Ambient Air Quality Monitoring Report
2019-2020
EPBC 2008/45546

Yara Pilbara Nitrates
Lot 564 and 3017 Village Road
BURRUP WA 6714 Australia

1 October 2020

59721/132,568 (Rev 0)

JBS&G Australia Pty Ltd T/A Strategen-JBS&G

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Abbreviations and definitions

Term	Definition	Description and context for this report
µm	Micrometre	One millionth (0.000001) of a metre
CSIRO	The Commonwealth Scientific and Industrial Research Organisation	The Commonwealth Scientific and Industrial Research Organisation is an independent Australian federal government agency responsible for scientific research.
EPBC	Environment Protection and Biodiversity Conservation	Refers to the Australian Government EPBC Act of 1999
Insoluble fraction	Component of deposited dust that is not soluble in water	Deposited dust can comprise of aqueous soluble and insoluble materials depending on mechanisms and sources of dust emissions. The insoluble fraction is typically derived from crustal materials.
MicroVol	MicroVol 1100 low volume sampler	LVAS instrument for sampling of TSP, manufactured by Ecotech
NH_3	Ammonia	Gaseous air pollutant from natural sources and industrial sources (including YPN TAN plant)
NO_2	Nitrogen dioxide	Gaseous air pollutant from combustion sources
OEMP	Operational Environmental Management Plan	Management plan prepared by YPN in accordance with Condition 7 of the EPBC Approval (as varied on 12 September 2017)
Passive sampling	Ambient air sampling for gaseous substances involving passive samplers	Sampling technique whereby airborne gaseous pollutants are extracted from the air column onto an adsorbent material via a diffusive mechanism
PM_{10}	Particulate matter (10 micrometre)	Dust particles which are present in ambient air with equivalent aerodynamic diameter of 10 micrometres (µm)
Radiello® passive sampler	Sampler for gaseous substances in ambient air	Sampling devices manufactured by Sigma Aldrich under licence from Fondazione Salvatore Maugeri IRCCS for passively monitoring airborne concentrations of gases
SO_2	Sulfur dioxide	Gaseous air pollutant from oxidation (combustion) of sulfur containing substances
Soluble fraction	Component of deposited dust that is soluble in water	Deposited dust can comprise of aqueous soluble and insoluble materials depending on mechanisms and sources of dust emissions. The soluble fraction is typically derived from marine aerosols
TAN Plant	Technical Ammonium Nitrate Plant	YPN plant on the Burrup for production of ammonium nitrate
TSP	Total suspended particulates	Dust particles which are present in ambient air with equivalent aerodynamic diameter of 50 micrometres (µm)
YPN	Yara Pilbara Nitrates	The operator of the TAN Plant

1. Introduction

Conditions 9 and 9A of EPBC Approval 2008/4546 (as varied on 12 September 2017) for the Yara Pilbara Nitrates Pty Ltd (YPN) Technical Ammonium Nitrate (TAN) Plant require monitoring of various air quality parameters. Condition 3 of the EPBC Approval outlines reporting requirements, including an analysis of monitoring data from the monitoring program conducted under condition 9A. This report is provided in response to Condition 3(a) of the EPBC Approval for the reporting period 1 July 2019 to 30 June 2020.

2. Scope of monitoring program

EPBC Approval 2008/4546 required baseline monitoring to be conducted for a period of not less than 24 months from commencement of construction of the TAN Plant. YPN issued a report to the Department of the Environment and Energy on 16 June 2017 in compliance with requirements of Conditions 9(a), (b), (c) and (d) (YPN 2017).

Condition 9A of EPBC Approval 2008/4546 (as varied 12 September 2017) informed the scope of the ongoing monitoring program and is reproduced below (Figure 1).

9A. To protect the values of the Dampier Archipelago (including Burrup Peninsula) National Heritage Place, particularly the rock art sites, the person taking the action must ensure:

a) Ongoing air quality monitoring is undertaken within 30 days after this condition comes into effect (the date the relevant variation to conditions notice is signed) and until expiry of the approval.

b) Air quality monitoring parameters are monitored at the rock art sites: Site 5 (Burrup Road), Site 6 (Water tanks site) and Site 7 (Deep Gorge site) as shown in Attachment 2.

c) Monitoring of air quality at rock art sites is undertaken by a suitably qualified person (Air Quality)

The air quality monitoring parameters in the table below must be monitored at the frequencies indicated in the table below:

Element of air quality to be monitored	Specific air quality parameter to be sampled	Minimum frequency of monitoring
Ambient air concentration of gases	NH_3 (ammonia)	Continuous monitoring for at least 14 consecutive days, every month
	NO_2 (nitrogen oxide)	
	SO_2 (sulfur oxide)	
Airborne particulate concentration	Total suspended particulates up to 50 µm (TSP)	Every 6 days
Deposited dust	Total dust deposition per month (Insoluble Fraction)	Quarterly
	Total dust deposition per month (Soluble Fraction)	

Figure 1: Condition 9A of EPBC Approval 2008/4546 (as varied 12 September 2017)

Condition 3(a)i of EPBC Approval 2008/4546 (as varied 12 September 2017) requires (in part) publication of a report that includes *"...an analysis of monitoring data required under Condition 9A..."*.

The initial report for analysis of the monitoring data as required by the EPBC Approval was issued in October 2018 for the period 2017-2018 (Strategen 2018) and a report for the period 2018-2019 was issued in October 2019 (Strategen-JBS&G 2019). This report presents an analysis of monitoring data obtained for the monitoring period 1 July 2019 to 30 June 2020 (referred to herein as 2019-2020).

3. TAN Plant operation 2019-2020

The TAN plant operated between 1 July 2019 to 4 July 2019, then ceased operation on 4 July 2019 remaining off-line while the TAN Recovery Project works were carried out. Restart occurred on 19 April 2020; however, the plant was shut down again on 20 April 2020. Restart was then re-commenced on 13 May 2020 reaching steady-state by 28 May 2020. The Nitric Acid Plant was offline from 10 June 2020 to 12 June 2020 (production of ammonium nitrate and prill continued during this interruption) and then remained online to the end of the reporting period. No emissions from the plant were recorded outside those operating periods.

4. Air quality monitoring program

4.1 Gases (NH_3, NO_2, SO_2 and HNO_3)

4.1.1 Results of NH_3, NO_2, SO_2 and HNO_3 monitoring

Monitoring of gases NH_3, NO_2 and SO_2 using Radiello passive sampling was carried out continuously throughout the 2019-2020 monitoring period at the three specified monitoring sites – Site 5 Burrup Road, Site 6 Water Tanks and Site 7 Deep Gorge.

The Deep Gorge monitoring site was relocated on 8 April 2020 which required an interruption to the monitoring from 07:00AM on 7 April 2020 to 09:16AM on the 9 April 2020. During this period, the samplers were not exposed to the atmosphere. The exposure duration for the sampling period starting 30 January 2020 was seven days as the samplers were recovered early due to Tropical Cyclone Damien. The results for these truncated sampling periods were determined to be valid and not be obvious outliers, and thus were included in the subsequent analysis.

A total of 24 fortnightly measurements were made of NH_3 concentrations at each site in the period 1 July 2019 to 30 June 2020. A total of 23 measurements were made of the other respective gases at Burrup Road and Water Tanks and 22 at Deep Gorge.[1]

Sampling commenced on 1 July 2019 when samplers deployed for the previous fortnight were replaced, and sampling concluded on 30 June 2020.

Results of monitoring are shown in Appendix A. The concentrations for each parameter at the respective sites are illustrated in Figure 2 for NH_3, Figure 3 for NO_2 and Figure 4 for SO_2.

Note that earlier studies carried out by CSIRO included monitoring of gaseous nitric acid (HNO_3). The EPBC Approval does not require monitoring of this substance. However, as described in the Operational Environmental Management Plan (OEMP) prepared by YPN for the EPBC Approval, YPN has continued monitoring of HNO_3 since the CSIRO studies concluded. This allows for direct comparisons of current deposition rates with the rates determined since 2003. The concentrations of HNO_3 are illustrated in Figure 5.

[1] One set of samplers were found on the ground at Burrup Road and Water Tanks, and two sets at Deep Gorge. Those samples were not analysed due to potential for contamination or interference in sampling rates.

