OUT19/4949

Alex Irwin
Principal Environmental Consultant
Umwelt (Australia) Pty Limited

airwin@umwelt.com.au

Dear Mr Irwin

Roberts Road Quarry Modification 4 (DA 267-11-99)
Comment on the Secretary's Environmental Assessment Requirements (SEARs)

I refer to your email of 10 April 2019 to the Department of Industry (DoI) about the above matter.

The following advice for you to consider is from relevant branches of DoI Lands & Water and the Department of Primary Industries. The SEARS should include:

DoI -– Water and Natural Resources Access Regulator

- The identification of an adequate and secure water supply for the life of the project. This includes confirmation that water can be sourced from an appropriately authorised and reliable supply. This is also to include an assessment of the current market depth where water entitlement is required to be purchased.
- A detailed and consolidated site water balance.
- Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, and groundwater dependent ecosystems, and measures proposed to reduce and mitigate these impacts.
- Proposed surface and groundwater monitoring activities and methodologies.
- Consideration of relevant legislation, policies and guidelines, including the NSW Aquifer Interference Policy (2012), the Guidelines for Controlled Activities on Waterfront Land (2018) and the relevant Water Sharing Plans (available at https://www.industry.nsw.gov.au/water).

DPI Agriculture

- A biosecurity (pests and weeds) risk assessment outlining the likely plant, animal and community risks from imported material.
- A biosecurity response plan to manage identified weed / pest animal risks.

Any further referrals to Department of Industry can be sent by email to landuse.enquiries@dpi.nsw.gov.au.

Yours sincerely

Liz Rogers
Manager, Assessments
Lands and Water – Strategic Relations
29 April 2019

10 May 2019

Alex Irwin
Principal Environmental Consultant
Umwelt (Australia) Pty Limited
Office 1, 3 Hampden Avenue
Orange NSW 2800

Emailed: airwin@umwelt.com.au

Your Reference: DA 267-11-99
Our Reference: DOC19/345516

Dear Mr Irwin,

Re: Request for Environmental Assessment Requirements
Roberts Road Quarry (DA 267-11-99) Modification 4.

Thank you for the opportunity to provide advice on the Environmental Assessment Requirements (EARs) for the application to modify development consent for the Roberts Road Quarry operated by Hodgson Quarries and Plant Pty Ltd. This is a response from NSW Department of Planning & Environment – Division of Resources & Geoscience (the Division).

Sand is not a prescribed mineral under the *Mining Act 1992*. However, the Division is the principal government authority responsible for assessing the State's resources of construction materials and for advising State and local government on their planning and management.

All environmental reports (Statement of Environmental Effect (SEE) or similar) accompanying Development Applications for extractive industry lodged under the *Environmental Planning & Assessment Act 1979* should include a resource assessment which:

- Documents the size and quality of the resource and demonstrates that both have been adequately assessed; and

- Documents the methods used to assess the resource and its suitability for the intended applications.

The above information should be summarised in the SEE, with full documentation appended. If deemed commercial-in-confidence, the resource assessment summary included in the SEE should commit to providing the Division with full resource assessment documentation separately. Applications to modify, expand, extend or intensify an existing consent that has already been adequately reported using the above protocol in publicly available documents, may restrict detailed documentation to the additional resources to be used, if accompanied by a summary of past resource assessments and of past production.

The Division collects data on the quantity of construction materials produced annually throughout the State. Forms are sent to all operating quarries at the end of each financial year for this purpose. The statistical data collected is of great value to Government and industry in planning and resource management, particularly as a basis for analysing trends in production and for estimating future demand for particular commodities or in particular regions. Production data may be published in aggregated form, however production data for individual operations is kept strictly confidential.

During the preparation of the SEE, the Division recommends that the proponent consult NSW Department of Planning & Environment's *'EIS Guideline - Extractive Industries – Quarries'*. This guideline is available from:

http://www.planning.nsw.gov.au/Assess-and-Regulate/Development-Assessment/~/media/4A89C0947A8C4D70A983F8EE1D7B9790.ashx

Should any biodiversity conservation measures become necessary, the Division requests early consultation to ensure there is no consequent reduction in access to prospective land for mineral exploration, or potential for sterilisation of mineral or extractive resources.

Queries regarding the above information should be directed to the Division of Resources & Geoscience - Land Use team at landuse.minerals@geoscience.nsw.gov.au.

Yours sincerely

Steven Palmer
A/Manager - Land Use

From:	Greg Kininmonth
To:	Alex Irwin
Cc:	Hodgson Quarries and Plant Pty Ltd .; Adam Banister; DRG RO Assessment Coordination Mailbox
Subject:	RE: 4465_Roberts Road Quarry_Proposed Modification to Operations (DA 267-11-99) - Resources Regulator Response
Date:	Friday, 26 April 2019 5:23:35 PM
Attachments:	image001.png image002.jpg image003.png image004.jpg image005.jpg image006.jpg

Hi Alex

With reference to your email dated 10 April 2019, the Resources Regulator Compliance Operations section has reviewed the proposed Modification.

It is noted that there is no Mining Title covering the Roberts Road Quarry and it is understood, with reference to your email dated 17 April 2019 (below), that no Mining Title is required as operations do not involve the processing or sale of prescribed minerals, specifically Group 5 (Clay Minerals).

As such, the Resources Regulator, Compliance Operations section has no jurisdiction over this site and no comments to provide on the Proposed Modification to DA 267-11-99.

Mine Safety

It is relevant to note that the Resource Regulator Mine Safety Operations is responsible for ensuring mine operators manage the risk to worker health and safety though compliance with the Work Health and Safety (Mines and Petroleum Sites) Act 2013 and the subordinate mining legislation. In particular the effective management of risk associated with the principal hazards as specified in the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014. The Resource Regulator Mine Safety Operations have not identified any risk that would require comment in relation to this matter.

If you require further information with regard to this issue please feel free to contact me.

Regards

Greg Kininmonth
Manager Environmental Operations (Southern)
Compliance Operations
Resources Regulator
Level 3, Block F | 84 Crown Street | Wollongong NSW 2500
PO Box 674 | Wollongong NSW 2500
T 02 4276 7428 M 0429 168 021

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From: Alex Irwin <airwin@umwelt.com.au>
Sent: Wednesday, 17 April 2019 11:37 AM
To: Greg Kininmonth <greg.kininmonth@planning.nsw.gov.au>
Cc: Hodgson Quarries and Plant Pty Ltd . <hodgsonquarries@gmail.com>
Subject: RE: 4465_Roberts Road Quarry_Proposed Modification to Operations (DA 267-11-99)

Gday Greg,

Hodgson's have confirmed that any clay extracted is stockpiled and used as a backfill material, on site construction works, e.g. bunds, or other rehabilitation activities. No processing or sale of clay is undertaken or planned.

Regards,

Alex Irwin
Principal Environmental Consultant

Umwelt (Australia) Pty Limited
Office 1, 3 Hampden Avenue
Orange, NSW 2800

Phone: (02) 4950 5322
Mobile: 0436 606 529

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Newcastle ph. 02 4950 5322 | **Perth** ph. 08 6260 0700 | **Canberra** ph. 02 6262 9484 | **Sydney** ph. 1300 793 267 | **Brisbane** ph. 1300 793 267

From: Greg Kininmonth <greg.kininmonth@planning.nsw.gov.au>
Sent: Tuesday, 16 April 2019 3:00 PM
To: Alex Irwin <airwin@umwelt.com.au>
Subject: RE: 4465_Roberts Road Quarry_Proposed Modification to Operations (DA 267-11-99)

Hi Alex

Any update on your email below?

Regards

Greg Kininmonth
Manager Environmental Operations (Southern)
Compliance Operations
Resources Regulator
Level 3, Block F | 84 Crown Street | Wollongong NSW 2500
PO Box 674 | Wollongong NSW 2500
T 02 4276 7428 M 0429 168 021

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cid:image002.jpg@01D4F54E.64E41370

From: Alex Irwin <airwin@umwelt.com.au>
Sent: Monday, 15 April 2019 1:32 PM
To: Greg Kininmonth <greg.kininmonth@planning.nsw.gov.au>
Cc: 'Stuart Reed' <hodgsonquarries@gmail.com>
Subject: RE: 4465_Roberts Road Quarry_Proposed Modification to Operations (DA 267-11-99)

Greg,

It is my understanding that the clay which occurs through the sand resource is only used for landform construction / rehabilitation purposes on the Quarry Site.

I will check with the operator and confirm.

Regards,

Alex Irwin
Principal Environmental Consultant

Umwelt (Australia) Pty Limited
Office 1, 3 Hampden Avenue
Orange, NSW 2800

Phone: (02) 4950 5322
Mobile: 0436 606 529

www.umwelt.com.au

From: Greg Kininmonth <greg.kininmonth@planning.nsw.gov.au>
Sent: Monday, 15 April 2019 1:02 PM
To: Alex Irwin <airwin@umwelt.com.au>
Subject: FW: 4465_Roberts Road Quarry_Proposed Modification to Operations (DA 267-11-99)

Hi Alex

I note that there is some clay processing which occurs at this site.

Can you confirm whether or not this may fit in with the Prescribed Minerals referenced in the Mining Regulation 2016, specifically "Schedule 2 – Group of Minerals" which includes:

Group 5 (Clay minerals)

- bentonite (including fuller's earth)
- clay/shale
- kaolin
- structural clay

Link to Mining Regulation is below:
https://www.legislation.nsw.gov.au/#/view/regulation/2016/498/sch2

Regards

Greg Kininmonth
Manager Environmental Operations (Southern)
Compliance Operations
Resources Regulator
Level 3, Block F | 84 Crown Street | Wollongong NSW 2500
PO Box 674 | Wollongong NSW 2500
T 02 4276 7428 M 0429 168 021

cid:image002.jpg@01D4F54E.64E41370

From: Adam Banister **On Behalf Of** DRG RO Assessment Coordination Mailbox
Sent: Wednesday, 10 April 2019 2:19 PM
To: RRD EO Resources Regulator Mailbox <resources.regulator@planning.nsw.gov.au>
Subject: FW: 4465_Roberts Road Quarry_Proposed Modification to Operations (DA 267-11-99)

FYI.

Regards,

Assessment Coordination Unit
Resource Operations
Division of Resources & Geoscience
516 High Street Maitland NSW 2320 | PO Box 344 HRMC NSW 2310
T +61 2 4063 6534 | assessment.coordination@planning.nsw.gov.au

NSW-DPE-Colour-hi_res

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Please contact the Assessment Coordination Unit for enquiries regarding development assessment, CPDP, project development, resource & economic assessments and engagement with operations

Visit the following links for further information about ACU role & CPDP policy

---

From: Alex Irwin <airwin@umwelt.com.au>
Sent: Wednesday, 10 April 2019 8:52 AM
To: DRG RO Assessment Coordination Mailbox <assessment.coordination@planning.nsw.gov.au>
Subject: 4465_Roberts Road Quarry_Proposed Modification to Operations (DA 267-11-99)

Dear Sir/Madam,

Hodgson Quarries and Plant Pty Ltd are proposing to modify operations at the Roberts Road Quarry (the Quarry) located on Lots 1 and 2 DP 228308, and Lot 2 DP 312327, at Maroota within The Hills Shire Council Local Government Area (LGA). The Quarry has approval for the extraction and on-site processing of sand from the Maroota Sands geological formation under DA 267-11-99, a State Significant Development in accordance with State Environmental Planning Policy (State and Regional Development) 2011 (SRD SEPP).

Environmental Assessment Requirements were sought from the NSW Department of Planning & Environment on 11 March 2019, with these provided in a letter from the DPE on 2 April 2019. In accordance with these EARs (which are attached), we are seeking from the Resources Regulator

any specific assessment requirements. To assist you in your consideration, please find attached correspondence summarising the proposed modification and a link to a Preliminary Environmental Assessment.

https://umwelt.sharefile.com/d-s843ea16173946928

If possible, we would appreciate your feedback and assessment requirements by 30 April 2019.

Regards,

Alex Irwin
Principal Environmental Consultant

Umwelt (Australia) Pty Limited
Office 1, 3 Hampden Avenue
Orange, NSW 2800

Phone: (02) 4950 5322
Mobile: 0436 606 529

www.umwelt.com.au

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Newcastle ph. 02 4950 5322 | **Perth** ph. 08 6260 0700 | **Canberra** ph. 02 6262 9484 | **Sydney** ph. 1300 793 267 | **Brisbane** ph. 1300 793 267

From: Timothy Olliver
To: Alex Irwin; OEH HD Customer Strategies Mailbox
Cc: Adrian Hohenzollern
Subject: RE: 4465_Roberts Road Quarry_Proposed Modification to Operations (DA 267-11-99)
Date: Tuesday, 23 April 2019 10:52:09 AM
Attachments: image001.png

Hi Alex,

Thanks for the referral, I've had a look at the documents. The Heritage Division has no issues or concerns in relation to State Heritage matters, and therefore are not a relevant stakeholder in this instance.

DPE does not need to refer this project, including any future modifications, to the Heritage Council (i.e Heritage Division of OEH), however other Divisions of OEH may respond separately in relation to Aboriginal Cultural Heritage.

Kind regards,

Tim Olliver
A/Senior Customer Strategies Officer
Heritage Division
Locked Bag 5020, Parramatta 2150
T 02 4927 3203

From: Alex Irwin <airwin@umwelt.com.au>
Sent: Wednesday, 10 April 2019 9:01 AM
To: OEH HD Customer Strategies Mailbox <customer.strategies@environment.nsw.gov.au>
Subject: 4465_Roberts Road Quarry_Proposed Modification to Operations (DA 267-11-99)

Dear Sir/Madam,

Hodgson Quarries and Plant Pty Ltd are proposing to modify operations at the Roberts Road Quarry (the Quarry) located on Lots 1 and 2 DP 228308, and Lot 2 DP 312327, at Maroota within The Hills Shire Council Local Government Area (LGA). The Quarry has approval for the extraction and on-site processing of sand from the Maroota Sands geological formation under DA 267-11-99, a State Significant Development in accordance with State Environmental Planning Policy (State and Regional Development) 2011 (SRD SEPP).

Environmental Assessment Requirements were sought from the NSW Department of Planning & Environment on 11 March 2019, with these provided in a letter from the DPE on 2 April 2019. In accordance with these EARs (which are attached), we are seeking from the NSW Office of Environment and Heritage any specific assessment requirements. To assist you in your consideration, please find attached correspondence summarising the proposed modification and a link to a Preliminary Environmental Assessment.

https://umwelt.sharefile.com/d-s843ea16173946928

If possible, we would appreciate your feedback and assessment requirements by 30 April 2019.

Regards,

Alex Irwin

Principal Environmental Consultant

Umwelt (Australia) Pty Limited
Office 1, 3 Hampden Avenue
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Phone: (02) 4950 5322
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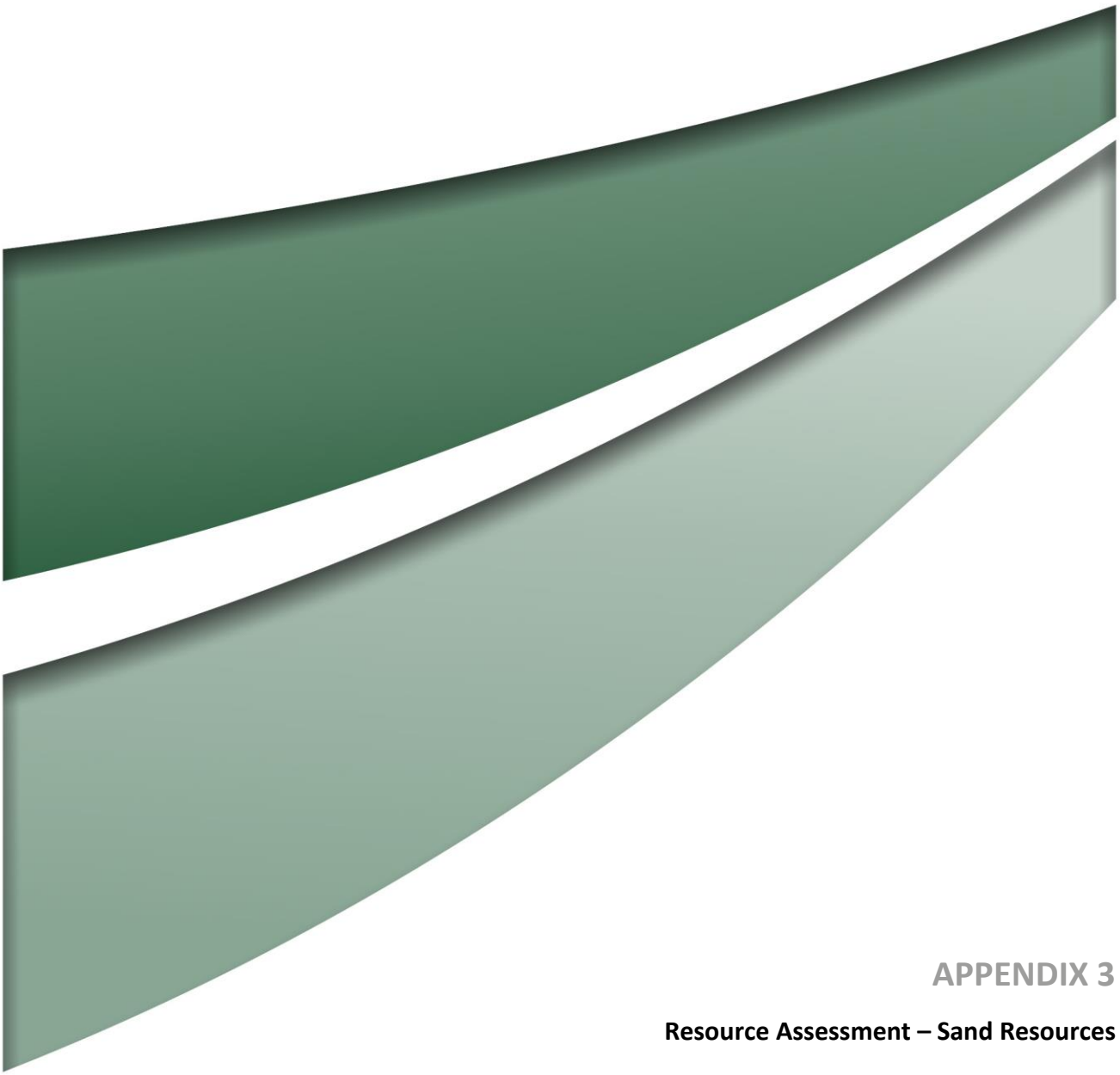


APPENDIX 3

Resource Assessment – Sand Resources

Environmental
Compliance
Solutions Pty Ltd

PO Box 2335 Greenhills NSW 2323
P (02)4028 6412 E mail@vgt.com.au
www.vgt.com.au ABN 26 621 943 888

18th May 2018

Hodgson Quarries and Plant Pty Limited

PO Box 1778

Gosford NSW 2250

Job No. 5910

Attention: Martin Hodgson

Dear Martin,

RE: Resource Calculation for Maroota Quarry

VGT has undertaken a resource calculation for your site at the corner of Northern Road and Roberts Road, Maroota.

The resource calculation has been based upon the following:

1. Survey obtained from Integral Survey on 9th May 2016 (see FS 1);
2. Utilization of SURPAC software;
3. 30 metre buffer from Northern and Roberts Road as specified in EIS Figure MP-05 B;
4. 10 metre buffer from the north boundary as specified in EIS Figure MP-05 B;
5. The quarry resource floor was identified as RL 187m (as specified by client) based upon an average of the current wet weather high groundwater levels as determined by Peter Dundon GWMP February 2018. As seen in attached Figures 19 and 21 from the Dundon report the ground water is not a horizontal plane, and this will change as the ground water levels change;
6. A single 1 horizontal: 1 vertical batter was used in consultation, pers. comm. 15th May 2018, with the client, Martin Hodgson;
7. Soil / overburden depth 0.5 metres; and
8. Statement of Accuracy see attached.

Table 1. Resource Table

Area to be extracted (m^2)	Overburden Volume (m^3)	Volume (m^3)
215,190	32,760	2,900,870

Discussion

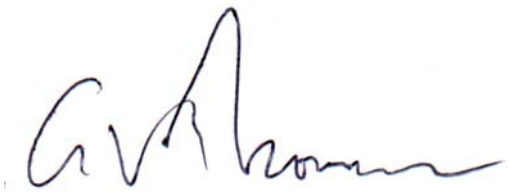
The landform presented in FS 1 is not the final landform. The final landform is the attached consented Figure MP-05.

The total volume described above is a combination of sand, sandstone and clay. Mining and processing of this resource involves crushing, screening and washing of most of the resource. Thicker clay bands are selectively mined out, but due to the lensing nature of these the amount of clay is not known. The overburden is topsoil.

The resource calculation is based upon 2016 survey, i.e. it is 2 years old, to achieve a more accurate resource volume, the author recommends either an updated survey or undertake a review of resources extracted from 9th May 2016.

I trust this meets with your expectations and if you have questions please do not hesitate to contact me.

Yours Sincerely



Greg Thomson

Director

Appendix A: Fieldsheet 1(FS1)

Plan of:	Field Sheet - Roberts Rd Maroota Sand Quarry Resource Calculation 2018
Figure:	FS1
Sheet:	1 of 1
Version/Date:	V0 18/05/2018

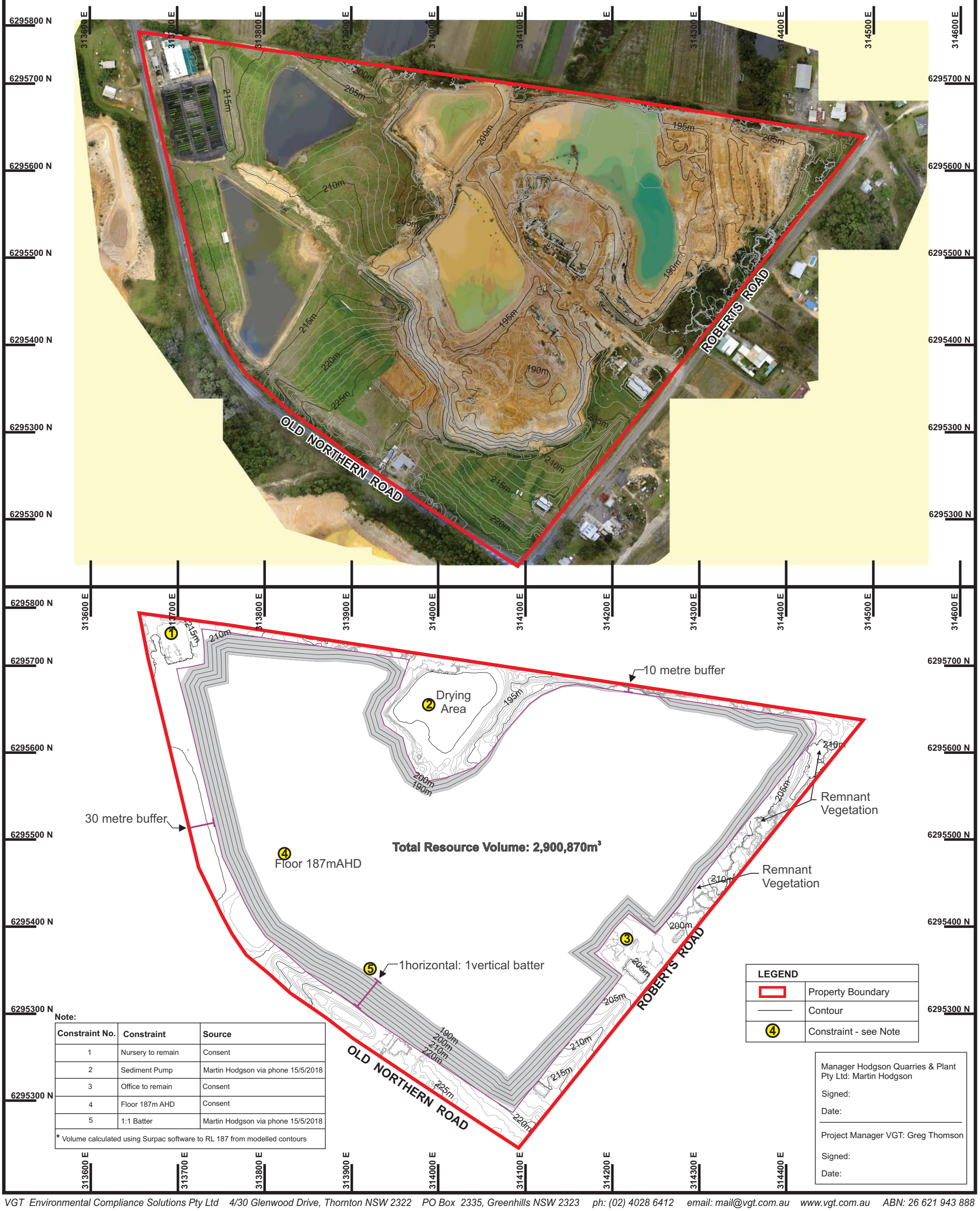
This figure is used as a working site plan and is not Quality Assured.

N

0 20 40 60 80 100m

vgt
Environmental Compliance Solutions Pty Ltd

Location:	Maroota Quarry, Roberts Road, Maroota, NSW	***Source:***	Integral Surveys May 2016, Surpac, Consent documents and pers. comm MH May 2018	***Our Ref:***	5910_HMA_RC2018_FS01_V0_FS1.cdr
Council:	Hills Shire Council	***Survey:***	Integral Surveys May 2016	***Plan By:***	SK/GT
Tenures:	N/A	***Projection:***	MGA	***Project Manager:***	GVT
Client:	Hodgson Quarries & Plant Pty Ltd	***Contour Interval:***	1m	***Office:***	Thornton



Note:

Constraint No.	Constraint	Source
1	Nursery to remain	Consent
2	Sediment Pump	Martin Hodgson via phone 15/5/2018
3	Office to remain	Consent
4	Floor 187m AHD	Consent
5	1:1 Batter	Martin Hodgson via phone 15/5/2018

* Volume calculated using Surpac software to RL 187 from modelled contours

LEGEND	
	Property Boundary
	Contour
4	Constraint - see Note

Manager Hodgson Quarries & Plant Pty Ltd: Martin Hodgson

Signed:

Date:

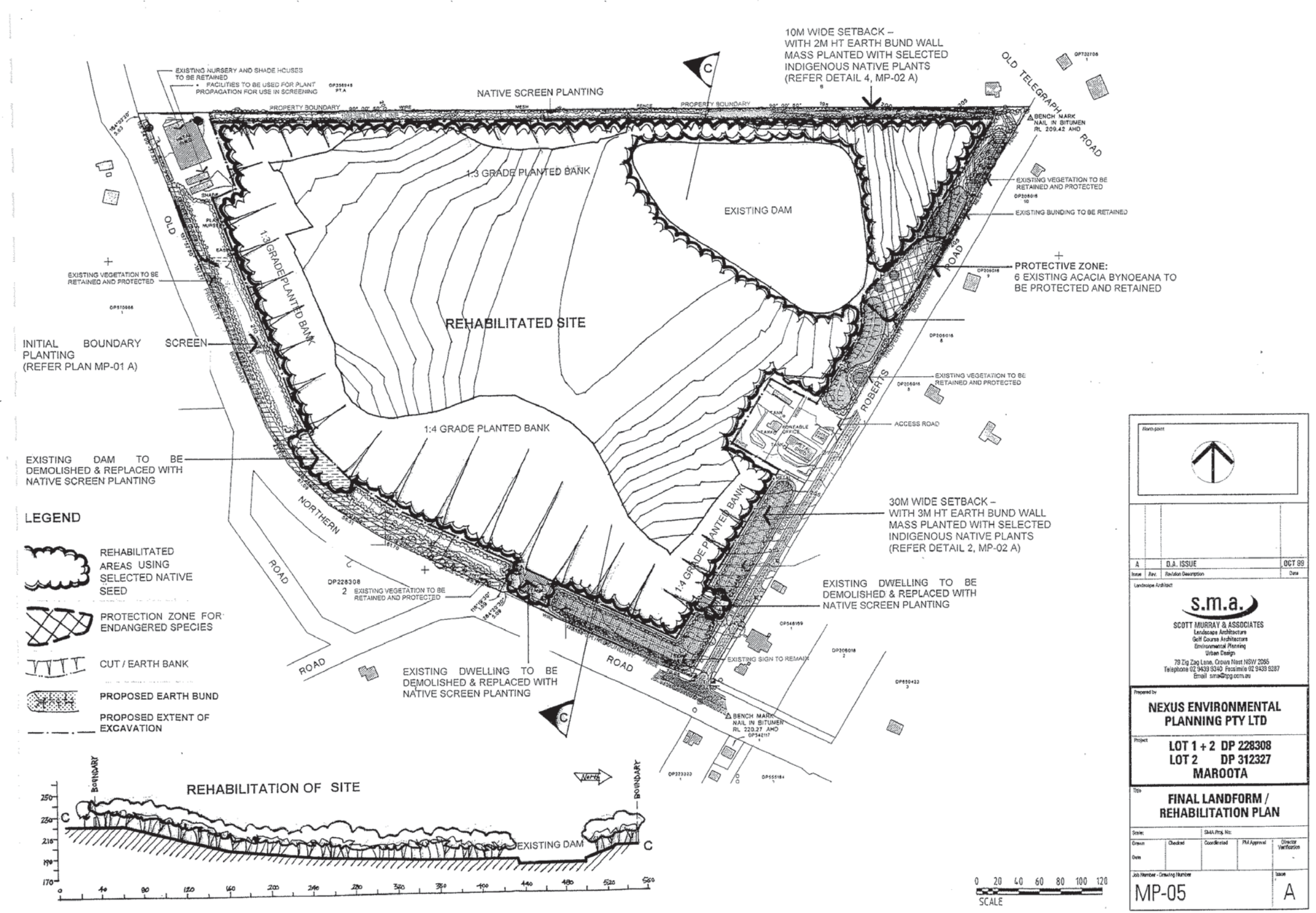
Project Manager VGT: Greg Thomson

Signed:

Date:

VGT Environmental Compliance Solutions Pty Ltd 4/30 Glenwood Drive, Thornton NSW 2322 PO Box 2335, Greenhills NSW 2323 ph: (02) 4028 6412 email: mail@vgt.com.au www.vgt.com.au ABN: 26 621 943 888

Appendix B: 1999Rehabilitation Report Figure MP-05 B



North point

Issue	Rev.	Revision Description	Date
A		D.A. ISSUE	OCT 99

Landscape Architect

s.m.a.

