Tillegra Dam

Planning and Environmental Assessment

WORKING PAPER

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Air Quality Assessment

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Hunter Water

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Aurecon came into existence in March 2009 through the merger of Connell Wagner Pty Ltd and two South African companies, Africon (Pty) Ltd and Ninham Shand (Pty) Ltd. This post-dated Hunter Water Corporation's engagement of Connell Wagner in July 2007 for professional services for the Tillegra Dam Planning and Environmental Assessment. All references to Connell Wagner in this report should be taken to now refer to Aurecon.

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Report prepared by aurecon

1. Introduction

1.1 Background

Hunter Water Corporation (HWC) is proposing to construct a 450 gigalitre dam at Tillegra near the town of Dungog in the Williams valley. Connell Wagner was engaged by HWC to undertake an environmental assessment and to assist in securing development approval for the Tillegra Dam project. The Project will be assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

To obtain approval from the Minister for Planning, HWC is required to assess the potential environmental impact of the proposed construction and operation of the dam (including related works such as the relocation of Salisbury Road). This has been done in two discrete stages:

- a preliminary environmental assessment to support a Major Project Application (completed in October 2007)
- a more detailed environmental assessment.

The Director-General's requirements for the Project were issued on 8 January 2008. With respect to air quality, the environmental assessment is required to

> include an assessment of air quality impacts associated with the project, particularly the winning of extractive material, and potential impacts on nearby sensitive receptors, prepared in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005).

This report is intended to address these matters.

1.2 Key air quality issues

The key issues relate principally to dust emissions and air quality impacts associated with the construction activities for both the dam and road works. Post-construction emissions are not considered a significant management issue.

This report addresses the following matters:

- air quality assessment of the Project activities was based on the DECC guidelines and standard industry practice
- description of the Project in terms of its location, nearby sensitive receptors and construction plant technology

- consideration of relevant NSW and Commonwealth regulations and guidelines
- understanding of the existing environment in terms of both the meteorology and current air quality
- definition of construction schedule, activities, intensities and quantification of dust emissions (TSP, PM_{10} and $PM_{2.5}$):
- TSP – total suspended particulate matter
- PM_{10} – particulate matter with aerodynamic diameter < 10 μm
- $PM_{2.5}$ – particulate matter with aerodynamic diameter < 2.5 μm
- description of parameters used in the air dispersion model, including the methodology used to assess the likely worst case airborne concentrations as well as deposition levels
- results of air dispersion modelling and assessment of the impact of emissions from the proposed activities on sensitive receptors associated with both dam and road construction activities.

1.3 Assessment methodology

The air quality assessment comprises:

- assessment of the Project impacts in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005)
- assessment of the local topography and land use
- identification of sensitive receptors
- identification of air emissions and hazards
- preparation of an emissions inventory of potential sources
- assessment of site-specific meteorology, in particular definition of the implications of wind speed, mixing height and stability class parameters
- assessment of current regional air quality using monitored results at the nearest DECC monitoring station
- meteorological air dispersion modelling using the CSIRO-developed TAPM (The Air Pollution Model) to accurately account for undulating terrain (the model will use worst case meteorological conditions as included in reference year 2004)
- assimilation of wind speed data to Bureau of Meteorology (BoM) monitored data at the nearest automatic weather station (AWS) and evaluation against the measured data
- calculation of short term cumulative ground level concentrations of $PM_{2.5}$, PM_{10} and TSP (deposition rates included)
- evaluation of results with regard to NSW and Commonwealth impact assessment criteria.

2. Project Description

2.1 Project overview

HWC is proposing to construct a dam at Tillegra near the town of Dungog in the Williams valley. The Project would inundate an area of approximately 2,100 hectares and have the capacity to store 450 gigalitres of water. Subject to HWC securing all necessary approvals, construction would commence with the construction of the new bridges and approaches for the relocated section of Salisbury Road. Construction of the dam would begin approximately 12 months later. The upper Williams River catchment receives large, regular flood flows which are expected to allow the dam to begin delivering water approximately four years after the start of construction.

The Project would comprise the following components:

Dam wall	A concrete face rockfill dam (CRFD), approximately 76 metres high and 800 metres wide located at Tillegra.
Spillway	A simple chute spillway controlled by an ogee crest located on the right abutment (looking downstream). The spillway would be 40 m wide at the crest contracting to a 30 metre wide chute, and approximately 600 metres long. The spillway would be designed to handle the PFM (Probable Maximum Flood) with a full storage prior to flood inflow and a dry freeboard above Design Flood Level of 1.3 metres.
Multi-level offtake tower	The dam design includes an offtake tower with full height selective withdrawal facilities. This would allow selection of water at optimum quality for releases.
Mini hydroelectric power plant	The dam outlet works include provision for installation of a mini HEP plant to take advantage of environmental flow releases and bulk water transfers from the dam. The plant could generate up to 3,000 MWh of electricity annually which is roughly equal to the energy demands of 500 households.
Transfer pipeline and pump station	The design includes a pipeline to transfer water from the dam to the Chichester Trunk Gravity Main (CTGM) which conveys water from Chichester Dam to Dungog water treatment plant, and then to various towns/settlements in the lower Hunter. The pipeline would be used as a backup to the existing water supply from Chichester Dam in the event of a water quality problem in the Chichester catchment.

The pipeline would be buried and located generally within the road reserve on the northern side of Salisbury Road.

Chlorination plant

A chlorination plant would be installed at Tillegra Dam to treat water prior to transfer to the CTGM. The purpose of this is to minimise the risk of bacterial growth, etc in the water as it is conveyed to the Dungog WTP.

Dam access roads

Access to the dam wall would be provided from below the dam. This access would be used for construction and modified as required for permanent access following completion of construction.

Salisbury Road realignment

The inundation area behind the dam wall would flood approximately 17 kilometres of Salisbury Road. The dam wall itself would be situated in the vicinity of Tillegra bridge (which is also within the dam footprint).

The relocated section of the road would run around the eastern side of the storage. This would include a new bridge over the Williams River approximately 500 metres downstream of Tillegra bridge. There would also be two bridge crossings over the Williams River at the northern end of the storage area in the vicinity of Underbank.

The road would be one lane in each direction with 3.5 metre lane widths and 0.5 metre shoulders/verges. It would be designed to applicable standards.

Provision of other access roads

Access to the Quart Pot Creek locality is currently via Quart Pot Creek Road which runs off the section of Salisbury Road in the inundation area. Alternative access would be provided to the locality off Salisbury Road above the inundation area.

Relocation of utilities and public infrastructure

The Project would impact on a number of utilities which currently traverse the inundation area. These include approximately 20 kilometres of telecommunications and electrical supply.

The Rural Fire Service (RFS) has a station located within the inundation area. An alternative location has been identified above the storage near where the new section of Salisbury Road would join the existing Salisbury Road.

Heritage conservation works

These works would largely comprise preservation of the historic Munni House and relocation of Quart Pot/Munni cemetery.

Carbon offset initiatives

The Project would include various initiatives to offset carbon emissions associated with construction and operation of the dam. These may include planting of trees, riparian revegetation, etc.

Ancillary works

A number of ancillary works are being considered as part of the Project. These include viewing areas, boat ramp, walking tracks, information centre, caretaker's residences, an office building and storage sheds, and a weather station.

2.2 Project site and sensitive receptors

The topography of Williams River catchment area where the dam would be located is undulating with large forested areas in the west and the Barrington Tops National Park immediately north of the proposed site. The elevation in the Williams River floodplain and within the proposed inundation area increases to 250 metres at the western-most construction site boundary and falls to approximately 125 metres at the northern-most site boundary.

Land in the immediate catchment area and the proposed inundation area is predominantly grassland and used primarily for agriculture. Small settlements including Bendolba, Bandon Grove, Fosterton, Munni and Brownmore are located in the vicinity of or within the proposed inundation area. Due to the predominantly rural setting the local air environment is not significantly affected by industrial or metropolitan emissions.

There are a number of sensitive receptors in the Tillegra locality and these are identified in Figure 2.1.

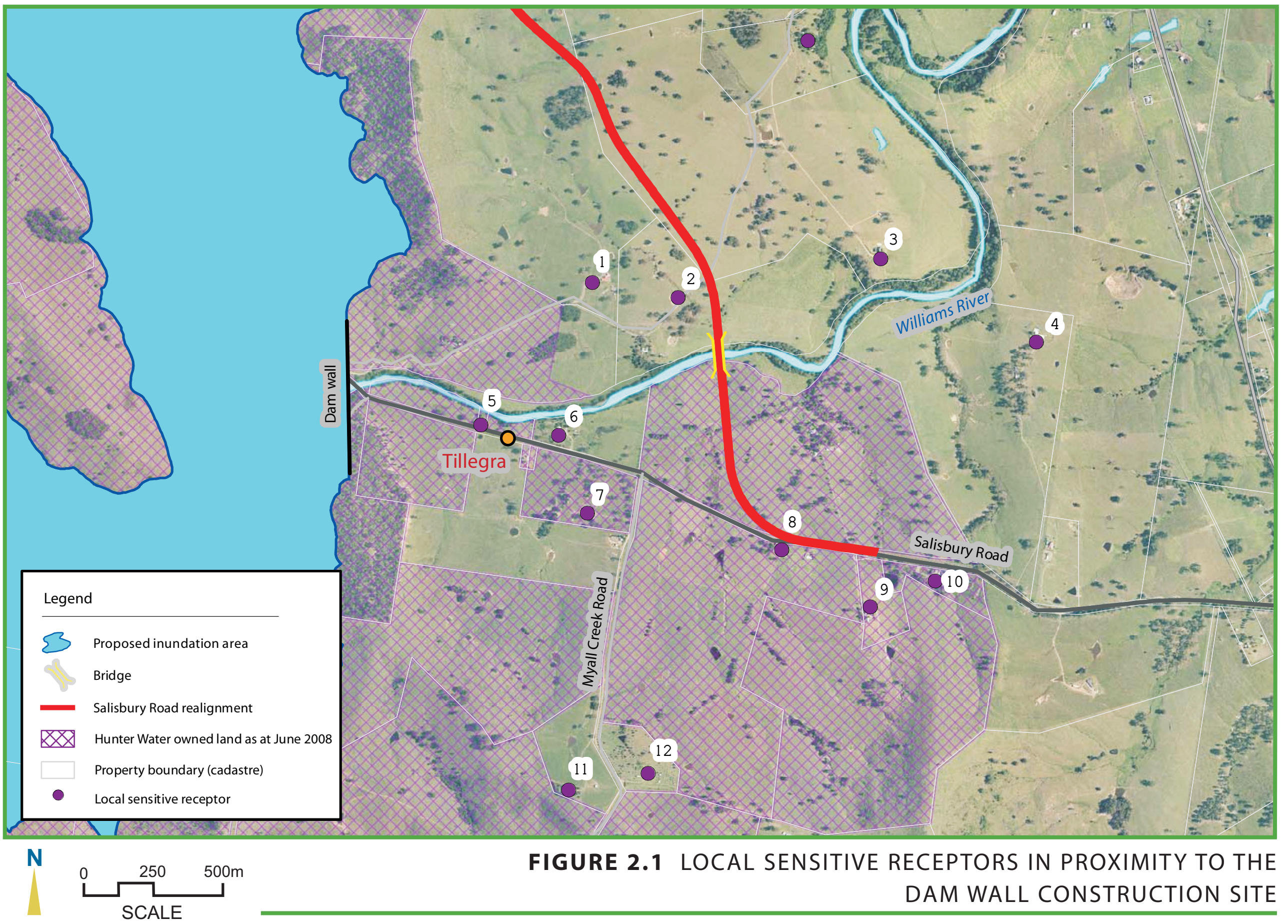


FIGURE 2.1 LOCAL SENSITIVE RECEPTORS IN PROXIMITY TO THE DAM WALL CONSTRUCTION SITE

There are seven receptors (1, 2, 8, 9, 10, 19, 20) located between the dam wall site and the realigned section of Salisbury Road. Three receptors (1, 2, 8) are on private land; the remainder are on HWC-owned land and currently leased. The leases would likely be terminated prior to construction but it is understood this would be considered on a case by case basis.

It is expected that impacts would likely be greatest at these locations although this would be mitigated to some extent by staging of construction works. Construction of the bridges and bridge approaches would occur prior to the commencement of dam construction activities. Minor air quality impacts could also be associated with the relocation of telecommunications and electrical supply infrastructure.

Taking a slightly wider perspective, there are a further six properties (6, 7, 11, 15, 16, 18) near the dam construction site; four of these (6, 7, 11, 18) are also owned by HWC.

Investigations undertaken by the Department of Commerce (DoC 2007) identified three potential sources of materials for construction. Quarry B, located approximately 500 metres to the west of the dam construction site, is the preferred source for construction material and is expected to provide most of the rockfill required for the dam embankment.

3. Construction Activities and Emissions

This section describes the construction activities and their anticipated timing. This information has been used to develop emissions estimates and dust emission rates associated with each major construction phase. The assumptions made in quantifying these emissions are also discussed.

3.1 Activities and timing

Construction activities would extend over approximately a four year period. Subject to HWC securing all necessary approvals, work would start in Year 1 with construction of the bridges for the realigned section of Salisbury Road together with the approaches to these crossings. The balance of work on Salisbury Road and other works such as construction of the alternate access to the Quart Pot Creek area would commence in Year 2. Construction of the dam would also commence in Year 2 and go through to Year 4. The majority of construction works would be completed by the end of Year 3.

Working hours would be subject to the final approval but construction is proposed to take place six days a week (excluding Sundays and public holidays) from 7.00 am to 6.00 pm. Some construction activities (eg major concrete pours) may need to take place outside of this period and would be addressed on a case by case basis. Some dust emissions could be associated with these activities.

Construction of the dam would occur in three major phases while road works would comprise two major phases, these overlapping to some extent. These are described briefly in Table 3.1 together with the anticipated dust generating activities.

TABLE 3.1 CONSTRUCTION PHASES AND LIKELY DUST-GENERATING ACTIVITIES

CONSTRUCTION PHASE AND MAIN ACTIVITIES	START DATE AND DURATION	LIKELY DUST-GENERATING ACTIVITIES
1 Road construction • bridges and approaches	Year 1 52 weeks	Clearing, grubbing and stripping of vegetation – mulching and stockpiling using dozers and mulchers. Excavation for road – haulage of waste Construction of roads Establishment of quarry, batching facilities, crushing plant. Dust generation from earthmovers Wheel generated dust from vehicular traffic on unsealed roads
2 Road construction • remaining works	Year 2 104 weeks	
1 Dam construction • site clearing • establishment of site access roads, quarry, crushing plant • excavation of inlet and outlet channels, lower spillway, embankment (above river level) and upstream coffer dam • excavation of diversion tunnel and upper spillway • preparation of embankment foundations below river level	Year 2 48 weeks	Rock excavation – open cut blasting Drilling pre-split holes Spillway excavation Drilling of drainage holes Quarry stripping – rockfill haulage Foundation excavation/preparation – waste rock haulage. Main embankment – rockfill haulage, placement and compacting Main embankment – foundation grouting. Wind erosion from exposed areas Concrete batching – toe slab, parapet wall, face slab. Crushing of aggregate Wheel generated dust emissions from vehicular traffic on unsealed roads Erosion from stockpiles Dust generation from earthmoving activities
2 Dam construction • completion of excavation of lower spillway (through Salisbury Road) • construction of coffer dams and diversion of river through tunnel • construction of embankment • closure of river diversion • construction of CTGM transfer pipeline	Year 3 108 weeks	
3 Dam construction • valve block and outlet • parapet wall and embankment road • amenities, landscaping, etc	Year 4 24 weeks	Wheel generated dust emissions from vehicular traffic on unsealed roads Emissions from excavation activities Concrete batching Rock crushing Waste haulage

3.2 Emissions quantification

Dust emission rates from the described construction activities were quantified from the NPI Emissions Estimation Handbook for Mining and Processing of Non-metallic Minerals. The US EPA guideline AP42 *Compilation of Air Pollutant Emission Factors* for concrete batching and crushed stone processing was used for emissions from sources/activities not covered by the NPI handbooks. The emission factors for TSP and PM_{10} from various construction activities are listed in Table 3.2.