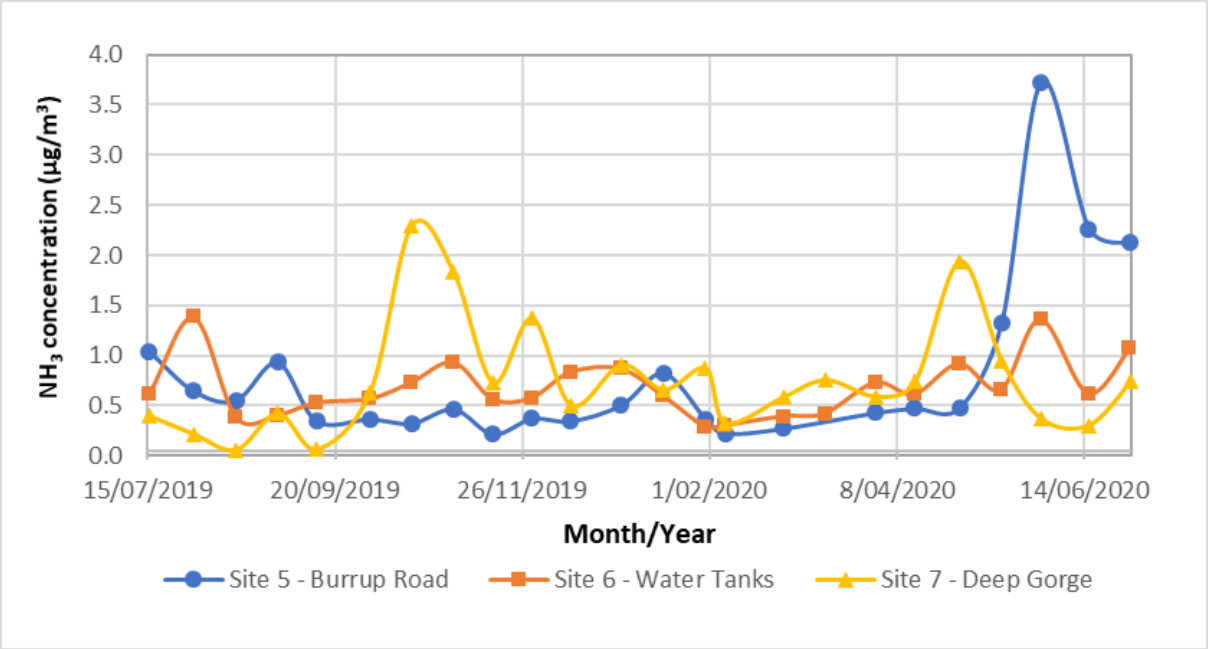

Figure 2: Measured NH_3 concentrations for 1 July 2019 to 30 June 2020

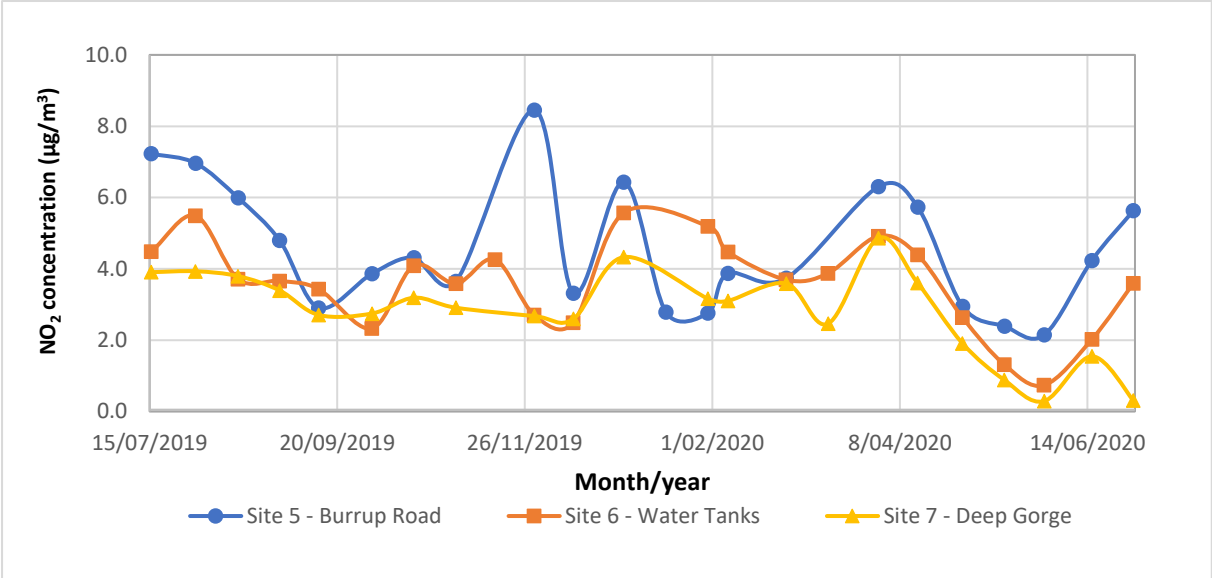

Figure 3: Measured NO_2 concentrations for 1 July 2019 to 30 June 2020

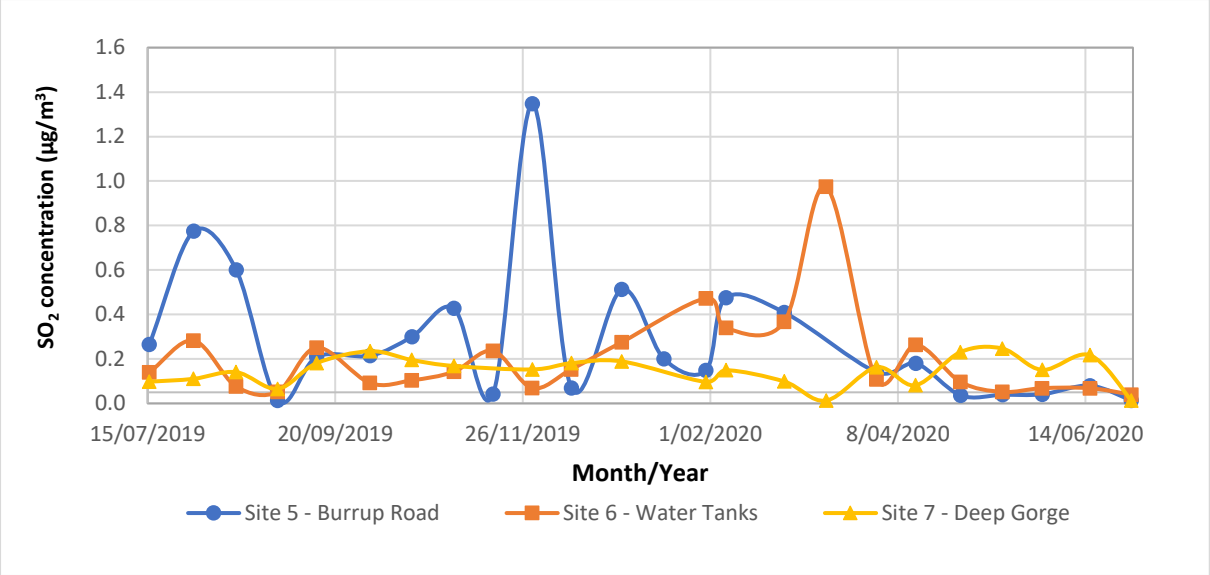

Figure 4: Measured SO_2 concentrations for 1 July 2019 to 30 June 2020

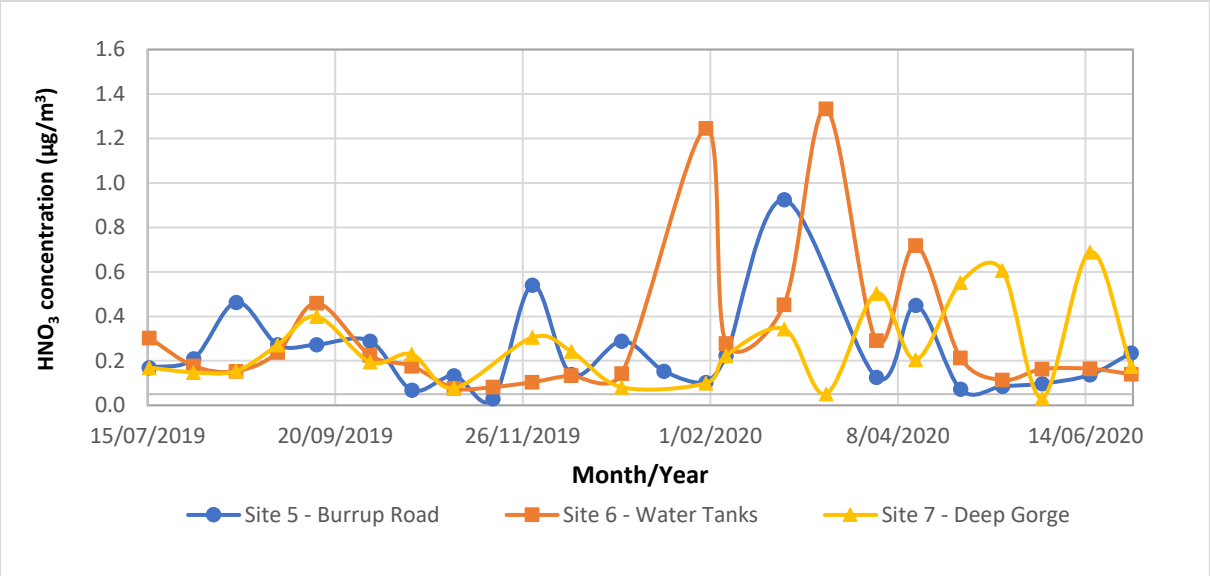

Figure 5: Measured HNO_3 concentrations for 1 July 2019 to 30 June 2020

4.1.2 Analysis of NH_3, NO_2 and SO_2 data

The analysis of measured concentrations involved comparison of descriptive statistics for 2019-2020 with those from monitoring conducted in the baseline study (YPN 2017). These statistics are shown in Table 1 for concentrations of NH_3, Table 2 for NO_2, Table 3 for SO_2 and Table 4 for HNO_3. Concentrations are calculated for the actual duration of exposure of the samplers, which were nominally 15 days but may vary a day either side of that duration for logistical reasons.

Table 1: Descriptive statistics for NH_3 concentrations (2019-2020 and baseline)

Ammonia concentration µg/m³						
Statistic	Site 5 - Burrup Rd		Site 6 - Water Tanks		Site 7 - Deep Gorge	
	2019-2020	Baseline	2019-2020	Baseline	2019-2020	Baseline
Minimum	0.22	0	0.29	0	0.06	0
Average	0.79	0.44	0.68	0.93	0.76	0.75
Maximum	3.73	1.2	1.38	3.97	2.29	4.35
Standard deviation	0.83	0.34	0.29	0.76	0.57	0.82

Table 2: Descriptive statistics for NO_2 monitoring (2019-2020 and baseline)

Nitrogen Dioxide concentration µg/m³						
Statistic	Site 5 - Burrup Rd		Site 6 - Water Tanks		Site 7 - Deep Gorge	
	2019-2020	Baseline	2019-2020	Baseline	2019-2020	Baseline
Minimum	2.15	0.38	0.74	0.31	0.29	0.4
Average	4.57	3.6	3.59	2.56	2.81	2.31
Maximum	8.46	6.53	5.57	5.27	4.86	4.12
Standard deviation	1.77	1.46	1.27	1.04	1.21	0.69

Table 3: Descriptive statistics for SO_2 monitoring (2019-2020 and baseline)

Sulfur Dioxide concentration µg/m³						
Statistic	Site 5 - Burrup Rd		Site 6 - Water Tanks		Site 7 - Deep Gorge	
	2019-2020	Baseline	2019-2020	Baseline	2019-2020	Baseline
Minimum	0.01	0.07	0.04	0	0.01	0.13
Average	0.28	1.38	0.21	0.95	0.14	0.82
Maximum	1.35	3.09	0.97	3.5	0.25	2.01
Standard deviation	0.31	0.83	0.21	0.84	0.07	0.53

Table 4: Descriptive statistics for HNO_3 monitoring (2019-2020 and baseline)

Nitric acid concentration µg/m³						
Statistic	Site 5 - Burrup Rd		Site 6 - Water Tanks		Site 7 - Deep Gorge	
	2019-2020	Baseline	2019-2020	Baseline	2019-2020	Baseline
Minimum	0.03	0.00	0.08	0.00	0.03	0.00
Average	0.24	0.58	0.32	0.54	0.26	0.48
Maximum	0.92	1.55	1.33	1.81	0.69	1.42
Standard deviation	0.20	0.45	0.34	0.48	0.18	0.37

The concentrations from 2019-2020 have been compared with the baseline (for each location) via statistical analysis (t-test) to determine if differences in the average concentrations are statistically significant. The results are summarised in Table 5 and key findings from these data are summarised in Table 6.