SCOTT MURRAY & ASSOCIATES
Landscape Architecture
Golf Course Architecture
Environmental Planning
Urban Design
79 Zig Zag Lane, Crows Nest NSW 2065
Telephone 02 9439 9340 Facsimile 02 9439 9287
Email sma@tpg.com.au

Prepared by

NEXUS ENVIRONMENTAL PLANNING PTY LTD

Project

LOT 1 + 2 DP 228308
LOT 2 DP 312327
MAROOTA

Title

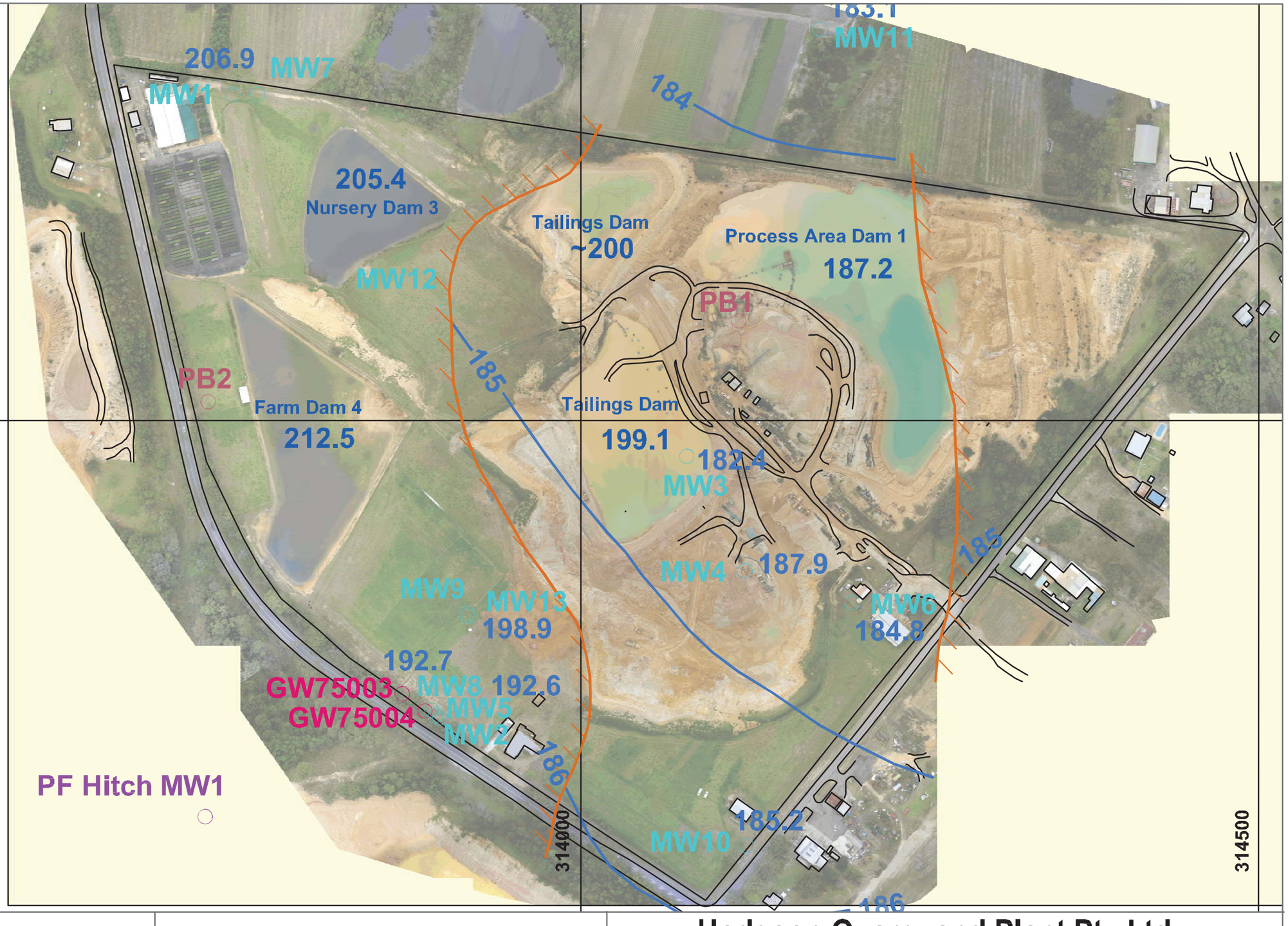
FINAL LANDFORM / REHABILITATION PLAN

Scale:		SMA Proj. No:		
Drawn	Checked	Coordinated	PM Approval	Director Verification
Date				

Job Number - Drawing Number: MP-05

Issue: A

Appendix C: Figures 19 & 21 from Peter Dundon GWMP February 2018



LEGEND:

- Hodgson monitoring bore
- Hodgson production bore
- 185.2 Maroota Sands WWHGWL (mAHD)l
- Contours of wet weather high GW level
- Edge of saturated Maroota Sands

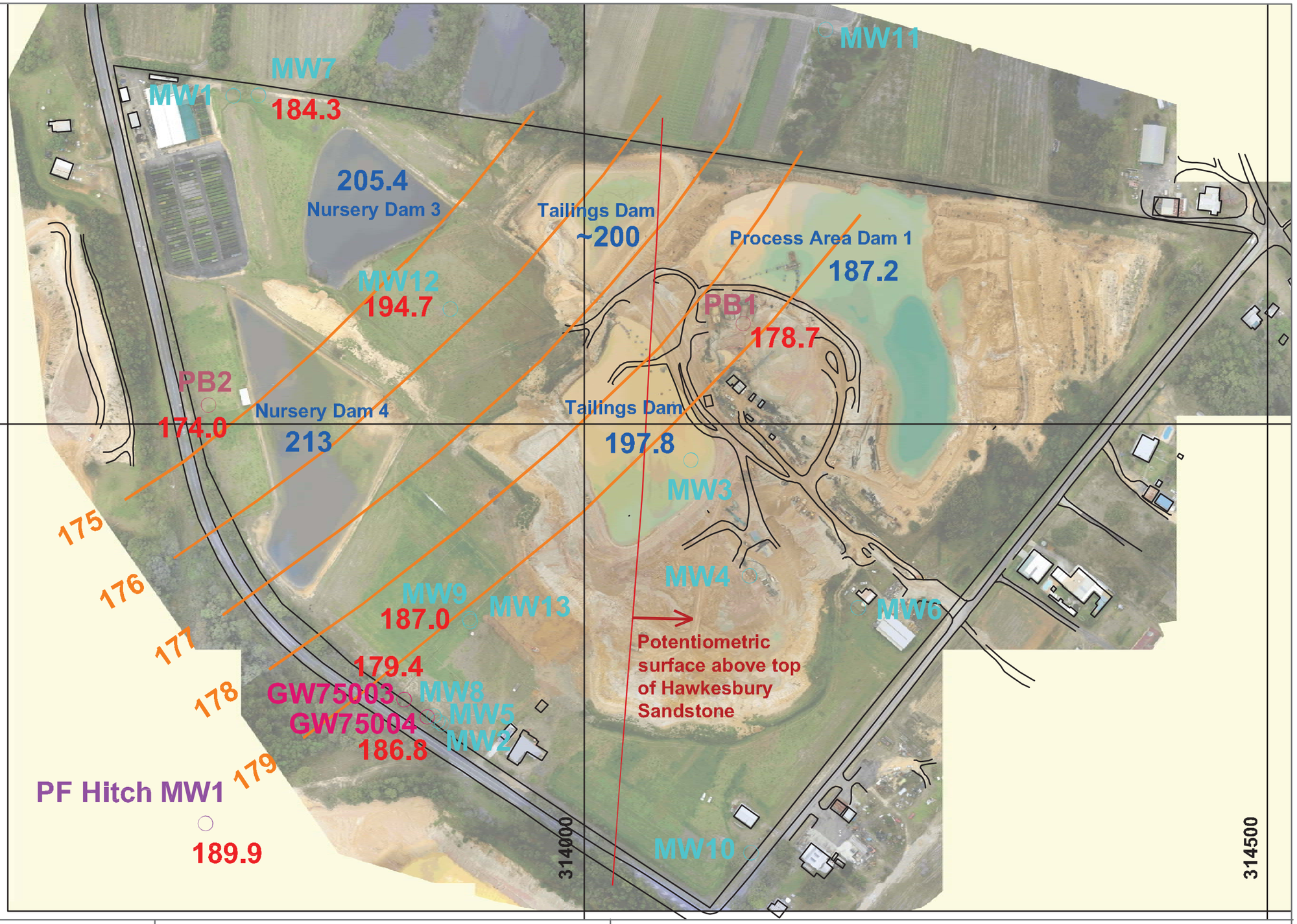
DATE: 8 March 2018	SCALE:
PROJECT NO: 06-0318	AUTHOR: PD
DRAWING NO: 06-0318-020d	REVISION: D

Dundon Consulting Pty Ltd

Hodgson Quarry and Plant Pty Ltd

ROBERTS ROAD MAROOTA SAND QUARRY
Wet Weather High Groundwater Level
Maroota Sands (February 2018)

Figure 19



LEGEND:

- Hodgson monitoring bore
- Hodgson production bore
- 174.0 Hawkesbury Sandstone water level
- Contours of wet weather high GW level
- Potentiometric surface above top of HS

DATE: 15 April 2018	SCALE:
PROJECT NO: 06-0318	AUTHOR: PD
DRAWING NO: 06-0318-021e	REVISION: E

Dundon Consulting Pty Ltd

Hodgson Quarry and Plant Pty Ltd

ROBERTS ROAD MAROOTA SAND QUARRY

Wet Weather High Groundwater Level Hawkesbury Sandstone (February 2018)

Figure 21

Appendix D: Statement of Accuracy

Statement of Accuracy Maroota Quarry– as of 17th May 2018

Table 1 Data Acquisition

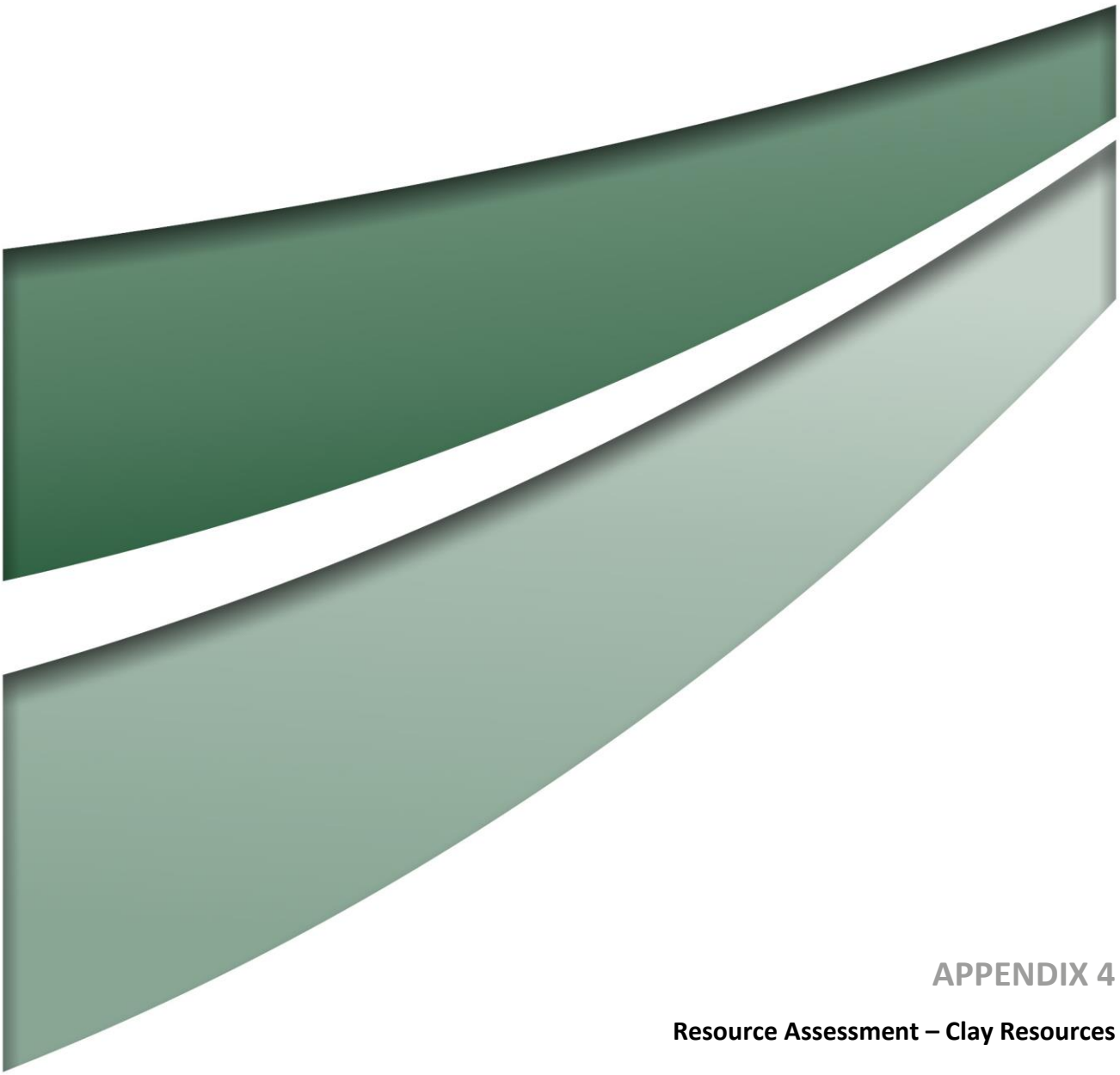
Item	Description
Source of survey	Integral Survey, Hugh Stephenson, 15 James Scott Crescent, Lemon Tree Passage, 2319. 0499 944 434
Date of Survey	9th May 2016
Date files received	2nd June 2016
File format	Geo referenced Ortho-photo and DXF
Ground control	Not supplied
Data Accuracy	Not supplied
Equipment	UAV
Software	12D
Property Boundary	Inferred, not verified.
Mine lease or Authority Boundary	Not required

Table 2 Processing and Manipulation

Item	Description
VGT Raw File location	V:\Jobs_HMA Maroota\1_Base_Boundary\surpac\Topo2016.dxf
VGT file import	Converted DXF to STR file using SURPAC
VGT manipulation	Erroneous heights were deleted, as the drone picked up trees, buildings etc that would provide false positives. 16th May 2018 Now Topo2018.str and DTM. Both found in V:\Jobs_HMA Maroota\1_Base_Boundary\surpac
Ground truthing	Review topography visually and overly air photography (provided or nearmaps)
Conversion of data	String (str) file converted to Digital Terrain Model (DTM) using Surpac
Quarry Model Development	Top of cut was digitised using Surpac tool
Batter and Bench design	A 1 horizontal: 1 vertical single batter was adopted as defined by client. No benches.
Base of Resource	A base of resource is adopted via the latest groundwater high level (RL 185m) identified in GWMP and an additional consented 2 metres giving a base of RL 187m.
Verification	12D

Table 3 Attributes

Item	Description
Buffers	EIS Mod 2 Figure MP-05 B July 2000, Final Landform/Rehabilitation Plan, prepared by Nexus
Infrastructure	As identified in EIS Mod 2 Figure MP-05 B July 2000, Final Landform/Rehabilitation Plan, prepared by Nexus
Overburden	Site observations suggest and average topsoil thickness of 0.5 metres. This has been excluded from the calculations.
Resource Type	The lensing nature of sand, clay and sandstone is too difficult to predict amounts, therefore a total volume is presented.
Mining techniques	The mining procedure involves most of the resource to be processed.
Onsite Processing	The sand processing involves crushing, sorting and cleaning the sand. Reject fines are stored in ponds.
Verification	



APPENDIX 4

Resource Assessment – Clay Resources

Environmental
Compliance
Solutions Pty Ltd
PO Box 2335 Greenhills NSW 2323
P (02)4028 6412 E mail@vgt.com.au
www.vgt.com.au ABN 26 621 943 888

10th January 2019

Hodgson Quarries and Plant Pty Limited

PO Box 1778

Gosford NSW 2250

Job No. 6920

Attention: Martin Hodgson

Dear Martin,

RE: Clay Calculation for Maroota Quarry

VGT Environmental Compliance Solutions Pty Limited (VGT) was engaged by Hodgson Quarries & Plant Pty Ltd to review the insitu remaining clays onsite.

Field Visit: A site visit was undertaken on the 7th January 2019 where photographs were taken and a hand held GPS was used to record some of the site.

Investigation Data: Presented in *Figure 1* are the photographs taken on the 7th January 2019. The black dashed line is the visual estimation of the contact between the clay and the underlying sands. The distances listed on *Figure 1* are also estimates based upon scaling from the house height estimation.

Drill holes MW 8, MW 9, MW 10 and MW 12 sunk in 2016 these were referenced to determine the clay base, logs are attached.

Table 1 Drill Hole Data

Drill Hole	Overburden Clay Thickness (m)
MW 8	16
MW 9	15
MW 10	10
MW 12	0

Maroota Geology: The Maroota sand and clay bands tend to vary in thickness over relatively short distances as seen in *Figure 1*. These are situated in a paleo channel of the older Hawkesbury Sandstone, as seen in *Figure 1,* out cropping to the west. Drill hole locations are found on *Figure 2*, the clay appears to be thickening to the south and disappears to the west.

Resource Calculation: has been based upon the following:

1. Survey obtained from NSW Spatial Services – DEM format May 2017;
2. Utilization of SURPAC software;
3. 30 metre buffer from Northern and Roberts Road as specified in EIS Figure MP-05 B;
4. The clay thickness has been estimated using visual review of photographs presented in *Figure 1* and drill hole data presented in Table 1;
5. A single 1 horizontal : 0.5 vertical batter was used, as similar batters were found on the May 2017 survey; and
6. Statement of Accuracy see attached.

Table 2 Clay Volume

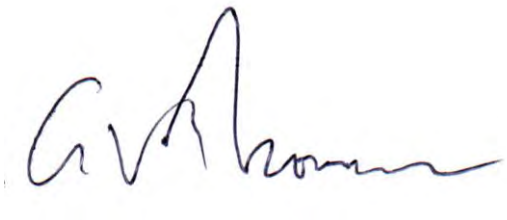
Estimated Area of Clay (m^2)	Clay Overburden Volume (m^3)
26,600	234,700

Discussion

The clay volume could significantly vary from the 234,700 cubic metres, as discussed previously due to the lateral variation in thickness in these units and the estimation of the thickness in the photography.

I trust this meets with your expectations and if you have questions please do not hesitate to contact me.

Yours Sincerely



Greg Thomson

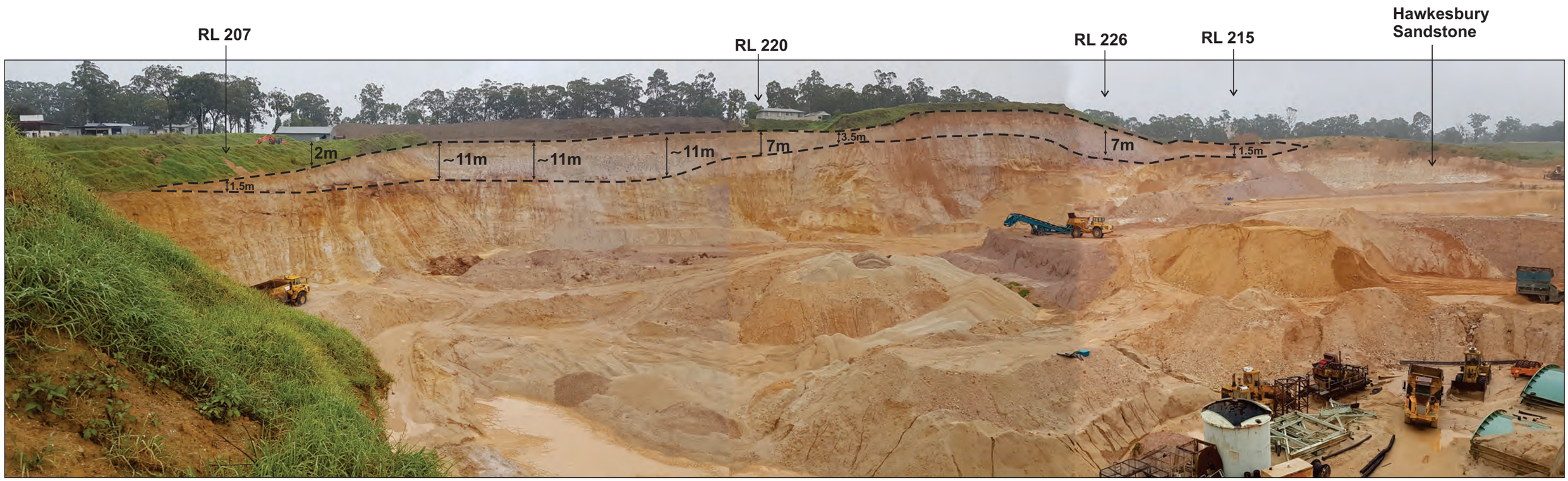
Director

Appendix A: Figures

Plan of:	Roberts Rd Maroota Sand Quarry Clay Review 2019 - Clay Resource	***Location:***	Maroota Quarry, Roberts Road, Maroota, NSW	***Source:***	VGT - Image Dated 07/01/2019	***Our Ref:***	6920_HMA_CR2019_C003_V1_F31.cdr
Figure:	ONE	***Council:***	Hills Shire Council	***Survey:***	N/A	***Plan By:***	SC/JD
Sheet:	1 of 1	***Tenures:***	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Version/Date:	V1 10/01/2019	***Client:***	Hodgson Quarries & Plant Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton

vgt Environmental Compliance Solutions Pty Ltd

VIEW LOOKING SOUTH



Legend

Clay Overburden

Manager Hodgson Quarries & Plant Pty Ltd: Martin Hodgson

Signed:

Date:

Project Manager VGT: Greg Thomson

Signed:

Date:

Plan of:	Roberts Rd Maroota Sand Quarry Clay Review 2019 - Drill Hole & Clay Volume Plan	***Location:***	Maroota Quarry, Roberts Road, Maroota, NSW	***Source:***	N/A	***Our Ref:***	6920_HMA_CR2019_C003_V1_F31.cdr
Figure:	TWO	***Council:***	Hills Shire Council	***Survey:***	NSW Government Spatial Services, May 2017 Survey, Accessed Through ELVIS	***Plan By:***	SC/JD
Sheet:	1 of 1	***Tenures:***	N/A	***Projection:***	N/A	***Project Manager:***	GVT
Version/Date:	V0 10/01/2019	***Client:***	Hodgson Quarries & Plant Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton

N

0 20 40 60 80 100m

vgt Environmental Compliance Solutions Pty Ltd

313600 E 313700 E 313800 E 313900 E 314000 E 314100 E 314200 E 314300 E 314400 E 314500 E 314600 E

6295800 N 6295700 N 6295600 N 6295500 N 6295400 N 6295300 N

Dam 3
Drying Area
Dam 4
Drying Pond Dam 2
Process Area Dam 1
Processing Plant
Weighbridge
Office
Stockpile Area
House
MW12
MW9
MW8
MW10
200m
210m
214m
205m
207m
1H:0.5V Batter
OLD NORTHERN ROAD
ROBERTS ROAD

LEGEND	
	Property Boundary
	Water Management Area
	Building
MW9	Drill Hole
	Existing Bund Wall
	Contour

Manager Hodgson Quarries & Plant Pty Ltd: Martin Hodgson

Signed:

Date:

Project Manager VGT: Greg Thomson

Signed:

Date:

Appendix B: Drill Holes

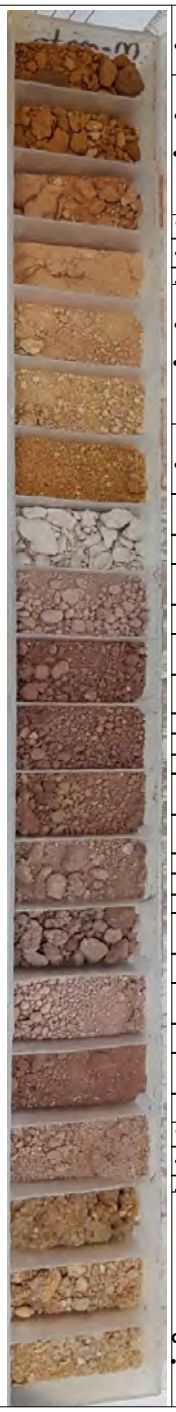
BOREHOLE LOG

Name of Hole: MW8

Project Number: 2801
Client: Hodgson Quarry Products and Plant
Project: Drilling Operations/ Groundwater Study
Location: Off Roberts Road, Maroota, NSW
Logged by: MA

MAROOTA

Date Commenced: 5/12/2016
Date Completed: 6/12/2016
Surface RL: 227.01m
Collar Height: 0.42m
Coordinates: 313889 6295287
Drilling Contractor: Ultra Drilling Waterbores



Drill Type	Elevation (RL)	Depth (m)	Piezometer Design	Graphic Log	Description	Additional Information
Hammer Bit	227	0			Silty Sand- orange to light brown, fine to medium grained, subrounded to rounded grains	Feruginised fragments and some clay
	226	1			Silty Sand- orange, fine to medium grained, subrounded to rounded grains	Feruginised fragments and some clay
	225	2				
	224	3			Clayey Sand- orange to light orange, fine grained, subrounded to rounded	
	223	4			Silty Sand- light orange to orange, fine to coarse grained subrounded to rounded	Hammer bit not firing
	222	5				
	221	6			Silty Sand- orange, fine to coarse grained, subrounded to rounded grains	Hammer bit not firing
	220	7			Clay- white to light brown	Hammer bit not firing
	219	8			Clay- purple to pink	
	218	9			Clay- Deep purple	
	217	10				
	216	11			Clay-Purple to light brown	Water seepage @ 13m
	215	12				
	214	13			Clay- Deep purple	Hammer bit not firing
	213	14			Clay- light brown to purple	Hammer bit not firing
	212	15			Clay- dark brown to red	Hammer bit not firing
	211	16			Clayey Sand- cream to orange, fine grained, subrounded to rounded grains	Hammer bit not firing
	210	17				
	209	18				
	208	19				
	207	20				

Other Information:GPS Coordinates sourced from handheld devices. Survey conducted post exploration.
Stratum contacts determined by hardness, colour, sample recovery and litholoIgical analysis.

Logged By: MA	Checked By: GT (12/01/2017)	2801_HMA_DO_LOG_MW8_V3

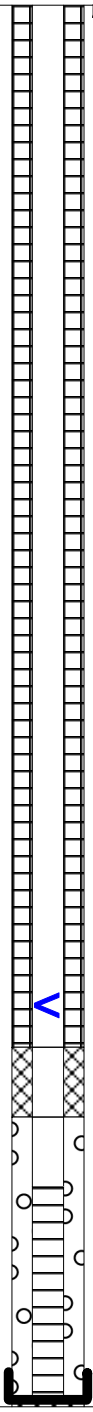
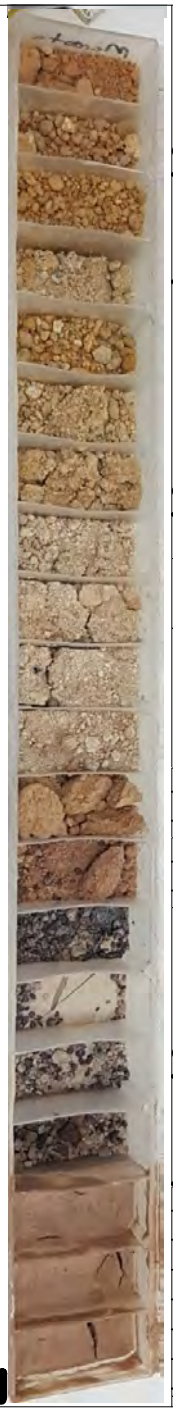
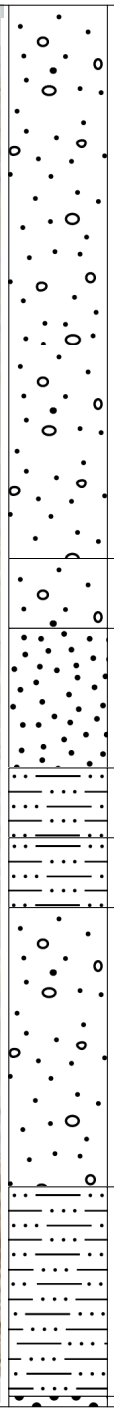
BOREHOLE LOG

Name of Hole: MW8

Project Number: 2801
Client: Hodgson Quarry Products and Plant
Project: Drilling Operations/ Groundwater Study
Location: Off Roberts Road, Maroota, NSW
Logged by: MA

MAROOTA

Date Commenced: 5/12/2016
Date Completed: 6/12/2016
Surface RL: 227.01m
Collar Height: 0.42m
Coordinates: 313889 6295287
Drilling Contractor: Ultra Drilling Waterbores

Drill Type	Elevation (RL)	Depth (m)	Piezometer Design	Photo Log	Graphic Log	Description	Additional Information
Hammer Bit	206 – 205 – 204 – 203 – 202 – 201 – 200 – 199 – 198 – 197 – 196 – 195 – 194 – 193 – 192 – 191 – 190 – 189 – 188 – 187	21 – 22 – 23 – 24 – 25 – 26 – 27 – 28 – 29 – 30 – 31 – 32 – 33 – 34 – 35 – 36 – 37 – 38 – 39 – 40				Pebbly Sand - orange to light brown, coarse to very coarse, rounded to subrounded	Hammer bit not firing to 20.5m, some clay
						Pebbly Sand- light brown, fine grained, subrounded to rounded grains	Some clay
						Sand- white to light brown, fine grained, subrounded to rounded	Some clay
						Sandy Clay- brown to light purple, fine grained, subrounded to rounded	Water injected
						Clayey Sand- brown to light brown, fine grained, subrounded to rounded	
						Pebbly Sand- brown to pink, very coarse to fine , subrounded to rounded	Feruginised fragments
						Clayey Sand- brown to purple, medium grained, subrounded to rounded grains	Hardness increasing

Other Information:GPS Coordinates sourced from handheld devices. Survey conducted post exploration.
Stratum contacts determined by hardness, colour, sample recovery and litholoIgical analysis.

Logged By: MA	Checked By: GT (12/01/2017)	2801_HMA_DO_LOG_MW8_V3

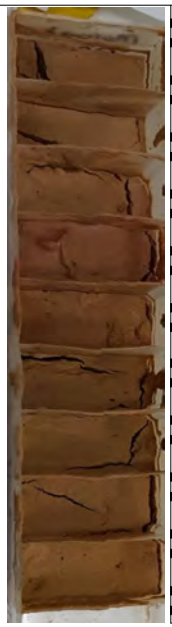
BOREHOLE LOG

Name of Hole: MW8

Project Number: 2801
Client: Hodgson Quarry Products and Plant
Project: Drilling Operations/ Groundwater Study
Location: Off Roberts Road, Maroota, NSW
Logged by: MA

MAROOTA

Date Commenced: 5/12/2016
Date Completed: 6/12/2016
Surface RL: 227.01m
Collar Height: 0.42m
Coordinates: 313889 6295287
Drilling Contractor: Ultra Drilling Waterbores

Drill Type	Elevation (RL)	Depth (m)	Piezometer Design	Photo Log	Graphic Log	Description	Additional Information
Hammer Bit	186	41				Sandstone - orange to brown	Interbedded shale laminations
	185	42					
	184	43					
	183	44					
	182	45					
	181	46					
	180	47					
	179	48					
	178	49					
						Hole Terminated in Hawkesbury Sandstone	
	177	50					
	176	51					
	175	52					

Piezo Legend

- 2mm Gravel Pack
- Bentonite Seal
- Casing Blank
- Casing Slotted
- Fill
- Cap

Other Information: GPS Coordinates sourced from handheld devices. Survey conducted post exploration.
Stratum contacts determined by hardness, colour, sample recovery and litholoIgical analysis.

Logged By: MA	Checked By: GT (12/01/2017)	2801_HMA_DO_LOG_MW8_V3

BOREHOLE LOG

Name of Hole: MW8

Project Number: 2801
Client: Hodgson Quarry Products and Plant
Project: Drilling Operations/ Groundwater Study
Location: Off Roberts Road, Maroota, NSW
Logged by: MA

MAROOTA

Date Commenced: 5/12/2016
Date Completed: 6/12/2016
Surface RL: 227.01m
Collar Height: 0.42m
Coordinates: 313889 6295287
Drilling Contractor: Ultra Drilling Waterbores

Drill Type	Elevation (RL)	Depth (m)	Piezometer Design	Photo Log	Graphic Log	Description	Additional Information

Other Information: GPS Coordinates sourced from handheld devices. Survey conducted post exploration.
Stratum contacts determined by hardness, colour, sample recovery and litholoIgical analysis.

Logged By: MA	Checked By: GT (12/01/2017)	2801_HMA_DO_LOG_MW8_V3

BOREHOLE LOG

Name of Hole: MW9

Project Number: 2801

Client: Hodgson Quarry Products and Plant

Project: Drilling Operations/ Groundwater Study

Location: Off Roberts Road, Maroota, NSW

Logged by: MA

MAROOTA

Date Commenced: 19/12/2016

Date Completed: 19/12/2016

Surface RL:225.577 m

Collar Height: 0.52m

Coordinates: 313916 6295355

Drilling Contractor: Ultra Drilling Waterbores

Drill Type	Elevation (RL)	Depth (m)	Piezometer Design	Photo Log	Graphic Log	Description	Additional Information
Auger	225	0				Clayey Sand- orange to brown, fine to coarse grained, subrounded to rounded grains	Topsoil 0 - 0.3m
		1				Clayey sand- light brown to red, coarse grained, subrounded to rounded grains	Feruginised chips
	224	2				Clayey Sand- red to light orange, fine to coarse grained, subrounded to rounded grains	
	223	3				Clayey Sand- red to light brown, fine to coarse grained, rounded to subrounded grains	Feruginised Chips
	222	4				Clay- Pink to red	Some cream clay
	221	5					
Blade Bit	220	6				Clay- Pink to red	Some silt
	219	7					
	218	8					
	217	9					
	216	10				Clay- Cream to pink- silty	Water seapage @12m
	215	11					
	214	12					
	213	13					
Hammer Bit	212	14				Clay- Red, no sand	
	211	15					
	210	16				Pebbly Sand- light orange, fine to very coarse grained, subrounded to rounded grains	
	209	17					
	208	18				Pebbly Sand- orange to light orange, fine to very coarse grained, subrounded to rounded grains	
	207	19					
	206	20					

Other Information: GPS Coordinates sourced from handheld devices. Survey conducted post exploration.
Stratum contacts determined by hardness, colour, sample recovery and litholoIgical analysis.