TABLE 3.2 PREDICTED EMISSION FACTORS FROM CONSTRUCTION ACTIVITIES PROPOSED

ACTIVITY	EMISSION FACTORS		UNITS	DUST CONTROL	REFERENCE
	TSP	PM_{10}			
Loading trucks (Excavator)	0.0022	0.0011	kg/t	Moisture ~ 2%	NPI Mining and Processing Handbook
Excavation of rock from quarry	0.029	0.014	kg/t	–	Excavators on coal 'NPI Mining and Processing Handbook
Excavation of overburden from quarry	0.025	0.012	kg/t	–	Excavators on overburden – NPI Mining and Processing Handbook
Excavation of alluvium	0.005	0.002	kg/t	Assumed to be material with 100% moisture content	NPI Mining and Processing Handbook
Dozer on stockpiles	16.74	4.07	kg/ha	Silt content = 10 Moisture = 2% 8 hrs/day	NPI Mining and Processing Handbook
Wind erosion from exposed areas	4969.3	2484.7	kg/ha/year	50 % control with water sprays. 109 rain days pa 14.8 % winds > 5.3 m/s	NPI Mining and Processing Handbook
Wheel generated dust >50t haul trucks	4.1	1.0	kg/VKT	75% control with water sprays Silt content = 10 Moisture = 2%	US EPA AP 42
Blasting	97.2	50.5	kg/blast	Average Area ~ 190 m^2 Blast Depth ~ 10 m Moisture ~ 2%	US EPA AP 42
Drilling	0.177	0.093	kg/hole	70 % Control with water sprays/fabric filter	NPI Mining and Processing Handbook
Crushing aggregate	0.0027	0.0012	kg/t	Wet suppression (spray nozzles)	US EPA AP42 Crushed Stone Processing
Concrete batching	0.0045	0.0024	kg/t	Baghouse on silo transfers, watering down of aggregate stockpiles and clean paved areas around plant	US EPA AP42 Concrete Batching
Trucks dumping overburden	0.012	0.0043	kg/t	–	NPI Mining and Processing Handbook
Embankment wind erosion	4969.3	2484.7	kg/t	–	NPI Mining and Processing Handbook

The emission factors listed in Table 3.2 were used in conjunction with the predicted construction activity rates for each type of activity as listed in Table 3.3, in order to determine the PM_{10} and TSP emission rates. The activity rates were sourced from the options study (NSW Department of Commerce 2007). The emissions quantified are representative of the latter part of Stage 1 and a large proportion of Stage 2 of the dam construction program as outlined in the options study. The emissions were quantified for a one year period commencing in the final quarter of Year 2, when construction activities are expected to result in the most significant degree of airborne emissions.

TABLE 3.3 PREDICTED EMISSION FACTORS FROM CONSTRUCTION ACTIVITIES PROPOSED

ACTIVITY	ACTIVITY RATE	ACTIVITY RATE	EMISSION RATE (g/s)	
			PM_{10}	TSP
Loading trucks (excavator)	2.33×10^6	tonnes/year	0.19	0.39
Excavation of rock from quarry	2.33×10^6	tonnes/year	2.48	5.1389
Excavation of overburden from quarry	2.33×10^6	tonnes/year	2.13	4.4301
Excavation of alluvium for embankment foundations	101,250	tonnes/year	0.02	0.0384
Dozer on stockpiles	2,920	hrs/year	0.90	3.7088
Wind erosion from exposed areas	16	ha	3.02	6.03
Embankment wind erosion	11	ha	2.07	4.15
Wheel generated dust > 50 t haul trucks	58,370	VKT/year	4.39	28.4
Blasting	365	blast/year	1.40	2.69
Drilling	7,665	holes/year	0.054	0.103
Crushing aggregate	64	tonnes/hr	0.021	0.048
Concrete batching	2.53×10^5	tonnes/year	0.046	0.086
Trucks dumping overburden	2.33×10^6	tonnes/year	0.76	2.12

3.2.1 Key assumptions

In order to make the above estimations several key assumptions were made with regards to the site activities and the nature of the local environment. These assumptions are summarised in Table 3.4.

TABLE 3.4 KEY ASSUMPTIONS WITH REGARD TO EMISSIONS ESTIMATION

SUBJECT	ASSUMPTIONS
Wind blown dust	Assumed to be a source of emissions 11 hours a day every day of the year. It is assumed that large stockpiles exposed to the wind would be shielded by a cover and/or barriers. Such measures are recommended to be incorporated into the construction air quality management plan. Wind erosion from other exposed surfaces during night time is generally likely to be negligible due to low wind speeds at night time, leading to insignificant dispersion of airborne dust.
Haulage of waste and quarry material	Assumed to be a source for 11 hours a day Monday to Saturday. Wheel-generated dust assumed to be predominantly from haulage of quarry rockfill material from Quarry B to main embankment area. Wheel-generated dust from traffic on sealed roads assumed to be negligible. Particulate emissions from diesel exhaust assumed to be negligible in comparison with wheel-generated dust hence was not included in emissions.

SUBJECT	ASSUMPTIONS
	Adequate dust control would be achieved by watering of haulage routes within the Project site boundary and on unsealed road. 75 percent emissions control expected to be achieved by watering at a rate of 2 $L/m^2/hr$.
Soil moisture/silt content	Moisture content of soil in this area assumed to be approximately two per cent for all cases. Silt content assumed to be approximately 10 per cent.
Daily emissions duration	All other emissions expected to be a source 11 hours/day from the hours between 7.00 am–6.00 pm, Monday to Saturday.

4. Assessment Criteria

4.1 New South Wales

The *Protection of the Environment Operations (Clean Air) Regulation 2002* replaced a multitude of documents that governed air quality impact for a range of industrial and domestic polluting activities. Part 4 of the Regulation deals with emissions of air impurities from activities and plant. In particular, the Regulation:

- sets maximum limits on emissions from activities and plant for a number of substances, including oxides of nitrogen, smoke, solid particles, chlorine, dioxins, furans and heavy metals
- imposes operational requirements for certain afterburners, flares, vapour recovery units and other treatment plant
- deals with the transport and storage of volatile organic liquids (Part 5)
- restricts the use of high sulphur liquid fuel (Part 6).

This first bullet point is of relevance to the air quality assessment of construction and operational activities for the Tillegra Dam project. The NSW air quality guidelines applicable to this project are provided in Table 4.1.

TABLE 4.1 NSW AIR QUALITY GUIDELINES

POLLUTANT	AVERAGING PERIOD	CONCENTRATION	
		µg/m³	g/m²/MONTH
PM_{10}	24 hours	50	–
PM_{10}	Annual	30	–
TSP		90	–
Deposited dust	Annual	–	2*
	–	–	4^

1 Sourced from the guideline Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DECC 2005)
* Maximum increase in deposited dust level
^ Maximum total deposited dust level

The air quality assessment has also considered emissions of particulate matter with a diameter of 2.5 micrometres in size ($PM_{2.5}$). Currently, there is no NSW standard for this pollutant. The DECC website indicates that this is due to insufficient data but a standard is in preparation. Advisory levels exist at the national level and are discussed in the following section.

4.2 Commonwealth

4.2.1 NEPM criteria pollutants

The Environment Protection and Heritage Council (EHPC) incorporates the National Environment Protection Council (NEPC). The EPHC/NEPC has developed National Environmental Protection Measures (NEPMs) which outline agreed national objectives for protecting and managing aspects of the environment.

The Ambient Air Quality NEPM sets standards and goals at levels that protect human health and well being, aesthetic enjoyment and local amenity. The standards are defined as concentrations either in parts per million (ppm) or, for particulate matter, micrograms per cubic metre (μg/m^3). The goals in the Ambient Air Quality NEPM specify a maximum permissible number of days per year when the standards may be exceeded and a timeframe of 10 years (1998–2008) within which these goals must be met. These are listed in Table 4.2

TABLE 4.2 ENVIRONMENT PROTECTION (AIR QUALITY) POLICY

POLLUTANT	AVERAGING PERIOD	MAXIMUM CONCENTRATION		MAXIMUM ALLOWABLE EXCEEDANCES (DAYS/YR)
		ppm	μg/m^3 @ STP*	
Nitrogen dioxide	1 hour	0.12	226	1
Nitrogen dioxide	Annual	0.03	58	–
Carbon monoxide	8 hours	9.0	1100	1
Sulphur dioxide	1 hour	0.2	525	1
Sulphur dioxide	1 day	0.08	210	1
Sulphur dioxide	1 year	0.02	53	–
Coarse particulates (PM_{10})	1 day		50	5

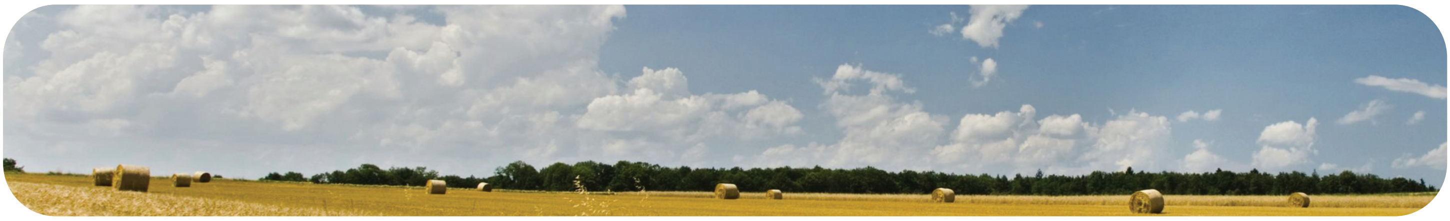
* The guideline defines STP (standard temperature and pressure) as 25 C and at an absolute pressure of one atmosphere

In May 2003, the NEPC made the Variation to the Ambient Air Quality NEPM which strengthens air quality standards to help protect Australians from the adverse health impacts of small pollutant particles. The Variation introduces advisory reporting standards for fine particles 2.5 micrometres or less in size (ie $PM_{2.5}$). These are listed in Table 4.3. The advisory reporting standards will assist in gathering sufficient data nationally on fine particles, with the information used to inform the review process for the Ambient Air Quality NEPM.

TABLE 4.3 ENVIRONMENT PROTECTION (AIR QUALITY) POLICY AMENDMENT (INVESTIGATIVE LEVEL)

POLLUTANT	MAXIMUM CONCENTRATION		MAXIMUM ALLOWABLE EXCEEDANCES (DAYS/YR)
	ppm	μg/m^3 @ STP	
1 day	n/a	25	Not established
1 year	n/a	8	Not established

The intention of the advisory reporting standards is to assist in gathering sufficient data nationally on fine particles. The information will be used to inform the review process for the Ambient Air Quality NEPM.



5. Existing Air Quality

5.1 Air quality monitoring in study area

Air quality within Dungog Shire is primarily influenced by fugitive emissions of particulate matter as PM_{10}. Sources of this particulate matter include wind-blown dust, prescribed burning or bushfires, domestic combustion of solid fuel, quarrying and motor vehicle emissions.

Emissions of particulate matter from construction activities are of concern for the proposed project. The guideline *Approved Methods for the Modelling and Assessment of Air Pollutants* in NSW (DECC 2005) requires inclusion of background concentrations of pollutants in assessing impacts on receptors. Section 5.1 of the guideline notes that ideally background concentrations of air pollutants are obtained from ambient monitoring data collected at the proposed site. It further notes that this is extremely rare and accordingly, data is typically obtained from a monitoring site as close as possible to the proposed location where the sources of air pollution resemble the existing (or in this case, likely) sources at the proposed site.

In the absence of publicly accessible site-specific air quality monitoring data, a continuous day of monitoring was undertaken near the settlements of Underbank and Tillegra. The ground level concentration (GLC) profile of a single day (7 August 2007) is plotted in Figure 5.1.

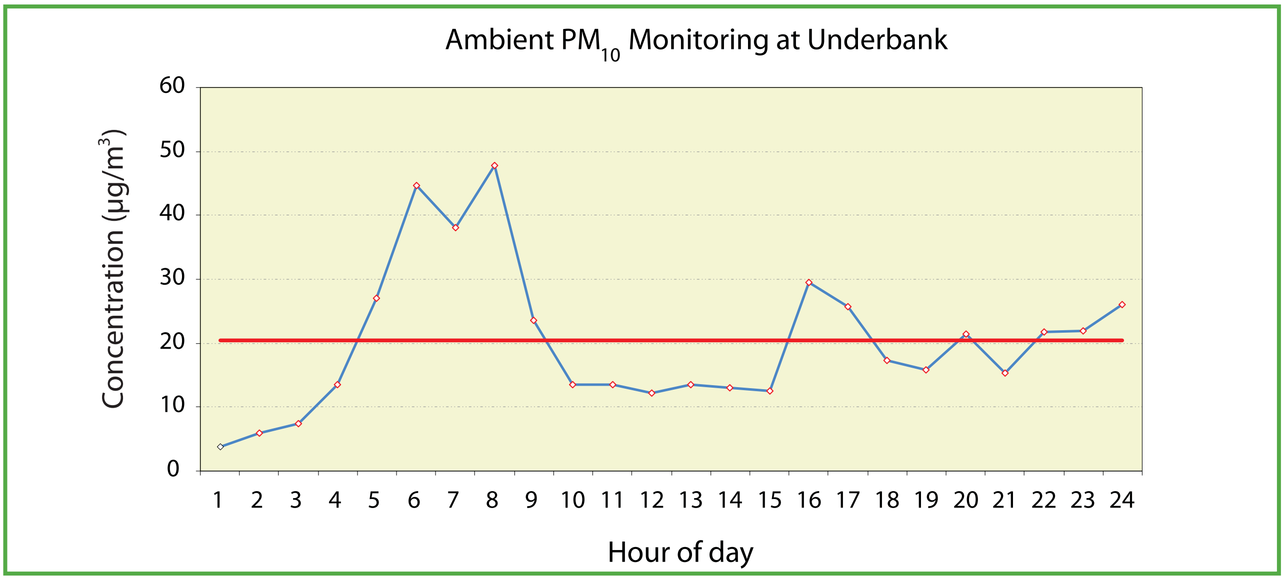


FIGURE 5.1 AMBIENT PM_{10} (µG/M³) GROUND LEVEL CONCENTRATION MONITORING

The concentration profile shows that levels are maximised early in the morning and in the early evening when temperature inversions which inhibit air mixing results in accumulation of pollutants at ground level. The daily averaged concentration was found to be approximately 20.5 $\mu g/m^3$ (denoted by the red line).

While this provides a limited 'snapshot' of local air quality, the recorded data was not considered to be of sufficient length to accurately characterise baseline conditions nor the seasonal variations in recorded ground level concentrations at Tillegra with any reasonable degree of confidence.

