MT TODD PROJECT

Dust Monitoring and Mitigation Programme

Prepared for:

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DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
680.10533-R06-v0.5	11 June 2019	Jason Shepherd	Kirsten Lawrence	Paul Turyn
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CONTENTS

CONTENTS

DOCUMENT REFERENCES

TABLES

FIGURES

APPENDICES

1 Introduction

1.1 Project Description

Vista Gold intends to re-open and operate the Mt Todd Project located 50 kilometres (km) north of Katherine, Northern Territory (NT) (the Project) (see **Figure 1**). The Mt Todd Project lies in the Yinberrie Hills (Pine Creek Bioregion), an area regarded by the NT Department of Environmental and Natural Resources (DLRM) as a Site of Conservation Significance. The listing is predominantly focused on the presence of a large breeding population of the nationally threatened Gouldian Finch (*Erythrura gouldiae*) which is listed as endangered under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and vulnerable under the Territory Parks and Wildlife Conservation Act 2006 (TPWC Act).

This Dust Monitoring and Mitigation Programme (DMMP) has been prepared to ensure that appropriate mitigation of fugitive dust emissions is implemented during the re-opening and operation of the mine to minimise any potential impacts on the Gouldian Finch population. The DMMP also includes an ambient air quality monitoring programme to provide data on baseline suspended particulate concentrations within the identified Gouldian Finch nesting and breeding areas. The programme will be continued to provide ongoing information during the mine development phase on the impacts of dust emissions from the mine on ambient particulate levels. This information will be used to inform appropriate management and operational responses to mitigate any potential adverse effects on the Gouldian Finch population.

1.2 Australian Government Requirements

This DMMP has been prepared to support an environmental impact assessment process for the Mt Todd Project under the Commonwealth EPBC Act Approval for the project (EPBC Act reference: 2011/5967). It provides a framework for:

- monitoring baseline air quality;
- monitoring the impacts of mine operations on ambient air quality; and
- implementation of mitigation and management measures to minimise dust emissions from the Project.

In January 2018, the Commonwealth Department of Environment and Energy (DoEE) approved the Mt Todd Project subject to a number of conditions being met prior to the Project commencing and throughout the life of the action. Condition two (2) of the approval notice states that -

The Approval holder must undertake the action in accordance with the following objectives for the Gouldian Finch for the life of the action. The action must not result in:

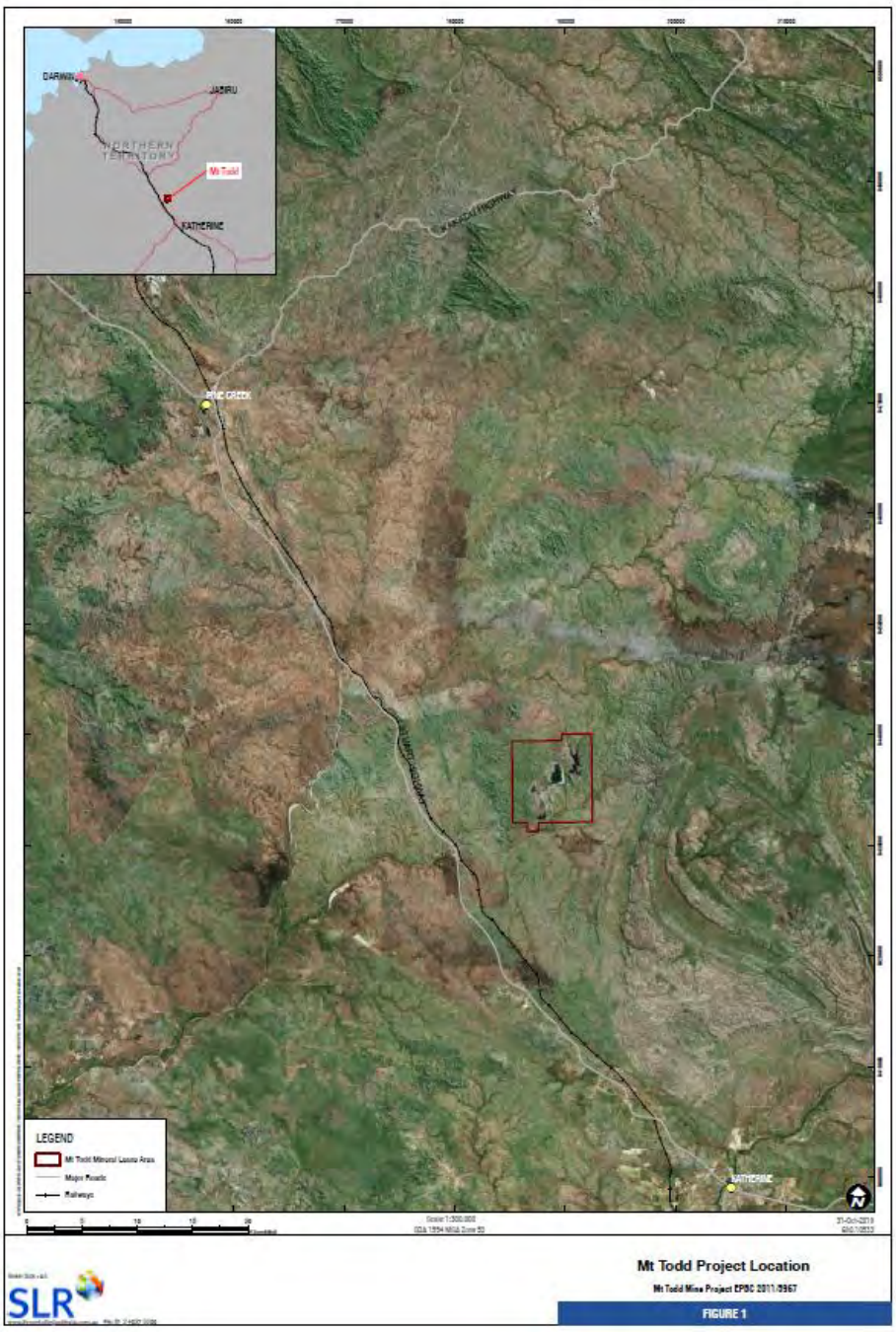
a. *significant reduction in the quality or extent of breeding habitat outside of the project footprint, or*
b. *significant reduction in the quality or extent of foraging habitat outside the project footprint, or*
c. *significant decrease in the short, medium or long-term abundance or distribution of the Gouldian Finch within the Yinberrie Hills Site of Conservation Significance, or*
d. *significant decrease in the short, medium or long-term health of the Gouldian Finch population within the Yinberrie Hills Site of Conservation Significance.*

Subsequent to the above, Condition 3 of the notice is summarised below as -

The Approval holder must prepare and submit to the Department a Gouldian Finch Management Plan (the Plan) detailing how the objectives outlined in Condition 2 of this approval will be achieved. The Plan must be prepared by a suitably qualified expert(s). The Approval holder must not commence the action unless the Minister has approved the Plan. The approved Plan must be implemented.

As dust emissions from the operation of the Mt Todd Project have been identified as a risk to the health of the Gouldian Finch population, this DMMP has been prepared to inform the above Gouldian Finch Management Plan.

Figure 1 Site Location



In **Section 3**, this DMMP sets out the dust threshold values that have been derived from empirical data on current site conditions to be protective of Gouldian Finch populations. These thresholds have been developed based on a review of data available from the preliminary and current baseline monitoring programmes, and a review of data from other mine sites where Gouldian Finches are known to be present.

The considerations for reducing the impacts of dust emissions on the Gouldian Finch population follow the hierarchy of principles below:

- **Avoid** – to the extent possible, the development has been designed to avoid or minimise ecological impacts.
- **Mitigate** – where certain impacts are unavoidable through design changes; mitigation measures have been introduced to ameliorate the ecological impacts of the proposal.
- **Compensate** – the residual impact of the project, following the implementation of mitigation measures, will be compensated to offset what would otherwise be a net loss of habitat.

The purpose of this DMMP is to ensure the protection of Gouldian Finch populations through better understanding of the mine's impact on ambient dust levels within the area inhabited by the species, and through best practice mitigation of dust emissions from mine operations.

1.3 Programme Aims

The key aim of the DMMP is to ensure that there are no significant long-term adverse effects on the Gouldian Finch population caused by dust emissions from construction and mining activities at the Mt Todd Project. The long-term persistence and health of the Yinberrie Hills Gouldian Finch population is a key goal of the Mt Todd Project. It is therefore important that monitoring and management of dust emissions is performed to enable assessment against appropriate objectives and thresholds in order to achieve this goal.

The overall aims of the DMMP are:

- Collect sufficient data to characterise baseline levels of suspended particulate matter within areas currently inhabited by the existing Gouldian Finch population, including information on seasonal variations in dust levels.
- Based on the results of the baseline monitoring programmes, review the proposed dust thresholds and short-term trigger levels for the management of dust emissions from the Mt Todd gold mine to ensure they are reflective of baseline conditions and the range of existing dust levels currently being tolerated by the existing Gouldian Finch population.
- Provide information on the incremental and cumulative impacts of dust emissions from construction and ongoing mining activities at the Mt Todd gold mine within the area inhabited by the Gouldian Finch, and through the Reactive Dust Management Strategy, alert site personnel to the need for action to be taken to reduce dust emissions in the event that the measured short-term PM_{10} levels within the Goulding Finch habitat are becoming elevated.
- Identify the mitigation measures to be implemented to minimise emissions of dust from the Mt Todd gold mine, and remedial actions to be followed in the event that any the short-term dust trigger levels outlined in the Reactive Dust Management Strategy are measured.

This DMMP includes needs, goals and objectives, identifies methodology and monitoring parameters, outlines the data analysis, data storage and reporting procedures, and allows for overall programme evaluation.

1.4 Consultation

SLR, on behalf of Vista Gold, has undertaken extensive consultation with Gouldian Finch experts and various stakeholders of the Mt Todd gold mine during the development of the DMMP. The Gouldian Finch experts and stakeholders involved have included:

- Technical Advisory Committee;
- NT Department of Land Resource Management;
- NT Environmental Protection Authority;
- Australian Government Department of the Environment;
- a biostatistician; and
- Jawoyn Aboriginal Association Corporation.

Vista Gold will continue to engage relevant members of these key stakeholder groups and specialists to create a forum for information sharing and detailed consideration of a broad range of views and issues as related to the impacts on Gouldian Finches associated with the expansion of the Mt Todd gold mine.

1.5 Risk Assessment and Impact Analysis

Additional work undertaken during the production of the EIS Supplement 2 (SLR 2015a) relevant to potential dust impacts from the mine, includes:

- review of the area historically known as the 'core breeding area' as well as important habitat in proximity to the core breeding area and potential foraging habitat (identified as land containing the native grass *Alloteropsis semialata*); and
- a detailed review and update of the air quality (dust) impact assessment (SLR 2015b).

A risk assessment workshop was conducted with the Technical Advisory Committee on 20 July 2015. The revised risk assessment and advice provided by the Committee members have informed the production of the DMMP contained herein.

2 Potential Impacts of Particulate Matter on the Gouldian Finch

The potential impacts of dust inhalation and ingestion on the Gouldian Finch have been identified as follows:

- increased pulmonary arterial pressure;
- reduced respiratory capacity;
- decreased immunity levels;
- decreased oxygen intake leading to an increase in heart size;
- body weight gain; and
- eventual death from over-exposure to dust.

Evidence suggest finches typically use a lot of respiratory function and exhibit high levels of oxygen demand compared to other birds when singing (Franz & Goller, 2003). Increased dust inhalation by male Gouldian Finches is likely to affect their ability to sing, and thus attract a suitable mate (Franz & Goller, 2003). This is an area of concern because breeding success and rates are likely to be affected if the ability of attracting a mate is reduced.

Birds have a well-developed bronchus-associated lymphoid tissue, but small particles penetrate the lung bronchi and eventually the air sacs much further than large (>1 µm) particles (Corbanie et al. 2006), leading to reduced lung function and increased pulmonary pressure (Lai et al. 2009). Dust emissions from mining, however, are predominantly mechanically-generated particles, which are generally larger in size than combustion-related particulate. For example, a study examining the size fraction in dust from a wide range of industrial processes (Ehrlich et al, 2007) concluded that for thermal process (i.e. combustion) the PM_1 portion lies between 20 – 60% of the total dust, while for mechanical processes (the main source of particulate matter emissions from the Mt Todd Gold Mine) the PM_1 fraction ranges from 0-30%.

It is also noted that the dust threshold values derived for suspended particulate levels as part of this DMMP (refer **Section 3**) are based on TSP monitoring data from another site where a healthy and viable population of Gouldian Finches was known be present. While there is some data available on ambient PM_{10}/TSP ratios in the vicinity of mines (which has been used to derive PM_{10} concentrations from this TSP dataset), there is significantly less data available on $PM_{2.5}$/TSP ratios that could be used to extrapolate the empirical data on TSP levels to $PM_{2.5}$.

For the above reasons, this DMMP is limited to monitoring of PM_{10} concentrations, and monitoring of smaller size fractions of suspended particulate matter, such as $PM_{2.5}$, is not included. It is noted that by monitoring and managing exposure to PM_{10} concentrations, the measures implemented will by default also minimise exposure to the smaller size fractions such as $PM_{2.5}$.

Increases in dust deposition rates due to dust emissions from the Mt Todd Project also have the potential to impact on Gouldian Finch foraging (feeding) habitat, with factors including inhibition of growth and seed production, health and disease resistance of plants, and loss of attraction to birds. Dust effects on vegetation have been connected to the decrease in the amount of light available for photosynthesis, an increase in leaf temperature due to changed surface optical properties, and interference with the diffusion of gases into and out of leaves (Prajapati, 2012). The accumulation of dust on a plant leaf varies according to a range of characteristics including leaf arrangement (phyllotaxy), leaf attributes such as presence of cuticles and pubescence, and canopy density.

3 PROJECT-SPECIFIC DUST THRESHOLDS

3.1 Project-Specific Dust Threshold Values

Current guidelines for ambient particulate concentrations and dust deposition rates have been developed to address potential human health and nuisance impacts in residential areas and are not directly relevant to impacts on birds or the environmental surrounding Mt Todd Project. Detailed analysis (provided in **Appendix A**) has therefore been performed to derive project specific thresholds based on the Mt Todd Project baseline monitoring data available to date, monitoring data from Darwin, and historic data from Ranger Uranium Mine. These are all areas where there are known populations of successfully breeding Gouldian finches. It follows that the Gouldian Finch population in Yinberrie Hills should be able to tolerate similar conditions.

The project-specific dust threshold values to be used as compliance targets for the operational phase of the Mt Todd Project and are listed in **Table 1**. These thresholds will be reviewed and revised (if required) at the completion of the baseline monitoring programme when the full baseline dataset is available.

Table 1 Project-Specific Dust Threshold Values

Indicator	Averaging Period	Threshold Value
PM_{10}	Annual average	Maximum annual average concentration limit of 20 µg/m^3
	24-hour average	Maximum of 18 days above 60 µg/m^3 per year (5% of the year).
	7-day average	Maximum 7-day concentration limit of 40 µg/m^3.
Dust Deposition	30-day Average	Maximum rate of 4 g/m^2/month

4 DUST MONITORING PROGRAMME

The monitoring will be performed under an adaptive monitoring framework and therefore as monitoring data becomes available, management and monitoring priorities will be adapted over time and the number and location of monitoring sites and duration of the monitoring programme may be revised in consultation with the Technical Advisory Committee (if relevant) and relevant government agencies.

4.1 General Requirements of the Dust Monitoring Programme

The dust monitoring programme will monitor particulate matter (as PM_{10} and dust deposition) and meteorological conditions. Continuous monitoring of ambient PM_{10} concentrations will be performed using beta-attenuation monitors (BAMs). The automatic weather station (AWS) installed at the Mt Todd Project will also be used in interpreting the data from the dust monitoring programme and to assist in the management of dust from the site.