Logged By: MA	Checked By GT (12/01/2017)	Version: 2801_HMA_DO_LOG_MW9_V3

BOREHOLE LOG

Name of Hole: MW9

Project Number: 2801

Client: Hodgson Quarry Products and Plant

Project: Drilling Operations/ Groundwater Study

Location: Off Roberts Road, Maroota, NSW

Logged by: MA

MAROOTA

Date Commenced: 19/12/2016

Date Completed: 19/12/2016

Surface RL:225.577 m

Collar Height: 0.52m

Coordinates: 313916 6295355

Drilling Contractor: Ultra Drilling Waterbores

Drill Type	Elevation (RL)	Depth (m)	Piezometer Design	Photo Log	Graphic Log	Description	Additional Information
Hammer Bit	205	21					
	204	22				Sand- orange to pink, fine to coarse grained, subrounded/subangular to rounded grains	
	203	23				Sand- light brown, fine to coarse grained, subrounded/subangular to rounded grains	Feruginised chips
	202	24					
	201	25					
	200	26				Sand- brown to orange, fine grained	Feruginised chips
	199	27					
	198	28					
	197	29					
	196	30					
	195	31				Sandstone- brown to light orange	Hardness progressively increasing
	194	32					
	193	33					
	192	34					
	191	35					
	190	36					
	189	37					
	188	38					
	187	39				Sandstone- light orange to red	
	186	40					

Other Information: GPS Coordinates sourced from handheld devices. Survey conducted post exploration.
Stratum contacts determined by hardness, colour, sample recovery and litholoIgical analysis.

Logged By: MA	Checked By GT (12/01/2017)	Version: 2801_HMA_DO_LOG_MW9_V3

BOREHOLE LOG

Name of Hole: MW9

Project Number: 2801

Client: Hodgson Quarry Products and Plant

Project: Drilling Operations/ Groundwater Study

Location: Off Roberts Road, Maroota, NSW

Logged by: MA

MAROOTA

Date Commenced: 19/12/2016

Date Completed: 19/12/2016

Surface RL:225.577 m

Collar Height: 0.52m

Coordinates: 313916 6295355

Drilling Contractor: Ultra Drilling Waterbores

Drill Type	Elevation (RL)	Depth (m)	Piezometer Design	Photo Log	Graphic Log	Description	Additional Information
Hammer Bit	185	41					
	184	42					
	183	43					
	182	44					
	181	45				Sandstone- light brown	Water injeted @49m
	180	46					
	179	47					
	178	48					
	177	49					
	176	50					
	175	51				Hole Terminated in Hawkesbury Sandstone	
	174	52					

Piezo Legend

- 2mm Gravel Pack
- Bentonite Seal
- Casing Blank
- Casing Slotted
- Fill
- Cap

Other Information: GPS Coordinates sourced from handheld devices. Survey conducted post exploration. Stratum contacts determined by hardness, colour, sample recovery and litholoIgical analysis.

Logged By: MA	Checked By GT (12/01/2017)	Version: 2801_HMA_DO_LOG_MW9_V3

BOREHOLE LOG

Name of Hole: MW10

Project Number: 2801

Client: Hodgson Quarry Products and Plant

Project: Drilling Operations/ Groundwater Study

Location: Off Roberts Road, Maroota, NSW

Logged by: MA

MAROOTA

Date Commenced: 12/12/2016

Date Completed: 14/12/2016

Surface RL: 217.124m

Collar Height: 0.49m

Coordinates: 314122 6295186

Drilling Contractor: Ultra Drilling Waterbores

Drill Type	Elevation (RL)	Depth (m)	Piezometer Design	Photo Log	Graphic Log	Description	Additional Information
Auger	217	0				Silty Clay - Orange to grey	Topsoil 0-0.2m
	216	1					
	215	2				Clay- red to cream, no sand	
	214	3				Clay- red, no sand	Some Silt
	213	4					
	212	5				Clay- cream to red, no sand	Some Silt
	211	6					
	210	7				Clay- red to orange, no sand	
Blade Bit	209	8				Clay- pink to cream, no sand	
	208	9				Clay- pink to purple, no sand	Some Silt
	207	10				Sand- light orange, fine grained, subrounded to rounded grains	Some Clay
	206	11					
	205	12					
	204	13					
	203	14					
	202	15				Sand- dark orange, fine to very coarse, grained, subrounded/subangular to rounded grains	Not hammering @ 18m
	201	16					
	200	17					
	199	18					
Hammer Bit	198	19					
	197	20					

Other Information: GPS Coordinates sourced from handheld devices. Survey conducted post exploration.
Stratum contacts determined by hardness, colour, sample recovery and litholoIgical analysis.

Logged By: MA	Checked By: GT (12/01/2017)	Date: 2801_HMA_DO_LOG_MW10_V3

BOREHOLE LOG

Name of Hole: MW10

Project Number: 2801

Client: Hodgson Quarry Products and Plant

Project: Drilling Operations/ Groundwater Study

Location: Off Roberts Road, Maroota, NSW

Logged by: MA

MAROOTA

Date Commenced: 12/12/2016

Date Completed: 14/12/2016

Surface RL: 217.124m

Collar Height: 0.49m

Coordinates: 314122 6295186

Drilling Contractor: Ultra Drilling Waterbores

Drill Type	Elevation (RL)	Depth (m)	Piezometer Design	Photo Log	Graphic Log	Description	Additional Information
Hammer Bit	196	21				Pebbly Sand- orange to red, coarse to very coarse, subrounded to rounded grains	Not hammering
	195	22					
	194	23					
	193	24				Sand- cream to light orange, fine to medium grained, subrounded/subangular to rounded grains	Not hammering
	192	25					
	191	26				Sand- orange, fine to coarse grained, subrounded/subangular to rounded	Not hammering
	190	27					
	189	28				Pebbly Sand- pink to orange, fine to very coarse grained, subangular to rounded grains	Not hammering, minor clay bands
	188	29				Pebbly Sand- pink to cream, coarse to very coarse, subrounded to rounded grains	Not hammering, minor clay bands
	187	30					
	186	31				Pebbly Sand- Pink to light brown, coarse to very coarse grained, subrounded to rounded grains	Hammering
	185	32	<			Pebbly Sand- pink to red, coarse to very coarse grained, subangular/subrounded to rounded grains	
	184	33				Pebbly Sand- pink to red, coarse to very coarse grained, subangular/subrounded to rounded grains	Water seepage
	183	34					
	182	35					
	181	36					
	180	37					
	179	38					
	178	39					
	177	40					

Other Information: GPS Coordinates sourced from handheld devices. Survey conducted post exploration.
Stratum contacts determined by hardness, colour, sample recovery and litholoIgical analysis.

Logged By: MA	Checked By: GT (12/01/2017)	Date: 2801_HMA_DO_LOG_MW10_V3

BOREHOLE LOG

Name of Hole: MW10

Project Number: 2801
Client: Hodgson Quarry Products and Plant
Project: Drilling Operations/ Groundwater Study
Location: Off Roberts Road, Maroota, NSW
Logged by: MA

MAROOTA

Date Commenced: 12/12/2016
Date Completed: 14/12/2016
Surface RL: 217.124m
Collar Height: 0.49m
Coordinates: 314122 6295186
Drilling Contractor: Ultra Drilling Waterbores

Drill Type	Elevation (RL)	Depth (m)	Piezometer Design	Photo Log	Graphic Log	Description	Additional Information
Hammer Bit	176	41				Pebbly Sand- brown, coarse to very coarse grained, subrounded to rounded grains	
	175	42					
	174	43					
	173	44					
	172	45					
	171	46				Pebbly Sand- red, coarse to very coarse grained, subangular/subrounded to rounded grains	
	170	47					
	169	48				Pebbly Sand- pink to orange, some very coarse to coarse grains, subrounded to rounded	
	168	49					
	167	50				Hole Terminated in Hawkesbury Sandstone as determined by drill penetration rates and colour change in drill water. No sample retained	
	166	51					
	165	52					

Piezo Legend

- 2mm Gravel Pack
- Bentonite Seal
- Casing Blank
- Casing Slotted
- Fill
- Cap

Other Information: GPS Coordinates sourced from handheld devices. Survey conducted post exploration.
Stratum contacts determined by hardness, colour, sample recovery and litholoIgical analysis.

Logged By: MA	Checked By: GT (12/01/2017)	Date: 2801_HMA_DO_LOG_MW10_V3

BOREHOLE LOG

Name of Hole: MW10

Project Number: 2801

Client: Hodgson Quarry Products and Plant

Project: Drilling Operations/ Groundwater Study

Location: Off Roberts Road, Maroota, NSW

Logged by: MA

MAROOTA

Date Commenced: 12/12/2016

Date Completed: 14/12/2016

Surface RL: 217.124m

Collar Height: 0.49m

Coordinates: 314122 6295186

Drilling Contractor: Ultra Drilling Waterbores

Drill Type	Elevation (RL)	Depth (m)	Piezometer Design	Photo Log	Graphic Log	Description	Additional Information

Other Information: GPS Coordinates sourced from handheld devices. Survey conducted post exploration.
Stratum contacts determined by hardness, colour, sample recovery and litholoIgical analysis.

Logged By: MA	Checked By: GT (12/01/2017)	Date: 2801_HMA_DO_LOG_MW10_V3

BOREHOLE LOG

Name of Hole:MW12

Project Number: 2801

Client: Hodgson Quarry Products and Plant

Project: Drilling Operations/ Groundwater Study

Location: Off Roberts Road, Maroota, NSW

Logged by: MA

MAROOTA

Date Commenced: 08/12/2016

Date Completed: 08/12/2016

Surface RL: 210.275m

Collar Height: 0.48m

Coordinates: 313902 6295583

Drilling Contractor: Ultra Drilling Waterbores

Drill Type	Elevation (RL)	Depth (m)	Piezometer Design	Photo Log	Graphic Log	Description	Additional Information
Blade	210	0				Sand- orange to dark orange coarse to very coarse grained, subrounded to rounded grains	
	209	1				Sand- dark orange, fine to coarse grained, subrounded to rounded grains	Feruginised chips, some clay bands
	208	2				Sand- orange to red, fine to coarse grained, subrounded to rounded	Feruginised chips
	207	3				Sand- red to cream, fine to medium grained, subrounded to rounded grains	Feruginised chips
	206	4				Silty Sand- cream to light orange, fine to medium grained, subrounded to rounded grains	
	205	5					
	204	6					
	203	7				Sand- cream, fine to medium grained, rounded to subrounded grains	
	202	8					
	201	9					
	200	10				Sand- cream to pink fine to medium grained, subrounded to rounded grains	Water seepage
Hammer Bit	199	11				Sand- pink to light brown, fine grained, subrounded to rounded grains	
	198	12					
	197	13					
	196	14				Sand- cream to light brown, very coarse to coarse grained, subrounded to rounded grains	
	195	15					
	194	16	<				
	193	17				Sand- cream to light brown, coarse to very coarse, rounded to subrounded grains	
	192	18					
	191	19					
	190	20					

Other Information: GPS Coordinates sourced from handheld devices. Survey conducted post exploration.
Stratum contacts determined by hardness, colour, sample recovery and litholgical analysis.

Logged By: MA	Checked By GT (12/01/2017)	Version: 2801_HMA_DO_LOG_MW12_V3

BOREHOLE LOG

Name of Hole:MW12

Project Number: 2801
Client: Hodgson Quarry Products and Plant
Project: Drilling Operations/ Groundwater Study
Location: Off Roberts Road, Maroota, NSW
Logged by: MA

MAROOTA

Date Commenced: 08/12/2016
Date Completed: 08/12/2016
Surface RL: 210.275m
Collar Height: 0.48m
Coordinates: 313902 6295583
Drilling Contractor: Ultra Drilling Waterbores

Drill Type	Elevation (RL)	Depth (m)	Piezometer Design	Photo Log	Graphic Log	Description	Additional Information
Hammer Bit	189	21				Sand- brown to light brown, fine to coarse, subrounded to rounded	Not Hammering
	188	22					
	187	23					
	186	24				Sandstone- grey to brown, fine to medium grained, subrounded to rounded grains	Shale laminations, hard
	185	25					
	184	26					
	183	27					
	182	28				Hole Terminated in Hawkesbury Sandstone	

Piezo Legend

- 2mm Gravel Pack
- Bentonite Seal
- Casing Blank
- Casing Slotted
- Fill
- Cap

Other Information: GPS Coordinates sourced from handheld devices. Survey conducted post exploration.
Stratum contacts determined by hardness, colour, sample recovery and litholgical analysis.

Logged By: MA	Checked By GT (12/01/2017)	Version: 2801_HMA_DO_LOG_MW12_V3

BOREHOLE LOG

Name of Hole:MW12

Project Number: 2801

Client: Hodgson Quarry Products and Plant

Project: Drilling Operations/ Groundwater Study

Location: Off Roberts Road, Maroota, NSW

Logged by: MA

MAROOTA

Date Commenced: 08/12/2016

Date Completed: 08/12/2016

Surface RL: 210.275m

Collar Height: 0.48m

Coordinates: 313902 6295583

Drilling Contractor: Ultra Drilling Waterbores

Drill Type	Elevation (RL)	Depth (m)	Piezometer Design	Photo Log	Graphic Log	Description	Additional Information

Other Information: GPS Coordinates sourced from handheld devices. Survey conducted post exploration.
Stratum contacts determined by hardness, colour, sample recovery and litholgical analysis.

Logged By: MA	Checked By GT (12/01/2017)	Version: 2801_HMA_DO_LOG_MW12_V3

Appendix C: Statement of Accuracy

Statement of Accuracy Maroota Quarry– as of 10th January 2019

Table 1 Data Acquisition

Item	Description
Source of survey	NSW Spatial Services – DEM format May 2017
Date of Survey	May 2017
Date files received	8th January 2019
File format	Geo referenced Ortho-photo and DXF
Ground control	Not supplied
Data Accuracy	Not supplied
Equipment	Not supplied
Software	SURPAC
Property Boundary	Inferred, not verified.
Mine lease or Authority Boundary	Not required

Table 2 Processing and Manipulation

Item	Description
VGT Raw File location	V:\Jobs_HMA Maroota\1_Base_Boundary\3D Survey\gov survey May 2017\DATA_6383\NSW Government\DEMs\1 Metre
VGT file import	Converted DXF to STR file using SURPAC
VGT manipulation	12d conversion from Digital Elevation Model (DEM) to Triangular Irregular Network (TIN) then contoured to produce DXF for surpac input.
Ground truthing	Review topography visually and overlay air photography (provided from nearmaps)
Conversion of data	String (str) file converted to Digital Terrain Model (DTM) using Surpac
Quarry Model Development	Top of cut was digitised using Surpac tool, utilised previous southern and eastern boundaries from resource review undertaken in May 2018
Batter and Bench design	A 1 horizontal: 0.5 vertical single batter was adopted, as similar batters were found in 2017 survey.
Base of Clay	A base of clay was determined using photography interpolation and drill holes.
Verification	None

Table 3 Attributes

Item	Description
Buffers	EIS Mod 2 Figure MP-05 B July 2000, Final Landform/Rehabilitation Plan, prepared by Nexus
Infrastructure	As identified in EIS Mod 2 Figure MP-05 B July 2000, Final Landform/Rehabilitation Plan, prepared by Nexus
Overburden	Site observations suggest and average topsoil thickness of 0.5 metres. This has been excluded from the calculations.
Resource Type	The lensing nature of sand, clay and sandstone is too difficult to predict amounts, therefore a total volume is presented.
Mining techniques	The mining procedure involves most of the resource to be processed.
Onsite Processing	The sand processing involves crushing, sorting and cleaning the sand. Reject fines are stored in ponds.
Verification	

APPENDIX 5

Figure Three – Landscape and Rehabilitation Plan

Plan of:	Roberts Rd Maroota Sand Quarry Rehabilitation Plan 2017 - Final Rehabilitation Plan (EA Plan LPDA 15-94/4)	***Location:***	Maroota Quarry, Roberts Road, Maroota, NSW	***Source:***	Conzept Landscape Architects/Nexus Environmental Planning Pty Ltd Proposed Rehabilitation of Existing Sand Mine/Final Rehabilitation Details/Section 75W Modification 2 Dwg No:LPDA 15-94/4 Rev D 7/09/2015	***Our Ref:***	5072_HMA_EMP_RP17_C003_V2_F3.cdr
Figure:	THREE	***Council:***	Hills Shire Council	***Survey:***	N/A	***Plan By:***	LT/JD
Sheet:	1 of 1	***Tenures:***	N/A	***Projection:***	N/A	***Project Manager:***	LT
Version/Date:	V2 09/03/2018	***Client:***	Hodgson Quarries & Plant Pty Ltd	***Contour Interval:***	N/A	***Office:***	Thornton

N

0 20 40 60 80 100m

vgt Environmental Compliance Solutions Pty Ltd

LEGEND

- FINAL DAM LOCATION AND EXTENTS - REFER ENGINEER'S PLANS
- EXISTING VEGETATION TO BE RETAINED AND PROTECTED
- STAGES 3, 4, 5 AND 6 BUND WALLS TO BE STABILISED WITH JUTE MATTING AND POCKET PLANTING - REFER DETAILS 4, 5 AND 6
- STAGES 3, 4, 5 AND 6 BUND WALLS TO BE REMOVED WHERE WITHIN FINAL EXCAVATION EXTENTS
- EXISTING VEGETATED BUND WALLS TO BE RETAINED
- EXISTING VEGETATED BUND WALLS TO BE REMOVED WHERE WITHIN FINAL EXCAVATION EXTENTS
- BOTTOM OF PIT TO BE HYDRO-MULCHED WITH NATIVE SEED MIX - REFER DETAIL 10
- 1V:3H GRADE EMBANKMENTS MASS PLANTED WITH ENDEMIC SPECIES - REFER DETAILS 07 AND 08
- EMBANKMENTS WITH FINAL SLOPES STEEPER THAN 1V:3H TO BE STABILISED WITH JUTE MATTING AND POCKET PLANTED WITH ENDEMIC SPECIES - REFER DETAILS 07 AND 11
- ENDEMIC SCREEN PLANTING WITHIN PERIMETER BUFFER SETBACKS - REFER DETAILS 07 AND 08
- STAGE 5B EXTRACTION ZONE TO BE USED FOR THE STOCKPILING OF SITE TOPSOIL AND SUBSOIL, AND USED FOR FINAL REHABILITATION PLANTING PREPARATION WORKS - REFER DETAILS

THE FOLLOWING SHALL BE UNDERTAKEN TO ENSURE AVAILABLE MATERIAL FOR THE PLANTING PREPARATION OF THE FINAL REHABILITATED SITE:

- 300MM DEPTH TOPSOIL TO BE EXCAVATED AND STOCKPILED (WITHIN STAGE 5 EXCAVATION ZONE)
- SUBSOIL TO BE TO BE EXCAVATED AND STOCKPILED (WITHIN STAGE 5 EXCAVATION ZONE)

THIS MATERIAL SHALL BE EXCAVATED AND STOCKPILED PRIOR TO COMMENCEMENT OF THE EXTRACTION WORKS FOR EACH STAGE, AND SHALL BE STORED SEPARATELY TO STOCKPILED MATERIAL FOR BUND WALL CONSTRUCTION.

STOCKPILED MATERIAL SHALL BE USED PROGRESSIVELY AS AREAS OF THE SITE ARE EXCAVATED AND FINISHED IN THEIR FINAL FORM AND READY FOR REHABILITATION PLANTING WORKS.

STOCKPILES MUST BE CLEARLY LABELLED AND IDENTIFIABLE TO ENSURE CORRECT FUTURE USE. APPROPRIATE SEDIMENT AND EROSION CONTROL MEASURES SHALL BE UNDERTAKEN TO ENSURE NO MIXING, LEACHING, RUN-OFF OR CONTAMINATION OF STOCKPILES.

CONSULTANTS INFORMATION

REFER TO PLANS, DETAILS, SPECIFICATION AND REPORTS PREPARED BY OTHER CONSULTANTS FOR ALL INFORMATION RELATING TO THAT PRACTICE, INCLUDING:

- NEXUS ENVIRONMENTAL PLANNING: PROJECT MANAGEMENT AND PLANNING
- LYLE MARSHALL & ASSOCIATES: TRAFFIC AND ACCESS
- AUSTRALIAN GROUNDWATER TECHNOLOGIES: GROUNDWATER MONITORING & MANAGEMENT
- PETER DUNDON & ASSOCIATES: GROUNDWATER
- VGT ENVIRONMENTAL COMPLIANCE SOLUTIONS: SITE LAYOUT AND EXTRACTION PLANS, MODIFIED DAM DESIGN, MODIFIED RESOURCE VOLUMES
- WILKINSON MURRAY: ACOUSTIC IMPACT ASSESSMENT, AIR QUALITY ASSESSMENT

Manager Hodgson Quarries & Plant Pty Ltd: Martin Hodgson
Signed: Martin R. Hodgson
Date: 20/3/18

Project Manager VGT: Lisa Thomson
Signed: Lisa Thomson
Date: 16/3/18

CANOPY TREE: *ANGOPHORA COSTATA*

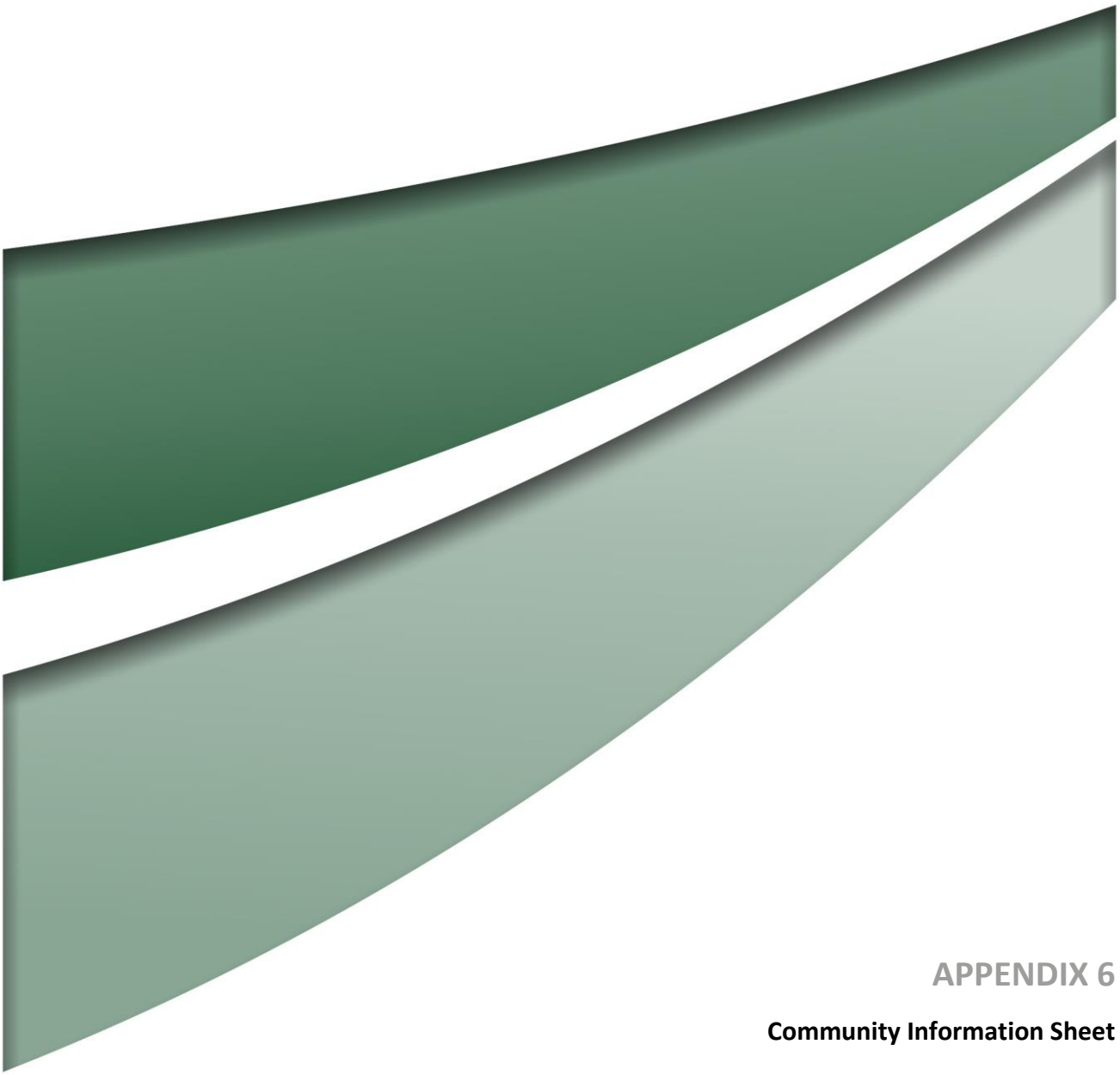
CANOPY TREE: *A. FLORIBUNDA*

SMALL TREE: *ACACIA PARRAMATTENSIS*

SMALL TREE: *ALLOCASUARINA LITTORALIS*

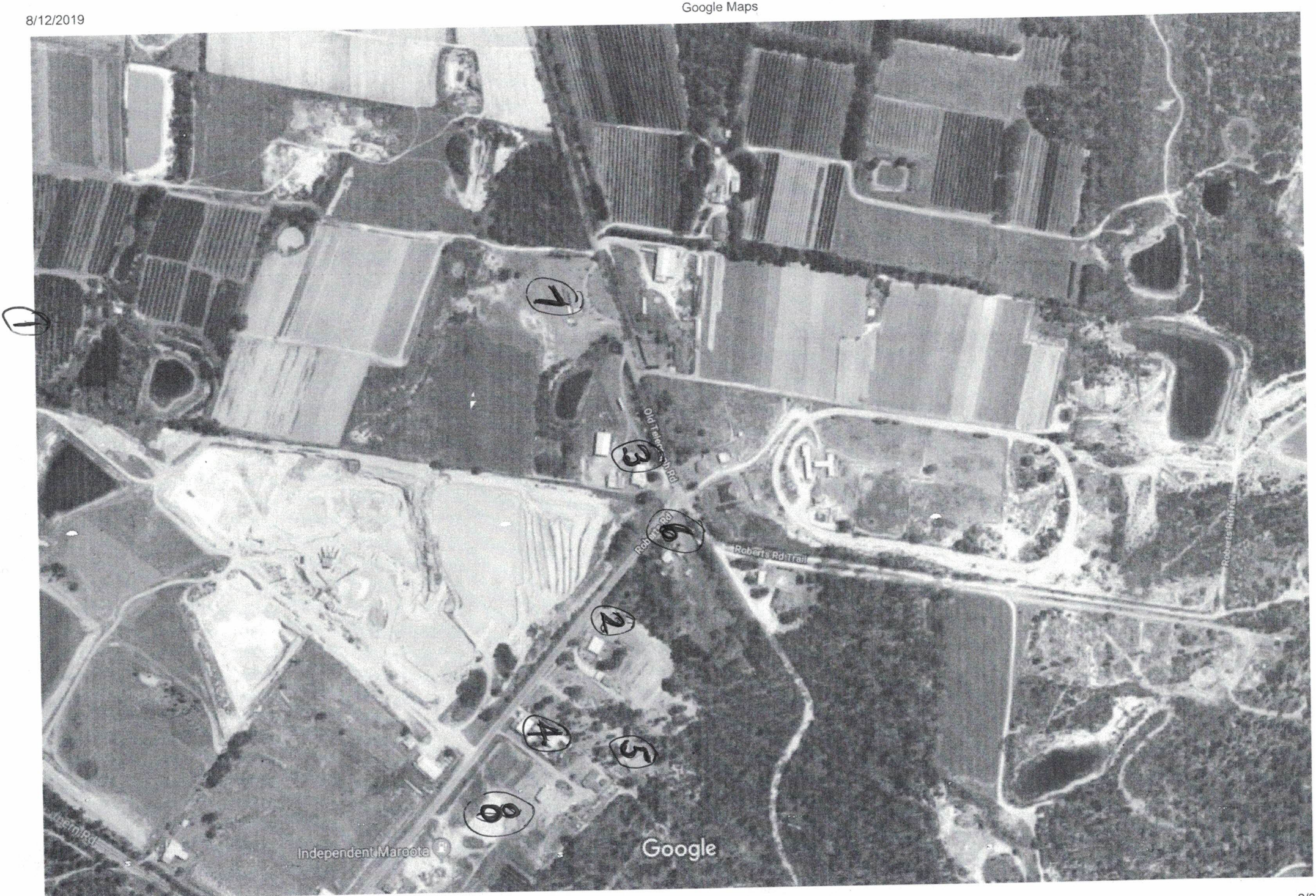
NATIVE GRASS: *LOMANDRA LONGIFOLIA*

GROUNDCOVER: *HARDENBERGIA*



APPENDIX 6

Community Information Sheet


1
7
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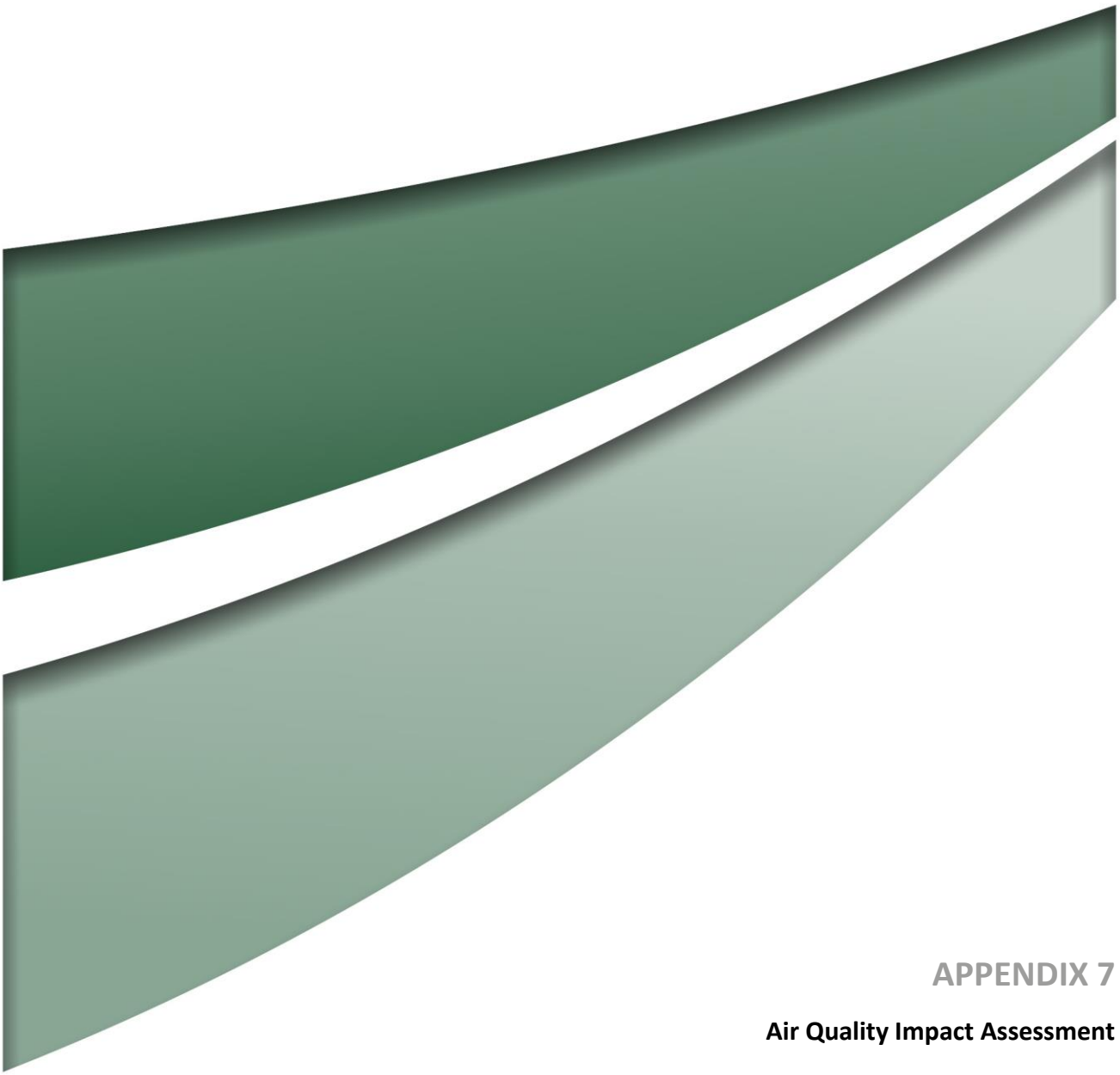
Roberts Rd Trail
Independent Maroota
Google



APPENDIX 7

Air Quality Impact Assessment

Roberts Road Quarry

Umwelt Australia Pty Ltd

Air Quality Impact Assessment for Proposed Modification 4

F0 | v0

34 Jun 2019

Roberts Road Quarry

Project No:	IA206300
Document Title:	Air Quality Impact Assessment for Proposed Modification 4
Document No.:	F0
Revision:	v0
Date:	34 Jun 2019
Client Name:	Umwelt Australia Pty Ltd
Project Manager:	Luke Spencer
Author:	Luke Spencer
File Name:	J:\IE\Projects\04_Eastern\IA206300\21 Deliverables\11_Report\Roberts Road Quarry_AQIA_F0v0.docx

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Document history and status

Revision	Date	Description	By	Review	Approved
D0v0	31/05/2019	Initial draft for internal technical review	LS	SL	SL
D0v1	03/06/2019	Second draft following initial client review	LS	SL	SL
F0v0	04/06/2019	Final	LS	SL	SL

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Executive Summary

This report provides an assessment of the air quality impacts of the proposed modification to allow VENM/ENM importation at Roberts Road Quarry. The air quality impact assessment has been carried out in accordance with the EPA's "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (EPA, 2016).