Table 5: T-test results for comparison of 2019-2020 and baseline NH_3, NO_2, SO_2 and HNO_3 concentration data

Parameter	Monitoring period	Statistic	Site 5 - Burrup Rd	Site 6 - Water Tanks	Site 7 - Deep Gorge
NH_3	2019-2020	Average	0.79	0.68	0.76
	baseline	Average	0.44	0.93	0.75
		P value	0.06	0.05	0.95
NO_2	2019-2020	Average	4.57	3.59	2.81
	baseline	Average	3.60	2.56	2.31
		P value	0.04	0.001	0.09
SO_2	2019-2020	Average	0.28	0.21	0.14
	baseline	Average	1.38	0.95	0.82
		P value	7.2×10^{-9}	1.3×10^{-7}	5.02×10^{-10}
HNO_3	2019-2020	Average	0.24	0.32	0.26
	baseline	Average	0.58	0.54	0.48
		P value	0.0002	0.04	0.003

Table 6: Analysis of NH_3, NO_2, SO_2 and HNO_3 concentration data

Parameter	Site	Finding
NH_3	Burrup Rd	The (higher) average NH_3 concentration from 2019-20120 monitoring compared with baseline monitoring is not statistically significant
	Water Tanks	The (lower) average NH_3 concentration from 2019-20120 monitoring compared with baseline monitoring at this site is not statistically significant.
	Deep Gorge	The (higher) average NH_3 concentration from 2019-2020 monitoring compared with baseline monitoring at this site is not statistically significant.
NO_2	Burrup Road	Higher average NO_2 concentrations from 2019-2020 compared with baseline monitoring at this site is statistically significant. Negligible impacts from TAN Plant expected due to relatively short duration of operation in 2019-2020
	Water Tanks	Higher average NO_2 concentrations from 2019-2020 compared with baseline monitoring at this site is statistically significant. Negligible impacts from TAN Plant expected due to relatively short duration of operation in 2019-2020
	Deep Gorge	Higher average NO_2 concentrations from 2019-2020 and baseline monitoring at this site is not statistically significant.
SO_2	Burrup Road	The (lower) average SO_2 concentrations from 2018-2019 monitoring compared with baseline monitoring are statistically significant.
	Water Tanks	
	Deep Gorge	
HNO_3	Burrup Road	The (lower) average HNO_3 concentrations from 2018-2019 monitoring compared with baseline monitoring are statistically significant.
	Water Tanks	
	Deep Gorge	

The average concentrations of NH_3 detected at Burrup Road, Water Tanks and Deep Gorge during 2019-2020 were determined to be statistically insignificant from the baseline dataset. The TAN Plant was not operational for the majority of the monitoring period. During the period that the TAN Plant was operational (13th May 2020 onwards with the exception of 10 to 12 June 2020), the NH_3 concentration at Burrup Road was elevated compared to the rest of the year (Figure 2). Burrup Road is directly downwind of the TAN Plant during the easterly wind which prevails at this time of year and, therefore, may be impacted by NH_3 emissions to a greater extent than the other two sites. The peak concentration recorded (3.73 µg/m^3) occurred in the monitoring period 15 May 2020 to 29 May 2020. This period is inclusive of the majority of the TAN Plant start-up period which commenced on 12 May 2020, with the plant reported as achieving steady-state by 28 May 2020[2]. During start up, elevated ammonia emissions may occur as a result of the need to vent ammonia from Unit 12 (Nitric Acid Plant).

Peaks in the NH_3 trend recorded at Deep Gorge (Figure 2) occurred during times that the TAN Plant was not operational suggesting an NH_3 source other than the TAN Plant was influencing the concentrations recorded at this site.

The statistically significant differences in average concentrations of NO_2 at Burrup Road and Water Tanks recorded during 2019-2020 and baseline (Table 5) are unlikely to be due to the operation of the TAN Plant due to the limited TAN Plant operation during the reporting period. Furthermore, there is no elevation of the measured concentrations from May 2020 onwards during which the TAN Plant was operational for the majority of the time (Figure 3). The peak concentration (8.5 µg/m^3) for the sample collected from 15 November 2019 to 29 November 2019 at Burrup Road is not attributable to TAN Plant emissions since the TAN Plant was not operational at this time.

[2] Production of ammonium nitrate and prill continued during the interruption to TAN plant operation during June 2020.

The difference in average concentrations of NO_2 at Deep Gorge recorded during 2019-2020 and baseline was not statistically significant.

Statistically significant decreases in the SO_2 concentrations recorded during the 2019-2020 monitoring period compared with the baseline study were determined for all three monitoring sites (Table 5). The reasons for the apparent decrease in average SO_2 concentrations since the baseline data was recorded is not known, but may reflect a reduced frequency of flaring at the two gas plants on the Burrup Peninsula or use of lower sulfur fuels in ships that visit the Dampier port.

Statistically significant decreases in the HNO_3 concentrations recorded during the 2019-2020 monitoring period to the baseline study were determined for all three monitoring sites (Table 5). The reasons for the apparent decrease in average HNO_3 concentrations is unknown.

4.1.3 Dry deposition rates - gases

Annual (total) dry deposition rates were calculated from the gas sampling at the three monitoring sites for the duration of the baseline and ongoing monitoring program monitoring. Total annual deposition rates were calculated from the combined rates for NH_3, NO_2, SO_2 and HNO_3. The results for total annual dry deposition are illustrated in Figure 6.

Monitoring periods are from the start of July to end of June in the following year, with the exception of the 2013-2014 monitoring period which is reported for September 2013 to August 2014; thus, overlapping with the 2014-2015 period to represent an entire 12-month period.

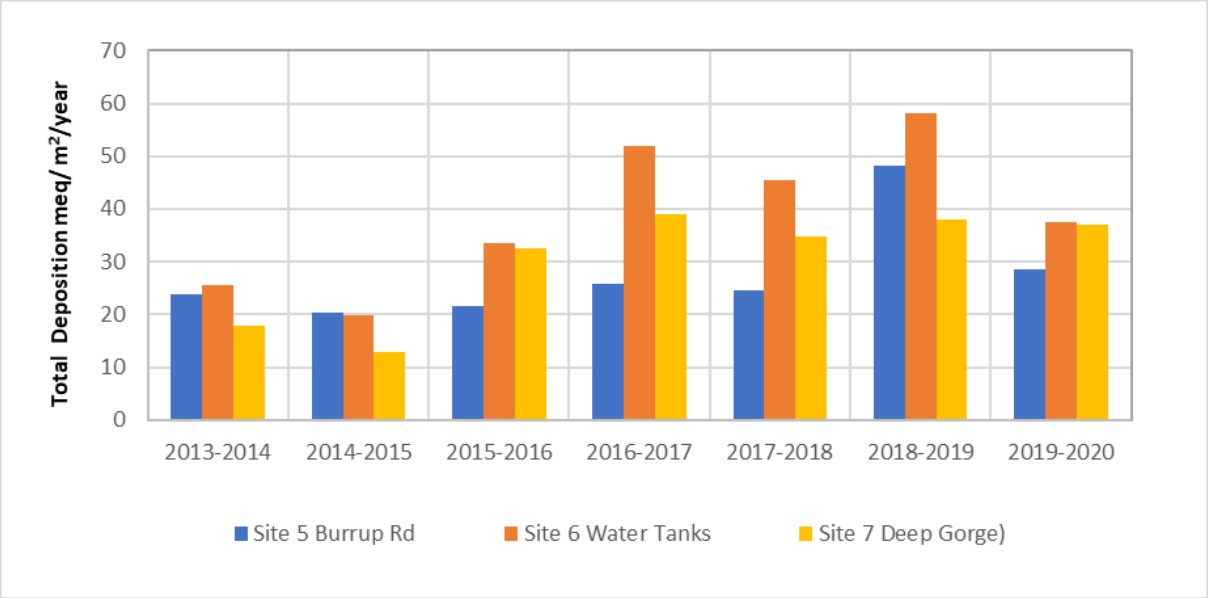

Figure 6: Annual deposition rates from measured gases (2013-2019)

The results are summarised in Table 7. Investigation levels were derived from the average of rolling monthly annual deposition rates from the baseline period plus three standard deviations (as described in the OEMP).

Table 7: Annual dry deposition rates

Year	Annual deposition rates meq/m²/year		
	Site 5 Burrup Rd	Site 6 Water Tanks	Site 7 Deep Gorge
2013-2014	23.9	25.6	17.9
2014-2015	20.2	19.8	12.9
2015-2016	21.6	33.6	32.4
2016-2017	25.9	52.0	38.9
2017-2018	24.6	45.6	34.9
2018-2019	48.3	58.2	38.0
2019-2020	28.5	37.4	37.1
Investigation level	27.1	48.0	57.5

Annual rates for 1 July to 30June, except for 2013-2014 which is for 1 September 2013 to 31 August 2014

Dry deposition rates of gas species have decreased at all three sites in 2019-2020 compared to the 2018-2019 period. The Burrup Road site was determined to remain above the investigation level in 2019-2020 while while Water Tanks and Deep Gorge were below the investigation level. The composition of the total deposition at each site is illustrated in Figure 7 to Figure 9.