Air quality monitoring will be undertaken by a suitably qualified person. The air quality monitoring procedures employed throughout the monitoring programme will be guided by the requirements of the relevant Australian Standards where applicable, as listed below:

- AS 3580.1.1:2016 Methods for sampling and analysis of ambient air – Guide to siting air monitoring equipment, subject to local site constraints.
- AS/NZS 3580.9.11:2016 *Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM_{10} beta attenuation monitors.*
- AS/NZS 3580.14:2014 *Method for sampling and analysis of ambient air - Meteorological monitoring for ambient air quality monitoring applications.*
- AS/NZS 3580.10.1:2016 *Methods for sampling and analysis of ambient air - Determination of particulate matter - Deposited matter - Gravimetric method.*

All air quality monitoring equipment and meteorological instrumentation employed throughout the monitoring programme will carry current NATA or manufacturer calibration certificates.

4.2 Baseline Dust Monitoring Programme

4.2.1 Overview

The baseline dust monitoring programme is an integral part of the overall DMMP.

The ongoing collection of baseline data on existing particulate levels will be performed until the Mt Todd Project commences operations to confirm whether the adopted threshold levels are appropriate for the monitoring and management of dust emissions from operational activities, as well as providing additional information on the baseline conditions prior to mining.

4.2.2 Monitoring Locations

The baseline dust monitoring programme includes the operation of three BAMs (powered using solar panels) in the area surrounding the mine site and within the Gouldian Finch nesting area. The locations of the monitoring sites have been selected to comply with the requirements of AS 3580.1.1:2007 as follows:

- sampling inlet located 2 to 5 m above ground;
- distance to nearby trees greater than 10 m;
- minimum clear sky angle above sampling inlet of 120°; and
- nearby buildings/obstacles taller than the sampling inlet are to be located greater than twice the height difference between the sampling inlet and the obstacle.

The BAMs are fitted with a PM_{10} sampling inlet to provide information on baseline concentrations of this size fraction compared to the adopted Gouldian Finch 24-hour average threshold level. Three BAMs have currently been installed at the site as part of the baseline dust monitoring programme, one of which (BAM1) will become the 'upwind' monitoring site during the operational phase. The current locations of the three BAMs are shown in **Figure 2**.

In addition to the BAMs, ten dust deposition gauges (DDGs) have also been deployed as part of the baseline monitoring programme. The results of the dust deposition monitoring programme will be used to assess whether there is any correlation between measured dust deposition rates and any observed impacts on *Alloteropsis semialata*. The number and location of dust deposition monitoring sites is not anticipated to change from the current network of gauges during the operational phase.

Figure 2 Monitoring Locations

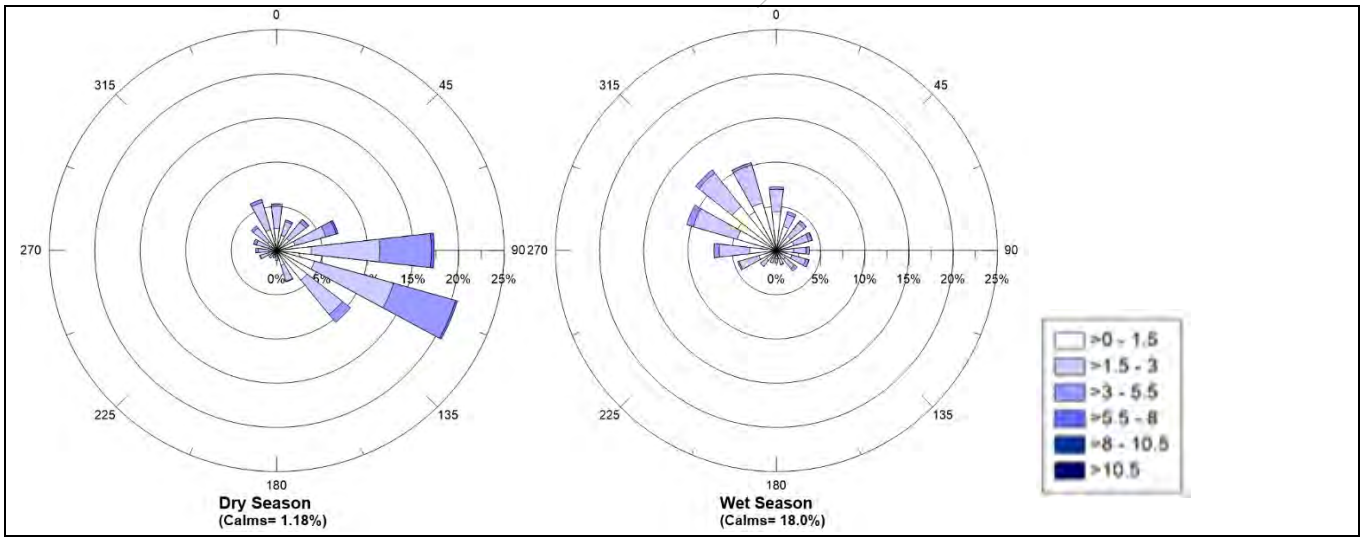
The locations of the DDGs are shown in **Figure 2**. The monitoring sites have been selected to comply with the requirements of AS 3580.1.1:2007 as described above. The existing DDGs are located as follows:

- Three DDGs (DDG1, DDG2 and DDG3) have been co-located with the BAMS.
- Another three DDGs (DDG4, DDG5 and DDG6) have been located north and west of the Project to measure dust deposition rates in other areas of the Yinberrie Hills where finches have been known to be located.
- Two DDGs (DDG7 and DDG8) have been located northeast of the Project to serve as 'control sites'. Dust deposition impacts from the Project are predicted to be minimal in this direction during both wet and dry seasons due to predominant wind directions in the area (see **Figure 3**).
- Two DDGs (DDG9 and DDG10) have been located to the south and southwest of the Project.

The sites to the west and southeast of the site will be downwind of the mine under the predominant wind directions during the dry and wet seasons respectively (see **Figure 3**). The sites to the northeast of the mine represent areas where *Alloteropsis semialata* is expected to be present close to the mine, and also within areas where the dust modelling predicts the highest dust deposition rates.

Regular vegetation surveys will be performed at the DGG sites to monitor the health of the grass so that the findings can be compared against the results of the dust deposition monitoring programme.

Figure 3 Mt Todd Gold Mind Wind Roses (2018)



4.2.3 Sampling Frequency/Duration and Minimum Data Capture Rate

Baseline PM_{10} monitoring commenced in November 2015 and will be conducted continuously for twelve months per year to enable sufficient data to be collected to provide a robust assessment of baseline dust concentrations and the impact of seasonal and inter-annual variations in meteorology and other events (e.g. wildfires, dust storms) on the measured dust concentrations.

The BAMs will continuously log 15-minute and 1-hour average PM_{10} concentrations. Data recorded by the BAMs will be continuously uploaded to the Vista Gold environmental database via remote telemetry. Analysis of the 24-hour average concentrations will be performed using this data for comparison against the adopted threshold levels.

The value of a dataset is determined by the quantity of its data values as well as by the quality of those data values. A measure of quantity is the data capture rate (%) which is a measure of the percent of record captured within the period summarised. A station with no missing record will have a data capture rate of 100%, while a station with 30% missing record will have a data capture rate of 70%. Allowing for the daily and monthly calibrations, as well as the potential for some data loss due to monitoring at a remote site, a key performance indicator for the monitoring stations will be a minimum 85% data capture rate. 24-hour average concentrations will be calculated for days with minimum of 75% data capture.

For the baseline dust deposition monitoring programme, as a minimum, three 1-month (30±2 days) dust deposition samples will be collected at each of the ten DDG sites during the dry season (March – October). Due to site access issues and high rainfall resulting in gauges overflowing during the wet season, dust deposition monitoring may need to be temporarily suspended. The collected DDG samples will be sent to a NATA-accredited laboratory for analysis of soluble solids, insoluble solids and ash content.

4.3 Operational-Phase Dust Monitoring

4.3.1 Overview

The baseline dust monitoring programme will continue until the construction activities associated with mine development begin, at which point the dust monitoring will enter the operational-phase. From this point onwards, the key objectives of the operational dust monitoring programme will be to:

- Monitor suspended particulate concentrations at key breeding and foraging areas across the full extent of the Gouldian Finch habitat potentially impacted by dust;
- Provide data that enables an assessment of the cumulative and incremental impacts on ambient PM_{10} concentrations of dust emissions from the Mt Todd gold mine;
- Provide warnings of the potential for an exceedance of the 24-hour average PM_{10} threshold value derived for Gouldian Finches to occur, based on a series of short-term (1-hour average) trigger levels so that proactive measures can be implemented at the mine to reduce dust emissions;
- Collect data on dust deposition rates in areas where vegetation surveys for *Alloteropsis semialata* are being performed, to identify whether elevated dust deposition rates are impacting on the health of the grass and whether a threshold level of dust deposition rates is required/appropriate.

To fulfil these objectives, it is anticipated that two (2) additional PM_{10} monitoring sites will be established prior to the commencement of the operational-phase dust monitoring. The location and number of these monitoring locations will be confirmed prior to commencement of the operational-phase dust monitoring. It is anticipated that the number of dust deposition monitoring sites would not need to be modified but this will also be reviewed prior to commencement of the operational-phase dust monitoring. Decisions on the number and location of all monitoring sites will be made in consultation with relevant stakeholders.

4.3.2 Monitoring Locations

As discussed above, the location and number of monitoring locations will be confirmed prior to commencing the operational-phase dust monitoring. It is anticipated that the three BAMs located at the baseline dust monitoring sites will remain to provide a continuous dataset of particulate concentrations at these locations. This will enable a direct comparison of the pre- and post- mining measurements to assess impacts from the Mt Todd Project. Similarly, the dust deposition monitoring sites are anticipated to remain unchanged.

The exact locations and number of additional PM_{10} monitoring locations for the operational dust monitoring programme will be established prior to the commencement of the operational-phase dust monitoring, however indicative locations are shown in **Figure 2**.

The DoE requirements for the DMMP include the monitoring of particulate concentrations at control sites located outside of the area potentially impacted by dust from the mine. The baseline monitoring programme currently includes PM_{10} monitoring at BAM1 which is located upwind of the mine under the predominant wind conditions during the dry season, whereas BAM3 is located upwind of the mine during the wet season (see **Figure 3**). It is therefore proposed that these monitoring stations can act as a 'control sites' for the operational phase as they will provide measurements of PM_{10} levels that are representative of background concentrations for the majority of the time during each respective season. In addition, as the monitoring is being performed using real-time dust monitors which provide continuous measurements of 15-minute and 1-hour average PM_{10} concentrations, a comparison of the particulate concentrations measured each hour by the 'upwind' and 'downwind' will enable the incremental impact of the mine emissions to be assessed.

As per the baseline dust monitoring phase, decisions on the number and location of PM_{10} monitoring sites will be made in consultation with relevant stakeholders and the locations of each monitoring site will be selected to comply with the requirements of AS 3580.1.1:2007.

4.3.3 Sampling Frequency/Duration and Minimum Data Capture Rate

The baseline dust monitoring programme will continue until the construction activities associated with mine development begin, at which point the dust monitoring will enter the operational-phase. The commencement of the operational-phase dust monitoring programme will therefore simply depend upon the Project schedule.

PM_{10} monitoring will be conducted at each monitoring site continuously for twelve months per year. Data recorded by the BAMs will be continuously uploaded to the Vista Gold environmental database via remote telemetry. The BAMs will continuously log the measured 15-minute and 1-hour average PM_{10} concentrations. Calculation and analysis of the 24-hour average concentrations will be performed using this data for comparison against the proposed threshold levels.

The 15-minute average data will also be analysed based on the wind speed and wind direction data concurrently recorded by the on-site weather station (refer **Section 4.4**) so that the incremental impact of the mine emissions above background levels can be assessed (i.e. when the wind is blowing from the mine towards the monitor, the measured particulate levels will reflect cumulative impacts; when the wind is blowing from the monitor towards the mine, the measured concentrations are reflective of background levels).

A key performance indicator for the BAM monitoring stations is a minimum 85% data capture rate.

The dust deposition monitoring programme will continue to include a minimum of three 1-month (i.e., 30±2 days) dust deposition samples during the dry season (March – October) for each of the ten DDG sites.

4.4 Meteorological Monitoring

4.4.1 Overview

Data from the on-site automatic weather station/s (AWS) installed at the Mt Todd Project will be utilised in the analysis of the measured particulate levels and will also be available to site personnel to assist in real-time response to elevated dust events.

The meteorological parameters recorded by the AWS are as follows:

- humidity (%);
- wind direction (°);
- standard deviation of wind direction (°);
- wind velocity (m/s);
- barometric pressure (HPa);
- solar radiation (W/m^2);
- net radiation (W/m^2);
- air temperature (°C).

4.4.2 Monitoring Locations

The station is located on the Mt Todd mine site at UTM53 188,425 m E, 8,435,195 m N, approximately 380 m northeast of the processing area.

4.4.3 Sampling Frequency/Duration and Minimum Data Capture Rate

Meteorological data are measured and logged continuously.

A key performance indicator for the AWS is a minimum 90% data capture rate.

4.5 Data Management, QA/QC and Analysis

- The BAMs will provide real-time measurements of PM_{10} concentrations which will be uploaded to the Vista Gold environmental database via remote telemetry.
- On a regular basis (annually during the baseline dust monitoring phase and monthly during the operational phase) a statistical analysis of the BAM data will be performed, to identify trends in the data and (during the operational phase) assess the cumulative and incremental impact of emissions from the mine compared to background levels.
- During the operational phase, alerts of measured exceedances of pre-set alarm levels for PM_{10} will be provided to relevant site personnel via SMS to enable immediate investigation, and if appropriate, implementation of additional dust controls. These alarm levels would be based on the short-term (1-hour average) concentrations recorded by the monitors to provide immediate warning that particulate concentrations are approaching levels that could result in exceedances of the 24-hour average threshold levels. Further details regarding the Reactive Dust Management Strategy are provided in **Section 6.2.1** .

- During the operational phase, daily reviews of the PM_{10} data will also be performed to review the concentrations recorded to confirm the mitigation measures being implemented are effectively managing dust emissions and to identify any data quality issues not identified by the internal instrument calibration checks and maintenance alerts.
- The collected DDG samples will be sent to a NATA-accredited laboratory for analysis of soluble solids, insoluble solids and ash content. The results of this analysis will be entered into to the Vista Gold environmental database and be made available for use in the analysis of the vegetation survey findings.
- Monthly summaries of the monitoring data (PM_{10} and deposited dust) will be prepared, which will include a detailed QA/QC of all data. The justification for any data removed from the dataset will be fully documented and the raw data files retained for future reference.

5 PREDICTED PM_{10} IMPACTS IN YINBERRIE HILLS DUE TO MT TODD PROJECT

PM_{10} concentrations within the Yinberrie Hills in areas where the Gouldian Finch is present due to emissions from the Mt Todd Project have been predicted as part of a detailed atmospheric dispersion modelling study. Details of the study are provided in **Appendix B**.

A summary of the predicted cumulative impacts is provided in **Table 2** showing that there are areas within the historic Gouldian Finch nesting site area that are predicted to exceed the PM_{10} threshold values derived for the Project. It is anticipated that these exceedances can be prevented from occurring by using the Reactive Dust Management Strategy outlined in **Section 6.2.1** to minimise dust emissions. This Reactive Dust Management Strategy includes a number of trigger levels to initiate actions to reduce dust emissions if elevated PM_{10} levels start to be recorded that have a potential to result in an exceedance of the Project-specific dust threshold values.

Table 2 Predicted Performance Against Project-Specific Dust Threshold for PM_{10} (Year 3 Operations)

Performance Criteria	Predicted Cumulative Impacts		
	Receptor 1	Receptor 3	Receptor 10
Annual average limit of 20 µg/m^3	17.9 µg/m^3	25.2 µg/m^3	26.6 µg/m^3
Maximum of 11 days above 60 µg/m^3 (24-hour average) per year	0 day	2 days	7 days
7-day average limit of 40 µg/m^3	Exceeded 4.1% of the time	Exceeded 9.0% of the time	Exceeded 12% of the time

6 DUST MITIGATION PROGRAMME

The Project has been designed with substantial mitigation measures. These measures have been proposed to ameliorate the impacts of the project on the Gouldian Finch.

