Ambient Air Quality Monitoring Report
2020-2021
EPBC 2008/45546

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

30 September 2021

61744/140,508 (Rev 0)

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

Table of Contents

List of Tables

List of Figures

Appendices

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	Low volume air sampling 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 2020 to 30 June 2021.

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…"*.

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 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), a report for the period 2018-2019 was issued in October 2019 (Strategen-JBS&G 2019) and for the period 2019-2020 was issued in October 2020 (Strategen-JBS&G 2020). This report presents an analysis of monitoring data obtained for the monitoring period 1 July 2020 to 30 June 2021 (referred to herein as 2020-2021).

3. TAN Plant operation 2020-2021

The TAN Plant operated between the start of reporting period to 22 July 2020, 28 July to 12 September 2020, 27 September 2020 to the 26 January 2021, 5 February 2021 to the 13 March 2021, 24 March 2021 to the 1 June 2021 and was restarted on the 13 June 2021 and then remained online to the end of the reporting period. No air 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, SO_2 and HNO_3 using Radiello passive sampling was carried out continuously throughout the 2020-2021 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 during the preceding reporting period therefore monitoring was at the new Deep Gorge location for the entire 2020-2021 reporting period.

A total of 24 fortnightly measurements were made of NH_3, NO_2, SO_2 and HNO_3 concentrations at each site during the 1 July 2020 to 30 June 2021 reporting period. Sampling commenced on 1 July 2020 when samplers deployed for the previous fortnight were replaced, and sampling concluded on 30 June 2021.

Tabulated 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. The concentrations of HNO_3 are illustrated in Figure 5.