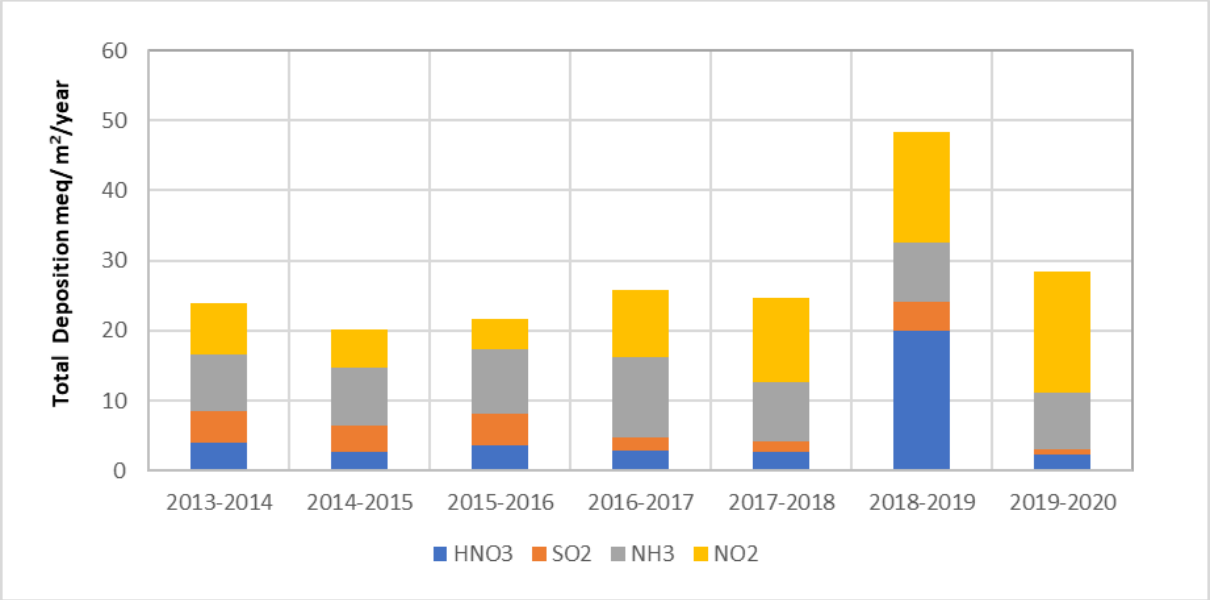

Figure 7: Burrup Road dry deposition composition

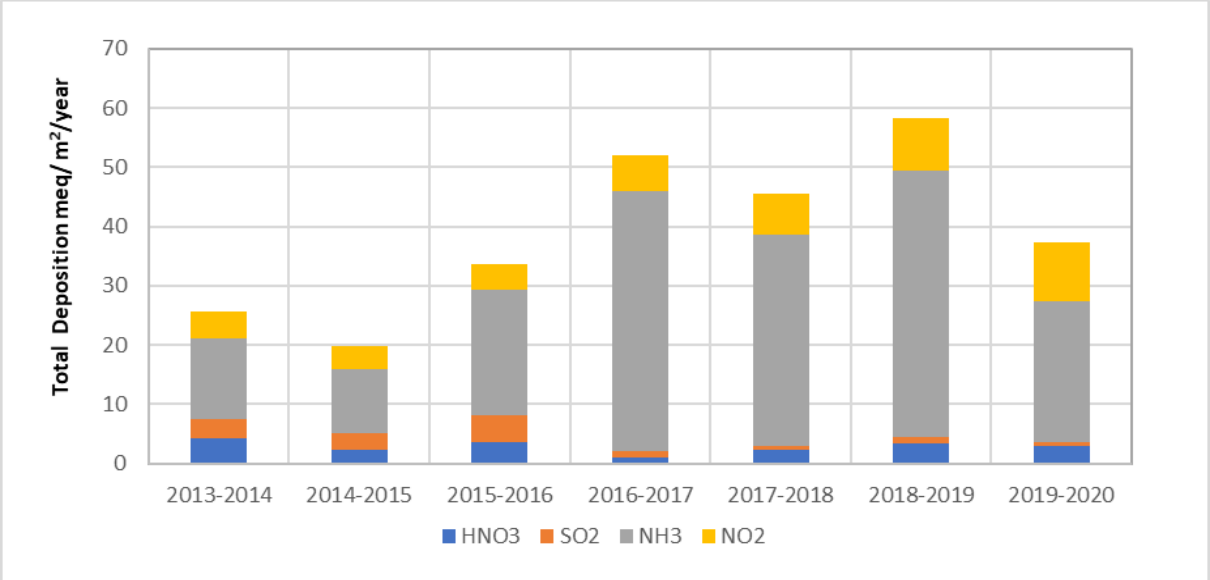

Figure 8: Water Tanks dry deposition rates

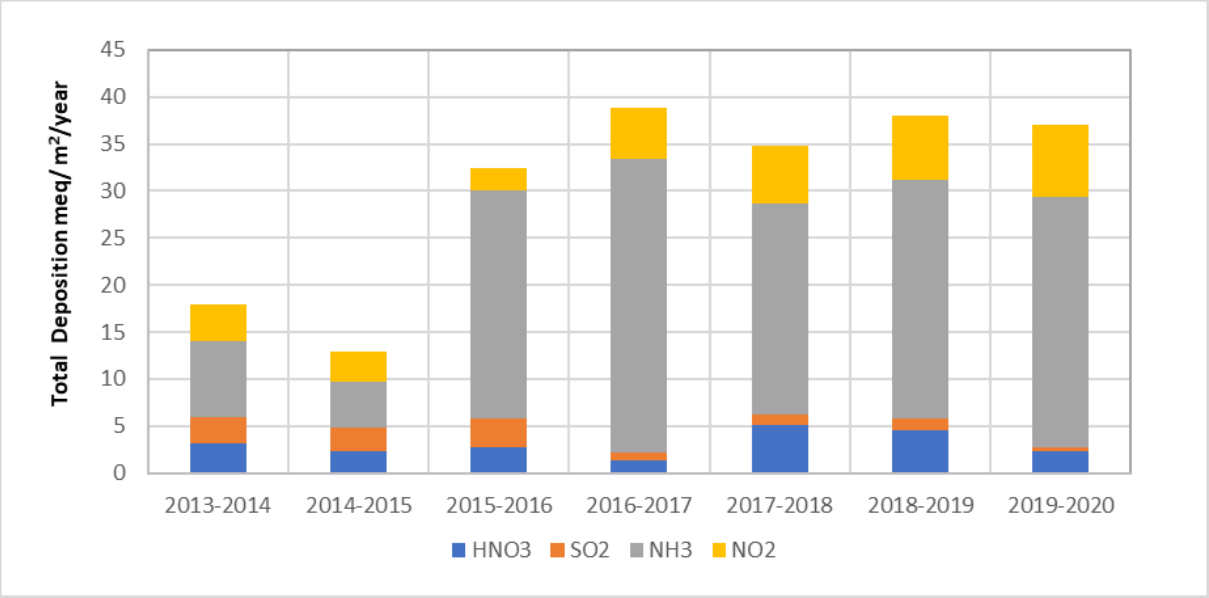

Figure 9: Deep Gorge dry deposition rates

The OEMP advises that increases in deposition rates above the control limits (now referred to as investigation levels) will trigger an investigation into the reasons for the increase. Findings from that investigation are discussed in Section 5.

4.2 Total suspended particulates

4.2.1 Results of TSP monitoring 2019-2020

Monitoring for total suspended particulate (TSP) using MicroVol samplers was conducted at the three monitoring site. Monitoring was conducted for 24 hours every six days with the following exceptions:

- Sampling on 4 January 2020 at all sites did not commence due to an EcoTech MIcroVol1100 software bug caused by the date roll over to 2020. Valid sampling recommenced on 10 January 2020 when the bug fix was uploaded to the instruments.
- No data is available for the Burrup Road and Water Tanks sites on the 15 February 2020, 20 February 2020 and 26 February 2020 due to damage sustained from Tropical Cyclone Damien.
- Results from all sites for scheduled runs on the 16 March 2020 and 22 March 2020 are not available due to the filters not being exchanged.
- The sampling duration for Deep Gorge on the 9 April 2020 does not conform to the run time 24 h +/- 1h as stated in AS 3580.9.9. The result from this sample is indicative only.

Similar trends in the concentrations from the three monitoring sites are observable across the year (Figure 10). This suggests the monitoring data reflects TSP trends in the Burrup airshed rather than direct impacts from individual local sources. The cause of the high recorded TSP (following the missed sample due to a software bug) at Water Tanks and Deep Gorge for 10 January 2020 has not been determined. Examination of the field sheets did not reveal an anomalous run time or volume recorded by the instrument for these samples. Furthermore, the wind data for the 10 January 2020 does not reveal a probable cause for a high 24 hour TSP result. It is, however, noted that there was rainfall recorded during the period that the filters were in the samplers (11.7 mm recorded during sampling at Water Tanks and 13.7 mm recorded during sampling at Deep Gorge). It is not possible to determine if this could have influenced the results.