6.1 Measures to Avoid and Mitigate Impacts

The site-specific dust mitigation measures proposed for the Mt Todd Project are listed in **Table 3**. These measures cover both the construction and operational phases, and focus on the haul roads, wind erosion and the crushing and grinding of ore at the processing plant during operation, which were three most significant sources identified in the air quality impact assessment.

Table 3 Dust Mitigation Measures

Source	Strategy	Mitigation or Management Measure
General	Site inductions	• All staff are to be inducted as to the requirements of this Dust Monitoring and Mitigation Programme

	Daily site inspections	• Daily site inspections will be carried out during construction and mining phases which will include, but not be limited to:
		  • Meteorological observations (wind strength/direction, recent rainfall etc)
		  • Visual inspection of airborne dust
		  • Inspection of erosion and sediment controls
		  • Inspection of dust suppression systems including liaison with water truck drivers and processing plant operators
		  • Inspection of any rehabilitated areas (where relevant)
		• Records of the above observations will be kept, with remedial or corrective actions noted (as appropriate)

	Dust monitoring programme	• Timely response to any SMS alerts of measured exceedances of pre-set alarm levels recorded by the BAMs, including immediate investigation and, if appropriate, implementation of additional dust controls
Haul Roads	Reduce dust emissions from haul roads during the construction phase and operation of the mine	• Post and enforce speed limits to reduce airborne fugitive dust from vehicular traffic • Use of water sprays and water carts to reduce dust generation from roads and during clearing activities with a watering rate of 2 litres/m^2/application to all haul roads • Undertake chemical treatment of key haul roads to reduce ongoing dust generation where required. • Periodic water application to other exposed areas • Minimise hauling and vehicle travel in the dry season when prevailing winds and strength of winds would result in spatially extensive and heavy dust deposition in the Gouldian Finch habitat area. • Haul trucks to be maintained and operated in a proper and efficient condition • Truck queuing and unnecessary trips are minimised through logistical planning
Minor Roads	Reduce dust emissions from minor roads including within the Finch habitat	• Enforce speed limits on all on-site vehicles to minimise wheel-generated dust • Use of pooled vehicles such as buses and work vehicles to minimise emissions • Permits will be allocated for vehicle access to known breeding habitat during the critical breeding season

Source	Strategy	Mitigation or Management Measure
Wind Erosion	Reduce dust emissions from disturbed areas and stockpiles during the construction phase and operation of the mine	• Cover areas of disturbed soil, stockpiles and temporary spoil stockpiles with mulch, cover crop or other material where practicable if they are a source of fugitive dust • Apply chemical stabilisers to waste rock dumps to reduce ongoing dust generation, where required • Retain vegetation as a buffer and to limit potential dust sources • Revegetate disturbed areas as soon as possible after disturbance • Erosion and sedimentation controls to be regularly inspected to ensure that they do not become a potential source of dust
Processing Plant	Reduce dust emissions from plant during operation of the mine	• Install a spray on primary crusher dump pocket • Ore will be wet prior to crushing and the crusher will be hooded • Maintenance programme for crushing equipment will ensure that it is operating at peak efficiency • Enclose High Pressure Grinding Role (HPGR) • Dust suppression sprays on conveyors to minimise dust

Mining	Reduce dust emissions from blasting during operation of the mine	• Material drop heights during loading and unloading are reduced as far as practical
		• Initiate a detailed blast monitoring programme in parallel with the bird monitoring activities and refine blasting processes where necessary, for example:
		  • Rescheduling blasting activities if meteorological conditions have the potential to results in transport of dust towards the Gouldian Finch breeding areas
		  • Avoiding blasting during 'sensitive' periods (e.g. breeding and moulting)
		  • Limiting blasting to once per day

Fire	Minimise the generation of particulate matter from fires	• Burning of waste and materials will not be allowed on site at any time • Controlled asset protection burns will only be carried out over a four-week prior in the early dry season. Additional details of asset protection using fire management will be contained within a Fire Management Plan to be developed prior to the commencement of construction

6.2 Management Reponses

An important component of the monitoring framework and the instigation of mitigation measures is identification of trigger levels when action should occur. This is discussed further below in **Section 6.2.1**.

Potential additional remedial actions for dust control if trigger levels are reached are as follows:

- increased watering rates;
- use of chemical stabilisers; and
- relocation or temporary suspension of dust-producing activities until meteorological conditions become more favourable.

6.2.1 Reactive Dust Management Strategy

6.2.1.1 1-Hour Average Trigger Levels

The proposed 24-hour average dust threshold for Gouldian Finches of 60 µg/m^3 has been used to derive a short-term (1-hour average) trigger levels as part of a Reactive Dust Management Strategy to be implemented at the site as part of this DMMP.

The 1-hour average time period has been selected as a practical time-step for identifying sustained elevated dust concentrations that could potentially result in an exceedance of the 24-hour average threshold level, while providing sufficient time for additional mitigation measures to be implemented at the mine to reduce dust emissions before such an exceedance occurs. Details of the derivation are provided in **Appendix C**.

The proposed 1-hour average trigger levels will be reviewed based on additional data collected by the baseline dust monitoring programme (and revised as necessary) prior to commencement of the operational-phase dust monitoring to ensure they are appropriate for the ongoing monitoring and management of dust emissions from the Mt Todd gold mine. Any amendments to the trigger levels will be undertaken in consultation with relevant stakeholders.

The associated trigger levels and responses are provided in **Table 4**.

Table 4 Trigger Levels and Responses

Trigger / Response	PM_{10} Concentration Alert Level	PM_{10} Concentration Action I Trigger Level	PM_{10} Concentration Action II Trigger Level
Trigger	**1-hour average PM_{10} ≥ 130 µg/m³ but ≤ 165 µg/m³**	**1-hour average PM_{10} ≥ 165 µg/m³ but ≤ 200 µg/m³**	**1-hour average PM_{10} ≥ 200 µg/m³**
Response	Review operations and continue to monitor dust emissions Assess whether elevated dust levels are due to elevated regional background concentrations or are due to emissions from the Mine.	If emissions from the Mine are identified as having a significant impact on the measured PM_{10} concentrations: • Reduce speed of equipment / vehicles • Implement Dust Suppression – Ensure water cart is operating effectively in key dust-producing areas • Consider holding off on blasting • Note changed state and monitor for further change	If emissions from the Mine are identified as having a significant impact on the measured PM_{10} concentrations: • Reduce speed of equipment / vehicle • Review planned operation with consideration to exposed areas • Implement additional dust suppression: - Water Cart - Chemical stabilisers - Water sprays on stockpiles and any other dusty areas • Cease any non-critical truck movements on unpaved haul roads • Cease any non-critical movement of dozers, graders and other dust generating mobile equipment • Hold off on blasting • Note changed state and monitor for further change

6.2.1.2 Visual Observations

In addition to the EBAM monitoring programme, a reactive dust management system based on visual observations of dust generated by trucks on the haul routes will also be implemented. The hauling of overburden and ore are the main sources of dust emissions for the site based on the emission inventories prepared for the Project. Visual observations of dust generated by the truck movements do not rely on wind direction to blow the emissions towards the monitoring sites and will complement the real-time dust measurement trigger levels.

Trigger / Response	Visual Inspection Normal Operations	Visual Inspection Action I Trigger Level	Visual Inspection Action II Trigger Level
Trigger	No visible dust above tray of haul truck	Visible dust above tray height of haul truck	Visible dust above tray height of haul truck for a sustained period
Response	Undertake tasks as normal	• Reduce speed of equipment / vehicle • Notify water truck driver for additional dust suppression	• Reduce speed of equipment / vehicle • Notify water truck driver for additional dust suppression • Assess haul road and consider redirecting or stopping haul circuit until dust levels return to acceptable levels • Review any grading activities occurring on haul circuit and limit grading activities where required

6.2.1.3 Daily PM_{10} Monitoring Data Reviews

The PM_{10} concentrations recorded by the monitoring network will also be reviewed on a daily basis to assess the ongoing compliance with the threshold values. These reviews will include:

- A review of the performance of the operations against the dust threshold limits of:
  - Maximum of 18 days per year (5% of the year) above the 24-hour average PM_{10} concentration limit of 60 µg/m^3; and
  - Maximum 7-day average PM_{10} concentration limit of 40 µg/m^3 (as a daily rolling average).
- Checks of the 24-hour average PM_{10} concentrations recorded over the previous day and whether the upwind and downwind monitoring sites indicate a significant impact due to the mine compared to background concentrations.
- A review of the effectiveness of any additional dust control measures implemented in response to an exceedance of any of the 1-hour average trigger levels.

7 REPORTING

In accordance with the Gouldian Finch Monitoring and Mitigation Programme, an Annual Gouldian Finch Monitoring Report will be prepared each year and contain systematic, comprehensive and informative reports on mitigation measures and monitoring at Mt Todd. This report will present the results of a range of monitoring programmes implemented by the mine to assess the impacts of the Mt Todd gold mine of the Gouldian Finch population, including the results of the DMMP.

A separate Annual Dust Monitoring and Mitigation Programme Report summarising the methodology and results of the dust monitoring programme will be prepared to inform the Annual Gouldian Finch Monitoring Report.

8 ROLES AND RESPONSIBILITIES

The responsibility for implementation, monitoring and review of the DMMP lies with the Mt Todd Mine Manager. As such, the Mine Manager has the ultimate responsibility for the implementation of the DMMP and shall make appropriate resources available. The roles and responsibilities for this DMMP are outlined in **Table 5**.

Table 5 Roles and Responsibilities

Role	Responsibility
Mine Manager	• Ensuring that sufficient resources are available to implement and execute the requirements of this DMMP • Liaison with government environmental agencies • Reporting triggers/non-conformances to external stakeholders
Environment Officer	• Implementation, monitoring and review of this DMMP, including: • Ensuring that the requirements of the DMMP are complied with, including the deployment and maintenance of equipment, and that personnel performing the monitoring are suitably qualified. • Reporting triggers/non-conformances internally to the Mine Manager as appropriate • Consultation during the review process with relevant stakeholders and distributing this DMMP • Reviewing this DMMP
TAC Members	• Assistance with the development of this DMMP, including: • Review of draft Gouldian Finch Monitoring and Mitigation Programme • Provision of advice for mitigation strategies and monitoring requirements

9 PROGRAMME REVIEW

In accordance with the Gouldian Finch Monitoring and Mitigation Programme, an annual audit, review and reporting of the effectiveness of monitoring, mitigation measures, remedial actions, operating controls and implementation of any required improvements to management conditions will be conducted under the guidance of an endorsed Gouldian Finch expert. This process will enable the results of all the relevant monitoring programmes to be assessed against the measured dust levels. Based on this analysis, the appropriateness of the dust threshold values and short-term trigger levels will be reviewed and confirmed.

This DMMP will be reviewed after the completion of baseline surveys and then every two years, or in the event that the following occur:

- Stakeholders raise issues that are agreed to necessitate a review;
- There are changes to the management requirements (e.g. a new monitoring site is established, or if there are changes to related approvals);
- Where unpredicted impacts or consequences have required implementation of contingency actions under this plan; and
- Monitoring, incident, or audit processes demonstrate that a review is warranted.

Any amendments to the DMMP will be undertaken in consultation with relevant stakeholders.

10 ABBREVIATIONS

°	degrees
°C	degrees Celsius
%	percent
AWS	Automatic Weather Station
BAM	Beta-Attenuation Monitor
DLRM	Department of Land Resource Management
DoE	Commonwealth Department of the Environment
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EPBC Act	Commonwealth Environment Protection and Biodiversity Conservation Act 1999
g/m^2/month	grams per square metre per month
Hpa	hectopascals
km	kilometre
m/s	metres per second
NATA	National Association of Testing Authorities, Australia
NT	Northern Territory
$PM_{2.5}$	Particulate Matter up to 2.5 micrometers in size
PM_{10}	Particulate Matter up to 10 micrometers in size
TAC	Technical Advisory Committee
TSP	Total Suspended Particulate
µg/m^3	micrograms per cubic metre
Vista Gold	Vista Gold Australia Pty Ltd
W/m^2	Watts per square metre

11 REFERENCES

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APPENDIX A

Project Specific Dust Thresholds

Current guidelines for ambient particulate concentrations and dust deposition rates have been developed to address potential human health and nuisance impacts in residential areas and are not directly relevant to impacts on birds or the environmental surrounding the Mt Todd Project.

Detailed analysis has therefore been performed to derive project specific thresholds based on the Mt Todd Project baseline monitoring data available to date, monitoring data from Darwin, and historic data from Ranger Uranium Mine. These are all areas where there are known populations of successfully breeding Gouldian finches. It follows that the Gouldian Finch population in Yinberrie Hills should be able to tolerate similar conditions.

The methodology used to derive project-specific dust threshold values to be used as compliance targets for the operational phase of the Mt Todd Gold Mine is outlined below. These thresholds will be reviewed and revised (if required) at the completion of the baseline monitoring programme when the full baseline dataset is available. The dust threshold values have been developed based on:

- An analysis of the 11.5 months (December 2015 to November 2016) of PM_{10} monitoring data from the preliminary baseline monitoring undertaken at the two initial monitoring locations;
- An analysis of the first 22 months (July 2017 to April 2019) of PM_{10} monitoring data available at the time of writing from the current baseline monitoring programme at three monitoring locations;
- A review of dust deposition monitoring data collected over a 12-month period (August 2017 to July 2018) during the current baseline monitoring programme at ten monitoring locations;
- A comparison of the Mt Todd Mine baseline data against data recorded in Darwin over the same periods, where captive and wild finch populations are known to be present; and
- A review of TSP monitoring data collected over a 26-year period at the Ranger Uranium Mine, during which time both wild populations of finches and a viable and healthy captive breeding population of Gouldian Finches were known to be present.

NTEPA PM_{10} Monitoring Data - Darwin

Aside from the baseline air quality monitoring network initially installed at the site in December 2015 by Vista Gold, the nearest air quality monitoring stations recording ambient concentrations of particulate matter are the NT EPA monitoring stations located at Palmerston and Winnellie in Darwin, 240 km from the Mt Todd Gold Mine. While these monitoring sites are a significant distance from the Mt Todd Gold Mine, they provide long term information on PM_{10} concentrations in a region where captive and wild finch populations are known to be present.

A summary of the PM_{10} data collected by the Palmerston and Winnellie monitoring stations from January 2012 to May 2019 is shown in **Figure A1**. **Table A1** presents a summary of key statistics.

The data show a strong seasonal dependence, with ambient particulate concentrations dropping significantly during the wet season (November to February) and remaining low during the start of the dry season until around May. For example, the measured 24-hour average PM_{10} concentrations generally peak at around 70 $\mu g/m^3$ in the dry season and drop to around 5 $\mu g/m^3$ in the wet season.