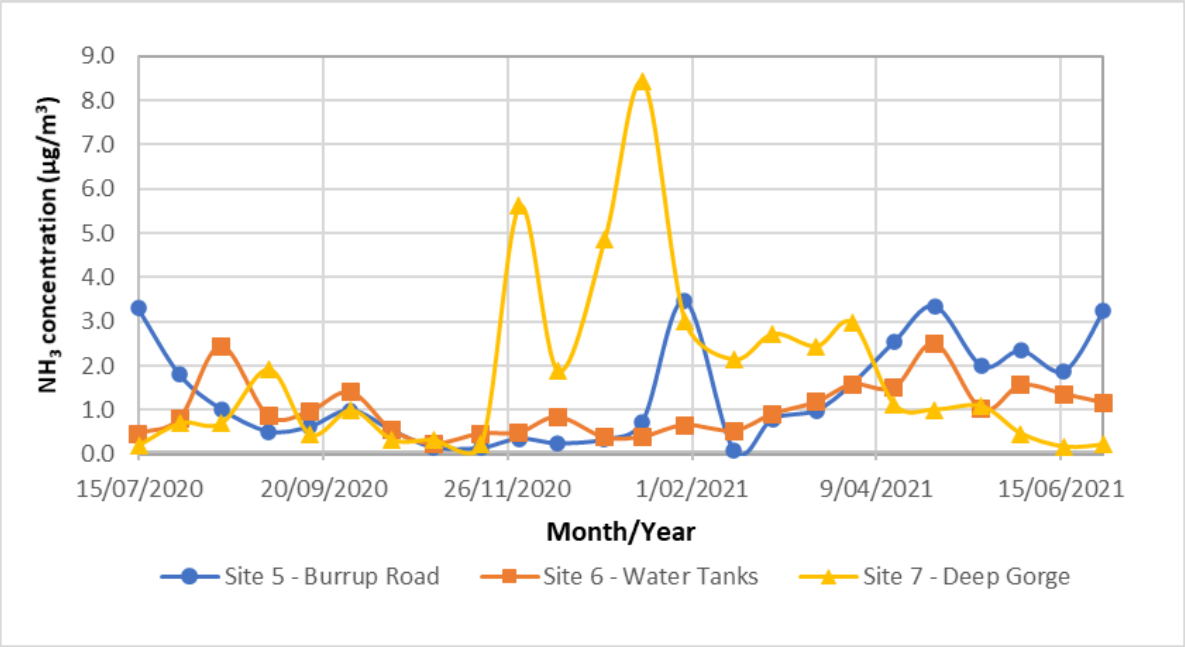

Figure 2: Measured NH_3 concentrations for 1 July 2020 to 30 June 2021

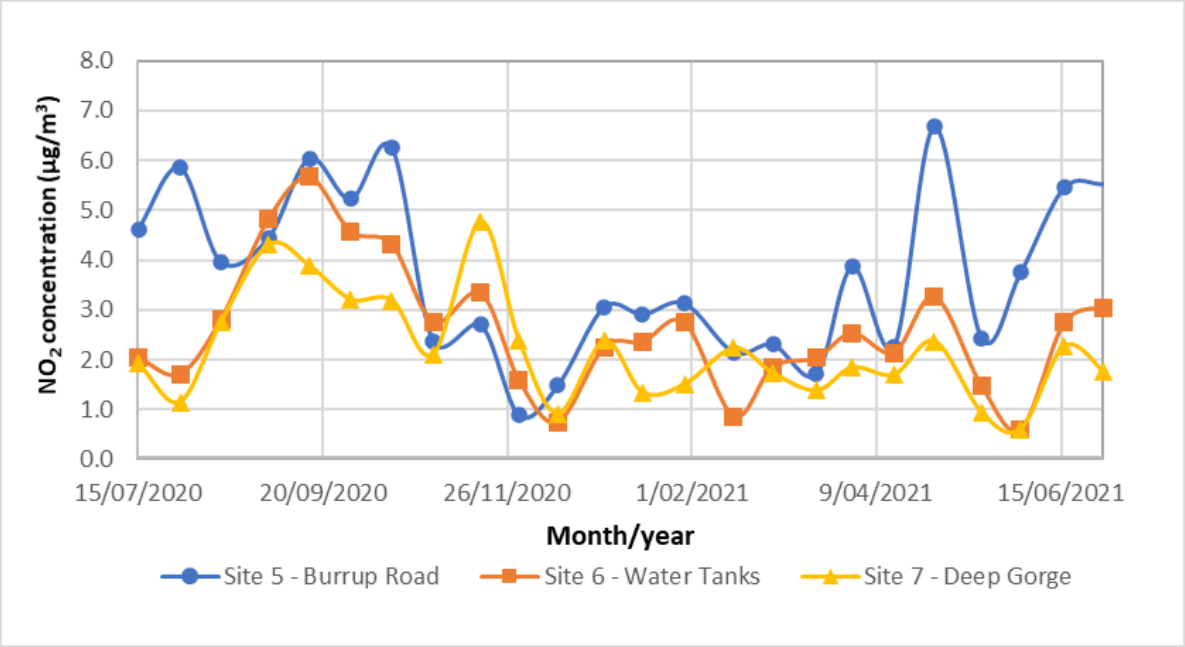

Figure 3: Measured NO_2 concentrations for 1 July 2020 to 30 June 2021

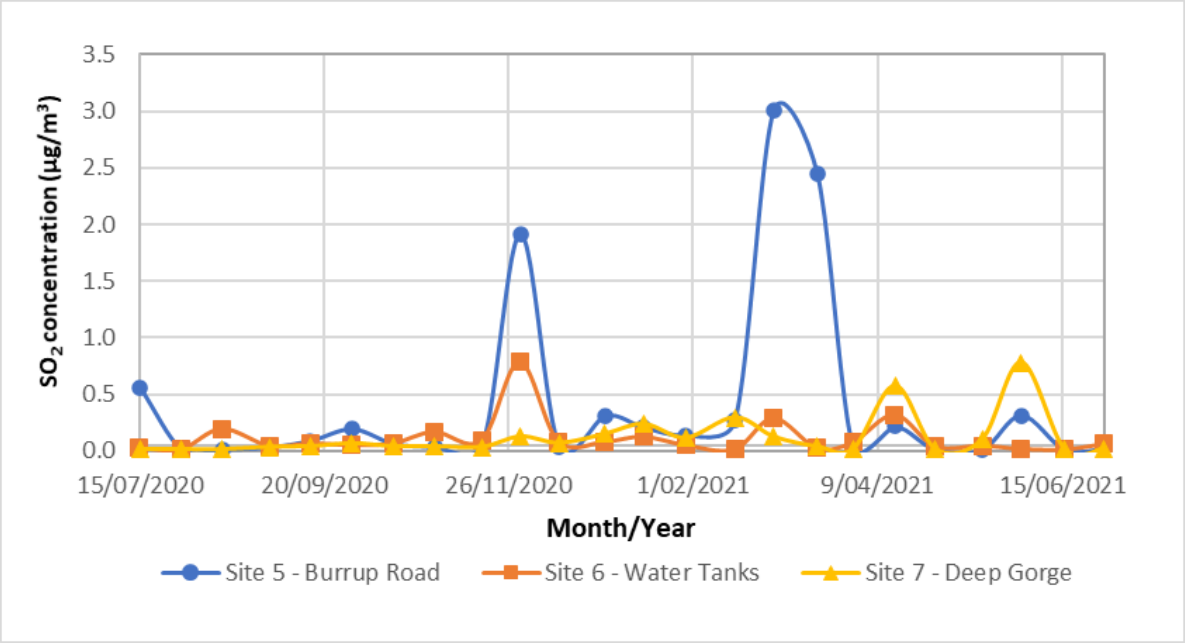

Figure 4: Measured SO_2 concentrations for 1 July 2020 to 30 June 2021

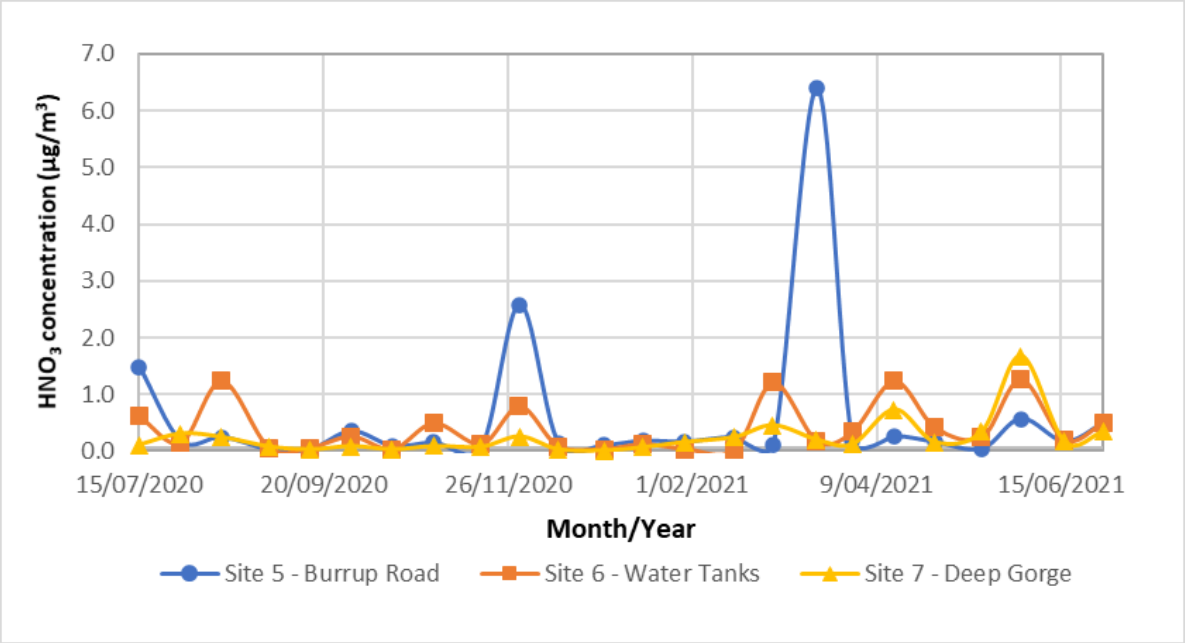

Figure 5: Measured HNO_3 concentrations for 1 July 2020 to 30 June 2021

4.1.2 Analysis of NH_3, NO_2 and SO_2 data

The analysis of measured concentrations involved comparison of descriptive statistics for 2020-2021 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 (2020-2021 and baseline)

Ammonia concentration µg/m³						
Statistic	Site 5 - Burrup Rd		Site 6 - Water Tanks		Site 7 - Deep Gorge	
	2020-2021	Baseline	2020-2021	Baseline	2020-2021	Baseline
Minimum	0.09	0	0.24	0	0.17	0
Average	1.37	0.44	1.01	0.93	1.83	0.75
Maximum	3.47	1.2	2.50	3.97	8.42	4.35
Standard deviation	1.14	0.34	0.60	0.76	2.03	0.82

Table 2: Descriptive statistics for NO_2 monitoring (2020-2021 and baseline)

Nitrogen Dioxide concentration µg/m³						
Statistic	Site 5 - Burrup Rd		Site 6 - Water Tanks		Site 7 - Deep Gorge	
	2020-2021	Baseline	2020-2021	Baseline	2020-2021	Baseline
Minimum	0.89	0.38	0.60	0.31	0.61	0.4
Average	3.71	3.6	2.59	2.56	2.19	2.31
Maximum	6.68	6.53	5.67	5.27	4.77	4.12
Standard deviation	1.68	1.46	1.28	1.04	1.06	0.69

Table 3: Descriptive statistics for SO_2 monitoring (2020-2021 and baseline)

Sulfur Dioxide concentration µg/m³						
Statistic	Site 5 - Burrup Rd		Site 6 - Water Tanks		Site 7 - Deep Gorge	
	2020-2021	Baseline	2020-2021	Baseline	2020-2021	Baseline
Minimum	0.01	0.07	0.01	0	0.01	0.13
Average	0.42	1.38	0.11	0.95	0.12	0.82
Maximum	3.01	3.09	0.78	3.5	0.78	2.01
Standard deviation	0.81	0.83	0.16	0.84	0.19	0.53

Table 4: Descriptive statistics for HNO_3 monitoring (2020-2021 and baseline)

Nitric acid concentration µg/m³						
Statistic	Site 5 - Burrup Rd		Site 6 - Water Tanks		Site 7 - Deep Gorge	
	2020-2021	Baseline	2020-2021	Baseline	2020-2021	Baseline
Minimum	0.03	0.00	0.01	0.00	0.01	0.00
Average	0.60	0.58	0.40	0.54	0.25	0.48
Maximum	6.39	1.55	1.26	1.81	1.67	1.42
Standard deviation	1.36	0.45	0.43	0.48	0.34	0.37

The concentrations from 2020-2021 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 2020-2021 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	2020-2021	Average	1.37	1.01	1.83
	baseline	Average	0.44	0.93	0.75
		P value	$5.67x10^{-05}$	0.61	0.02
NO_2	2020-2021	Average	3.71	2.59	2.19
	baseline	Average	3.60	2.56	2.31
		P value	0.79	0.90	0.64
SO_2	2020-2021	Average	0.42	0.11	0.12
	baseline	Average	1.38	0.95	0.82
		P value	$5.68x10^{-05}$	$5.48x10^{-09}$	$3.91x10^{-10}$
HNO_3	2020-2021	Average	0.60	0.40	0.25
	baseline	Average	0.58	0.54	0.48
		P value	0.95	0.24	0.02

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 2020-2021 monitoring compared with baseline monitoring at this site is statistically significant.
	Water Tanks	The (higher) average NH_3 concentration from 2020-2021 monitoring compared with baseline monitoring is not statistically significant
	Deep Gorge	The (higher) average NH_3 concentration from 2020-2021 monitoring compared with baseline monitoring at this site is statistically significant.
NO_2	Burrup Road	Differences in the NO_2 concentrations from 2020-2021 compared with baseline monitoring at this site are not statistically significant.
	Water Tanks	
	Deep Gorge	
SO_2	Burrup Road	The (lower) average SO_2 concentrations from 2020-2021 monitoring compared with baseline monitoring are statistically significant.
	Water Tanks	
	Deep Gorge	
HNO_3	Burrup Road	The (lower) average HNO_3 concentrations from 2020-2021 monitoring compared with baseline monitoring are not statistically significant.
	Water Tanks	
	Deep Gorge	The (lower) average HNO_3 concentrations from 2020-2021 monitoring compared with baseline monitoring are statistically significant.

The average concentrations of NH_3 detected at Water Tanks during 2020-2021 were determined to be statistically insignificant from the baseline dataset. The higher NH_3 levels measured at Burrup Road and Deep Gorge, however, were determined to be statistically significant. Elevated NH_3 levels detected in November and January did not coincide with TAN Plant start up periods when elevated emissions may occur, suggesting other source(s) of ammonia may have contributed to the ambient concentrations.

The differences in average concentrations of NO_2 at all three sites recorded during 2020-2021 and baseline were not statistically significant.

Continuing from previous years statistically significant decreases in the SO_2 concentrations recorded during the 2020-2021 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 gas plants on the Burrup Peninsula or use of lower sulfur fuels in ships that visit the Dampier port.

The reason for a statistically significant decrease in the HNO_3 concentrations recorded at Deep Gorge during the 2020-2021 monitoring period relative to the baseline study is unknown (Table 5).

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. 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.

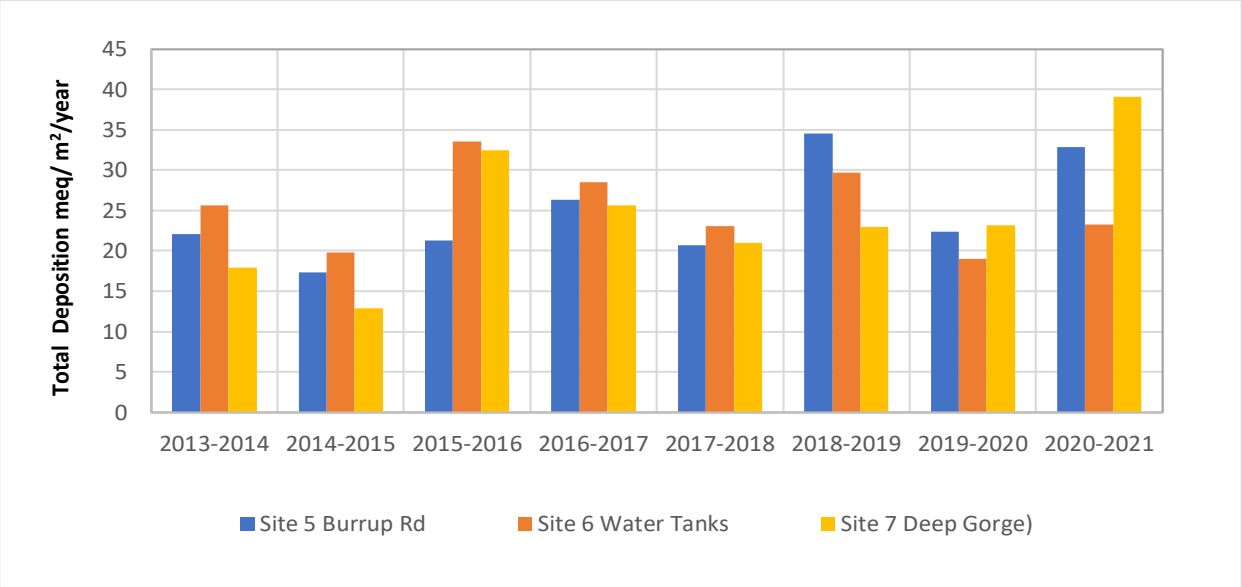

Figure 6: Annual deposition rates from measured gases (2013-2021)

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	22.1	25.6	17.9
2014-2015	17.3	19.8	12.9
2015-2016	21.3	33.6	32.4
2016-2017	26.3	28.5	25.6
2017-2018	20.7	23.0	21.0
2018-2019	34.5	29.7	23.0
2019-2020	22.4	19.0	23.2
2020-2021	32.9	23.3	39.1
investigation level	25.5	42.2	51.8

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

Dry deposition rates of gas species have increased at all three sites in 2020-2021 compared to the 2019-2020 period. The Burrup Road site was determined to remain above the investigation level in 2020-2021 while while Water Tanks and Deep Gorge continue to remain below the investigation level. The composition of the total deposition at each site is illustrated in Figure 7 to Figure 9.