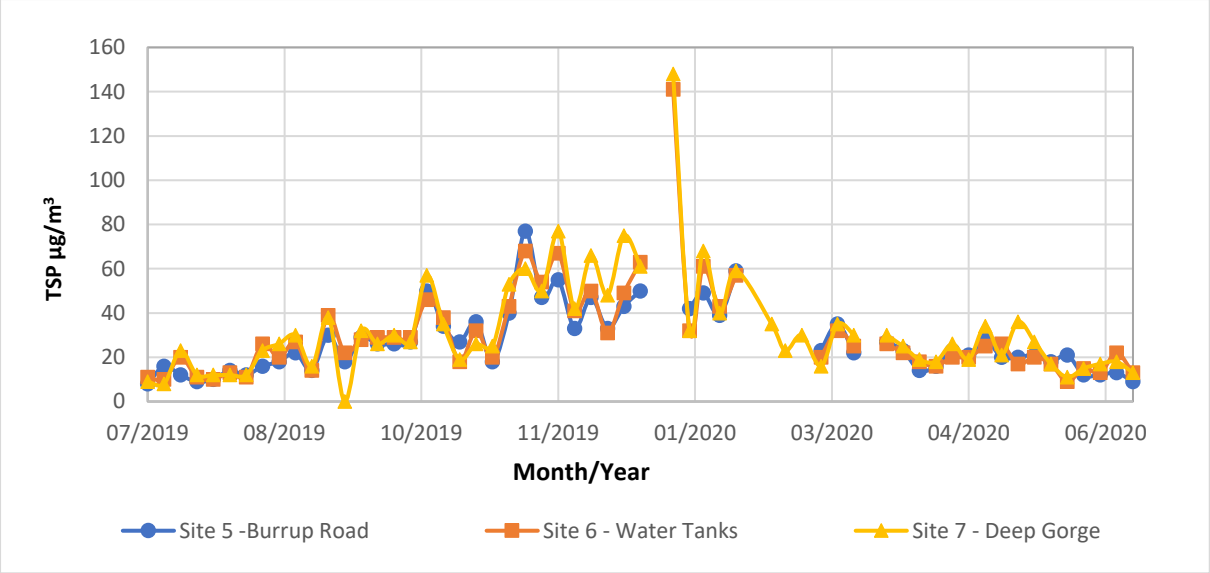

Figure 10: Measured TSP concentrations for 1 July 2019 to 30 June 2020

The baseline dataset was derived from direct TSP measurements as well as from estimates calculated from measured PM_{10} concentrations as described in the baseline report (YPN 2017). Furthermore, the measured baseline dataset for Water Tanks was impacted by local activities associated with the construction of the TAN Plant resulting in likely over-representation of background levels at that site. The ongoing measured average concentration data are consequently compared to both the measured and calculated datasets for baseline (Figure 11).

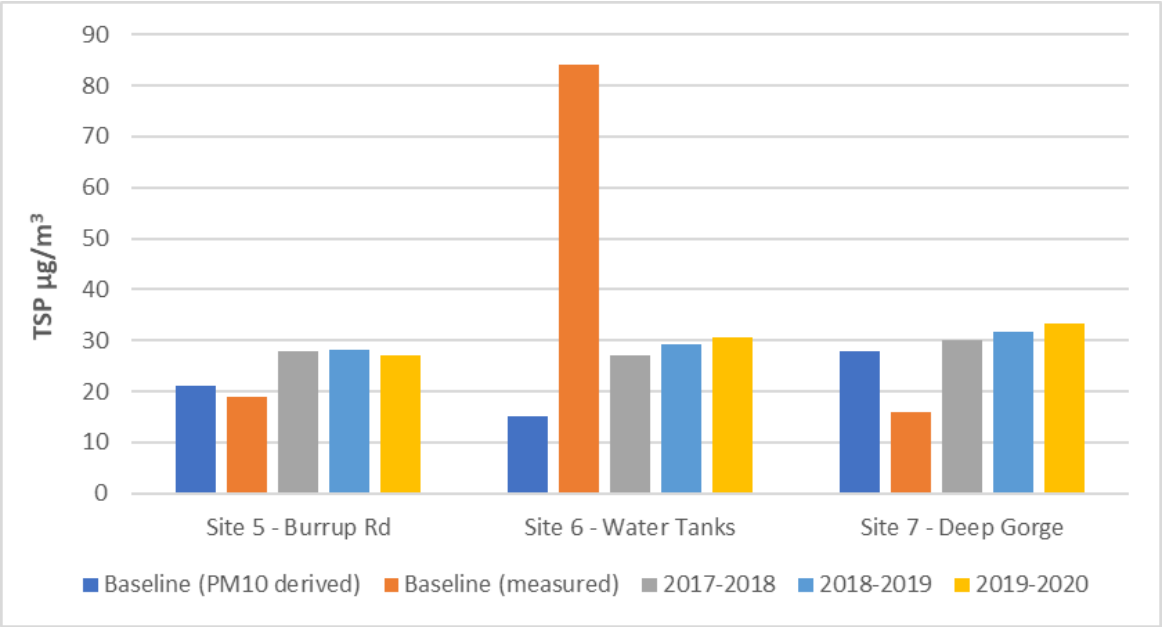

Figure 11: Comparison of average TSP concentrations for 1 July 2019 to 30 June 2020 with previous years' and baseline data

Descriptive statistics for 2019-2020 TSP monitoring at all three sites are shown in Table 8 alongside the monitoring data for 2018-2019 and 2017-2018.

Table 8: Descriptive statistics for TSP monitoring 2019-2020, 2018-2019 and 2017-2018 – all sites

TSP concentration µg/m³									
Statistic	Site 5 - Burrup Rd			Site 6 - Water Tanks			Site 7 - Deep Gorge		
	2019-2020	2018-2019	2017-2018	2019-2020	2018-2019	2017-2018	2019-2020	2018-2019	2017-2018
Minimum	8	2	6	9	8	6	8	8	11
Average	27	28	28	31	29	27	33	32	30
Maximum	77	66	76	141	63	76	148	67	79
Standard deviation	15	14	13	22	13	12	23	15	15

Comparison of the mean TSP concentrations measured during baseline and the subsequent three years of the monitoring program shows the average TSP concentration for 2018-2019 was similar to the results from the two previous years (Figure 11 and Table 8). The levels monitored at Water Tanks in the three years subsequent to the baseline study have been lower than the baseline measured data and comparable to the levels recorded at other sites. This supports the hypothesis that the baseline measurements at the Water Tanks site were affected by construction activities.

The 2019-2020 data was compared to the measured dataset from 2017-2018 to determine if there was any change in the recorded ambient TSP levels. The 2019-2020 dataset was determined not to be statistically significantly different from the 2017-2018 data.

4.3 Dust deposition

4.3.1 Results from monitoring deposited dust for 2019-2020

Results of dust deposition monitoring at the three sites are shown in Table 9. Values with a < prefix indicate deposition rates measured below the method detection limits, with the value indicating the limit. The detection limit was high for the January 2020 sample due to the volume of rainwater in the dust deposition bottles.

Table 9: Results of dust deposition monitoring 2018-2019

		Site 5 - Burrup Road		Site 6 - Water Tanks		Site 7 - Deep Gorge	
Date Deployed	Date Collected	Soluble solids g/m²/month	Insoluble solids g/m²/month	Soluble solids g/m²/month	Insoluble solids g/m²/month	Soluble solids g/m²/month	Insoluble solids g/m²/month
1/07/2019	31/07/2019	0.7	1.1	1	0.9	0.8	1
31/07/2019	30/08/2019	1.1	<0.8	0.9	1	0.8	1.8
30/08/2019	2/10/2019	<0.7	<0.8	1.4	0.9	1	<0.8
2/10/2019	1/11/2019	1	<0.8	1.4	1.1	0.9	1.2
1/11/2019	29/11/2019	0.9	<0.8	0.8	1.4	1.2	1.1
29/11/2019	31/12/2019	1.1	2.1	0.8	2.6	<0.7	3.2
31/12/2019	30/01/2020	<3	2.1	<3	1.9	<3	1.8
30/01/2020	27/02/2020	<0.7	1.5	0.8	1.4	<0.7	1
27/02/2020	31/03/2020	1.2	1.4	1.1	1.2	1.4	<0.8
31/03/2020	30/04/2020	<0.7	0.9	<0.7	1	<0.7	1
30/04/2020	29/05/2020	2.2	1.4	2.1	1.3	2.4	1.6
29/05/2020	30/06/2020	0.8	<0.8	1	0.8	0.8	<0.8

4.3.2 Analysis of dust deposition data

A comparison of the dust deposition data from 2019-2020 with the baseline data (insoluble fraction only) is shown in Table 10.

Table 10: Descriptive statistics for dust deposition monitoring 2018-2019 and baseline study

Statistic[1]	Burrup Rd (g/m²/month)			Water Tanks (g/m²/month)			Deep Gorge (g/m²/month)		
	2019-2020		Baseline	2019-2020		Baseline	2019-2020		Baseline
	Soluble	Insoluble	Insoluble	Soluble	Insoluble	Insoluble	Soluble	Insoluble	Insoluble
Minimum	0.4	0.4	0.02	0.4	0.8	0	0.4	0.4	0.01
Average	1.0	1.0	0.88	1.1	1.3	0.84	1.0	1.2	1.07
95th percentile	1.8	2.1	1.75	1.8	2.2	1.86	1.9	2.4	2.31
Maximum	2.2	2.1	2	2.1	2.6	2.05	2.4	3.2	5.03

(1) Half method detection limit deposition rates for non-detect results were used for calculations of statistics.

Average deposition rates for the insoluble fraction are a slightly higher than the baseline across the three monitoring sites; however, the difference was not statistically significant at the Burrup Road and Deep Gorge sites (determined by t-test P values >0.05). The insoluble fraction deposition at Water Tanks was significantly higher than the baseline. The reason for this is not evident from the information available.

Similar trends in the deposition rates were observed at the three sites (Figure 12). It is likely that the increase compared to baseline is due to an increase in the insoluble fraction in the airshed dust rather than influence of a specific source in the locality of the TAN Plant. Note that these comparisons reflect the use of non-detect deposition rates of half the detection limits for the 2019-2020 data. The actual deposition rates below detection limits may be lower or higher than the half detection rates.