Figure A1 PM_{10} Monitoring Data – Darwin (2012-2019)

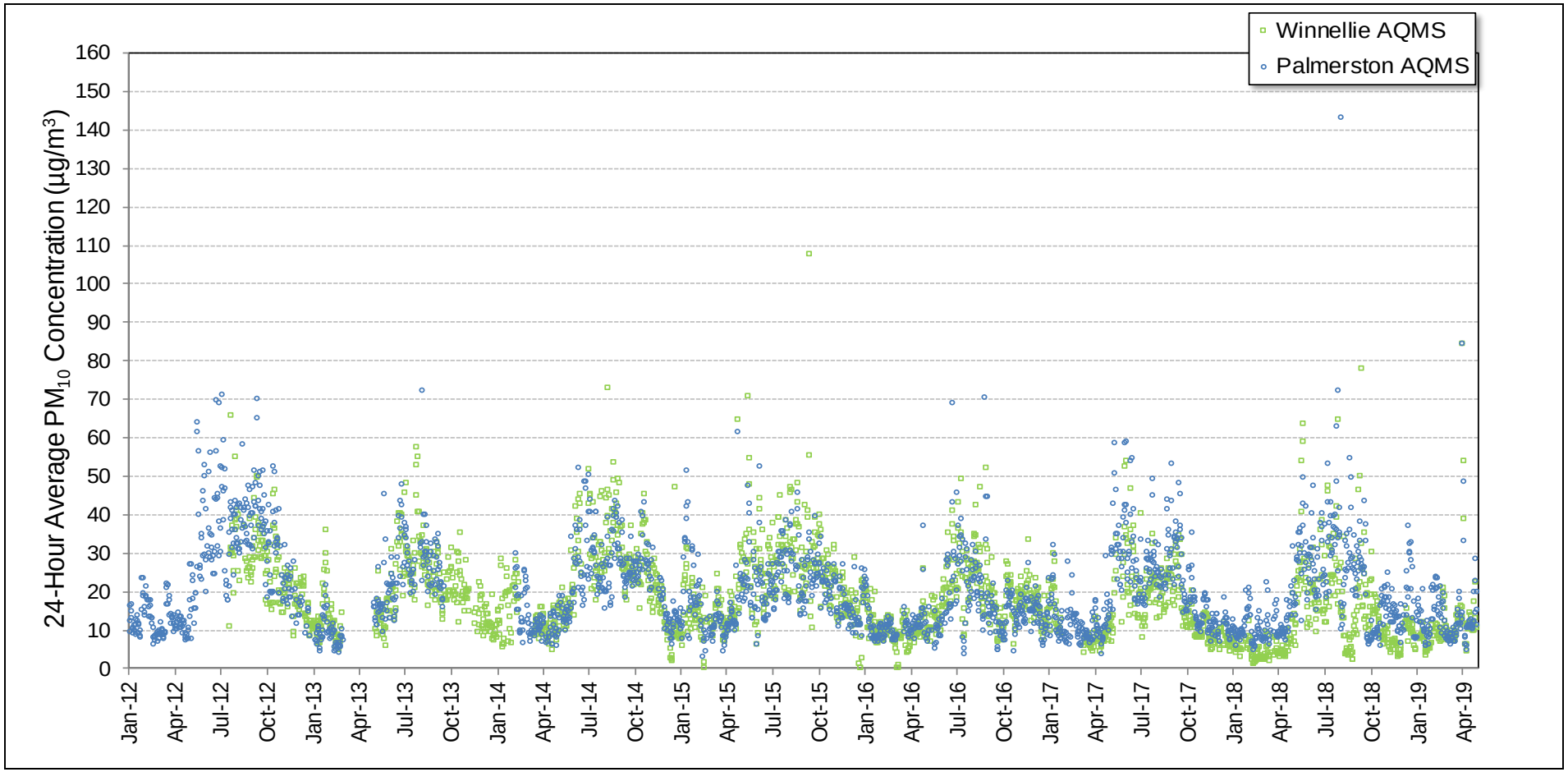


Table A1 Statistical Analysis – Darwin PM_{10} Monitoring Data (2012 – 2019)

Statistic	Palmerston (µg/m³)								Winnellie (µg/m³)								All Data (µg/m³)
	2012	2013	2014	2015	2016	2017	2018	2019[1]	2012	2013	2014	2015	2016	2017	2018	2019[1]	
24-Hour Averages																	
Maximum 24-hour average	71	72	52	61	70	59	143	85	66	58	73	108	52	54	78	85	143
90th %ile 24-hour average	45	34	35	31	26	34	35	23	37	31	38	34	27	28	27	22	34
70th %ile 24-hour average	34	26	26	24	17	24	25	15	29	24	27	27	19	19	16	12	23
50th %ile 24-hour average	23	19	20	19	13	17	17	12	24	19	20	21	15	13	10	10	17
% time 24-hour >40 µg/m³	21	2.8	5.3	3.2	1.8	6.0	5.4	3.1	5.4	3.6	8.6	4.8	1.7	1.3	3.2	3.3	5.2
% time 24-hour >50 µg/m³	6.9	0.6	0.7	0.9	0.6	2.0	1.4	0.8	1.3	1.1	1.0	1.4	0.3	0.7	1.5	2.5	1.5
% time 24-hour >60 µg/m³	2.1	0.6	0.0	0.3	0.6	0.0	0.9	0.8	0.7	0.0	0.3	0.8	0.0	0.0	0.9	0.8	0.5
Annual average	**26**	**20**	**21**	**20**	**15**	**20**	**20**	**15**	**25**	**20**	**22**	**22**	**16**	**15**	**13**	**13**	**19**
Breeding Season																	
Breeding season average	28	25	21	20	18	23	25	15	31	25	24	24	18	17	16	16	21.4
% time 24-hour >40 µg/m³	24	4.7	8.0	4.5	3.8	10.6	10.3	5.3	9	8.5	14.9	6.5	3.3	2.4	4.5	5.9	8.2
% time 24-hour >50 µg/m³	8.3	0.9	1.1	1.1	1.3	3.9	2.9	1.3	6.1	2.5	1.9	1.6	0.5	1.2	2.3	4.4	2.4
% time 24-hour >60 µg/m³	2.8	0.9	0.0	0.6	1.3	0.0	1.7	1.3	3.0	0.0	0.6	1.1	0.0	0.0	1.1	1.5	0.9

1 Up to 18 May 2019.

Mt Todd Baseline Monitoring Programme

Preliminary Baseline Monitoring Programme (2015-2017) – PM_{10}

The 20 months (December 2015 – July 2017) of PM_{10} monitoring data from the Mt Todd preliminary baseline monitoring programme are presented in **Figure A2** to **Figure A4** along with the data recorded in Darwin over the same period. Note that 24-hour averages are only calculated for those days which reported 75% or greater data capture, in accordance with the National Environment Protection (Ambient Air Quality) Measure (NEPM (AAQ)).

The monitor at the "House" monitoring site was relocated to "Bore 6" on 22 June 2016 due to concerns that the adjacent road at the House monitoring site was impacting on the results. The 24-hour average concentrations recorded at the Bore 6 and Yinberrie Hills monitoring sites have been consistently similar aside from one day in August 2016 and a few days in late October 2016, indicating that neither site is being regularly affected by any localised sources of dust. Key statistics for the two sites are presented in **Table A2** and compared with Darwin over the same period. The statistics show that the 70th percentile, 50th percentile and average PM_{10} concentrations recorded at the two sites were similar, and less than those recorded at the Darwin sites. Note there is insufficient data capture to calculate annual averages for Bore 6 or Yinberrie Hills.

The data presented in **Figure A2** to **Figure A4** indicate that the existing Gouldian finch population in Yinberrie Hills is successfully breeding and foraging in an area where 24-hour PM_{10} concentrations generally range from 5 – 19 µg/m^3 (based on 10 and 90 percentile values), with isolated peak events up to 100 µg/m^3 recorded as a 24-hour average.

The data also indicates that baseline 24-hour average PM_{10} concentrations at the Mt Todd Project are typically around 5 µg/m^3 lower than the levels being recorded in Darwin. For example, during the 2016 and 2017 breeding seasons (i.e. from 1 March to 31 August) the average PM_{10} concentration recorded at Mt Todd was 12.0 µg/m^3, compared to 20.9 µg/m^3 and 17.9 µg/m^3 at Palmerston and Winnellie respectively.

24-hour average PM_{10} concentrations above 60 µ/m^3 were recorded by the Mt Todd Project preliminary baseline monitoring programme 0.5% of the time based on the combined measurements at the Yinberrie Hills and Bore 6 sites (this increases to 0.8% of the time if data from the House monitoring site is included, however these readings may have been impacted by a nearby road). **Table A2** shows that concentrations above 60 µg/m^3 were recorded at Palmerston and Winnellie less than 0.3% of the time during the preliminary baseline monitoring period.

Figure A2 24-Hour Average PM_{10} Concentrations Recorded at Mt Todd Compared to Winnellie and Palmerston (November 2015 – June 2016)

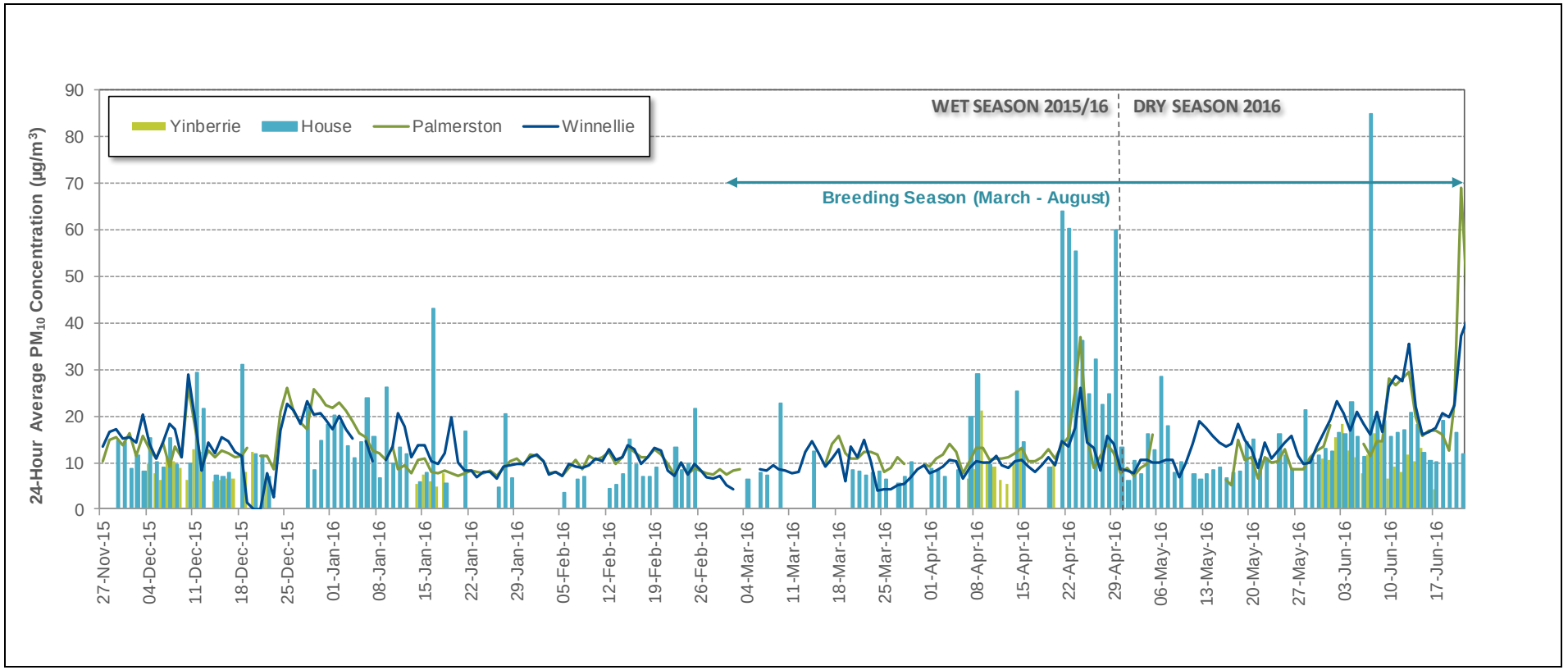


Figure A3 24-Hour Average PM_{10} Concentrations Recorded at Mt Todd Compared to Winnellie and Palmerston (June 2016 – December 2016)

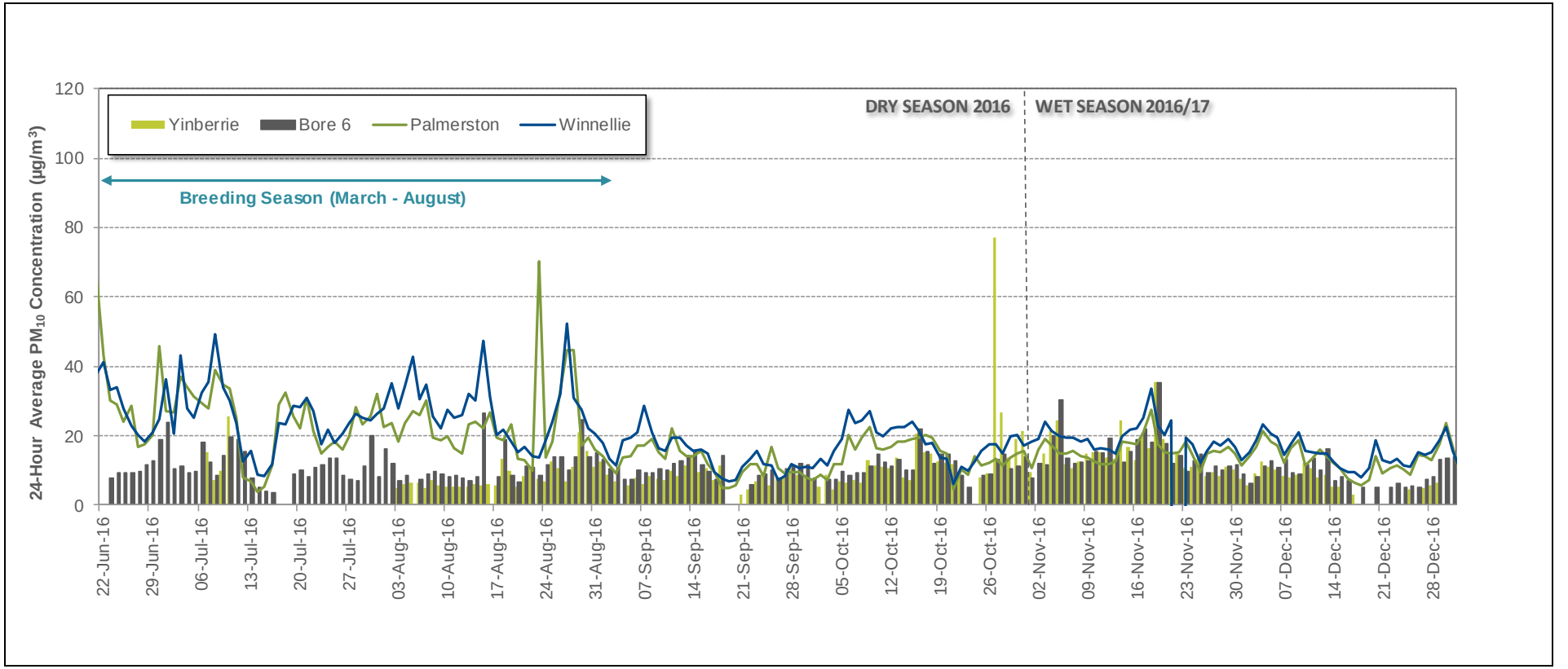


Figure A4 24-Hour Average PM_{10} Concentrations Recorded at Mt Todd Compared to Winellie and Palmerston (January 2017 – August 2017)