Accordingly, a suitable alternative information source was required. The following section describes how this was identified.

5.2 DECC air quality monitoring data

Identification of a suitable alternative data source initially involved a review of the DECC air quality monitoring network to identify firstly the station closest to the site and secondly, other stations with surrounding land uses similar to Tillegra. In both instances, it was desirable for a station to have suitable records of at least 12 months duration to consider seasonal variations.

The nearest DECC monitoring station is located at Beresfield; approximately 60 kilometres to the south of Tillegra. Concentrations of ozone, particulates as PM_{10}, nitrogen dioxide (NO_2), and sulphur dioxide (SO_2) are recorded at this site. However, ground-level concentrations are likely to be influenced by emissions from urban and industrial sources from nearby Newcastle as well as from intermittent sea spray effects.

Given the differing locational contexts of Tillegra and Beresfield, it was considered that use of data from Beresfield would likely overestimate pollutant levels and not accurately characterise background conditions at Tillegra and therefore impacts on receptors.

There are two other stations in the lower Hunter (Newcastle, Wallsend) but neither were considered suitable for similar reasons to the Beresfield station.

Other DECC stations that were potentially more representative (relatively) and which monitored PM_{10} levels included Bathurst, Albury, Wagga Wagga, and Tamworth.

Of these stations, Bathurst was considered potentially the most suitable. The station is located at the Bathurst wastewater treatment plant which is on the northern outskirts and is adjacent to a substantial rural/semi-rural area.

However, there is a notable difference in agricultural land use between Tillegra and the Bathurst monitoring station. The former is under pastoral/grazing while the latter is under cropping. Use of the Bathurst monitoring data could therefore potentially overestimate particulate emissions at Tillegra due to the greater exposure, both in terms of extent and duration, of bare soil surfaces.

Additionally, all stations are located within or on the outskirts of substantial settlements and as such, likely not directly comparable with the Tillegra locality.

Given the considered limitations of the DECC stations, a search was then undertaken of other potential information sources in the lower Hunter region. A number of possible sites, principally associated with mining developments were identified. Publicly available ambient air quality information was obtained for two locations, namely Stratford Coal Mine and Glennies Creek Open Cut Mine. For the former, 24-hour average PM_{10} concentration data was available for the period 5 July 2001 to 27 June 2006, while date for the latter covered the period 25 August 2005 to 26 August 2006.

Monitoring was undertaken at two sites initially for the Stratford Coal Mine with a further two sites added in March 2003. For the Glennies Creek Open Cut Mine, monitoring was undertaken at two sites. The monitoring results for the Stratford Coal Mine included annual 24-hour average PM_{10} concentrations and are reproduced in the following table.

TABLE 5.1 STRATFORD COAL MINE ANNUAL 24-HOUR AVERAGE PM_{10} CONCENTRATIONS[1]

PERIOD	WHEATLEYS RD	CRAVEN	ELLIS RESIDENCE	CLARKE RESIDENCE
Jul 2001 to Jun 2002	8.6	11.0	ND[2]	ND
Jul 2002 to Jun 2003	16.2	16.6	ND	ND
Jul 2003 to Jun 2004	13.0	11.9	16.2	13.3
Jul 2004 to Jun 2005	11.6	10.7	13.2	10.0
Jul 2005 to Jun 2006	10.3	9.2	14.5	6.9

1 Concentrations in µg/m^3
2 No data available

The average of the above readings is approximately 12 µg/m^3. In view of this, it was considered reasonable to adopt a background of 15 µg/m^3 for the Tillegra locality.

A value judgment was made in determining an appropriate background concentration that represents the ambient levels in the region being considered in a manner that is not overly conservative. In this situation that value judgment involved the selection of values that were not overly influenced by the operations at Stratford coal mine.

From a review of the data for the period December 2006 to December 2007, values of 10 µg/m^3 and 0.8 g/m^2/mth were adopted as background levels for annual average PM_{10} and average monthly TSP respectively.

Data representing annual average TSP concentrations was not provided in these reports. Reference was subsequently made to monitoring results collected from a high volume sampler operated for 24 hours every six days as per AS3580.9.3 for two sites, one in the upper Hunter and the other at Mayfield in Newcastle. The former site has exposure to coal mining operations while the latter is exposed to a busy road and a large remediation site, so neither could be considered representative of the Tillegra locality, where land use is predominantly rural, agricultural (grazing).

They were, however, still considered to be of value in assessing quantitatively where the Tillegra locality might sit relative to these locations. The annual average TSP values for 2008 for these the upper Hunter and Mayfield sites were 79 µg/m^3 and 36 µg/m^3 respectively. Based on these values, it is expected that annual average TSP for the Tillegra locality would be less than the lower of these values. Accordingly, a value of 30 µg/m^3 has been adopted for the assessment.

Report prepared by aurecon

6. Prognostic Meteorological and Air Dispersion Model

6.1 TAPM

TAPM (The Air Pollution Model) is a CSIRO-developed prognostic meteorological and air dispersion modelling tool. This was used to accurately account for complex terrain effects in the study area and to pre-process spatially varying hourly meteorological data. TAPM produces meteorological data, upper air information and temperature profiles for a simulation period in three dimensions for all the grid points across the modelling domain by solving the Navier-Stokes equations initialised with the input synoptic analyses. The gridded meteorological data generated by TAPM is calculated from the synoptic information determined from the six hour interval limited area prediction system (LAPS) (Puri *et al* 1998). The final meteorological data is representative of the local topography, land use, surface roughness and temperature effects caused by water bodies.

The TAPM nesting grid (mesh) was determined for this model via consideration of the required terrain resolution in the radius of influence (approximately five kilometres). The required terrain resolution was achieved via use of a nested grid with a minimum spacing of 400 metres which reflects the gentle, rolling gradient of the local topography. The dispersion grid was modelled with a smaller grid spacing of 200 metres due to the requirement for good near field source resolution. The default Eulerian mathematical computational option incorporated into TAPM was used when running the dispersion model.

6.2 Model configuration

A basic summary of the data and parameters used in both the meteorological and dispersion parts of TAPM is provided in Table 6.1.

TABLE 6.1 TAPM INPUT PARAMETERS

LOCATION (GRID CENTRE)	32° 41' 18" S 151° 41' 18" E UTM ZONE: 56S mE: 376539 mN: 6423385	
Dates	2004 (GMT +10.1)	
	Meteorology	**Dispersion**
Grid	27 x 27 x 20 (nx x ny x nz)	45 x 45 (nx x ny)
Nesting	20 – 5 – 1.6 – 0.4 km	10 – 2.5 – 0.8 – 0.2 km
Assimilation	Hourly wind data from BoM station Paterson AWS	
Pollutants	Dust mode with deposition and settling	

The DECC approved modelling methods states that meteorological assimilation is necessary for surface borne emissions due to the fact that the current version of TAPM is unable to accurately predict the frequency of low wind speeds during stable conditions. Prediction of these wind speeds is important to develop a worst case assessment, due to the fact that low wind speeds inhibit pollutant dispersion and hence enhance the accumulation of pollutant concentrations. However, the application of the dispersion model in this assessment requires adequate prediction of high wind speeds to allow for dispersion of surface borne dust emissions into sensitive regions, beyond the construction site boundary.

To assist in this, hourly wind data (measured at 10 metres) for the modelling reference year (refer Section 7.1)) was sourced from the nearest Bureau of Meteorology (BoM) weather station at Paterson AWS, this being the closest station with sufficient record length of hourly wind data. Paterson AWS is approximately 40 kilometres south of Tillegra.

The ability of TAPM to accurately predict the magnitude and direction of wind speed on a seasonal, annual and cumulative wind class frequency basis against the measured BoM data is discussed in Section 7.2.1. A reasonable frequency of high wind speeds must also be predicted to enable dispersion of pollutants outside of the site boundary into sensitive regions. Analysis of the TAPM data shows that the predicted meteorology will allow the emissions to be dispersed in a manner that represents a worst-case assessment.

All the emissions sources listed in Table 3.3, with the exception of rockfill haulage and emissions from alluvium excavation, were input as area sources with TAPM in tracer mode (with deposition and settling) for this application. This approach is standard industry practice when performing dispersion modelling in TAPM. Dust emissions were assumed to cycle every 24 hours with non-zero emissions only between the work hours of 7.00 am and 6.00 pm daily. Results were adjusted to remove Sundays to reflect this being a non-work day.

7. Meteorology

7.1 Introduction

Ground-level concentrations resulting from a constant discharge of contaminants change according to the weather (particularly the wind and atmospheric stability) conditions at the time. Meteorology is fundamental for the dispersion of pollutants because it is the primary factor determining the dilution effect of the atmosphere. Therefore, it is important that meteorology is carefully considered when modelling pollutant dispersion. Surface pollutant dispersion and deposition over distances are affected by:

- wind speed, profile and turbulence intensity (which are affected by terrain)
- temperature gradient which is determined from atmospheric stability (which in itself is determined from wind speed, cloud cover and solar radiation)
- mixing height
- wet deposition of pollutants by rainfall.

Measured meteorological conditions were simulated for a full year with 2004 selected as the reference year. This year was selected as it was considered to be representative of the long term climatic conditions in this region. This is shown via a comparison of particular meteorological parameters between that monitored during the reference year and the long term average levels. These were sourced from the BoM for the closest weather station (Lostock Dam).

The comparison of the long term average (LTA) monthly mean maximum temperatures with the 2004 monitored data in Figure 7.1 shows that average meteorological conditions in 2004 did not vary significantly from the long-term conditions at the site. Similarly, the comparison of the monitored 9.00 am wind speed conditions at Lostock Dam (Figure 7.2) shows that the monitored data for 2004 approximately correlates with the LTA data set. In view of this, it is considered that 2004 is an appropriate reference year. TAPM's ability to predict the meteorological conditions that will enable a worst case assessment is discussed in Section 7.2.

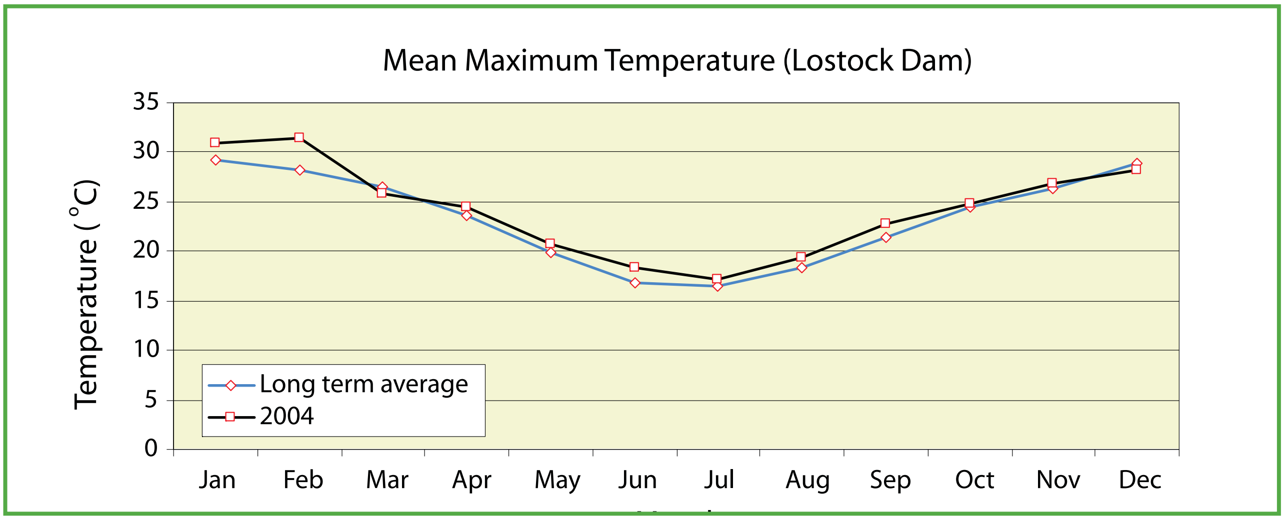


FIGURE 7.1 COMPARISON OF MEAN MAXIMUM TEMPERATURE FOR LONG TERM AVERAGE AND 2004

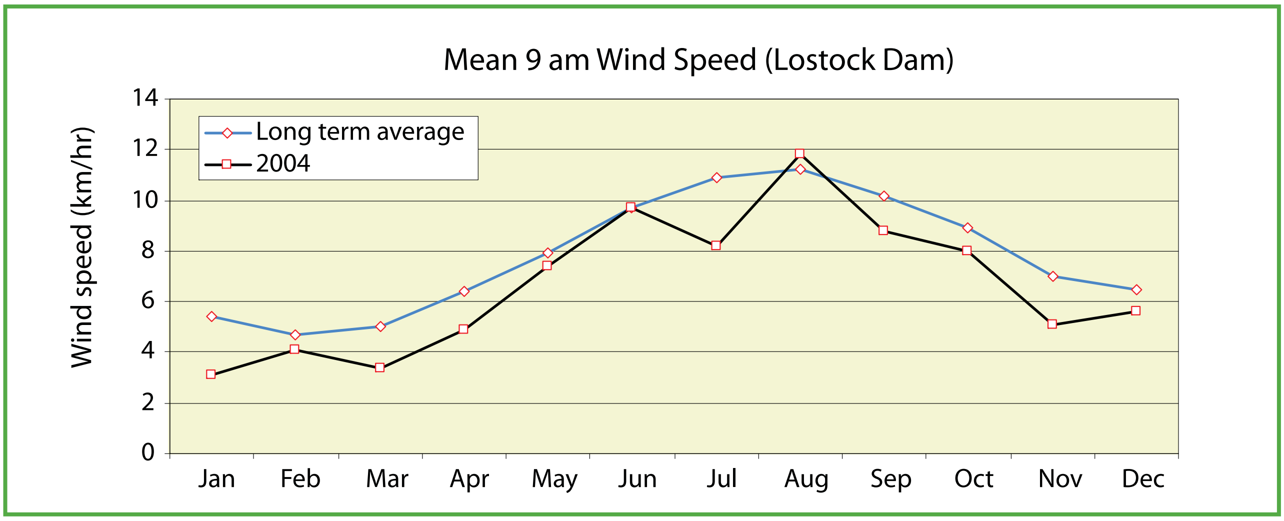


FIGURE 7.2 COMPARISON OF MEAN 9.00 AM WIND SPEED FOR LONG TERM AVERAGE AND 2004

7.2 Wind

Synoptic data for the Hunter region was obtained from the BoM and used to configure TAPM to predict meteorological parameters for the reference year (2004). The following sections compare TAPM's predicted data with BoM measured data at Paterson AWS to evaluate the accuracy of TAPM at predicting wind conditions as these are important to a worst case assessment. This is done by comparison of seasonal and annual wind statistics given the joint probability of wind speed and direction (wind rose comparisons), and cumulative wind class frequency distributions for a full year of wind data.

Local (ie at the construction site) prevailing wind conditions; in terms of both wind speed and direction, that are likely to influence dispersion of surface emissions from construction activities are also described.