Identification of key risks

The primary air quality issue associated with the proposal was identified to be dust (that is, particulate matter in the form of TSP, deposited dust, PM_{10} or $PM_{2.5}$) from continued quarrying operations, as well as planned VENM/ENM importation activities.

Existing environment

A detailed review of the existing environment was carried out to understand key features of the existing environment. Aerial imagery was reviewed to identify sensitive receivers around the Quarry. Meteorological observations from the on-site automatic weather station were analysed to identify a suitable meteorological year for the assessment. Air quality monitoring data collected from dust deposition gauges and a High-Volume Air Sampler at the Quarry were reviewed, as well as data from a nearby monitor operated at the Maroota Public School by Dixon Sands. These data were used to establish background conditions around the Quarry, identify any current air quality related issues and establish values to be applied as part of the assessment.

Assessment of impacts

The computer-based dispersion model known as CALPUFF was used to predict the potential air quality impacts of the proposed modification. The dispersion modelling accounted for meteorological conditions, land use and terrain information and used dust emission estimates to predict the off-site air quality impacts. The focus of the assessment was on the potential change in air quality, noting that the Quarry already contributes to existing air quality.

The main conclusions of the assessment for each key pollutant and assessable averaging time were:

- Annually averaged TSP, annually averaged PM_{10}, and deposited dust: The proposed modification would not result in exceedances of the EPA's relevant impact assessment criteria at any of the nearest sensitive receivers.
- 24-hour averaged PM_{10}: The proposed modification has a potential to result in additional exceedances at the most-affected sensitive receivers.
- Annually averaged $PM_{2.5}$: Background concentrations already exceed the EPA's 8 µg/m^3 criterion, however data from the nearest OEH station indicates that the monitored levels may be unexplainably higher than what could be expected. Still, the proposed modification was predicted to increase annual average $PM_{2.5}$ concentrations by 0.5 µg/m^3 (i.e. around 4 percent) and 0.4 µg/m^3 (i.e. approximately 3 percent) at the most-affected sensitive receivers for VENM/ENM filling in the north and south of the Quarry respectively.
- 24-hour averaged $PM_{2.5}$: The proposed modification would not lead to any additional exceedances at the most-affected sensitive receivers.

The key matter identified was the potential for additional days exceeding the EPA's 50 µg/m^3 24-hour average PM_{10} criteria at the nearest sensitive receivers. Further reviews of the circumstances leading to these additional exceedances were completed which identified that the main potential for exceedances was on days when PM_{10} concentrations were already elevated.

Recommended safeguards

Safeguard measures have been recommended to proactively identify meteorological conditions that could lead to elevated background PM_{10} concentrations, to assist with operations planning and management. Further visual verifications were recommended should conditions arise during operations, such that the level of activity,

location and controls would need to be reviewed. Review of the siting of the on-site meteorological station was also recommended, to improve the usefulness of data collected.

With respect to Voluntary Land Acquisition and Mitigation Policy (VLAMP), which is applicable to the Quarry as a State Significant Development, the conservative, potential predictions of the assessment indicate that the provisions of this guideline could apply. To ascertain whether operations present an actual rather than potential risk, it was recommended that future monitoring be considered with the EPA.

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to quantify the potential air quality impacts of the proposed VENM/ENM importation modification at Roberts Road Quarry in accordance with the scope of services set out in the contract between Jacobs and Umwelt Australia Pty Ltd (Umwelt). That scope of services, as described in this report, was developed with Umwelt.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by Umwelt and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from Umwelt (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, Umwelt, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Umwelt accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1. Introduction

Roberts Road Quarry (the Quarry) is operated by Hodgson Quarries and Plant Pty Ltd (Hodgson Quarries) on Lots 1 and 2, DP 228308; and Lot 2, DP 312327, within the Hills Shire Council Local Government Area (LGA) (see to **Figure 1-1** below). The Quarry operates in accordance with Development Consent DA 267-11-99 which permits the extraction and on-site processing of sand, clay and pebble. DA 267-11-99 has been modified three times, with the most recent update allowing an amendment to the dam construction process from stages two and three, modification to the sequence and process of extraction, and extension of the approved life until 2026, granted 18 March 2016.

Hodgson Quarries is proposing a fourth modification to DA 267-11-99 to allow the importation of clean fill material generated from Sydney construction projects, increase the number of truck movements generated by the Quarry, and extend the life of the Quarry (beyond 2026). Umwelt (Australia) Pty Ltd (Umwelt) is assisting Hodgson Quarries with the environmental approval process for this modification and has engaged Jacobs Group Australia Pty Ltd (Jacobs) to prepare an Air Quality Impact Assessment (AQIA) to assess the potential for air quality impacts as a result of the proposed modification. A Preliminary Environmental Assessment (PEA) prepared by Umwelt to support an application for Environmental Assessment Requirements from the Department of Planning & Environment (DPE) (Umwelt, 2019) identified the need for

> *"further review of potential sources of dust emissions will be undertaken and dispersion modelling undertaken to demonstrate that the minor modifications to operations will not result in exceedance of the nominated air quality criteria".*

Additionally, the NSW Environment Protection Authority (NSW EPA) requested an air quality assessment be completed for the modification. Their requirements and where they are addressed in this report as listed in **Table 1-1**.

Table 1-1 NSW EPA air quality assessment requirements for the modification

Environmental aspect	Requirement	Where addressed in this report
Air quality	The additional processing of some VENM and ENM materials, increase in daily truck movements and additional area exposure has the potential to increase the generation of dust (PM_{10} and $PM_{2.5}$) and other pollutant emission beyond the boundary of the premises. It is therefore recommended that you undertake an air assessment in accordance with the Approved Methods for the Modelling and assessment of Air Pollutants in NSW and Approved Methods for the Sampling and Analysis of Air Pollutants in NSW, including:	This report
	- a description of the existing air quality and meteorology using existing information and site representative ambient monitoring data;	**Section 5**
	- an outline of the point and fugitive sources of all pollutant emissions and the resulting ground level concentrations of all pollutants at all sensitive receivers;	**Section 6** and **Section 7**
	- a description of the effects and significance of resulting pollutant concentrations on the environment, human health, amenity and regional ambient air quality standard and goals; and	**Section 8**
	- details of the mitigation measures proposed in managing the any additional impacts of air emission from the proposed modification.	**Section 9**

In achieving the assessment objectives identified in the PEA and assessment requirements of the NSW EPA, the objectives of this report were to:

- Outline existing and proposed Quarry operations, and the wider local setting (**Section 2**);
- Identify key air quality risks associated with the proposed modifications (**Section 3**);
- Establish suitable assessment criteria (**Section 4**);

- Describe existing local meteorological and background air quality conditions (**Section 5**);
- Estimate changes in emissions to air as a result of the proposed modification (**Section 6**);
- Explain the methods used to predict potential air quality impacts (**Section 7**);
- Present potential air quality impacts, as determined by the comparison of results from dispersion modelling with criteria, and results for existing operations (**Section 8**); and
- Recommend suitable mitigation, management and monitoring measures to address any predicted increases in impacts (**Section 9**).

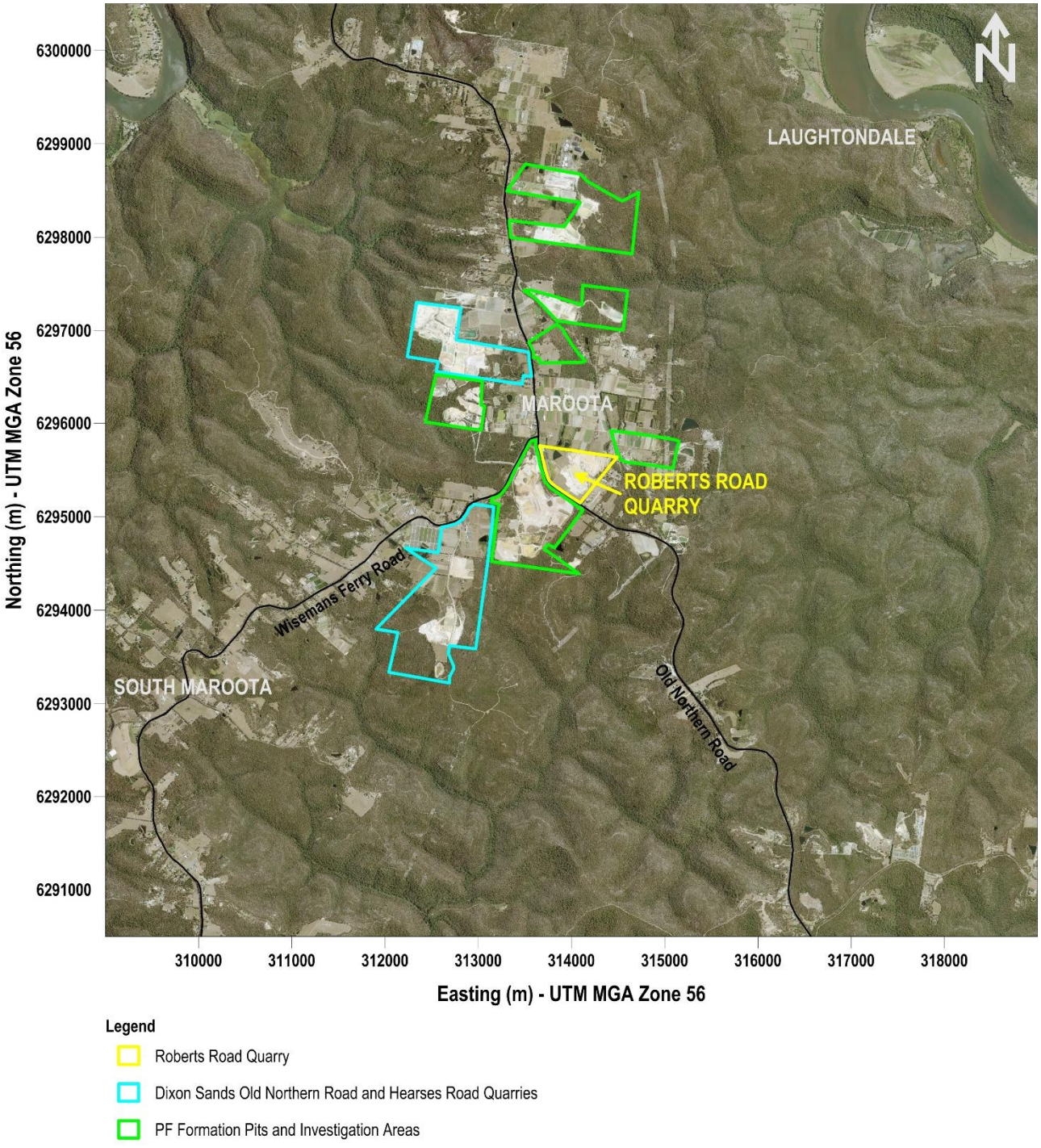


Figure 1-1 Location of Roberts Road Quarry

2. Project description

The Quarry is currently approved to produce a range of coarse, fine and ultra-fine sand, clay and pebble products. Although DA 267-11-99 does not include a limit on annual extraction, production is limited by the number of truck movements allowed from the Quarry. This limit is presently 50 laden trucks (i.e. 100 movements) per day and a maximum of 20 movements per hour; equating to a theoretical maximum of around 480,000 tonnes per annum (tpa). Extraction and processing of these products are undertaken at the Quarry, with most products transported to Sydney construction projects. The proposed modification seeks to change operations at the Quarry in the following ways:

- Up to 300,000 t of Virgin Excavated Natural Material (VENM) and Excavated Natural Material (ENM) would be imported to the Quarry annually.
- The VENM and ENM would be primarily used to backfill the completed sections of the extraction area and recreate a final landform which more closely reflects the pre-Quarry topography. A portion of the imported VENM and ENM, containing sufficiently high proportion of sandstone or sand, would be blended with existing resources at the Quarry to extend its operational life. Based on an analysis of the remaining resources of the Quarry and selective blending with the imported VENM/ENM, a further increase in the life of the Quarry of around 5 years to 2030 is proposed.
- To accommodate the importation of VENM and ENM, the number of daily truck movements to and from the Quarry would need to increase from 100 to 140 movements per day.
- To accommodate the additional activities associated with the importation, placement and profiling of the VENM and ENM, Condition 29 (c) of DA 267-11-99 which restricts the extent of the ‘exposed and active’ working areas to 3 hectares would also need to be amended.

Figure 2-1 below shows the approximate boundary of the Quarry, and the nearest surrounding sensitive receiver locations. It is noted that the Quarry boundary would not change as a result of the proposed modification. As **Figure 2-1** displays, the nearest residential receivers are located to the east of the site off Roberts Road, to the south and west off the Old Northern Road and northwest off Old Telegraph Road.

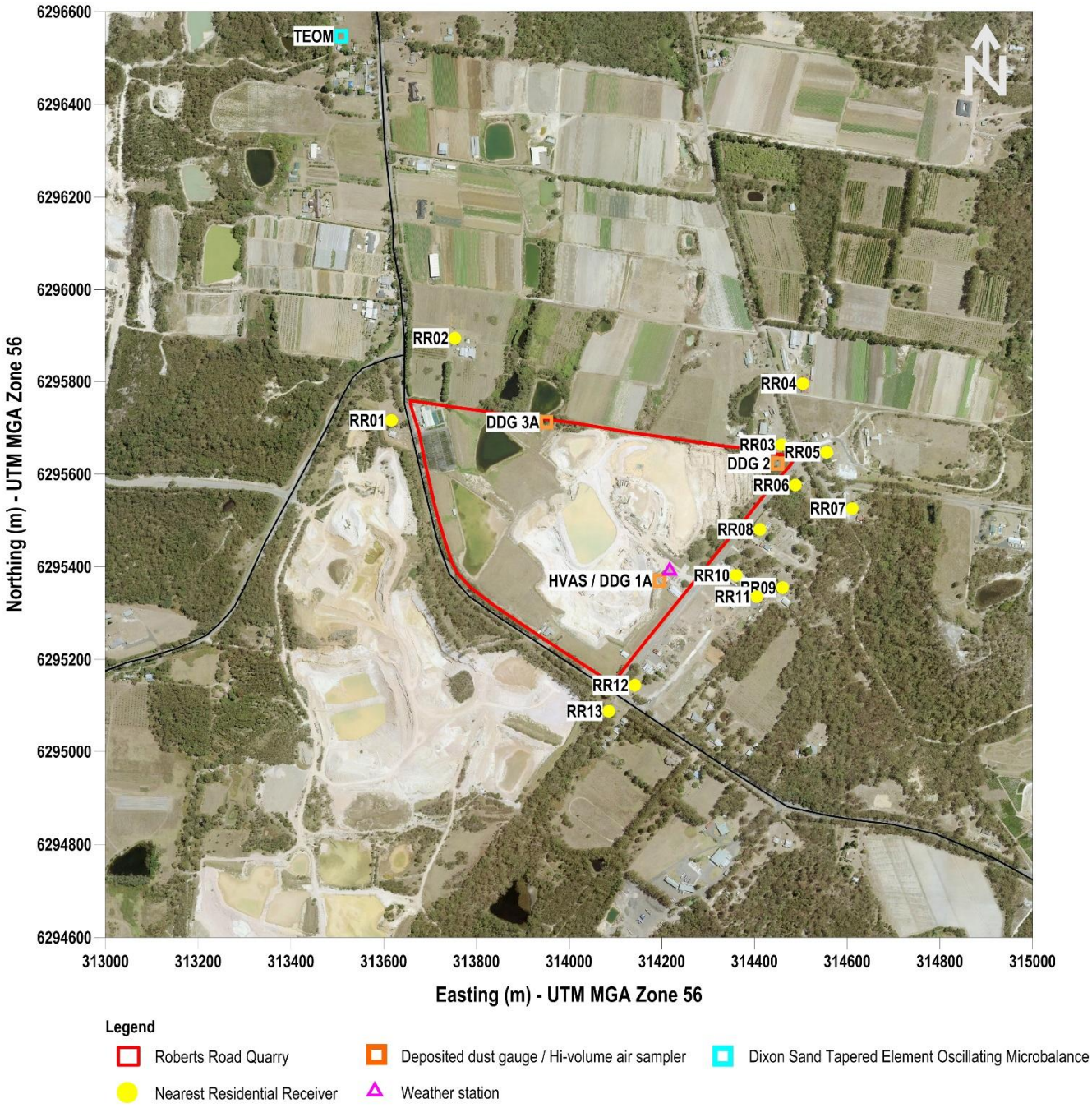


Figure 2-1 Roberts Road Quarry and surrounding residential receivers and monitoring stations

3. Air quality risks

Air quality issues can arise when emissions from an industry or activity lead to a deterioration in the ambient air quality. Potential air quality issues have been identified from a review of the proposed modification and its associated activities. This identification process has considered the types of emissions to air and proximity of these emission sources to sensitive receptors.

Emissions to air will occur from a variety of activities including material extraction, material handling, material transport, processing, and wind erosion of stored materials and exposed surfaces. These emissions would mainly comprise of particulate matter in the form of total suspended particulates (TSP), particulate matter with equivalent aerodynamic diameter of 10 microns or less (PM_{10}) and particulate matter with equivalent aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$). There would also be relatively minor emissions from machinery exhausts such as carbon monoxide (CO), oxides of nitrogen (NO_x) and particulate matter.

The primary air quality issue associated with the proposed modification was identified to be dust (that is, particulate matter in the form of TSP, deposited dust, PM_{10} or $PM_{2.5}$) from existing quarrying and planned VENM/ENM importation activities. The focus of this assessment was to predict how concentrations of dust generated by the modified operations at surrounding residential receivers would compare against existing (unmodified) operations and assessment criteria from applicable guidelines (refer to **Section 4** below).

4. Policy setting and assessment criteria

Typically, air quality is quantified by the concentrations of air pollutants in the ambient air. Air pollution occurs when the concentration (or some other measure of intensity) of substances known to cause health, nuisance and/or environmental effects, exceeds a certain level. With regard to human health and nuisance effects, the air pollutants most relevant to the Quarry are particulate matter emissions from, excavation works and material handling, transport and processing activities; as well as from wind erosion of stored materials and exposed surfaces (see **Section 3**).

There are various classifications of particulate matter and the EPA has developed assessment criteria for:

- TSP, to protect against nuisance amenity impacts;
- PM_{10}, to protect against health impacts;
- $PM_{2.5}$, to protect against health impacts; and
- Deposited dust, to protect against nuisance amenity impacts.

Most of the EPA criteria are drawn from national standards for air quality set by the National Environmental Protection Council of Australia (NEPC) as part of the National Environment Protection Measures (NEPM). To measure compliance with ambient air quality criteria, the Office of Environment and Heritage (OEH) has established a network of monitoring stations across the State and up-to-date records are published on the OEH website.

Air quality impacts from a project are determined by the level of compliance with the air quality criteria set by the EPA as part of their 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW' (Approved Methods), (EPA, 2016). These criteria are outlined in **Table 4-1** and apply to existing and potential sensitive receptors such as such as residences, schools and hospitals.

Table 4-1 EPA Impact assessment criteria

Substance	Averaging time	Criterion	Source
Particulate matter (PM_{10})	24-hour	50 µg/m^3	EPA (2016) / DoE (2016)
	Annual	25 µg/m^3	EPA (2016) / DoE (2016)
Particulate matter ($PM_{2.5}$)	24-hour	25 µg/m^3	EPA (2016) / DoE (2016)
	Annual	8 µg/m^3	EPA (2016) / DoE (2016)
Particulate matter (TSP)	Annual	90 µg/m^3	EPA (2016) / NHMRC (1996)
Deposited dust	Annual (maximum increase)	2 g/m^2/month	EPA (2016) / NERDDC (1998)
	Annual (maximum total)	4 g/m^2/month	EPA (2016) / NERDDC (1998)
Nitrogen dioxide (NO_2)	1-hour	246 µg/m^3	EPA (2016) / NEPC (1998)
	Annual	62 µg/m^3	EPA (2016) / NEPC (1998)

The EPA air quality assessment criteria relate to the total concentration of air pollutant in the air (that is, cumulative) and not just the contribution from project-specific sources. Therefore, some consideration of background levels needs to be made when using these criteria to assess the potential impacts. Further discussion of background levels around the proposal is provided in **Section 5**.

In situations where background levels are elevated, the proponent must "demonstrate that no additional exceedances of the impact assessment criteria will occur as a result of the proposed activity and that best management practices will be implemented to minimise emissions of air pollutants as far as is practical" (EPA, 2016).

The NSW Voluntary Land Acquisition and Mitigation Policy (VLAMP) (2018) includes the NSW Government's policy for voluntary mitigation and land acquisition to address dust (particulate matter) impacts from state

significant mining, petroleum and extractive industry developments. The VLAMP (2018) brings the air quality criteria in line with the NEPM standards and EPA criteria. From this Policy, voluntary mitigation or acquisition rights may apply where, even with best practice management, the development contributes to exceedances of the criteria specified in VLAMP 2018. The applicability of the VLAMP has been reviewed in the context of the certainty of potential air quality risks of the proposed modification.

5. Existing environment

5.1 Meteorology

Meteorological conditions are important for determining the direction and rate at which emissions from a source will disperse. The key meteorological requirements of air dispersion models are, typically, hourly records of wind speed, wind direction, temperature, and atmospheric stability. For air quality assessments, a minimum one year of hourly data is usually required, which means that almost all possible meteorological conditions, including seasonal variations, are considered in the model simulations.

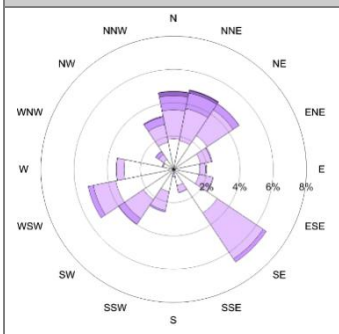
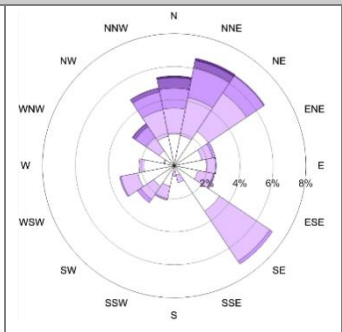
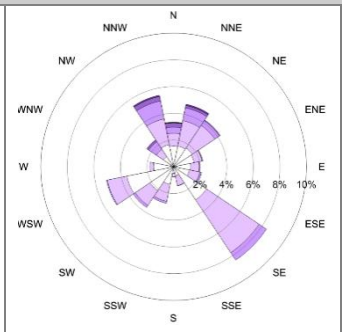
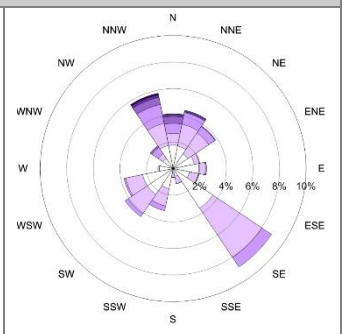
Hodgson Quarries operates a meteorological station on-site at Roberts Road Quarry. As **Figure 2-1** shows, the meteorological station is located near the southwestern boundary of the site, adjacent to the main site access point off Roberts Road. Data from the station for the period from 28 December 2013 to 7 February 2019 were provided by VGT Environmental Compliance Solutions who provide environmental monitoring and management services to the Quarry.

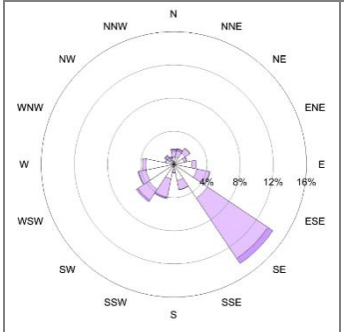
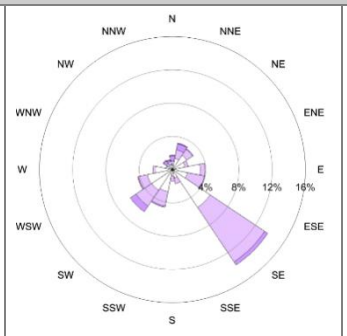
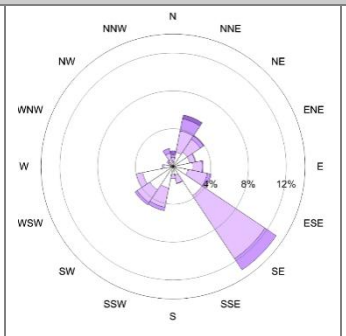
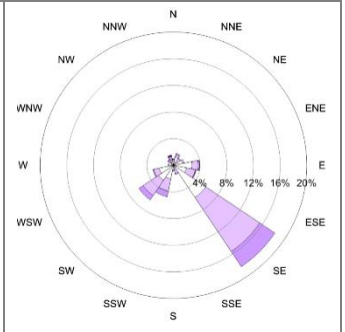
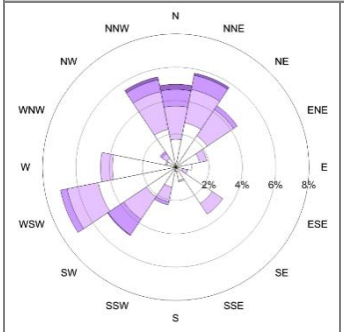
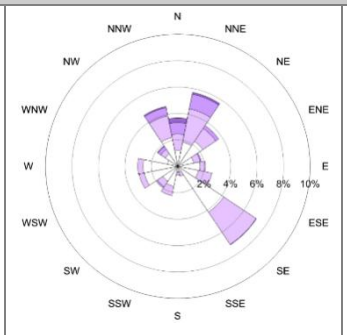
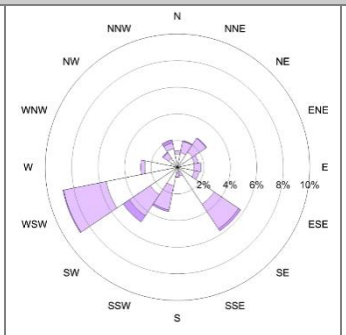
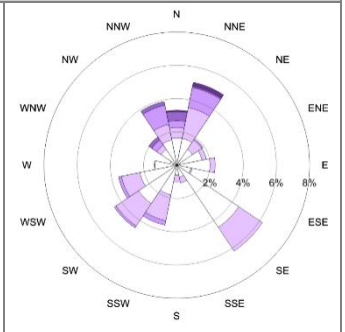
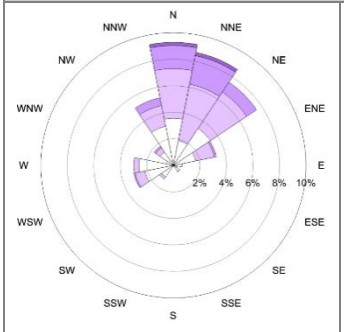
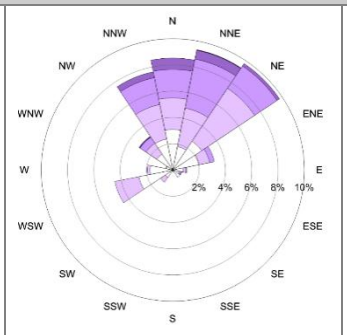
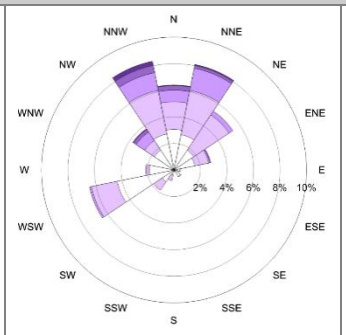
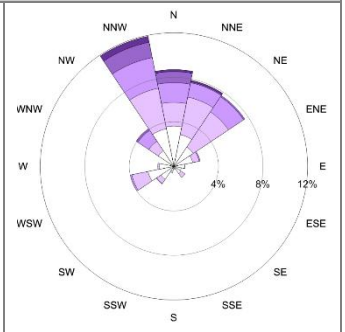
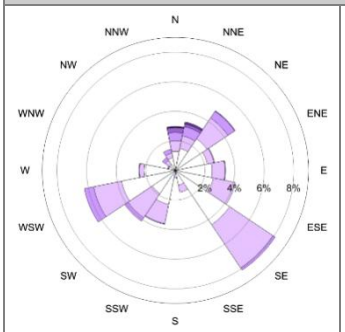
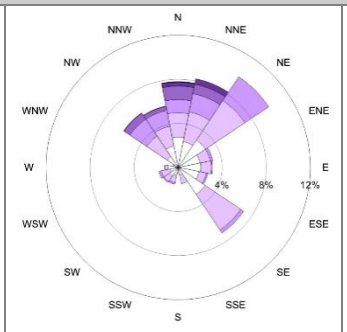
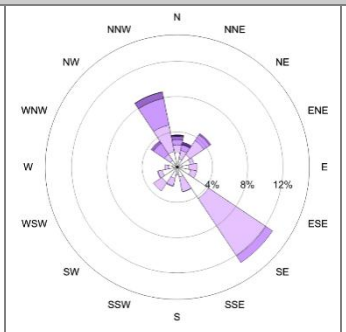
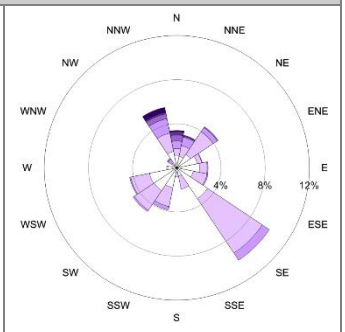
As outlined above, a minimum of one year of data is generally required for dispersion modelling assessments, and so data from the years' 2014 to 2018 were reviewed to determine a suitable year for the assessment. **Table 5-1** shows the statistics reviewed as part of this analysis.

Table 5-1 Annual statistics from meteorological data collected at Roberts Road Quarry meteorological station (2014 to 2018)

Statistic	2014	2015	2016	2017	2018
Percent complete (%)	85.1	97.6	99.9	91.6	99.9
Mean wind speed (m/s)	1.0	0.9	1.1	1.0	1.1
99th percentile wind speed (m/s)	4.9	4.0	5.4	4.9	5.8
Percentage of calms (%)	46.0	49.7	46.0	49.2	49.9
Percentage of winds >6 m/s (%)	0.3	0.1	0.3	0.3	0.6

As displayed in **Table 5-1**, mean wind speeds were generally of the order of 1.0 m/s. 99th percentile wind speeds (i.e. wind speeds only exceeded one percent of the time) were also consistent, ranging between 4.0 and 5.8 m/s. The percentage occurrence of calm conditions (i.e. when wind speeds were recorded less than 0.5 m/s) was also consistent, ranging from 46 to 50 percent. The EPA requires that, for "Level 2" assessments based on site-specific information, the meteorological data should be derived from a site-specific source and at least 90 percent complete. The 2015, 2016, 2017 and 2018 datasets meet the EPA's site-specific data capture rate requirements. With 2014 excluded owing to insufficient dataset completion; meteorological conditions in 2015, 2016, 2017 and 2018 were further analysed to identify representative year for modelling. Annual and seasonal wind roses were developed for these years. These are displayed below in **Figure 5-1**.