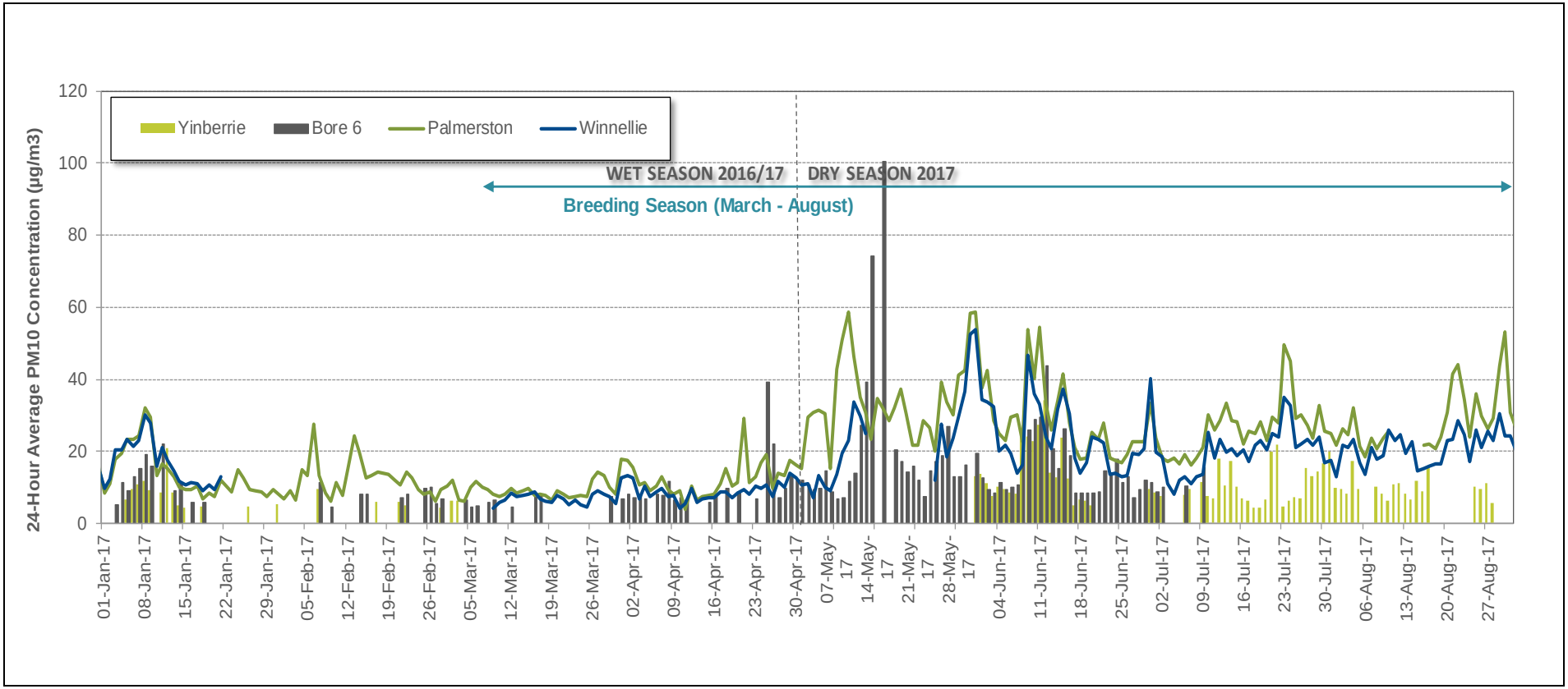


Table A2 Preliminary On-Site PM_{10} Monitoring Data Statistics (2015-2017)

Statistic	Yinberrie Hills	Bore 6	Palmerston	Winnellie
1-hour data capture (%)	48	84	N/A	N/A
Annual Average (µg/m^3)	-*	-*	-*	-*
Number of records (days; >=75% data capture)	274	296	620	588
Maximum 24-hour average (µg/m^3)	77	101	70.3	53.8
90th %ile 24-hour average (µg/m^3)	17.2	19.0	30.8	27.7
70th %ile 24-hour average (µg/m^3)	11.3	13.0	20.2	20.3
50th %ile 24-hour average (µg/m^3)	9.3	10.6	14.6	15.4
10th %ile 24-hour average (µg/m^3)	5.3	6.8	8.1	7.7
Breeding Season Average (µg/m^3)	10.7	13.2	20.9	17.9
% time 24-hour average >40 µg/m^3	0.4	1.0	4.0	1.7
% time 24-hour average >50 µg/m^3	0.4	0.7	1.5	0.5
% time 24-hour average >60 µg/m^3	0.4	0.7	0.3	0.0

* Insufficient data capture.

Current Baseline Monitoring Programme – PM_{10} (2017 – 2019)

The first 22 months (July 2018 – May 2019) PM_{10} of monitoring data from the current Mt Todd Project baseline monitoring programme are presented in **Figure A5** to **Figure A8**, along with the data recorded in Darwin over the same period.

Key statistics for the three sites are presented in **Table A3** and compared with Darwin over the same period. The statistics show that the 70th percentile, 50th percentile and average PM_{10} concentrations recorded at the three Mt Todd Project baseline monitoring sites over this period were similar to or slightly higher than the data recorded in Darwin during the wet season but were often significantly lower than the Darwin data during the dry season.

Consistent with the preliminary baseline monitoring, the data presented indicate that the existing Gouldian finch population in Yinberrie Hills is successfully breeding and foraging in an area where 24-hour PM_{10} concentrations generally range from 5 – 20 µg/m^3 (based on 10 and 90 percentile values), with isolated peak events over 100 µg/m^3 recorded as a 24-hour average.

The data also indicate that existing baseline 24-hour average PM_{10} concentrations at the Mt Todd Project are typically 5 µg/m^3 lower than the levels being recorded in Darwin. For example, during the breeding season the average PM_{10} concentration recorded at Mt Todd was 15 µg/m^3, compared to 19.7 µg/m^3 in Darwin.

To date, 24-hour average PM_{10} concentrations above 60 µ/m^3 have been recorded by the Mt Todd Mine current baseline monitoring programme 0.7% of the time based on the combined measurements at the three monitoring locations.

Table A3 shows that concentrations above 60 µg/m^3 were recorded at either Palmerston or Winnellie up to 0.6% of the time during the current baseline monitoring period.

Figure A5 24-Hour Average PM_{10} Concentrations Recorded at Mt Todd Compared to Winnellie and Palmerston (July 2017 – December 2018)

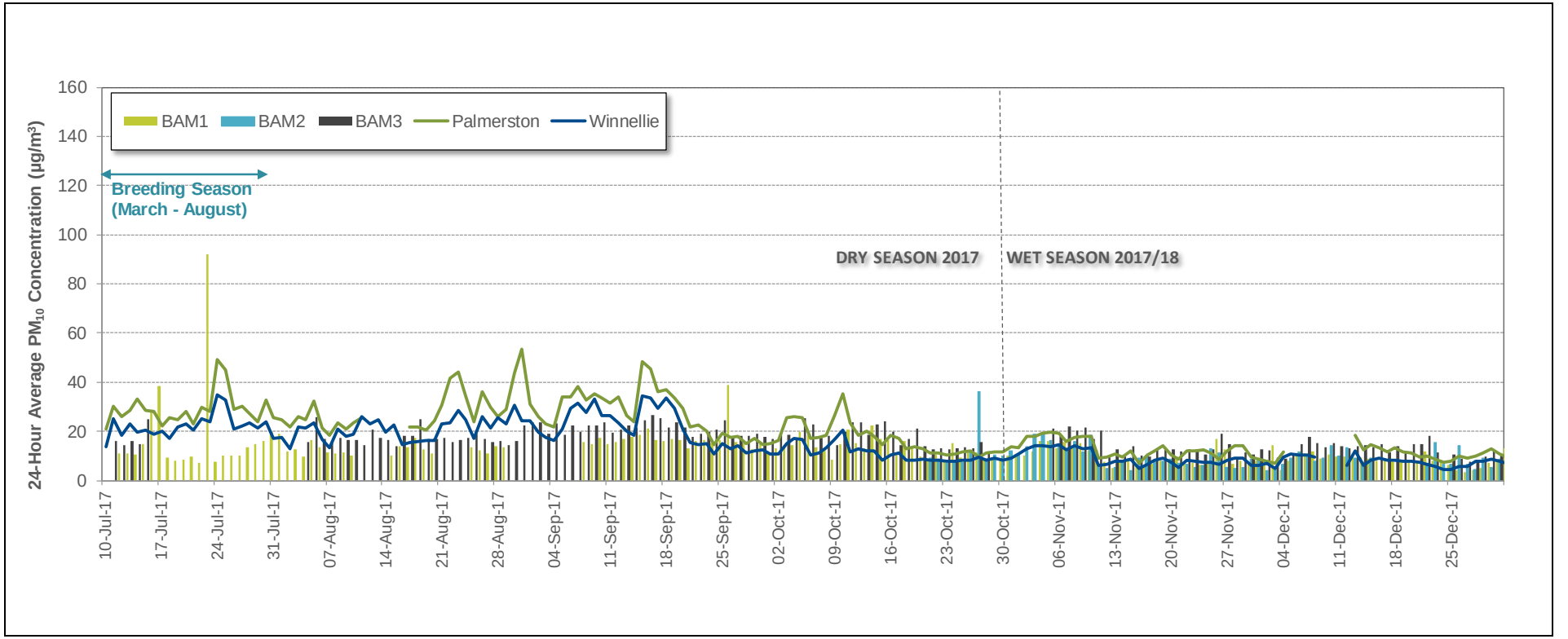


Figure A6 24-Hour Average PM_{10} Concentrations Recorded at Mt Todd Compared to Winnellie and Palmerston (January 2018 – June 2018)

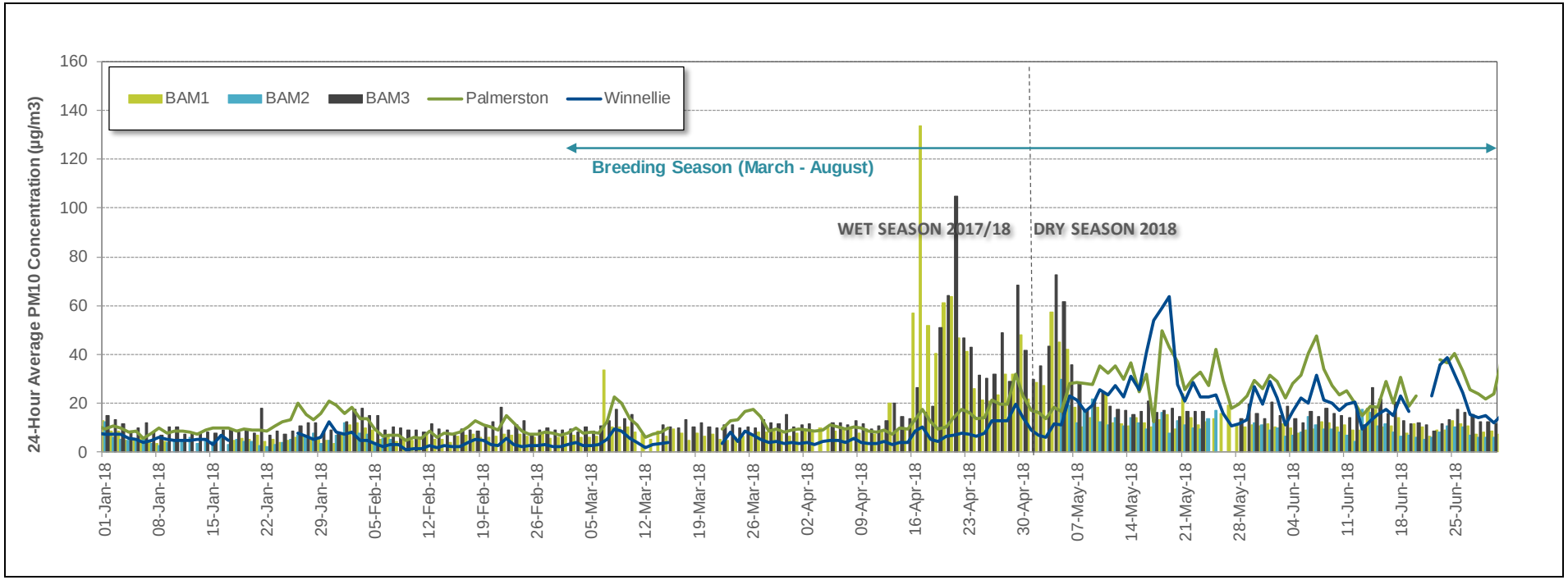


Figure A7 24-Hour Average PM_{10} Concentrations Recorded at Mt Todd Compared to Winnellie and Palmerston (July 2018 – December 2018)

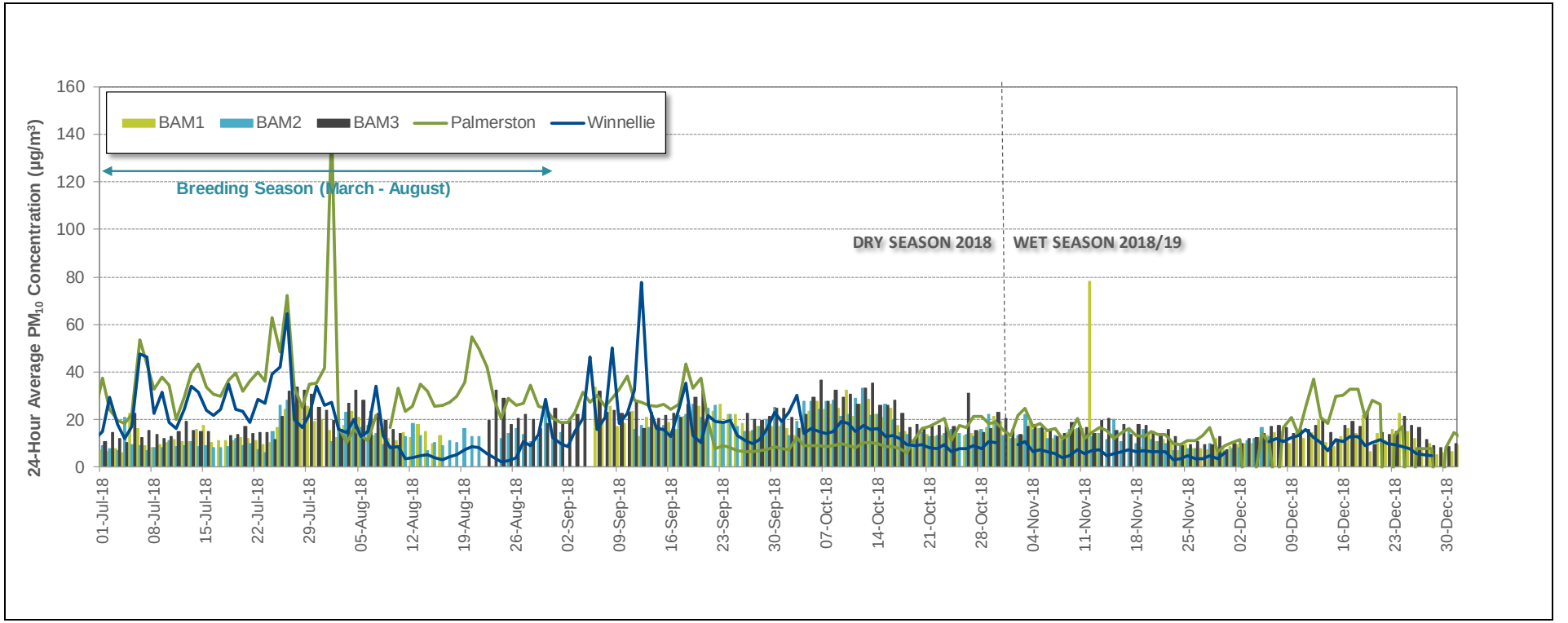


Figure A8 24-Hour Average PM_{10} Concentrations Recorded at Mt Todd Compared to Winnellie and Palmerston (January 2019 – May 2019)