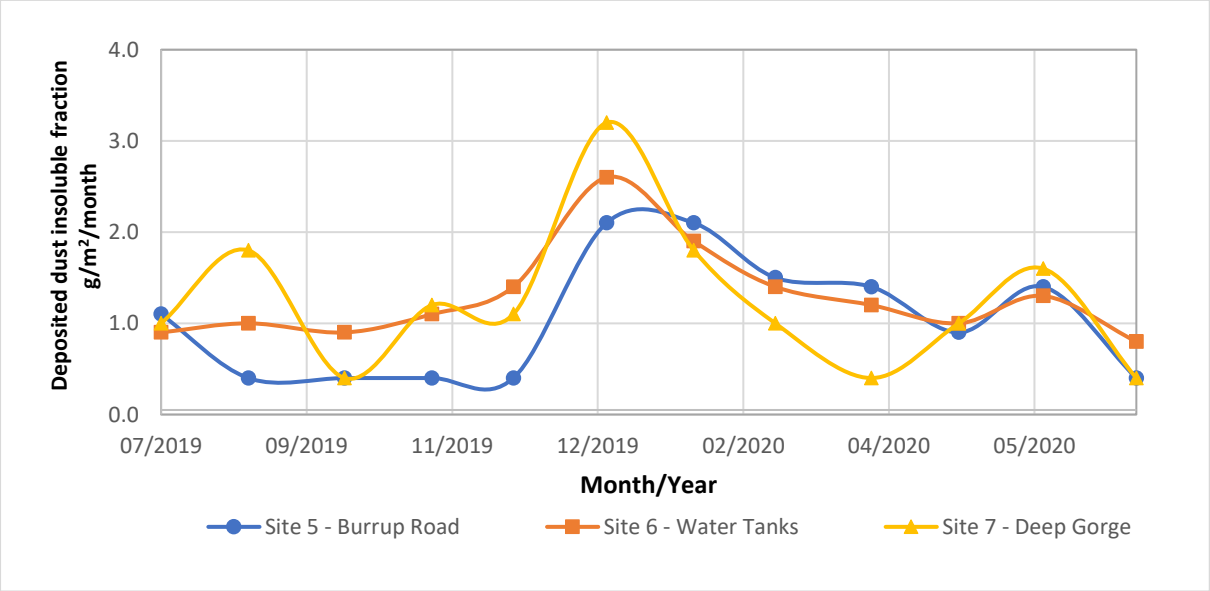

Figure 12: Deposited dust insoluble fraction 2019-2020

The soluble fraction was not determined in samples collected for the baseline study, since the EPBC Approval at the time (dated 14 September 2011) only required measurements of TSP and "dust". The latter requirement was interpreted to mean the insoluble fraction of deposited dust. The amended approval of 12 September 2017 requires both insoluble and soluble fractions of deposited dust to be monitored. In the absence of baseline data, the data for the 2019-2020 soluble fraction is compared to the data collected for the 2017-2018 and 2018-2019 monitoring periods.

The average soluble fraction measured from the deposited dust collected in 2018-2019 was higher than the 2017-2018 period at Water Tanks but lower at the other two monitoring sites (Figure 13).

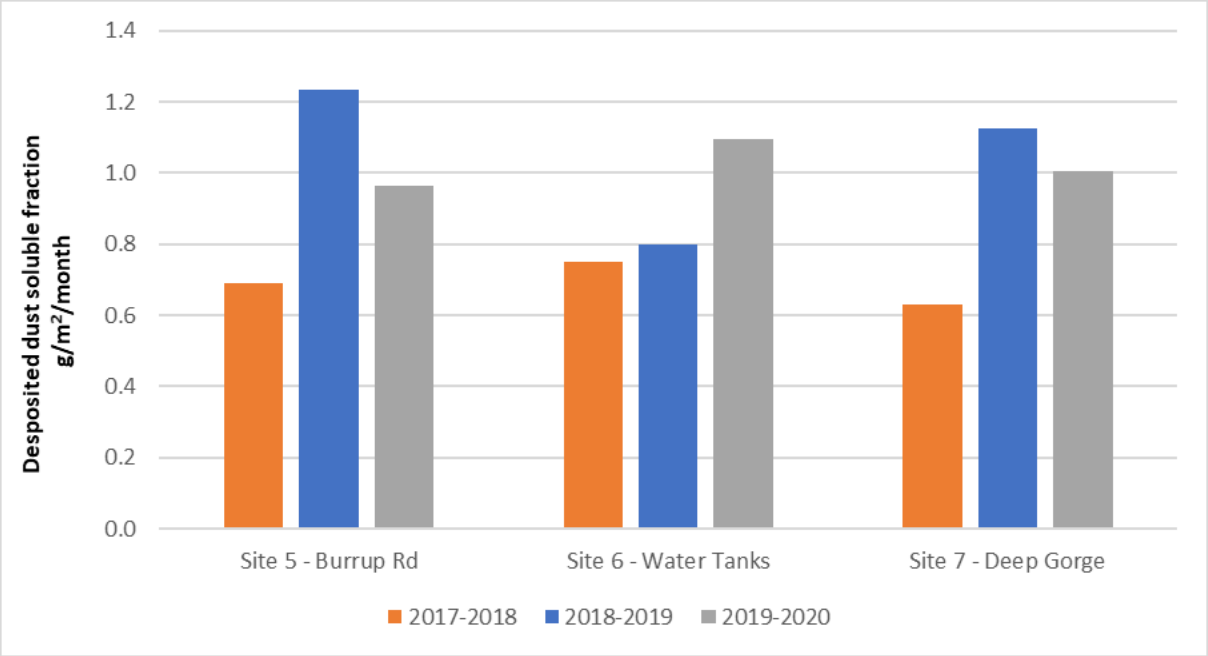

Figure 13: Deposited dust average soluble fraction 2019-2020

The monthly data reveals considerable variability in the soluble fraction of deposited dust across the three monitoring sites for September 2019 to early March 2020 while the data collect in other months[3] shows sites trending together (Figure 14).

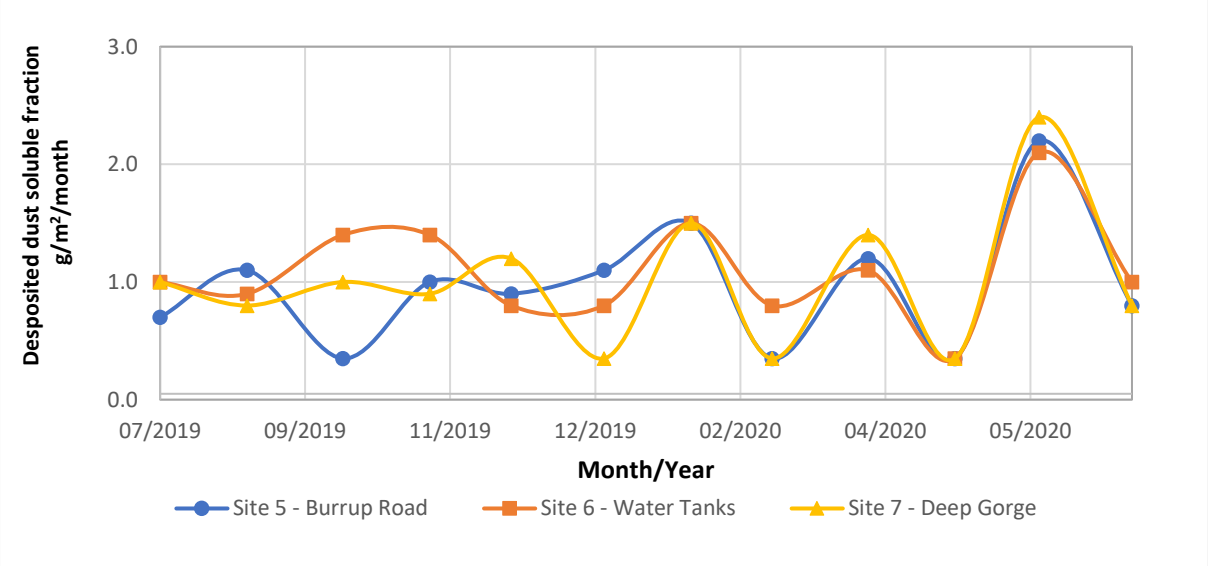

Figure 14: Deposited dust soluble fraction 2019-2020

The majority of soluble dust deposited on the Burrup is expected to be from marine sources, i.e. sea salt, which suggests similar soluble deposition rates should be observed at the three monitoring sites. The variable nature of soluble deposition rates during September to January may reflect the wind being predominantly from the west. During the westerly wind, the landform that air coming from over the ocean must pass over could influence the amount of entrained sea salt and thus deposition varies at the three sites which have varying degrees of shielding to the west. During the months that the three sites record similar deposition the winds are predominantly from the east.

[3] Note the January 2020 data was a non detect at all sites and the detection limit was elevated due to large volume of water in the dust deposition gauges.

During an easterly wind sea salt could be carried relatively unimpeded from the ocean to the three monitoring sites.

A confounding factor for soluble deposition at the three sites is the potential for aerosol emissions from the sea-water cooling tower at the adjacent Ammonia Plant and the (smaller) sea-water cooling tower on the NW corner of the TAN plant. Aerosol emissions (known as "drift") may occur from the top of the towers if the mist eliminator efficiency declines in the cooling towers or if strong cross-winds occur that mobilise droplets from the sides of the cooling towers. The water in the aerosols is likely to evaporate leaving behind particulate matter (salt) that will deposit in the immediate surrounds of the towers depending on the particle size. If salt particles persist in the air column then they can report to the soluble deposition fraction at the monitoring sites for relevant wind directions.

Note that sea salt deposition is accounted for in the calculation of total deposition rates to facilitate the identification of other sources of particulate matter that can deposit on surfaces in the vicinity of the Ammonia Plant and TAN Plant.

Overall, the levels of dust deposited at the monitoring sites are largely consistent with those observed from the baseline study.

5. Dry deposition rate investigation and actions

5.1 Investigation

As described in Section 4.1.3, the monitoring conducted for 2019-2020 showed dry deposition rates at Burrup Road (28.5 meq/m^2/y) that exceeded the investigation levels (27.1 meq/m^2/y) established from the baseline study. This outcome has triggered an investigation as per the OEMP.

Key factors examined include trends and contributions of individual gases to the total deposition rates and TAN Plant availability.

Trends in deposition rates since 2014 (as monthly rolling annual total rates) are illustrated in Figure 15. The TAN Plant 2019-2020 operating period is indicated in the graph. Nitrogen dioxide was the dominant contributor to dry deposition at Burrup Road (Figure 15).