2015	2016	2017	2018
Annual			
 Calms: 49.7%	 Calms: 46.0%	 Calms: 49.2%	 Calms: 49.7%

2015	2016	2017	2018
Summer			
 Calms: 45.2%	 Calms: 44.5%	 Calms: 44.9%	 Calms: 48.4%
Autumn			
 Calms: 50.5%	 Calms: 54.3%	 Calms: 57.9%	 Calms: 56.9%
Winter			
 Calms: 54.7%	 Calms: 47.6%	 Calms: 52.2%	 Calms: 45.9%
Spring			
 Calms: 48.8%	 Calms: 37.5%	 Calms: 44.1%	 Calms: 47.6%
Legend			

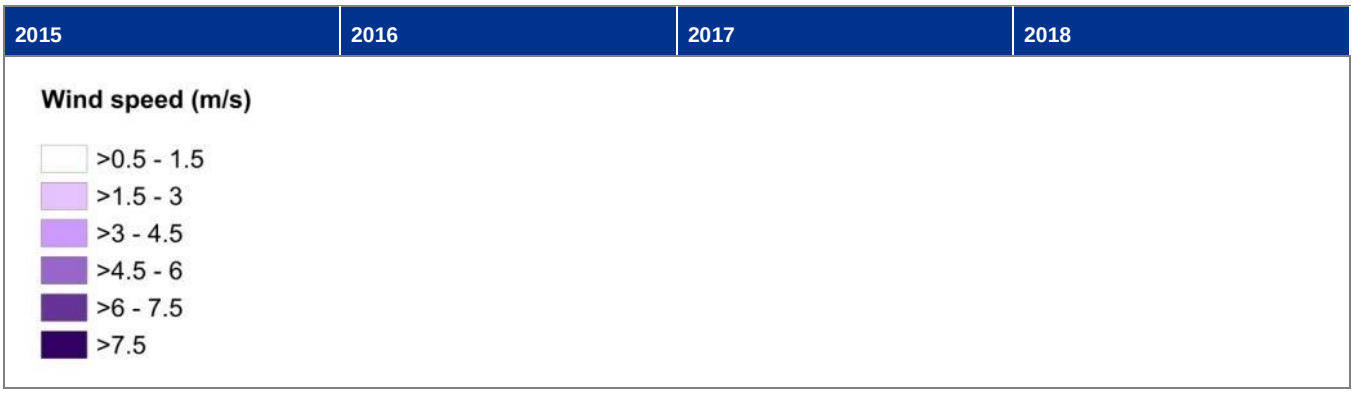


Figure 5-1 Annual and seasonal wind roses 2015 to 2018

The 2018 calendar year was selected selected as the meteorological modelling year. The reasoning for this selection was as follows:

- 2018 had a higher data capture rate compared with 2017, 2016 and 2015.
- A higher frequency of calm conditions was recorded in 2018. Calm conditions typically lead to higher predictions of ground-level concentrations as these conditions are often associated with poor dispersion whereby any dust emissions disperse more slowly and allow higher concentrations to exist for extended periods of time.
- Contemporaneous background data is available for 2018, to allow a more detailed review of changes in the number of exceedances. Further detail of this is provided below in **Section 5.2**.

5.2 Air quality conditions

The EPA air quality criteria refer to levels of substances which generally include the contribution from the project of interest as well as the contribution from existing sources. To fully assess impacts against all the relevant air quality criteria (see **Section 4**) it is necessary to have information or estimates of the existing air quality conditions. This section provides a description of the existing air quality.

Air quality around Roberts Road Quarry is monitored by VGT Environmental Compliance Solutions (VGT). This monitoring includes the measurement of:

- Total suspended particulates (TSP);
- Particulate matter (as PM_{10} and $PM_{2.5}$); and
- Dust deposition.

As displayed above in **Figure 2-1**, deposited dust is measured at three deposited dust gauges (DDGs) 1A, 2 and 3A located towards the eastern, north-eastern and northern boundaries of the site respectively. As shown, a high-volume air sampler (HVAS) measuring TSP, PM_{10} and $PM_{2.5}$ is also located near the eastern boundary adjacent to DDG 1A. Data collected from these locations from 15 January 2016 to 7 March 2019 reported on Hodgson Quarries website were reviewed to identify existing conditions around the Quarry.

As displayed in **Figure 1-1** there are several other quarries and extractive operations located near Roberts Road Quarry. Dixon Sand Penrith Pty Ltd (Dixon Sand) conduct quarrying operations at the Old Northern Road (one kilometre to the northwest of the Roberts Road Quarry) and Haerses Road (around one and a half kilometres to the southwest). Dixon Sand operate a tapered element oscillating microbalance (TEOM) at the Maroota Public School just to the southeast of their operations at the Old Northern Road Quarry. The indicative location of the TEOM in relation to Roberts Road Quarry is displayed above in **Figure 2-1**. Daily PM_{10} concentrations are measured at the TEOM, with data available on the website for 2017 and 2018 calendar years.

5.2.1 Total suspended particulates (TSP)

TSP data are collected every six days from the HVAS near DDG 1A. TSP concentration measurements were available from 18 August 2016 to 16 April 2018. The daily concentrations measured are summarised below in **Figure 5-2**.

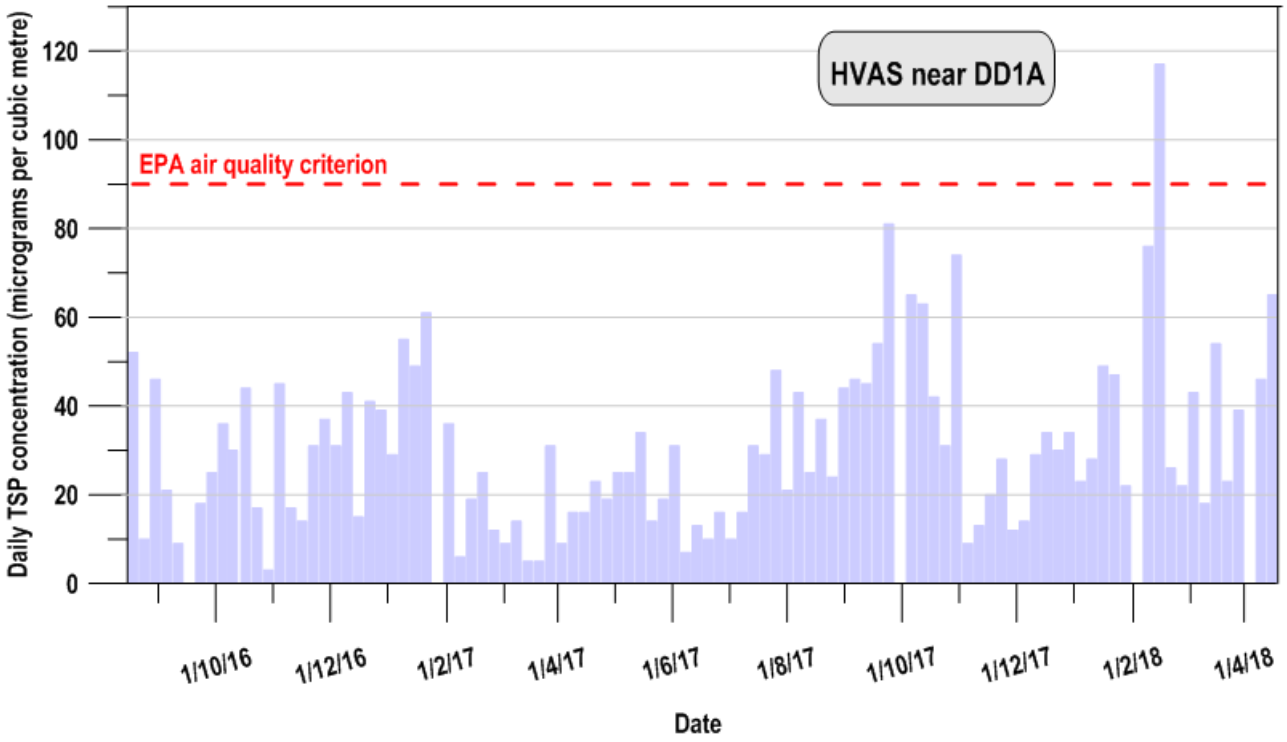


Figure 5-2 Measured 24-hour averaged TSP concentrations measured at Roberts Road Quarry HVAS

As displayed, annual TSP concentrations from this monitor were only able to be estimated from these data from one calendar year (2017), noting that the data for 2016 and 2018 were incomplete. For 2017, an annual TSP average of 29 µg/m^3 was measured, well below the EPA's 90 µg/m^3 assessment criteria.

5.2.2 Particulate matter (PM_{10})

Roberts Road Quarry HVAS

PM_{10} concentrations were also collected every 6 days from the Roberts Road Quarry HVAS. The data collected are displayed below in **Figure 5-3**.

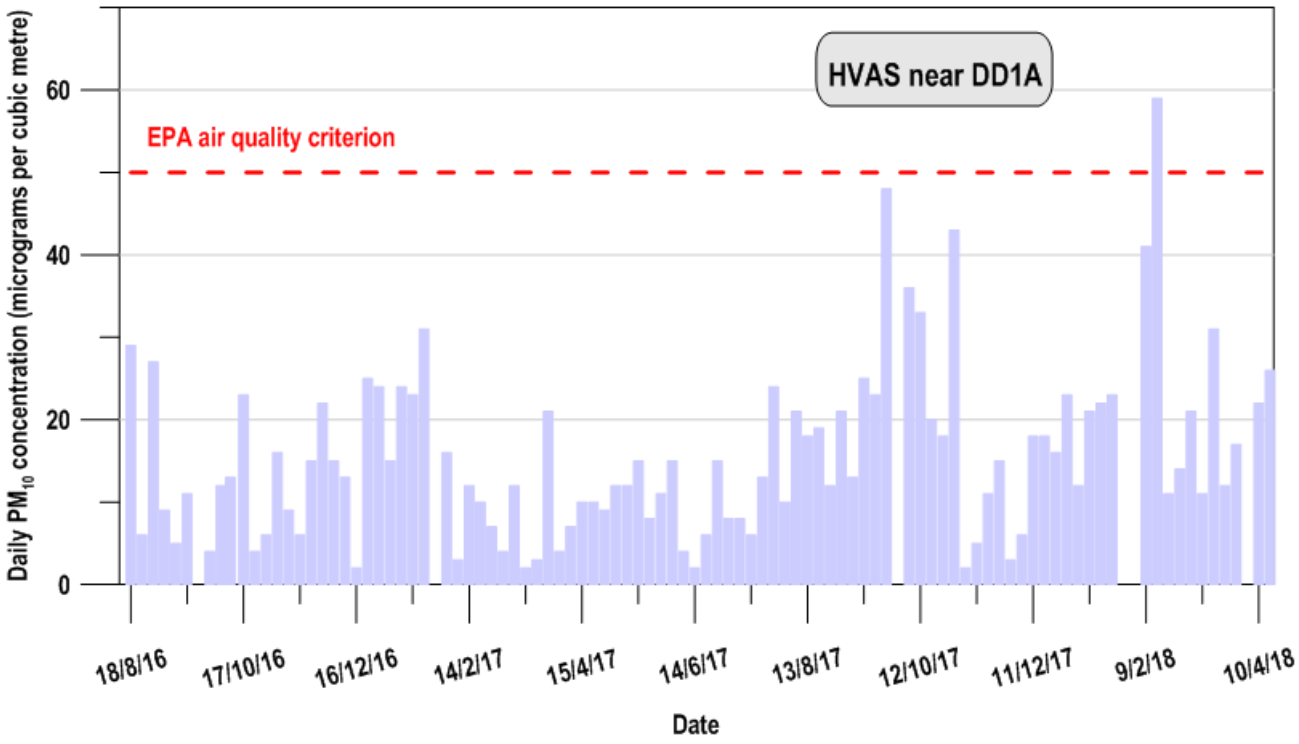


Figure 5-3 Measured 24-hour averaged PM_{10} concentrations measured at Roberts Road Quarry HVAS

Over the approximately 20 months of measurements between August 2016 and April 2018 the EPA's 24-hour averaged assessment criteria of 50 µg/m^3 was recorded to have been exceeded once. There may have been further exceedances over the period of available data, noting the six-day sampling frequency of the HVAS. For the only full calendar year (2017), the maximum recorded 24-hour average was 48 µg/m^3, with the maximum value over the 20-month period being 59 µg/m^3. The annually averaged PM_{10} concentration in 2017 was 15 µg/m^3, 10 µg/m^3 below the EPA's 25 µg/m^3 annual PM_{10} impact assessment criteria.

Dixon Sand TEOM

Daily measurements of PM_{10} are collected at the TEOM run by Dixon Sand near their Old Northern Road quarrying operations. These data are displayed below in **Figure 5-4**.

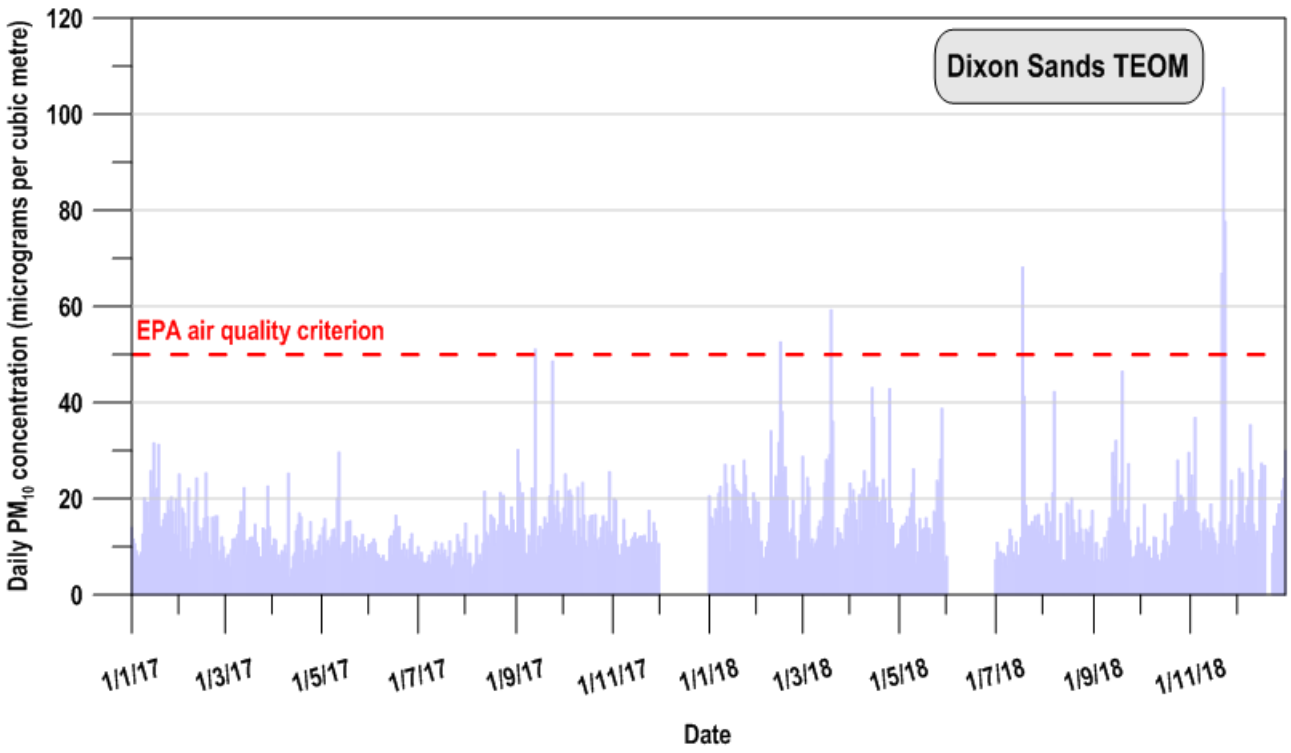


Figure 5-4 Measured 24-hour averaged PM_{10} concentrations measured at Dixon Sand Quarry TEOM

For the 2017 and 2018 period reviewed there were seven instances when 24-hour-averaged PM_{10} exceeded 50 µg/m^3. Each instance was investigated in their monitoring log, with six of the seven instances of exceedances having been in some way attributed to Dixon Sand's operations. Noting the data gaps in December 2017, June 2018 and 19 to 22 December 2018, annually averaged PM_{10} concentrations of 13 µg/m^3 and 17 µg/m^3 were measured in 2017 and 2018 respectively.

5.2.3 Particulate matter ($PM_{2.5}$)

The Roberts Road Quarry HVAS also measured $PM_{2.5}$ on a six-day cycle between August 2016 and April 2018. **Figure 5-5** below shows the 24-hour averaged $PM_{2.5}$ monitoring values.

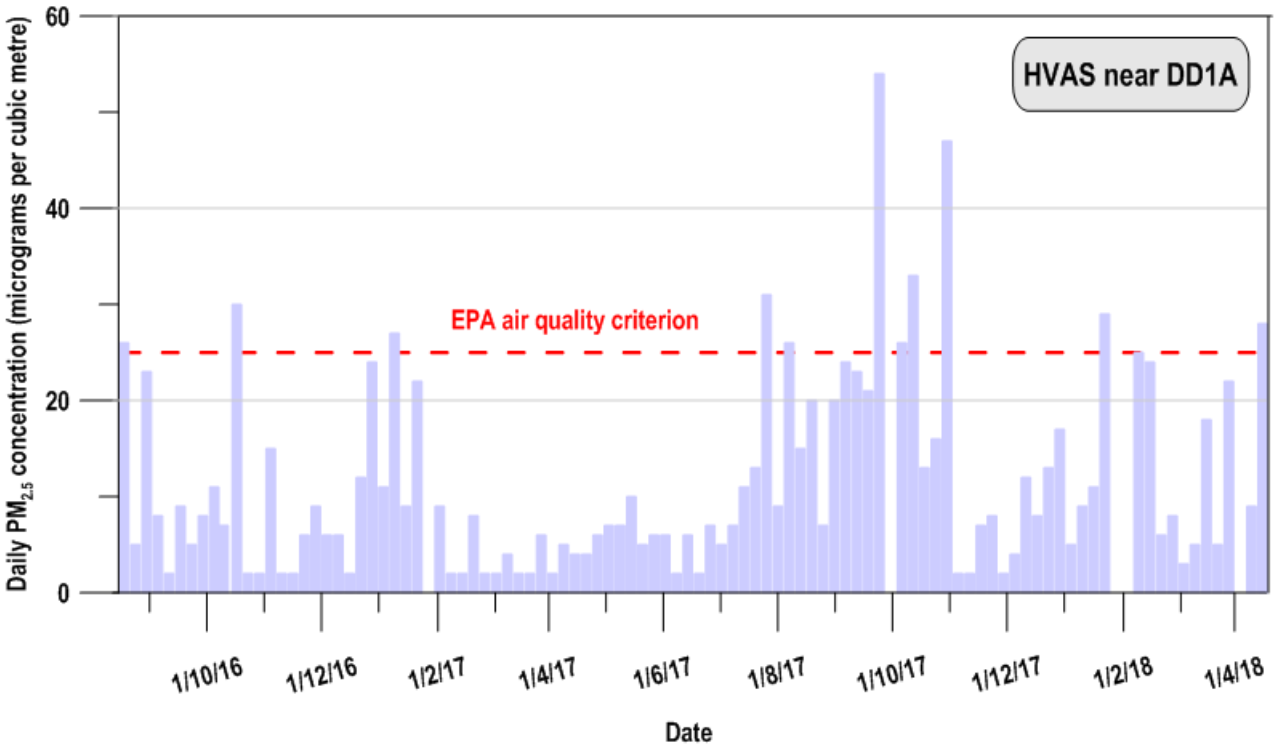


Figure 5-5 Measured 24-hour averaged $PM_{2.5}$ concentrations measured at Roberts Road Quarry HVAS

As displayed, there were 11 instances where the EPA's 24-hour averaged $PM_{2.5}$ assessment criteria of 25 µg/m^3 was exceeded, with seven of these instances recorded during the 2017 calendar year. There may have been further exceedances over the period of available data, noting the six-day sampling frequency of the HVAS.

For the 2017 calendar year, the maximum 24-hour averaged $PM_{2.5}$ concentration was 54 µg/m^3; that is, above the EPA's 25 µg/m^3 assessment criteria from the Approved Methods. The annual average in 2017 was 11.6 µg/m^3, 3.6 µg/m^3 above the 8 µg/m^3 EPA assessment criteria. It is noted that these values are high compared with the measured PM_{10} concentrations. It is generally common that $PM_{2.5}$ concentrations are around 50% or less than PM_{10}, although at the Quarry's HVAS they have been reported as being around 77%. The measured annual average of 11.6 µg/m^3 at the Quarry is also well above the values measured over the last five calendar years (2014 to 2018 inclusive) at the nearest air quality monitoring station operated by the Office of Environment and Heritage (OEH) at Richmond. Over these five years' annual averages of 6.7, 7.7, 7.9, 7.0, and 8.1 µg/m^3 were measured.

5.2.4 Deposited dust

Table 5-2 shows the annual average deposited dust levels for each gauge from data collected between 2016 and 2017.

Table 5-2 Summary of measured deposited dust levels near Roberts Road Quarry

Year	Annual average expressed as g/m^2/month			
	DDG 1A	DDG 2	DDG 3A	EPA criteria
2016	1.9	1.2	1.3	4
2017	1.9	1.8	1.9	

As displayed, deposited dust levels remained less than 50% of the EPA's 4 g/m^2/month at all three deposited dust gauges over 2016 and 2017.

5.3 Adopted background levels

One of the objectives for reviewing the air quality monitoring data was to determine appropriate background levels to be added to model predictions for the assessment of potential cumulative impacts, that is, Project contribution plus other sources. The establishment of background levels also needs to consider that there is an existing Quarry that is likely to contribute to measured levels. The estimated background levels that apply at sensitive receptors are shown below in **Table 5-3**.

Table 5-3 Assumed background levels that apply at sensitive receptors

Substance	Averaging time	Assumed background level that applies at sensitive receptors	Notes
Particulate matter (PM_{10})	24-hour	Daily PM_{10} measured values from Dixon Sand TEOM	Time-varying data collected at Dixon Sand TEOM for year of modelling (2018)
	Annual	17 µg/m^3	Annual average of data collected at Dixon Sand TEOM for year of modelling (2018)
Particulate matter ($PM_{2.5}$)	24-hour	Daily values based on measurements from Dixon Sand TEOM	Time-varying data collected at Dixon Sand TEOM for year of modelling (2018) with scaling applied based on the ratio of PM_{10} to $PM_{2.5}$ measured at Roberts Road HVAS. This ratio was 0.73.
	Annual	13 µg/m^3	Annual average of data collected at Dixon Sand TEOM for year of modelling (2018) with scaling applied based on the ratio of PM_{10} to $PM_{2.5}$ measured at Roberts Road HVAS. The measured on-site annual average in 2017 was 12 µg/m^3, so the value adopted is considered to be conservative.
Particulate matter (TSP)	Annual	32 µg/m^3	Annual average of data collected at Dixon Sand TEOM for year of modelling (2018) with scaling applied based on the ratio of PM_{10} to TSP measured at Roberts Road HVAS. It should be noted that the assumed level of 32 µg/m^3 is higher than the on-site measurement of 29 µg/m^3. This is a conservative approach.
Deposited dust	Annual	1.9 g/m^2/month	Highest value measured at DDG 1A, DDG 2 and DDG 3A for available 2016 and 2017 monitoring data

6. Emissions to air

6.1 Roberts Road Quarry

The most significant emission to air from the Quarry will be dust (particulate matter) due to material handling, material transport, processing, and wind erosion of stored and exposed surfaces. Estimates of these emissions are required by the dispersion model. Total dust emissions have been estimated by analysing the material handling schedule, equipment listing and Quarry plans and identifying the location and intensity of dust generating activities. Operations have been combined with emissions factors developed both locally and by the US EPA.

The emission factors used for this assessment have been drawn largely from the following sources:

- *Emission Estimation Technique Manual for Mining* (NPI, 2012); and
- AP 42 (US EPA, 1985 and updates).

Dust emission inventories have been developed for each of the modelled scenarios, namely:

- Existing operations, at the approved extraction rate, for comparison with future operations;
- Proposed Modification with VENM/ENM filling at northeast corner of the Quarry; and
- Proposed Modification with VENM/ENM filling at southeast corner of the Quarry.

The inventories applied in the assessment for each of these scenarios are summarised below in **Table 6-1** (existing), **Table 6-2** (proposed modification with VENM/ENM filling in the north) and **Table 6-3** (proposed modification with VENM/ENM filling in the south). The key change in these inventories between the assessment scenarios for the two modification options and existing operations are additional emissions associated with the hauling, unloading, and placement of VENM/ENM materials.

Table 6-1 Estimated TSP emissions from the Quarry

Activity	Estimated annual emissions (kg/y)		
	Existing	Proposed Modification, North	Proposed Modification, South
Dozers ripping materials	2,775	2,775	2,775
Excavators loading raw product to trucks	274	274	274
Hauling raw product to Screening 1	3,183	1,591	1,591
Unloading raw product to Screens 1	864	864	864
Screening 1	3,000	7,200	7,200
Loading product stockpiles	15	69	69
Excavators loading screened product to trucks	137	137	137
Hauling raw product to Screening 2	1,910	1,910	1,910
Unloading raw product to Screens 2	864	864	864
Screening 2	3,000	7,200	7,200
Loading product stockpiles	29	137	137
Excavators loading screened product to trucks	274	274	274
Hauling product off-site	1,715	1715	1715
Wind erosion from exposed areas, inactive	5,396	5,396	5,396
Wind erosion from exposed areas, active	4,906	4,906	4,906
Wind erosion from rehabilitation area (VENM/ENM placement), inactive in existing and	4,415	3,154	3,154

Activity	Estimated annual emissions (kg/y)		
	Existing	Proposed Modification, North	Proposed Modification, South
active in proposed options			
Wind erosion from product stockpiles	3,854	3,854	3,854
Hauling VENM/ENM to site	0	3,809	4,353
Unloading VENM/ENM	0	1,152	1,152
Dozers placing materials	0	2,775	2,775
Total	**36,612**	**47,282**	**47,826**

Table 6-2 Estimated PM_{10} emissions from the Quarry

Activity	Estimated annual emissions (kg/y)		
	Existing	Proposed Modification, North	Proposed Modification, South
Dozers ripping materials	417	417	417
Excavators loading raw product to trucks	130	130	130
Hauling raw product to Screening 1	681	340	340
Unloading raw product to Screens 1	310	310	310
Screening 1	1,032	2,400	2,400
Loading product stockpiles	7	32	32
Excavators loading screened product to trucks	65	65	65
Hauling raw product to Screening 2	409	409	409
Unloading raw product to Screens 2	310	310	310
Screening 2	1,032	2,400	2,400
Loading product stockpiles	14	65	65
Excavators loading screened product to trucks	130	130	130
Hauling product off-site	367	367	367
Wind erosion from exposed areas, inactive	2,698	2,698	2,698
Wind erosion from exposed areas, active	2,453	2,453	2,453
Wind erosion from rehabilitation area (VENM/ENM placement), inactive in existing and active in proposed options	2,208	1,577	1,577
Wind erosion from product stockpiles	1,927	1,927	1,927
Hauling VENM/ENM to site	0	815	931
Unloading VENM/ENM	0	413	413
Dozers placing materials	0	417	417
Total	**13,770**	**17,256**	**17,373**

Table 6-3 Estimated $PM_{2.5}$ emissions from the Quarry

Activity	Estimated annual emissions (kg/y)		
	Existing	Proposed Modification, North	Proposed Modification, South
Dozers ripping materials	21	21	21
Excavators loading raw product to trucks	14	14	14
Hauling raw product to Screening 1	34	17	17
Unloading raw product to Screens 1	43	43	43
Screening 1	150	360	360
Loading product stockpiles	1	3	3
Excavators loading screened product to trucks	7	7	7
Hauling raw product to Screening 2	20	20	20
Unloading raw product to Screens 2	43	43	43
Screening 2	150	360	360
Loading product stockpiles	1	7	7
Excavators loading screened product to trucks	14	14	14
Hauling product off-site	18	18	18
Wind erosion from exposed areas, inactive	135	135	135
Wind erosion from exposed areas, active	123	123	123
Wind erosion from rehabilitation area (VENM/ENM placement), inactive in existing and active in proposed options	110	79	79
Wind erosion from product stockpiles	96	96	96
Hauling VENM/ENM to site	0	41	47
Unloading VENM/ENM	0	58	58
Dozers placing materials	0	21	21
Total	**960**	**1,459**	**1,465**

It should be noted that the main intent of the inventories is to capture the most significant emission sources that may affect off-site air quality. Not every source will be captured, however, the contribution of emissions from sources not identified will be captured in the assumed background levels and these data have been added to the predicted Project contributions.

The following emission controls have been assumed to be applicable to the Project:

- Watering of unsealed access roads (leading to a 50% control on emissions);
- Watering during unloading of materials to screens (leading to a 70% control of emissions);
- Water sprays during loading of materials to stockpiles (leading to a 50% control of emissions);
- Water sprays on inactive (leading to a 30% control on emissions) and active extraction (leading to a 50% control on emissions) areas; and
- Partial rehabilitation in-place for the proposed northern VENM/ENM filling area for the existing scenario (leading to a 30% control on emissions).

6.2 Other local sources

As identified above in **Figure 1-1**, several other quarries are located in close proximity to the Quarry. It is expected that the same types of activities are taking place at these locations and that these operations would also contribute to local particulate matter air quality conditions.

7. Approach to assessment

7.1 Overview

This assessment has followed the EPA's Approved Methods which specifies how assessments based on the use of air dispersion models should be undertaken. The Approved Methods include guidelines for the preparation of meteorological data, reporting requirements and air quality assessment criteria to assess the significance of dispersion model predictions.

The CALPUFF computer-based air dispersion model has been used to predict ground-level concentrations and deposition levels due to the identified emission sources, and the model predictions have been compared with relevant air quality criteria. The choice of model has considered the expected transport distances for the emissions, as well as the potential for temporally and spatially varying flow fields due to influences of the locally complex terrain, non-uniform land use, and potential for stagnation conditions characterised by calm or very low wind speeds with variable wind directions.

The CALPUFF model, through the CALMET meteorological pre-processor, simulates complex meteorological patterns that exist in a particular region. The effects of local topography and changes in land surface characteristics are accounted for by this model. The model comprises meteorological modelling as well as dispersion modelling, both of which are described below.

7.2 Meteorological modelling

The air dispersion model used for this assessment, CALPUFF, requires information on the meteorological conditions in the modelled region. This information is typically generated by the meteorological pre-processor, CALMET, using surface observation data from local weather stations and upper air data from radio-sondes or numerical models, such as the CSIRO's prognostic model known as TAPM (The Air Pollution Model). CALMET also requires information on the local land-use and terrain. The result of a CALMET simulation is a year-long, three-dimensional output of meteorological conditions that can be used as input to the CALPUFF air dispersion model.

There are no known meteorological stations in the Roberts Road Quarry area that collect suitable surface or upper air data for CALMET. The closest station with suitable data is operated by the Bureau of Meteorology at Richmond, approximately 30 km to the southwest. The necessary surface and upper air data were therefore generated by TAPM, using influence from the surface observations at the Roberts Road Quarry meteorological station. Key setup details for TAPM are listed in **Table 7-1**.

Table 7-1 TAPM setup details

Parameter	Value(s)
Model version	4.0.5
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Number of grids point	35 x 35 x 25
Year(s) of analysis	2018, with one “spin-up” day.
Centre of analysis	Roberts Road Quarry (33°27.5’ S, 151°0’ E)
Terrain data source	Shuttle Research Topography Mission (SRTM), 30 m resolution
Land use data source	Default
Meteorological data assimilation	Roberts Road Quarry meteorological station. Radius of influence = 10 km. Number of vertical levels for assimilation = 4. Quality factor = 0.1. This quality factor value was adopted so that the observation data were considered in the meteorological assimilation in TAPM, with appropriate adjustments made for potential uncertainties around these data.

CALTAPM was used to process the outputs from TAPM into a suitable format for CALMET. Meteorological modelling in CALMET was completed in ‘no observations’ mode. This setting was applied rather than ‘observations’ mode using the surface observation data from the monitoring station at Roberts Road Quarry as there was some uncertainty of observations from the privately-operated station. This was primarily due to the frequency of calm conditions measured (refer to Table 5-1) being higher than might be expected for this location. This might suggest some localised screening around the station. The approach adopted allowed these data to be considered, with weighting also given to synoptic data from TAPM. **Table 7-2** lists the key settings that were applied in CALMET.