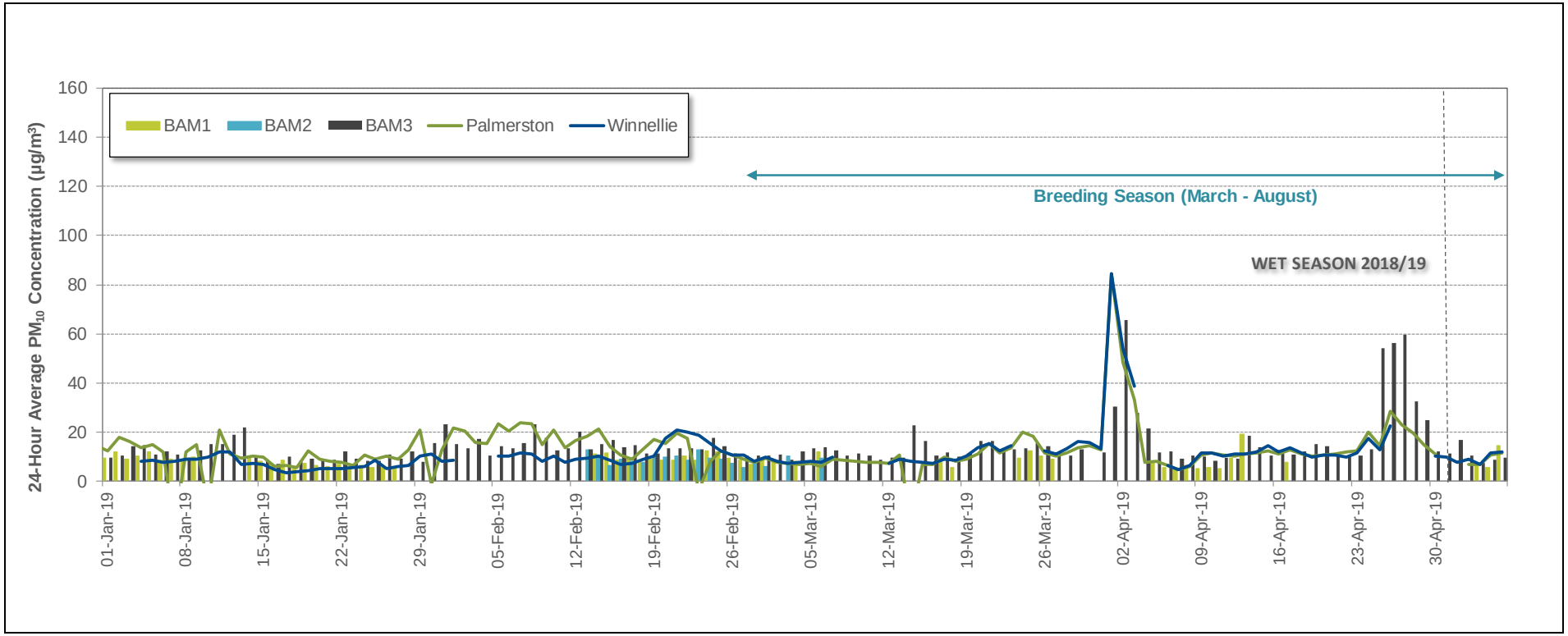


Table A3 On-Site PM_{10} Monitoring Data Statistics (2017 – 2019)

Statistic	BAM1	BAM2	BAM3	Palmerston	Winnellie
1-hour data capture (%)	85	56	92	N/A	N/A
Annual Average – 2018 (µg/m^3)	-*	-*	17	20	13
Number of records (days; >=75% data capture)	548	318	608	630	619
Maximum 24-hour average (µg/m^3)	134	36.1	105	143	84.6
90th %ile 24-hour average (µg/m^3)	21.4	20.1	25.1	33.7	25.0
70th %ile 24-hour average (µg/m^3)	14.3	13.6	18.0	22.7	15.8
50th %ile 24-hour average (µg/m^3)	10.9	10.4	14.9	15.1	10.6
10th %ile 24-hour average (µg/m^3)	6.1	5.2	9.3	7.8	4.1
Breeding Season Average (µg/m^3)	14.9	11.7	18.5	23.0	16.5
% time 24-hour average >40 µg/m^3	2.6	0.0	2.5	4.6	2.1
% time 24-hour average >50 µg/m^3	1.5	0.0	1.6	1.1	1.1
% time 24-hour average >60 µg/m^3	0.9	0.0	1.0	0.6	0.6

* Insufficient data capture.

Current Baseline Monitoring Programme – Dust Deposition

The first 12 months of dust deposition monitoring data from the current Mt Todd Project baseline monitoring programme (August 2017 – July 2018) are presented in **Figure A9**. The data indicates broad variation in the dust deposition rates recorded by the dust deposition gauges (DGGs), both between monitoring locations and between monitoring periods, including peaks in the both the dry and wet seasons.

Key statistics for the ten monitoring locations are presented in **Table A4**. The lowest maximum deposition rate was recorded by DDG8 to the north of the site; the greatest maximum deposition rate was recorded to the south of the site by DDG9.

Further comparison between the locations for each month are provided in **Table A5**. The maximum difference in deposition rates between monitoring locations occurred in March 2018 with 12.9 g/m^2/month reported for DDG9 and 0.17 g/m^2/month reported for DDG4. March also reported the maximum difference between the 90th percentile result and 10th percentile result, with a difference of 7.0 g/m^2/month.

Figure A9 Monthly Average Dust Deposition Rate Recorded at Mt Todd (August 2017 – July 2018)

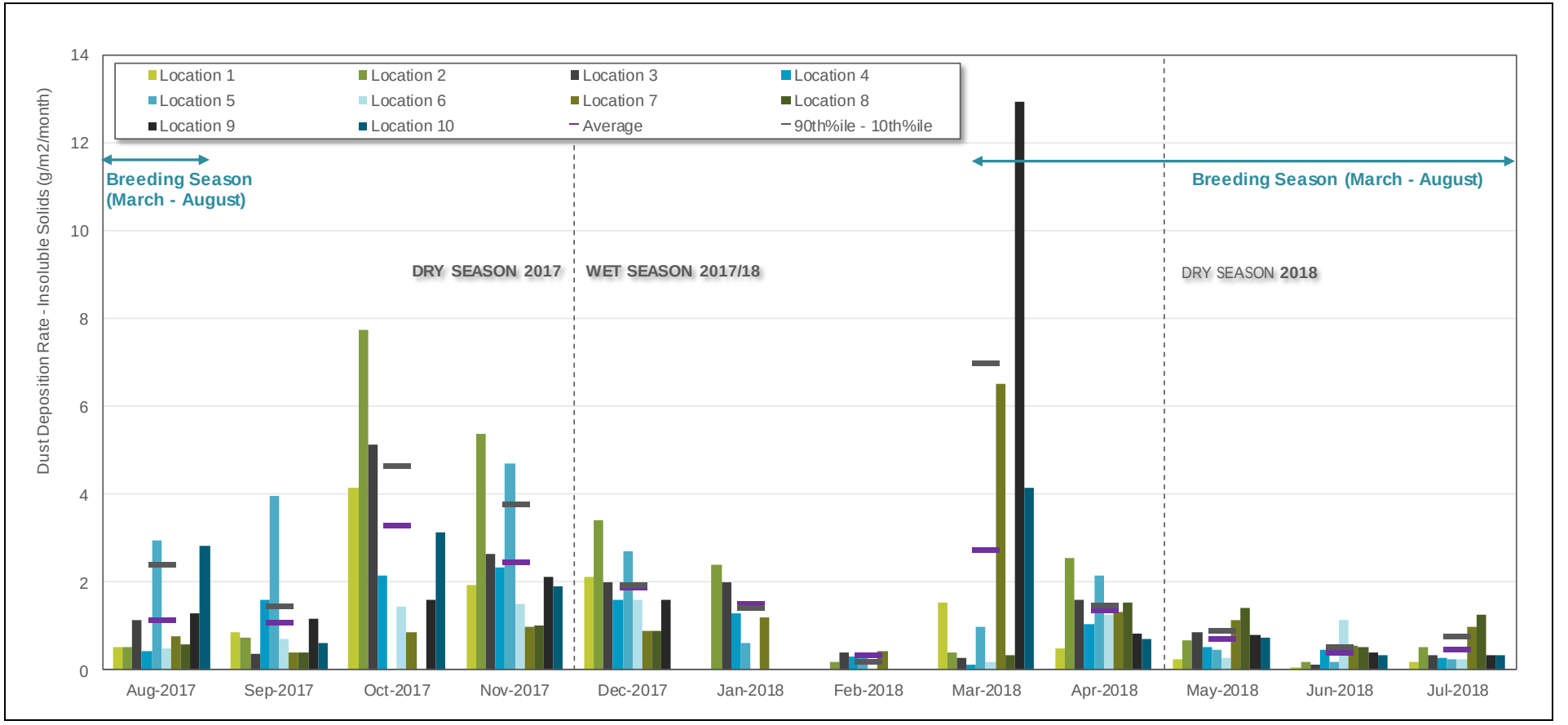


Table A4 Dust Deposition Monitoring Data – Key Statistics

Monitoring Site	Maximum (g/m^2/month)	90th %ile (g/m^2/month)	70th %ile (g/m^2/month)	50th %ile (g/m^2/month)	10th %ile (g/m^2/month)
DDG1	4.1	2.3	2.5	1.7	0.2
DDG2	7.7	5.2	5.0	2.5	0.2
DDG3	5.1	2.6	2.5	1.8	0.3
DDG4	2.3	2.1	2.0	1.2	0.3
DDG5	4.7	4.0	4.0	1.0	0.2
DDG6	1.6	1.5	1.5	1.3	0.2
DDG7	6.5	1.3	1.3	1.1	0.6
DDG8	1.5	1.4	1.5	1.2	0.5
DDG9	12.9	3.2	4.3	1.6	0.4
DDG10	4.1	3.3	3.5	1.9	0.3

Table A5 Dust Deposition Monitoring Data – Analysis of Data Variability

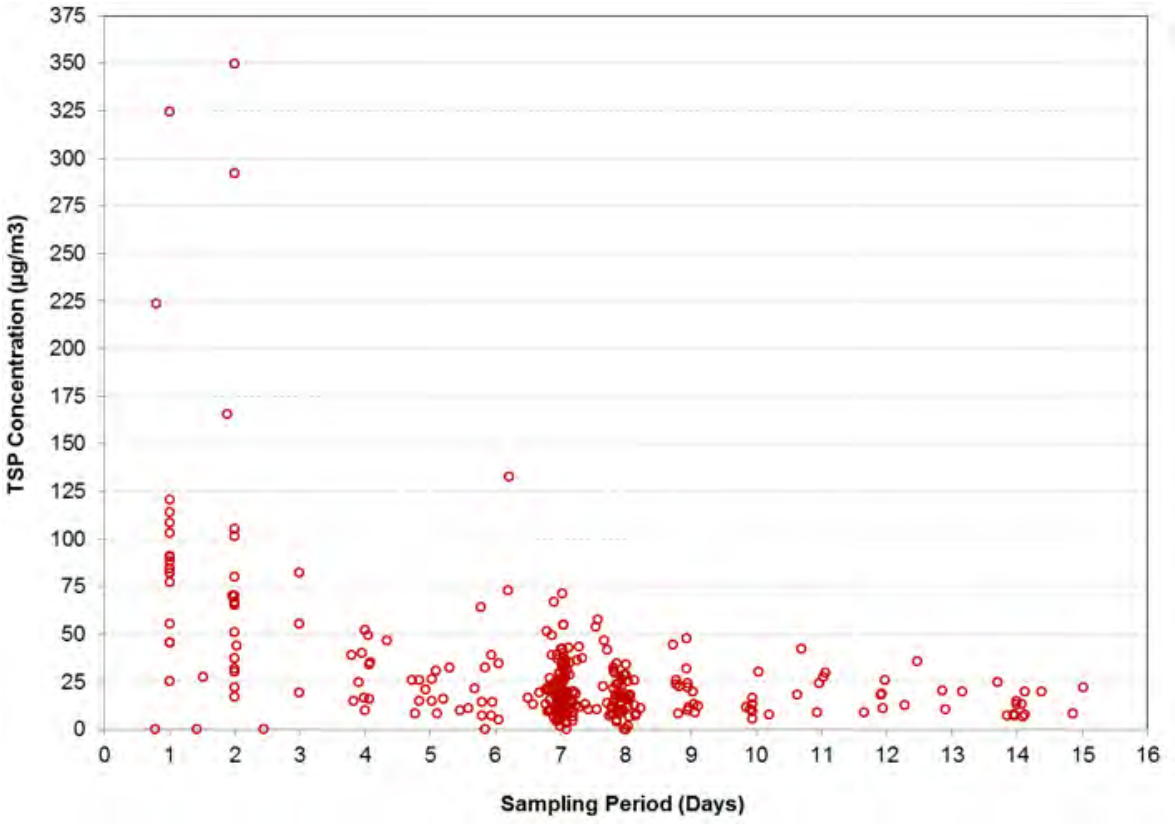
Monitoring Period	Average (g/m^2/month)	Difference: maximum – minimum (g/m^2/month)	Difference: 90th %ile – 10th %ile (g/m^2/month)
Aug-2017	1.1	2.5	2.4
Sep-2017	1.1	3.6	1.5
Oct-2017	3.3	6.9	4.6
Nov-2017	2.4	4.4	3.8
Dec-2017	1.9	2.5	1.9
Jan-2018	1.5	1.8	1.4
Feb-2018	0.3	0.2	0.2
Mar-2018	2.7	12.8	7.0
Apr-2018	1.3	2.0	1.5
May-2018	0.7	1.2	0.9
Jun-2018	0.4	1.1	0.5
Jul-2018	0.5	1.1	0.8

7-Day Rolling Average PM_{10} Monitoring Data

In developing ambient particulate thresholds for the Mt Todd Project suitable for protecting the nearby finch populations, ambient Total Suspended Particulate (TSP) concentration data recorded at the Ranger Uranium Mine over the 26-year period from 1980 to 2006 was reviewed. An aviary housing a breeding population of finches was located at the Ranger Uranium Mine during this period and the data was therefore considered to be useful in assessing dust levels that would be tolerated by the finches.

The sampling period for these measurements ranged from 1 – 15 days, with most samples (52%) collected over a 7- or 8-day sampling period. An extended sampling period (compared to the standard 24-hour period for TSP monitoring) was used to collect a sufficiently large sample of particulate matter for subsequent radiation analysis. A plot showing the impact of the sampling duration on the measured TSP concentrations is shown in **Figure A10**. As would be expected, the shorter sampling periods gave the highest TSP concentrations. The 7-day average TSP concentrations (108 samples, representing 35% of all samples) ranged from 1.8 – 71.3 µg/m^3.

Figure A10 Ranger Uranium Mine East TSP Data – Plot of Sampling Period versus TSP Concentration



The peak TSP concentration of 71.3 µg/m^3 shown in **Figure A10** for a 7-day average, is estimated to be equivalent to a peak 7-day average PM_{10} concentration of 36 µg/m^3 based on an assumed PM_{10}/TSP ratio of 50%. This PM_{10}/TSP ratio is taken from a 2-year baseline monitoring programme performed in Broken Hill, where the median PM_{10}/TSP ratio was 47% and the mean was 52% (Broken Hill Operations Pty Ltd – Air Quality Monitoring Program, 2012). Environmental factors relevant to the ambient PM_{10}/TSP ratio such as surrounding land use, predominant particulate sources etc in Broken Hill are expected to be comparable to Mt Todd, hence a ratio of 50% is concluded to be representative.

Based on the above, a 7-day average PM_{10} threshold value of 36 µg/m^3 was initially proposed for the Mt Todd Gold Mine. Now that there is a comprehensive set of data available from the Mt Todd Gold Mine baseline monitoring programme, 7-day average PM_{10} concentrations recorded by the BAMs have been analysed to provide an updated 7-day average PM_{10} threshold value for use in the DMMP. This analysis is provided below.

The rolling 7-day average PM_{10} concentrations recorded during the preliminary (Yinberrie Hills and Bore 6) and current (BAM1, BAM2 and BAM3) baseline monitoring programmes are shown in **Figure A11** and **Figure A12.**

The 7-day average PM_{10} concentrations recorded to date in the vicinity of the mine site typically range from 7 – 23 µg/m^3 (based on 10th and 90th percentile values) and are comparable to the 7-day average PM_{10} concentrations recorded in Darwin, where captive and wild finch populations are known to be present. **Figure A11** and **Figure A12** indicate that the 7-day average concentration recorded in Darwin peaks at just under 43 µg/m^3. Two events with peaks of over 55 µg/m^3 were recorded at Mt Todd between December 2015 and April 2019.

