Inventory, (2001), "Emission Estimation Technique Manual for Mining". National Environment Protection Council.

New South Wales Mineral Council (2000), "Particulate matter and mining", a NSW Minerals Council Technical Paper.

Parrett FW, (1992), "Dust emission – a review", Applied Environmetrics (Balwyn).
Queensland Coal Board, (1997), Queensland Coals Physical and Chemical Properties Colliery and Company Information, 11th Edition

USEPA (October 1998). Chapter 11.9 "Western Surface Coal Mining", AP-42. USEPA Office of Air Quality Planning and Standards.

ATTACHMENT C: METEOROLOGICAL AND DISPERSION MODELLING METHODOLGY

The meteorological data for this study was generated by coupling TAPM, a prognostic mesoscale model to CALMET, a diagnostic dispersion model. The coupled TAPM/CALMET modelling system was developed by Katestone to enable high resolution modelling capabilities for regulatory and environmental assessments. The modelling system incorporates synoptic, mesoscale and local atmospheric conditions, detailed topography and land use categorisation schemes to simulate synoptic and regional scale meteorology for input into pollutant dispersion models, such as CALPUFF. Details of the model configuration are supplied in the following sections.

C1 TAPM meteorological simulations

The prognostic meteorological model, TAPM (The Air Pollution Model) Version 3.0.7, was developed by the CSIRO and has been validated by the CSIRO, Katestone Environmental and others for many locations in Australia, in southeast Asia and in North America (see www.cmar.csiro.au/research/tapm for more details on the model and validation results from the CSIRO). Katestone Environmental has used the TAPM model throughout Australia as well as in parts of New Caledonia, Bangladesh and Vietnam. This model has performed well for simulating regional winds patterns. TAPM has proven to be a useful model for simulating meteorology in locations where monitoring data is unavailable.

TAPM is a prognostic meteorological model which predicts the flows important to regional and local scale meteorology, such as sea breezes and terrain-induced flows from the larger-scale meteorology provided by the synoptic analyses. TAPM solves the fundamental fluid dynamics equations to predict meteorology at a mesoscale (20 km to 200 km) and at a local scale (down to a few hundred metres). TAPM includes parameterisations for cloud/rain micro-physical processes, urban/vegetation canopy and soil, and radiative fluxes.

TAPM requires synoptic meteorological information for the Wandoan region. This information is generated by a global model similar to the large-scale models used to forecast the weather. The data are supplied on a grid resolution of approximately 75 km, and at elevations of 100 m to 5 km above the ground. TAPM uses this synoptic information, along with specific details of the location such as surrounding terrain, land-use, soil moisture content and soil type to simulate the meteorology of a region as well as at a specific location.

TAPM was configured as follows:

- Mother domain of 30 km with 3 nested daughter grids of 10 km, 3 km and 1 km
- 40 x 40 grid points for all modelling domains resulting in a 40 x 40 km grid at 1 km resolution
- 27 vertical levels, from the surface up to an altitude of 8000 m above sea level;
- AUSLIG 9 second DEM terrain data
- The TAPM defaults for sea surface temperature and land use
- Default options selected for advanced meteorological inputs
- Year modelled: 3 April 2007 to 31 March 2008

TAPM was modelled using data assimilation from the Wandoan meteorological site located at 26° 7’ 6” S 149° 56’ 28” E.

C2 CALMET meteorological simulations

CALMET is an advanced non-steady-state diagnostic three-dimensional meteorological model with micro-meteorological modules for overwater and overland boundary layers. The model is the meteorological pre-processor for the CALPUFF Modelling system. CALMET is capable reading in hourly meteorological data as data assimilation from multiple sites within the modelling domain; it can also be initialised with the gridded three-dimensional prognostic output from other meteorological models such as TAPM. This can improve dispersion model output, particularly over complex terrain as the near surface meteorological conditions are calculated for each grid point.

CALMET v6 was used to simulate meteorological conditions in the Wandoan region. Two CALMET wind fields were generated for input into the dispersion model. The first at a resolution of 1 km acting as a mirror to the 1 km TAPM domain. This was done to encompass the wider community of Wandoan and to include the entire the MLA (refer to TAPM section for domain characteristics). The second was a high resolution modelling domain set to act as fourth daughter grid of the TAPM 1 km domain at a resolution of 300 m comprising of 44 grid cells (approximately 13 km x 13 km).