7.2.1 Evaluation of predicted wind conditions at Paterson

Seasonal and annual wind roses allowing a comparison between BoM and TAPM wind speed and directionality are shown in Appendix A:

- **Summer**: BoM data shows winds are predominantly from the east, TAPM slightly over predicts the frequency of wind speeds in the north east quadrant. Good correlation observed between wind speed and directionality.
- **Autumn**: BoM data shows winds are predominantly from the west and north west. Reasonable correlation in wind direction with a strong norther westerly and easterly components being over predicted by TAPM. The frequency of low wind speeds is predicted reasonably by TAPM with the exception of calms.
- **Winter**: BoM data shows winds are predominantly from the west and north-west. Good correlation for both wind direction and wind speeds is obtained. TAPM over predicts the frequency of north westerly winds and under predicts the westerly component. TAPM underpredicts calm conditions.
- **Spring**: BoM data shows winds are predominantly from the west. Reasonable correlation in wind direction with north westerly and easterly components being over predicted by TAPM. The frequency of low wind speeds is predicted reasonably by TAPM with the exception of calms.

The BoM data shows strong westerly components of wind that are overpredicted by TAPM; however other wind directions are shown to have reasonable correlation. The frequency of calm conditions is under predicted by TAPM with low wind speeds predicted well, this is shown in the annual wind class frequency distribution is shown in Appendix A. The TAPM dataset is seen to underpredict the frequency of high wind speeds and over predict mid range wind speeds (2.1–3.6 m/s). This notwithstanding, TAPM provides a reasonable frequency of low and high wind speeds to enable the probability of worst case meteorological conditions that would result in pollutant accumulation in sensitive areas.

7.2.2 Predicted wind conditions at Tillegra

The annual wind rose for Tillegra as predicted by TAPM data is shown in Figure 7.3. This shows that the prevailing wind is from the north-west throughout the year. However the analysis of the wind directionality and speeds at Paterson AWS shows that the frequency of this direction at Tillegra might be over predicted.

The analysis of seasonal wind roses at Tillegra indicates the following:

- Easterly winds from both the south east and north east quadrants, as well as north west winds are most common during the construction working hours (7.00 am to 6.00 pm) in the summer months (December, January and February)
- North-westerly winds dominate the winter months with 75 per cent of winds having magnitude less than 5.3 m/s
- Autumn winds are dominated by those blowing from the west as well as those blowing from the north and south east quadrants. 85 per cent of wind speeds are less than 5.3 m/s in magnitude. Periods of low wind speeds are most common during this season
- As expected the stronger winds generally tend to occur during the summer months and in the afternoon hours.

The cumulative annual wind class frequency distribution for this site as predicted by TAPM is shown in Figure 7.4. This shows that more than 85 per cent of wind speeds predicted have magnitudes less than 5.3 m/s.

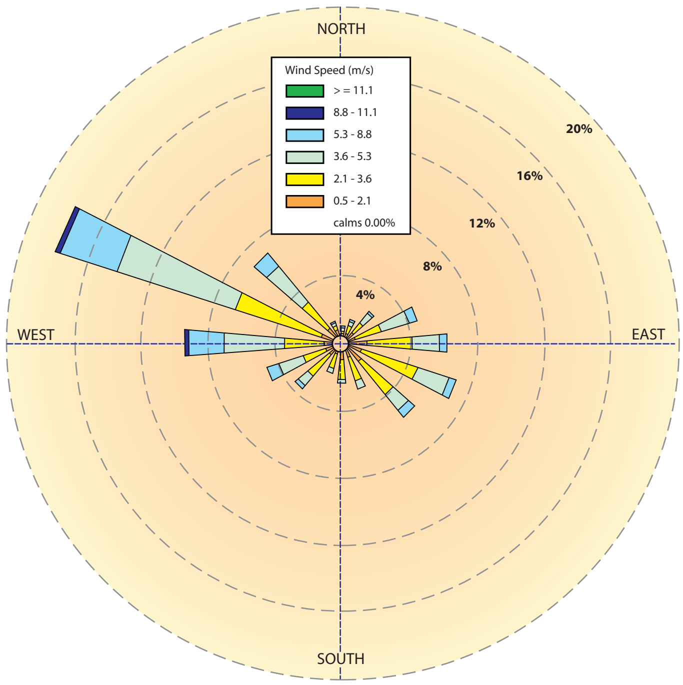


FIGURE 7.3 ANNUAL WIND ROSE FOR TILLEGRA AS PREDICTED BY TAPM WIND ASSIMILATED DATA SET

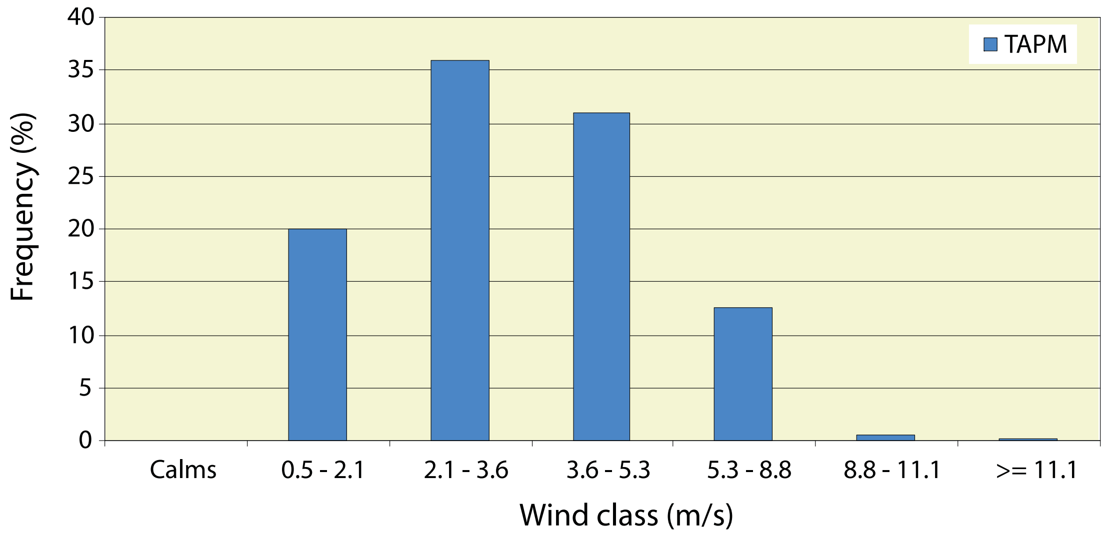


FIGURE 7.4 ANNUAL CUMULATIVE WIND CLASS FREQUENCY DISTRIBUTION FOR TILLEGRA AS PREDICTED BY TAPM WIND ASSIMILATED DATA SET

7.3 Atmospheric stability at Tillegra

The degree of stability in the atmosphere is determined by the temperature difference between an 'air parcel' and the air surrounding it. This difference can cause the air parcel to move vertically, and this movement is characterised by four basic conditions that describe the general stability of the atmosphere. In stable conditions, this vertical movement is discouraged, whereas in unstable conditions the air parcel tends to move upward or downward and to continue that movement. When conditions neither encourage nor discourage that movement beyond the rate of adiabatic heating or cooling they are considered neutral. When conditions are extremely stable, cooler air near the surface is trapped by a layer of warmer air above it, with this condition being called an inversion which results in virtually no vertical air motion.

The Pasquill-Gifford (P-G) stability category scheme is normally used to describe atmospheric stability. Stability class under the P-G scheme is designated a letter from A-F (and sometime G), ranging from highly unstable to extremely stable. There are a number of methods for determining stability classes with Turner's method the most common. This method estimates the effects of net radiation on stability from solar altitude, total cloud cover and ceiling height. The stability class is estimated as a function of wind speed and net radiation as shown in Table 7.1.

TABLE 7.1 STABILITY CATEGORIES

WIND SPEED[a] (M/S)	DAY-TIME INCOMING SOLAR RADIATION (MW/cm^2)				1 HOUR BEFORE SUNSET OR AFTER SUNRISE	NIGHT-TIME CLOUD COVER (OCTAS)		
	>60	30-60	<30	OVERCAST		0-3	4-7	8
< 1.5	A	A-B	B	C	D	F or G[b]	F	D
2.0 - 2.5	A-B	B	C	C	D	F	E	D
3.0 - 4.5	B	B-C	C	C	D	E	D	D
5.0 - 6.0	C	C-D	D	D	D	D	D	D
> 6.0	D	D	D	D	D	D	D	D

[a] Wind speed is measured to the nearest 0.5 m/s
[b] Category G is restricted to night-time with less than 1 octa of cloud and a wind speed less than 0.5m/s

The stability class rose and the frequency distribution of stability classes for the site are shown in Figures 7.5 and 7.6 respectively. As can be seen, the Project area is dominated by neutral and stable conditions with stability class D being significantly dominant. The high occurrence of relatively stable meteorological conditions is due to the low wind speeds in the area. Significant cloud cover in the area resulting in minimal solar radiation also causes reduced heating and cooling of the surface leading to neutral conditions.

The frequency distribution of stability class with time of day is shown in table 7.2. Neutral and stable stability classes are observed through the night-time, as expected. Throughout the day however the stability class shifts from neutral-stable to neutral-unstable due to the convective nature of the boundary layer. The convection arises from the solar irradiation of the earth's surface, resulting in enhanced mixing.

Table 7.3 displays the frequency distribution of stability versus wind speed. The wind speeds are observed to follow the expected outcome with stability class. In view of this, the processed surface data appears to provide reliable data based on stability class.

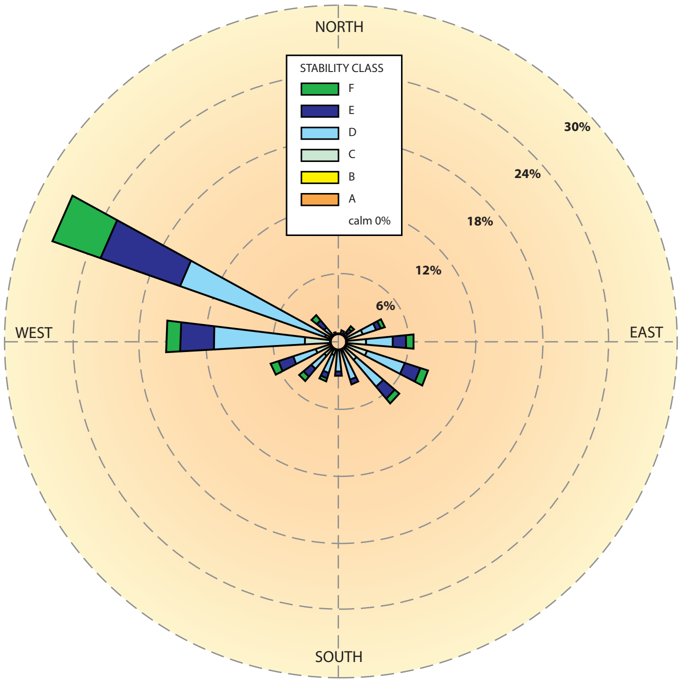


FIGURE 7.5 STABILITY CLASS ROSE

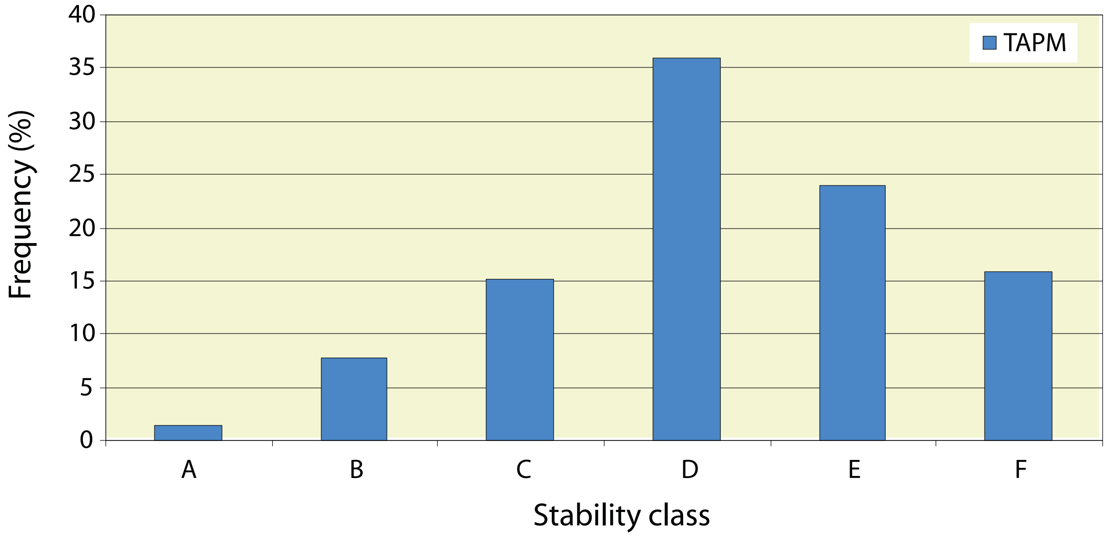


FIGURE 7.6 STABILITY CLASS FREQUENCY DISTRIBUTION

TABLE 7.2 FREQUENCY DISTRIBUTION OF STABILITY CLASS VERSUS TIME OF DAY

HOUR OF DAY	STABILITY CLASS					
	A	B	C	D	E	F
1	0	0	0	68	186	112
2	0	0	0	65	189	112
3	0	0	0	63	196	107
4	0	0	0	66	189	111
5	0	0	0	79	172	115
6	0	0	0	213	95	58
7	0	0	2	325	23	16
8	0	0	62	304	0	0
9	0	16	148	202	0	0
10	0	69	175	122	0	0
11	4	133	128	101	0	0
12	36	106	132	92	0	0
13	31	107	136	92	0	0
14	26	96	142	102	0	0
15	19	74	154	119	0	0
16	4	67	120	175	0	0
17	0	18	101	247	0	0
18	0	0	28	277	38	23
19	0	0	0	183	111	72
20	0	0	0	34	188	144
21	0	0	0	48	175	143
22	0	0	0	56	182	128
23	0	0	0	64	174	128
24	0	0	0	62	185	119

TABLE 7.3 FREQUENCY DISTRIBUTION OF STABILITY CLASS VERSUS WIND SPEED

SPEED (m/s)	A	B	C	D	E	F	G
0-2.0	61	94	168	519	517	253	0
2.0-4.0	59	412	482	1145	827	1135	0
4.0-6.0	0	180	554	1074	759	0	0
6.0-8.0	0	0	124	339	0	0	0
8.0-10.0	0	0	0	78	0	0	0

7.4 Mixing height at Tillegra

The mixing height is the height of the turbulent boundary layer of air near the earth's surface within which ground level emissions are rapidly mixed. A plume emitted above this height will remain isolated from the ground until the mixing height reaches the height of the plume. A plume emitted below this height will be mixed subject to the stability class and wind climate. The height of the mixing layer is controlled by convection (resulting from solar heating of the ground during the day) and by mechanically generated turbulence as the wind blows over rough ground (hence the importance of land use data).

The mixing height at the construction site was estimated using gridded surface and upper air meteorological data that was generated by TAPM. TAPM is able to generate detailed, three-dimensional gridded (in x, y and z dimensions) meteorological data up to a level of eight kilometres above sea level from preprocessed synoptic meteorological data.

The estimated mixing height for the Tillegra site rises very quickly in the early morning from just after sunrise until mid afternoon. After this time, the mixing height remains at a relatively stable value until returning to a lower level early in the evening. This diurnal variation of atmospheric structure is consistent and expected to that found at similar sites with undulating terrain features and a similar climate to this region. Large values for mixing height occur in the summer months as expected due to the greater convective effects. The main change throughout the year is the length of the period of strong convection and the variation in the wind speed and directionality characteristics.

8. Impact Assessment

8.1 Emissions from dam construction activities

All particulate matter airborne concentrations are published as daily averaged levels. Analysis of maximum predicted levels at the nearest receptor on private land and on HWC-owned land has been undertaken through study of the contours generated for daily averaged (GLC) ground level concentrations of $PM_{2.5}$, PM_{210} and TSP.