Figure A11 Mt Todd Baseline – Rolling 7 Day Average PM_{10}

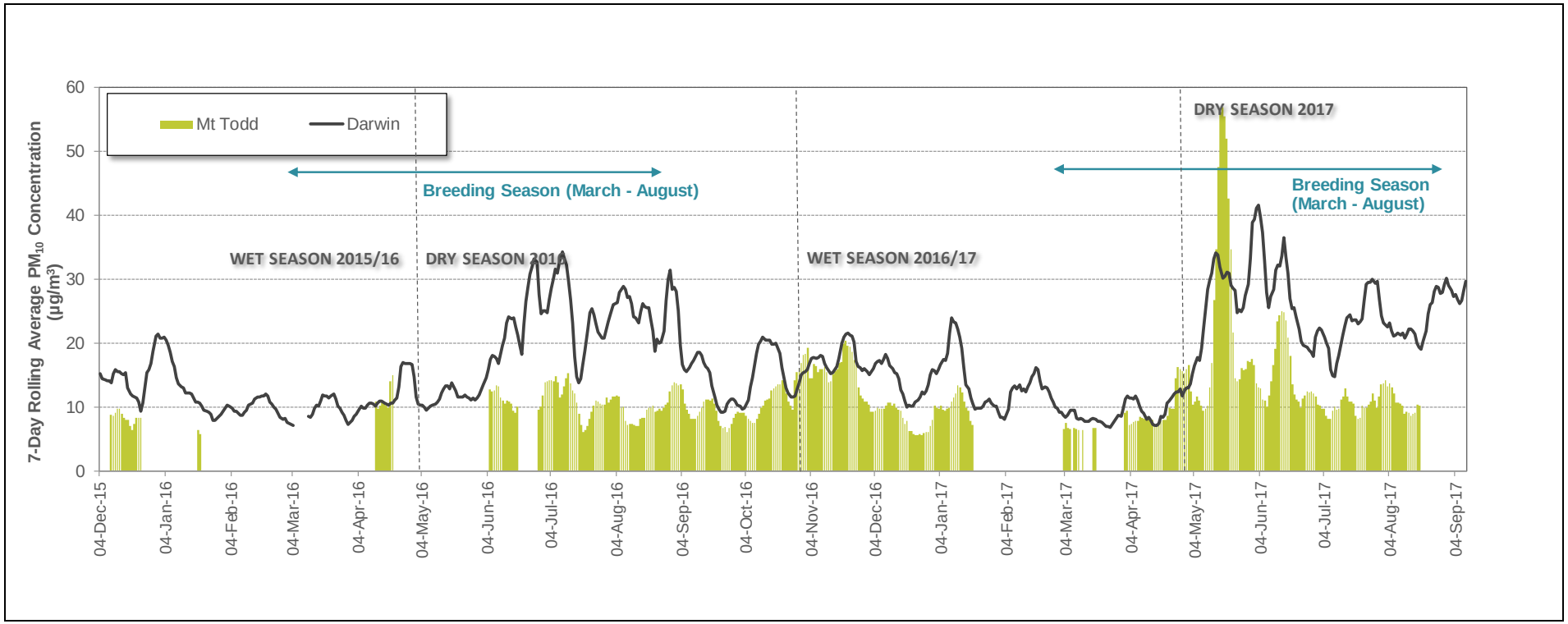
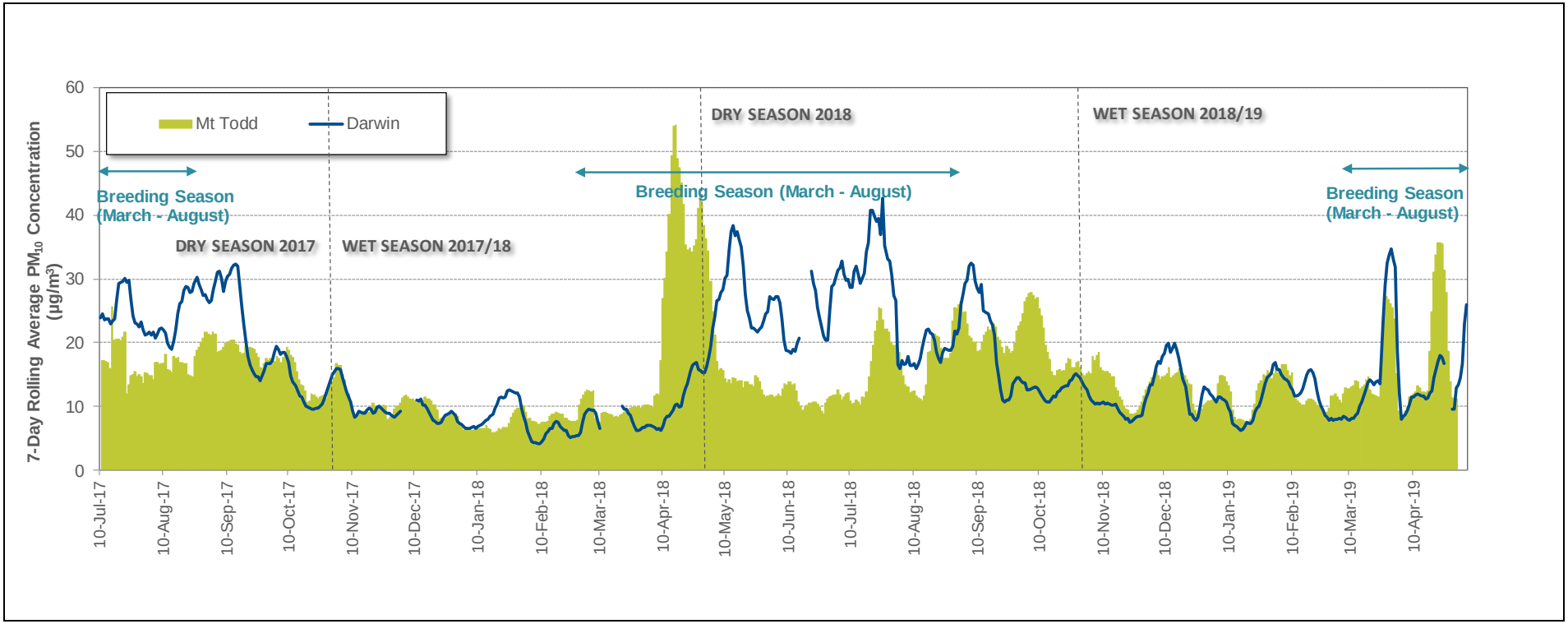


Figure A12 Mt Todd Baseline – Rolling 7 Day Average PM_{10}



PROJECT-SPECIFIC DUST THRESHOLD VALUES

The data analysis detailed above suggests that the Gouldian Finch population in Yinberrie Hills should be able to tolerate:

- **Annual average PM_{10} concentrations of 20 µg/m^3**

  This is based on monitoring data from Palmerston and Winellie in Darwin, where annual average concentrations of 20 µg/m^3 or higher were recorded at both sites over the seven years from 2012 to 2018.

- **24-hour average PM_{10} concentrations up to 60 µg/m^3, with exceedances of this threshold permitted up to 3% of the time (11 days per year)**

  This is based on monitoring data from Mt Todd, where 24-hour average concentrations of 60 µg/m^3 or higher were recorded on several occasions during the baseline monitoring to date, but on average less than 1% (2 days) during the breeding period. An allowable frequency of exceedance of 3% reflects the frequency of 24-hour average concentrations above 60 µg/m^3 recorded in Darwin, which ranges up to 3% per annum. The current baseline monitoring programme indicates that 24-hour PM_{10} concentrations at the monitoring sites have exceeded 60 µg/m^3 up to 7 days per year.

- **Maximum 7-day average PM_{10} concentrations of 40 µg/m^3 with exceedances of this threshold permitted up to 3% of the time (11 days per year)**

  This is based on monitoring data from and Palmerston and Winellie in Darwin, where a peak 7-day rolling average concentration of 43 µg/m^3 was recorded on one occasion during the period of baseline monitoring performed to date. The baseline monitoring data from Mt Todd shows events where the rolling 7-day average concentration has exceeded 40 µg/m^3 on 1.7% of the time.

A project-specific dust deposition threshold value has not been nominated at this stage as the results of the baseline dust deposition monitoring programme to date indicate broad spatial and temporal variation making such a determination difficult. The dust monitoring data will be used in conjunction with the finch health and vegetation surveys to assess whether elevated dust deposition rates may be associated with any measured impacts on plant or bird health. In the interim, the DMMP refers to the Queensland Department of Environment and Science Guideline: Model Mining Conditions ('Model Mining Conditions') target rate of 120 mg/m^2/day, equivalent to 3.6 g/m^2/month / OR the EPA Victoria Protocol for Environmental Management Mining and Extractive Industries ('Mining PEM') criterion of 4 g/m^2/month as being appropriate for dust management purposes. To date, 93% of the dust deposition results to date are less than 4g/m^2/month, with exceedances recorded during three months of the year.

APPENDIX B

Dispersion Modelling - Predicted PM_{10} Impacts

A detailed atmospheric dispersion modelling study[1] was performed as part of the Mt Todd Gold Mine approvals process to predict worst-case PM_{10} concentrations within the Yinberrie Hills in areas where the Gouldian Finch is present due to emissions from the Mt Todd Gold Mine. This modelling study used published dust emission factors to estimate dust emissions from operational activities, taking into account proposed dust mitigation measures where dust control factors are available in the literature. The locations and estimated emission rates of each significant dust source associated with the proposed operational activities were then input into the CALPUFF dispersion model, along with the site-representative 1-year meteorological data set based on 2014 observed weather data. The CALPUFF model was then used to predict the incremental PM_{10} concentrations that would occur due to these estimated emissions under the meteorological conditions modelled.

The results from the worst-case operational year investigated in the modelling study, Year 3 operations, are presented below to provide an assessment of the predicted level of compliance with the PM_{10} thresholds derived as part of the DMMP for the Mt Todd Gold Mine. In reviewing the findings of this analysis, it should be noted that:

- The modelling was performed using a meteorological dataset based on 2014 observational data for the study area. The following analysis of potential cumulative impacts has included the use of the 2018 measured baseline monitoring data presented in the main report. The meteorological conditions associated with the two datasets are therefore different, however air quality criteria associated with 7-day averages, or even 24-hour averages, will be less sensitive to meteorological factors compared to 1-hour averages. Use of the two datasets is therefore considered to provide a useful indication of potential cumulative impacts.
- The estimation of fugitive dust emissions from mines is subject to uncertainties associated with the use of published emission factors and control factors based on data from other sites and regions. Site-specific factors, such as the dust generating potential of soils at the site (i.e. silt content, moisture content etc), the effectiveness with which controls are applied, the construction and maintenance of haul roads have the potential to affect the dust emission rates at a given site. To address this uncertainty, conservative assumptions were made in the modelling and the predicted incremental impacts due to the mine operations are expected to overestimate actual impacts.
- This analysis is based on the worst-case operational year (Year 3) investigated in the modelling study, when dust generating activities such as hauling are assumed to be at their maximum operations. The impacts predicted for other stages of the mine life are lower than that predicted for Year 3.
- Not all dust controls proposed to be applied at Mt Todd Gold Mine have published emission factors, hence they could not all be accounted for in the modelling. This includes the Reactive Dust Management Strategy outlined in the DMMP. The objective of the Reactive Dust Management Strategy is to reduce impacts predicted by the modelling by targeting additional dust control measures during periods when high PM_{10} concentrations are being measured by the ambient air quality monitoring network.

Cumulative 7-day average PM_{10} concentrations (i.e. mine impact plus measured baseline(background) concentrations) were predicted at three locations within the Gouldian Finch breeding area, referred to as receptors R1, R3 and R10. The locations of these receptors are shown in **Figure B1**.

[1] SLR. 2015b. Mt. Todd Gold Mine: Air Quality Impact Assessment. SLR Consulting Australia

Figure B1 Modelled Receptor Locations

Figure B2 to **Figure B4** present these cumulative 7-day average PM_{10} concentrations based on the following:

- The background 7-day average PM_{10} concentrations (rolling daily average) based on the average concentration recorded over the previous 7 days at the BAM1, BAM2 and BAM3 baseline air quality monitoring locations during 2018 (dark green bars). This is considered an appropriate approach (as opposed to using the maximum for example) given that the data are being used as a measure of regional background levels.
- The incremental 7-day average PM_{10} concentration predicted by the modelling for Year 3 operations based on 2014 meteorological data (light green bars) at the relevant receptor (R1, R3 or R10) added on top of the background concentration.
- The 7-day average PM_{10} concentration recorded in Darwin on the same day of the year during 2018 (blue solid line).

Figure B2 to **Figure B4** indicate the following:

- The incremental impacts predicted at R1, located at the southwestern-most extent of identified historic Gouldian Finch nesting sites, are minimal compared to current measured background levels. 12 additional exceedances of the project-specific 7-day average maximum PM_{10} threshold limit of 40µg/m^3 are predicted to occur in April/May due to the incremental impacts of mining operations (i.e. increases from 3 days to 15 days of exceedances per year).
- Incremental impacts predicted at R3 are more significant and 33 exceedances of the project-specific maximum 7-day average threshold of 40 µg/m^3 are predicted, occurring in April/May, August and September. Receptor R3 is located near the south-eastern end of the area of identified historic Gouldian Finch nesting sites.
- The incremental impacts predicted at R10 are the greatest of the three receptors investigated, however the cumulative impacts are similar to R3. Cumulative PM_{10} concentrations are predicted to exceed the project-specific maximum 7-day average threshold of 40 µg/m^3 during April May, August and September. Receptor R10 is centrally located within the area of identified historic Gouldian Finch nesting sites.

A summary of the predicted cumulative impacts (as shown in **Figure B2** to **Figure B4**) compared to the Project-specific PM_{10} thresholds is provided in **Table B1**. The analysis shows that there are areas within the historic Gouldian Finch nesting site area that are predicted to exceed the PM_{10} threshold values derived for the Project. As discussed above, the dispersion modelling study and cumulative impact analysis include a number of conservative assumptions and are expected to over-predict actual impacts. The analysis also does not account for the impacts of the Reactive Dust Management Strategy outlined in the DMMP to minimise dust emissions. This Reactive Dust Management Strategy includes a number of trigger levels to initiate actions to reduce dust emissions if elevated PM_{10} levels start to be recorded that have a potential to result in an exceedance of the Project-specific dust threshold values. Through this approach, it is anticipated that the exceedances shown in **Table B1** can be prevented from occurring.