Both CALMET simulations were initialised with the gridded TAPM three dimensional wind field data from the 1 km grid. Use of the 1 km grid for input into CALMET is a sound practice in that the representation of mesoscale and synoptic flows will not change between the 1 km and 300 m domains and it allows CALMET to compute its own calculations for terrain effects at the finer 300m resolution. CALMET treats the prognostic model output as the initial guess field for the CALMET diagnostic model wind fields. CALMET then adjusts the initial guess field for the kinematic effects of terrain, slope flows, blocking effects and 3-dimensional divergence minimisation.

CALMET was set up with twelve vertical levels with heights at 20 m, 60 m, 100 m, 140 m, 180 m, 30 m, 500 m, 800 m, 1400 m, 2400 m, 4400 m and 5500 m at each grid point. The geophysical data (land use and terrain heights) were generated from TAPM 1 km and 300 m terrain and terrain provided by the client for their respective resolutions. All default options and factors were selected except where noted below.

Key features of CALMET used to generate the windfields are as follows:

- Two domain areas of 40 by 40 at 1 km spacing and 44 by 44 grids at 300 m spacing
- 361 days (4 April 2007 to 31 March 2008). This was done to match the available observational data.
- Prognostic wind fields input as MM5/3D.dat for "initial guess" field only (as generated from TAPM)
- Mixing height parameters all set as default
- Temperature parameters used 1/R**2 as interpolation method, with radius of influence of 500 km
- Surface winds always extrapolated using similarity theory
- Step 1 wind field options include kinematic effects, divergence minimisation, Froude adjustment to a critical Froude number of 1 and slope flows
- Terrain radius of influence set at 2 km
- Radius of influence of observation data set at 1 km for surface and 3 km for aloft (RMAX1 and RMAX2)
- Relative weighting of step 1 wind fields versus observations set at 1 km for surface and 3 km aloft
- Data assimilation of one meteorological station present within the modelled domain

C3 CALPUFF Dispersion modelling

The CALPUFF v6.0 dispersion model utilises the three-dimensional wind fields developed using the TAPM and CALMET meteorological models to simulate the dispersion of air pollutants to predict ground-level concentrations across a gridded domain. CALPUFF is a non-steady-state Lagrangian Gaussian puff model containing parameterisations for complex terrain effects, overwater transport, coastal interaction effects, building downwash, wet and dry removal, and simple chemical transformation. CALPUFF employs the three dimensional meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal. CALPUFF contains algorithms that can resolve near-source effects such as building downwash, transitional plume rise, partial plume penetration, subgrid scale terrain interactions, as well as the long range effects of removal, transformation, vertical wind shear, overwater transport and coastal interactions. Emission sources can be characterised as arbitrarily-varying point, area, volume and lines or any combination of those sources within the modelling domain.

CALPUFF v6.0 was used to simulate the dispersion characteristics and concentrations particulate matter generated by the proposed mining activities near the town of Wandoan and the wider the community within the region. Hourly varying meteorological conditions were obtained from CALMET at 1 km and 300 m resolution. CALPUFF has the ability to refine the dispersion calculations via a nesting factor, where the two base computational grid resolutions of 1 km and 300 m is reduced to 500 m and 150 m respectively. This was employed to increase the accuracy of the simulated concentrations within the modelling domain as terrain influences and turbulence parameters are better resolved.

Key Features of CALPUFF used to simulate dispersion:

- Domain area of 80 by 80 grids at 500 m spacing and 88 by 88 grids at 150 metre grid spacing;
- 361 days (4 April 2007 to 31 March 2008). This was done to match the available observational data.
- Gridded 3-D hourly-varying meteorological conditions generated by CALMET
- Partial plume path adjustment for terrain modelled
- Dispersion coefficients calculated internally from sigma v and sigma w using micrometeorological variables
- Dry deposition on For annual concentrations and dust deposition
- All other options set to default.

C4 Model output

Due to the size of the proposed operation to effectively model the potential impacts of mining activities on the town of Wandoan and surrounding areas, two sets of CALMET/CALPUFF outputs where generated. One at a 500 m resolution including all the potential sources of particulates from the proposed activities covering the entire Wandoan Coal Project area and a second at the 150 m resolution to ensure a robust result for activities near the town itself. The two resolutions where the combined to produce an hourly varying concentration file at 500 m resolution for activities greater than 13 km from the town and a finer scale 150 m resolution for activities within 13 km of the town. This was done to ensure that dust generated from the proposed mining activities anywhere within the mine lease area would be taken into account at any of the sensitive receptors within the 40 km modelling domain.