A summary of the model predictions for each pollutant type is provided in Table 8.1 together with relevant NSW and Commonwealth goals.

TABLE 8.1 PREDICTED GROUND LEVEL CONCENTRATIONS AT NEAREST SENSITIVE RECEPTORS

UNITS – µG/M^3 (UNLESS OTHERWISE SPECIFIED)	$PM_{2.5}$	PM_{10}		TSP	MAXIMUM ADDITIONAL DEPOSITED DUST (g/m^2/MONTH)
Averaging period	**Daily**	**Daily**	**Annual**	**Annual**	**Cumulative Monthly**
Background level	–	15	10*	30^	0.8#
Maximum predicted level at nearest receptor on HWC-owned land	22	55	18	75	3.2
Maximum predicted level at nearest receptor on private land	15	45[1]	16	65	2.4
NSW cumulative criterion/goal	–	50	30	90	4
NEPM advisory criterion/goal	25	50	–	–	–

* Stratford NSW – high volume PM_{10} dust monitoring over Dec 2006 – Dec 2007
\# Stratford NSW – monthly dust deposition Dec 2006 – Dec 2007
^ Assumed based on 2008 monitoring results for Upper Hunter and Mayfield sites

8.1.1 $PM_{2.5}$

The modelling shows that the maximum daily averaged $PM_{2.5}$ concentrations at the nearest sensitive receivers are about or less than 20 µg/m^3 (Figure 8.1). The nearest sensitive receivers where this ground level concentration is predicted are located within the nominal construction site boundary on HWC-owned land. This level is the maximum expected concentration from the construction activities including emissions from wind erosion, stockpiling and wheel dust from haulage routes and is less than the NEPM advisory air quality goal for $PM_{2.5}$ (25 µg/m^3. Receptors further east of the nearest receiver are predicted to experience levels less than 10 µg/m^3 at the height of construction activities.

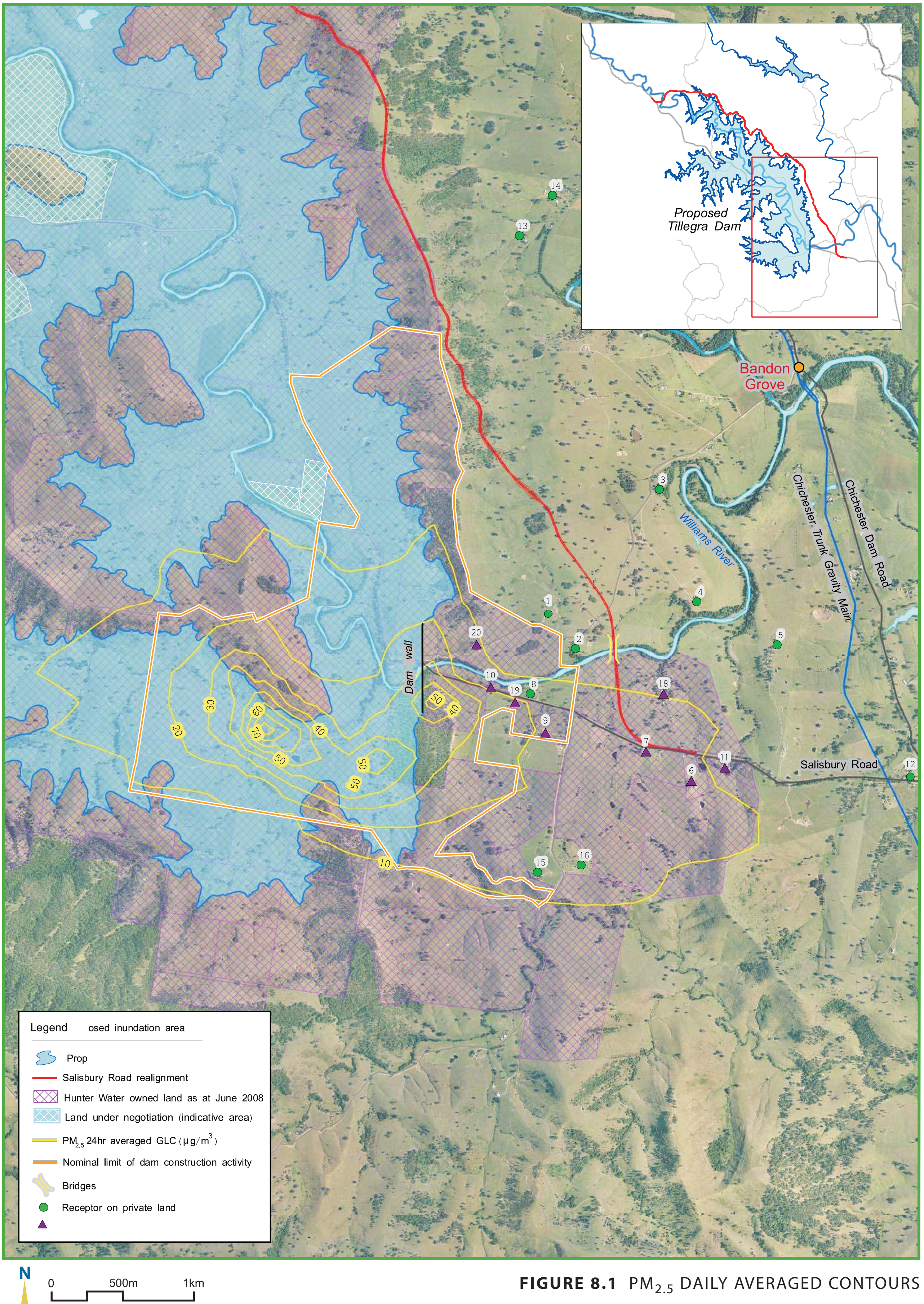


FIGURE 8.1 PM$_{2.5}$ DAILY AVERAGED CONTOURS

8.1.2 PM_{10}

The modelling of the dispersion of PM_{10} emissions shows that predicted levels from dam construction activities (and allowing for background) at the nearest sensitive receivers are approximately 55 µg/m^3 for daily averaged PM_{10} (refer Figure 8.2) and 18 µg/m^3 for annual averaged PM_{10} (refer Figure 8.3). These are HWC-owned properties which are currently leased but which would likely have the leases terminated prior to construction. Sensitive receptors located further east of the construction site experience ground level concentrations in the region of 35 µg/m^3 and 20 µg/m^3 for daily averaged PM_{10} and annual averaged PM_{10} respectively.

Table 8.2 shows the estimated concentrations at the nearest sensitive receptors for daily averaged PM_{10} and annual averaged PM_{10}. Receptors with exceedances are denoted by shading.

TABLE 8.2 PREDICTED PM_{10} LEVELS AT NEAREST RECEPTORS

RECEPTOR NO.	AVERAGED DAILY	AVERAGED ANNUAL
1	<35	<22
2	<35	<22
8	45	26
9*	53	26
10*	54	28
13	30	<22
14	23	<22
15	40	25
16	40	25
19*	56	30
20*	36	24

* HWC-owned properties

As may be seen, there would be minor exceedances for several receptors for daily averaged PM_{10} and for one receptor for annual averaged PM_{10}. All receptors are on HWC-owned land.

8.1.3 Total suspended particulates

There is no available guideline level of acceptable daily averaged TSP concentrations hence the predicted concentrations cannot be compared against published allowable limits. Annually averaged concentrations do however have an acceptable guideline level which has been stipulated by the DECC to be 90 µg/m^3 (refer Table 4.1).

Modelling of TSP emissions showed that annual averaged concentration at the nearest sensitive receptors (same as for $PM_{2.5}$ and PM_{10}) is predicted to be approximately 75 µg/m^3 (Figure 8.4). These receptors are all on HWC-owned land. The predicted level for the nearest receptor on private land is approximately 65 µg/m^3 which would comply with the DECC criterion.

Ground level concentrations of TSP are more likely to have nuisance impact on sensitive receivers as opposed to any significant health impacts.

8.1.4 Predicted monthly dust deposition

Monthly dust deposition levels at the nearest receptor on private property receiver show that for the worst case assessment, the predicted level is less than 2 g/m^2/month (refer Figure 8.5). This level meets the maximum allowed increase in deposited dust as shown in Table 4.1.