Table B1 Predicted Performance Against Project-Specific Dust Threshold for PM_{10} (Year 3 Operations)

Performance Criteria	Predicted Cumulative Impacts		
	R1	R3	R10
Annual average limit of 20 µg/m^3	17.9 µg/m^3	25.2 µg/m^3	26.6 µg/m^3
Maximum of 11 days above 60 µg/m^3 (24-hour average) per year	0 day	2 days	7 days
7-day average limit of 40 µg/m^3	Exceeded 4.1% of the time	Exceeded 9.0% of the time	Exceeded 12% of the time

Figure B2 Receptor R1 - Cumulative 7-Day Average PM_{10} Concentrations Predicted in the Yinberrie Hills (Year 3)

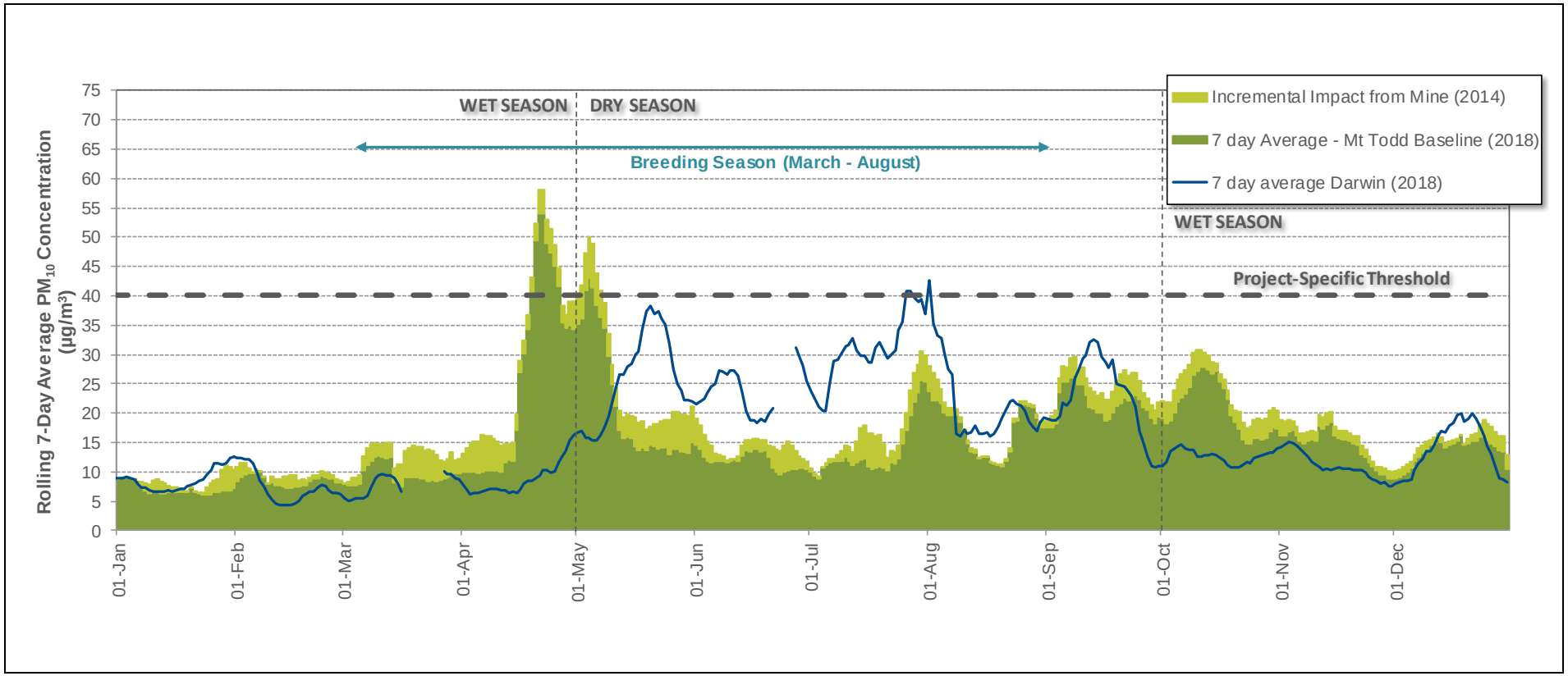


Figure B3 Receptor 3 - Cumulative 7-Day Average PM_{10} Concentrations Predicted in the Yinberrie Hills (Year 3)

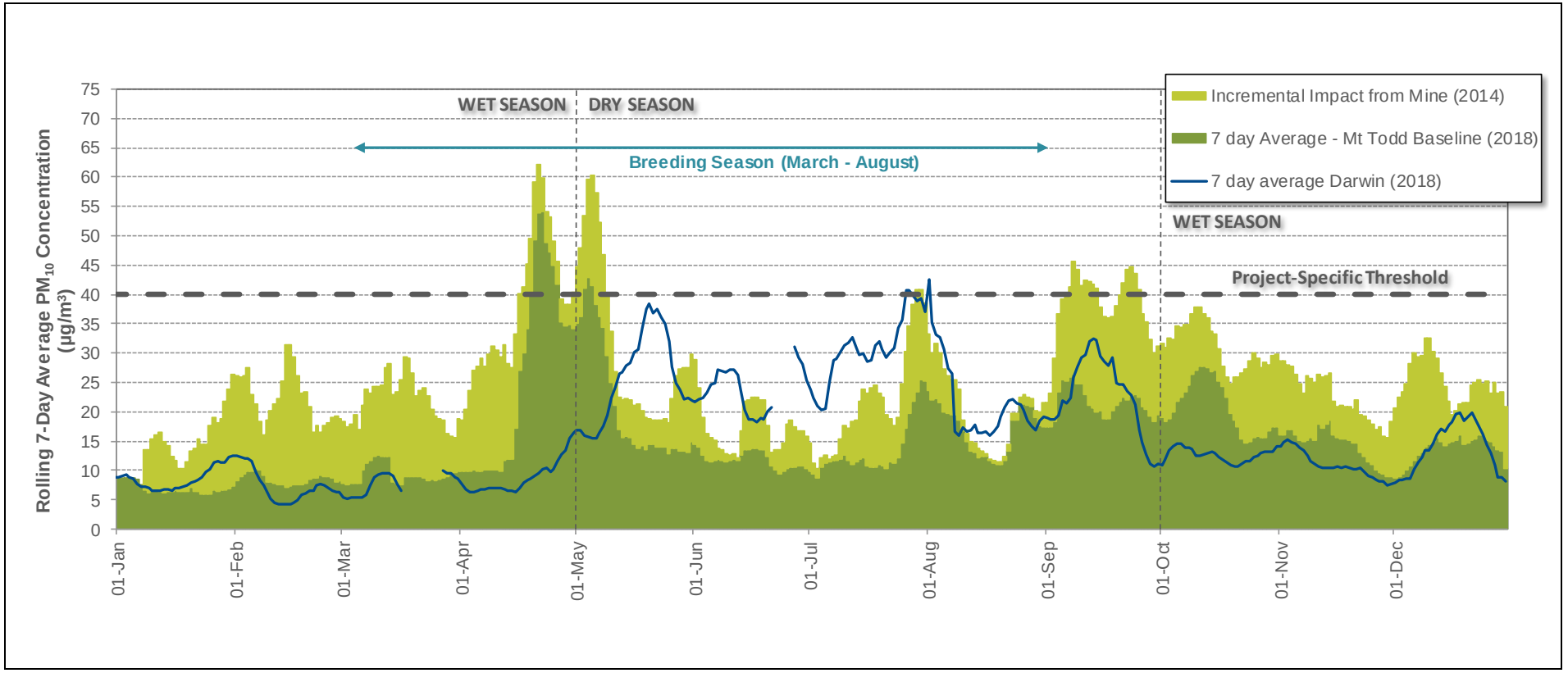
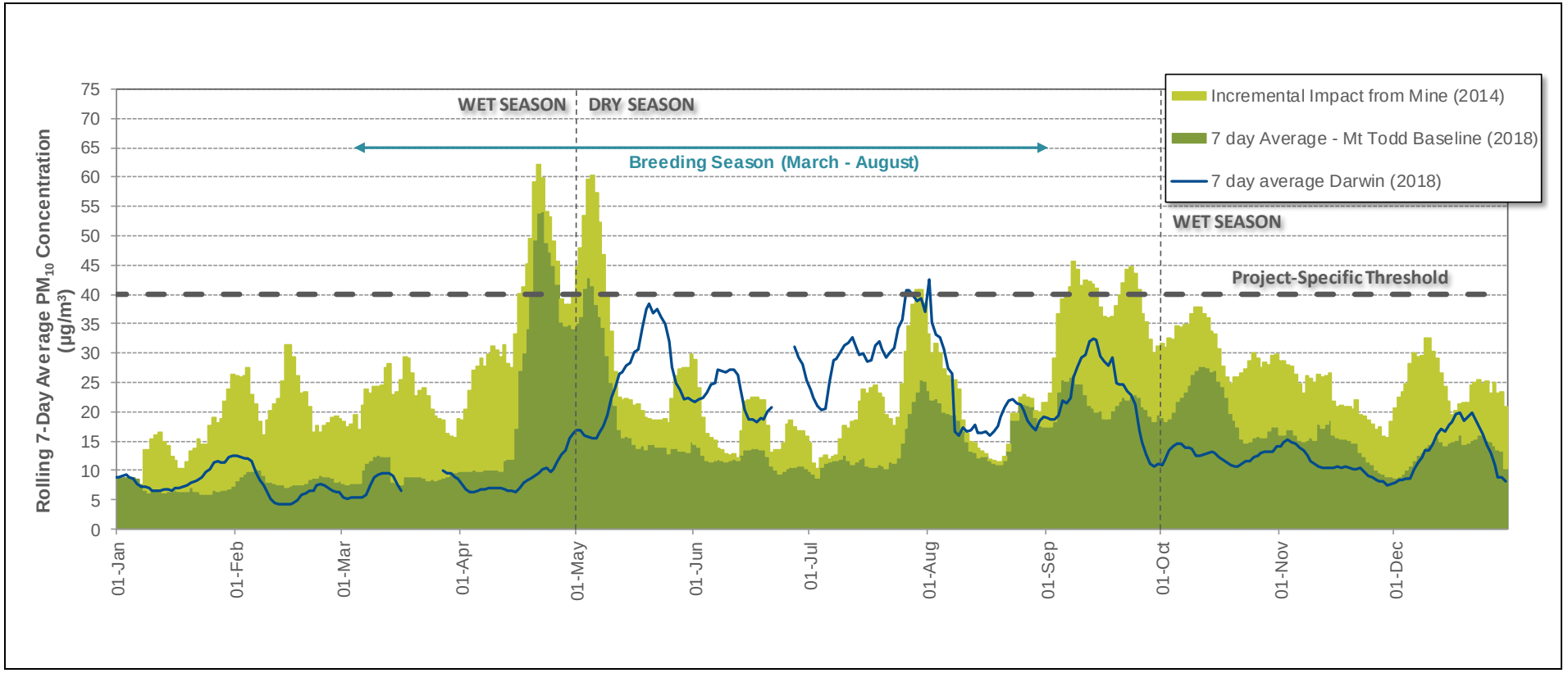


Figure B4 Receptor 10 - Cumulative 7-Day Average PM_{10} Concentrations Predicted in the Yinberrie Hills (Year 3)



APPENDIX C

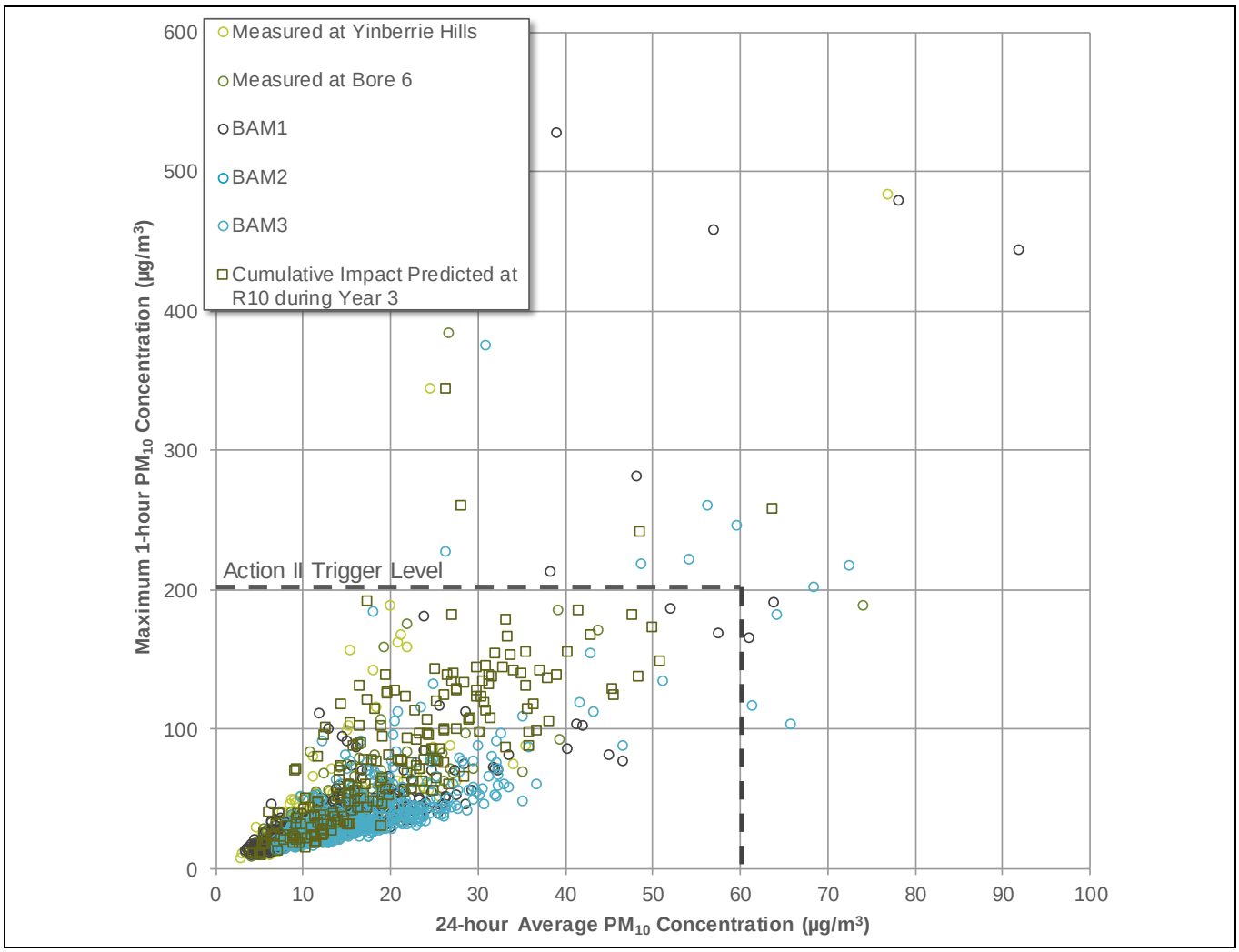
1-Hour Average Trigger Levels

To develop short-term trigger levels for the Reactive Dust Management Strategy, PM_{10} dispersion modelling predictions for future mine operations have been analysed to examine the relationships between the peak 1-hour average concentrations and the 24-hour average concentrations, focussing on days when high 24-hour average PM_{10} concentrations are predicted at locations within the finch habitat. The peak to mean ratios (1hour/24hour) in the baseline PM_{10} data collected to date has also been examined.

The relationship between both the measured (baseline) and predicted (incremental impact) 24-hour average PM_{10} concentrations and the peak 1-hour average concentrations during that 24-hour period are shown in **Figure C1**. This plot indicates that when the peak 1-hour average PM_{10} concentration is below 200 µg/m^3, then the 24-hour average should be below 60 µg/m^3 (i.e. a peak to mean ratio of 200/60 or 3.33), with 98.6% of all data lying within these bounds (2015 data points out of 2041). There are only 8 data points (0.4%) with the peak 1-hour average exceeding 200 µg/m^3 and the 24-hour average above 60 µg/m^3 and six data points with a peak 1-hour average above 200 µg/m^3 but the 24-hour average is still below 60 µg/m^3.

Based on this analysis, a trigger level (the "Action II trigger level) of 60 µg/m^3 as a 1-hour average is considered to be conservative, yet not impractical for mine operations.

Figure C1 Peak to Mean Comparison for Measured and Predicated PM_{10} Concentrations



As a protective measure, an interim trigger level ("Action I") has been set at a lower level to alert the mine to increasing short term concentrations which would prompt a review of the dust management measures and meteorological conditions to confirm that all standard practices are being followed, and to increase/relocate watering where required based on visible dust etc. It is noted that even if the increased PM_{10} concentrations are concluded to be due to elevated background levels rather than emissions from the mine, steps should still be taken to minimise the additional incremental impacts from the mine where possible.

An exceedance of the Action II trigger level would require more direct action to reduce dust levels, e.g. assessing whether activities need to be temporarily stopped or relocated until conditions improve.

An alert level has also been nominated at which point mine management would review the wind directions etc and determine if the dust is from the mine or a background issue and become alert to any further increase that may require action.

The 1-hour average trigger levels forest based on the 24-hour average PM_{10} criterion of 60 µg/m^3 are provided in **Table C1**.

Table C1 Trigger Levels

Alert	130 µg/m^3	Alert level is the half-point between the threshold of 60 µg/m^3 and Action II trigger level
Action I	165 µg/m^3	Action I trigger level is the half-point between Alert and Action II trigger level
Action II	200 µg/m^3	Action II trigger level is based on the minimum P/M ratio of 3.33

As an indication of the potential frequency of these trigger levels being exceeded, the cumulative 1-hour average PM_{10} concentrations predicted at R10 for Year 3 operations exceed:

- 130 µg/m^3 on 147 hours of the year;
- 165 µg/m^3 on 52 hours of the year; and
- 200 µg/m^3 on 21 hours of the year.

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