ATTACHMENT D: ODOUR

D1 Description

The Dalby Regional Council operates and maintains the sewerage system for the town of Wandoan including the Wandoan Wastewater Treatment Plant (WWTP) on Golden St, Wandoan. The WWTP is designed for a treatment capacity of 550 kilolitres per day (kL/d), although the flow rate has diminished in recent years to approximately 104 kL/d corresponding to the reduced local population served of 380 people. Current average daily demand is approximately 280 litres per person per day (L/p/d), which includes flows from commercial and industrial facilities. This demand is considered to overestimate the likely demand of new residential development and subsequently a rate of 240 L/p/d is used to forecast future demand.

The development of the Wandoan Coal Project is estimated to increase the total treatment demand on the existing WWTP. Average daily demand for sewerage infrastructure is summarised in Table D1.

Table D1 Average daily demand for sewerage services

Details	Maximum requirement (kL/d)
Current town population (380 persons current demand)	104
New Wandoan residents and visitors resulting from growth in economic activity	14
Peak accommodation facilities residents during construction	336
Estimated peak Plant requirements	*454*

While the estimated peak requirements are less than the 550 kL/d treatment capacity of the current Plant, the design guidelines require the capacity to treat three times average dry weather flow (ADWF). Consequently, the Plant must be upgraded, and in addition to a design treatment capacity of three times ADWF, the Plant must provide for initial screening and sedimentation of flows up to five times ADWF.

The current Wandoan Wastewater Treatment Plant comprises three basic phases of sewage treatment including the infrastructure presented in Table D2.

Table D2 Current sewage treatment infrastructure at Wandoan WWTP

Treatment phase	Treatment unit	Description
Primary	Inlet channel	Sewerage system enters plant below ground
	Screen chamber	Chamber above Imhoff tank screens large wastes and allows settling of biosolids
	Imhoff tank	Anaerobic digestion tank situated beneath screen chamber with two outer chambers exposed to atmosphere
Secondary	Oxidation pond 1	Aerobic lagoon, no aerators
	Oxidation pond 2	Aerobic lagoon, no aerators
	Oxidation pond 3	Aerobic lagoon, no aerators
	Sludge drying bed	Sludge pumped from Imhoff tank to sludge drying beds for dewatering, before disposal
Tertiary	Holding pond	Final polishing pond used as storage prior to discharge to creek or used for golf course irrigation

The preliminary design of the proposed upgrade of the WWTP includes improvements to the inlet head works and operation of the oxidation ponds, and the addition of primary treatment capacity and sludge drying area. The inlet works will be improved to allow for combined flows from the mine and town up to five times ADWF. Flows up to three times ADWF will go into the improved primary treatment plant, while excess flows will be screened and diverted into the first pond for settling.

Table D3 Proposed upgrade infrastructure at Wandoan WWTP

Treatment phase	Treatment unit	Description
Primary	Inlet works	Flow combination chamber
		Inlet channel
		Emergency bypass around screen in the event of blockage of screen
		Manually cleaned screen
		Overflow weir for flows in excess of three times ADWF to oxidation ponds
		Parshall flume for flow measurement
		Manifold to split flows between Imhoff tanks
	Imhoff tank and Screen chamber	Three additional Imhoff tanks and screening chambers of equal capacity to current infrastructure
Secondary	Sludge drying bed	Two additional sludge drying beds of equal capacity to current infrastructure
	Oxidation pond 1	Addition of baffles to pond to prevent short circuiting
		Addition of four floating aerators
		Increase in pond depth from 1.2 m to 2.5 m
		Construction of an outlet structure with an intake 2.5 m above current pond bed
	Oxidation pond 2	Addition of baffles to pond to prevent short circuiting
		Increase in pond depth from 1.2 m to 2.5 m
		Construction of an outlet structure with an intake 2.5 m above current pond bed
	Oxidation pond 3	Addition of baffles to pond to prevent short circuiting
Tertiary	Holding pond	Final polishing pond used as storage prior to discharge to creek or used for golf course irrigation

This assessment investigates the odour impact from the current WWTP and the proposed upgraded WWTP based on the preliminary upgrade design provided by Parsons Brinckerhoff.