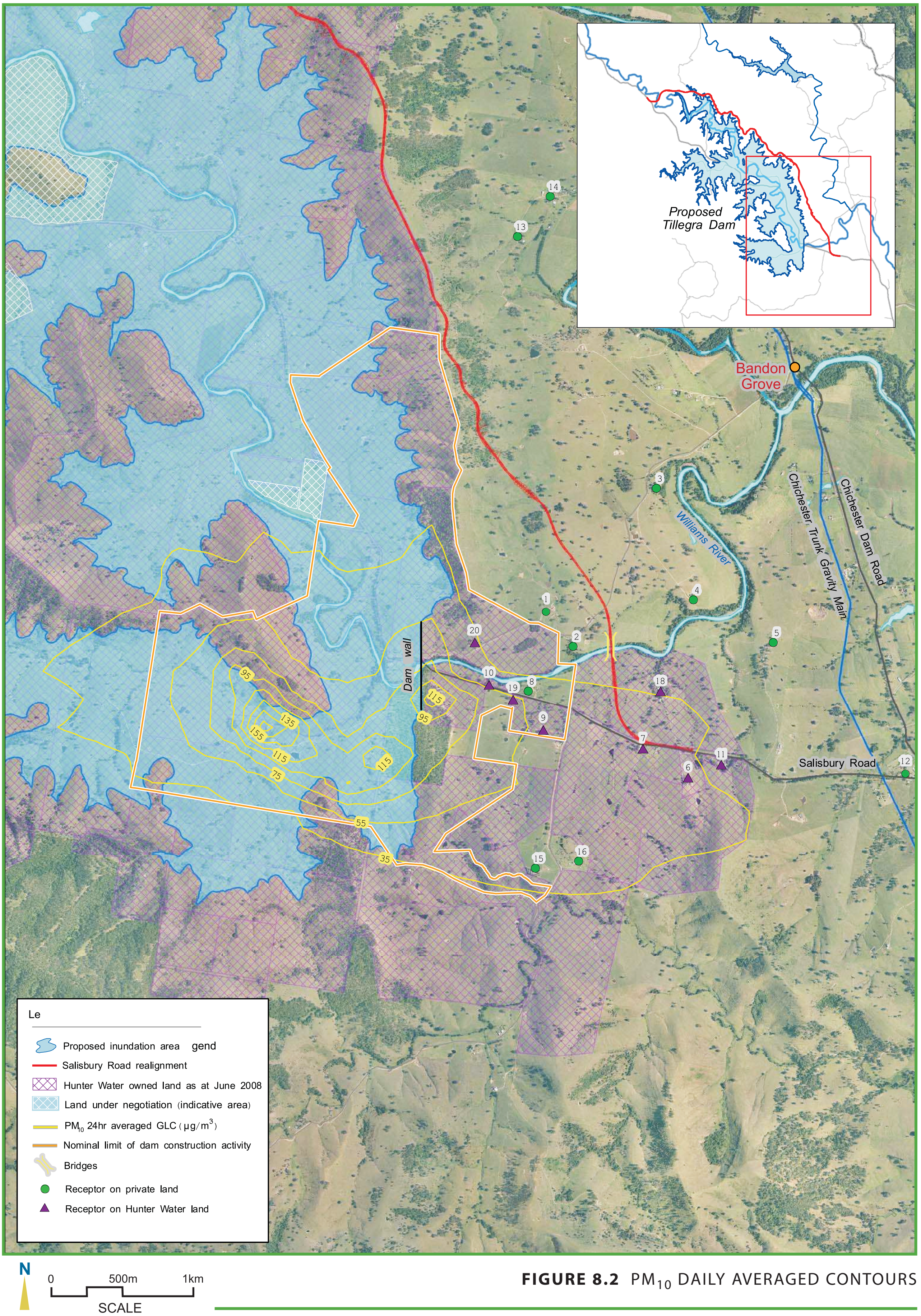


FIGURE 8.2 PM_{10} DAILY AVERAGED CONTOURS

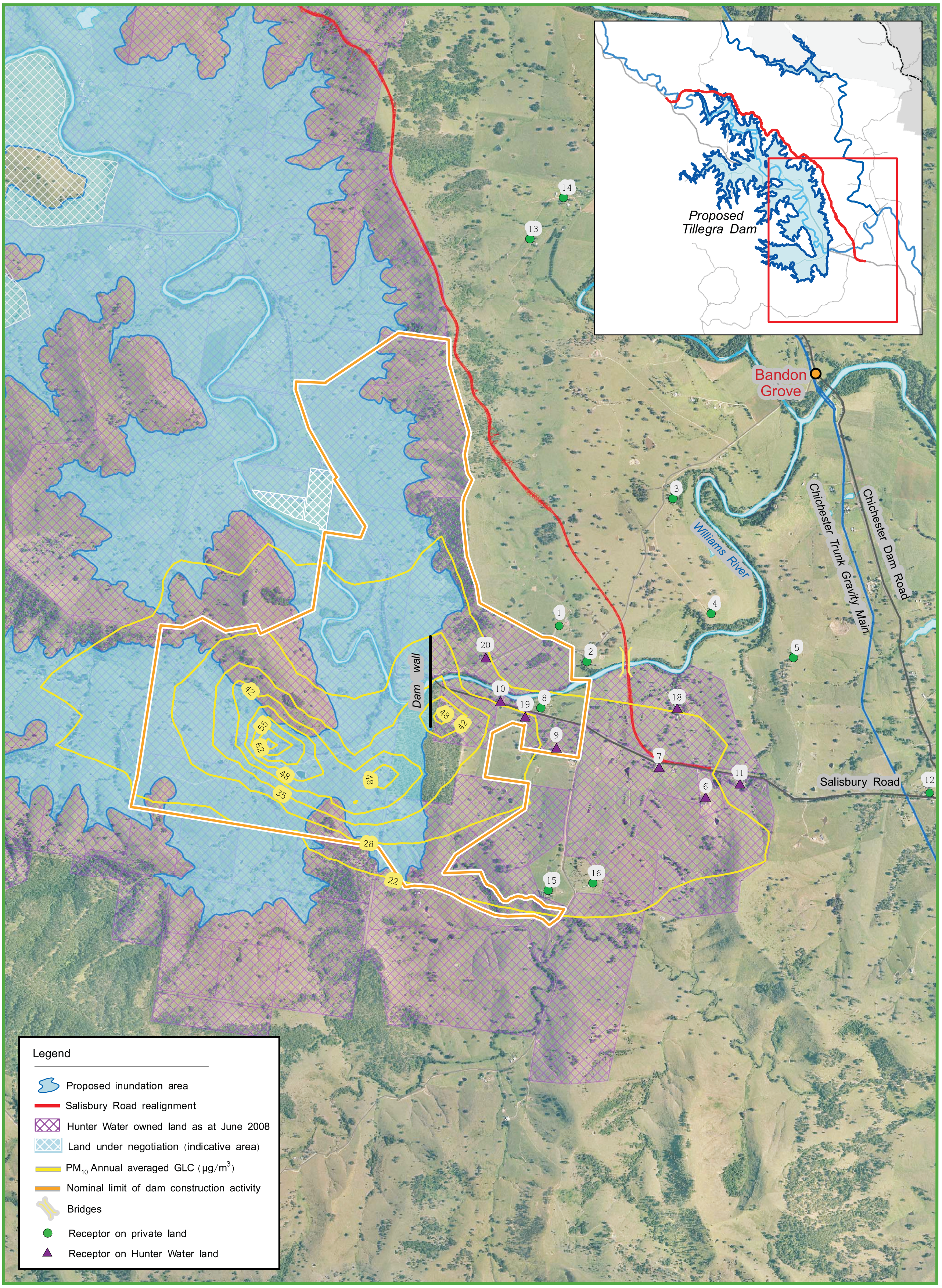


FIGURE 8.3 PM$_{10}$ ANNUAL AVERAGED CONTOURS

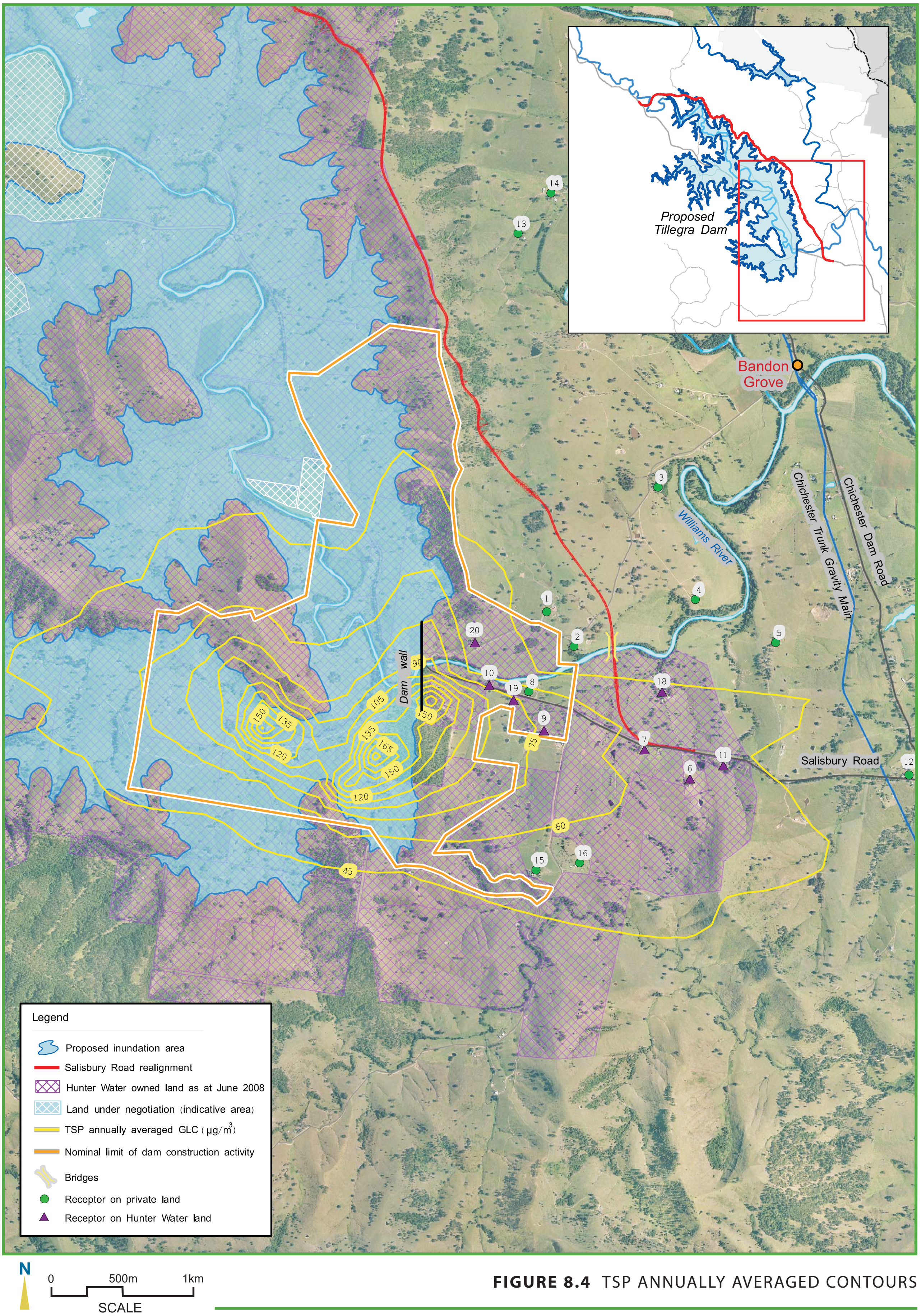


FIGURE 8.4 TSP ANNUALLY AVERAGED CONTOURS

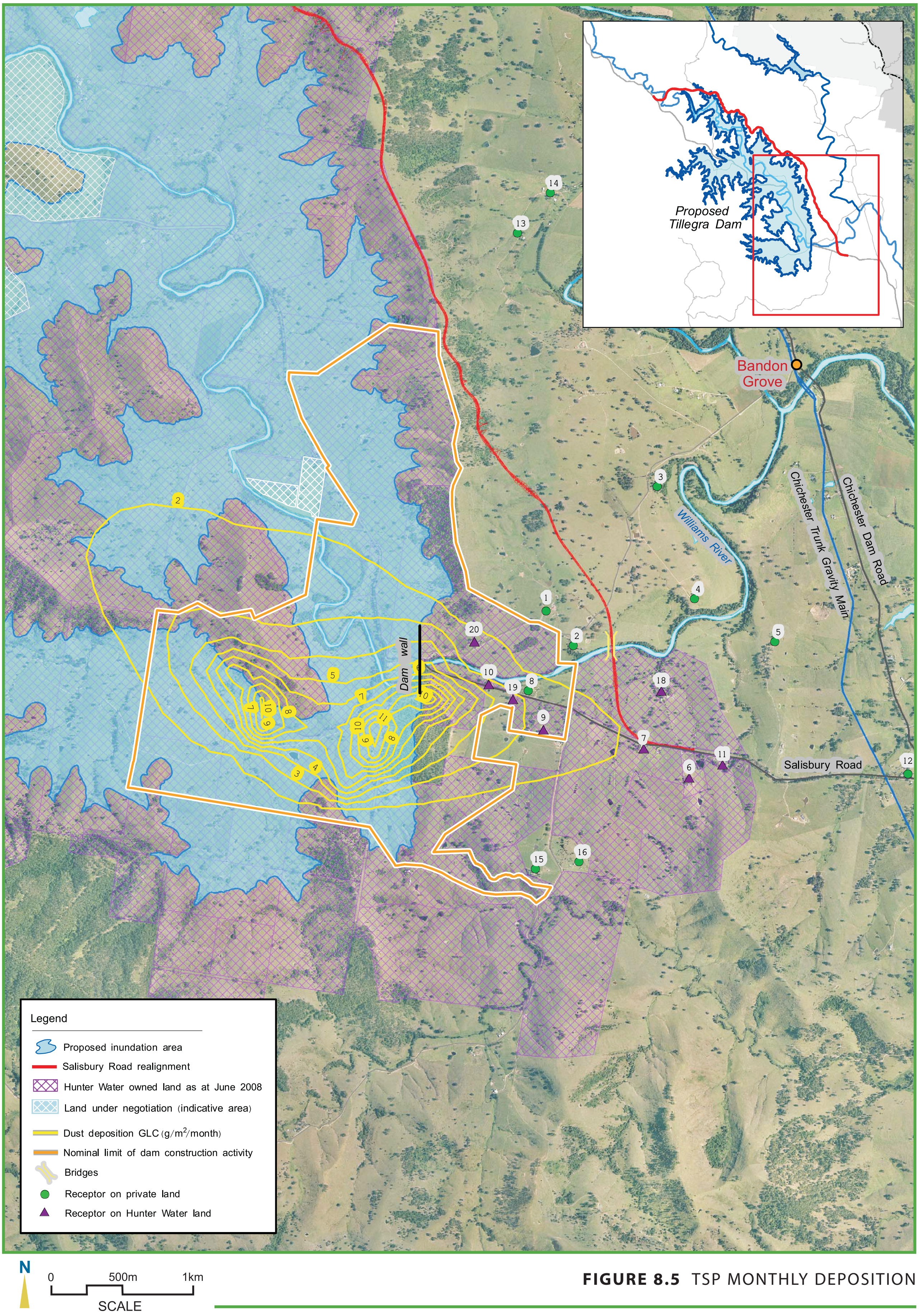


FIGURE 8.5 TSP MONTHLY DEPOSITION

8.1.5 Discussion of results

The level of exceedance at each sensitive receiver is directly dependant on the distance from the emissions source and the level of activity, due to the fact that all dust emissions from construction activities are not emitted from an elevated point, ie they are surface borne. The predicted data is indicative of the requirement of a detailed air quality management plan, which would facilitate the appropriate supervision and application of mitigating measures where applicable in order to minimise dust emissions. However it is expected that the majority of locations where exceedances are expected to occur are likely to be within the project site boundary or on land that is either owned or would be acquired by HWC.

This assessment has shown that the emissions originating from wind erosion of exposed areas (eg exposed stockpiles, main embankment area), wheel generated dust, blasting, excavation of overburden and rock from the quarry have the largest air quality impact for the Project. Consequently it is recommended that a suitable detailed air quality management plan be developed to facilitate the implementation of appropriate mitigation measures during construction to minimise dust emissions from these sources. The plan should have sufficient flexibility to accommodate changing conditions during construction. A regime of regular community consultation and feedback should be implemented so as to build a good rapport with residents likely to be worst exposed.

8.1.6 Construction vehicles and plant emissions

Emissions from construction vehicles and plant were not considered explicitly in the air quality assessment as these were expected to be minor sources relative to the potential for dust generation. The impact of emissions from construction vehicles and machinery is dependant on the type of fuel used, hours of operation and the relative distance between the emissions source and the sensitive receivers.

The main sources of emissions are likely to be from combustion of diesel fuel in heavy vehicles, stationary combustion plants and mobile excavation equipment. The main air emissions of concern from diesel combustion include emissions of particulate compounds, CO, VOCs, NOx and heavy metals.

As noted previously, the anticipated hours of operation 7.00 am to 5.00 pm Monday to Saturday but it is noted that some vehicles would have to operate on multiple shifts per day during temporary stages of the construction schedule. In addition to this it has been assumed that the bulk of emissions are likely to be due to the movement of heavy vehicles along haulage routes within the site boundary. This is not considered likely to have a significant impact on air quality in the region irrespective of the distance between sensitive receivers and emissions sources due to the diffuse nature of emissions and the broad area over which they occur.

Notwithstanding this, the air quality management plan for construction should include appropriate measures to reduce these emissions where practicable. These could include maintenance of plant in accordance with manufacturers' recommendations, switching off plant when not in use, etc.

8.2 Emissions from road construction activities

Emissions from road construction activities are expected to be generally similar to those associated with dam construction activities though on a smaller scale and varying over time as specific work phases are completed in individual locations. The potential for emissions would progressively decrease over time as the area of bare ground is reduced as the road pavement is constructed.

The greatest potential for dust emissions would occur following land clearing and during the early stages of construction when movement and stockpiling of unconsolidated material would take place. Dust emissions would be associated with wind erosion from unsealed surfaces and exposed stockpiles, wheel generated dust from the movement of heavy machinery etc. Emissions from these localised sources would be readily controlled through mitigation measures such as watering of exposed surfaces and covering of stockpiles for instance. These would be implemented within the framework of formal air quality management plan which would likely form part of the overall construction environmental management plan.

Potential air quality impacts associated with the realignment of Salisbury Road were considered by simulating emissions from the construction activities as a line source over the worst case period and for the most likely affected receptors. The period used was the same for the predicted maximum particulate and TSP concentrations from emissions associated with the principal dam construction activities. The predicted contours for the PM_{10} daily averaged ground level concentrations are provided in Figure 8.6.

These show that the PM_{10} daily averaged ground level concentration at the nearest sensitive receiver (13) would be between 25 μg/m^3 and 35 μg/m^3 . This would not exceed the DECC GLC criterion.

8.3 Operational activities

8.3.1 Traffic

The main potential concern with regard to traffic emissions relates to the possible increase in the number of vehicles travelling along Salisbury Road which could be associated with recreational activities on and around the storage. The realigned section of Salisbury Road would be closer to some residences than was previously the case prior to construction of the Project. The main air emissions of potential concern in relation to this are CO, NO_x, PM_{10}, $PM_{2.5}$, VOCs and heavy metals.

Annual average daily traffic flows are expected to increase to approximately 375 vehicles per day by 2023 from the current average of 280 vehicles per day. This could vary substantially depending on the type of development that might occur around and in the vicinity of the storage. Less than one per cent is expected to comprise heavy vehicles. This level of growth is not expected to significantly impact on receivers.

This level of traffic would not lead to any significant air quality impacts on the sensitive receptors surrounding the Project area. This conclusion is based on the findings of an air quality assessment that modelled pollutant emissions from Port Wakefield Road, a major arterial road in South Australia that experiences significant higher levels of traffic flow and congestion then would be experienced along Salisbury Road. This assessment demonstrated that the expected emissions from 43,400 vehicles per day would not lead to any exceedances of ambient air quality criterion at the exposed sensitive receptors and predicted the likely ground level concentrations of NEPM criteria pollutants including PM_{10}, $PM_{2.5}$, NO_x and air toxic (Consulting Environmental Engineers 2007).

8.3.2 Dam operation

Air emissions from dam operations are expected to be negligible. These would be related mainly to maintenance activities such as vegetation control using petrol-powered tools such as weed slashers. There would also be a certain amount of emissions associated with the use of motor vehicles to travel around the storage. These are not considered to be a direct source of any noxious air emissions. Therefore there would be a minimal post-construction air quality impact from the proposed project.