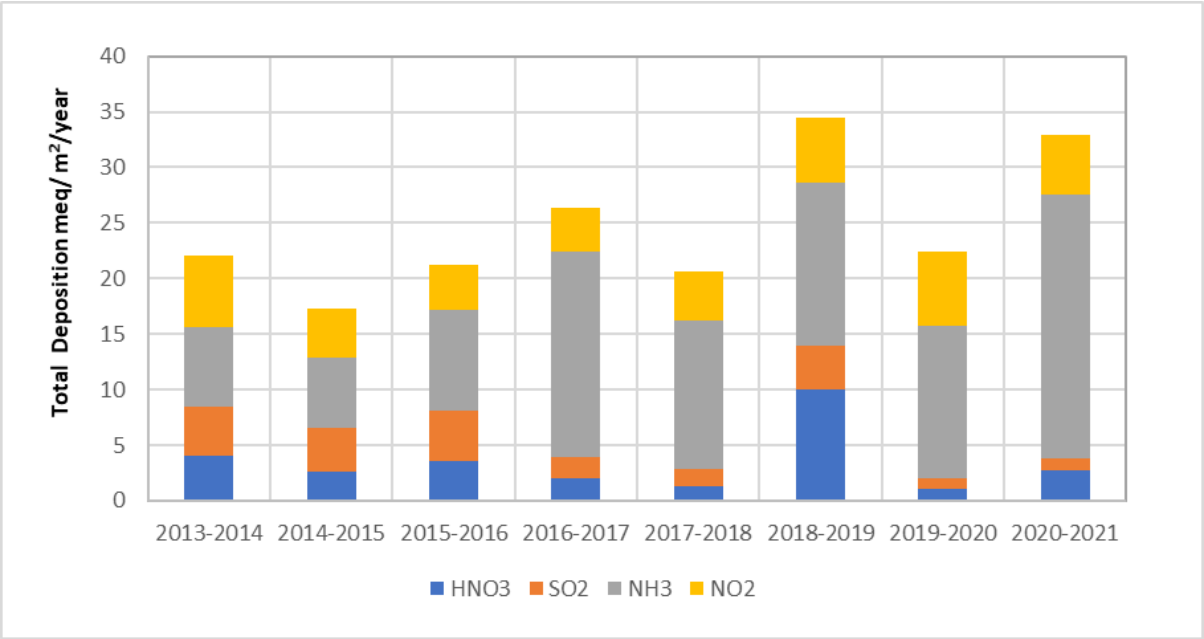

Figure 7: Burrup Road dry deposition composition

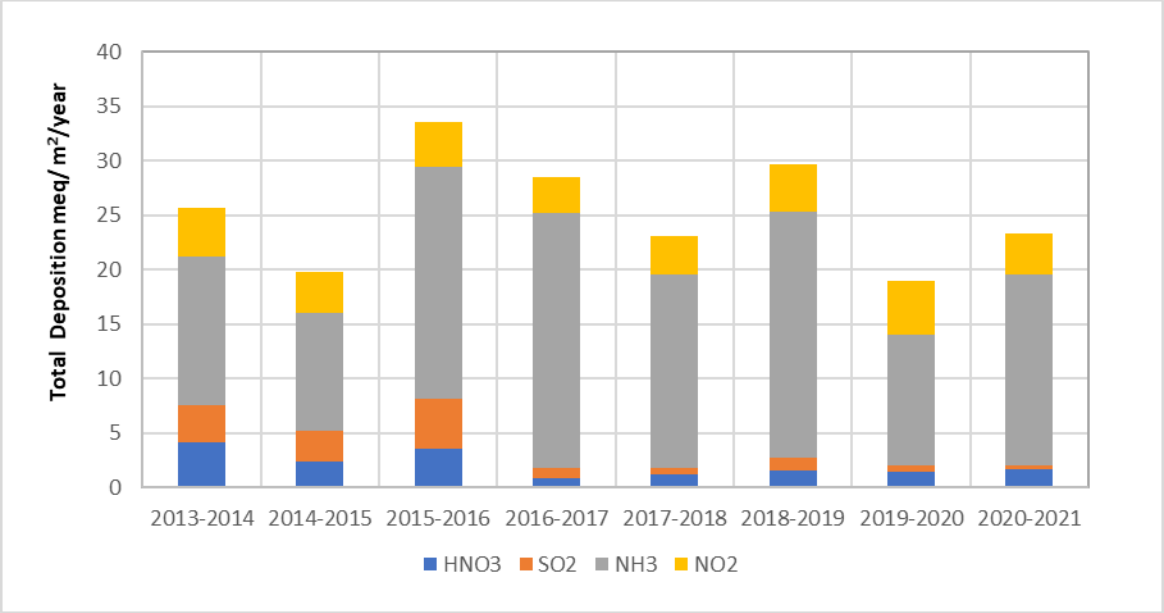

Figure 8: Water Tanks dry deposition rates

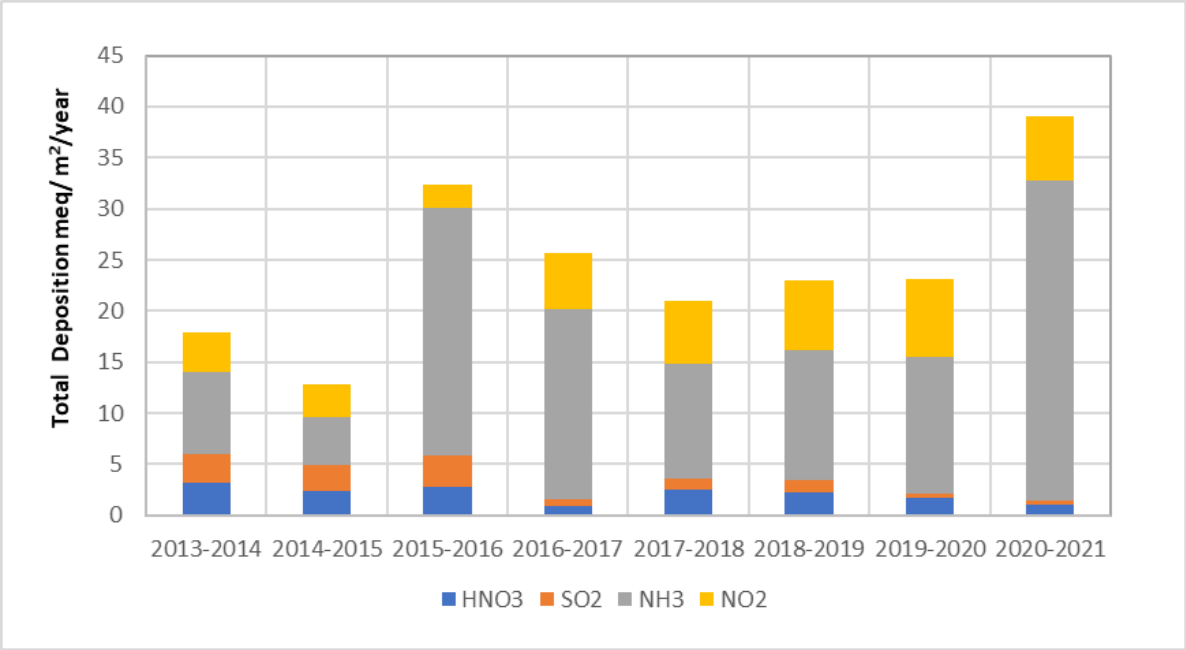

Figure 9: Deep Gorge dry deposition rates

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 2020-2021

Monitoring for total suspended particulate (TSP) using MicroVol samplers was conducted at the three monitoring sites. Monitoring was conducted for 24 hours every six days from the period 2 July 2020 to 3 July 2021. The exceptions were sampling during February which was disrupted; sampling on the 15 February was conducted after a 7 day interval and on 22 February following 5 days, this did not compromise the quality of the data collected.

Valid data was collected at all sites throughout the monitoring with the following exceptions:

- The sample filter from the Water Tanks Site for 11 December 2020 was determined to have discoloration around edge of filter (documented by laboratory) and results were therefore flagged indicative only. Rain was recorded on 11 December 2020 and water may have entered the unit. The TSP result was an extreme outlier (both in the site trending and relative to other sites) therefore the spoiled sample data were removed from the dataset.
- Upon collection water was found on the sample filter from Water Tanks for the 4 May 2021. Rain was recorded during the day of sampling (63 mm recorded at Karratha Airport BOM site 24 hours to 9 am on 5 May 2021) which is most likely the source of the contamination Furthermore the difference between the start and end flow readings was 7-10% and the reported concentration was an outlier. Therefore, the sample result was removed from the dataset.

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.