Table 7-2 CALMET setup details

Parameter	Value(s)
Model version	6.334
Run mode	No-observations mode
Terrain data source(s)	NASA SRTM1 30 metre resolution dataset
Land-use data source(s)	Digitized from aerial imagery and classified as ‘forest’, ‘water’, ‘barren’ or ‘agricultural’ categories specified in “CALPUFF Modeling System Version 6 User Instructions”, (TRC, 2011). This is displayed below in **Figure 7-1**.
Meteorological grid domain	10 kilometres x 10 kilometres x 0 to 3 kilometres depth spread over 11 vertical layers
Meteorological grid resolution	0.1 km
Meteorological grid dimensions	100 x 100 x 11
Meteorological grid origin	309000 mE, 6290500 mN. MGA Zone 56
Surface meteorological inputs	Wind speed, wind direction, ceiling height, cloud cover, temperature, relative humidity and air pressure for the site location from TAPM.
Upper air meteorological inputs	Wind speed, wind direction, ceiling height, cloud cover, temperature, relative humidity and air pressure for the site location from TAPM.
Simulation length	8760 hours (1 Jan 2018 to 31 Dec 2018)

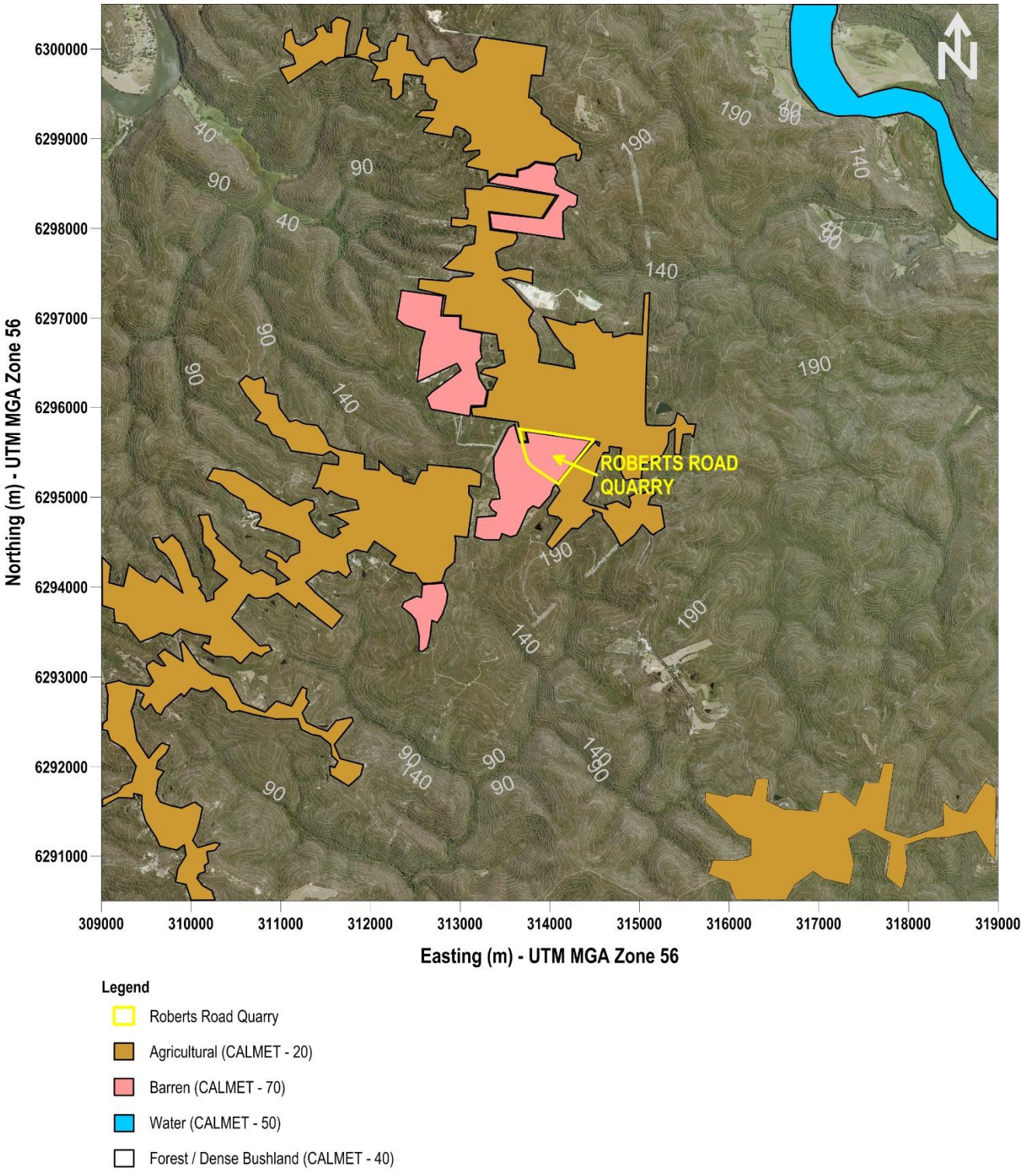


Figure 7-1 CALMET land use classifications

7.3 Dispersion modelling

Ground-level concentration and deposition levels due to the identified emission sources have been predicted using the air dispersion model known as CALPUFF (Version 6.42). CALPUFF is a Lagrangian dispersion model that simulates the dispersion of pollutants within a turbulent atmosphere by representing emissions as a series of puffs emitted sequentially. Provided the rate at which the puffs are emitted is sufficiently rapid, the puffs overlap, and the serial release is representative of a continuous release.

The CALPUFF model differs from traditional Gaussian plume models (such as AUSPLUME and ISCST3) in that it can model spatially varying wind and turbulence fields that are important in complex terrain, long-range transport and near calm conditions. It is the preferred model of the United States Environmental Protection Agency for the long-range transport of pollutants and for complex terrain (TRC, 2007). CALPUFF has the ability to model the effect of emissions entrained into the thermal internal boundary layer that forms over land, both through fumigation and plume trapping. CALPUFF is an air dispersion model which has been approved by the EPA for these types of assessments (EPA, 2016).

The modelling was performed using the emission estimates from **Section 6** and using the meteorological information provided by the CALMET model, described in **Section 7.2**. Predictions were made at 481 discrete receptors (including the 13 nearby sensitive receptors shown in **Figure 2-1**) to allow for contouring of results. The locations of the model receptors are shown in **Figure 7-2**.

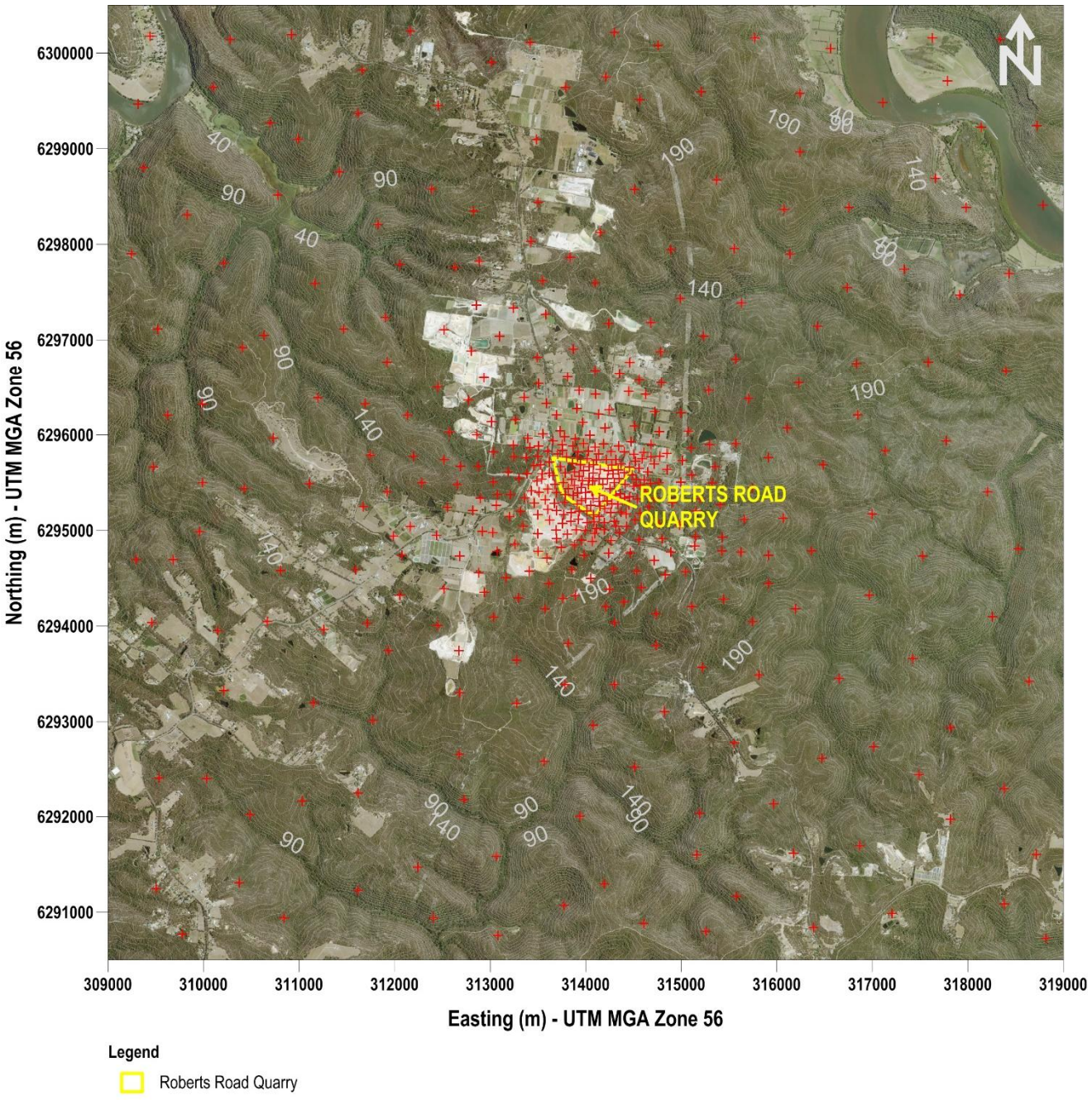


Figure 7-2 CALPUFF discrete receiver locations

Quarry operations were represented by a series of volume sources located according to the location of activities for each modelled scenario. TSP, PM_{10} and $PM_{2.5}$ emissions for existing operations listed in **Table 6-1**, **Table 6-2** and **Table 6-3** were applied as displayed **Figure 7-3**. For the proposed modification with VENM/ENM placement in the north of the Quarry, emissions outlined in these tables were modelled as shown in **Figure 7-4**. Finally, for the modification option where VENM/ENM filling would take place in the south of the site, the location where different dust generating sources were modelled is shown in **Figure 7-5**.

Dust emissions for all modelled Quarry-related sources have been considered to fit in one of three categories, as follows:

- Wind insensitive sources, where emissions are relatively insensitive to wind speed (for example, dozers).
- Wind sensitive sources, where emissions vary with the hourly wind speed, raised to the power of 1.3, a generic relationship published by the US EPA (1987). This relationship has been applied to sources such as loading and unloading of materials to/from trucks and results in increased emissions with increased wind speed.
- Wind sensitive sources, where emissions also vary with the hourly wind speed, but raised to the power of 3, a generic relationship published by Skidmore (1998). This relationship has been applied to sources including wind erosion from stockpiles, exposed areas or active pits, and results in increased emissions with increased wind speed.

Emissions from each volume source were developed on an hourly time step, taking into account the level of activity at that location and, in some cases, the hourly wind speed. This approach ensured that light winds corresponded with lower dust generation and higher winds, with higher dust generation.

All site activities have been modelled for the hours of day proposed under the proposed modification, for every day of the year. Further, the model considers these activities occurring at all locations displayed in **Figure 7-3**, **Figure 7-4** and **Figure 7-5** which is not likely to be the case for extraction, loading and VENM/ENM placement activities. Also, the model assumes the maximum rate of activity which in practice is not expected to be achieved. These assumptions were necessary to ensure that all source and meteorological interactions are considered although these aspects of the model result in predictions were the quarries likely contribution to local air quality is over-estimated.

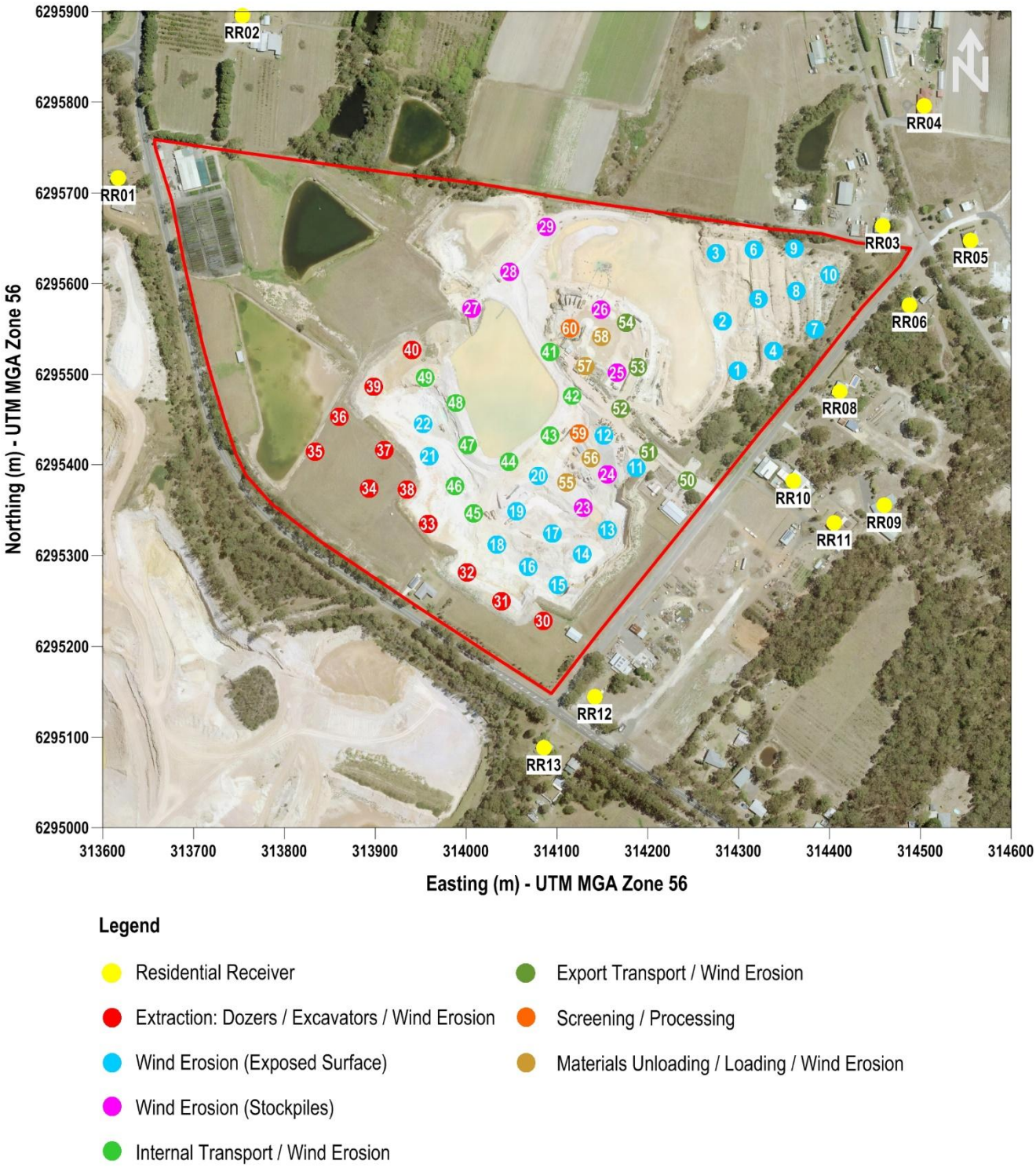


Figure 7-3 Location of modelled sources – Existing operations (no VENM/ENM placement)

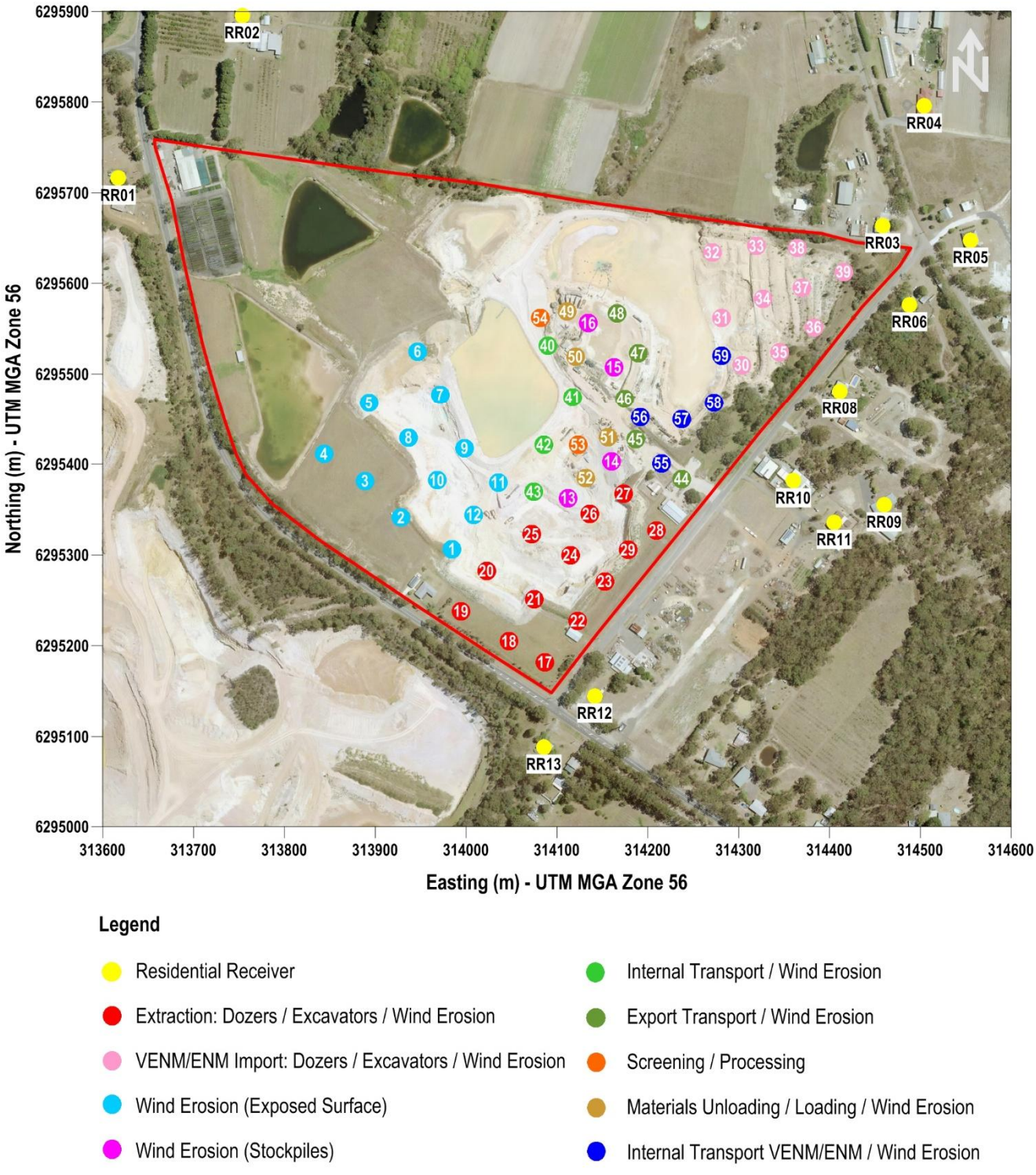


Figure 7-4 Location of modelled sources – Proposed operations, VENM/ENM placement at northeast of the Quarry

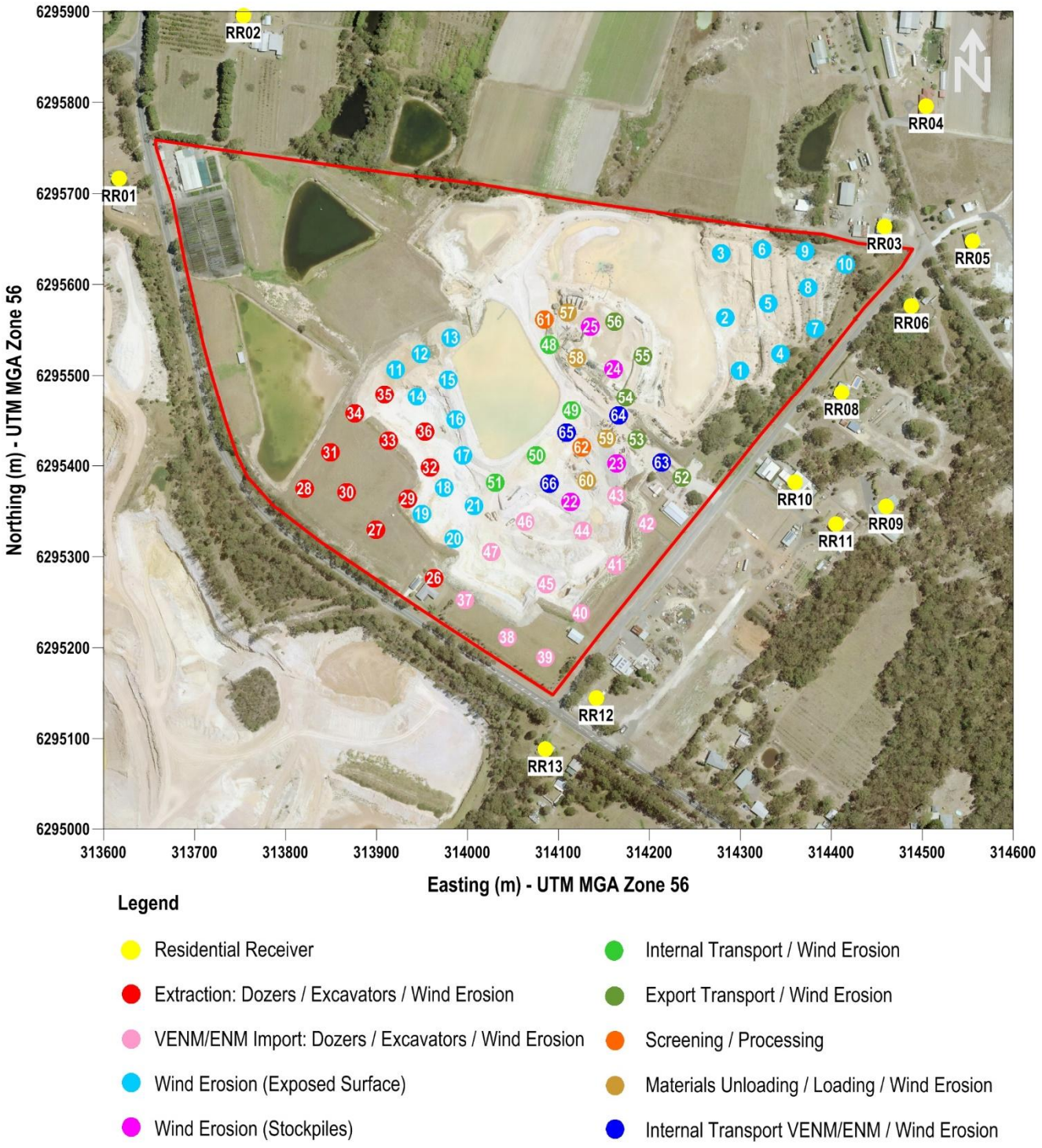


Figure 7-5 Location of modelled sources – Proposed operations, VENM/ENM placement at southeast of the Quarry

8. Assessment of impacts

This section provides an assessment of the key air quality issues associated with the proposed modification, primarily based on model predictions and comparisons to air quality criteria. One objective of this study was to predict the extent of air quality impacts due to the proposed modification, and to identify the potential changes in air quality over existing levels, recognising that the Quarry currently exists and that the proposed modification represents the continuation of quarrying activities up to the same maximum approved rate of extraction, albeit with an increase in activity arising from the importation of VENM/ENM products. For this objective, examination of the predicted incremental change from existing to proposed operations is useful. Therefore "Cumulative" has been defined as the "Project" (as modelled) minus "Existing" (as modelled) plus "Background". This approach also addressed potential cumulative impacts with neighbouring quarries as the contributions from these quarries will be contained in the assumed background levels.

Results are presented and discussed by pollutant in the sub-sections below.

8.1 Total suspended particulates (TSP)

Table 8-1 shows the predicted annually averaged TSP concentrations at the nearest sensitive receiver locations (refer to **Figure 2-1**), in tabular form. Compliance with the EPA's assessment criterion for annual average TSP (90 µg/m^3) is predicted at all locations.

Table 8-1 Predicted annual average TSP concentrations (µg/m^3)

ID	Due to Quarry			Background	Cumulative		Criteria
	Existing	Proposed Modification (North)	Proposed Modification (South)		Proposed Modification (North)	Proposed Modification (South)	
1	3	3	4	32	32	33	90
2	2	3	3	32	33	33	90
3	10	19	10	32	41	32	90
4	4	7	5	32	35	33	90
5	5	9	5	32	36	32	90
6	9	17	9	32	40	32	90
7	3	6	4	32	35	33	90
8	16	27	15	32	43	31	90
9	7	11	8	32	36	33	90
10	13	24	18	32	43	37	90
11	8	14	11	32	38	35	90
12	14	22	22	32	40	40	90
13	9	14	15	32	37	38	90

Changes in TSP concentrations as a result of the proposal operations are displayed as contour plots in **Appendix B**.

8.2 Particulate matter (PM_{10})

Table 8-2 shows the predicted annually averaged PM_{10} concentrations at the nearest sensitive receiver locations (refer to **Figure 2-1**), in tabular form. Compliance with the EPA's assessment criterion for annual average PM_{10} (25 µg/m^3) was predicted at all locations.

Table 8-2 Predicted annual average PM_{10} concentrations (µg/m^3)

ID	Due to Quarry			Background	Cumulative		Criteria
	Existing	Proposed Modification (North)	Proposed Modification (South)		Proposed Modification (North)	Proposed Modification (South)	
1	3	3	3	17	17	18	25
2	3	3	3	17	17	17	25
3	9	13	9	17	20	17	25
4	5	7	5	17	18	17	25
5	6	8	6	17	19	17	25
6	9	12	8	17	20	17	25
7	4	6	5	17	18	17	25
8	12	16	12	17	21	16	25
9	7	9	7	17	19	18	25
10	10	15	13	17	22	19	25
11	8	11	9	17	20	19	25
12	10	14	14	17	21	21	25
13	7	9	10	17	19	20	25

Changes in annually averaged PM_{10} concentrations as a result of the modification are also displayed as contour plots in **Appendix B**.

Regarding 24-hour averaged PM_{10}, the 2018 (year of assessment) background air quality data from Dixon Sand's TEOM presented above in **Section 5.2.2** shows how daily background PM_{10} concentrations already exceeded the EPA's 50 µg/m^3 assessment criteria on up to six days per year. For these types of situations where background concentrations are already elevated, the Approved Methods requires the determination of whether "additional exceedances of the impact assessment criteria will occur as a result of the proposed activity". This analysis was performed at the four nearest receivers in different directions from the site (RR01, RR03, RR08 and RR12). Gaps in Dixon Sand's 2018 daily PM_{10} 2018 dataset (June 2018 and 19 to 22 December 2018) with filled using data collected from the HVAS at Roberts Road Quarry, with averaged values applied for days were no data were available, noting the 6-day sampling frequency of the HVAS. **Figure 8-1** and **Figure 8-2** display the results of this review for the proposed modification with VENM/ENM filling at the north and south of the site respectively.

As **Figure 8-1** shows, with VENM/ENM importation taking place at the northeast corner of the site no additional exceedances were predicted to occur at RR01. One additional exceedance per year was predicted at RR03 and RR08. Four additional days where concentrations exceeded 50 µg/m^3 in the year were predicted at RR12.

For the alternative option involving VENM/ENM importation occurring in the southeast corner, **Figure 8-2** shows how no additional instances of daily PM_{10} concentrations above 50 µg/m^3 were predicted at RR01, RR03 and RR08. One additional exceedance per year was predicted at RR12. On this day it is noted that the background concentration was 47 µg/m^3 and contributions from the site were 5 µg/m^3.

These results are discussed further, below in **Section 8.5**.

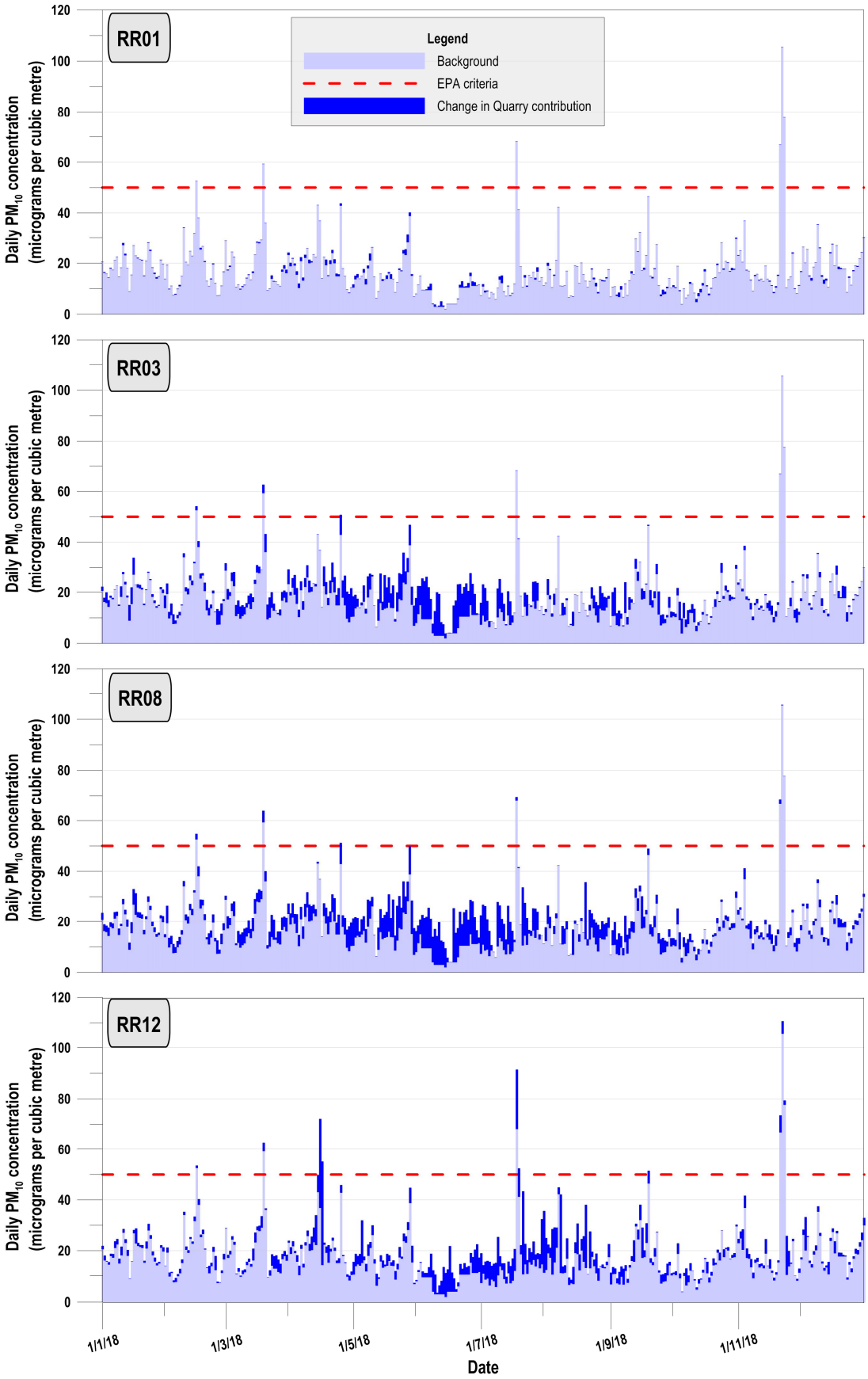


Figure 8-1 Change in 24-hour averaged PM_{10} at RR01, RR03, RR08 and RR12 – Proposed modification (north)

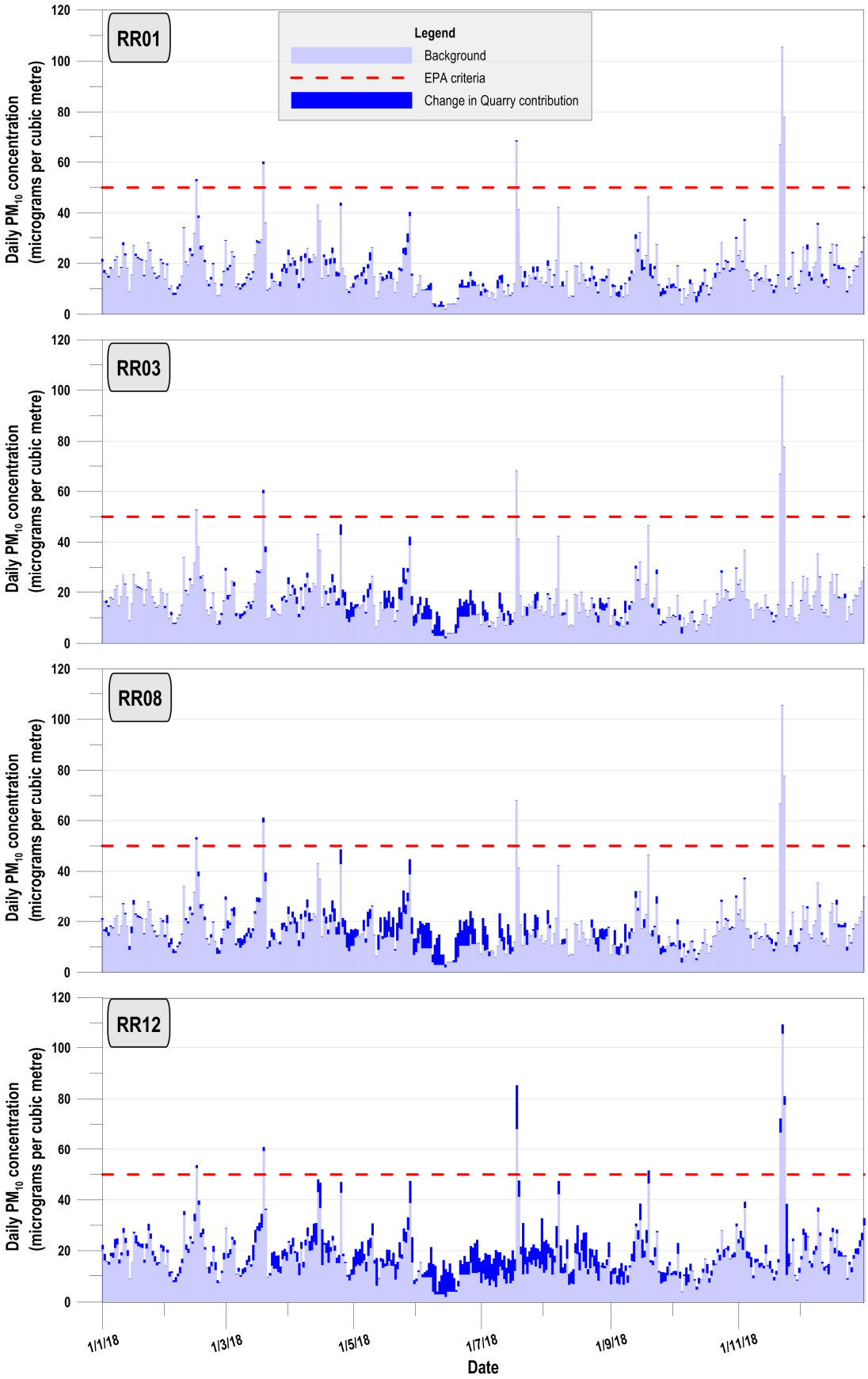


Figure 8-2 Change in 24-hour averaged PM_{10} at RR01, RR03, RR08 and RR12 – Proposed modification (South)

8.3 Particulate matter ($PM_{2.5}$)

Table 8-3 lists the predicted annually averaged $PM_{2.5}$ concentrations at the nearby sensitive receiver locations displayed in **Figure 2-1**. As shown, annually the averaged $PM_{2.5}$ background concentration in 2018 (13.5 µg/m^3 inferred from PM_{10} measurements at Dixon Sand's TEOM and the relationship between PM_{10} and $PM_{2.5}$ at the HVAS located at Roberts Road Quarry)) already exceeded the 8 µg/m^3 assessment criteria in the Approved Methods. Increases of up to 0.5 µg/m^3 (i.e. around 4 percent) and 0.4 µg/m^3 (i.e. approximately 3 percent) were predicted for the proposed modification with VENM/ENM filling in the north and south of the site respectively. It can also be seen from **Table 8-3** that the contribution of the existing Quarry to $PM_{2.5}$ concentrations is less than 1 µg/m^3 at all nearest receivers. This means that the existing (and proposed) Quarry operation is not likely to be the cause of background annual average $PM_{2.5}$ concentrations which exceed the 8 µg/m^3 criterion. The assumed background level of 13.5 µg/m^3 is taken to be conservatively high.