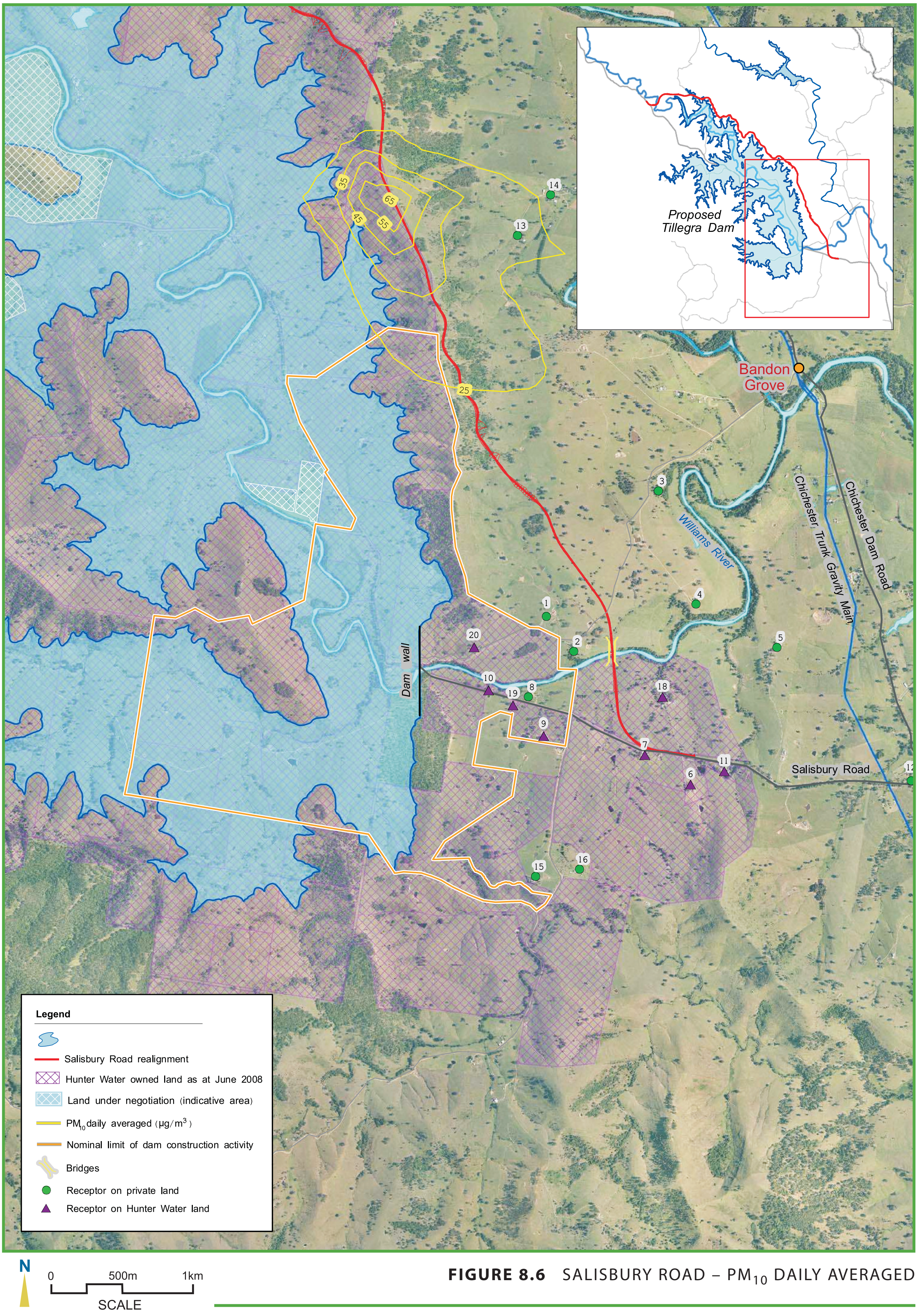


FIGURE 8.6 SALISBURY ROAD – PM_{10} DAILY AVERAGED

8.4 Mitigation of impacts

The following mitigation measures should be incorporated into an air quality management plan to minimise airborne dust emissions from construction and related activities:

- limit construction activities to 7.00 am to 5.00 pm Monday to Saturday
- advising residents of any out of hours works
- develop a construction traffic management plan to advise all truck drivers, contractors and vehicular machinery operators of designated vehicle access routes and protocols
- position frequently trafficked haulage routes as far from sensitive receivers as practicable (ideally a minimum of 20 metres)
- seal heavily trafficked areas
- restrict vehicle speeds (eg 20-40 km/hr) to minimise wheel-generated dust on unsealed routes
- minimise diesel engine idle times and queuing
- install truck cleaning stations at site boundaries to minimise off-site transport of material which could cause dust emissions
- cover all truck loads where there is potential for dust emissions during transport
- limit truck loads to a vertical height no greater than 0.5 m above the side walls of the vehicle
- maintain all fossil-fuelled plant and equipment to facilitate efficient operation
- install appropriate emission control mechanisms (eg fabric filter) to minimise air emissions
- undertake regular watering of exposed surfaces including exposed stockpiles, unsealed roadways, dry/fine material in regions within blasting/drilling areas to suppress dust generation
- covering/protection of areas susceptible to significant dust emissions from wind erosion
- locate stockpiles as far away from sensitive receivers as practicable
- use natural landforms to shield exposed areas and dust generating construction operations from prevailing strong winds blowing towards sensitive receivers
- use water sprays on all conveyor transfers on concrete batching operations to minimise dust emissions
- minimise drop heights of conveyor transfer systems and other material transfer systems to control visible dust
- install emission control devices (eg fabric filters) on concrete batching/crusher plants
- restrict/cease activities with high dust generating potential (including, blasting and drilling) during periods when strong winds are blowing towards sensitive regions prevail
- dampening down blasting areas to suppress dust generation
- consideration of potential for dust emissions as part of blast design
- engagement of the affected community such as by responding to queries regarding construction methodologies and responding to complaints/concerns offered by community members
- provide regular updates to community members to inform them of upcoming work that could result in any increased levels of emissions
- develop an iterative air quality management plan to facilitate the implementation of mitigation measures with reference to:
  - maintenance of plant equipment
  - dust suppression methodology and implementation processes
  - efficient machine operation
  - emissions control technology
- consider community input when updating the air quality management plan.

9. Conclusion

The objectives of this air quality impact assessment were to study the impacts of air emissions from construction and associated activities, and during operation of the dam. The assessment has shown that emissions from construction and associated activities would be the most significant with operational impacts expected to be negligible. The assessment qualified and quantified the likely air emissions from dam construction activities based on the Tillegra Dam options study (Department of Commerce 2007), outlined the relevant NSW and Commonwealth ambient air quality guidelines, assessed the likely impact of the air emissions against these guidelines, and identified necessary impact mitigation measures. The assessment has been conducted with due reference to the DECC guideline Approved methods for the modelling and assessment of air pollutants in NSW as per the direction given in the Director-General's requirements.

The investigation has shown that the emission and dispersion of dust is highly dependant on the type of equipment and/or the activities that produce the emissions and the dominant meteorological conditions that prevail in the locality. The assessment has shown that air quality impacts associated with construction of the new section of Salisbury Road are not expected to be significant and could be readily managed with the implementation of suitable mitigation measures. Post-construction air emissions are expected to be negligible and not represent a significant issue for local air quality.

The assessment has shown that there would minor exceedances of relevant NSW DECC air quality criterion at some receptors for cumulative PM_{10} emissions. These are all on HWC-owned land. Based on the modelling undertaken, it is not expected there would be any exceedances at receptors on private land.

As part of the construction air quality mitigation measures, it is recommended that HWC consider terminating the leases for receptors 9, 10 and 19 prior to construction. It is understood the residence at receptor 20 is not occupied.

Given their proximity to the dam construction site, receptors 1, 2 and 8 (particularly the latter) could also experience reduced air quality which, while not exceeding applicable criteria, may affect amenity. Similarly, receptors 13 and 14 could experience reduced air quality while road construction activities are undertaken in proximity to their residences. Accordingly, it is recommended that these receptors be consulted with respect to the air quality management measures that would be implemented for construction.

HWC has met with the occupants of the privately owned residences at receptors 1, 2 and 8 to discuss air quality issues. With respect to air quality issues, HWC would commit to:

- installation of monitoring equipment to record levels of particulates during construction and to identify any issues not adequately resolved through the construction environmental management plan
- work with the affected residents to develop a practicable and satisfactory resolution to the issue(s) in question.

No significant air quality impacts are expected at other receptors in the vicinity, however, appropriate monitoring should be undertaken during construction. This forms part of the recommended mitigation measures identified in Section 8 for inclusion in a project-specific construction air quality management plan.