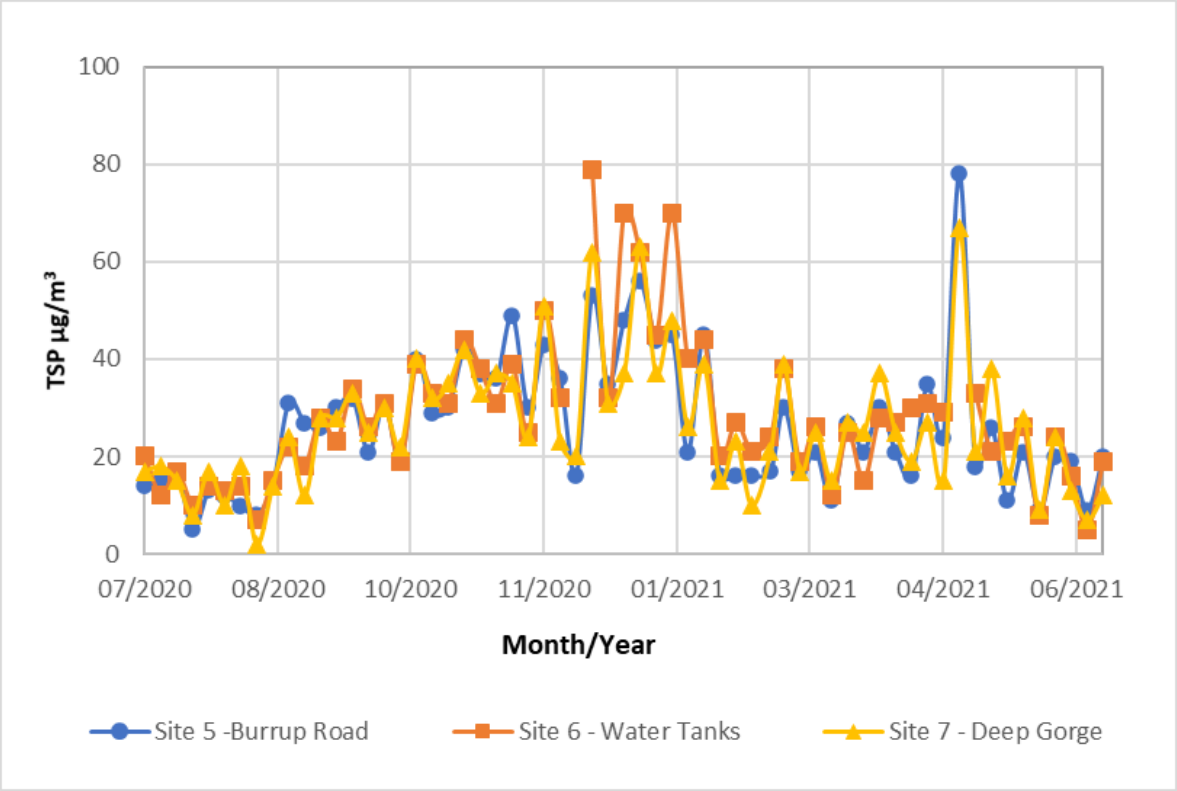

Figure 10: Measured TSP concentrations for 2020-2021

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).

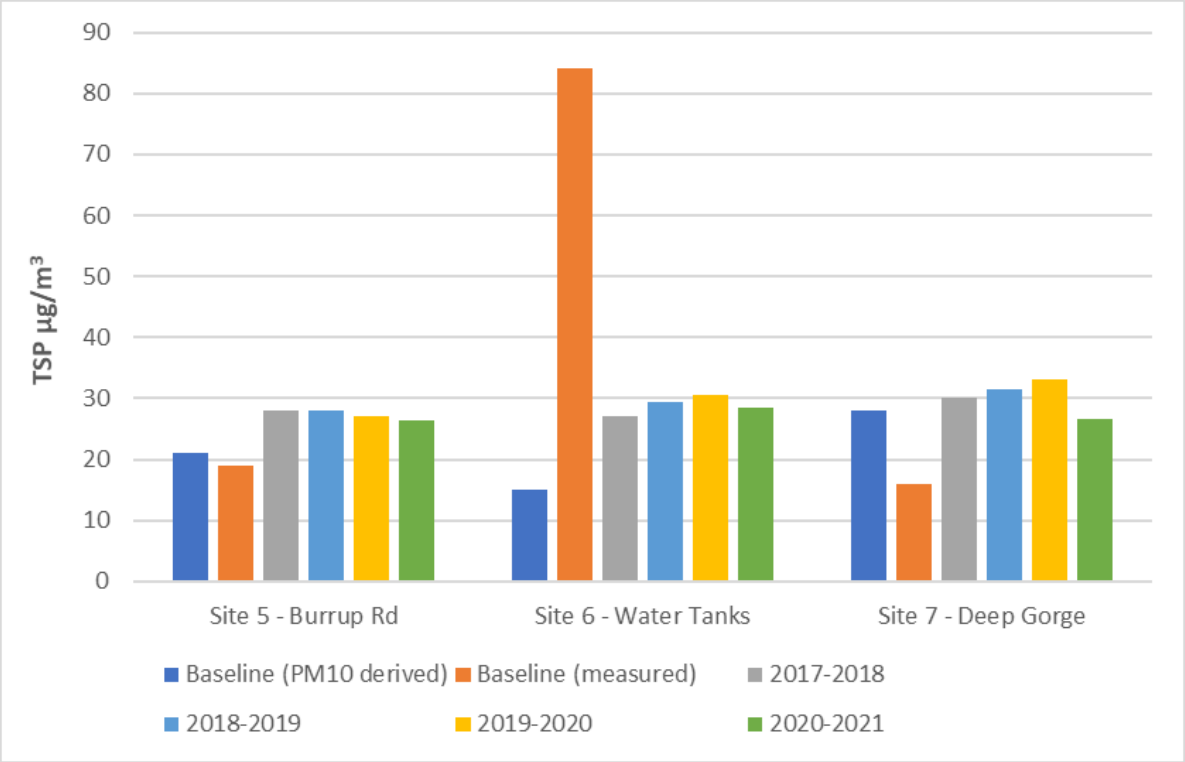

Figure 11: Comparison of average TSP concentrations for 2020 to 2021 with previous years' and baseline data

Descriptive statistics for 2020-2021 TSP monitoring at all three sites are shown in Table 8 alongside the monitoring data for 2019-2020, 2018-2019 and 2017-2018.

Table 8: Descriptive statistics for TSP monitoring 2018 to 2021 – all sites

TSP concentration µg/m³												
	Site 5 - Burrup Rd				Site 6 - Water Tanks				Site 7 - Deep Gorge			
Statistic	2020-2021	2019-2020	2018-2019	2017-2018	2020-2021	2019-2020	2018-2019	2017-2018	2020-2021	2019-2020	2018-2019	2017-2018
Minimum	5	8	2	6	5	9	8	6	7	8	8	11
Average	27	27	28	28	30	31	29	27	27	33	32	30
Maximum	78	77	66	76	113	141	63	76	67	148	67	79
Standard deviation	14	15	14	13	19	22	13	12	14	23	15	15

Comparison of the mean TSP concentrations measured during baseline and the subsequent four years of the monitoring program shows the average TSP concentration for 2020-2021 was similar to the results from the three previous years (Figure 11 and Table 8). The levels monitored at Water Tanks in the four years subsequent to the baseline study have been lower than the baseline measured data and comparable to the levels recorded at other sites. This continues to support the hypothesis that the baseline measurements at the Water Tanks site were affected by construction activities.

The 2020-2021 data were compared to the measured datasets from 2017-2018, 2018-2019 and 2019-2020 to determine if there was any significant change in the recorded ambient TSP levels. The 2020-2021 dataset was determined not to be statistically significantly different from previous reporting years with the exception of the Deep Gorge data between the 2019-2020 and 2020-2021 reporting years. The average TSP level recorded for the current year were lower than previous years, it is however noted that the monitoring site is in a different location (relocated April 2020) which could have influenced the results.

4.3 Dust deposition

4.3.1 Results from monitoring deposited dust for 2020-2021

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 July 2020, November 2020 and February, April, and May 2021 sample due to the volume of rainwater in the dust deposition bottles.

Table 9: Results of dust deposition monitoring 2020-2021

		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
30/06/2020	30/07/2020	<3	<0.8	<3	<0.8	<3	<0.8
30/07/2020	31/08/2020	0.9	1	1.6	<0.8	0.7	<0.8
31/08/2020	30/09/2020	<0.7	1.6	<0.7	1.6	0.8	1.4
30/09/2020	30/10/2020	0.7	1	<0.7	0.9	<0.7	0.9
30/10/2020	30/11/2020	<0.7	0.8	<0.7	0.9	<0.7	1.0
30/11/2020	31/12/2020	3.3	1.5	2.3	1.5	<1.5	1.3
31/12/2020	29/01/2021	1.4	2.1	1	1.9	1.6	2.4
1/02/2021	2/03/2021	2.4	1.2	<2	0.9	1.9	1.0
2/03/2021	31/03/2021	0.9	1.0	1.3	1.2	0.7	<0.8
31/03/2021	30/04/2021	<1.5	1.8	3.7	0.9	2.5	1.0
30/04/2021	31/05/2021	<3	0.9	8.6	<0.8	<3	<0.8
31/05/2021	30/06/2021	0.8	<0.8	1.1	0.8	0.8	0.9

4.3.2 Analysis of dust deposition data

A comparison of the dust deposition data from 2020-2021 with the baseline data (insoluble fraction only) is shown in Table 10.

Table 10: Descriptive statistics for dust deposition monitoring 2020-2021 and baseline study

Statistic(1)	Burrup Rd (g/m²/month)			Water Tanks (g/m²/month)			Deep Gorge (g/m²/month)		
	2020-2021		Baseline	2020-2021		Baseline	2020-2021		Baseline
	Soluble	Insoluble	Insoluble	Soluble	Insoluble	Insoluble	Soluble	Insoluble	Insoluble
Minimum	0.4	0.4	0.02	0.4	0.4	0	0.4	0.4	0.01
Average	1.2	1.1	0.88	1.9	1.0	0.84	1.1	1.0	1.07
95th percentile	2.81	1.94	1.75	5.91	1.74	1.86	2.17	1.85	2.31
Maximum	3.3	2.1	2	8.6	1.9	2.05	2.5	2.4	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 slightly higher than the baseline across the Burrup Road and Water Tanks monitoring sites, and Deep Gorge was slightly lower. The differences between the datasets were not statistically significant at the Burrup Road and Deep Gorge sites (determined by t-test P values >0.05). The average insoluble fraction measured is within the range seen in other years (Figure 12).