D2 Monitoring data

Katestone Environmental commissioned The Odour Unit Pty Limited (TOU), a specialist odour sampling and testing consultant, to conduct an odour survey of the WWTP to provide specific odour emission rates (SOER) and source characteristic information for use in an odour dispersion model.

Sources of odorous air emissions at the WWTP were identified by Katestone Environmental through the description of treatment processes provided by Parsons Brinckerhoff, from aerial photos and from discussions with wastewater treatment plant operations personnel at Dalby Regional Council. All emission sources identified were area sources. Table D4 outlines the odour sources identified and the number of samples collected in the odour sampling survey.

Table D4 Odour sources and sampling program at Wandoan WWTP (August 2008)

Sewage treatment unit	Location	Number of samples collected
Imhoff tank	Pre-screen zone	0
	Post-screen effluent settling zone	1
	Post-screen effluent rear zone	1
	Anaerobic digestion outer zones	0
Channel between Imhoff tank and oxidation pond 1	Channel is partly open and partly underground	0
Oxidation pond 1	First quadrant	1
	Third quadrant	1
	Fourth quadrant	1
Oxidation pond 2	Two-thirds way along pond	1
Oxidation pond 3	One-third way along pond	1
	Two-thirds way along pond	1
Sludge drying beds	On one of four quadrants	1
Rear holding pond		0
Total samples collected		*9*

Oxidation ponds are typically a large area source with very low to moderate SOER values, while the inlet works and Imhoff tank is a relatively small area source with considerably larger SOERs than the ponds. Consequently, the odour survey was designed to collect odour emission data for the entire plant and assess the spatial variability in odour emissions from the pond area.

Details of the sampling procedure can be provided if required.

Odour emissions data collected by TOU during the odour survey is presented in Table D5.

Table D5 Odour Survey Emissions Data

Source	Odour Concentration (ou)	SOER (ou.m^3 m^{-2} s^{-1})
Imhoff Tank – Post grit screen effluent settling zone	12,600	8.89
Imhoff Tank – Effluent outlet zone	16,500	11.6
Sludge Drying Bed	1,450	0.997
Oxidation Pond 1 – 1st quadrant	256	0.183
Oxidation Pond 1 – 3rd quadrant	194	0.139
Oxidation Pond 1 – 4th quadrant	39	0.028
Oxidation Pond 2 – two-thirds way along pond	315	0.228
Oxidation Pond 3 - one-third way along pond	256	0.185
Oxidation Pond 3 - two-thirds way along pond	39	0.028

D3 Emission rates

A conservative approach has been taken in the assignment of SOERs to plant sewage treatment units. Significant variability was found in odour emissions from the aerobic pond system, with SOERs ranging between 0.028 and 0.228 ou.m^3 m^{-2} s^{-1}. Odour survey data did not indicate a significant decrease in SOERs through the pond system. This may be due to the low loading on the WWTP and that effluent is treated in the primary treatment area and the first aerobic pond, with further significant treatment unable to be achieved through the second and third ponds.

Access to the ponds was also restricted and consequently IFH samples were collected from near the water's edge. This zone is likely to reflect water that is slightly less odourous than the centre of the ponds above areas of decaying organic material that has settled. Consequently, an SOER value of 0.2 ou.m^3 m^{-2} s^{-1} has been adopted for the Oxidation Ponds to reflect the higher range of odour emissions measured, and account for the spatial and temporal variability of the system. An SOER of 0.2 ou.m^3 m^{-2} s^{-1} has also been used for the Rear Holding Pond. Additionally, a sample was not collected directly from the area at the inlet to the first Oxidation Pond. SOERs measured in the Imhoff Tank upstream of the pond were approximately 12.0 ou.m^3 m^{-2} s^{-1}, and therefore an SOER value of 3.0 ou.m^3 m^{-2} s^{-1} (25% of the Imhoff Tank SOER value) has been used for 20% of the surface area of the first pond at the inlet end.

Two odour samples were collected from the Imhoff Tank, in the post grit screen effluent settling zone and rear outlet zone, and an SOER (12.0 ou.m^3 m^{-2} s^{-1}) value reflecting the higher of the two measurements was adopted. The area measured represented the largest section of the Imhoff Tank's exposed surface area. An SOER value of 12.0 ou.m^3 m^{-2} s^{-1} was also adopted for the short section of exposed channel that links the Imhoff Tank to the first aerobic pond.