Table 8-3 Predicted annual average $PM_{2.5}$ concentrations (µg/m^3)

ID	Due to Quarry			Background	Cumulative		Criteria
	Existing	Proposed Modification (North)	Proposed Modification (South)		Proposed Modification (North)	Proposed Modification (South)	
1	0.2	0.3	0.3	13.5	13.6	13.6	8
2	0.2	0.3	0.3	13.5	13.6	13.6	8
3	0.6	1.0	0.8	13.5	13.9	13.6	8
4	0.4	0.6	0.5	13.5	13.7	13.6	8
5	0.4	0.7	0.5	13.5	13.8	13.6	8
6	0.6	1.0	0.7	13.5	13.9	13.6	8
7	0.3	0.5	0.4	13.5	13.7	13.6	8
8	0.8	1.3	1.0	13.5	14.0	13.7	8
9	0.5	0.7	0.7	13.5	13.8	13.7	8
10	0.7	1.2	1.1	13.5	14.0	13.9	8
11	0.5	0.9	0.8	13.5	13.8	13.8	8
12	0.7	1.0	1.1	13.5	13.9	13.9	8
13	0.5	0.7	0.8	13.5	13.7	13.8	8

As for PM_{10}, daily background $PM_{2.5}$ concentrations in 2018 were also measured to occasionally exceed the 25 µg/m^3 impact assessment criteria. The same assessment approach was applied, with the average ratio of PM_{10} to $PM_{2.5}$ measured at the Roberts Road HVAS used to scale the daily PM_{10} to estimate daily $PM_{2.5}$ at Dixon Sand's TEOM. Since $PM_{2.5}$ data from the HVAS were only available to April 2018, the June and December 2018 gaps in the Dixon Sand TEOM dataset were filled using the annually averaged $PM_{2.5}$ concentration (13 µg/m^3). **Figure 8-3** and **Figure 8-4** display the results of this review for the proposed modification with VENM/ENM filling at the north and south of the site respectively.

As **Figure 8-3** displays, with VENM/ENM importation taking place at the northeast corner of the site no additional exceedances were predicted to occur at RR01, RR03, RR08 and RR12. For the alternative option involving VENM/ENM importation occurring in the southeast corner, **Figure 8-4** shows how no additional instances of daily $PM_{2.5}$ concentrations above 25 µg/m^3 were predicted at RR01, RR03, RR08 and RR12.

These results are discussed further, below in **Section 8.5**.

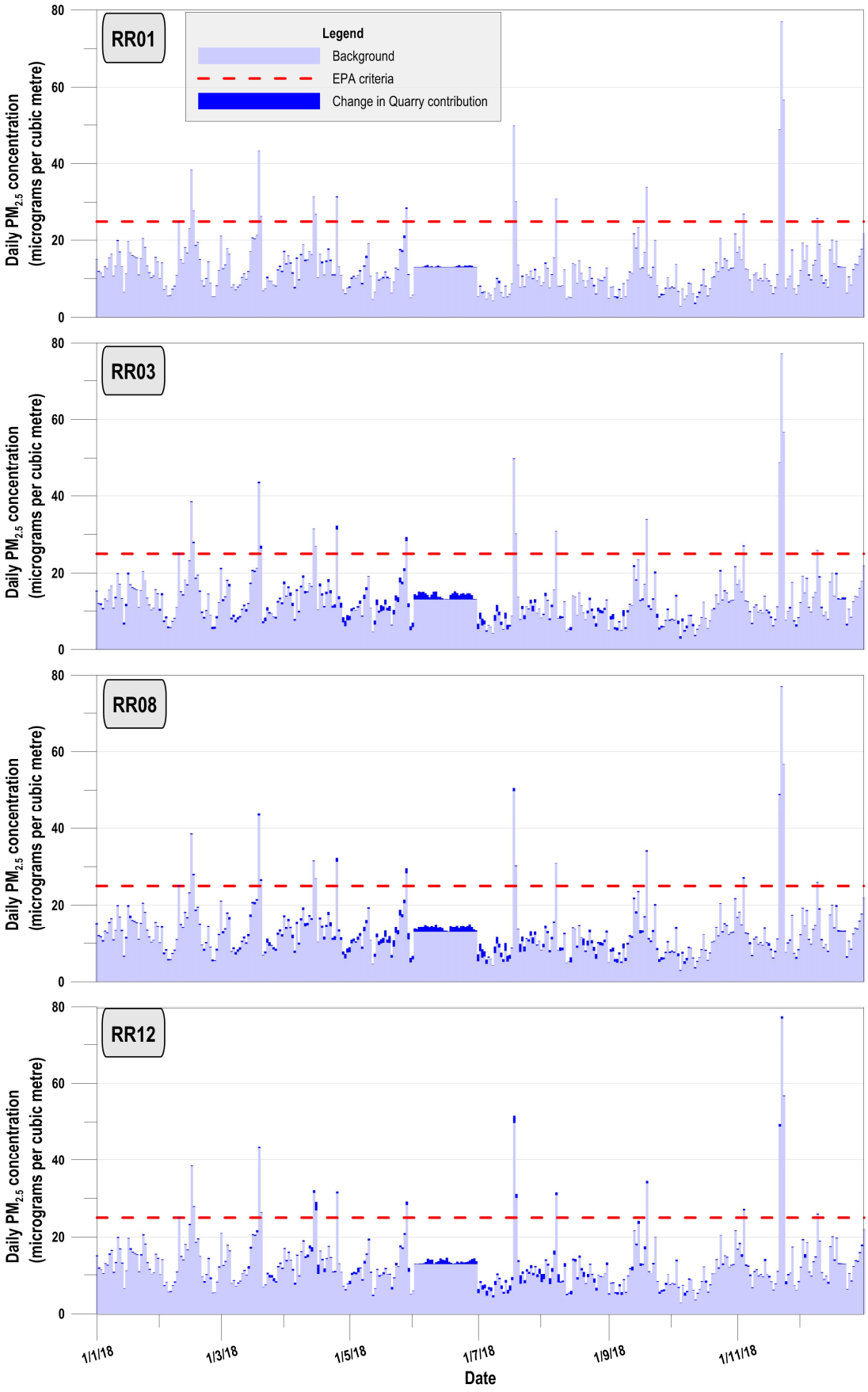


Figure 8-3 Change in 24-hour averaged $PM_{2.5}$ at RR01, RR03, RR08 and RR12 – Proposed modification (north)

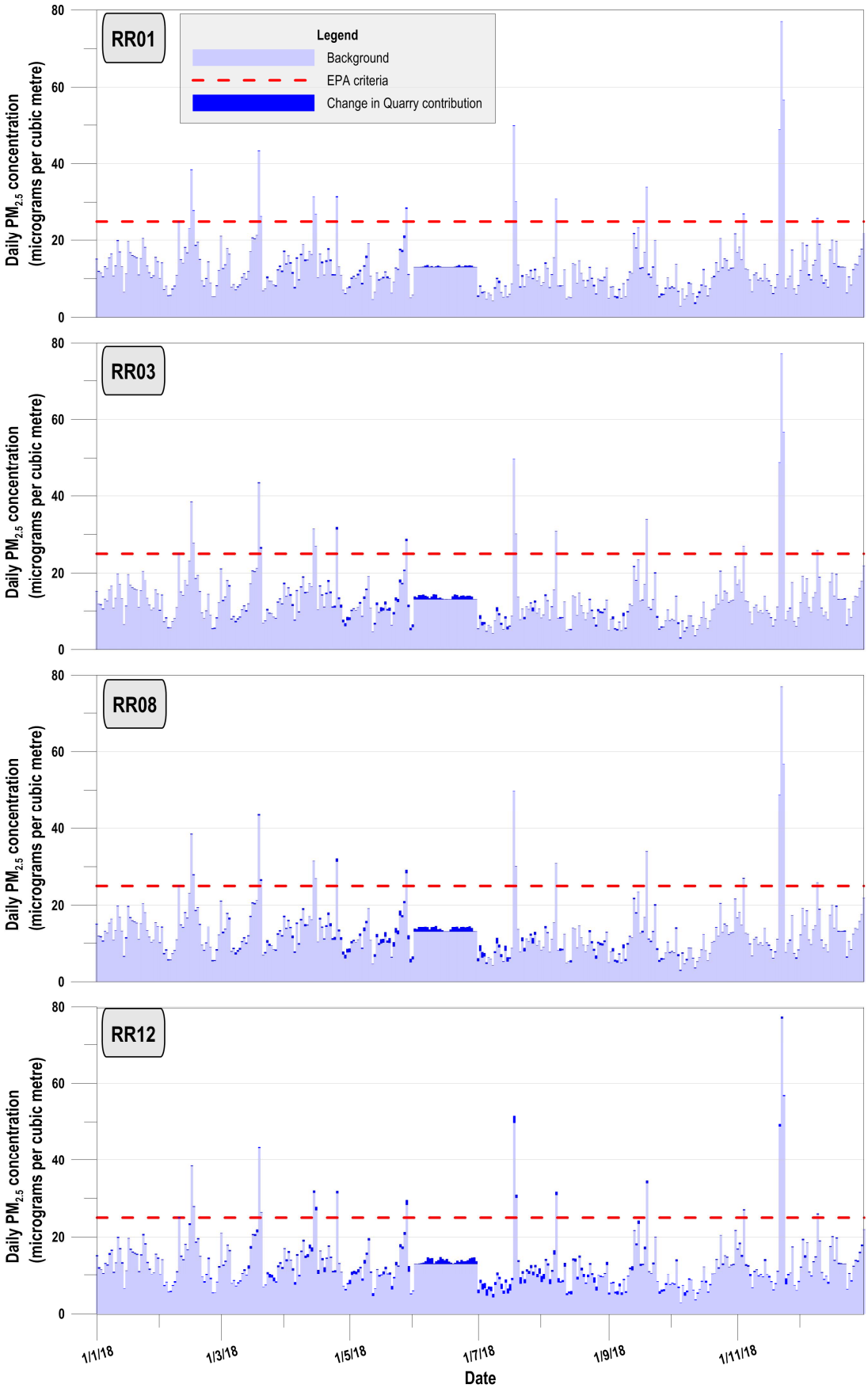


Figure 8-4 Change in 24-hour averaged $PM_{2.5}$ at RR01, RR03, RR08 and RR12 – Proposed modification (south)

8.4 Deposited dust

Table 8-4 shows the predicted deposited dust levels at the nearest sensitive receiver locations (refer to **Figure 2-1**), in tabular form. Compliance with the EPA's assessment criterion for annual average criterion of 4 g/m^2/month was predicted at all locations.

Table 8-4 Predicted dust deposition (g/m^2/month)

ID	Due to Quarry			Background	Cumulative		Criteria
	Existing	Proposed Modification (North)	Proposed Modification (South)		Proposed Modification (North)	Proposed Modification (South)	
1	0.3	0.3	0.3	1.9	1.9	2.0	4
2	0.2	0.2	0.3	1.9	1.9	2.0	4
3	0.8	1.5	0.8	1.9	2.6	1.9	4
4	0.4	0.6	0.4	1.9	2.1	1.9	4
5	0.4	0.7	0.4	1.9	2.2	1.9	4
6	0.8	1.4	0.8	1.9	2.5	1.9	4
7	0.3	0.5	0.3	1.9	2.1	1.9	4
8	1.3	2.2	1.2	1.9	2.7	1.8	4
9	0.6	1.0	0.7	1.9	2.2	2.0	4
10	1.1	2.0	1.5	1.9	2.8	2.3	4
11	0.7	1.2	1.0	1.9	2.4	2.1	4
12	1.2	1.8	1.8	1.9	2.5	2.5	4
13	0.8	1.1	1.2	1.9	2.3	2.4	4

Changes in deposited dust due resulting from the modification are also displayed as contour plots in **Appendix B**.

8.5 Summary and interpretation

8.5.1 Summary

In summary, the following changes in local air quality as a result of the proposed modification were predicted:

- TSP, annually averaged PM_{10}, and deposited dust: Changes would not result in exceedance of the EPA's relevant impact assessment criteria at any of the nearest sensitive receivers.
- Daily PM_{10}: The potential for additional exceedances at the most-affected sensitive receivers under both scenarios modelled.
- Annually averaged $PM_{2.5}$: Background concentrations already exceed the EPA's 8 µg/m^3 criterion, with increases of 0.5 µg/m^3 (i.e. around 4 percent) and 0.4 µg/m^3 (i.e. approximately 3 percent) predicted at the most-affected sensitive receivers for VENM/ENM filling in the north and south of the site respectively.
- Daily $PM_{2.5}$: No additional exceedances at the most-affected sensitive receivers for VENM/ENM filling in the north or south of the site.

8.5.2 Interpretation

Changes in the frequency of 24-hour averaged PM_{10} concentrations exceeding 50 µg/m^3 at the nearest, most-affected sensitive receivers around the Quarry was the only potential air quality risk identified for the proposed modification. The following factors should be considered in the interpretation of this result:

- **Conservatism of modelling:** As discussed above in **Section 7.3**, the site activities were modelled for the hours of day proposed under the proposed modification, for every day of the year. In reality the Quarry will not operate for every day of the year. Further, the model considers these activities occurring at all locations

displayed in **Figure 7-3**, **Figure 7-4** and **Figure 7-5** which is not likely to be the case for extraction, loading and VENM/ENM placement activities. Also, the model assumes the maximum rate of activity which in practice is not expected to be achieved. These assumptions were necessary to ensure that all source and meteorological interactions are considered. However, these assumptions of the model result in predictions where the contribution of the Quarry to local air quality is over-estimated.

- **Complaints:** No dust-related complaints have been received from the nearest sensitive receivers around the site (Umwelt, 2019). This suggests that dust from existing operations are not presently an issue for surrounding nearby residents.
- **Meteorological sensitivity review:** Sensitivity runs were performed noting that the reliability value was scaled back for the on-site meteorological station that was assimilated into TAPM. Consistent with the previous air quality impact assessment completed at the site (Wilkinson Murray, 2015), predictions were also reviewed without the influence of measurements from the on-site meteorological station in TAPM. Regarding 24-hour averaged PM_{10}, the number of additional exceedances decreased compared with the results presented in **Section 8**, although there was still one additional exceedance predicted for the option of VENM/ENM filling in the south. As the sensitivity review confirmed the potential for additional daily averaged PM_{10} exceedances at the nearest receivers as a result of the proposed modification, the potential for such exceedances would need to be managed by Hodgson Quarries.
- **Review of exceedances:** As discussed in **Section 8.2**, the following additional daily averaged PM_{10} exceedances were predicted:
  - VENM/ENM importation taking place at the northeast corner of the site: No additional exceedances were predicted at RR01; one additional exceedance at RR03 and RR08; and four additional exceedances at RR12.
  - VENM/ENM importation taking place at the southeast corner of the site: No additional exceedances at RR01, RR03 and RR08; with one additional exceedance predicted at RR12.

  Each exceedance was reviewed to confirm the relative contributions of background concentrations and contributions from the site:

  - VENM/ENM importation taking place at the northeast corner of the site:
    - RR03: Background was 43 $\mu g/m^3$, site additional contribution 8 $\mu g/m^3$ (16% of total).
    - RR08: Background was 43 $\mu g/m^3$, site additional contribution 8 $\mu g/m^3$ (16% of total).
    - RR12: Background was 37 $\mu g/m^3$, 14 $\mu g/m^3$, 41 $\mu g/m^3$ and 47 $\mu g/m^3$, and site additional contributions were 35 $\mu g/m^3$ (49% of total), 41 $\mu g/m^3$ (75% of total), 11 $\mu g/m^3$ (21% of total) and 5 $\mu g/m^3$ (10% of total) respectively.
  - VENM/ENM importation taking place at the southeast corner of the site:
    - RR12: Background was 47 $\mu g/m^3$, site additional contribution 5 $\mu g/m^3$ (10% of total).

In most cases, these additional exceedances were primarily the result of elevated background concentrations. There was once instance for the scenario involving VENM/ENM importation taking place at the northeast corner at RR12 were background concentrations were low (14 $\mu g/m^3$), and the primary contributor to the exceedance was Quarry operations. It should be noted that for this scenario, VENM/ENM importation and placement activities were taking place away from RR12 and that the activity most proximal was existing extraction operations.

These results suggest the need for additional measures to 1) minimise site contributions during days of elevated background PM_{10} concentrations, and 2) review the conditions when extractive and emplacement activities take place towards the perimeter of the site. Safeguards to address these two requirements are recommended in **Section 9** below.

9. Safeguards and monitoring

As outlined above in **Section 6**, several operational control measures are already implemented at the Quarry including watering at extraction areas, haulage routes, during stockpiling and of inactive areas. This assessment has considered the application of these measures to VENM/ENM importation and placement activities. This will involve:

- Watering of unsealed roads used for importation of VENM/ENM;
- Water sprays during unloading of VENM/ENM; and
- Watering during placement of VENM/ENM.

To address the potential for additional daily averaged PM_{10} exceedances at nearby residential receivers, there is a need for mechanisms to identify conditions that could lead to these instances. As identified above, exceedances would be more likely when background concentrations are elevated (that is, around 40 µg/m^3 or more). Regional PM_{10} concentrations are highest during hot, dry and windy conditions. To proactively identify and appropriately plan for these conditions before they occur, local meteorological forecasts should be reviewed each day. Where unfavourable meteorological conditions are forecast, the intensity (including number of trucks), types and location of activities and the controls to be implemented should be reviewed and adjusted.

A second trigger involving visual inspections should also be implemented. This would involve routine inspections to review whether the planned intensity, types, location and level of activities and the levels of controls in place remain adequate, or whether operations need to be scaled back or temporarily suspended. Metrics for making this determination would include whether:

- Dust is emanating from Quarry operations;
- The efficacy of control measures is observable as being impaired; and
- Meteorological conditions have changed so that wind is blowing dust in the direction from the site to the nearest surrounding receivers.

To improve the level of understanding of meteorological conditions at the Quarry, the location of the on-site meteorological station should be reviewed against the siting requirements detailed in Section 2.6.1 of Australian/New Zealand Standard AS/NZS 3580.14:2014 Methods for sampling and analysis of ambient air - Part 14: Meteorological monitoring for ambient air quality monitoring applications. $PM_{2.5}$ measurement at the on-site HVAS should also be reviewed, noting the potential issues outlined above in **Section 5.2.3**.

In respect of the VLAMP, the conservative, potential predictions of the assessment indicate that the provisions of this guideline could apply. To ascertain whether operations present an actual rather than potential risk, future monitoring should be considered as appropriate, in consultation with the EPA.

10. Conclusion

This report has assessed the potential for adverse changes in local air quality from a proposed modification to operations at Roberts Road Quarry. The proposed modification would involve the importation and placement of VENM/ENM at the Quarry, an increase in the number of daily truck movements and removal of a restrictive condition associated with the area of 'active and exposed' areas at the Quarry.

The primary air quality issue associated with the proposed modification was identified to be dust (that is, particulate matter in the form of TSP, deposited dust, PM_{10} or $PM_{2.5}$) from existing Quarrying and planned VENM/ENM importation activities.

Statutes, policies and guidelines were reviewed to identify a suitable approach and criteria for assessing potential impacts from the modification. From the EPA's Approved Methods and consistent with the EPA's specific assessment requirements for the proposal it was confirmed that impacts were to be assessed quantitatively, and suitable criteria were established.

The assessment required an understanding of key features of the existing environment including the presence and location of sensitive receivers; local meteorological conditions; and existing background pollutant concentrations. Nearby sensitive receivers around the site were identified by reviewing aerial imagery.

Consistent with EPA guidance, the last 5 calendar years of meteorological data collected at the Roberts Road Quarry automatic weather station were reviewed to identify a representative year for the purpose of the assessment. Based on this review, 2018 was confirmed as a suitable year for the purpose of the assessment. For 2018, as for the other years reviewed, winds were measured predominantly blowing from the southeast annually, with winds from the north-northwest also common.

The EPA's impact assessment criteria are based on the total concentration of these pollutants, that is the existing background concentrations as well as any changes as a result of the modification. Data collected from the on-site dust deposition gauges and a High-Volume Air Sampler at the Quarry were reviewed, as well as data from a nearby TEOM operated by Dixon Sands at the Maroota Public School to establish background conditions around the Quarry.

The computer-based dispersion model known as CALPUFF was used to predict the potential air quality impacts of the existing and proposed modified Quarry operations. The dispersion modelling accounted for meteorological conditions, land use and terrain information and used dust emission estimates to predict the off-site air quality impacts. The focus of the assessment was on the potential change in air quality, noting that the Quarry already contributes to existing air quality.

The main conclusions of the assessment for each key pollutant and assessable averaging time were:

- Annually averaged TSP, annually averaged PM_{10}, and deposited dust: The proposed modification would not result in exceedances of the EPA's relevant impact assessment criteria at any of the nearest sensitive receivers.
- 24-hour averaged PM_{10}: The proposed modification has a potential to result in additional exceedances at the most-affected sensitive receivers.
- Annually averaged $PM_{2.5}$: Background concentrations already exceed the EPA's 8 $\mu g/m^3$ criterion, however data from the nearest OEH station indicates that the monitored levels may be unexplainably higher than what could be expected. Still, the proposed modification was predicted to increase annual average $PM_{2.5}$ concentrations by 0.5 $\mu g/m^3$ (i.e. around 4 percent) and 0.4 $\mu g/m^3$ (i.e. approximately 3 percent) at the most-affected sensitive receivers for VENM/ENM filling in the north and south of the Quarry respectively.
- 24-hour averaged $PM_{2.5}$: The proposed modification would not lead to any additional exceedances at the most-affected sensitive receivers for VENM/ENM filling in the north or south of the Quarry.

The key matter identified was the potential for additional days exceeding the EPA's 50 $\mu g/m^3$ daily PM_{10} criteria at the nearest sensitive receivers. Further reviews of the circumstances leading to these additional

exceedances were completed which identified that most occurred on days where daily PM_{10} concentrations were already elevated. Safeguard measures to proactively identify meteorological conditions that could lead to elevated background PM_{10} concentrations so that they could be planned for and effectively managed were recommended. Further visual verifications were recommended should conditions arise during operations, such that the level of activity, location and controls would need to be reviewed. Review of the siting of the on-site meteorological station and $PM_{2.5}$ monitoring at the HVAS was also recommended, to improve the usefulness of data collected.

Regarding the VLAMP, the conservative, potential predictions of the assessment indicate that the provisions of this guideline could apply. To ascertain whether operations present an actual rather than potential risk, it was recommended that future monitoring be considered with the EPA.

11. References

EPA (2016) “Approved Methods for the Modelling and Assessment of Air Pollutants in NSW”.

DoE (2016) *National Environment Protection (Ambient Air Quality) Measure – as amended*, Federal Register of Legislative Instruments F2016C00215, Department of the Environment, Canberra.

National Pollutant Inventory (2012) “Emission Estimation Technique Manual for Mining”. Version 3.1, January 2012.

NEPC (1998) “Ambient Air – National Environment Protection Measure for Ambient Air Quality”, National Environment Protection Council, Canberra.

NERDDC (1988) “Air Pollution from Surface Coal Mining: Measurement, Modelling and Community Perception”, Project No. 921, National Energy Research Development and Demonstration Council, Canberra.

NHMRC (1996) “Ambient Air Quality Goals Recommended by the National Health and Medical Research Council, National Health and Medical Research Council”, Canberra.

Skidmore, E.L. (1998) “Wind Erosion Processes”. USDA-ARS Wind Erosion Research Unit, Kansas State University. Wind Erosion in Africa and West Asia: Problems and Control Strategies. Proceedings of the expert group meeting 22-25 April 1997, Cairo, Egypt.

TRC (2007) CALPUFF model web-site (http://www.src.com/calpuff/regstat.htm).

TRC (2011) “Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the ‘Approved Methods for the Modelling and Assessments of Air Pollutants in NSW’”. Prepared for the Office of Environment and Heritage by TRC, March 2011.

Umwelt (2019) “Roberts Road Quarry Project Overview and Preliminary Environmental Assessment of Proposed Modification 4”

US EPA (1985 and updates) “Compilation of Air Pollutant Emission Factors”, AP-42, Fourth Edition United States Environmental Protection Agency, Office of Air and Radiation Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711. Now a web-based document.

US EPA (1987) Update of fugitive dust emission factors in AP-42 Section 11.2, EPA Contract No. 68-02-3891, Midwest Research Institute, Kansas City, MO, July 1987.