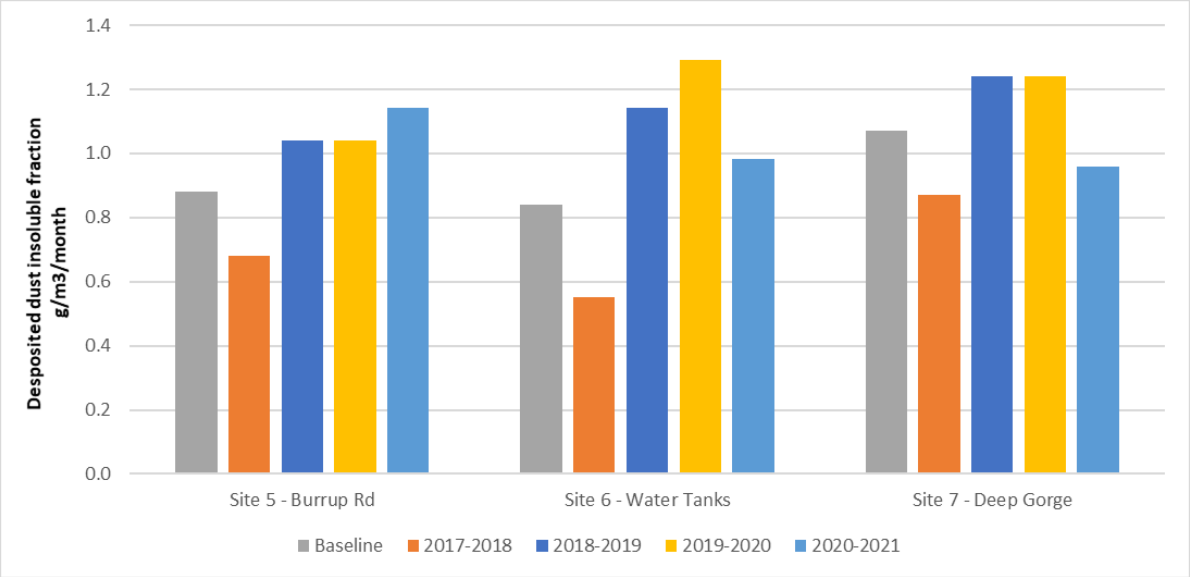

Figure 12: Deposited dust average insoluble fraction 2020-2021

Similar trends in the deposition rates were observed at the three sites across the reporting period (Figure 13). 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 2020-2021 data. The actual deposition rates below detection limits may be lower or higher than the half detection rates.

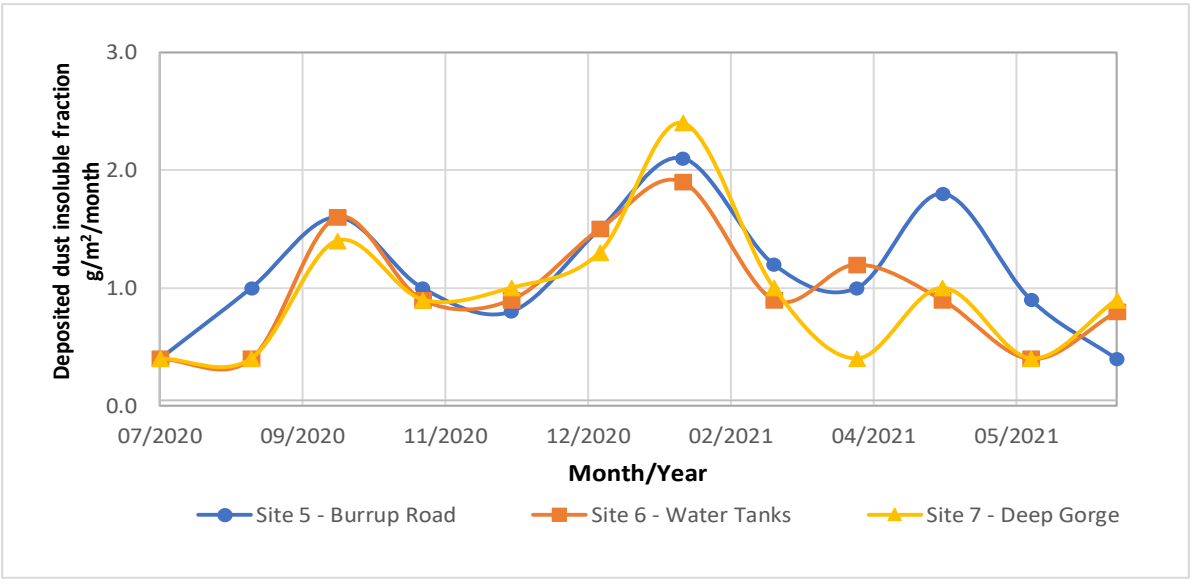

Figure 13: Deposited dust insoluble fraction 2020-2021

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 2020-2021 soluble fraction is compared to the data collected for the 2017-2018, 2018-2019 and 2019-2020 monitoring periods.

The average soluble fraction measured from the deposited dust collected in 2020-2021 is comparable to previous years at Burrup Road and Deep Gorge (Figure 14). The soluble fraction at Water Tanks was however elevated with respect to previous years.

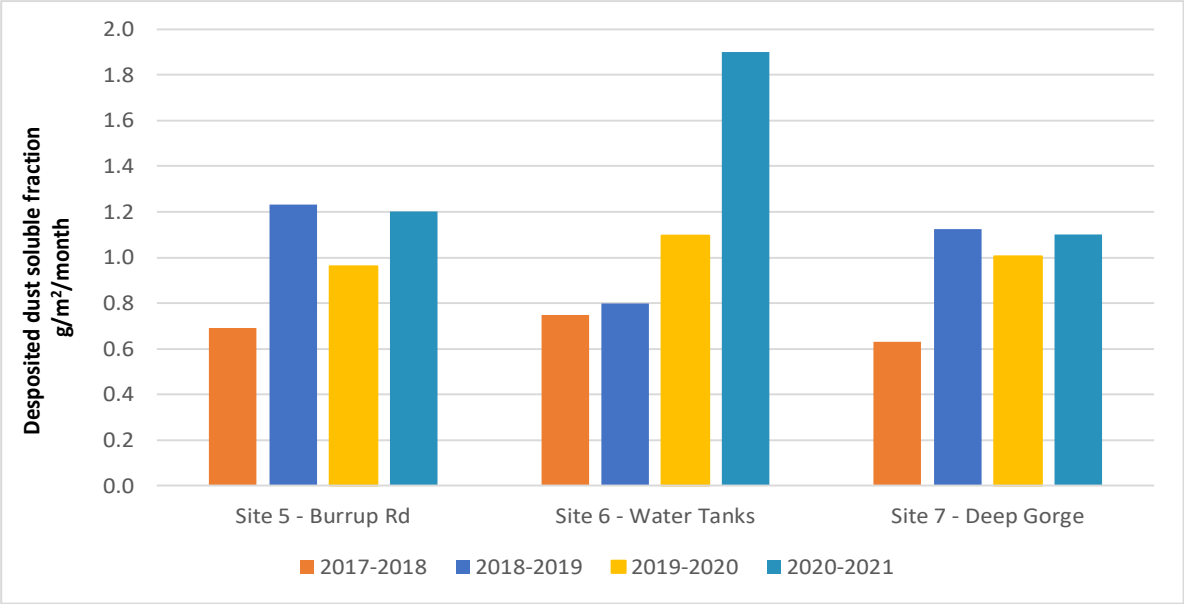

Figure 14: Deposited dust average soluble fraction 2020-2021

The monthly data reveals some variability in the soluble fraction of deposited dust across the three monitoring sites from December 2020 onwards while the data collected in earlier months shows sites trending together (Figure 15). The May result from the Water Tanks analysis was very high compared to other samples from the site and from samples at other sites. The analysis quality control measures were within acceptable limits which suggests the result reflects the actual deposition. It is not evident why this result was elevated.

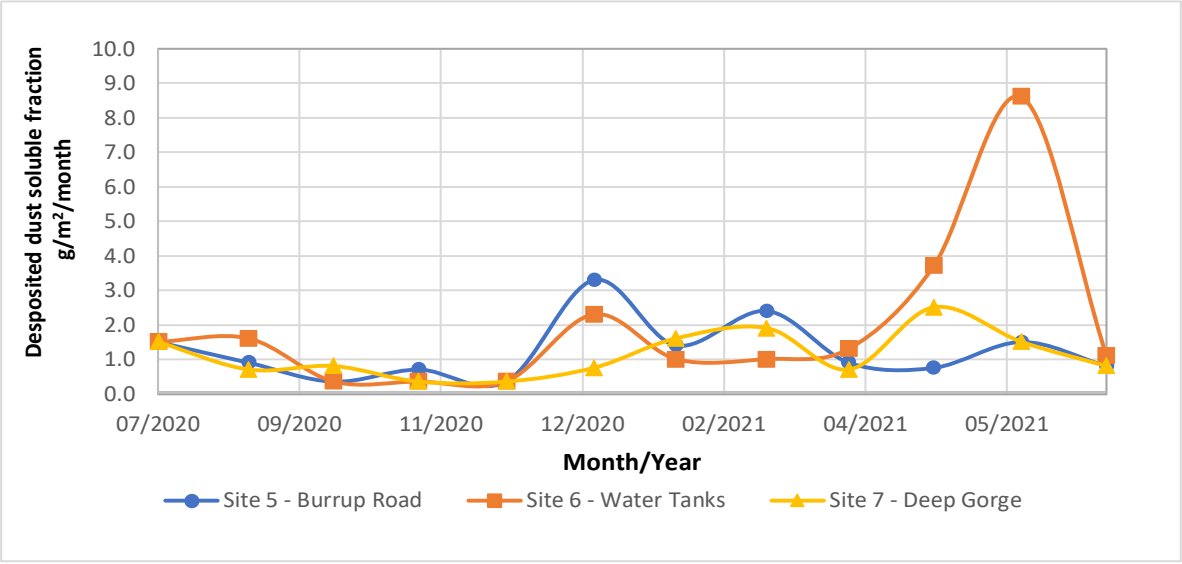

Figure 15: Deposited dust soluble fraction 2020-2021

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. 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 2020-2021 showed dry deposition rates at Burrup Road (32.9 meq/m^2/y) that exceeded the investigation levels (25.5 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 and operation.

Trends in deposition rates since 2014 (as monthly rolling annual total rates) are illustrated in Figure 16. The TAN Plant 2020-2021 operating period is indicated in the graph. Ammonia was the dominant contributor to dry deposition at Burrup Road (Figure 16). Ammonia annual deposition in the seond half of the reporting period exceeded annual deposition rates previously recorded. Monthly deposition rates were comparable to peak deposition rates, typically occuring during May - June, from previous years at Burrup Road (Figure 17).