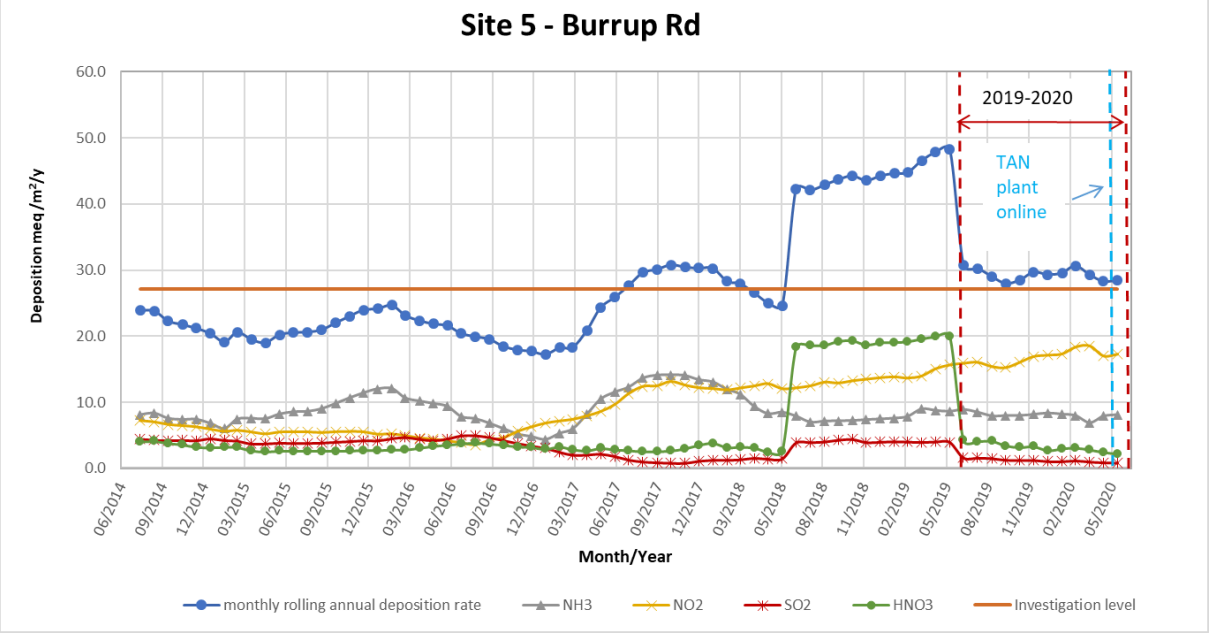

Figure 15: Monthly rolling annual total and individual gas dry deposition rates – Burrup Road

Key findings from the investigation into the elevated deposition rates are summarised in Table 11.

Table 11: Findings from investigation into elevated deposition rates

Factor	Investigation	Finding	Comment
Contributions from individual gases	Examine individual contributions to identify gases reasonable for increase in deposition rate compared to baseline	Burrup Road (see Figure 15): increase in NO_2 deposition rate across the entire year (i.e., not driven by a single very elevated point)	Increase in NO_2 due to sources other than the TAN Plant due to the TAN Plant operating for a small proportion of the reporting period
TAN Plant availability	Plant availability was limited due to the extended shutdown that occurred in 2019-2020	TAN Plant was operating from 1- 4 July 2019, 19- 20 April 2020, 13 May 2020 to 10 June 2020 and 12- 30 June 2020 (end of the reporting period)	As discussed, the relatively short duration of operations indicates that the TAN Plant is not a significant continuous source of emissions that contributed to increased acid deposition rates

Overall, the relatively short duration of TAN Plant operation in 2019-2020 and the trends in ambient concentrations indicate that the TAN Plant was not a significant contributor to increases in ambient NO_2 concentrations which have given rise to exceedances of dry deposition investigation levels.

6. Concluding remarks

Monitoring data are reported for all parameters specified in EPBC Approval 2008/4546 of 12 September 2017.

Analysis of data for gases shows the following:

- The average NH_3 concentration at Burrup Road and Deep Gorge, while higher than baseline, were not found to be statistically significantly different.
- The average NH_3 concentrations at Water Tanks was lower than baseline (and not statistically significant).
- The average NO_2 concentrations at all three monitoring locations in 2019-2020 was higher than the baseline concentrations; the differences were found to be statistically significant at both Burrup Road and Water tanks but not Deep Gorge.
- The average SO_2 concentrations at all three monitoring locations in 2018-2019 are lower than the baseline concentrations, with differences in the averages being statistically significant.

The TAN Plant was shut down for the majority of the 2019-2020 reporting period and only operated for four days during July 2019 and one and a half months from mid-May 2020 to end June 2020. Overall, there is no evidence to show that operation of the TAN Plant has resulted in significant increases in the NO_2 and levels over the 12-month monitoring period.

Analysis of annual dry deposition rates of gas species show the following:

- Dry deposition rates increased at Burrup Road in 2018-2019 compared to baseline.
- The Burrup Road dry deposition rate was above the investigation level derived from baseline measurements.
- NO_2 was the dominant contributor to dry deposition at the Burrup Road site in 2019-2020.
- NH_3 is the dominant contributor to dry deposition at Water Tanks and Deep Gorge sites.

The exceedance of the investigation level triggered an investigation as per the requirements of the OEMP. That investigation did not support a hypothesis that the emissions from TAN Plant operations in May 2020-June 2020 were responsible for exceedances of the investigation level.

Analysis of the TSP data shows the following:

- Concentrations of TSP measured in 2019-2020 continue to be reasonably consistent across the three sites suggesting reflection of air shed background concentrations as seen in the 2018-2019 reporting period.
- Average TSP concentrations at all three monitoring sites are very similar to the 2018-2019 dataset.
- A high maximum recorded at Water Tanks and Deep Gorge (Burrup Road failed to run) for 10 January 2020, which occurred after a software bug cannot be explained.

Overall, there is no evidence to show that operation of the TAN Plant has resulted in significant increase in ambient TSP concentrations in 2019-2020.

Analysis of dust deposition data shows the following:

- Similar average insoluble deposition rates were observed at all three sites.
- Average insoluble deposition at all sites was not statistically significantly different to those concentrations measured in the baseline study for Burrup Road and Deep Gorge.
- Average insoluble deposition at Water Tanks was statistically significantly different to those rate measured in the baseline study; however, the cause of this difference is not known.
- The soluble fraction of the deposited dust from 2019-2020 was higher than the 2017-2018 dataset at all sites.
- The soluble fraction deposition rates at Burrup Road and Deep Gorge were lower than the 2018-2019 dataset.
- The soluble fraction of the deposited dust at Water Tanks was higher than the 2018-2019 dataset.
- The soluble deposition rates were found to vary across the three sites for the first half of the year.

Overall, there is no evidence to suggest that the operation of the TAN Plant has resulted in materially significant increases in insoluble dust deposition rates. Influences on soluble deposition rates at Water Tanks appear to differ from the other two sites; however, those influences cannot be identified at this time.

7. References

Strategen (2018). *Yara Pilbara Nitrates, EPBC Approval 2008/4546.* Ambient air quality report 2017-2018. Document 250-200-EP-PN-0002, issued October 2018.

Strategen (2019). *Yara Pilbara Nitrates, EPBC Approval 2008/4546.* Ambient air quality report 2018-2019. Document 250-200-EP-PN-0002, issued October 2019.

YPN (2017). *Yara Pilbara Nitrates, EPBC Approval 2008/4546. Baseline Air Quality Monitoring Report*. Document 250-200-EP-PN-0002, issued 16 June 2017.

Limitations

Scope of services

This report ("the report") has been prepared by Strategen-JBS&G in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Strategen-JBS&G. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

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Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

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Appendix A Results from monitoring of gases for 2018-2019