Table D6 Wandoan WWTP baseline modelling scenario inventory

Odour source	Adopted SOER (ou.m^3 m^{-2} s^{-1})	Source Area (m^2)	OER (ou.m^3 m^{-2} s^{-1})	Percentage of Total Plant Emissions (%)
Imhoff Tank	12.0	28.3	339	10.8
Sludge Drying Beds	1.0	47	47	1.5
Channel between Imhoff Tank and Oxidation Pond 1	12.0	1.2	14	0.5
Oxidation Pond 1 – Inlet end, 20% of pond	3.0	450	1,350	43.1
Oxidation Pond 1 – remaining 80% of pond	0.2	1,800	360	11.5
Oxidation Pond 2 – 100% of pond	0.2	2,250	450	14.4
Oxidation Pond 3 – 100% of pond	0.2	2,250	450	14.4
Rear Holding Pond – 100% of pond	0.2	600	120	3.8
Total			**3,131**	**100**

The inventory for the Plant upgrade scenario includes an additional three Imhoff Tanks for Primary Treatment and two additional Sludge Drying Bed areas. Details of the additional inlet channels, bypass channels, flow combination chambers and overflow weirs were not provided in the preliminary Plant design and are likely to comprise only 1-2% of Plant odour emissions. These sources are likely to be small areas sources or covered, resulting in minimal odour emissions. Consequently, these small sources have not been included in the modelling. Table D7 presents the odour emissions inventory for the proposed upgrade scenario.

Table D7 Wandoan WWTP upgrade modelling scenario inventory

Odour source	Adopted SOER (ou.m^3 m^{-2} s^{-1})	Source Area (m^2)	OER (ou.m^3 m^{-2} s^{-1})	Percentage of Total Plant Emissions (%)
Imhoff Tank – total of four tanks	12.0	113	1,356	32.0
Sludge Drying Beds – total of three beds	1.0	141	141	3.3
Channel between Imhoff Tank and Oxidation Pond 1	12.0	1.2	14	0.3
Oxidation Pond 1 – Inlet end, 20% of pond	3.0	450	1,350	31.8
Oxidation Pond 1 – remaining 80% of pond	0.2	1,800	360	8.5
Oxidation Pond 2 – 100% of pond	0.2	2,250	450	10.6
Oxidation Pond 3 – 100% of pond	0.2	2,250	450	10.6
Rear Holding Pond – 100% of pond	0.2	600	120	2.8
Total			**4,242**	**100**

Odour impact from the upgraded Plant including odour control on the Imhoff Tanks in the Primary Treatment area was also considered. Table D8 presents the odour inventory modelled for the Upgrade with Primary Treatment odour control scenario. This scenario assumes a 98% capture efficiency of odorous air emissions from the surface of the four Imhoff Tanks and the channel linking the Imhoff Tanks with the aerobic pond system with treatment in a small biofilter or odour scrubber. Odour emissions from an odour control unit have not been included in the modelling as the treated emission will have a different odour character and therefore does not provide a cumulative effect with the untreated sources that have a sewage odour character.

Table D8 Wandoan WWTP upgrade modelling scenario inventory including collection and treatment odour emissions from Primary Treatment units

Odour source	Adopted SOER (ou.m^3 m^{-2} s^{-1})	Source Area (m^2)	OER (ou.m^3 m^{-2} s^{-1})	Percentage of Total Plant Emissions (%)
Imhoff Tank – total of four tanks with 98% capture efficiency and treatment of odour emissions	0.24	113	27	0.94
Sludge Drying Beds – total of three beds	1.0	141	141	4.86
Channel between Imhoff Tank and Oxidation Pond 1 with 98% capture efficiency and treatment of odour emissions	0.24	1.2	0.3	0.01
Oxidation Pond 1 – Inlet end, 20% of pond	3.0	450	1,350	46.58
Oxidation Pond 1 – remaining 80% of pond	0.2	1,800	360	12.42
Oxidation Pond 2 – 100% of pond	0.2	2,250	450	15.53
Oxidation Pond 3 – 100% of pond	0.2	2,250	450	15.53
Rear Holding Pond – 100% of pond	0.2	600	120	4.14
Total			**2,898.3**	**100**