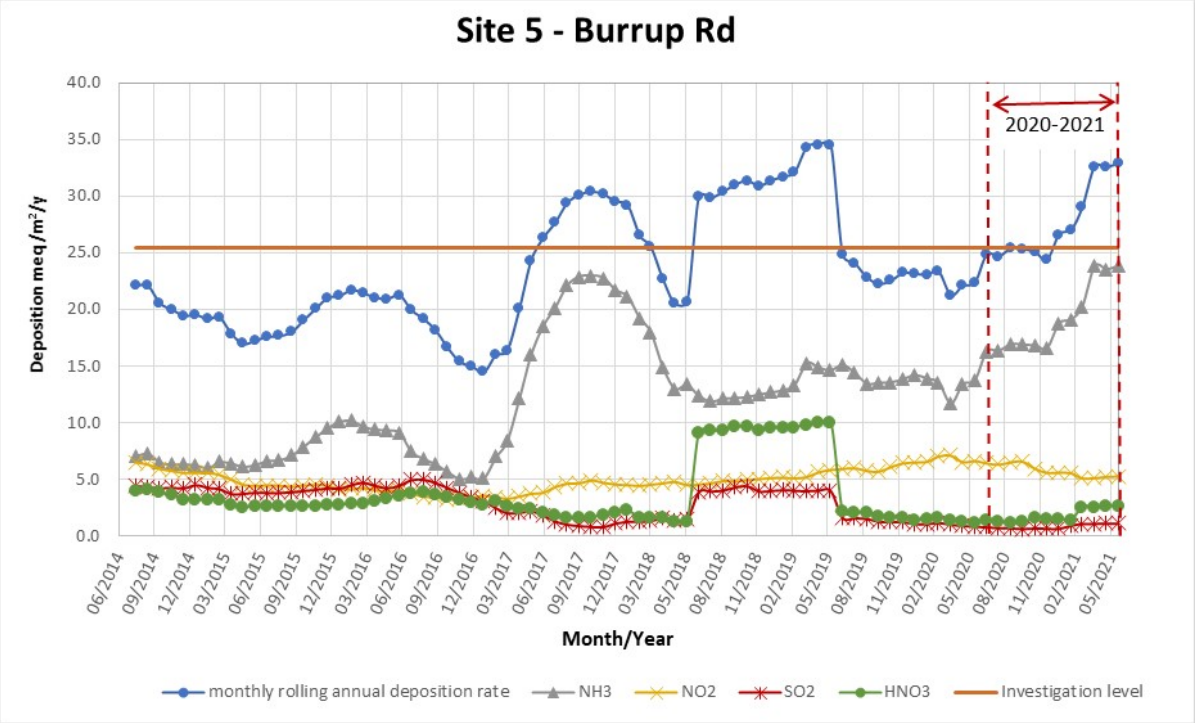

Figure 16: Monthly rolling annual total and individual gas dry deposition rates – Burrup Road

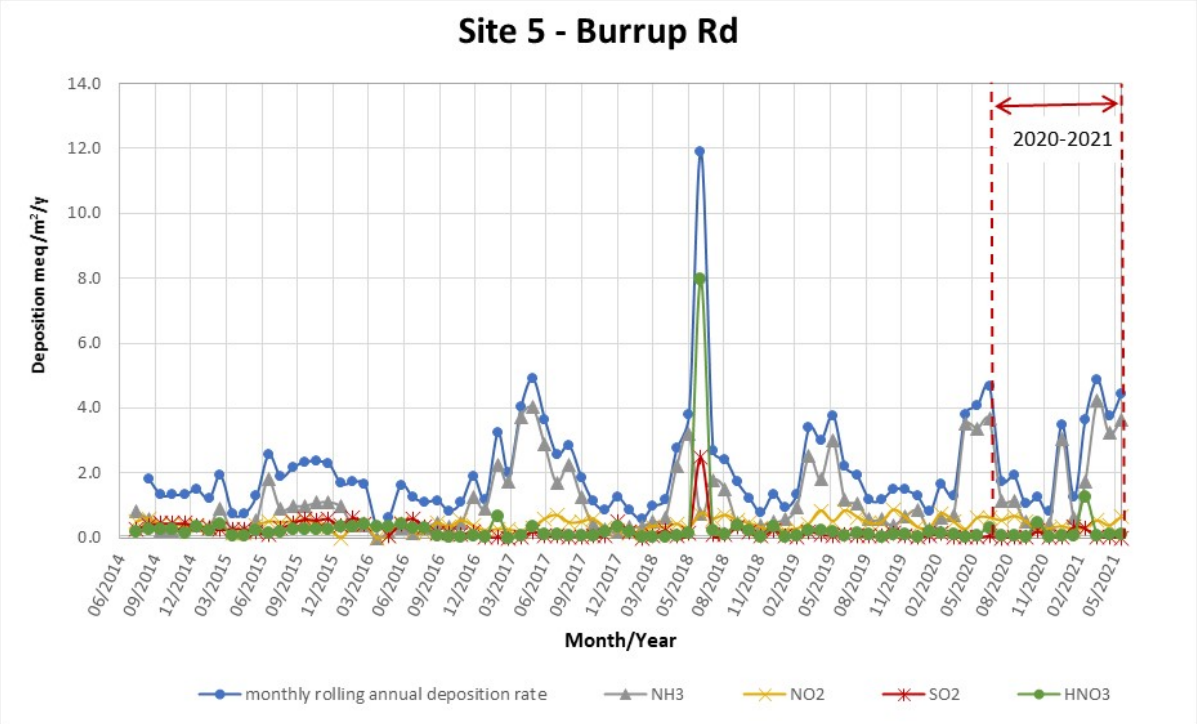

Figure 17: Monthly total and individual gas dry deposition rates – Burrup Road

Deposition at the Water Tanks site was within levels previously measured at the site (Figure 18).

Deep Gorge exhibited an increasing trend in the rolling average during the middle of the monitroing period (November through January) however large peaks of NH_3 deposition in November and January (maximun of 7.87 meq m^{-2} for January) were the dominant contributors to the cumulative annual deposition exceeding previous peak annual deposition in February 2016 (6.93 meq m^{-2}).

During January three plant trips at the Ammonia Plant (YPF) were recorded which included venting of ammonia on the 14 January 2021. Deposition rates fell following the peak to within previous ranges from February onwards (Figure 20).

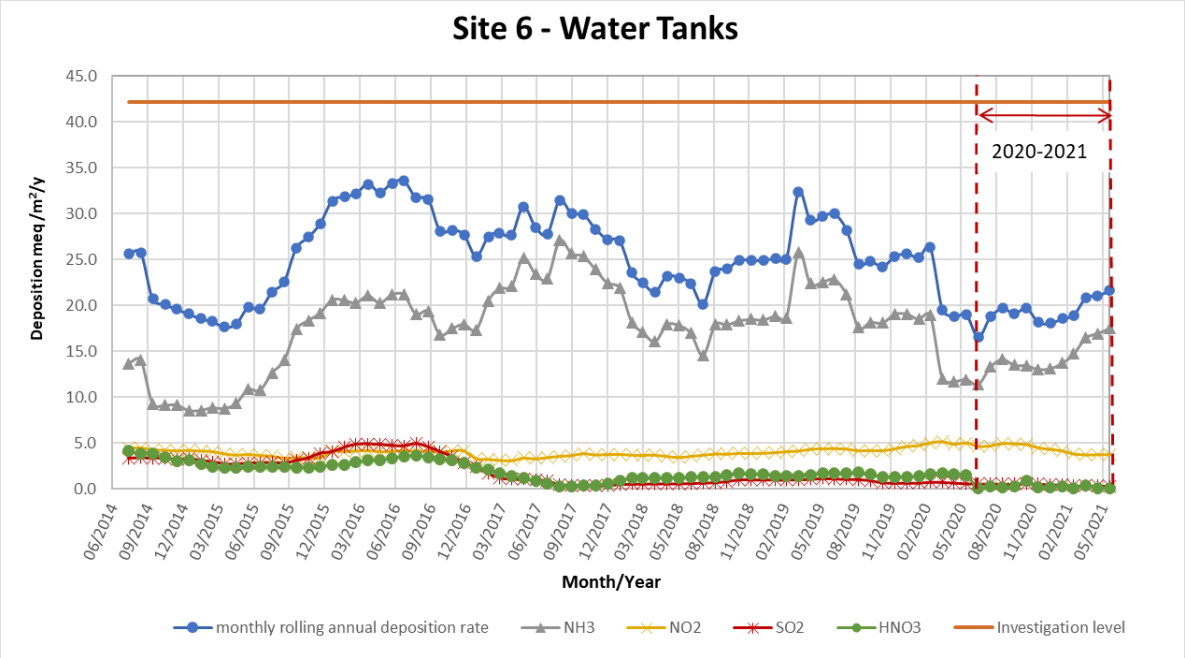

Figure 18: Monthly rolling annual total and individual gas dry deposition rates – Water Tanks