Site	Date on	Date off	NH_3 µg/m³	NO_2 µg/m³	SO_2 µg/m³	HNO_3 µg/m³
Site 5 - Burrup Road	1/07/2019 14:55	15/07/2019 14:00	1.04	7.23	0.26	0.17
Site 5 - Burrup Road	15/07/2019 14:00	31/07/2019 10:00	0.65	6.96	0.77	0.21
Site 5 - Burrup Road	31/07/2019 10:00	15/08/2019 14:59	0.55	5.99	0.60	0.46
Site 5 - Burrup Road	15/08/2019 14:59	30/08/2019 10:50	0.93	4.80	0.01	0.27
Site 5 - Burrup Road	30/08/2019 10:50	13/09/2019 9:45	0.35	2.91	0.21	0.27
Site 5 - Burrup Road	13/09/2019 9:45	2/10/2019 11:00	0.37	3.87	0.21	0.29
Site 5 - Burrup Road	2/10/2019 11:00	17/10/2019 9:20	0.32	4.31	0.30	0.07
Site 5 - Burrup Road	17/10/2019 9:20	1/11/2019 9:40	0.47	3.65	0.43	0.13
Site 5 - Burrup Road	1/11/2019 9:40	15/11/2019 10:00	0.22	-	0.04	0.03
Site 5 - Burrup Road	15/11/2019 10:00	29/11/2019 10:00	0.37	8.46	1.35	0.54
Site 5 - Burrup Road	29/11/2019 10:00	13/12/2019 9:00	0.35	3.32	0.07	0.14
Site 5 - Burrup Road	13/12/2019 09:00	31/12/2019 09:30	0.51	6.43	0.51	0.29
Site 5 - Burrup Road	31/12/2019 09:30	15/01/2020 10:00	0.82	2.79	0.20	0.15
Site 5 - Burrup Road	15/01/2020 10:00	30/01/2020 11:00	0.37	2.76	0.15	0.10
Site 5 - Burrup Road	30/01/2020 11:00	06/02/2020 15:00	0.23	3.87	0.47	0.22
Site 5 - Burrup Road	13/02/2020 15:00	27/02/2020 9:40	0.27	3.74	0.41	0.92
Site 5 - Burrup Road	27/02/2020 9:40	13/03/2020 9:25	0.32	-	-	-
Site 5 - Burrup Road	13/03/2020 9:25	31/03/2020 8:30	0.43	6.30	0.14	0.13
Site 5 - Burrup Road	31/03/2020 8:30	14/04/2020 9:30	0.47	5.73	0.18	0.45
Site 5 - Burrup Road	14/04/2020 09:30	30/04/2020 09:30	0.48	2.95	0.04	0.07
Site 5 - Burrup Road	30/04/2020 09:30	15/05/2020 09:00	1.33	2.39	0.04	0.09
Site 5 - Burrup Road	15/05/2020 09:00	29/05/2020 13:57	3.73	2.15	0.04	0.10
Site 5 - Burrup Road	29/05/2020 13:57	15/06/2020 15:00	2.26	4.24	0.08	0.14
Site 5 - Burrup Road	15/06/2020 15:00	30/06/2020 10:00	2.12	5.63	0.01	0.24
Site 6 - Water Tanks	1/07/2019	15/07/2019	0.62	4.48	0.14	0.30
Site 6 - Water Tanks	15/07/2019	31/07/2019	1.38	5.49	0.28	0.18
Site 6 - Water Tanks	31/07/2019	15/08/2019	0.38	3.71	0.08	0.15
Site 6 - Water Tanks	15/08/2019	30/08/2019	0.40	3.66	0.05	0.24
Site 6 - Water Tanks	30/08/2019	13/09/2019	0.53	3.43	0.25	0.46
Site 6 - Water Tanks	13/09/2019	2/10/2019	0.57	2.33	0.09	0.23
Site 6 - Water Tanks	2/10/2019	17/10/2019	0.73	4.09	0.10	0.18
Site 6 - Water Tanks	17/10/2019	1/11/2019	0.93	3.58	0.14	0.08
Site 6 - Water Tanks	1/11/2019	15/11/2019	0.56	4.26	0.24	0.08
Site 6 - Water Tanks	15/11/2019	29/11/2019	0.58	2.71	0.07	0.10
Site 6 - Water Tanks	29/11/2019	13/12/2019	0.84	2.49	0.15	0.13
Site 6 - Water Tanks	13/12/2019	31/12/2019	0.87	5.57	0.28	0.14
Site 6 - Water Tanks	31/12/2019	15/01/2020	0.60	-	-	-
Site 6 - Water Tanks	15/01/2020	30/01/2020	0.29	5.19	0.47	1.25
Site 6 - Water Tanks	30/01/2020	6/02/2020	0.30	4.47	0.34	0.28
Site 6 - Water Tanks	13/02/2020	27/02/2020	0.39	3.69	0.37	0.45
Site 6 - Water Tanks	27/02/2020	13/03/2020	0.42	3.87	0.97	1.33
Site 6 - Water Tanks	13/03/2020	31/03/2020	0.73	4.92	0.11	0.29
Site 6 - Water Tanks	31/03/2020	14/04/2020	0.61	4.39	0.26	0.72
Site 6 - Water Tanks	14/04/2020	30/04/2020	0.92	2.64	0.10	0.21
Site 6 - Water Tanks	30/04/2020	15/05/2020	0.66	1.31	0.05	0.11
Site 6 - Water Tanks	15/05/2020	29/05/2020	1.36	0.74	0.07	0.16
Site 6 - Water Tanks	29/05/2020	15/06/2020	0.62	2.02	0.07	0.16
Site 6 - Water Tanks	15/06/2020	30/06/2020	1.07	3.59	0.04	0.14
Site 7 - Deep Gorge	1/07/2019 14:30	15/07/2019 13:30	0.40	3.91	0.10	0.17
Site 7 - Deep Gorge	15/07/2019 13:30	31/07/2019 9:30	0.22	3.93	0.11	0.15
Site 7 - Deep Gorge	31/07/2019 9:30	15/08/2019 14:32	0.06	3.80	0.14	0.15
Site 7 - Deep Gorge	15/08/2019 14:32	30/08/2019 10:20	0.42	3.39	0.07	0.27

Site	Date on	Date off	NH_3 µg/m³	NO_2 µg/m³	SO_2 µg/m³	HNO_3 µg/m³
Site 7 - Deep Gorge	30/08/2019 10:20	13/09/2019 9:15	0.06	2.71	0.18	0.40
Site 7 - Deep Gorge	13/09/2019 9:15	2/10/2019 10:35	0.63	2.75	0.23	0.19
Site 7 - Deep Gorge	2/10/2019 10:35	17/10/2019 9:00	2.29	3.19	0.20	0.23
Site 7 - Deep Gorge	17/10/2019 9:00	1/11/2019 9:20	1.83	2.91	0.17	0.08
Site 7 - Deep Gorge	1/11/2019 9:20	15/11/2019 9:30	0.73	-	-	-
Site 7 - Deep Gorge	15/11/2019 9:30	29/11/2019 9:30	1.37	2.68	0.15	0.31
Site 7 - Deep Gorge	29/11/2019 9:30	13/12/2019 8:40	0.50	2.60	0.18	0.24
Site 7 - Deep Gorge	13/12/2019 8:40	31/12/2019 9:00	0.91	4.33	0.19	0.08
Site 7 - Deep Gorge	31/12/2019 9:00	15/01/2020 9:30	0.66	-	-	-
Site 7 - Deep Gorge	15/01/2020 9:30	30/01/2020 10:30	0.87	3.17	0.10	0.10
Site 7 - Deep Gorge	30/01/2020 10:30	6/02/2020 14:30	0.33	3.10	0.15	0.22
Site 7 - Deep Gorge	13/02/2020 14:30	27/02/2020 9:20	0.59	3.59	0.10	0.34
Site 7 - Deep Gorge	27/02/2020 9:20	13/03/2020 9:00	0.75	2.46	0.01	0.05
Site 7 - Deep Gorge	13/03/2020 9:00	31/03/2020 8:00	0.59	4.86	0.16	0.50
Site 7 - Deep Gorge	31/03/2020 8:00	14/04/2020 7:30	0.74	3.61	0.08	0.20
Site 7 - Deep Gorge	14/04/2020 9:00	30/04/2020 9:00	1.94	1.91	0.23	0.55
Site 7 - Deep Gorge	30/04/2020 9:00	15/05/2020 8:35	0.95	0.88	0.25	0.61
Site 7 - Deep Gorge	15/05/2020 8:35	29/05/2020 13:31	0.37	0.29	0.15	0.03
Site 7 - Deep Gorge	29/05/2020 13:31	15/06/2020 14:30	0.31	1.55	0.22	0.69
Site 7 - Deep Gorge	15/06/2020 14:30	30/06/2020 9:30	0.74	0.31	0.01	0.17

Appendix B Results from monitoring of TSP for 2019-2020

Period start date	Site 5 -Burrup Road TSP µg/m³	Site 6 - Water Tanks TSP µg/m³	Site 7 - Deep Gorge TSP µg/m³
02/07/2019	8	11	9
08/07/2019	16	10	8
14/07/2019	12	20	23
20/07/2019	9	11	12
26/07/2019	10	10	12
01/08/2019	14	13	12
07/08/2019	12	11	12
13/08/2019	16	26	23
19/08/2019	18	20	26
25/08/2019	22	27	30
31/08/2019	14	14	16
06/09/2019	30	39	38
12/09/2019	18	22	-
18/09/2019	29	28	32
24/09/2019	26	29	26
30/09/2019	26	29	30
06/10/2019	27	29	27
12/10/2019	50	46	57
18/10/2019	34	38	35
24/10/2019	27	18	19
30/10/2019	36	32	26
05/11/2019	18	20	25
11/11/2019	40	43	53
17/11/2019	77	68	60
23/11/2019	47	54	50
29/11/2019	55	67	77
05/12/2019	33	41	42
11/12/2019	47	50	66
17/12/2019	33	31	48
23/12/2019	43	49	75
29/12/2019	50	63	61
04/01/2020	-	-	-
10/01/2020	-	141	148
16/01/2020	42	32	32
21/01/2020	49	61	68
27/01/2020	39	43	40
02/02/2020	59	57	59
15/02/2020	-	-	35
20/02/2020	-	-	23
26/02/2020	-	-	30
04/03/2020	23	20	16
10/03/2020	35	32	35
16/03/2020	-	-	-
22/03/2020	-	-	-
28/03/2020	27	26	30
03/04/2020	23	22	25
09/04/2020	14	18	19
15/04/2020	16	16	18
21/04/2020	23	20	26
27/04/2020	21	20	19
03/05/2020	28	25	34
09/05/2020	20	26	21
15/05/2020	20	17	36
21/05/2020	21	20	27
27/05/2020	18	17	17

Period start date	Site 5 -Burrup Road TSP µg/m³	Site 6 - Water Tanks TSP µg/m³	Site 7 - Deep Gorge TSP µg/m³
02/06/2020	21	9	11
08/06/2020	12	15	15
14/06/2020	12	13	17
20/06/2020	13	22	18
26/06/2020	9	13	13

Appendix C Results from dust deposition monitoring 2019-2020

Date collected	Site 5 - Burrup Road		Site 6 - Water Tanks		Site 7 - Deep Gorge	
	Soluble solids	Insoluble solids	Soluble solids	Insoluble solids	Soluble solids	Insoluble solids
	g/m²/month	g/m²/month	g/m²/month	g/m²/month	g/m²/month	g/m²/month
31/07/2019	0.7	1.1	1.00	0.9	0.8	1
30/08/2019	1.1	<0.8	0.9	1	0.8	1.8
2/10/2019	<0.7	<0.8	1.4	0.9	1	<0.8
1/11/2019	1	<0.8	1.4	1.1	0.9	1.2
29/11/2019	0.9	<0.8	0.8	1.4	1.2	1.1
31/12/2019	1.1	2.1	0.8	2.6	<0.7	3.2
30/01/2020	<3	2.1	<3	1.9	<3	1.8
27/02/2020	<0.7	1.5	0.8	1.4	<0.7	1
31/03/2020	1.2	1.4	1.1	1.2	1.4	<0.8
30/04/2020	<0.7	0.9	<0.7	1	<0.7	1
29/05/2020	2.2	1.4	2.1	1.3	2.4	1.6
30/06/2020	0.8	<0.8	1	0.8	0.8	<0.8

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