10. References

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Appendix A

Comparison of wind roses for Paterson NSW using BoM and TAPM data sets

aurecon

Hunter Water

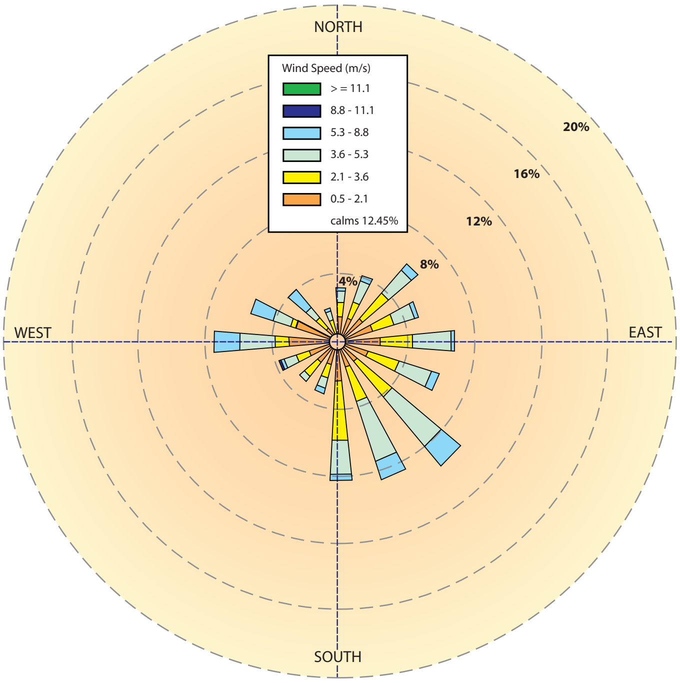


FIGURE A1 BoM SUMMER

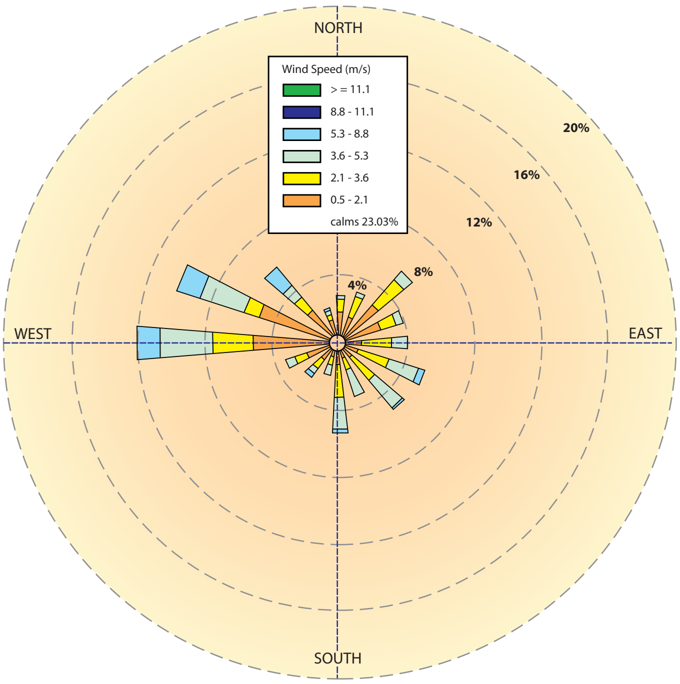


FIGURE A2 BoM AUTUMN

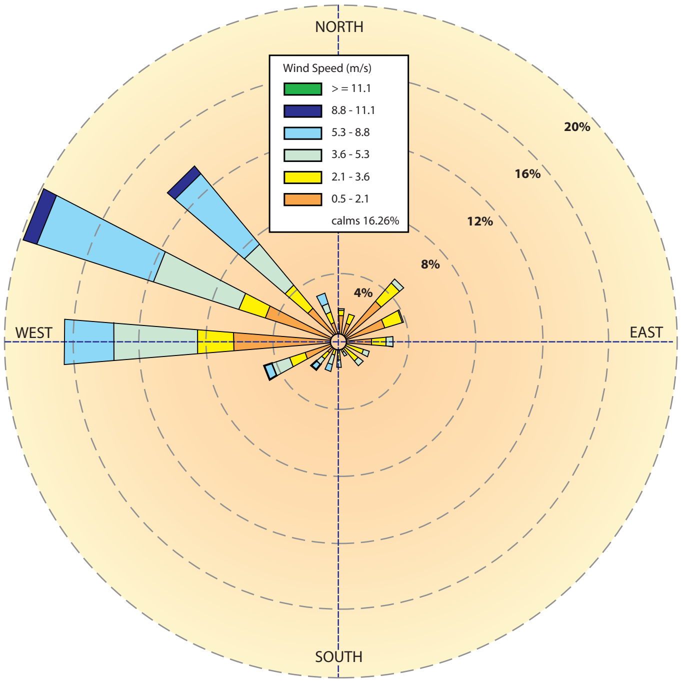


FIGURE A3 BoM WINTER

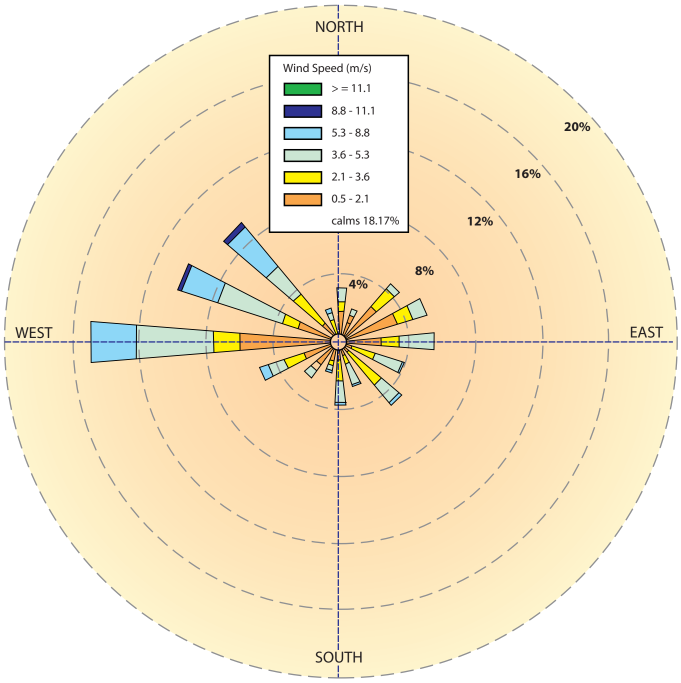


FIGURE A4 BoM SPRING

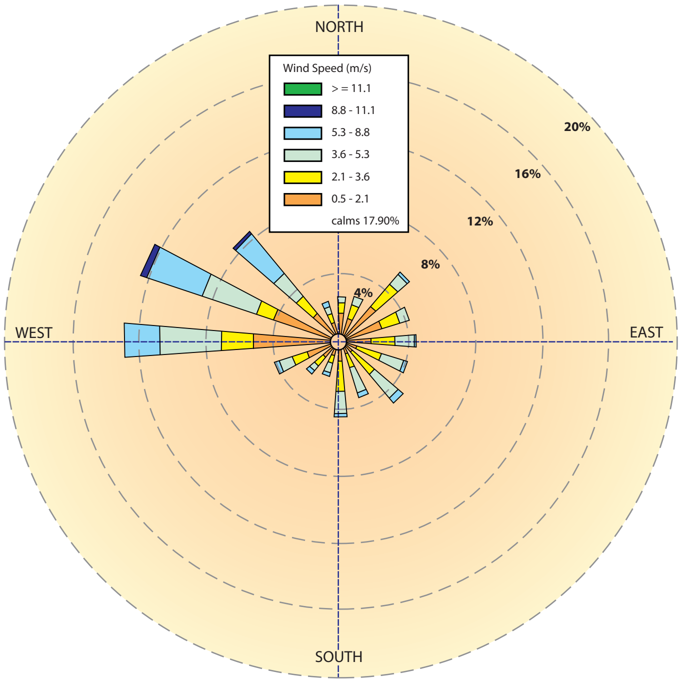


FIGURE A5 BoM FULL YEAR

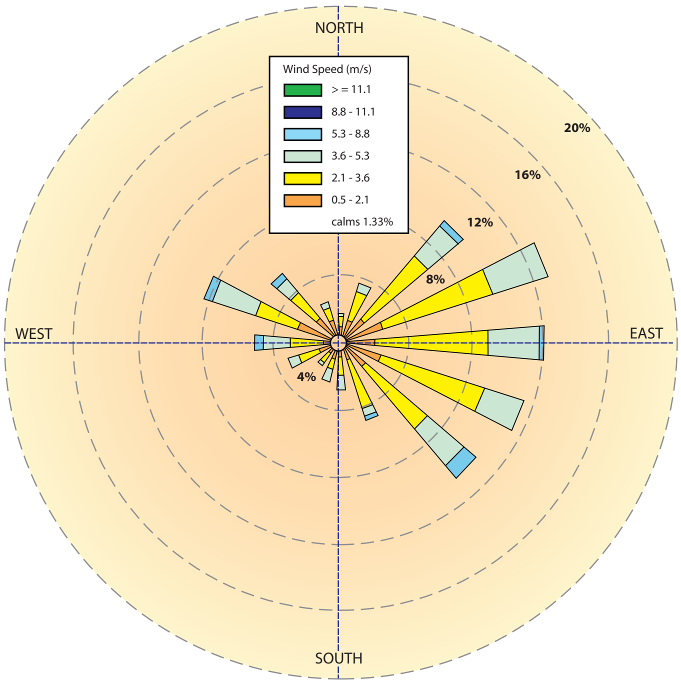


FIGURE A6 TAPM SUMMER

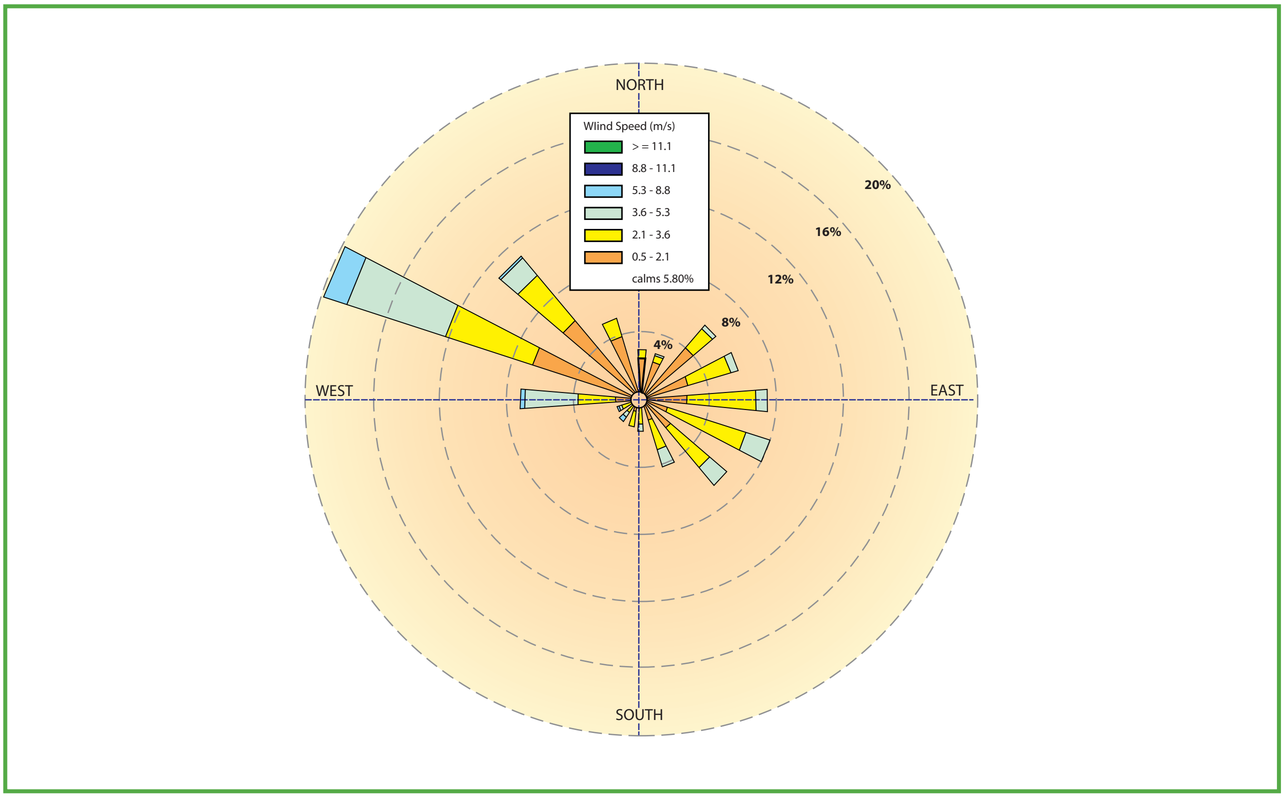


FIGURE A7 TAPM AUTUMN

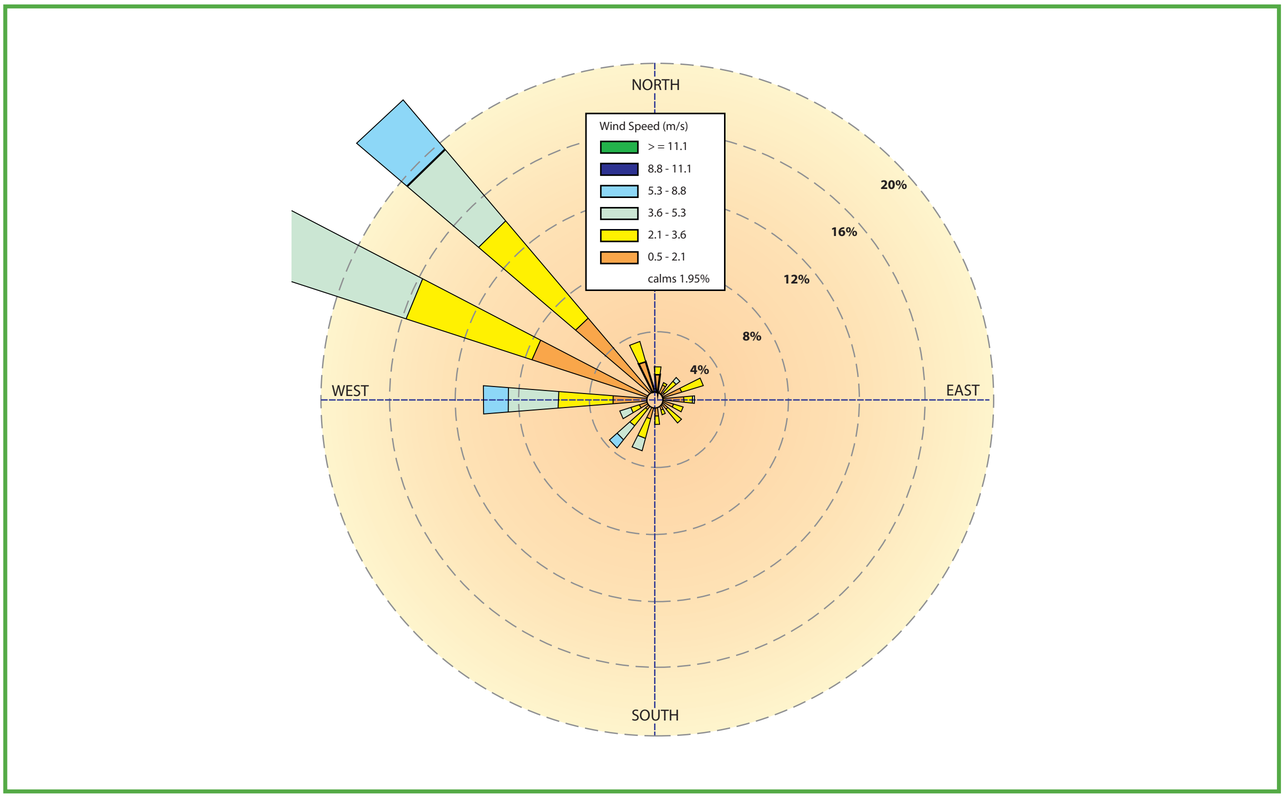


FIGURE A8 TAPM WINTER

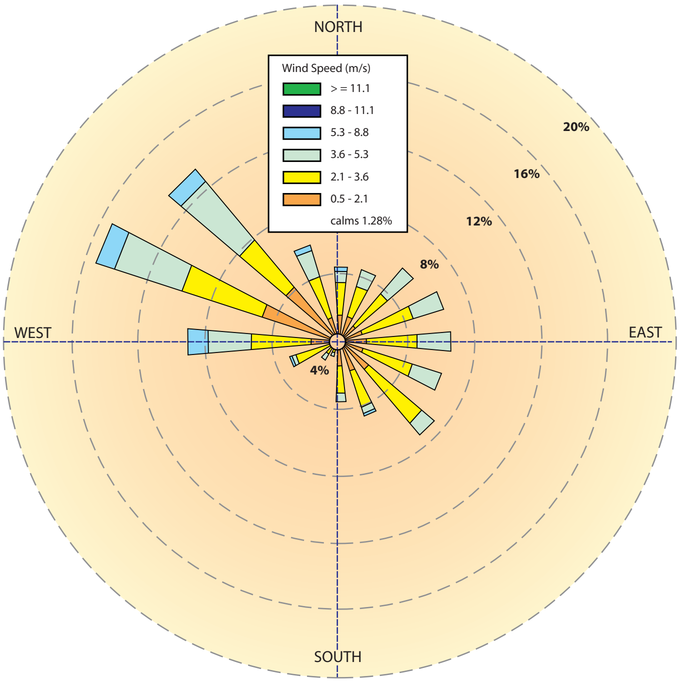


FIGURE A9 TAPM SPRING

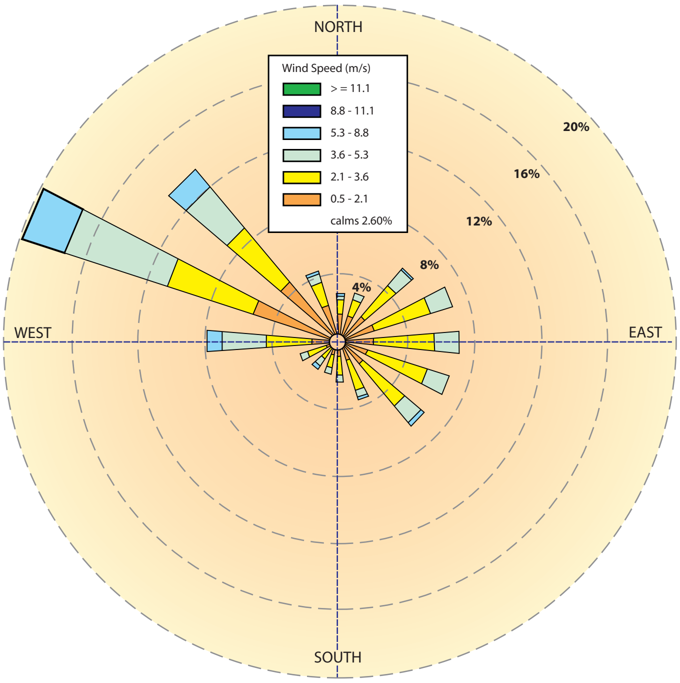
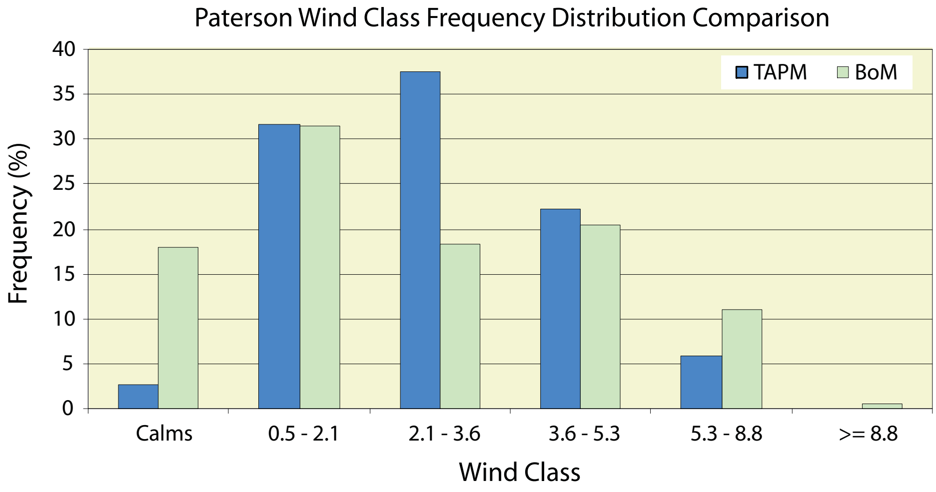
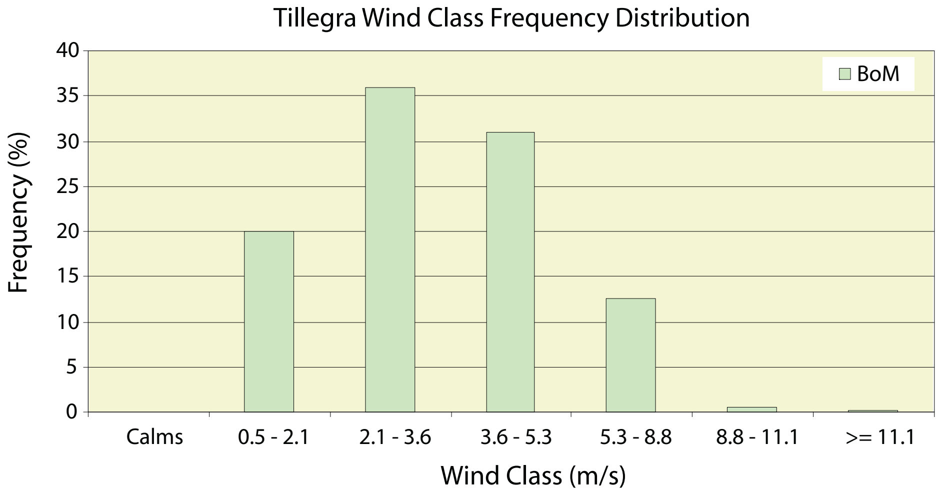


FIGURE A10 TAPM FULL YEAR





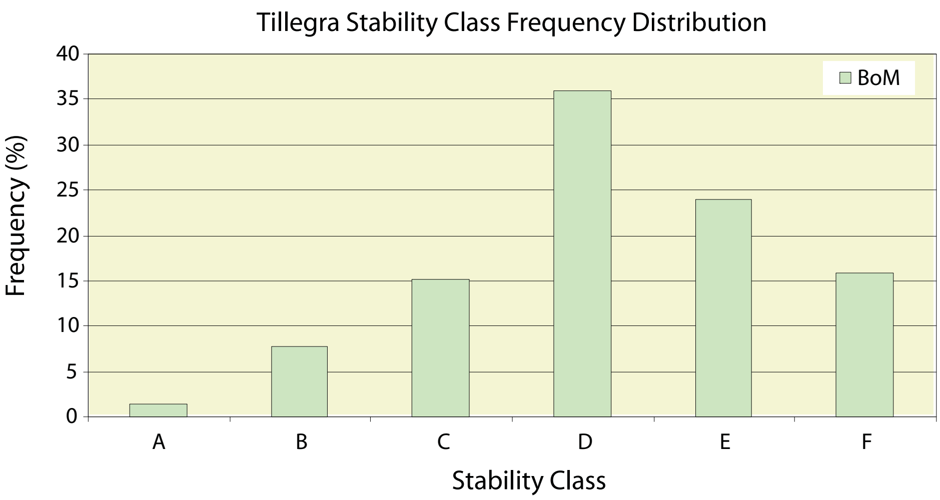


FIGURE A11 FREQDISTRIBUTION FREQUENCY DISTRIBUTIONS

Report prepared by aurecon