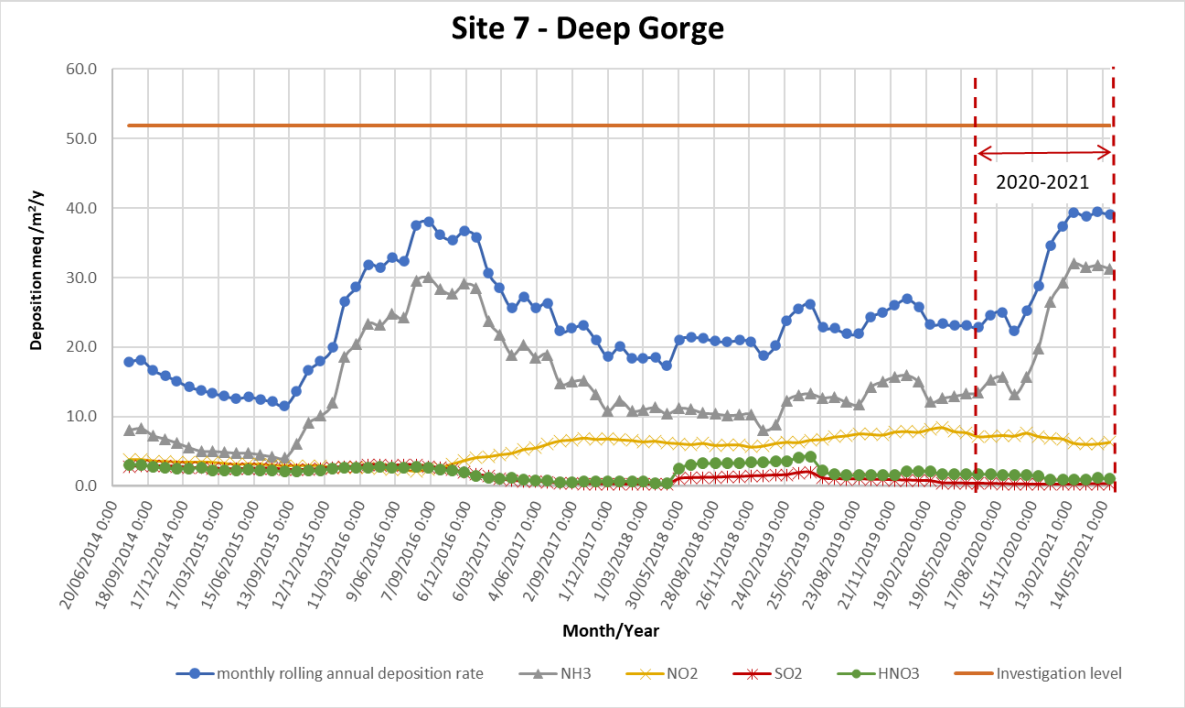

Figure 19: Monthly rolling annual total and individual gas dry deposition rates – Deep Gorge

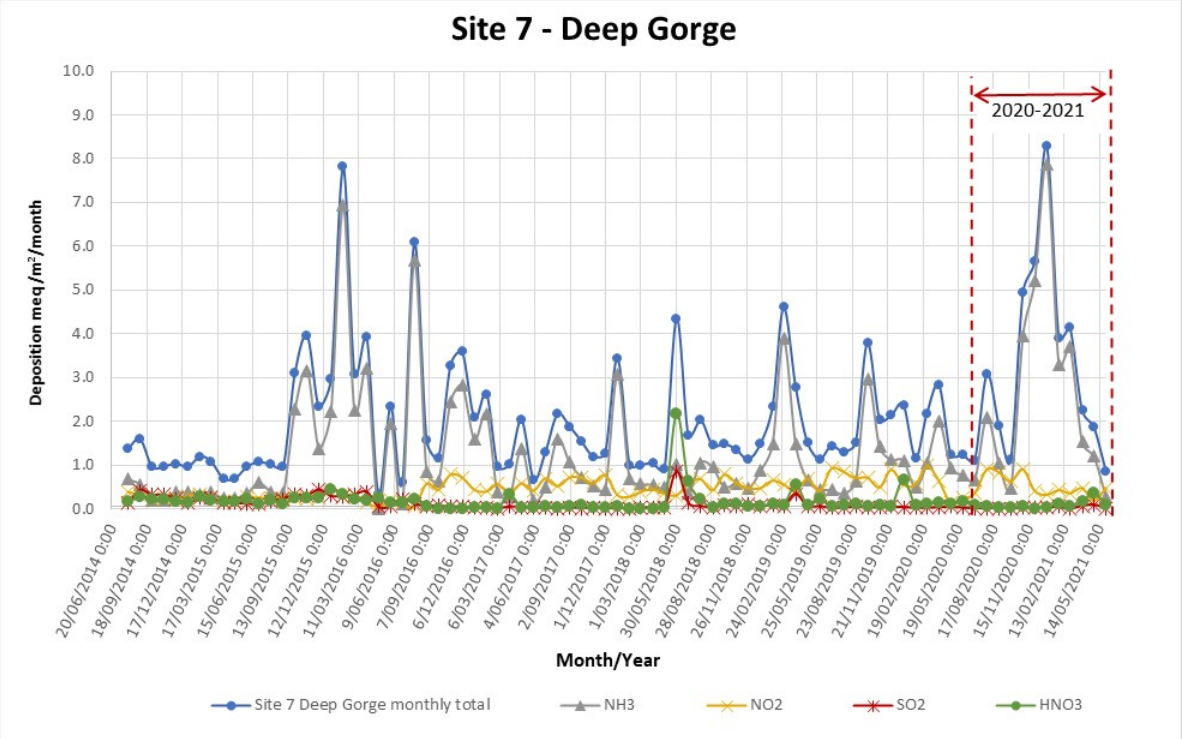

Figure 20: Monthly total and individual gas dry deposition rates – Deep Gorge

Key findings from the investigation into the elevated deposition rates exceeding the investigation level at Burrup Road 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: increase in NH_3 deposition rate in the second half of the year (i.e., not driven by a single very elevated point) (see Figure 16).	Increase in NH_3 may be due to sources other than the TAN Plant emissions. Elevated ambient concentrations did not directly correlate with elevated NH_3 CEMS data.
TAN Plant operations	TAN Plant availability. Determine any operating condition that could have led to elevated emissions from the nitric acid plant stack emissions or other sources associated with the TAN Plant.	Plant was operating under steady state for the majority of the monitoring period. There were no adverse plant conditions that led to elevated emissions being recorded by CEMS. Ammonia Plant venting contributed to ambient ammonia levels during January.	Preliminary review of emissions data did not identify a probable cause related to the TAN Plant operations for elevated ammonia concentrations.

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 concentrations at Burrup Road and Deep Gorge were found to be statistically significantly different (higher) to the baseline.
- The average NH_3 concentration at Water Tanks was higher than baseline but the difference was not statistically significant.
- The average NO_2 concentrations at all three monitoring locations were comparable to the baseline concentrations; the differences were found not to be statistically significant.
- The average SO_2 concentrations at all three monitoring locations in 2020-2021 are lower than the baseline concentrations, with differences in the averages being statistically significant.

The TAN Plant was operating at steady state for the majority of the reported period. Plant start-ups, when potentially higher NH_3 emissions may occur, did not correlate with elevated ambient concentrations.

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 and Deep Gorge in 2020-2021 compared to baseline.
- The Burrup Road dry deposition rate was above the investigation level derived from baseline measurements.
- NH_3 is the dominant contributor to dry deposition at all monitoring 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 were responsible for exceedances of the investigation level.

Analysis of the TSP data shows the following:

- Concentrations of TSP measured in 2020-2021 continue to be reasonably consistent across the three sites suggesting reflection of air shed background concentrations as seen in previous reporting periods.
- Average TSP concentrations at all three monitoring sites are very similar to the 2019-2020 dataset.

Overall, there is no evidence to show that operation of the TAN Plant has resulted in significant increase in ambient TSP concentrations in 2020-2021.

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 all sites.

- The soluble fraction of the deposited dust from 2020-2021 was comparable to 2019-2020 dataset at Burrup Road and Deep Gorge.
- The average soluble fraction of the deposited dust at Water Tanks during 2020-2021 was higher than the 2019-2020 dataset and other sites. This was driven by one very high result in May, the source of this elevated result has not been determined.

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.

7. References

Strategen (2018). *Yara Pilbara Nitrates, EPBC Approval 2008/4546.* Ambient air quality report 2017-2018. Document 650-200-rep-sec-0004, issued October 2018.

Strategen (2019). *Yara Pilbara Nitrates, EPBC Approval 2008/4546.* Ambient air quality report 2018-2019. Document 650-200-rep-sec-0006, issued October 2019.

Strategen (2020). *Yara Pilbara Nitrates, EPBC Approval 2008/4546.* Ambient air quality report 2019-2020. 650-200-rep-sec-0007, issued October 2020.

YPN (2017). *Yara Pilbara Nitrates, EPBC Approval 2008/4546. Baseline Air Quality Monitoring Report*. Document 250-200-rep-ypf-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.

Reliance on data

In preparing the report, Strategen-JBS&G has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise expressly stated in the report, Strategen-JBS&G has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Strategen-JBS&G has also not attempted to determine whether any material matter has been omitted from the data. Strategen-JBS&G will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented, or otherwise not fully disclosed to Strategen-JBS&G. The making of any assumption does not imply that Strategen-JBS&G has made any enquiry to verify the correctness of that assumption.

The report is based information received at the time of preparation of this report. Strategen-JBS&G disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law of Western Australia as at the date of this report.

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.

Strategen-JBS&G accepts no liability for use or interpretation by any person or body other than the client who commissioned the works. This report should not be reproduced without prior approval by the client, or amended in any way without prior approval by Strategen-JBS&G.