Appendix A. Emissions Calculations

Emission estimates, controls factors, emission factors and input variables

Emission calculations

Roberts Road Quarry Existing

	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables				
Activity	TSP	PM10	PM2.5	Control (%)	Intensity	Units	Factor	Units	Factor	Units	Factor	Units	(ws/2.2)^1.3	Moisture (%)	t/truck	km/trip	Silt (%)
Dozers ripping materials	2775	417	21	50	2288	h/y	2.42589	kg/h/v	0.3644	kg/h/v	0.01822	kg/h/v		2	-	-	2
Excavators loading raw product to trucks	274	130	14	0	480000	t/y	0.00057	kg/t	0.00027	kg/t	0.000	kg/t	0.48	2	-	-	-
Hauling raw product to Screening 1	3183	681	34	50	4364	VKT/y	1.45876	kg/VKT	0.31207	kg/VKT	0.016	kg/VKT	-	-	55	0.5	2
Unloading raw product to Screens 1	864	310	43	70	240000	t/y	0.01200	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-
Screening 1	3000	1032	150	0	240000	t/y	0.0125	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-
Loading product stockpiles	15	7	1	50	240000	t/y	0.00012	kg/t	5.8E-05	kg/t	0.000	kg/t	0.48	6	-	-	-
Excavators loading screened product to trucks	137	65	7	0	240000	t/y	0.00057	kg/t	0.00027	kg/t	0.000	kg/t	0.48	2	-	-	-
Hauling raw product to Screening 2	1910	409	20	50	2618	VKT/y	1.45876	kg/VKT	0.31207	kg/VKT	0.016	kg/VKT	-	-	55	0.3	2
Unloading raw product to Screens 2	864	310	43	70	240000	t/y	0.01200	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-
Screening 2	3000	1032	150	0	240000	t/y	0.0125	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-
Loading product stockpiles	29	14	1	50	480000	t/y	0.00012	kg/t	5.8E-05	kg/t	0.000	kg/t	0.48	6	-	-	-
Excavators loading screened product to trucks	274	130	14	0	480000	t/y	0.00057	kg/t	0.00027	kg/t	0.000	kg/t	0.48	2	-	-	-
Hauling product off-site	1715	367	18	75	5000	VKT/y	1.37208	kg/VKT	0.29353	kg/VKT	0.015	kg/VKT	-	-	48	0.5	2
Wind erosion from exposed areas, inactive	5396	2698	135	30	2.2	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	87.6	kg/ha/y	-	-	-	-	-
Wind erosion from exposed areas, active	4906	2453	123	50	2.8	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	87.6	kg/ha/y	-	-	-	-	-
Wind erosion from rehabilitation area, inactive	4415	2208	110	30	1.8	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	87.6	kg/ha/y	-	-	-	-	-
Wind erosion from product stockpiles	3854	1927	96	0	1.1	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	87.6	kg/ha/y	-	-	-	-	-
kg/yr	**36612**	**13770**	**960**														

Emission calculations

Roberts Road Quarry Proposed, VENM/ENM filling North

	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables				
Activity	TSP	PM10	PM2.5	Control (%)	Intensity	Units	Factor	Units	Factor	Units	Factor	Units	(ws/2.2)^1.3	Moisture (%)	t/truck	km/trip	Silt (%)
Dozers ripping materials	2775	417	21	50	2288	h/y	2.42589	kg/h/v	0.3644	kg/h/v	0.01822	kg/h/v		2	-	-	2
Excavators loading raw product to trucks	274	130	14	0	480000	t/y	0.00057	kg/t	0.00027	kg/t	0.000	kg/t	0.48	2	-	-	-
Hauling raw product to Screening 1	1591	340	17	50	2182	VKT/y	1.45876	kg/VKT	0.31207	kg/VKT	0.016	kg/VKT	-	-	55	0.25	2
Unloading raw product to Screens 1	864	310	43	70	240000	t/y	0.01200	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-
Screening 1	7200	2400	360	0	240000	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-
Loading product stockpiles	69	32	3	50	240000	t/y	0.00057	kg/t	0.00027	kg/t	0.000	kg/t	0.48	2	-	-	-
Excavators loading screened product to trucks	137	65	7	0	240000	t/y	0.00057	kg/t	0.00027	kg/t	0.000	kg/t	0.48	2	-	-	-
Hauling raw product to Screening 2	1910	409	20	50	2618	VKT/y	1.45876	kg/VKT	0.31207	kg/VKT	0.016	kg/VKT	-	-	55	0.3	2
Unloading raw product to Screens 2	864	310	43	70	240000	t/y	0.01200	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-
Screening 2	7200	2400	360	0	240000	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-
Loading product stockpiles	137	65	7	50	480000	t/y	0.00057	kg/t	0.00027	kg/t	0.000	kg/t	0.48	2	-	-	-
Excavators loading screened product to trucks	274	130	14	0	480000	t/y	0.00057	kg/t	0.00027	kg/t	0.000	kg/t	0.48	2	-	-	-
Hauling product off-site	1715	367	18	75	5000	VKT/y	1.37208	kg/VKT	0.29353	kg/VKT	0.015	kg/VKT	-	-	48	0.5	2
Wind erosion from exposed areas, inactive	5396	2698	135	30	2.2	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	87.6	kg/ha/y	-	-	-	-	-
Wind erosion from exposed areas, active	4906	2453	123	50	2.8	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	87.6	kg/ha/y	-	-	-	-	-
Wind erosion from rehabilitation area (VENM/ENM), active	3154	1577	79	50	1.8	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	87.6	kg/ha/y	-	-	-	-	-
Wind erosion from product stockpiles	3854	1927	96	0	1.1	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	87.6	kg/ha/y	-	-	-	-	-
Hauling ENM/VENM to site	3809	815	41	50	6400	VKT/y	1.19029	kg/VKT	0.25463	kg/VKT	0.013	kg/VKT	-	-	35	0.7	2
Unloading ENM/VENM	1152	413	58	70	320000	t/y	0.01200	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-
Dozers placing materials	2775	417	21	50	2288	h/y	2.42589	kg/h/v	0.3644	kg/h/v	0.01822	kg/h/v		2	-	-	2
kg/yr	**47282**	**17256**	**1459**														

Emission calculations

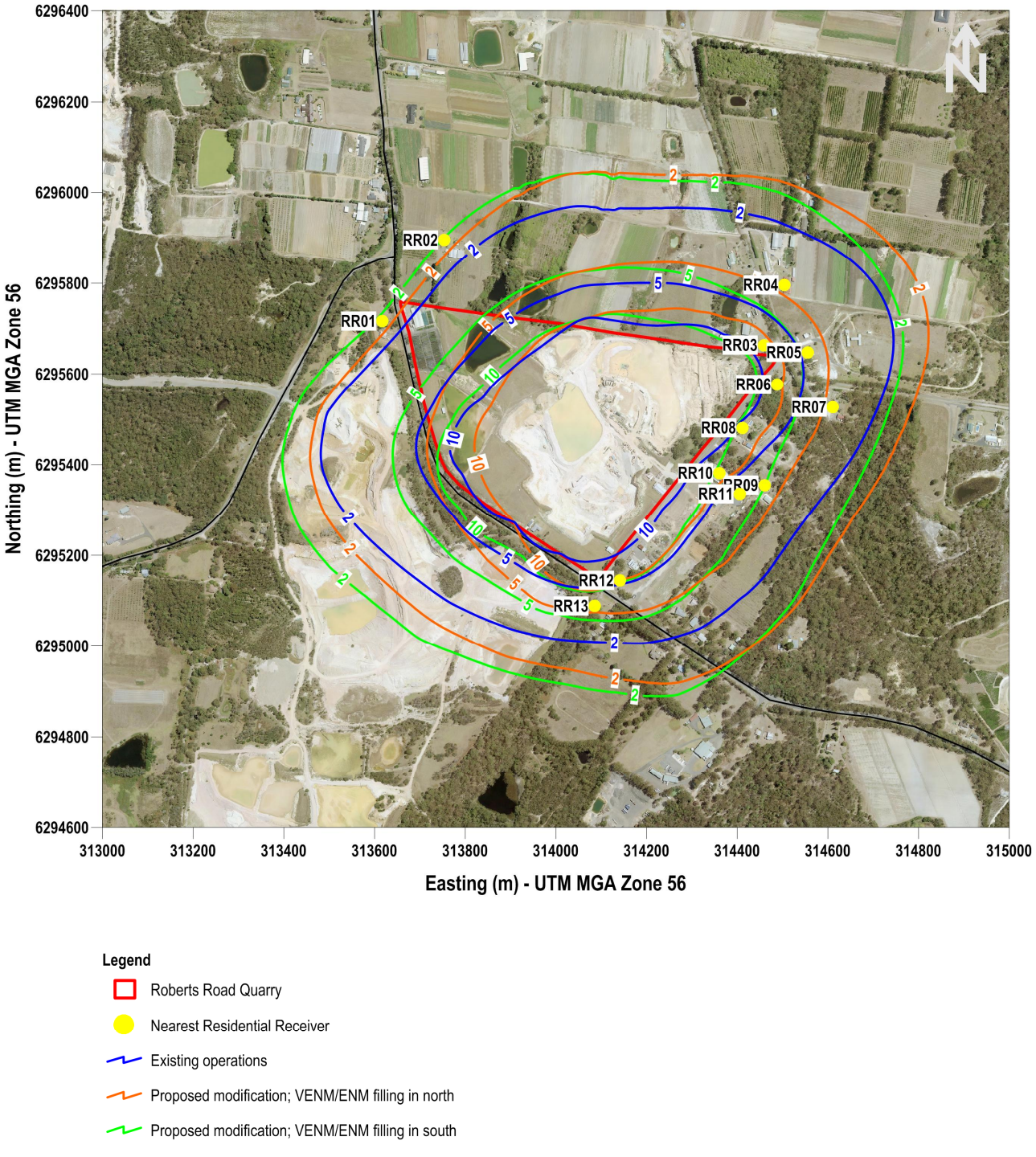
Roberts Road Quarry, Proposed South

	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables				
Activity	TSP	PM10	PM2.5	Control (%)	Intensity	Units	Factor	Units	Factor	Units	Factor	Units	(ws/2.2)^1.3	Moisture (%)	t/truck	km/trip	Silt (%)
Dozers ripping materials	2775	417	21	50	2288	h/y	2.42589	kg/h/v	0.3644	kg/h/v	0.01822	kg/h/v		2	-	-	2
Excavators loading raw product to trucks	274	130	14	0	480000	t/y	0.00057	kg/t	0.00027	kg/t	0.000	kg/t	0.48	2	-	-	-
Hauling raw product to Screening 1	1591	340	17	50	2182	VKT/y	1.45876	kg/VKT	0.31207	kg/VKT	0.016	kg/VKT	-	-	55	0.25	2
Unloading raw product to Screens 1	864	310	43	70	240000	t/y	0.01200	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-
Screening 1	7200	2400	360	0	240000	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-
Loading product stockpiles	69	32	3	50	240000	t/y	0.00057	kg/t	0.00027	kg/t	0.000	kg/t	0.48	2	-	-	-
Excavators loading screened product to trucks	137	65	7	0	240000	t/y	0.00057	kg/t	0.00027	kg/t	0.000	kg/t	0.48	2	-	-	-
Hauling raw product to Screening 2	1910	409	20	50	2618	VKT/y	1.45876	kg/VKT	0.31207	kg/VKT	0.016	kg/VKT	-	-	55	0.3	2
Unloading raw product to Screens 2	864	310	43	70	240000	t/y	0.01200	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-
Screening 2	7200	2400	360	0	240000	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-
Loading product stockpiles	137	65	7	50	480000	t/y	0.00057	kg/t	0.00027	kg/t	0.000	kg/t	0.48	2	-	-	-
Excavators loading screened product to trucks	274	130	14	0	480000	t/y	0.00057	kg/t	0.00027	kg/t	0.000	kg/t	0.48	2	-	-	-
Hauling product off-site	1715	367	18	75	5000	VKT/y	1.37208	kg/VKT	0.29353	kg/VKT	0.015	kg/VKT	-	-	48	0.5	2
Wind erosion from exposed areas, inactive	5396	2698	135	30	2.2	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	87.6	kg/ha/y	-	-	-	-	-
Wind erosion from exposed areas, active	4906	2453	123	50	2.8	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	87.6	kg/ha/y	-	-	-	-	-
Wind erosion from VENM/ENM area, active	3154	1577	79	50	1.8	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	87.6	kg/ha/y	-	-	-	-	-
Wind erosion from product stockpiles	3854	1927	96	0	1.1	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	87.6	kg/ha/y	-	-	-	-	-
Hauling ENM/VENM to site	4353	931	47	50	7314	VKT/y	1.19029	kg/VKT	0.25463	kg/VKT	0.013	kg/VKT	-	-	35	0.8	2
Unloading ENM/VENM	1152	413	58	70	320000	t/y	0.01200	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-
Dozers placing materials	2775	417	21	50	2288	h/y	2.42589	kg/h/v	0.3644	kg/h/v	0.01822	kg/h/v		2	-	-	2
kg/yr	**47826**	**17373**	**1465**														

Appendix B. Contour plots

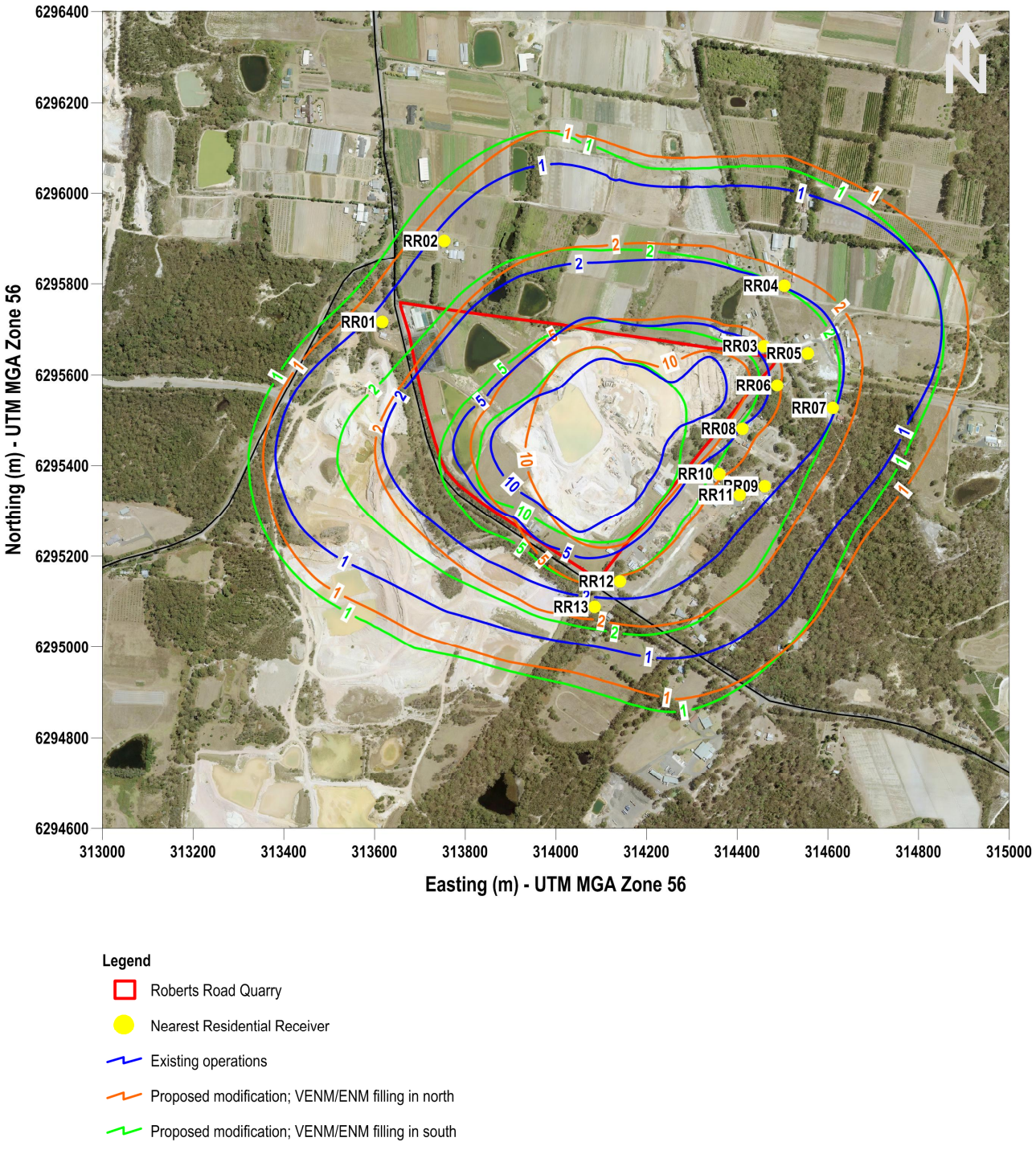
B.1 Total suspended particulates (TSP)

Annually averaged TSP, µg/m^3, site contribution only

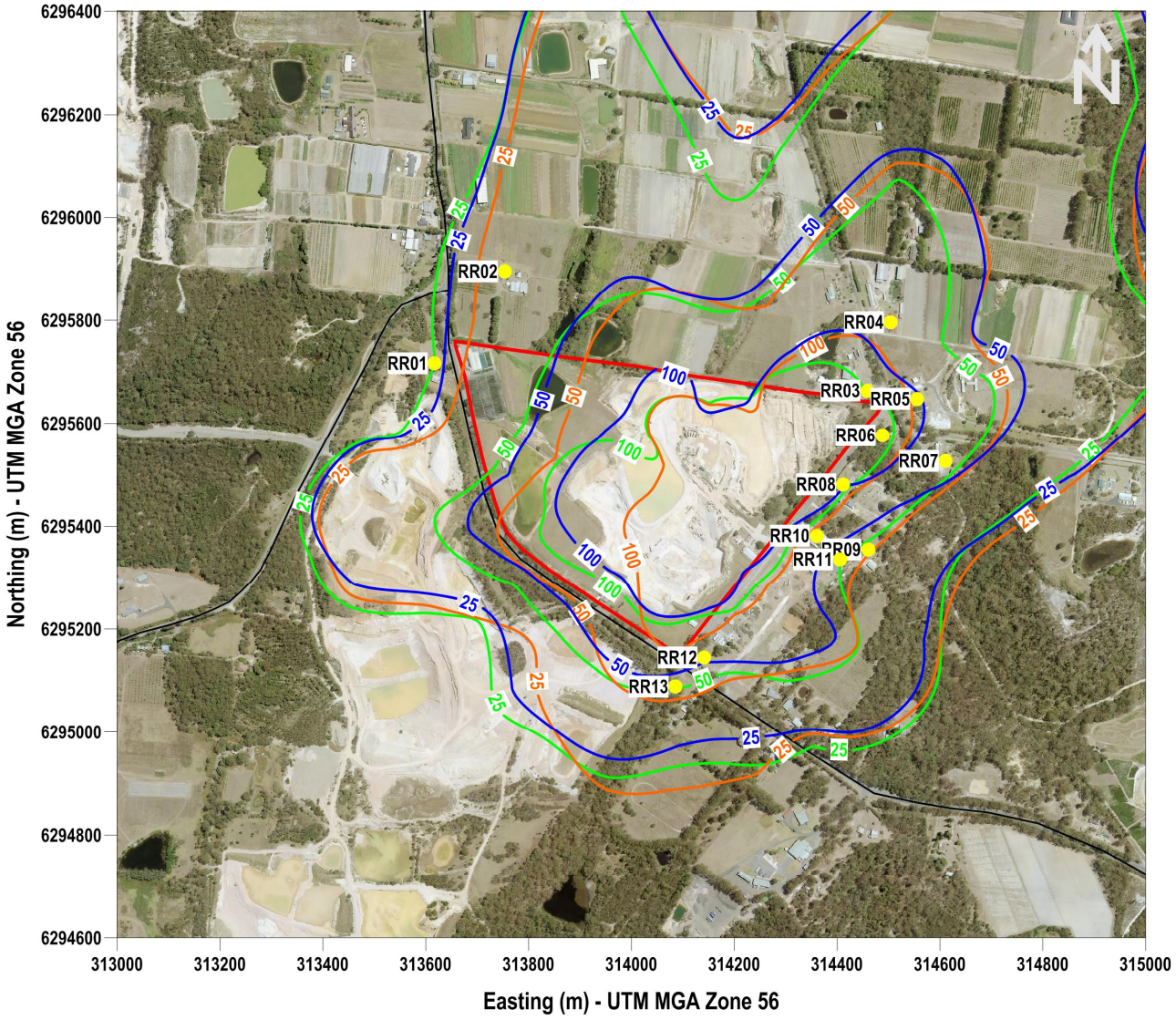


B.2 Particulate matter (PM_{10})

Annually averaged PM_{10}, µg/m^3, site contribution only

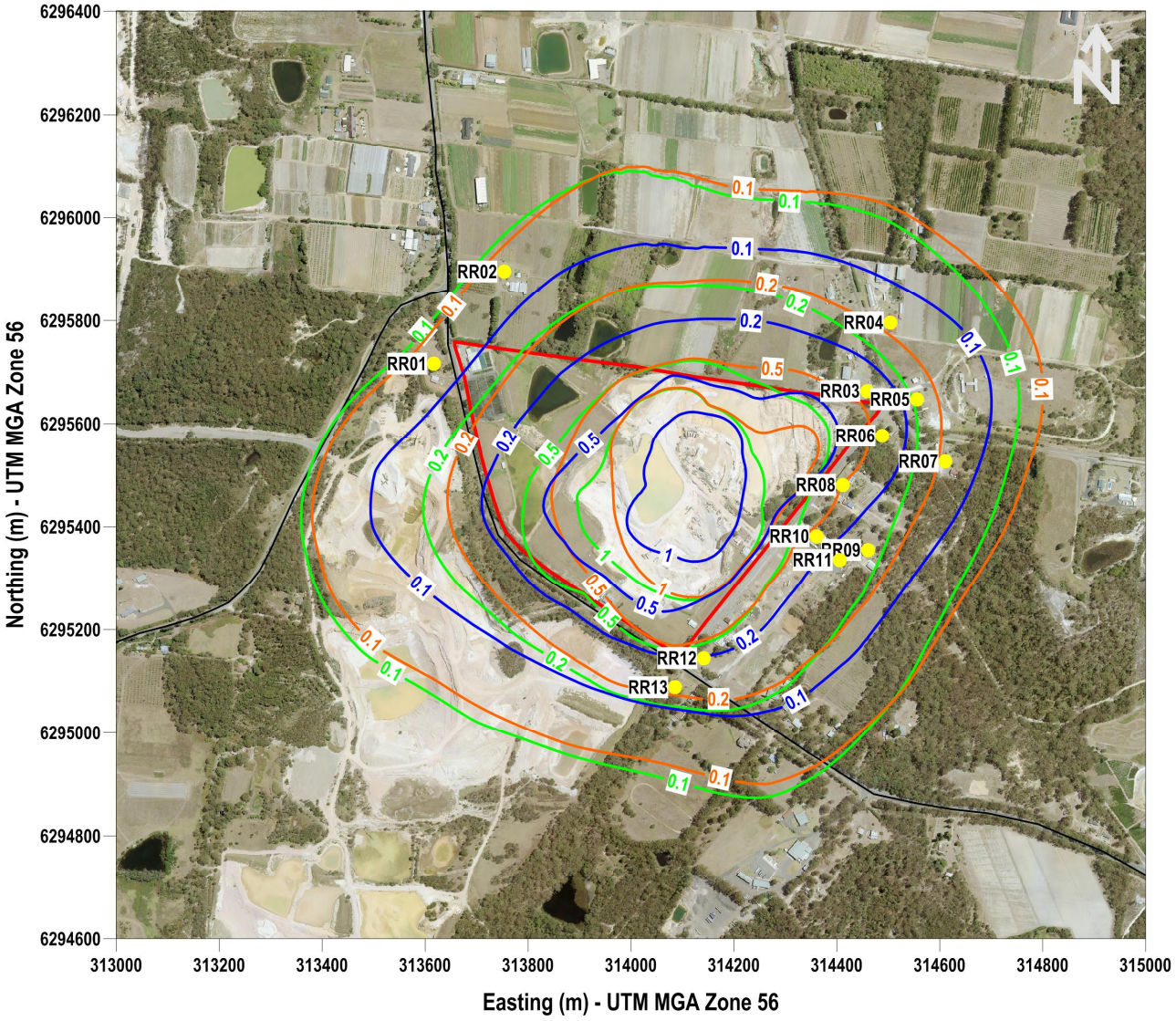


Maximum 24-hour averaged PM_{10}, $\mu g/m^3$, site contribution only

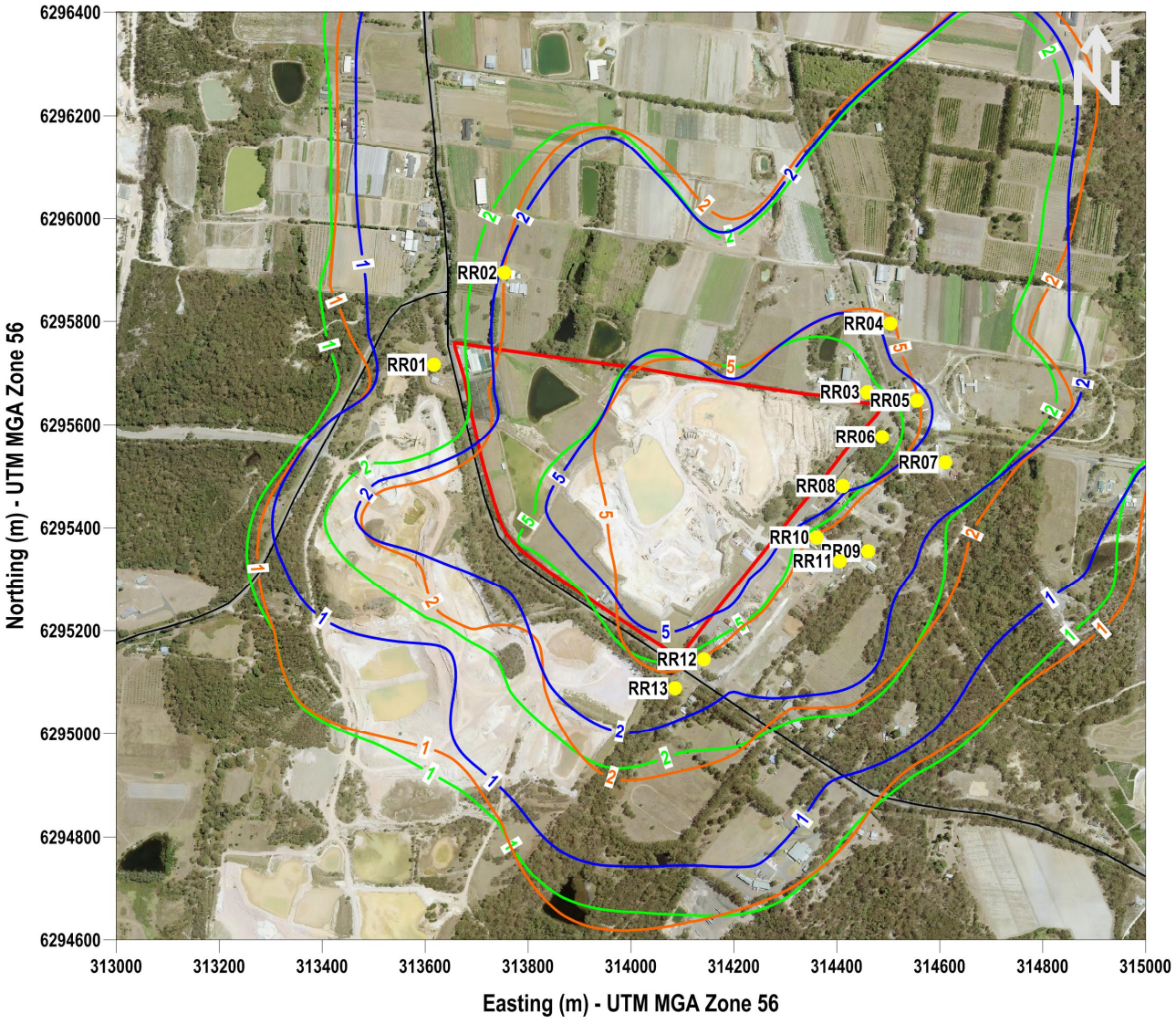


B.3 Particulate matter ($PM_{2.5}$)

Annually averaged $PM_{2.5}$, $\mu g/m^3$, site contribution only



Maximum 24-hour averaged $PM_{2.5}$, $\mu g/m^3$, site contribution only

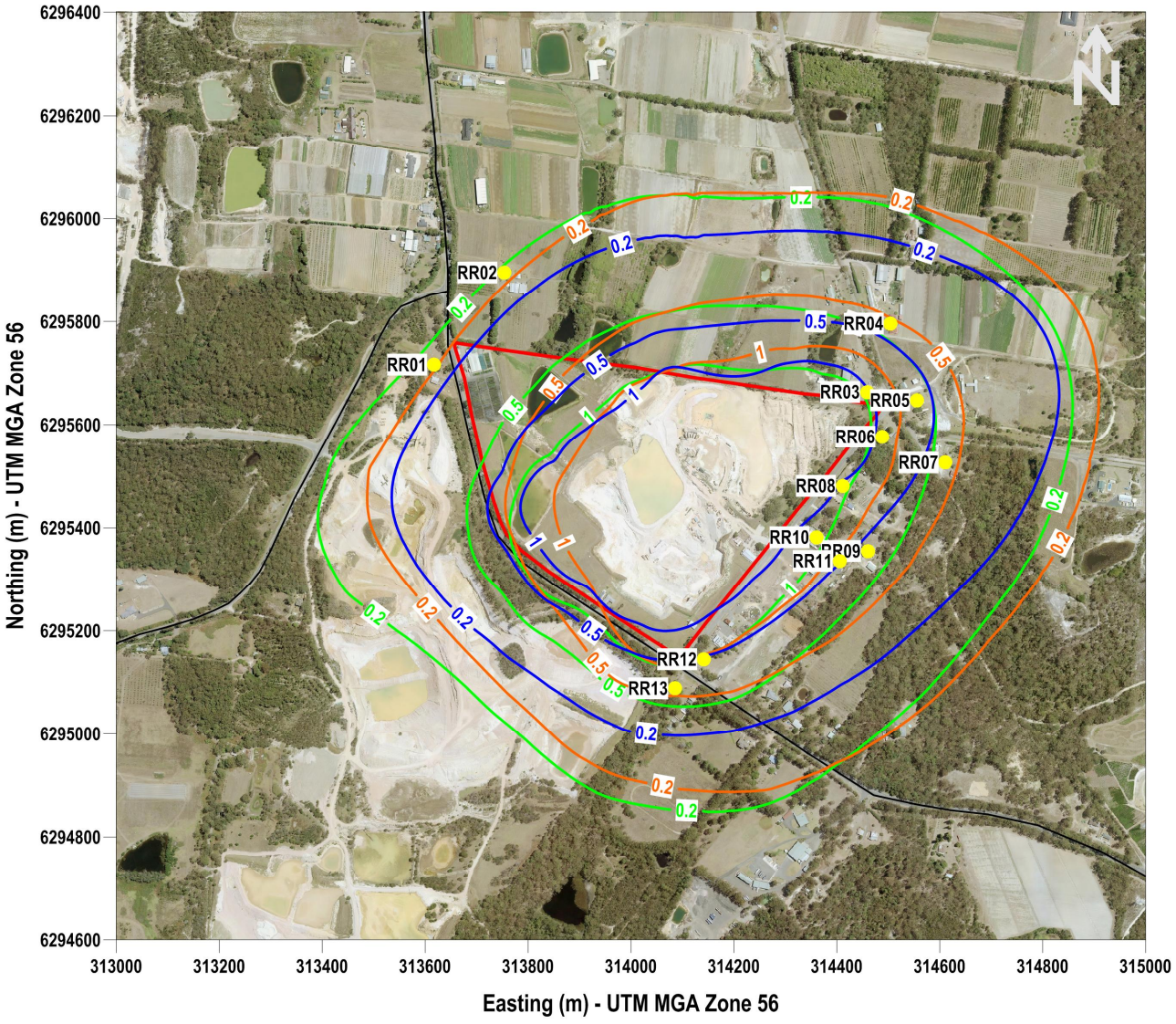


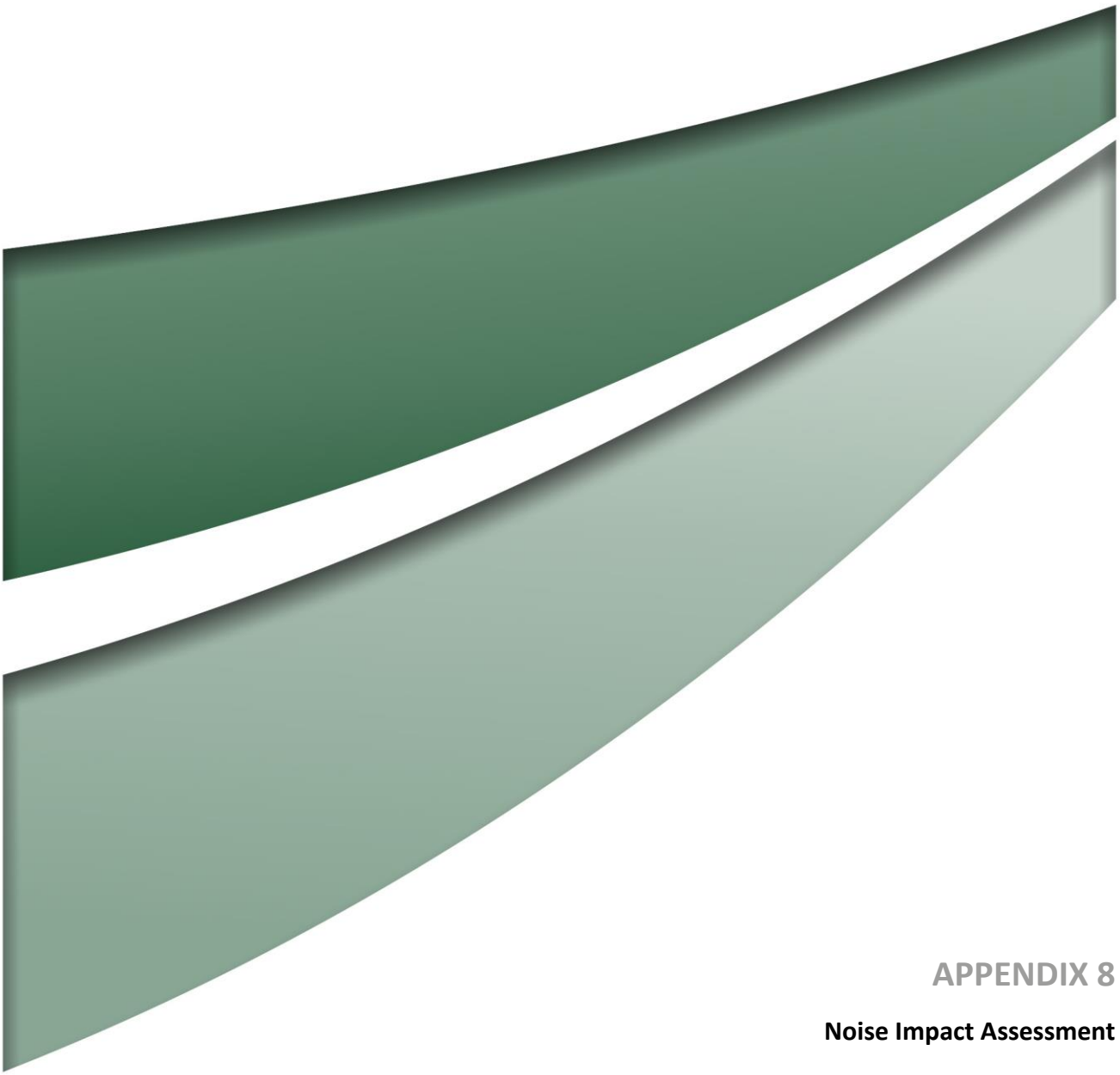
Legend

- Roberts Road Quarry
- Nearest Residential Receiver
- Existing operations
- Proposed modification; VENM/ENM filling in north
- Proposed modification; VENM/ENM filling in south

B.4 Deposited dust

Annually averaged maximum deposited dust (g/m^2/month), site contribution only





APPENDIX 8

Noise Impact Assessment