Appendix A Results from monitoring of gases for 2020-2021

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	30/06/2020	15/07/2020	3.30	4.62	0.56	1.49
Site 5 - Burrup Road	15/07/2020	30/07/2020	1.80	5.86	0.01	0.18
Site 5 - Burrup Road	30/07/2020	14/08/2020	1.02	3.96	0.01	0.24
Site 5 - Burrup Road	14/08/2020	31/08/2020	0.51	4.44	0.03	0.03
Site 5 - Burrup Road	31/08/2020	15/09/2020	0.61	6.04	0.09	0.03
Site 5 - Burrup Road	15/09/2020	30/09/2020	0.99	5.23	0.19	0.35
Site 5 - Burrup Road	30/09/2020	15/10/2020	0.54	6.25	0.06	0.09
Site 5 - Burrup Road	15/10/2020	30/10/2020	0.16	2.37	0.04	0.15
Site 5 - Burrup Road	30/10/2020	16/11/2020	0.14	2.71	0.06	0.07
Site 5 - Burrup Road	16/11/2020	30/11/2020	0.35	0.89	1.92	2.58
Site 5 - Burrup Road	30/11/2020	14/12/2020	0.24	1.48	0.04	0.14
Site 5 - Burrup Road	14/12/2020	31/12/2020	0.33	3.05	0.31	0.11
Site 5 - Burrup Road	31/12/2020	14/01/2021	0.73	2.91	0.21	0.18
Site 5 - Burrup Road	14/01/2021	29/01/2021	3.47	3.13	0.14	0.16
Site 5 - Burrup Road	2/02/2021	16/02/2021	0.09	2.15	0.27	0.24
Site 5 - Burrup Road	16/02/2021	2/03/2021	0.80	2.31	3.01	0.11
Site 5 - Burrup Road	2/03/2021	18/03/2021	0.99	1.71	2.45	6.39
Site 5 - Burrup Road	18/03/2021	31/03/2021	1.59	3.87	0.04	0.18
Site 5 - Burrup Road	31/03/2021	15/04/2021	2.54	2.27	0.22	0.26
Site 5 - Burrup Road	15/04/2021	30/04/2021	3.34	6.68	0.01	0.16
Site 5 - Burrup Road	30/04/2021	17/05/2021	1.99	2.43	0.01	0.04
Site 5 - Burrup Road	17/05/2021	31/05/2021	2.34	3.75	0.32	0.57
Site 5 - Burrup Road	31/05/2021	16/06/2021	1.88	5.46	0.01	0.17
Site 5 - Burrup Road	16/06/2021	30/06/2021	3.24	5.53	0.02	0.49
Site 6 - Water Tanks	30/06/2020	15/07/2020	0.47	2.03	0.03	0.61
Site 6 - Water Tanks	15/07/2020	30/07/2020	0.81	1.71	0.01	0.14
Site 6 - Water Tanks	30/07/2020	14/08/2020	2.44	2.81	0.20	1.24
Site 6 - Water Tanks	14/08/2020	31/08/2020	0.87	4.82	0.05	0.05
Site 6 - Water Tanks	31/08/2020	15/09/2020	0.96	5.67	0.07	0.06
Site 6 - Water Tanks	15/09/2020	30/09/2020	1.40	4.58	0.05	0.25
Site 6 - Water Tanks	30/09/2020	15/10/2020	0.55	4.32	0.06	0.03
Site 6 - Water Tanks	15/10/2020	30/10/2020	0.24	2.76	0.17	0.49
Site 6 - Water Tanks	30/10/2020	16/11/2020	0.47	3.33	0.09	0.12
Site 6 - Water Tanks	16/11/2020	30/11/2020	0.49	1.58	0.78	0.79
Site 6 - Water Tanks	30/11/2020	14/12/2020	0.84	0.74	0.08	0.08
Site 6 - Water Tanks	14/12/2020	31/12/2020	0.38	2.25	0.08	0.03
Site 6 - Water Tanks	31/12/2020	14/01/2021	0.40	2.36	0.13	0.12
Site 6 - Water Tanks	14/01/2021	29/01/2021	0.66	2.74	0.05	0.04
Site 6 - Water Tanks	1/02/2021	16/02/2021	0.53	0.86	0.01	0.01
Site 6 - Water Tanks	16/02/2021	2/03/2021	0.91	1.85	0.29	1.21
Site 6 - Water Tanks	2/03/2021	18/03/2021	1.18	2.03	0.02	0.18
Site 6 - Water Tanks	18/03/2021	31/03/2021	1.58	2.53	0.07	0.34
Site 6 - Water Tanks	31/03/2021	15/04/2021	1.51	2.14	0.32	1.24
Site 6 - Water Tanks	15/04/2021	30/04/2021	2.50	3.27	0.04	0.41
Site 6 - Water Tanks	30/04/2021	17/05/2021	1.01	1.47	0.05	0.24
Site 6 - Water Tanks	17/05/2021	31/05/2021	1.56	0.60	0.02	1.26
Site 6 - Water Tanks	31/05/2021	16/06/2021	1.35	2.74	0.01	0.20
Site 6 - Water Tanks	16/06/2021	30/06/2021	1.17	3.05	0.06	0.49
Site 7 - Deep Gorge	30/06/2020	15/07/2020	0.20	1.92	0.01	0.11
Site 7 - Deep Gorge	15/07/2020	30/07/2020	0.70	1.15	0.01	0.31
Site 7 - Deep Gorge	30/07/2020	14/08/2020	0.71	2.76	0.01	0.24
Site 7 - Deep Gorge	14/08/2020	31/08/2020	1.92	4.31	0.03	0.08

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	31/08/2020	15/09/2020	0.45	3.89	0.04	0.03
Site 7 - Deep Gorge	15/09/2020	30/09/2020	0.99	3.21	0.06	0.09
Site 7 - Deep Gorge	30/09/2020	15/10/2020	0.32	3.19	0.04	0.03
Site 7 - Deep Gorge	15/10/2020	30/10/2020	0.32	2.10	0.04	0.09
Site 7 - Deep Gorge	30/10/2020	16/11/2020	0.22	4.77	0.03	0.07
Site 7 - Deep Gorge	16/11/2020	30/11/2020	5.61	2.39	0.13	0.26
Site 7 - Deep Gorge	30/11/2020	14/12/2020	1.88	0.92	0.07	0.03
Site 7 - Deep Gorge	14/12/2020	31/12/2020	4.85	2.37	0.15	0.01
Site 7 - Deep Gorge	31/12/2020	14/01/2021	8.42	1.34	0.24	0.07
Site 7 - Deep Gorge	14/01/2021	29/01/2021	3.00	1.51	0.11	0.16
Site 7 - Deep Gorge	2/02/2021	16/02/2021	2.14	2.23	0.30	0.25
Site 7 - Deep Gorge	16/02/2021	2/03/2021	2.72	1.73	0.12	0.45
Site 7 - Deep Gorge	2/03/2021	18/03/2021	2.44	1.38	0.04	0.20
Site 7 - Deep Gorge	18/03/2021	31/03/2021	2.97	1.84	0.01	0.12
Site 7 - Deep Gorge	31/03/2021	15/04/2021	1.12	1.70	0.57	0.73
Site 7 - Deep Gorge	15/04/2021	30/04/2021	1.01	2.36	0.01	0.16
Site 7 - Deep Gorge	30/04/2021	17/05/2021	1.09	0.93	0.10	0.35
Site 7 - Deep Gorge	17/05/2021	31/05/2021	0.47	0.61	0.78	1.67
Site 7 - Deep Gorge	31/05/2021	16/06/2021	0.17	2.27	0.01	0.16
Site 7 - Deep Gorge	16/06/2021	30/06/2021	0.22	1.75	0.02	0.34

Appendix B Results from monitoring of TSP for 2020-2021

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-Jul-20	14	20	17
08-Jul-20	15	12	18
14-Jul-20	17	17	15
20-Jul-20	5	10	8
26-Jul-20	13	14	17
01-Aug-20	12	13	10
07-Aug-20	10	14	18
13-Aug-20	8	7	2
19-Aug-20	14	15	14
25-Aug-20	31	22	24
31-Aug-20	27	18	12
06-Sep-20	26	28	28
12-Sep-20	30	23	28
18-Sep-20	32	34	33
24-Sep-20	21	26	25
30-Sep-20	31	31	30
06-Oct-20	19	19	22
12-Oct-20	40	39	40
18-Oct-20	29	33	32
24-Oct-20	30	31	35
30-Oct-20	42	44	42
05-Nov-20	37	38	33
11-Nov-20	36	31	37
17-Nov-20	49	39	35
23-Nov-20	30	25	24
29-Nov-20	43	50	51
05-Dec-20	36	32	23
11-Dec-20	16	-	20
17-Dec-20	53	79	62
23-Dec-20	35	32	31
29-Dec-20	48	70	37
04-Jan-21	56	62	63
10-Jan-21	44	45	37
16-Jan-21	45	70	48
22-Jan-21	21	40	26
28-Jan-21	45	44	39
03-Feb-21	16	20	15
09-Feb-21	16	27	23
15-Feb-21	16	21	10
22-Feb-21	17	24	21
27-Feb-21	30	38	39
05-Mar-21	17	19	17
11-Mar-21	21	26	25
17-Mar-21	11	12	15
23-Mar-21	27	25	27
29-Mar-21	21	15	25
04-Apr-21	30	28	37
10-Apr-21	21	27	25
16-Apr-21	16	30	19
22-Apr-21	35	31	27
28-Apr-21	24	29	15
04-May-21	78	Spoiled sample	67
10-May-21	18	33	21
16-May-21	26	21	38
22-May-21	11	23	16

Period start date	Site 5 -Burrup Road TSP µg/m^3	Site 6 - Water Tanks TSP µg/m^3	Site 7 - Deep Gorge TSP µg/m^3
28-May-21	21	26	28
03-Jun-21	9	8	9
09-Jun-21	20	24	24
15-Jun-21	19	16	13
21-Jun-21	9	5	7
27-Jun-21	20	19	12

Appendix C Results from dust deposition monitoring 2020-2021

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
30/06/2020	<3	<0.8	<3	<0.8	<3	<0.8
30/07/2020	0.9	1	1.6	<0.8	0.7	<0.8
31/08/2020	<0.7	1.6	<0.7	1.6	0.8	1.4
30/09/2020	0.7	1	<0.7	0.9	<0.7	0.9
30/10/2020	<0.7	0.8	<0.7	0.9	<0.7	1.0
30/11/2020	3.3	1.5	2.3	1.5	<1.5	1.3
31/12/2020	1.4	2.1	1	1.9	1.6	2.4
1/02/2021	2.4	1.2	<2	0.9	1.9	1.0
2/03/2021	0.9	1.0	1.3	1.2	0.7	<0.8
31/03/2021	<1.5	1.8	3.7	0.9	2.5	1.0
30/04/2021	<3	0.9	8.6	<0.8	<3	<0.8
31/05/2021	0.8	<0.8	1.1	0.8	0.8	0.9

Document Distribution

Rev No.	Copies	Recipient	Date
0	Final report (electronic)	Yara Pilbara Nitrates	30 September 2021

Document Status

Rev No.	Author	Reviewer	Approved for Issue		
		Name	Name	Signature	Date
A	C. Ingram	P. Forster	P. Forster		23 September 2021
0	C. Ingram	J. Bailes	J. Bailes		30 September 2021

www.jbsg.com.au